Reuse And Salvage Guidelines
Reuse and Salvage for 3176, 3300, 3400 & C-Series Engine Cylinder Blocks {0670, 0672, 0761, 1201, 7225}
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Caterpillar: Confidential Yellow

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Reuse and Salvage for 3176, 3300, 3400 & C-Series Engine Cylinder Blocks {0670, 0672, 0761, 1201, 7225}

SMCS - 0670; 0672; 0761; 1201; 7225

Caterpillar Products
- **All 3100 Engines**
- **All 3300 Engines**
- **All 3400 Engines**
- **All C10 Engines**
- **All C11 Engines**
- **All C12 Engines**
- **All C13 Engines**
- **All C15 Engines**
- **All C16 Engines**
- **All C18 Engines**
- **All C27 Engines**
- **All C32 Engines**
- **All C7 Engines**
- **All C9 Engines**
- **All C9.3 Engines**

Engine D-Series
- **D-Series**

Introduction

Table 1

Revision	Summary of Changes in SEBF9008
36	Added sleeve installation.
35	Added new serial number prefixes for New Product Introduction (NPI).
34	Combined information from SEBF2120, SEBF2121, SEBF2122, SEBF2158, SEBF8069, SEBF8076, SEBF8196, SEBF8198, SEBF8282, SEBF8291, SEBF8330, SEBF8387, SEBF8875, SEBF9007, SEBF9071, SEBF9126, SEBF9132, SEBF9213, SEBF9389, SEBF9390, added part numbers and repaired 76 pixelated illustrations.

Information contained in this document is considered Caterpillar: Confidential Yellow.

This Reuse and Salvage Guideline contains the necessary information to allow a dealer to establish a parts reusability program. Reuse and salvage information enables Caterpillar dealers and customers to benefit from cost reductions. Every effort has been made to provide the most current information that is known to Caterpillar. Continuing improvement and advancement of product design might have caused changes to your product which are

not included in this publication. This Reuse and Salvage Guideline must be used with the latest technical information that is available from Caterpillar.

For technical questions when using this document, work with your Dealer Technical Communicator (TC).

To report suspected errors, inaccuracies, or suggestions regarding the document, submit a form for feedback in the Service Information System (SIS Web) interface.

Canceled Part Numbers and Replaced Part Numbers

This document may not include canceled part numbers and replaced part numbers. Use NPR on SIS for information about canceled part numbers and replaced part numbers. NPR will provide the current part numbers for replaced parts.

Important Safety Information

Illustration 1 g02139237

Work safely. Most accidents that involve product operation, maintenance, and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills, and tools to perform these functions properly. Safety precautions and warnings are provided in this instruction and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons. Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. Therefore, the warnings in this publication and the warnings that are on the product are not all inclusive. If a tool, a procedure, a work method, or operating technique that is not recommended by Caterpillar is used, ensure that it is safe for you and for other people to use. Ensure that the product will not be damaged or the product will not be made unsafe by the operation, lubrication, maintenance, or the repair procedures that are used.

WARNING

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the safety alert symbol which is followed by a signal word such as danger, warning, or caution. The "WARNING" safety alert symbol is shown below.

Illustration 2 g00008666

This safety alert symbol means:

Pay attention!

Become alert!

Your safety is involved.

The message that appears under the safety alert symbol explains the hazard.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The safety information in this document and the safety information on the machine are not all inclusive. Determine that the tools, procedures, work methods, and operating techniques are safe. Determine that the operation, lubrication, maintenance, and repair procedures will not damage the machine. Also, you must determine that the operation, lubrication, maintenance, and repair procedures will not make the machine unsafe.

The information, the specifications, and the illustrations that exist in this guideline are based on information which was available at the time of publication. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete, most current information before you start any job. Caterpillar dealers can supply the most current information.

Summary

This guideline describes the procedures to recondition the cylinder block for the 3176, 3300, 3400 & C-Series engines. The following procedures are part of reconditioning the cylinder block.

- Inserts for the coolant passage
- Inserts on the top deck
- Machining of the top deck
- Sleeve for the lower cylinder bore
- Center-mounted seats for the liner
- Bearing bores
- Measurements of the cylinder bore
- Inspection of the crosshatch

These procedures might not be necessary when the block is reconditioned. The block should be inspected to determine the procedures that are necessary.

Service Letters and Technical Information Bulletins

NOTICE

The most recent Service Letters and Technical Information Bulletins that are related to this component shall be reviewed before beginning work. Often Service Letters and Technical Information Bulletins contain upgrades in repair procedures, parts, and safety information that pertain to the parts or components being repaired.

References

Table 2

References	
Media Number	**Title**
GMG00981	Special Instruction, "Using 1P3537 Dial Bore Group to Check Cylinder Bore Size"
M0080689	Reuse And Salvage Guidelines, "Cylinder Block Cleaning and Audit Procedure"

NEHS0612	Tool Operating Manual, " **9U-7990** Counter Bore Tool Group for 3176, 3300 and 3400 Series Engines"
NEHS0733	Tool Operating Manual, "159-9404 Counterbore Tool Group for C-10 through C-13"
NEHS1102	Tool Operating Manual, "362-4250 Deck Height Measuring Tool"
SEBF8068	Reuse and Salvage Guidelines, "Inspection and Reuse Guideline of Cylinder Liners inch Cat Engines"
SEBF8148	Reuse and Salvage Guidelines, "General Salvage and Reconditioning Techniques"
SEBF8187	"Standardized Parts Marking Procedures"
SEBF8198	Reuse and Salvage Guidelines, "Procedure to Install Inserts for the Top Deck on 3300, 3176, and D-series Engines"
SEBF8301	Reuse and Salvage Guidelines, "Inspection and Reuse of Critical Fasteners Used inch All Engines"
SEBF8357	Reuse and Salvage Guidelines, "General Cleaning Methods"
SEBF8882	Reuse and Salvage Guidelines, "Using Lock-N-Stitch Procedures for Casting Repair"
SEBF9238	Reuse and Salvage Guidelines, "Fundamentals of Arc Spray for Reconditioning Components"
SEBF9240	Reuse and Salvage Guidelines, "Fundamentals of Flame Spray for Reconditioning Components"
SEHS8187	Special Instruction, "Using the **6V-7840** Deck Checking Tool Assembly"
SEHS8869	Special Instruction, "Cylinder Block Salvage Procedure Using Belzona® 1311 Ceramic R Metal"
SEHS8869	Special Instruction, "Cylinder Block Salvage Procedure Using Belzona Ceramic R Metal"
SEHS8919	Special Instruction, "Salvage Procedure For Cast Iron Cylinder Blocks"
SEHS9031	Special Instruction, "Storage Procedures for Caterpillar Products"
SEPD0768	Service Magazine, "Damaged Lifter Bores in 3400 Engines Can be Used Again"
SMHS7049	Special Instruction, "Installation of **5P-6595** Insert for Cylinder Liner Seat"
SMHS7221	Special Instruction, "Installation Of 1W-6265, 1W-6266 And 1W-6267 Insert For Cylinder Liner Seat"
SMHS7585	Special Instruction, "Installation of 8N-6150 or **8N-6742** Insert"
SMHS7600	Special Instruction, "Installation of 8N-6938 or **8N-6939** Insert"
SMHS7606	Special Instruction, "Use of **1P-4000** Line Boring Tool Group"
SMHS7727	Special Instruction, "Use of the **8T-0455** Cylinder Liner Projection Indicator Group"
SMHS8222	Special Instruction, "Installation of **2W-3815** Seat Insert or **5N-0093** Seat Insert"
SMHS8839	Special Instruction, "Using 5P-4175 Boring Tool Group And 5P-1618 Tool Arrangement"
Reference Media URL	Caterpillar Channel 1 Video "Sealant Application to Spacer Plate Gasket" https://channel1.mediaspace.kaltura.com/playlist/dedicated/71706731/1_rcz3oenx/1_i9ktbgnj

Replacement Parts

Consult the applicable Parts Identification manual for your engine.

WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Tooling and Equipment

NOTICE

Failure to follow the recommended procedure or the specified tooling that is required for the procedure could result in damage to components.

To avoid component damage, follow the recommended procedure using the recommended tools.

Table 3

Required Tooling and Equipment	
Part Number	**Description**
1D-5119	Nut
1P-0510	Driver Group
1P-0520	Driver Group
1P-3535	Dial Bore Gauge
1P-3537	Dial Bore Gauge
1P-3565	Chamfering Tool
1P-4000	Line Boring Tool Group
1P-5571 1P-5572 1P-5573 1P-5580	Brush
1P-0820	Hydraulic Puller
1P-2329	Insert
1U-7429	Brush
1U-8168	10 mm Drill Bit
4B-9820	Wrench
4C-3725	Plastic Divided Utility Box
4C-4783	Plastic Divided Utility Box
4C-6715	RTV Silicone Sealant
4C-9507	Retaining Compound
5P-1618	Counterboring Tool Group
5P-4175	Counterboring Tool Group
6B-7225	Wrench

6V-1541	Quick Cure Primer
6V-2012	Depth Micrometer
6V-2183	Forcing Screw
6V-7840	Deck Checking Tool Assembly
7B-7640	Wrench
7M-7456	Retaining Compound
8S-2269	Ridge Reamer
8S-3140	Counterboring Tool Group
8T-2790	Inner Insert Installation Tool
8T-7765	Surface Reconditioning Pad
9A-1593	Surface Texture Comparison Gauge
9U-6615	Size Setting Fixture Group
9U-7990[1]	Counterboring Tool Group
9U-7993	Depth Gauge Assembly
9S-6072	Adjusting Crank
107-7604	Cylinder Sleeve
125-2064	Cylinder Head Stress Plate [2]
129-9196	Puller Plate
129-9197	Puller Plate
135-7631	12 mm Outer Insert
135-7636	12 mm Inner Insert
135-7637	Outer Insert Installation Tool
135-7638	Outer Tang Break-Off Tool
135-7639	Tap
138-8441	Brake Cleaner
140-9740	16 mm Inner Insert
140-9745	16 mm Outer Insert
142-2285	Cylinder Head Stress Plate [2]
154-9731	Thread Lock
159-9404	Counterboring Tool Group
169-5464	Quick Cure Primer
174-6858	Cleaner
178-2349	Reamer (First Operation)[3]
178-2350	Reamer (Second Operation)[3]

178-2351	Reamer (Third Operation)[3]
178-2353	Tap (First Operation)[3]
178-2356	Tap (Second Operation)[3]
178-2467	Insert Installation Sleeve[3]
178-2501	Threaded Insert
178-2503	Threaded Insert
185-3998	Thread Lock Compound
222-3115	Penetrating Oil
222-3117	Brake Cleaner
303-9339	Lint Free Shop Towels
362-4250	Measuring Tool Group
362-4253	Gauge Kit
383-8887	Dual Scale Feeler Gauge Set
386-3364	Straight Edge Ruler
473-8688 or 473-8689	Internal Micrometer Set 2-12 inch
	Internal Micrometer Set 50-300 mm
473-8690	Outside Electronic Micrometer Set 0-4 inch
473-8691	Outside Electronic Micrometer Set 2-6 inch
466-2803	Sleeve
FT-1855	Pressure Test Group
FT-3295	Driver
PT-2801	Basic Kit (Jig Fixture)
PT-2801-3	Service Kit
PT-8704-A	Threaded insert used in 3406, 3408 and 3412 Engines
93028 [4]	Digital Disc Brake Calipers
-	Rottler Model F2VB [5]
-	Rottler Model FA2AVB [5]
-	Sunnen CK-10 [5]
-	Sunnen CK-616 [5]
-	Rottler Model HP3 [5]
-	Rottler Model HP3A [5]
-	Loctite® #1522029 Aviation Gasket Sealant

-	Loctite® 7649
-	Loctite® 620

(1) Use with 9U-7988 Plate Gp

(2) Stress plate is used only during measuring and honing of the cylinder sleeve bore. Do not use the stress plate during the block boring procedure.

(3) Part of the required tooling to repair threads.

(4) Cen-Tech part number

(5) Any of the following tools are acceptable for use in this procedure.

Note: In addition to the tools listed in the table, a STANDARD thickness cylinder head gasket must be used with 125-2064 or **142-2285** Cylinder Head Stress Plate for (C7 Engines) during the honing cycle. The cylinder head gasket may be reused several times with the stress plate, however a new gasket must be used during the final cylinder head installation.

Refer to the Parts Manual for the correct STANDARD thickness cylinder head gasket.

Measurement Requirements

NOTICE

Precise measurements shall be made when the component and measurement equipment are at 20° (68° F). Measurements shall be made after both the component and measurement equipment have had sufficient time to soak at 20° (68° F). This will ensure that both the surface and core of the material is at the same temperature.

Initial Cleaning of the Engine

Illustration 3 g06238164

Cap all machined surfaces and plug all the hoses and fuel lines.

Clean all the external surfaces before the engine is disassembled. Clean all the external surfaces before the engine is brought into the shop. Use a high-pressure washer to spray the engine with hot water and soap or **174-6858** Cleaner.

WARNING

Personal injury can result from working with cleaning solvent.

Because of the volatile nature of many cleaning solvents, extreme caution must be exercised when using them. If unsure about a particular cleaning fluid, refer to the manufacturer's instructions and directions.

Always wear protective clothing and eye protection when working with cleaning solvents.

NOTICE

All reconditioned components should be cleaned again before assembly. Any debris or residue on the parts such as metal chips, carbon deposits, or sludge can enter the system. Debris or residue can cause early engine failures.

After the initial cleaning of the engine, disassemble the engine. Refer to the appropriate Disassembly and Assembly manual for your engine.

All fasteners should be compared against Reuse and Salvage Guidelines, SEBF8301, "Inspection and Reuse of Critical Fasteners Used in All Engines". Pay special attention to head bolts, main bolts, connecting rod bolts, and rocker shaft bolts when considering reusability. Any visual damage to the bolts should disqualify the bolt from reuse.

Note: Itis recommended to replaceall cylinder head bolts and the spacer plates (if applicable) on any engine that has experienced a failure of the top deck/cylinder head joint.

Cleaning the Cylinder Block

One of the major reasons for a bearing failure after an engine overhaul is damage caused by debris in the oil passages. Remove all dirt, debris, and metal shavings from all openings, ports, and passages. Refer to M0080689 Reuse And Salvage Guidelines, "Cylinder Block Cleaning and Audit Procedure" for cylinder block cleaning.

NOTICE

Failure to remove all dirt, debris, and/or metal shavings from openings, ports, and passages, will result in damage to the engine and the related components. A cylinder block that is not cleaned thoroughly will result in piston seizure or rapid wear of the cylinder bores, pistons, and piston rings. Only the thorough use of a rotary brush will correctly remove abrasive particles.

Note: Do not use surface reconditioning pads on the top deck of the block, spacer plates, and cylinder head surfaces.

Reconditioning Suggestions

The following is a list of suggestions that are for common problems that can occur when the cylinder block is being reconditioned.

- The area around the cylinder sleeve can sometimes be polished by the slight movements between the cylinder sleeve and the block. This polished surface is sometimes seen as erosion. If the measurable erosion is not more than 0.03 mm (0.001 inch), there is no need to shave the top deck. The cylinder sleeve needs to be flush with the top of the block.
- The best way to salvage minor erosion that is at a depth of 0.13 mm (0.005 inch) or more depth that is on the top deck of the cylinder block use the Belzona® kit for the affected area.

Critical Factors for Reconditioning the Cylinder Blocks

There are several factors that affect the amount of material that can be removed from the surface of the component. The factors include the valve and projections of the cylinder sleeve and the mating surface flatness. The other factors that should be included are backlash of the timing gear and surface texture. When you are reconditioning the mating surfaces of the block and head be sure to measure the areas as well as the dimensions for the minimum thickness of the cylinder blocks.

In all the following reconditioning procedures, remove the minimum material that is necessary to make the repair.

Note: The dimensions assume that the centerline of the crankshaft has not been raised. Adjust the specifications accordingly if the machining has already occurred.

Surface Texture

The machined surface must be smooth to form a good seal. The machined finish that is between the cylinder head and the block must meet specifications.

Dimensions for Reconditioning

Note: When you are reconditioning the block, remove the minimum amount of material that is necessary to make the repair.

If a block is machined, the projection of the sleeve must be checked during assembly and also adjusted to the correct specifications.

When you are reconditioning an engine, both the block and head must be checked.

Marking the Reconditioned Block

Keep exact records on the amount of stock and the location of stock that was removed from the engine. Mark the block or stamp the block near the changed surface, but not in an area of the gasket seal. For additional information on the marking of the parts, refer to Reuse and Salvage Guide, SEBF8187, "Standardized Parts Marking Procedures".

The markings could also have code letters for the dealer and/or the machine shop. Write all this information in the Service Report for the engine history or the history of the vehicle. Write a report in the Service Information Management System (SIMS) to describe the machining that was performed on the engine.

Repair Damage to the Block

There are several methods of casting repair that are available, dependent on the type of damage to the block. Carefully follow the recommended Special Instructions for each method. Each method that is described below has a special application. Use only the method that is approved in the application.

Cast Iron Welding

A new cold welding procedure has been developed by Caterpillar which permits the repair of Caterpillar castings. Special welding rods of high nickel alloy are available through Caterpillar, required for a successful repair. The part numbers for the electrode and the Instructions for welding non-structural cracks are given in the Special Instruction, SEHS8919, "Salvage Procedure for Cast Iron Cylinder Blocks".

Lock-N-Stitch

Using the Lock-N-Stitch repair kits that are available from Caterpillar may be able to repair the holes that are caused by a single failure of the rod or cracks in a casting. These repairs should not be made in structural areas. The repair method that is utilized can achieve a permanent repair. The detailed instructions and the part numbers for the kit can be found in the Special Instruction, SEBF8882, "Using the Lock-N-Stitch Procedures for Casting Salvage".

Belzona® 1311 Ceramic R Metal

The mixed material can be used to repair porosity or pitting of the block. The composite material can only be used in the applications that are outlined because of the low material strength that is compared with welding and Lock-n-stitch. Instructions for obtaining the material and the application of material can be found in Special Instruction, SEHS8869, "Cylinder Block Salvage Procedure for Using Belzona® 1311 Ceramic R Metal".

The block needs to be thoroughly cleaned after each of the above repair methods. The repair of the block that is using Belzona® products cannot be placed in the strong caustic material at an elevated temperature. Using strong caustic material may soften the material of the repair.

Repairing Block Top Deck with Thermal Spray

A thermal spray process can also be used to restore the contact surfaces to the original dimensions. Refer to "Flame Spray and Arc Spray", for information about thermal spray repair procedures.

General Specifications

Flatness of the Top Deck

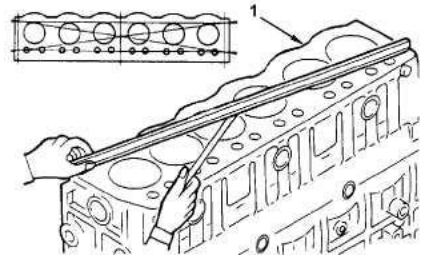

Illustration 4 g06337213
(1) Cylinder Block

Measure the flatness of the top deck. Use a straight edge and a feeler gauge to measure the flatness of the top deck. Measure the surface in two positions crosswise and measure the surface in two positions lengthwise.

The total flatness of the top contact surface of the cylinder block must be within 0.10 mm (0.004 inch).

The flatness of the top deck must be held for the entire surface. There can be no more than 0.05 mm (0.002 inch) over any 150.00 mm (6.000 inch) span.

Note: The 0.05 mm (0.002 inch) tolerance for flatness cannot be increased by increasing the 150.00 mm (6.000 inch) length.

Main Bearing Bores

Inspect the bore for the main bearings and the main bearing cap. Use a dial bore gauge to measure the bore. If necessary, the bore for the main bearings can be machined to use oversized bearings.

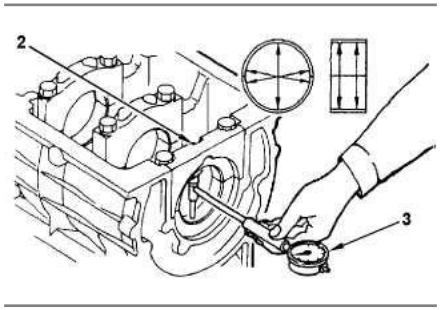

Illustration 5 g06337217
(2) Bearing Cap
(3) Dial Bore Gauge

Inspect the alignment of the main bearing bores. Use a boring machine to check the alignment of the main bearing bores. If a boring machine is not available, use a long machinists straight edge and a feeler gauge to check the alignment of the bearing bores. The following procedure describes the use of a machinists straightedge and a feeler gauge to check the alignment:

- Place a 0.038 mm (0.0015 inch) feeler gauge in the bore and then lay the straightedge across the feeler gauge and several of bearing bores. Do not put pressure on the straightedge.
- Check if the feeler gauge pulls out freely. If the feeler gauge pulls out freely, that bore is not in alignment.
- Use this procedure to check the alignment of each main bearing bore.

Note: The long straight edge must be handled carefully to prevent nicks and burrs. Support the cylinder block evenly so the measurements are accurate.

Check the size of the main bearing bores by using the **1P-3537** Dial Bore Gauge. Check Table 4 to make sure that the bore size for the main bearings meets the specifications. This dimension is used after the crankshaft is removed and the bearing caps are assembled and tightened according to the specifications in this service manual.

Refer to Illustration 8, through 13 with Table 4 for identification of several locations and dimensions that are frequently referenced during the reconditioning of a cylinder block.

Tightening Procedure for Main Bearing Cap Bolts

Install the bearing caps in the correct order of sequence. The bearing caps must be torqued from the front to the rear. Check the Identifying marks on the caps and the block before tightening.

1. Lubricate the bolt threads and the washer faces with clean engine oil.
2. Tighten the bolts in accordance with the proper torque specifications. Refer to the appropriate specifications manual for the torque specifications.

Camshaft Bore

Inspect the camshaft bores for wear and impact damage whenever the camshaft has been removed. Remove any raised material with a file, and polish with a Scotch Brite pad if necessary. Refer to the camshaft bore specifications in this Guideline for maximum bore diameter. If any bore shows excessive debris damage, the spacer block must be replaced or repaired using replacement bearings.

Illustration 6 g06344335

Inspect the camshaft bores for wear and impact damage.

Use Again

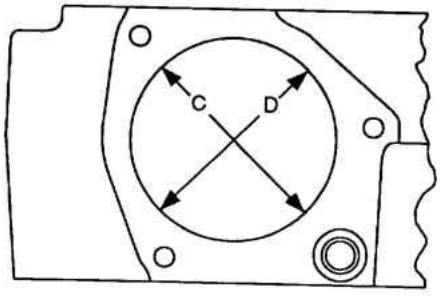

Illustration 7 g06344258

Checking camshaft bore for maximum average diameter and out-of-alignment. The average diameter should measure 75.075 mm (2.95570 inch), and out-of-alignment should be no more than 0.10 mm (0.00394 inch).

Measure the camshaft bores for diameter, roundness, and bore alignment whenever the camshaft is removed. Measure the diameter in two places (C) and (D) using bore gauge. It is important to inspect and certify the gauge before using it. It is necessary to bolt the spacer block to the cylinder block to measure the alignment.

Block Dimensions

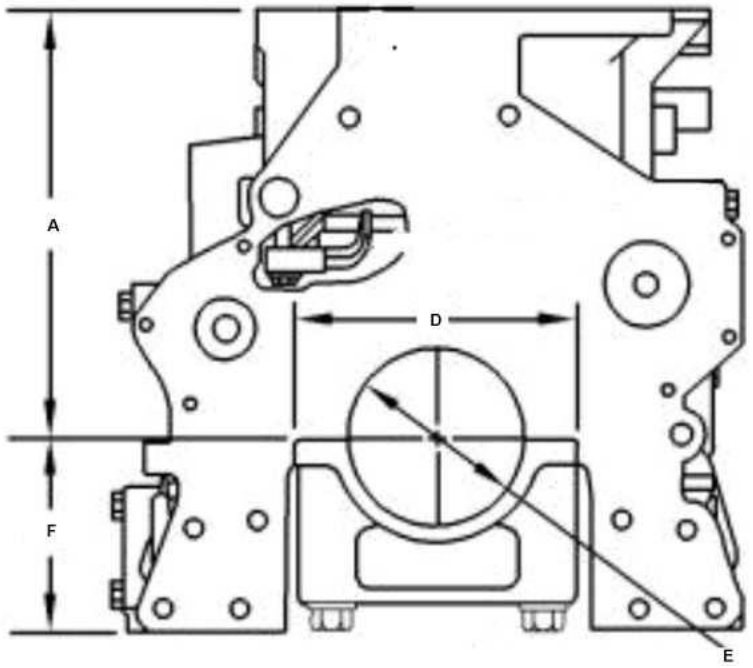

Illustration 8 g06344916

Example of a 3176 Cylinder Block
Refer to Table 4 for specifications of the cylinder block.
(A) Dimension from centerline of crankshaft bore to top of block
(D) Width of cylinder block for main bearing cap
(E) Bore for main bearings
(F) Dimension from centerline of crankshaft bore to pan rail

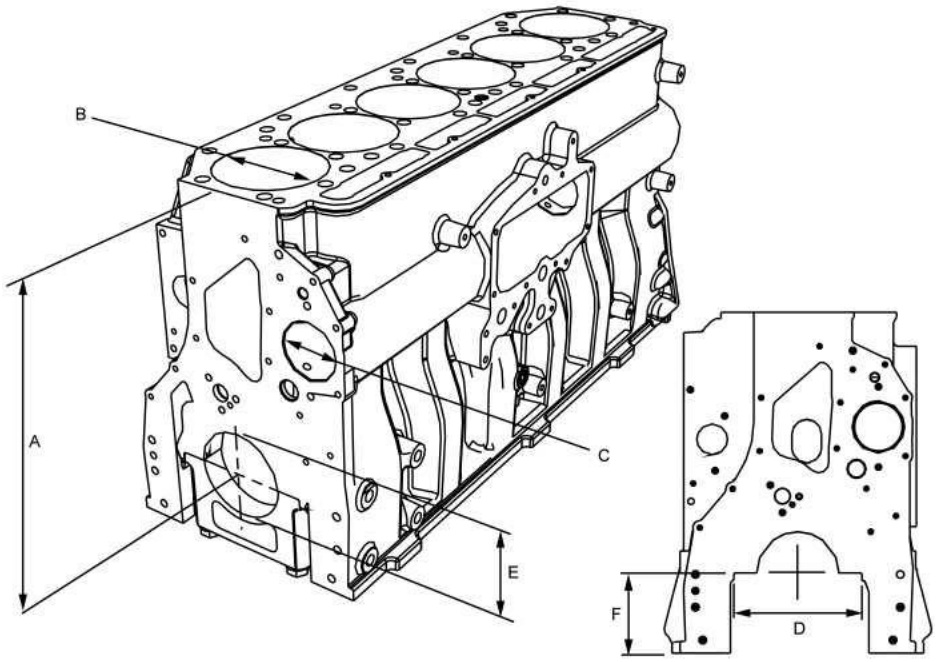

Illustration 9 g06238165

Example of a C7 or C9 Cylinder Block
Refer to Table 4 for specifications of the cylinder block.
(A) Dimension from centerline of crankshaft bore to top of block
(B) Cylinder Liner Bore Size
(C) Bore for front camshaft bearing
(D) Width of cylinder block for main bearing cap
(E) Bore for main bearings
(F) Dimension from centerline of crankshaft bore to pan rail

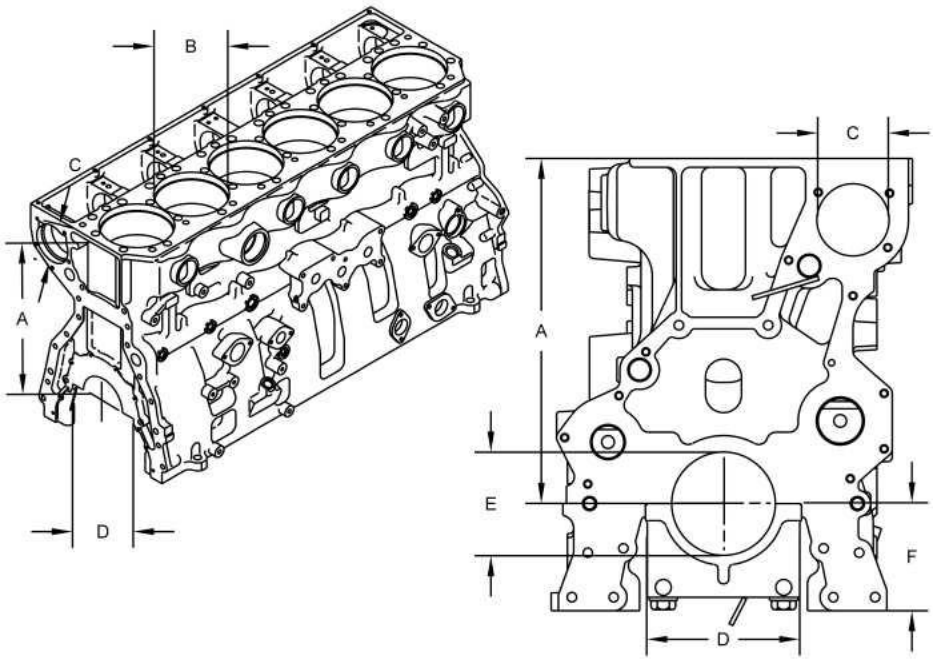

Illustration 10 g06238168

Example of a C-10 or C-12 Cylinder Block
(A) Dimension from centerline of crankshaft bore to top of block
(B) Cylinder Liner Bore Size
(C) Bore for front camshaft bearing
(D) Width of main bearing cap
(D) Width of cylinder block for main bearing cap
(E) Bore for main bearings
(F) Dimension from centerline of crankshaft bore to pan rail

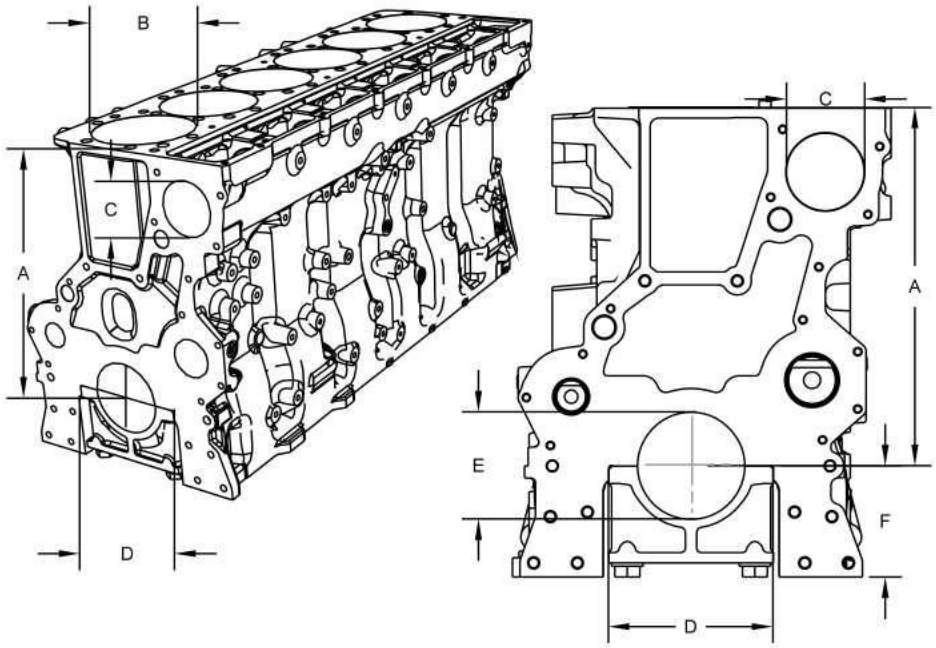

Illustration 11 g06238157

Example of a C11 or C13 Cylinder Block
(A) Dimension from centerline of crankshaft bore to top of block
(B) Cylinder Liner Bore Size
(C) Bore for front camshaft bearing
(D) Width of main bearing cap
(D) Width of cylinder block for main bearing cap
(E) Bore for main bearings
(F) Dimension from centerline of crankshaft bore to pan rail

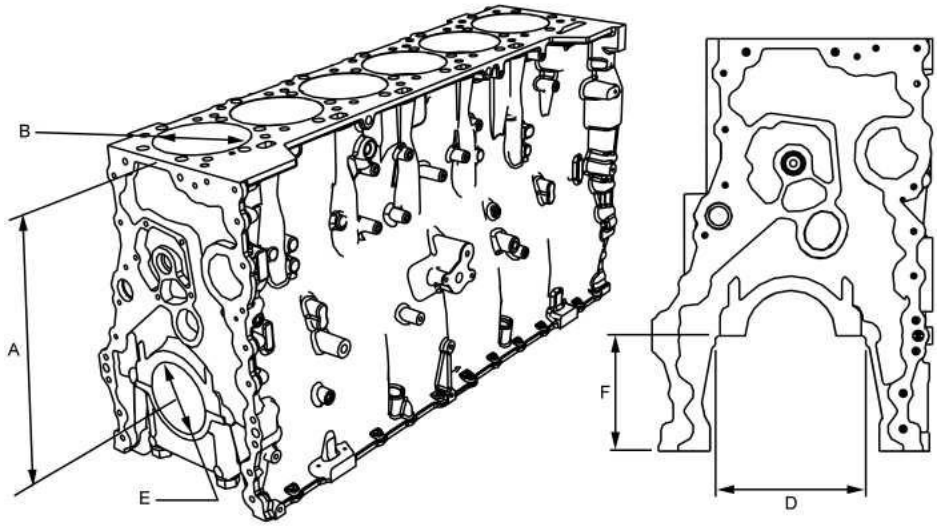

Illustration 12 g06238158

Example of a C15, C16, or C18 Cylinder Block.
Refer to Table 4 for specifications of the cylinder block.
(A) Dimension from centerline of crankshaft bore to top of block
(B) Cylinder Liner Bore Size
(C) Bore for front camshaft bearing (not shown) Refer to the cylinder head document
(D) Width of main bearing cap
(D) Width of cylinder block for main bearing cap
(E) Bore for main bearings
(F) Dimension from centerline of crankshaft bore to pan rail

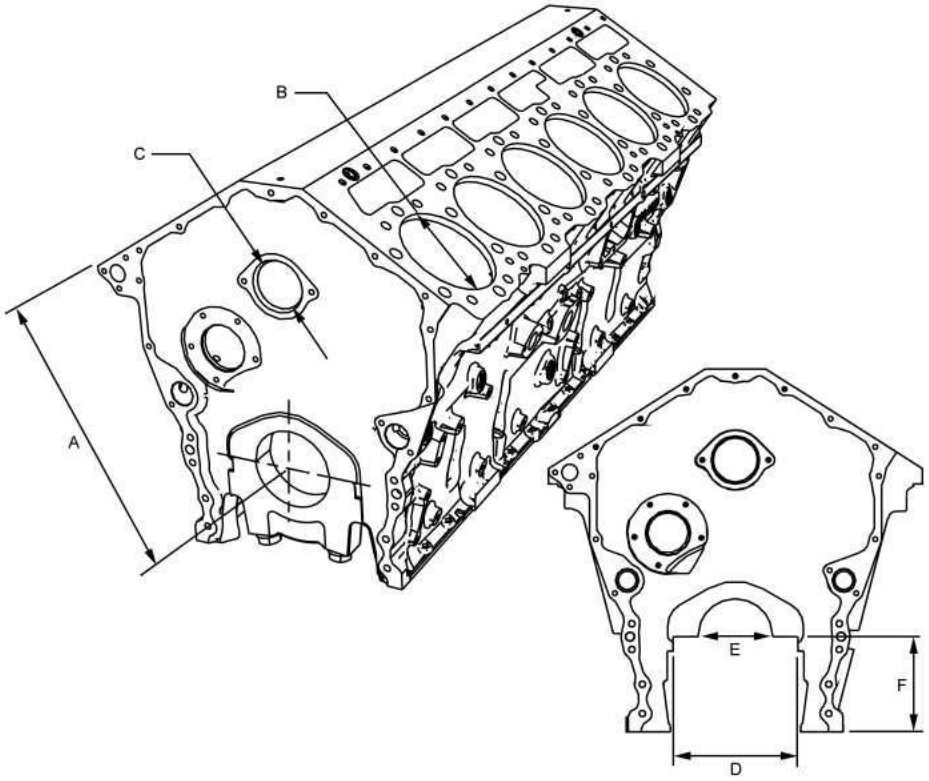

Illustration 13 g06238163

Example of a C27, C30 , or C32 Cylinder Block
Refer to Table 4 for specifications of the cylinder block.
(A) Dimension from centerline of crankshaft bore to top of block
(B) Cylinder Liner Bore Size
(C) Bore for front camshaft bearing
(D) Width of main bearing cap
(D) Width of cylinder block for main bearing cap
(E) Bore for main bearings
(F) Dimension from centerline of crankshaft bore to pan rail

Table 4

Dimensions on Front Face of Cylinder Block [1]								
Item	**Description**	**1674[2] D334**	**1676[3]D336**	**1676[2]D336**	**1693[3]D343**	**D343 1693[2]**	**D315 D318 D330A/B[3] D333A/B**	**D330C[3] D333C**
A	Dimension from centerline of crankshaft bore to top of block	383.51 ± 0.10 mm (15.099 ± 0.004 inch)	409.58 ± 0.05 mm (16.125 ± 0.002 inch)	399.39 ± 0.13 mm (15.724 ± 0.005 inch)	469.90 ± 0.13 mm (18.500 ± 0.005 inch)	456.64 ± 0.12 mm (17.978 ± 0.005 inch)	393.70 ± 0.32 mm (15.500 ± 0.013 inch)	393.70 ± 0.17 mm (15.500 ± 0.007 inch)
	Minimum	383.29 mm (15.090 inch)	409.40 mm (16.118 inch)	399.14 mm (15.714 inch)	469.65 mm (18.490 inch)	456.39 mm (17.968 inch)	393.34 mm (15.486 inch)	393.28 mm (15.483 inch)
-	Surface texture of the top deck	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch

(1) Original part numbers only and do not apply to Reman part numbers.

(2) Spacer plate

(3) Counterbore for inserts

Table 5

Dimensions on Front Face of Cylinder Block (1)								
Item	**Description**	**D342(2)**	**D342(3)**	**D346(3)**	**D346 D348 D349(2)**	**D353(3)**	**D353(2)**	**D379 D398 D399**
A	Dimension from centerline of crankshaft bore to top of block	614.36 ± 0.089 mm (24.187 ± 0.0035 inch)	601.68 ± 0.10 mm (23.688 ± 0.004 inch)	508.00 ± 0.05 mm (20.000 ± 0.002 inch)	494.74 ± 0.13 mm (19.478 ± 0.005 inch)	614.35 ± 0.10 mm (24.187 ± 0.004 inch)	601.68 ± 0.10 mm (23.688 ± 0.004 inch)	690.56 ± 0.06 mm (27.187 ± 0.002 inch)
	Minimum	613.99 mm (24.173 inch)	601.32 mm (23.674 inch)	507.82 mm (19.993 inch)	494.49 mm (19.468 inch)	613.99 mm (24.173 inch)	601.32 mm (23.674 inch)	690.25 mm (27.175 inch)
-	Surface texture of the top deck	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch

(1) Original part numbers only and do not apply to Reman part numbers.

(2) Counterbore for inserts

(3) Spacer plate

Table 6

Dimensions on Front Face of Cylinder Block (1)									
Item	**Description**	**1100 3100 3200 (2)**	**3054 3054B 3056 3056E**	**3054C 3054E**	**3204 (3)**	**3300 (4)**	**3300 (2)**	**3406 (2)**	**3408 3412 (2)**
A	Dimension from centerline of crankshaft bore to top of block	322.66 ± 0.13 mm (12.70312 ± 0.00512 inch)	441.33 mm (17.37516 inch)	441.274 mm (17.3730 inch)	322.66 ± 0.13 mm (12.703 ± 0.005 inch)	393.70 ± 0.17 mm (15.500 ± 0.007 inch)	383.52 ± 0.17 mm (15.099 ± 0.007 inch)	425.45 ± 0.15 mm (16.750 ± 0.006 inch)	419.10 ± 0.15 mm (16.500 ± 0.006 inch)
	Minimum	322.40 mm (12.69289 inch)	441.12 mm (17.36689 inch)	441.173 mm (17.3670 inch)	322.40 mm (12.693 inch)	393.28 mm (15.483 inch)	383.10 mm (15.083 inch)	425.02 mm (16.733 inch)	418.67 mm (16.483 in)
-	Surface texture of the top deck	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch

(1) Original part numbers only and do not apply to Reman part numbers.

(2) Direct Injection

(3) Precombustion

(4) Counterbore for inserts

Table 7

Dimensions on Front Face of Cylinder Block(1)								
Item	**Description**	**C7**	**C-9/C9**	**C9.3**	**C-10/C-12**	**C11**	**C13**	**3176 (2) 3176B**
A	Dimension from centerline of crankshaft bore to top of block	322.00 ± 0.17 mm (12.677 ± 0.007 inch)	356.50 ± 0.15 mm (14.035 ± 0.006 inch)	361.5 ± 0.03 mm (14.232 ± 0.00118 inch)	387.00 ± 0.15 mm (15.236 ± 0.006 inch)	387.00 ± 0.15 mm (15.236 ± 0.006 inch)	387.00 ± 0.15 mm (15.236 ± 0.006 inch)	265.15 + 0.00 - 0.15 mm (10.439 + 0.000 - 0.006 inch)
	Minimum	321.83 mm (12.670 inch)	356.35 mm (14.029 inch)	361.47 mm (14.231 inch)	386.85 mm (15.230 inch)	386.85 mm (15.230 inch)	386.85 mm (15.230 inch)	265.0 mm (10.43305 inch)

B	Cylinder bore in block or bore for liner	110.025 + 0.025 - 0.010 mm (4.3317 + 0.0010 - 0.0004 inch) (5)	129.00 ± 0.03 mm (5.079 ± 0.001 inch)	129.00 ± 0.03 mm (5.079 ± 0.001 inch)	151.50 ± 0.03 mm (5.965 ± 0.001 inch)	151.50 ± 0.03 mm (5.965 ± 0.001 inch)	151.50 ± 0.03 mm (5.965 ± 0.001 inch)	138.50 ± 0.03 mm (5.45275 ± 0.00118 inch)
C	Bore for front camshaft bearing	70.000 ± 0.025 mm (2.7559 ± 0.0010 inch)	70.000 ± 0.025 mm (2.7559 ± 0.0010 inch)	70.000 ± 0.025 mm (2.7559 ± 0.0010 inch)	80.950 ± 0.025 mm (3.18700 ± 0.00098 inch)	85 ± 0.015 mm (3.34645 ± 0.00059 inch)	85 ± 0.025 mm (3.34645 ± 0.00098 inch)	N/A
	Bore for remaining camshaft bearings	69.000 ± 0.038 mm (2.7165 ± 0.0015 inch)	70.000 ± 0.038 mm (2.7559 ± 0.0015 inch)	70.000 ± 0.038 mm (2.7559 ± 0.0015 inch)	80.950 ± 0.025 mm (3.18700 ± 0.00098 inch)	85 ± 0.015 mm (3.34645 ± 0.00059 inch)	85 ± 0.025 mm (3.34645 ± 0.00098 inch)	N/A
D	Width of main bearing cap	159.995 ± 0.020 mm (6.2990 ± 0.0008 inch)	175.000 ± 0.020 mm (6.8898 ± 0.0008 inch)	175.000 ± 0.020 mm (6.8898 ± 0.0008 inch)	175.000 ± 0.020 mm (6.8898 ± 0.0008 inch)	178.00 ± 0.020 mm (7.008 ± 0.0008 inch)	178.00 ± 0.020 mm (7.008 ± 0.0008 inch)	175.000 ± 0.020 mm (6.8898 ± 0.0008 inch)
	Width of cylinder block for main bearing cap	160.0 mm (6.29920 inch) + 0.018 mm (0.00071 inch) - 0.023 mm (0.00091 inch)	175.000 ± 0.018 mm (6.8898 ± 0.0007 inch)	175.000 ± 0.018 mm (6.8898 ± 0.0007 inch)	175.000 ± 0.018 mm (6.8898 ± 0.0007 inch)	178 ± 0.023 mm (7.00786 ± 0.00091 inch)	178 ± 0.023 mm (7.00786 ± 0.00091 inch)	175.000 ± 0.018 mm (6.8898 ± 0.0007 inch)
E	Bore for main bearings	95.000 ± 0.013 mm (3.7402 ± 0.0005 inch)	112.000 ± 0.013 mm (4.4094 ± 0.0005 inch)	112.000 ± 0.013 mm (4.4094 ± 0.0005 inch)	116.000 ± 0.013 mm (4.5669 ± 0.0005 inch)	116.000 ± 0.013 mm (4.5669 ± 0.0005 inch)	116.000 ± 0.013 mm (4.5669 ± 0.0005 inch)	108.0 ± 0.013 mm (4.25196 ± 0.00051 inch)
	Bore for oversized main bearings	95.508 ± 0.013 mm (3.7601 ± 0.0005 inch)	NA	NA	116.508 ± 0.013 mm (4.5869 ± 0.0005 inch)	116.508 ± 0.013 mm (4.5869 ± 0.0005 inch)	116.508 ± 0.013 mm (4.5869 ± 0.0005 inch)	109.281 ± 0.013 mm (4.30239 ± 0.00051 inch)
F	Dimension from centerline of crankshaft bore to pan rail	110.0 ± 0.10 mm (4.33 ± 0.004 inch)	110.0 ± 0.10 mm (4.33 ± 0.004 inch)	110.0 ± 0.10 mm (4.33 ± 0.004 inch)	120.00 ± 0.20 mm (4.724 ± 0.008 inch)	120.00 ± 0.20 mm (4.724 ± 0.008 inch)	120.00 ± 0.20 mm (4.724 ± 0.008 inch)	120.00 ± 0.20 mm (4.724 ± 0.008 inch)
-	Surface texture of the top deck	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch	3.2 µm 125 µinch

(1) Original part numbers only and do not apply to Reman part numbers.

(2) Spacer Plate

(3) For engines not equipped with NON-Brake.

(4) For engines equipped with Cat Brake.

(5) Stress plate needs to be installed to measure bore accurately

Note: Bore size must be checked with 125-2064 or **142-2285** Cylinder Head Stress Plate for (C7 Engines).

Line Boring the Cylinder Block

Tooling

Use **1P-4000** Line Boring Tool Group to perform the line bore. Refer to Special Instruction, SMHS7606, "Using 1P-4000 Line Boring Tool Group" for a description of this tool.

Centering Rings

Standard centering rings and oversized centering rings must be purchased.

Changes to Boring Procedure

Refer to Special Instruction, SMHS7606, "Use of 1P-4000 Line Boring Tool Group" for more information about this tool.

Follow the procedure in Special Instruction, SMHS7606, "Use of 1P-4000 Line Boring Tool Group" and use the centering rings.

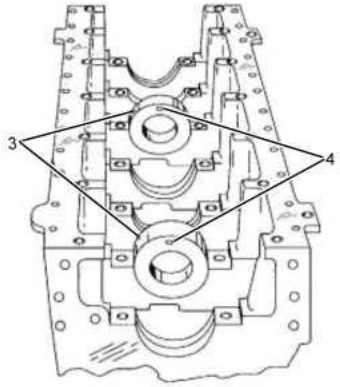

Illustration 14 g01370431

(3) Centering ring
(4) Oiler

Place the centering rings on either side of the cap that is being replaced. Verify that the oilers are facing upward. For an end cap, place the centering rings in the bearing bores that are next to the bearing bores on the end.

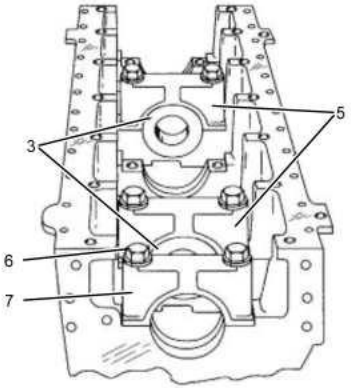

Illustration 15 g01370432

(3) Centering ring
(5) Original bearing cap
(6) Bolt
(7) New machined cap

Tighten the bolts on the bearing caps that have centering rings from a minimum of 27 N·m (20.0 lb ft) to a maximum of 70 N·m (52.0 lb ft). Rotate the boring bar to check for binding. All other bearing cap bolts should be tightened to the specifications in the service manual.

Place the cutting tool in the holder, and set the micrometer 1.78 mm (0.070 inch) less than the finished bore diameter to set the tool bit.

Note: This setting may change for a standard or an oversized centering ring. Verify that the dimensions are correct after machining has occurred and before the bearing caps are removed.

Tighten the bolts on the bearing caps with centering rings 27.0 N·m (19.91 lb ft) to 70.0 N·m (51.62 lb ft). All other bearing cap bolts should be tightened to the specifications in the service manual.

Place the tool bit in the holder and set the micrometer 1.78 mm (0.070 inch) less than the finished bore diameter. The finished bore diameter is 95.000 ± 0.013 mm (3.7402 ± 0.0005 inch). Verify that this dimension before bearing caps are removed.

Cylinder Block Top Deck Surface Inspection During In Frame Overhaul

Inspection of the cylinder block top deck, especially in the liner seat area, is critical to head gasket life. A visual inspection of the liner seat area will determine if the block is reusable. Head gasket failure and / or liner flange cracks can result from an irregular surface on the liner seat area regardless of liner projection results. If the block needs to have the liner seats counter bored contact your local Cat dealer. Your Cat dealer will have the latest documentation and the capability to counter bore the cylinder block and install liner seat shims.

Note: The liner seat of the cylinder block must be inspected to ensure that it is usable as is or if liner seat shims must be installed prior to the installation of the liner. Anytime the cylinder head is removed liner projection should be measured. Also, special consideration should be given to other areas such as the spacer plate joint to ensure proper sealing and long-term reliability.

If any of the following are true, cylinder block machining counter boring and installation of liner seat shims is required.

- Lack of original machining marks in the liner seat area
- Fretting, erosion, pitting, or corrosion in the liner seat area
- Liner projection is not within specification
- Engine block life is greater than 750,000 Miles or 15,000 hours
- Cylinder head is being removed because of a liner flange failure or a cylinder head gasket failure following an overhaul or previous head gasket repair
- Engine is being overhauled for a second time and liner seat inserts were not installed during first overhaul

Top Deck Visual Inspection

The following inspection process should be followed carefully. Any evidence of top deck wear, fretting, corrosion, pitting, or erosion should be addressed during the repair.

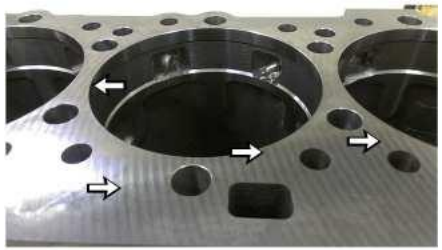

Illustration 16 g03817612

Machining marks present across the entire deck including the liner seat areas. **USE AS IS. NO COUNTERBORE WORK REQUIRED**

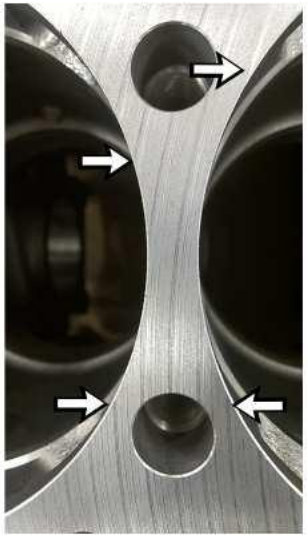

Illustration 17 g03817616

A closer view of the machining marks still apparent in the liner seat area.**USE AS IS. NO COUNTERBORE WORK REQUIRED**

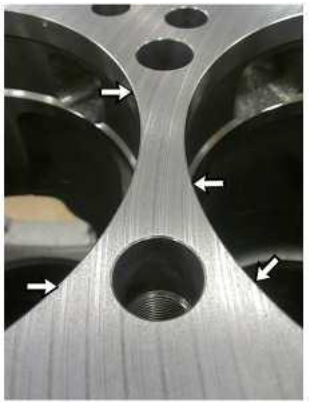

Illustration 18 g03817622

Machining marks still present in the liner seat. **USE AS IS. NO COUNTERBORE WORK REQUIRED**

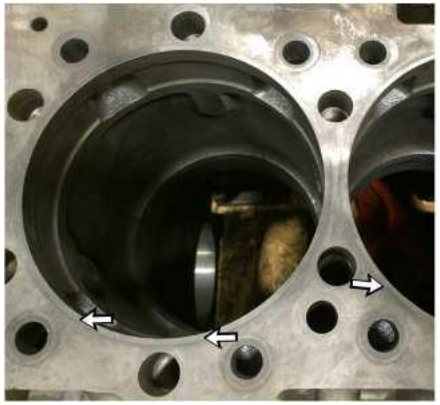

Illustration 19 g03817618

This block shows witness marks 360* around the liner bore seat. No wear can be felt with a fingernail. The machining marks are still present in the lower part of the illustration. **USE AS IS. NO COUNTERBORE WORK REQUIRED**

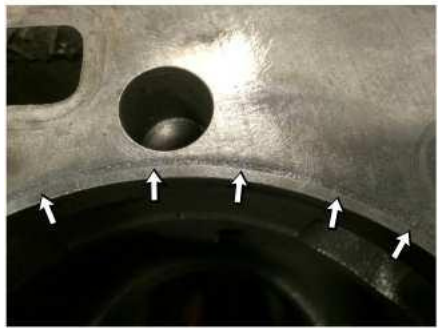

Illustration 20 g03817619

Liner seat showing corrosion pitting around the liner seat. **COUNTERBORE BLOCK BEFORE REUSING**

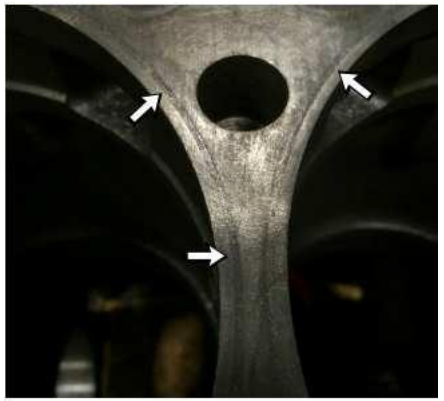

Illustration 21 g03817620

Fretting around the liner seat. This fretting can be felt with a fingernail. **COUNTERBORE BLOCK BEFORE REUSING**

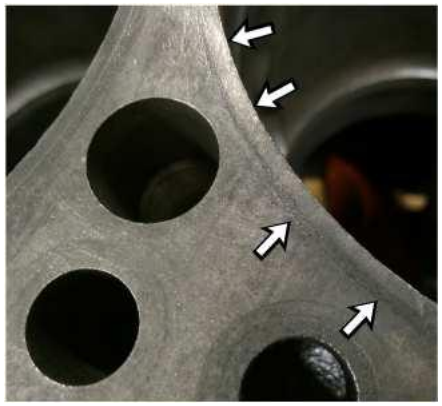

Illustration 22 g03817621

Polishing at the top of the liner seat and fretting at the bottom. **COUNTERBORE BLOCK BEFORE REUSING**

If your cylinder block requires counterboring and liner seat shims installed, see your Cat dealer. Your Cat dealer will be able to service the cylinder block bringing the cylinder back into specification.

Height of the Top Deck

Use the **6V-7840** Deck Checking Tool to measure the height of top deck of the block. Refer to the Special Instruction, SEHS8187, "Using the 6V-7840 Deck Checking Tool", for more information about this tool group.

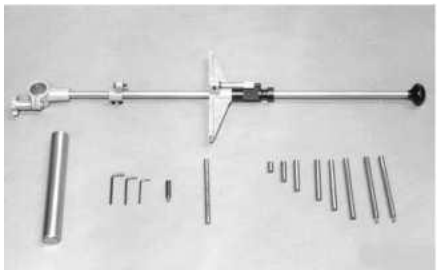

Illustration 23 g03412760

6V-7840 Deck Checking Tool assembly includes the following tools. **4B-7640** Wrench, **7B-7640** Wrench, and **6B-7225** Wrenches

Measuring the Distance to the Top Deck of 3400, C15, C-15, C-16, C18, C27, and C32 Engines

Assemble the 362–4250 Measuring Tool and 362–4253 Gauge Kit

Refer to Tool Operating Manual, NEHS1102, "362-4250 Deck Height Measuring Tool" for more information about this tool.

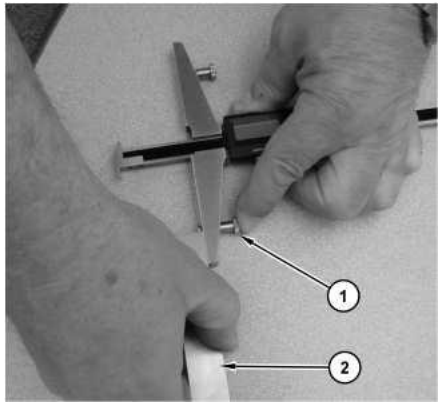

Illustration 24 g02151676

1. Depress one of the lock screws (1) and turn the lock screw clockwise. Rotate lock screw (1) clockwise until the T shaped end of the lock screw can be inserted into the corresponding T shaped slot of bar (2).

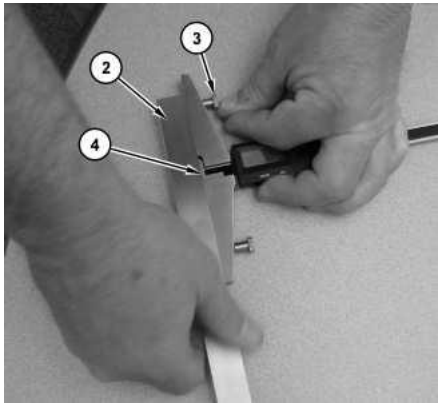

Illustration 25 g02151677

2. Fully retract the foot (4) of the depth gauge and slide bar (2) towards the second lock screw (3). Rotate the lock screw (3) clockwise until the T shaped end of the lock screw can be inserted into the corresponding T shaped slot of bar (2).

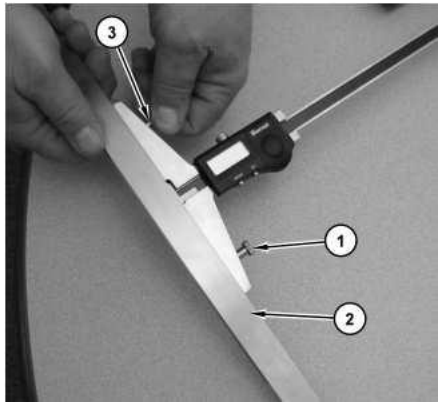

Illustration 26 g02152124

3. Center bar (2) with the depth gauge and turn locking screws (1) and (3) counterclockwise. This will lock bar (2) in position and hold the bar firmly against the depth gauge.

Illustration 27 g02154037

4. Place the bar onto a known flat surface, such as a layout table or a known flat piece of steel. Press the foot of the depth gauge against the flat surface and ZERO the depth gauge.

Measuring the Deck Height

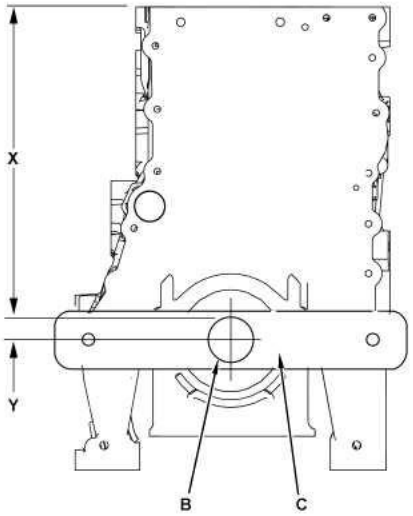

Illustration 28 g06344961

(B) Bar
(C) End Plate

This process will measure the distance (X) from the top of the deck to the top of the bar. Radius (Y) of the bar should be added to dimension (A) to get the distance from the top deck to the center of the bore of the main bearing. Measure the diameter of your specific bar and then use half of that dimension for the radius (Y).

For example, your specific bar could have a measured diameter of 38.100 mm (1.50000 inch). In this case, your radius (Y) dimension would be 19.05 mm (0.75000 inch).

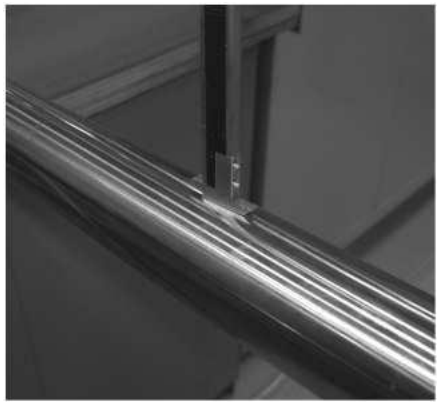

Illustration 29 g02151740

INCORRECT method of placing the end of the depth gage onto the bar.

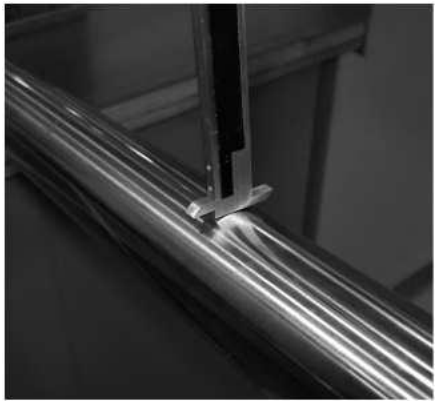

Illustration 30 g02151678

CORRECT method of placing the end of the depth gage onto the bar.

Special care should be taken when you place the foot of the depth gauge onto the bar. The foot of the depth gauge should be perpendicular to the bar, as shown in Illustration 30. Doing so will ensure that the foot of the depth gauge is resting on the TOP of the bar. If the foot of the depth gauge was resting parallel to the bar, the foot could be slightly off center and lead to incorrect measurements.

Store the bar in a protective cover, such as a piece of PVC pipe. One end of the PVC pipe should have a glued on cap and the other end of the PVC pipe should have a removable cap. The PVC pipe can also be left on the bar when you are sliding the bar through the engine block to prevent nicks and other damage to the bar.

Use the following procedure to measure the top deck height.

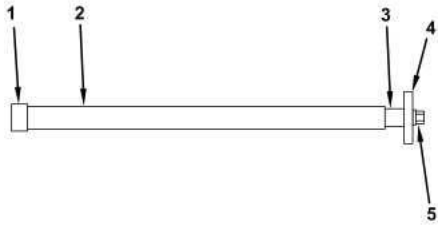

Illustration 31 g06344966

(1) Glued end cap
(2) PVC pipe
(3) Bar
(4) End plate
(5) Bolt and washer

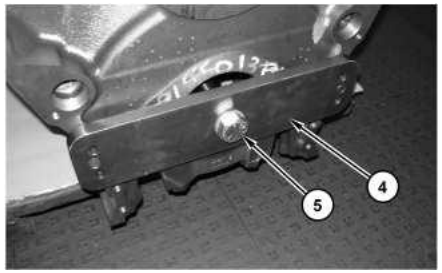

Illustration 32 g02154251

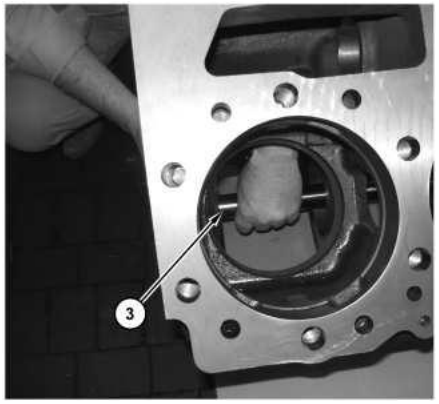

Illustration 33 g02154243

Using a second person to aid in the installation of the bar into the second end plate

1. Slide the bar (3) out of the PVC pipe (2) enough so that you can install the proper end plate (4). Secure the proper end plate (4) onto the bar with the bolt and washer (5). Slide the bar with the PVC pipe still attached through the engine block. You will need to use a second person to aid in the installation of the bar through the engine block.

   Note: Each of the end plates will be marked "FRONT" or "REAR". The end plates will also be marked "TOP". Make sure that the correct end plate is used on the proper side of the engine and each end plate is oriented correctly.

2. Position the end plate over the dowels on the end of the engine block. The end plates fit snug over the dowels but the end plates can be installed by hand.

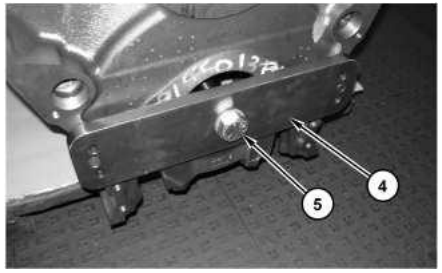

Illustration 34 g02154251

3. Remove the PVC pipe and install the other end plate onto the engine. Install the other bolt and washer (4). Tighten the bolt hand tight.

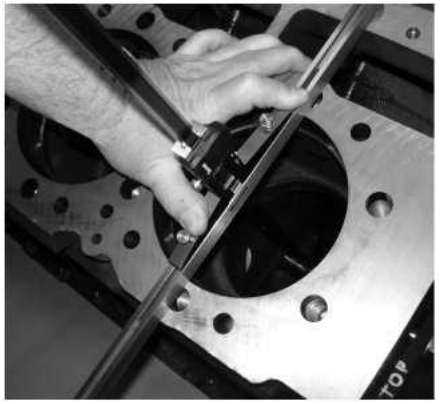

Illustration 35 g02154276
The depth gauge is centered horizontally and vertically

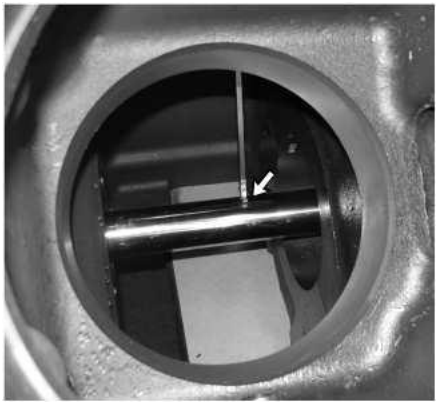

Illustration 36 g02154277
The foot of the depth gauge is perpendicular to the bar

4. Make sure that no burrs are present around the edges of the top deck surface or around the opening for the cylinder liner. Remove any burrs that may be present.
5. Position the depth gauge over the cylinder opening. The depth gauge should be vertically and horizontally centered, as shown.
6. Extend the foot of the depth gauge onto the bar. Make sure the foot of the depth gauge is perpendicular to the bar, as shown.

Illustration 37 g02154278

7. Record the measurement. Then, add the measured radius of the bar to the reading on the depth gauge. This will be the length from the top deck surface to the centerline of the crankshaft bearings.

   For example. You may have measured 400.05 mm (15.749 inch) on the depth gauge. The radius of the bar may have been determined to be 19.05 mm (0.750 inch). Your top deck measurement for that specific cylinder would then be 419.1 mm (16.500 inch).

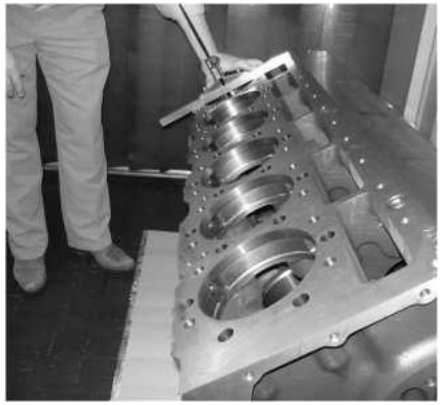

Illustration 38 g02154610
Measuring each cylinder

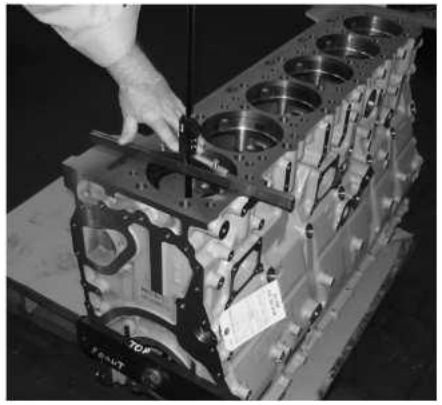

Illustration 39 g02154634
Measuring an in-line 6-cylinder engine.

8. Take a measurement for each cylinder and record all the values.

Determining How Much Material Should be Removed from the Top Deck

Use the following example for determining how much material can be removed from the top deck. The following information is only an example for a C15 engine block and your specific engine block will vary.

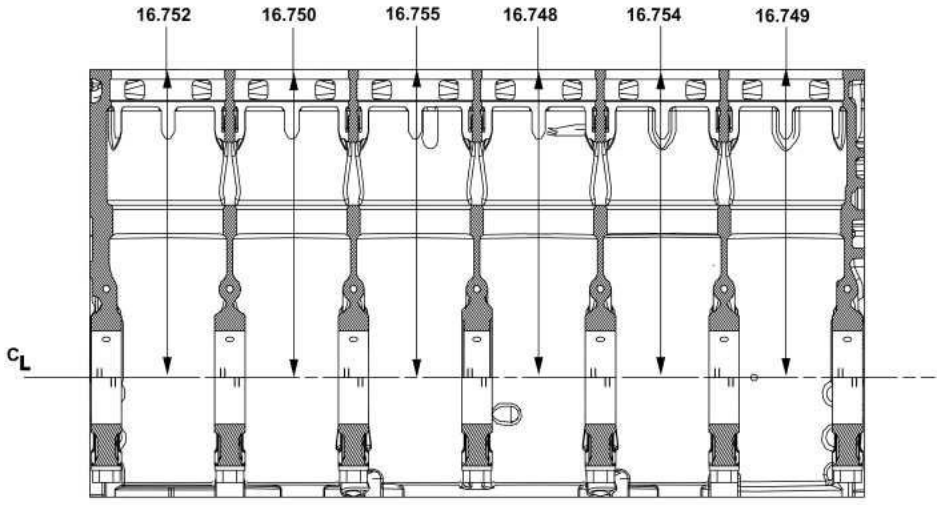

Illustration 40 g06344968
Cross sectional view of a C15 Engine Block.
The Dimensions shown are in INCHES.

The values that are shown in Illustration 40 were determined for each specific cylinder. These values represent the distance from the centerline of the crankshaft to the surface of the top deck. These values are only examples.

The shortest distance that was measured according to Illustration 40 is 425.39 mm (16.748 inch). You could machine up to 0.10 mm (0.004 inch) from the surface of the top deck and still be within the factory specifications.

The engine block could have as much as 0.3810 mm (0.015 inch) and still meet the minimum specifications that are listed.

Perform multiple passes over the top deck surface, taking off minimal material per pass. The first pass should remove approximately 0.025 mm (0.001 inch) below the lowest point that was measured. Then, you can use a feeler gauge and a straight edge at the areas that did not clean up to determine how much more material needs to be removed.

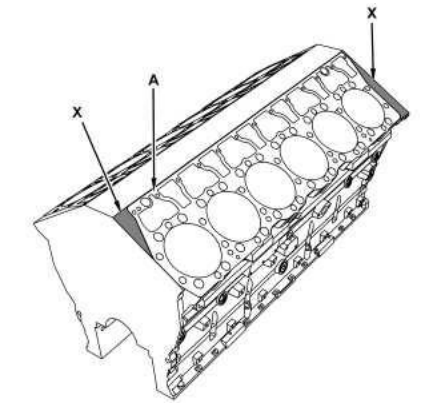

Illustration 41 g06344970

C32 Block is shown
(A) Gasket sealing area
(X) Area of the top deck not covered by the gasket

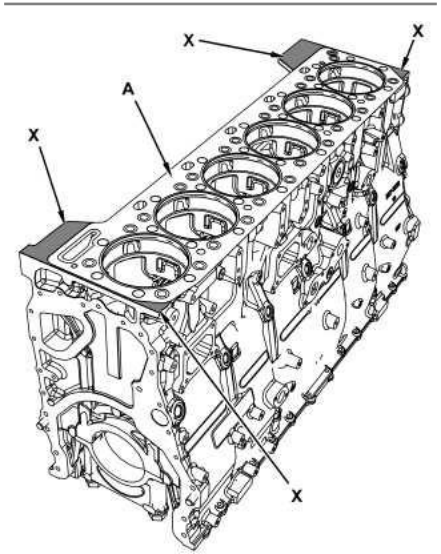

Illustration 42 g06344973

C18 Block is shown
(A) Gasket sealing area
(X) Area of the top deck not covered by the gasket

Only the area of the top deck that is covered by the gasket needs to be cleaned up by machining. If pitting remains in the area of the top deck (X) that is not covered by the gasket, it is not necessary to perform additional machining to remove the pitting.

Installation of Stress Plate for C7 Engines

Note: The stress plate is only used when measuring the bores and when hard honing. It is NOT to be used when boring the cylinders.

If the dimensions of a cylinder, or cylinders, is to be accurately measured with a 125-2064 or **142-2285** Cylinder Head Stress Plate for (C7 Engines) and a STANDARD thickness cylinder head gasket must be installed over each cylinder that is to be measured.

Table 8

Stress Plate Part Numbers		
Engine	**Stress Plate**	**Stress Plate Group**
C7	142-2285	125-2064

The correct installation of the STANDARD thickness cylinder head gasket, stress plate group or cylinder head stress plate, and cylinder head bolts will cause the cylinder bore to distort and have the same dimensions that it would have if the cylinder head was installed and properly tightened. Refer to Table 8 for stress plate group or cylinder head stress plate part numbers.

The gasket and stress plate must be installed to accurately measure the cylinder sleeve. If a stress plate group is used, it **must** be installed over each cylinder

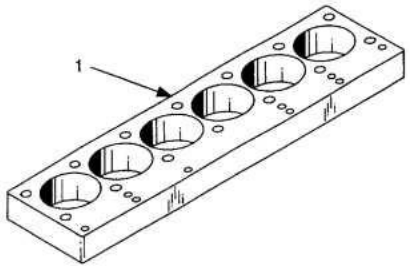

Illustration 43 g06337899

Cylinder head stress plate (1).

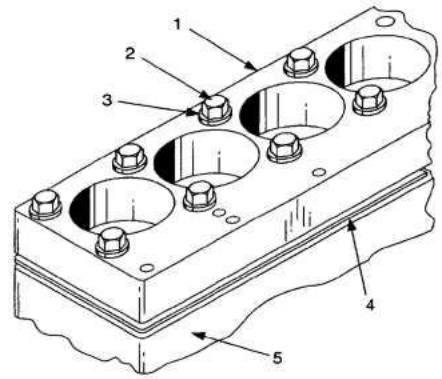

Illustration 44 g06337900

Cylinder head stress plate (1) installed on block (5) with STANDARD gasket (4) using bolts (2) and washers (3).

1. Install a STANDARD thickness cylinder head gasket (4) on cylinder block (5).

   Note: The head surface of the cylinder should contain dowels to position cylinder head gasket (4).

2. Position stress plate (1) over cylinder head gasket (4).

3. Install (original) cylinder head bolts (2) through the stress plate into cylinder block.

4. Initially tighten all bolts (2) evenly to 150 ± 15 N·m (110 ± 11 lb ft).

5. Finish tightening all bolts (2) evenly to 435 ± 20 N·m (320 ± 15 lb ft).

Measuring and Cleaning Cylinder Bores

Measuring the Cylinder Bores

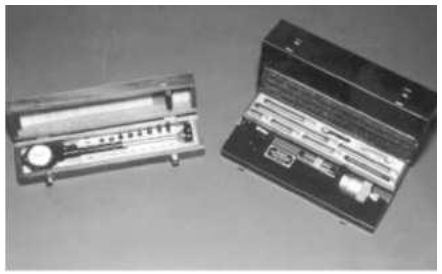

Illustration 45 g01402413
1P-3537 Dial Bore Gauge Group

Illustration 46 g06238831

Measure the cylinder bore parallel to the crankshaft. Measure the cylinder bore at a right angle to the crankshaft. Measure the cylinder bore at the top, the middle, and the bottom. The areas of the cylinder bore that receives the most wear is at the top and the bottom of ring travel.

Be sure that the gauge pin has sufficient travel to measure the points of maximum wear in the bore. In a cylinder bore, the maximum wear is usually across the diameter that is perpendicular to the centerline of the crankshaft, either at the top or the bottom of ring travel.

Use the **1P-3537** Dial Bore Gauge for the actual measurement. This group includes a **1P-3535** Dial Bore Gauge and a **1P-3536** Size Setting Fixture. Special Instruction, GMG00981, "Using 1P-3537 Dial Bore Gauge Group to Check Cylinder Bore Size".

C7 engines will require a 125-2064 or **142-2285** Cylinder Head Stress Plate and a STANDARD thickness cylinder head gasket must be installed over each cylinder that is to be measured.

Cleaning the Cylinder Bores

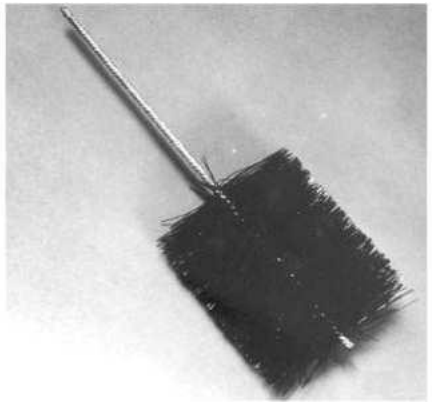

Illustration 47 g06338340
Typical example of a nylon brush that is used to clean the cylinder bores

Use a nylon brush to clean the cylinder bores. Clean the cylinder bores before measuring to ensure an accurate measurement. Refer to Table 9 for the part numbers of the nylon brushes.

Table 9

Sales Model	Brush
C7	1U-7429
C9	1U-7429
C10	1U-9788
C11	1U-9788
C12	1U-9788
C13	1U-9788
C15	4C-6345
C18	4C-6345
C27	4C-6345
C32	4C-6345

Honing Parent Cylinder Bores for C7 Engines

Make sure that the following preliminary check is made to determine if honing is necessary. Determine if honing is necessary, and if the bore's size allows honing. If the bore measures less than the maximum diameter, honing is possible. If the bore measures more than the maximum diameter, a sleeve must be installed.

The bore size determines the necessity of honing the bores or installing sleeves. Refer to Table 10 for honing limits.

Table 10

Honing Dimensions for the Cylinder	
Description	**C7**
New cylinder bore diameter	110.025 + 0.025 - 0.010 mm (4.3317 + 0.0010 - 0.00039 inch)
Limitations of the Flexible Hone	110.000 mm (4.3307 inch) to 110.130 mm (4.3358 inch)

Limitations of the Rigid Hone	110.131 mm (4.3359 inch) to 110.229 mm (4.3397 inch)

Cylinder bores which have at least 75% of crosshatch scratch pattern and only light vertical scratches can be restored by flexible honing of the cylinder bores.

Cylinder bores with less than 75% of the original pattern of the crosshatch should be reconditioned.

C7 bores that are larger than 110.229 mm (4.3397 inch) require a **107-7604** Cylinder Sleeve.

Note: Honing is not recommended on any engine that is restricted by emissions.

If honing is performed on an engine that is not restricted by emissions, oil consumption, wear, and blow by should be considered.

Cylinder reconditioning with flexible hones establishes cylinder wall finish and provides good oil control if done correctly, it also good for deglazing the walls of cylinders that are not out-of-round. The 125-2064 or **142-2285** Cylinder Head Stress Plate for (C7 Engines) is not used when the flexible honing operation is performed.

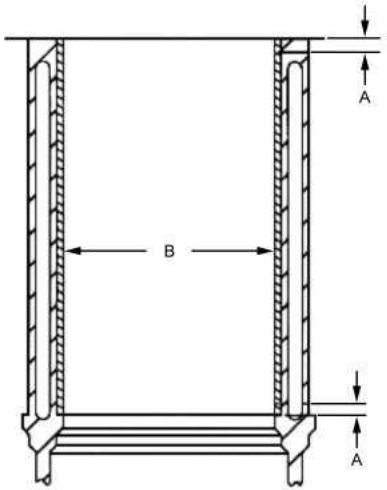

Illustration 48 g01687075

(A) 6.40 mm (0.25197 inch) from each end of the cylinder bore
(B) Center measurement location.

When using rigid bar honing, check the bore size at several locations. Be sure to check locations over the length of the bore and around the circumference. Measure the points that are perpendicular to the centerline of the crankshaft. These points are located (A) 6.40 mm (0.25197 inch) from each end and at the center of the bore. These specific locations are primary gauge positions during honing. Use the 125-2064 or **142-2285** Cylinder Head Stress Plate for (C7 Engines) during rigid bar honing.

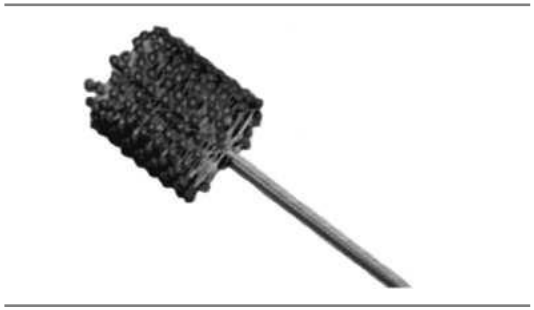

Illustration 49 g03682143

Flexible hone use to condition the cylinder bores prior to piston installation.

1. Use a flexible hone that has 240 grit abrasive on the tips. Caterpillar provides a **4C-6336** Flexible Hone (Flex-Hone) used for C7 Engines.
2. Apply a light solvent or kerosene for lubrication. Do not use engine lubricating oil.
3. While operating the hone, move up and down the liner at a rate of approximately 30 strokes per minutes, one stroke being one complete cycle up and down. (This rate would be one second down and one second up).
4. Vary the stroke rate as necessary to achieve the correct crosshatch angle (140±10°). If the crosshatch is much less than 140°, decrease the number of strokes per minute or increase the rpm of the drill. If the pattern is too flat (greater than 140°), increase the number of strokes per minute or decrease the speed of the drill.

A new flexible hone should restore the surface in approximately 30 seconds. Flexible hone that is worn out will not cut deep enough and the surface will be too smooth and shiny. An adjacent cylinder can be used as a reference for the correct crosshatch pattern.

Installing a 107–7604 Cylinder Sleeve for C7 Engines

The The **107-7604** Cylinder Sleeve is available for C7 Engines. Use the cylinder sleeves when it is determined that the existing cylinder wall(s) are not reusable because of wear, pin holes, cracks, or scoring.

Inspect the cylinder block carefully to be sure it is still usable. If sleeves are to be installed, use the procedure given in this Guideline.

If the dimension of a cylinder, or cylinders, is to be accurately measured, a 125-2064 or **142-2285** Cylinder Head Stress Plate for (C7 Engines) and a STANDARD thickness cylinder head gasket **must** be installed over each cylinder that is to be measured.

Measuring Wall Thickness

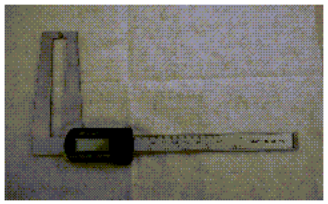

Illustration 50 g01360197
93028 Digital Disc Brake Caliper

Illustration 51 g01360198
Measuring cylinder bore wall thickness with 93028 Digital Disc Brake Caliper

1. Use the 93028 Digital Disc Brake Caliper to measure the wall thickness at the front of each cylinder 30.0 mm (1.18110 inch) below the top face of the block. Measure the block by putting the thin leg of the caliper through the water passage between the cylinders. If the minimum wall thickness on any cylinder is less than 4.3 mm (0.16929 inch), replace the block.

2. If the cylinder block passes Step 1, follow the procedure to install a sleeves in the bores that are not within factory specifications.

Machining Procedure

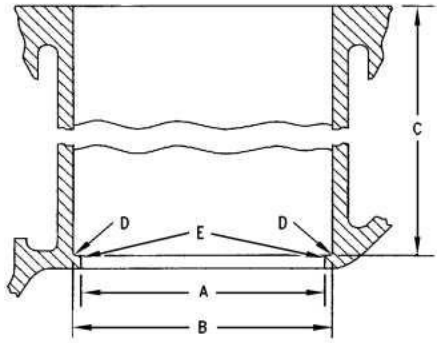

Illustration 52 g06337863

Machining specifications for bore in block.

Note: The stress plate group or the cylinder head stress plate is ONLY used when measuring the bores or performing the honing procedure. The stress plate is not used during block boring procedure. Refer to Table 8 for stress plate group or cylinder head stress plate part numbers.

Table 11

Bore in Block Machining Dimensions	
Callout	**107-7604 Cylinder Sleeve (C7)**
(A)	Original Cylinder Bore Diameter
(B)	114.775 ± 0.013 mm (4.51869 ± 0.00051 inch)
(C)	196.85 ± 0.08 mm (7.74998 ± 0.00315 inch)
(D)	0.3 mm (0.01181 inch) X 45 degree radius
(E)	0.5 mm (0.01969 inch) X 45 degree chamfer

Position boring tool on cylinder block.

Note: Dimension (A) is the diameter of the original bore.

1. Use the centerline of the original cylinder bore (A), and machine the bore to diameter (B) and depth (C). The new bore must be within 0.5 mm (0.01969 inch) total runout with the centerline of original cylinder bore (A).

   Note: Dimension (C) is measured from the top deck (top surface) of the cylinder block.

2. Remove the sharp corner and any burrs at the bottom edge of bore (E).

Installation of Cylinder Sleeve

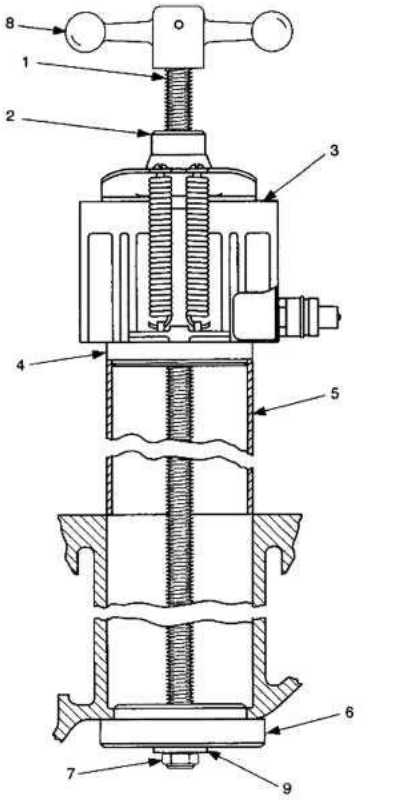

Illustration 53 g06337871

Cylinder sleeve installation tooling.

Table 12

Item Identification		
Callout	Description	Part Number
		C7
(1)	Forcing Screw	6V-2183
(2)	Insert	1P-2329
(3)	Hydraulic Puller Group	1P-0820
(4)	Puller Plate	129-9197
(5)	Cylinder Sleeve	107-7604
(6)	Puller Plate	129-9196
(7)	Nut	1D-5119
(8)	Adjusting Crank	9S-6072
(9)	Washer	5H-1504

1. Remove the **9S-6074** Adjusting Screw from hydraulic puller group (3) and install forcing screw (1) in its place.
2. Use hydraulic puller group (3) with forcing screw (1), insert (2), puller plate (4), puller plate (6), washer (9), nut (7), and cylinder sleeve (5) as shown in Illustration 53.

   Note: Install the cylinder sleeve (5) with the 10º outside diameter chamfer toward the cylinder block.
3. Put clean diesel fuel (No. 2) on the outside diameter of cylinder sleeve (5).
4. Connect a hydraulic pump to hydraulic puller group (3) and pull cylinder sleeve into the bore.
5. Reposition the hydraulic puller group.
   a. Retract hydraulic puller group (3).
   b. Loosen the socket head screw and readjust insert (2).

   Note: Insert (2) will need to be readjusted several times before the sleeve is fully installed.

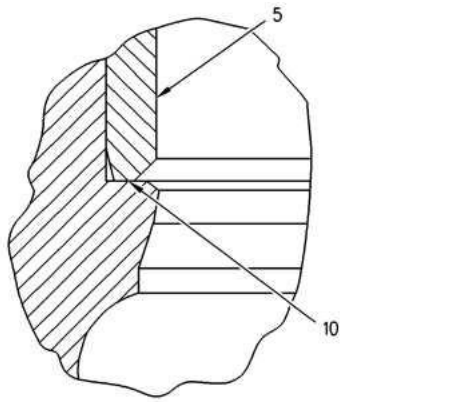

Illustration 54 g06337875
Cylinder sleeve (5) is installed and has complete contact (10) with bottom of bore.

6. Pull cylinder sleeve (5) into the bore until the bottom of the sleeve contacts the counterbore at location (10).

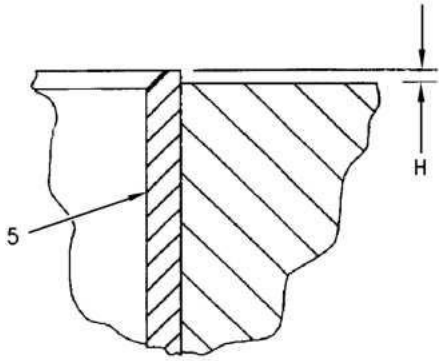

Illustration 55 g06337879
(5) Cylinder Sleeve

(H) Maximum of 0.013 mm (0.00051 inch) above the top deck of the block

NOTICE

If the top of the cylinder sleeve is machined, do NOT nick or cause damage to the top deck of the cylinder block. To ensure a correct seal between the bottom of the cylinder head and the top surface of the cylinder block near the cylinder sleeve, the cylinder head gasket MUST have a smooth surface to seal against.

7. After cylinder sleeve (5) is installed in the cylinder bore, it is acceptable for the top of the cylinder sleeve to extend a maximum of 0.013 mm (0.00051 inch), above the cylinder block top deck. For best installation results, the cylinder sleeve should be flush with the top deck of the cylinder block.

   Note: It is acceptable to machine the top of the cylinder sleeve, so it is even with the cylinder block top deck.

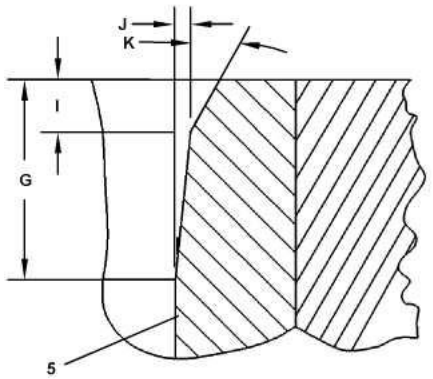

Illustration 56 g06391501

Machine chamfer (I) on the top of cylinder sleeve (5).

8. Machine a chamfer after the sleeve is inserted into the bore. See Illustration 56 and Table 13.

Table 13

Specifications for Cylinder Sleeves	
Callout	**C7**
G	4.0 mm (0.15748 inch) MAX
I	1.02 ± 0.25 mm (0.04016 ± 0.00984 inch)
J	Blend from chamfer (K) to the bore of the sleeve by using a flex-hone.
K	30°
F	Maximum of 0.013 mm (0.00051 inch) above the top deck of the block

9. Use the **1P-3565** Chamfering Group to remove the sharp corner at the bottom of each cylinder bore. The chamfer must be approximately 2.3 mm (0.09055 inch) x 15 degrees. The chamfer is necessary to prevent scuffing of the piston skirt.

Stress Honing Procedure

Installation of Stress Plate

If the dimensions of a cylinder, or cylinders, is to be accurately hone with a 125-2064 or **142-2285** Cylinder Head Stress Plate for (C7 Engines) and a STANDARD thickness cylinder head gasket must be installed over each cylinder that is to be honed.

Table 14

Stress Plate Part Numbers		
Engine	**Stress Plate**	**Stress Plate Group**
3114 / 3116	4C-4377	126-8132
3126	142-2285	125-2064

The correct installation of the STANDARD thickness cylinder head gasket, stress plate group or cylinder head stress plate, and cylinder head bolts will cause the cylinder bore to distort and have the same dimensions that it would have if the cylinder head was installed and properly tightened. Refer to Table 8 for stress plate group or cylinder head stress plate part numbers.

The gasket and stress plate must be installed to accurately measure the cylinder sleeve. If a stress plate group is used, it **must** be installed over each cylinder

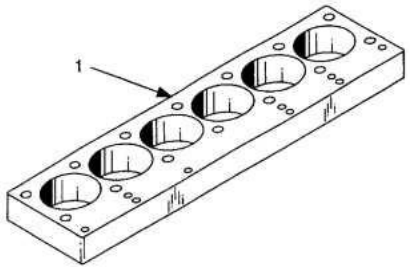

Illustration 57 g06337899

Cylinder head stress plate (1).

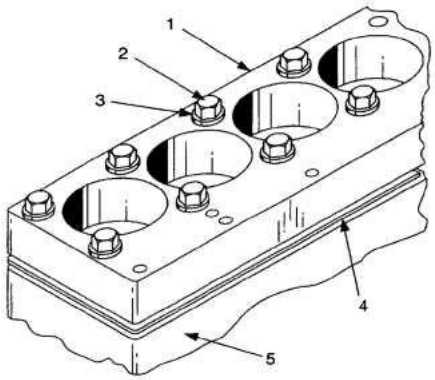

Illustration 58 g06337900

Cylinder head stress plate (1) installed on block (5) with STANDARD gasket (4) using bolts (2) and washers (3).

1. Install a STANDARD thickness cylinder head gasket (4) on cylinder block (5).

   Note: The head surface of the cylinder should contain dowels to position cylinder head gasket (4).

2. Position stress plate (1) over cylinder head gasket (4).

3. Install (original) cylinder head bolts (2) through the stress plate into cylinder block.

4. Initially tighten all bolts (2) evenly to 150 ± 15 N·m (110 ± 11 lb ft).

5. Finish tightening all bolts (2) evenly to 435 ± 20 N·m (320 ± 15 lb ft).

Honing Procedure

Finished bore dimension measurements must be made with the stress plate installed. The stress plate is to make sure that the correct cylinder dimensions are maintained after the cylinder head is installed.

Table 15

Rottler HP3A Honing Machine Data **Make sure that the stress plate is installed prior to any machining procedures on the cylinder sleeve.**			
Item	**Rough (1)**	**Semi-Finish**	**Finish**
	C7	**C7**	**C7**
Standard Bore	109.935 ± 0.025 mm (4.32814 ± 0.00098 inch)	109.986 ± 0.025 mm (4.33015 ± 0.00098 inch)	110.025 + 0.025 - 0.010 mm (4.3317 + 0.0010 - 0.00039 inch)
Cylinder Length	203.2 mm (7.99998 inch)	203.2 mm (7.99998 inch)	203.2 mm (7.99998 inch)
Hone Head	514-5-61B	514-5-61B	514-5-61B
Stroke Scale	15.9 mm (0.62598 inch)	15.9 mm (0.62598 inch)	15.9 mm (0.62598 inch)
Cylinder Length Setting	203.2 mm (7.99998 inch)	203.2 mm (7.99998 inch)	203.2 mm (7.99998 inch)
Rotation Speed (rpm)	165	165	165
Strokes per Minute	55	55	55
Feed Rate	0.0102 mm (0.00040 inch) per 2 strokes	0.0102 mm (0.00040 inch) per 5 strokes	0.0102 mm (0.00040 inch) per 7 strokes
Top Over Stroke	19.05 mm (0.75000 inch)	19.05 mm (0.75000 inch)	19.05 mm (0.75000 inch)
Stone	514–5–54M (80 grit)	514–5–54N (180 grit)	514–5–54Q (320 grit)
Load Meter	100%	80%	40%
Stock Removal Rate per Minute	0.076 to 0.102 mm (0.00299 to 0.00402 inch)	0.051 mm (0.00201 inch)	0.020 mm (0.00079 inch)
Honing per Each 0.03 mm (0.00118 inch) Stock Removal, Advance Feed	3 increments	3 increments	2 increments
Surface Texture	2.3 to 3.05 µm (90.55118 to 120.0787 µinch)	0.64 to 0.99 µm (2519685 to 38.97638 µinch)	0.31 to 0.50 µm (12.20472 to 19.68504 µinch)

(1) Rottler recommends boring (cutting) for the cylinder sleeve rough cut, rather than honing. Both methods are acceptable.

Table 16

Sunnen Honing Machine Data **Make sure that the stress plate is installed prior to any machining procedures on the cylinder sleeve.**			
Item	**Rough**	**Semi-Finish**	**Finish**
	C7	**C7**	**C7**
Standard Bore	109.935 ± 0.025 mm (4.32814 ± 0.00098 inch)	109.986 ± 0.025 mm (4.33015 ± 0.00098 inch)	110.025 + 0.025 - 0.010 mm (4.3317 + 0.0010 - 0.00039 inch)
Cylinder Length	203.2 mm (7.99998 inch)	203.2 mm (7.99998 inch)	203.2 mm (7.99998 inch)
Hone Head	CK–3000	CK–3000	CK–3000

Stroke Scale	69.9 mm (2.75196 inch)	69.9 mm (2.75196 inch)	69.9 mm (2.75196 inch)
Cylinder Length Setting	203.2 mm (7.99998 inch)	203.2 mm (7.99998 inch)	203.2 mm (7.99998 inch)
Cylinder Length Setting	152.0 mm (5.98424 inch)	152.0 mm (5.98424 inch)	152.0 mm (5.98424 inch)
Rotation Speed (rpm)	155 (1)	155 (1)	155 (1)
	170 (2)	170 (2)	170 (2)
Strokes per Minute	46 (1)	46 (1)	46 (1)
	57 (2)	57 (2)	57 (2)
Feed Rate	6	6	4
Top Over Stroke	9.5 mm (0.37402 inch)	9.5 mm (0.37402 inch)	9.5 mm (0.37402 inch)
Stone	EHU - 123	EHU - 525	EHU - 625
Load Meter	85%	75%	40%
Stock Removal Rate per Minute	0.13 mm (0.00512 inch)	0.064 mm (0.00252 inch)	0.051 to 0.064 mm (0.00201 to 0.00252 inch)
Honing per Each 0.03 mm (0.00118 inch) Stock Removal, Advance Feed	0.03 mm (0.00118 inch)	0.08 mm (0.00315 inch)	0.08 mm (0.00315 inch)
Surface Texture	N/A	N/A	0.20 to 0.50 µm (7.874016 to 19.68504 µinch)

(1) For a Sunnen CK-10 Honing Machine.

(2) For a Sunnen CV-616 Honing Machine.

1. After the stress plate group is correctly installed (as shown in Illustration 44) proceed with the honing operation.

Note: For the correct honing specifications, use Table 15 or Table 16, depending on the honing/boring machine being used.

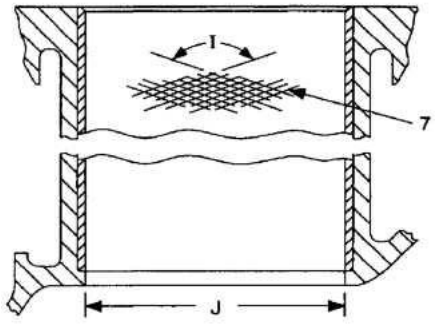

Illustration 59 g06337902

Cross hatch pattern and finished bore diameter.
(7) Cross hatch pattern
(I) 140 ± 10 degrees
(J) C7 Engines: 110.025 + 0.025 - 0.010 mm (4.3317 + 0.0010 - 0.00039 inch).

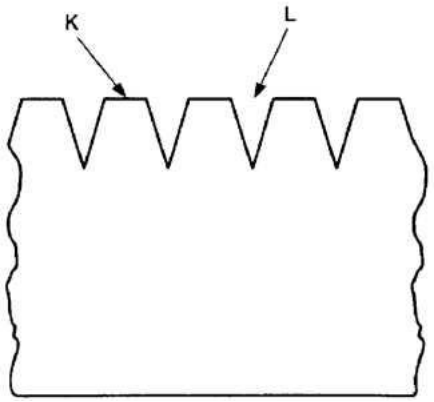

Illustration 60 g06337905

Magnified view of cross hatch pattern (7).
(K) Surface (land) area
(L) Honing scratch or groove

2. Hone the sleeve to obtain a cross hatch pattern (7), Illustration 59) with an angle of 140 ±10 degrees (I), Illustration 59). The cross hatch scratch pattern must be the same in both directions.

   Honing grooves (L), Illustration 60) must be 0.025 to 0.050 mm (0.00098 to 0.00197 inch) deep, and surface (K), Illustration 60) must be 40 to 65% of the surface.

   The scratch pattern must also be free of any material that can bend over and close the open area of honing grooves (L).

3. The honed surface must be free of glaze and/or burnish. Refer to the"Glaze"and "Burnish" sections for additional information.

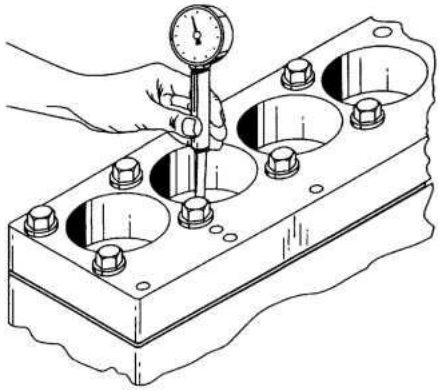

Illustration 61 g06337912

Use a dial bore indicator and check the diameter of the bore.

4. During honing, check the size of the bore at several locations along the length of the bore and also around the circumference.

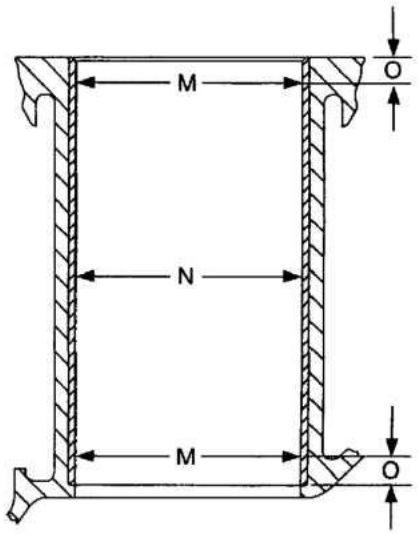

Illustration 62 g06337915

Check the bore diameter at locations (M) and (N). Location (M) is 6.4 mm (0.25197 inch) (O) from each end of the sleeve.

5. Inspect the bore dimension at several points that are perpendicular (at right angles) to the crankshaft centerline. The following three specific locations are primary gauge points, both during and after honing.
   a. Check the diameter at locations (M), Illustration 62), 6.4 mm (0.25197 inch), from each end of the sleeve.
   b. Check the diameter at the center of the sleeve, location (N), Illustration 62.
6. After the honing cycle is completed and before the engine is assembled, remove the camshaft bearings to permit cleaning of the cylinder block.

Glaze

Glazing produces a brown color on the surface of the cylinder wall.

Glazing can be caused by honing stones that are not cutting correctly or honing stones which are overheating. Overheating causes the honing oil to oxidize and transfer the residue into the cylinder wall.

Inspect the tooling to make sure that the honing stones are seated correctly in the holders. The honing stones must also be used with the recommended volume and type of honing oil.

Make sure the recommended Stock Removal Rate, Honing Per 0.03 mm (0.00118 inch) Stock Removal, and Advance Feed settings are correct for the tooling being used. Refer to Table 11 and 8.

Burnish

Burnish is when the cylinder walls have a smooth finish or shiny surface, but there are areas of the bore that have not been honed correctly.

Burnishing can be caused by honing stones that are not in even contact with the cylinder wall.

Inspect to make sure that the honing stones are seated correctly in the holders. Check for even wear of the honing stones and make sure that the tooling is correctly aligned.

Cleaning the Cylinder Bore

After the honing procedure is completed and before the engine is assembled, remove the camshaft bearings and clean the cylinder block.

NOTICE

The result of incomplete and/or insufficient cleaning of the cylinder block will be piston seizure or rapid wear of the cylinder sleeve bores,

pistons and piston rings.

Only the thorough use of a rotary brush will correctly remove the abrasive particles left behind from the honing procedure.

Use a **1P-5580** Brush with a strong detergent and water solution to thoroughly clean the cylinder block, the main oil gallery and oil supply passage, the camshaft bearing oil passages, and the cylinder bores.

The cylinder block must be thoroughly cleaned in an agitator-type cleaning tank.

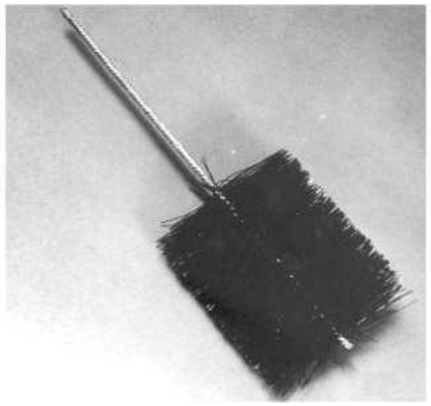

Illustration 63 g06338340

1U-7429 Nylon Brush is used to clean the cylinder bores after honing.

Note: Use the **1U-7429** Nylon Brush to clean the honed bore of the cylinder sleeve. Put clean SAE 30W engine oil on all machined surfaces after the cleaning procedure is completed.

Keep a protective cover on the cylinder block until final assembly.

Inspection of Spacer Plates

During visual inspection of spacer plates, they may appear damaged even though the operation of the engine has been normal. Signs of corrosion and erosion may appear to be severe, whereas most the time the spacer plate can be used again. Many times corrosion and erosion damage are the results of improperly maintained cooling systems.

A used and/or reconditioned spacer block must be inspected for corrosion or erosion damage to the liner bore, the bottom O-ring sealing surfaces, and the cylinder head mounting surfaces. Spacer plates must also be inspected for handling damage, flatness, and thickness.

Nomenclature

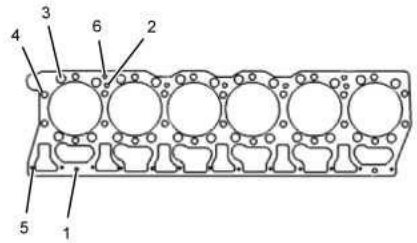

Illustration 64 g01530981

Typical Example
(1) Oil supply holes
(2) Oil drain holes
(3) Water ferrules
(4) Large bolt holes
(5) Small bolt holes
(6) Locating dowel holes for assembly

Initial Inspection

Visually inspect the spacer plate for bending, scratches, deep cuts, heat, and impact damage before cleaning. Do not reuse any spacer plate that contains the following:

- Cracks with spalling of material
- Burnt paths from exhaust gas leakage with measurable width and depth

General Inspection Procedure

Follow the instructions in this guideline to determine reusability of the spacer plate.

1. Visually inspect the general condition of the spacer plate for obvious damage.
2. Clean the spacer plate thoroughly.
3. Visually inspect the spacer plate for cracks, corrosion, erosion, handling damage, and other damage after cleaning the spacer plate. Be sure to check both sides of the spacer plate. If any of this damage is present, do not reuse the spacer plate.

Cleaning Methods

The spacer plate should be cleaned after the initial inspection. Cleaning the spacer plate aids in the thorough inspection of the spacer plate.

3400 Engines can use a die cast aluminum spacer plate. The aluminum spacer plate weighs less than the steel spacer plate. Caution must be used when an aluminum spacer plate is being cleaned. Xylene solvent and Scotch Brite pads are recommended materials for cleaning the plate.

Do not use the following methods for cleaning aluminum plates:

- Aluminum oxide
- Wire brush
- Sanding or Scraping

The recommended materials for removing PTFE residue and carbon are xylene solvent or Scotch-Brite cleaning pads.

The following methods are also acceptable for cleaning the steel spacer plate:

- Aluminum oxide
- Wire brush or wire wheel
- Scraping or sanding

Glass beads can be used to clean the spacer plates. Change the glass beads and check the nozzle regularly for best results. Use the following specifications for glass beads:

- Size 10 glass beads.
- 0.088 mm to 0.149 mm (0.0035 inch to 0.0059 inch)
- 550 kPa to 620 kPa (80.0 psi to 90.0 psi) air pressure

Note: Do not use glass beads that are larger than 0.23 mm (0.009 inch) to clean the spacer plate. Large glass beads may damage the spacer plate.

Plate Thickness for 3400 and C15 - C32 Engines

The thickness of the spacer plate should be 8.585 ± 0.025 mm (0.3380 ± 0.0010 inch). The thickness may vary up to 0.025 mm (0.0010 inch).

Visual Inspection

Illustration 65 g01531335

The spacer plate is bent or warped.

Do Not Use Again

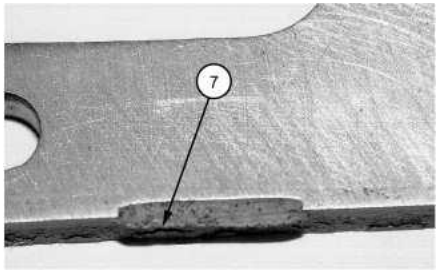

Illustration 66 g01531613

The edge of the spacer plate contains impact damage. Impact damage affects thickness and capability of sealing oil.
(7) Impact Damage

Do Not Use Again

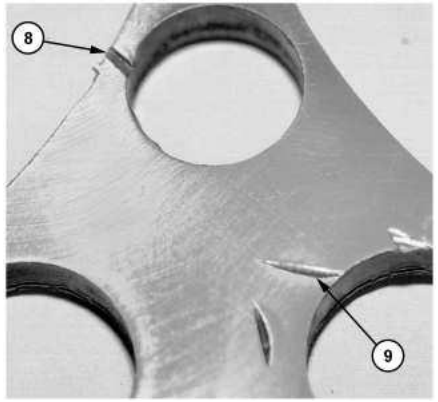

Illustration 67 g01531796

The spacer plate contains a deep cut
(8) Cut between large bolt hole (4) and the clearance hole for the cylinder liner
(9) Cut around water ferrules (3)

Do Not Use Again

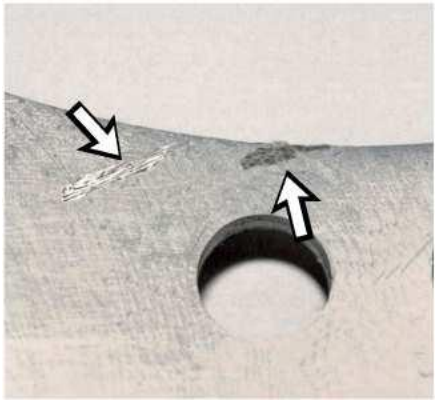

Illustration 68 g06147257
Deep scratches around oil supply hole.

Do Not Use Again

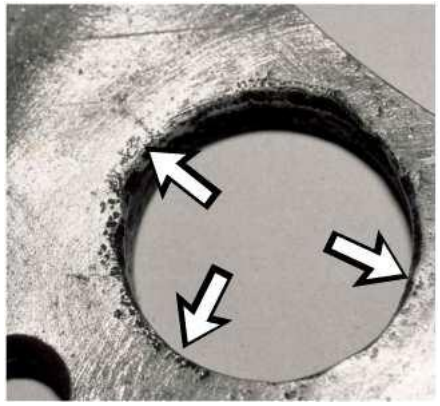

Illustration 69 g06147264
This spacer plate contains erosion. This erosion is around the water ferrule hole.

Do Not Use Again

Note: If the spacer plate has erosion do not reuse the spacer plate.

Areas outside the area of gasket contact on the spacer plate may have depressions on the surface that are 1.0 mm (0.04 inch) deep and 6.0 mm (0.24 inch) in diameter. This is applicable to both sides of the spacer plate. No raised material is allowed. No depressions are allowed within 6.0 mm (0.24 inch) of the edge of the spacer plate.

The 0.025 mm (0.0010 inch) maximum variation of thickness does not apply to the depressed areas.

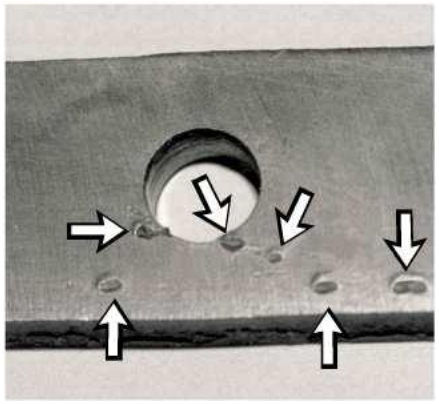

Illustration 70 g06147311

The spacer plate has depressions around small bolt holes (5) and depressions along the edge.

Use Again Reuse the spacer plate only if depressions are present and less than 1 mm (0.03937 inch). The raised areas must be removed with a file.

Do Not Use Again The spacer plate is not reusable if depressions are present. No depressions are allowed within 6 mm (0.24 inch) of the edge of the spacer plate.

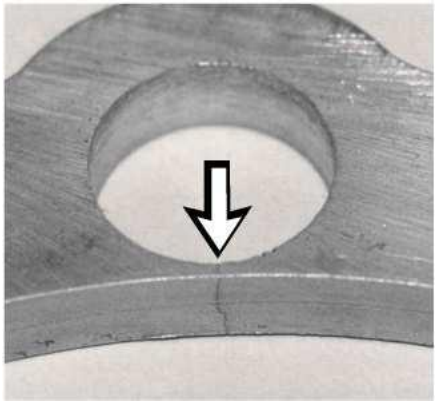

Illustration 71 g06147319

The spacer plate has a crack (17)

Cracks without measurable width are permitted between large bolt holes (4) and the clearance holes for the cylinder liner or pockets for the valves. Hairline cracks are also permitted between adjacent large clearance holes for the cylinder liner. Hairline cracks in these areas will not affect the function of the spacer plate.

Do Not Use Again

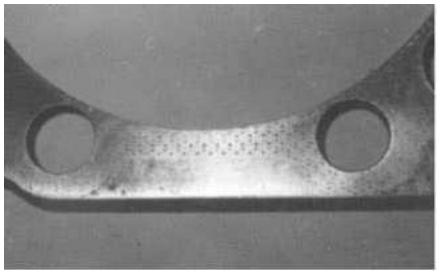

Illustration 72 g01533014

The spacer plate is imprinted from a perforated gasket.

Use Again

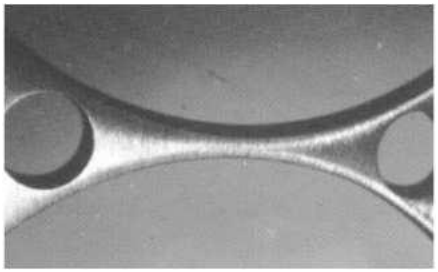

Illustration 73 g01533993

The spacer plate was damaged from unacceptable methods of cleaning.

Do Not Use Again

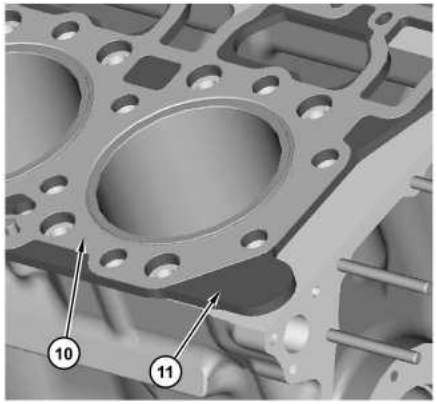

Illustration 74 g01532594

(10) Area of gasket contact on the spacer plate
(11) Spacer plate

Inspection for 3176 Spacer Plates

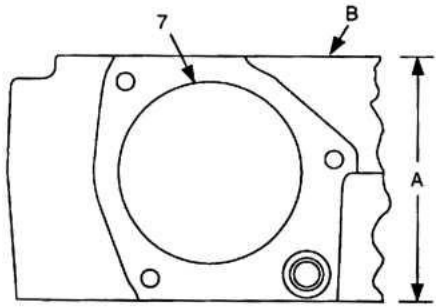

Illustration 75 g06344251

Minimum thickness and surface flatness.
(7) Camshaft bore
(A) Thickness measurement of 99.95 mm (3.93503 inch)
(B) Flatness specification of 0.05 mm (0.00197 inch) or less per 150 mm (5.90550 inch)

Before the spacer block is removed, check liner projection and flatness. If these dimensions are correct, there is no reason to measure the spacer block.

Measure the spacer block for thickness and flatness. When measuring the spacer block for flatness, use the procedures described in SEHS9540Special Instruction, "3176 Cylinder Head Gasket Repair Procedure" to secure the spacer block to the cylinder block.

To check flatness, use a feeler gauge and 150 mm (5.90550 inch) metal scale. The thickness should be measured at each cylinder liner bore and each end of the spacer block.

Top Land of Cylinder Liner Bore

Illustration 76 g06344262

Erosion damage to the top land surface.

Use Again - if erosion is less than 270° around the diameter of the bore and the erosion is less than 0.8 mm (0.03150 inch) deep.

Erosion on the top land diameter, as shown in Illustration 76, is allowed. Normally, if erosion damage is present on the top land surface, there will be additional damage to the area inside the cylinder liner water jacket.

Corrosion Above Seal Land

Illustration 77 g06344272

Corrosion which occurred during engine storage.

Use Again

The corrosion shown in Illustration 77 occurred during engine storage and prior to installation. There is no evidence that this type of damage will progress any further during normal operation of the engine. Cleaning is not necessary unless the spacer block has been removed from the engine and is being cleaned for other reasons. After cleaning, cosmetic repairs can be made using a composite material if the corrosion is deeper than 0.8 mm (0.03150 inch).

Erosion to Water Jacket Surface

Illustration 78 g06344278

Erosion damage showing signs of early problems in the cooling system.

Use Again

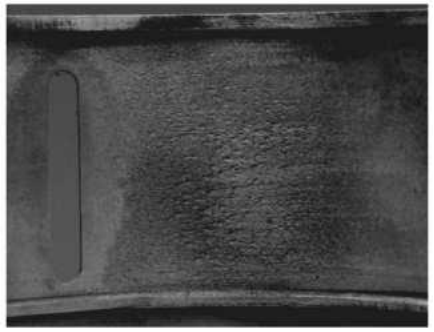

Illustration 79 g06344282
More severe erosion due to problems in the cooling system.

Use Again - after repairing the damage.

Erosion to Lower Land

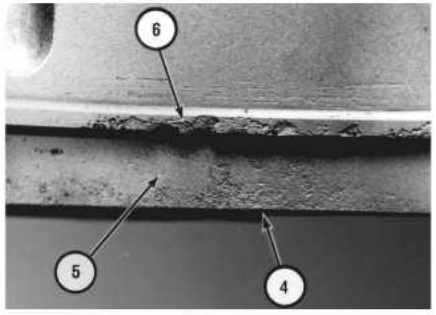

Illustration 80 g06344289
Damage to lower land and erosion with a path completely across the seal bore.
(4) Seal surface
(5) Liner seal surface
(6) Lower land

Use Again - after repairing the damage to the seal bore.

The lower land (6) is a non-functional surface; therefore, erosion in this area is acceptable.

If erosion has progressed completely across liner seal surface (5) and is less than 0.8 mm (0.03150 inch) deep, the spacer plate can be used again. If severe erosion is present on the seal surface (4), the bore must be repaired with a composite type material or metal spray. The bore must then be machined.

Head Gasket Surfaces

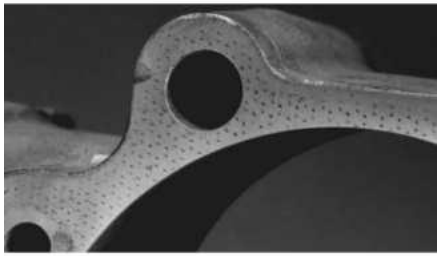

Illustration 81 g06344311

Head gasket pattern on top of spacer. These indentations do not need to be removed.

Use Again

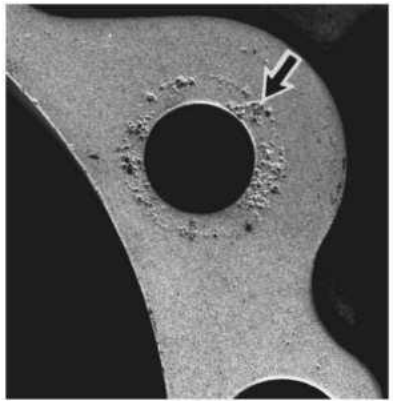

Illustration 82 g06344315

Pitting has occurred inside of a gasket hole but does not progress across the area covered by the gasket.

Use Again

It is not necessary to remove all residual black gasket coating material from the spacer plate. However, gasket material should be removed near the area around the liner bore to accurately measure liner projection. Clean the surface of the spacer block lightly with a hand-held Scotch Brite pad. Do not use heavy strokes with the pad. Do not use power tools or sharp tools such as chisels and screwdrivers on any machined surfaces.

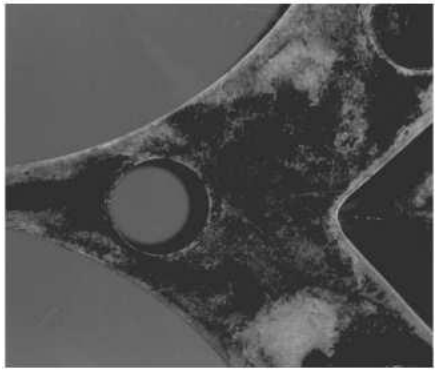

Illustration 83 g06344319

Black gasket compound on the surface of the spacer plate.

Use Again - after removing the gasket compound.

Impact Damage

Impact damage which creates a path between any bolt hole or water/oil passage cannot be used again unless first repaired. Filling the damaged area and eliminating possible leakage paths can be done with a composite material. Any raised material must be carefully removed with a flat file. Do not over-clean the surface.

After any repairs have been made to the top and/or bottom surfaces, the spacer block must be measured for flatness while it is bolted to the cylinder block. Measure the flatness of the spacer block using a straight edge and feeler gauge. The block must be flat within 0.05 mm (0.00197 inch). If not, the spacer block must be replaced or repaired.

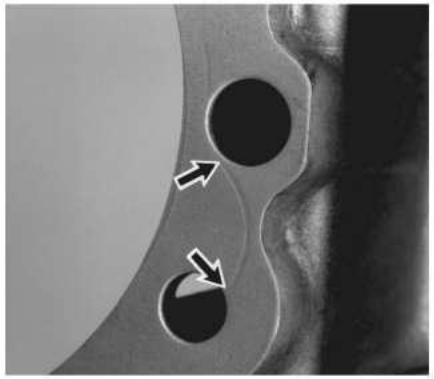

Illustration 84 g06344323

Indentation which connects two holes or passages.

Use Again - after repairing the damage.

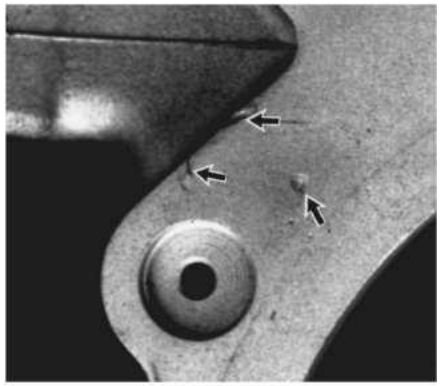

Illustration 85 g06344326

Use Again

The damage shown in Illustration 85 is minor and does not contact or connect any coolant passages. Carefully remove any raised material with a flat file. Do not damage the gasket sealing surfaces and maintain the flatness of the spacer plate.

Erosion Damage Around Fluid Passages

Any erosion damage which provides a path for fluids to leak from one passage to another or from a passage to the outside of the spacer plate cannot be used again. This type of erosion produces leakage paths which cannot be sealed by head gaskets. If the erosion damage can be corrected and the spacer plate meets thickness and flatness specifications, it can be used again.

Over-cleaning of the top or bottom surfaces will also provide a leakage path by polishing (removing metal). It can produce a low spot or path from the sealing area to an outside surface of the spacer plate.

Illustration 86 g06344330
Erosion and pitting is isolated and does not connect any passages.

Use Again

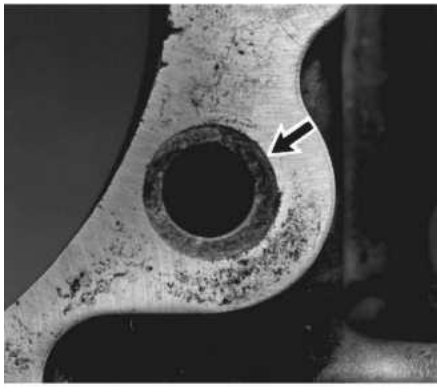

Illustration 87 g06344332
Erosion damage around a fluid passage.

Do Not Use Again - unless the surface is repaired.

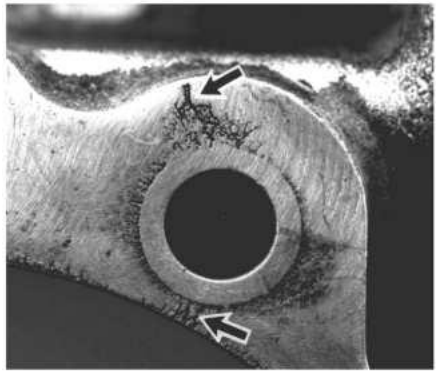

Illustration 88 g06344333

Severe erosion damage has caused a path, indicated by the arrows, between a fluid passage and the outside surfaces.

Do Not Use Again - unless the surface is repaired.

Twinsert Installation Procedure

Note: Do not repair the holes using the **4C-8451** Heli-Coil Insert Package (M8 x 1.25 x 12 mm long) which is offered in the Cat system. These inserts are a different length, and are intended for single-insert thread repair only; they **must not** be used in place of the **135-7636** Twinserts.

This procedure is used to repair M8 x 1.25 tapped holes in the spacer deck.

1. Carefully inspect for damaged holes. If required, remove any debris, old Heli-Coil insert, or pieces from the hole using needle nose pliers or a seal pick.
2. Measure the hole to determine the depth. Use a **1U-8168** Drill Bit to drill a 10 mm (0.39370 inch) diameter hole to the original depth of either 12.0 mm (0.47244 inch) or 16.0 mm (0.62992 inch).
3. Tap the hole to original depth using the special **135-7639** Tap.
4. Install a 135-7631 12.0 mm (0.47244 inch) or a 140-9745 16.0 mm (0.62992 inch) Outer Insert (larger diameter) using **135-7637** Installation Tool.
5. Break off the outer insert driving tang, using a **135-7638** Break-Off Tool.

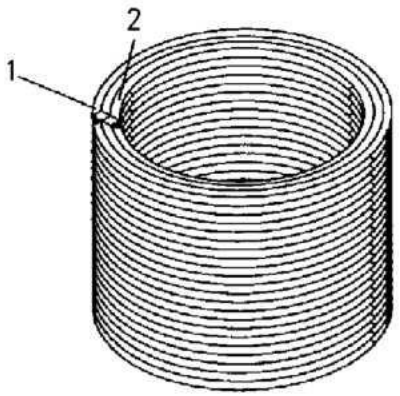

Illustration 89 g06344339

Proper installation of inner (2) and outer (1) Twinserts with ends of inner (2) and outer (1) inserts correctly aligned.

6. Install a 135-7636 12.0 mm (0.47244 inch) long or a 140-9740 16.0 mm (0.62992 inch) long Inner Insert (smaller diameter) using an **8T-2790** Installation Tool. Position inner insert (2) so the end coil of the inner insert is flush with the end coil of outer insert (1), as shown in Illustration 89.

7. Break off the inner insert driving tang using a rod or punch slightly smaller than the minor thread diameter. The completed assembly will provide a Class 2B fit

8. Several utility boxes in the Cat system, such as 4C-3725 or 4C-4783 Plastic Divided Utility Box, are useful for organizing and storing installation tools and Twinsert packages.

Dimensions for the Aluminum Washer

The aluminum spacer plate on some 3408 and 3412 engines has been modified. The plates now provide adequate material around the oil supply holes to the rocker arms for the O-Ring seal. The holes were counterbored from the bottom side only to accept an aluminum washer. This aluminum washer is not available for parts service. The spacer plate was machined to provide a press fit for the washer. Table contains the dimensions for machining the washers.

Table 17

Dimensions of the Aluminum Washer	
Description	**Dimension**
Thickness	3.7 ± 0.025 mm (0.14567 ± 0.00098 inch)
Outside Diameter	27 ± 0.025 mm (1.06299 ± 0.00098 inch)
Inside Diameter	9.9 ± 2.5 mm (0.38976 ± 0.09843 inch)

Note: Clean the counterbore in the spacer plate before installing a new aluminum washer. Do not use adhesive.

Application of Sealant to Spacer Plate Gasket

The spacer plate gasket should be coated with Loctite® #1522029 Aviation Gasket Sealant before installation. The spacer plate gasket is a single layer gasket and care should be taken to prevent damage to the gasket. Damaged gaskets will not seal correctly causing leaks. Gloves should be worn while applying Loctite® #1522029 Aviation Gasket Sealant to the spacer plate gasket. Obtain a small roller to help spread the Loctite® #1522029 Aviation Gasket Sealant out evenly across the spacer plate gasket. The following steps will help detail applying Loctite® #1522029 Aviation Gasket Sealant to the spacer plate gasket.

To provide addition clarification and details, a Caterpillar Channel 1 video has been created outlining the critical steps in applying gasket sealant. Reviewing the videos is recommended prior to starting the process.

Note: A CWS login is required to access Caterpillar Channel 1 Videos.

Table 18

Caterpillar Channel 1	
Title:	"Sealant Application to Spacer Plate Gasket"
Caterpillar Channel 1 URL:	**https://channel1.mediaspace.kaltura.com/playlist/dedicated/71706731/1_rcz3oenx/1_i9ktbgnj**

Note: Loctite® #1522029 Aviation Gasket Sealant is not a Caterpillar Part number and must be ordered from Loctite® Henkel Corp.

Illustration 90 g03853390

Loctite® #1522029 Aviation Gasket Sealant and a rubberized roller for spreading the Loctite® #1522029 Aviation Gasket Sealant .

Illustration 91 g03853384

1. Place the spacer plate gasket on a flat work surface.

Illustration 92 g03853388

2. Remove the plastic cover from the packaging. Keep the cardboard under the spacer plate gasket for easy cleanup after applying the gasket sealant.
3. Apply a thin coat of Loctite® #1522029 Aviation Gasket Sealant to the spacer plate gasket.

Illustration 93 g03853407

4. Use the roller to spread the Loctite® #1522029 Aviation Gasket Sealant.
5. Gently turn the spacer plate gasket over and repeat the above steps to coat the opposite side of the spacer plate gasket
6. Once the spacer plate gasket is fully coated install on the engine.

3406E, C15 Through C18 Liner Projection Measuring Procedure

Table 19

Required Tooling		
Part Number	**Part Description**	**Qty**
8T-0455	Liner Projection Tool Group	1

Table 20

Required Components for C15 Through C18				
Item	**Part Number**	**Description**	**Quantity For One Cylinder**	**Quantity For Six Cylinders**
1	7H-3598	Track Bolt	6	36
2	8F-1484	Washer	6	36
3	7X-0564	Washer	6	36

Note: For engines that use aluminum spacer plates use two **2F-0126** Copper Washers instead of the **7X-0564** Washer.

1. Clean the cylinder liner flange and the cylinder block surface. Remove any nicks on the top of the cylinder block.
2. Install a new spacer plate gasket and a clean spacer plate.
3. Install the cylinder liners in the cylinder block without seals or bands.

4. Install the washers.

5. Install all the bolts or the six bolts around the liner. Do not use impact tooling to install bolts. The correct torque for these bolts is 95 N·m (70.0 lb ft).

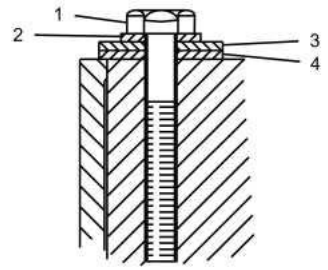

Illustration 94 g06238561

Location of the components
(1) Bolt
(2) Washer
(3) Washer
(4) Washer

6. The components should be assembled in the order that is shown in Illustration 94. **7K-1977** Washer (4) is made of a cotton fabric that is impregnated with resin. The washer will not damage the sealing surface of the cylinder block.

   Note: Inspect the washer before measuring the liner projection. Replace the washer if the washer is worn or damaged.

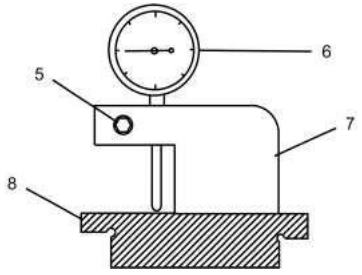

Illustration 95 g06238567

8T-0455 Liner Projection Tool Group
(5) Bolt
(6) Dial indicator
(7) Gauge body
(8) Gauge block

7. Loosen bolt (5) until dial indicator (6) can be moved. Place gauge body (7) and dial indicator (6) on the long side of gauge.

8. Slide dial indicator (6) into the correct position. When the point of the dial indicator contacts gauge block (8), the dial indicator is in the correct position. Slide the dial indicator until the needle of the gauge makes a quarter of a revolution clockwise. The needle should be in a vertical position. Tighten bolt (5) and zero the dial indicator.

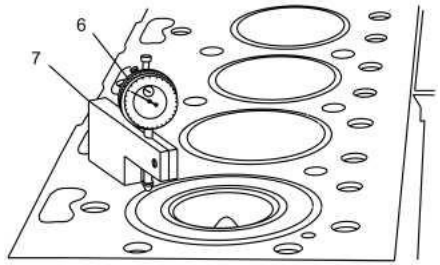

Illustration 96 g06238571

Measure the liner projection.
(6) Dial indicator
(7) Gauge body

9. Place gauge body (7) on the plate for the cylinder block. The indicator point should be on the liner flange. Read the dial indicator to find the amount of liner projection. Check the projection at four locations (every 90 degrees) around each cylinder liner.

10. Install the washers. Install all bolts or the six bolts around the liner.

    Torque for bolts ... 95 N·m (70 lb ft)

11. Use the **8T-0455** Liner Projection Tool Group to measure the liner projection at "A", "B", "C", and "D".

12. Record measurements for each cylinder.

13. Add the four readings for each cylinder. Divide the sum by four to find the average.

Table 21

Specifications for C15 Through C18	
Liner Projection for New, REMAN & Blocks Surface Milled Out of Chassis	0.025 to 0.152 mm (0.0010 to 0.0060 inch)
Liner Projection for Blocks Counterbored With Shims	0.08890 mm (0.0035 inch) to 0.15240 mm (0.0060 inch)
Maximum Variation inch Each Liner	0.051 mm (0.0020 inch)
Maximum Average Variation Between Adjacent Liners	0.051 mm (0.0020 inch)
Maximum Variation Between All Liners Excluding Blocks Counterbored With Shims	0.102 mm (0.0040 inch)
Maximum Variation Between All Liners for Blocks Counterbored With Shims	0.06350 mm (0.0025 inch)

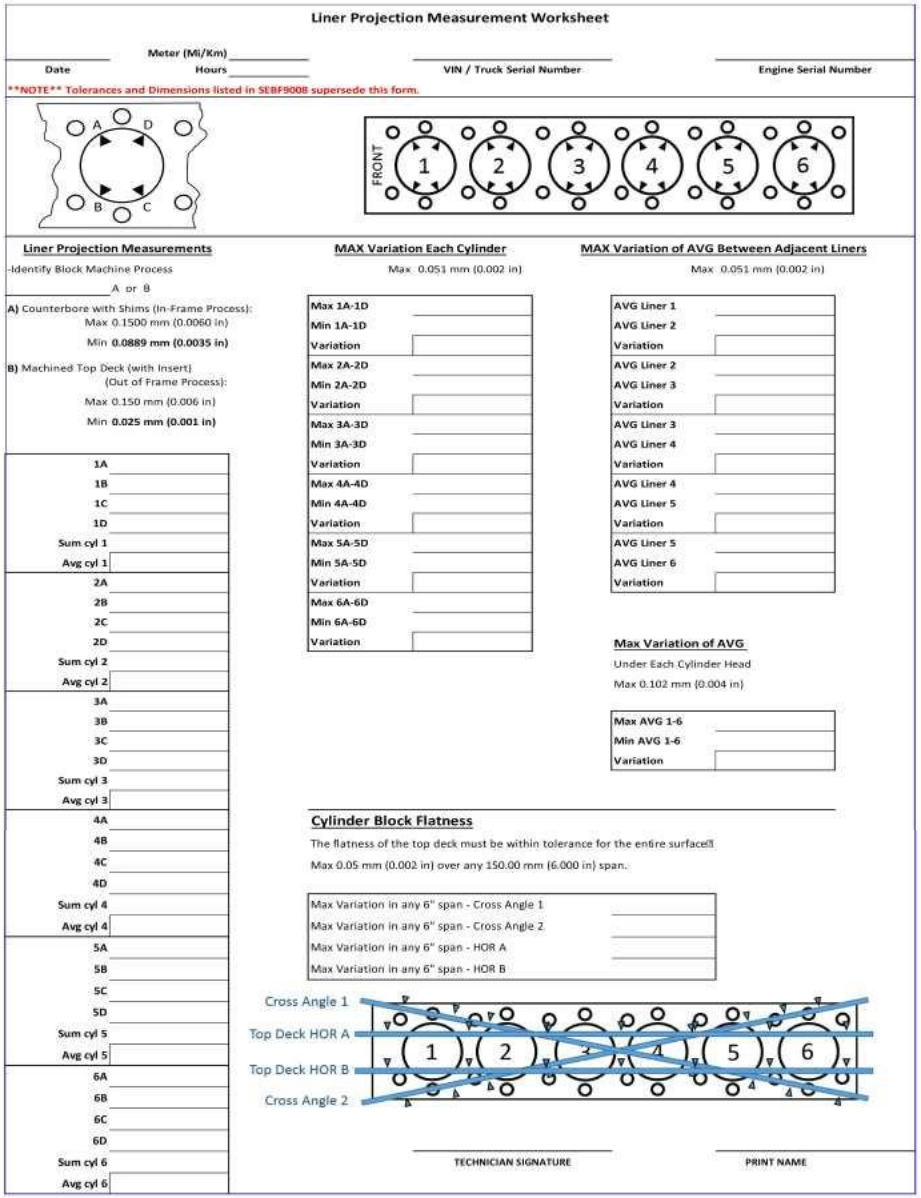

Illustration 97 g06229149

Table 22

Optional Thinner Spacer Plates	
Part Number	**Engines**
138-9381	C15, C-15, 3406E, C-16, C18, and 3456
284-8768	3412, C27, and C32

If the liner projection measurements are below the specifications, a thinner spacer plate can be used. The thinner spacer plate should also be installed if the liner projection measurements are low within a range. These plates are 0.076 mm (0.0030 inch) thinner than the regular plate. These plates will increase the liner projection. The crush of the fire ring will be increased. Use these spacer plates to compensate for low liner projections that are less than 0.076 mm (0.0030 inch). Use these spacer plates if the inspection of the top deck reveals no measurable damage directly under the liner flanges but the average liner projection is less than 0.076 mm (0.0030 inch).

Do not exceed the maximum liner projection of 0.152 mm (0.006 inch). The excessive liner projection will contribute to cracking of the liner flange.

When the liner projection is correct, put a temporary mark on the liner and the spacer plate. Set the liners aside.

Note: Refer to Disassembly and Assembly, "Cylinder Liner - Install" for the correct final installation procedure for the cylinder liners.

Machining the Top Deck

Illustration 98 g06238572

If the top deck is not flat within specifications, the top deck of the cylinder block will need to be machined. Machining the top deck will ensure that the top deck is flat and within specifications.

Note: When inserts need to be installed on the top deck, do not machine the top deck until these inserts have been installed.

Coolant Passage

Inspection

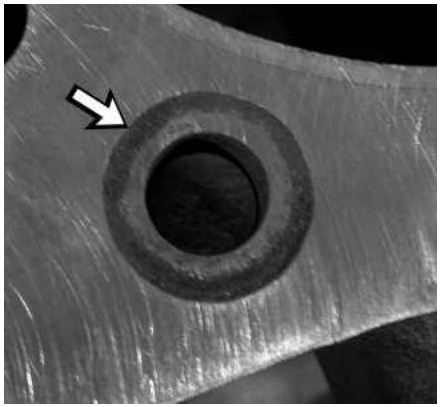

Illustration 99 g01387741
Erosion around the coolant passage

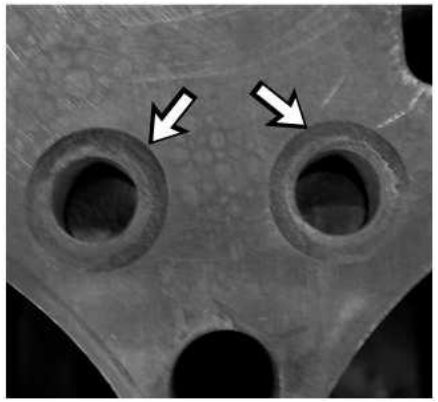

Illustration 100 g01387743

Erosion around the coolant passage

Erosion often takes place at the coolant passage. When the pitting is deeper than 0.13 mm (0.005 inch) or if the pitting has occurred completely around the coolant passage, then repair the pitting by installing Inserts . These inserts will minimize the amount of material that is removed from the top deck.

Installation of 179-5410 Plug into the Cylinder Block Water Passage

1. Place the cylinder block in a drill and clamp the block in place.

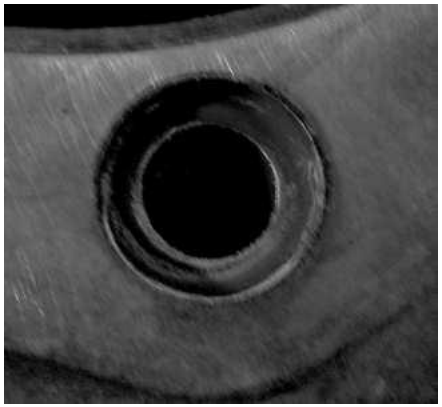

Illustration 101 g01387773

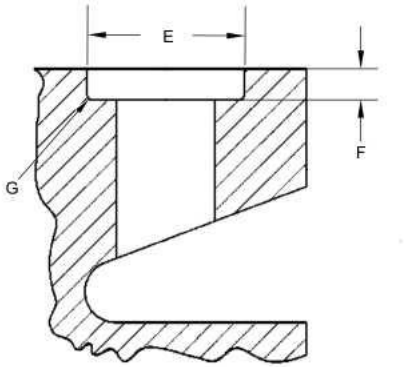

Illustration 102 g01394632

(E) Diameter of counterbore
(F) Depth of counterbore
(G) Chamfer of counterbore

2. Use a 25.362 mm (0.999 inch) end mill to machine the counterbore in the coolant passage. Refer to Illustration 102 and Table 23 for the correct dimensions of the counterbore.

Table 23

Dimensions for the Counterbore inch the Coolant Passage	
Diameter (E)	25.368 ± 0.011 mm (0.9987 ± 0.0004 inch)
Depth (F)	5.4mm +0/ -0.1 mm (0.21260inch +0/-0.004 inch)
Chamfer (G)	0.8 ± 0.1 mm (0.03 ± 0.004 inch)

3. Use Loctite® 7649 to clean the counterbore.

4. Apply Loctite® 620 to the outer diameter of the insert.

5. Start installation of the insert by hand into the counterbore.

Note: The chamfer on the outer diameter of the insert should be toward the cylinder block.

Illustration 103 g01387794

6. Use **1P-0520** Driver Group to drive the insert into the counterbore of the coolant passage.

Insert Specifications for 3176, 3300, and C15 through C32 Engines

- The insert should have a 0.07 mm to 0.10 mm (0.003 inch to 0.004 inch) press fit.
- The projection of the insert above the top deck is 0.000 mm to 0.025 mm (0.0000 inch to 0.0010 inch). Liners can then be installed with a projection of 0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch). The liner projection must also conform with the next two specifications.
- Each liner should be measured at four 90 degree locations. The maximum permissible difference of the four measurements cannot exceed 0.05 mm (0.002 inch).
- The maximum permissible difference between the height of all liners under one head is 0.10 mm (0.004 inch).
- The insert should be installed with the chamfer toward the cylinder block.

Type 1 Inserts

Dimensions for the Cylinder Block

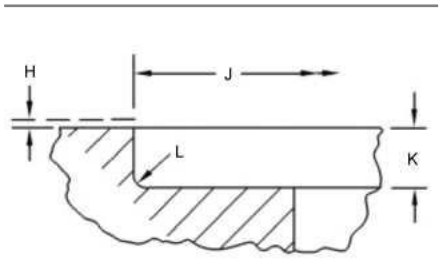

Illustration 104 g01376122

For Type 1 Inserts, machine the cylinder block to the dimensions that are shown in Illustration 104.

Table 24

Dimensions for Machining the Cylinder Block for Type 1 Inserts				
Part Number for the Insert	**Maximum Height of Projection after Installation of Insert (H)**	**Bore Diameter (J)**	**Depth of the Counterbore (K)**	**Chamfer or Radius (L)**
2W-3815	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	1.605 ± 0.013 mm (0.0632 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
5N-0093	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	2.710 ± 0.013 mm (0.1067 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
5P-4173	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	169.205 ± 0.015 mm (6.6616 ± 0.0006 inch)	5.080 ± 0.013 mm (0.2000 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
5P-4174	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	147.371 ± 0.025 mm (5.8020 ± 0.0010 inch)	5.210 ± 0.013 mm (0.2051 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
6I-4361	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	0.772 ± 0.013 mm (0.0304 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
6I-4362	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	0.872 ± 0.013 mm (0.0343 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
6I-4363	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm	1.555 ± 0.013 mm	0.25 ± 0.13 mm (0.010 ± 0.005 inch)

		(6.5321 ± 0.0006 inch)	(0.0612 ± 0.0005 inch)	
6I-4364	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	1.655 ± 0.013 mm (0.0652 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
6I-4365	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	2.660 ± 0.013 mm (0.1047 ± 0.0005 inch)	0.25 ± 0.13 mm (0.00984 ± 0.00512 inch)
6I-4366	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	2.760 ± 0.013 mm (0.1087 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
8N-6150	0.10 mm to 0.20 mm (0.004 inch to 0.008 inch)	178.283 ± 0.025 mm (7.0190 ± 0.0010 inch)	1.524 ± 0.025 mm (0.0600 ± 0.0010 inch)	0.63 ± 0.13 mm (0.025 ± 0.005 inch)
8N-6742	0.10 mm to 0.20 mm (0.004 inch to 0.008 inch)	178.283 ± 0.025 mm (7.0190 ± 0.0010 inch)	3.175 ± 0.025 mm (0.1250 ± 0.0010 inch)	0.63 ± 0.13 mm (0.025 ± 0.005 inch)
8N-6938	0.10 mm to 0.20 mm (0.004 inch to 0.008 inch)	191.211 ± 0.025 mm (7.5280 ± 0.0010 inch)	1.524 ± 0.025 mm (0.0600 ± 0.0010 inch)	0.63 ± 0.13 mm (0.025 ± 0.005 inch)
8N-6939	0.10 mm to 0.20 mm (0.004 inch to 0.008 inch)	191.211 ± 0.025 mm (7.5280 ± 0.0010 inch)	3.175 ± 0.025 mm (0.1250 ± 0.0010 inch)	0.63 ± 0.13 mm (0.025 ± 0.005 inch)
9Y-3368	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	0.822 ± 0.013 mm (0.0324 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
101-0523	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	5.210 ± 0.013 mm (0.2051 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
101-0524	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	5.160 ± 0.013 mm (0.2031 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
101-0525	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	165.915 ± 0.015 mm (6.5321 ± 0.0006 inch)	5.260 ± 0.013 mm (0.2071 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-5511	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	0.772 ± 0.013 mm (0.0304 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
104-5512	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	0.822 ± 0.013 mm (0.0324 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-5513	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	0.872 ± 0.013 mm (0.0343 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-5515	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	1.555 ± 0.013 mm (0.0612 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-5518	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	1.605 ± 0.013 mm (0.0632 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
104-5522	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	1.655 ± 0.013 mm (0.0652 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-5526	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	2.660 ± 0.013 mm (0.1047 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-5527	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	2.710 ± 0.013 mm (0.1067 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-5528	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	2.760 ± 0.013 mm (0.1087 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-5529	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	5.160 ± 0.013 mm (0.2032 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-5530	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm	5.210 ± 0.013 mm	0.25 ± 0.05 mm (0.010 ± 0.002 inch)

		(5.6713 ± 0.0010 inch)	(0.2051 ± 0.0005 inch)	
104-5531	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	144.051 ± 0.025 mm (5.6713 ± 0.0010 inch)	5.260 ± 0.013 mm (0.2071 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
104-7895	0.04 mm (0.002 inch) to 0.20 mm (0.008 inch)	145.850 ± 0.025 mm (5.7421 ± 0.0010 inch)	1.605 ± 0.013 mm (0.0632 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
104-7896	0.04 mm (0.002 inch) to 0.20 mm (0.008 inch)	145.850 ± 0.025 mm (5.7421 ± 0.0010 inch)	2.710 ± 0.013 mm (0.1067 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
104-7903	0.04 mm (0.002 inch) to 0.20 mm (0.008 inch)	145.850 ± 0.025 mm (5.7421 ± 0.0010 inch)	1.555 ± 0.013 mm (0.0612 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
104-7904	0.04 mm (0.002 inch) to 0.20 mm (0.008 inch)	145.850 ± 0.025 mm (5.7421 ± 0.0010 inch)	1.655 ± 0.013 mm (0.0652 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
104-7905	0.04 mm (0.002 inch) to 0.20 mm (0.008 inch)	145.850 ± 0.025 mm (5.7421 ± 0.0010 inch)	2.660 ± 0.013 mm (0.1047 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
104-7906	0.04 mm (0.002 inch) to 0.20 mm (0.008 inch)	145.850 ± 0.025 mm (5.7421 ± 0.0010 inch)	2.760 ± 0.013 mm (0.1087 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
105-4202	0.04 mm (0.002 inch) to 0.20 mm (0.008 inch)	145.850 ± 0.025 mm (5.7421 ± 0.0010 inch)	1.605 ± 0.013 mm (0.0632 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
105-4203	0.04 mm (0.002 inch) to 0.20 mm (0.008 inch)	145.850 ± 0.025 mm (5.7421 ± 0.0010 inch)	1.605 ± 0.013 mm (0.0632 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
105-4204	0.04 mm (0.002 inch) to 0.20 mm (0.008 inch)	145.850 ± 0.025 mm (5.7421 ± 0.0010 inch)	1.605 ± 0.013 mm (0.0632 ± 0.0005 inch)	0.25 ± 0.13 mm (0.010 ± 0.005 inch)
108-1068	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	169.333 ± 0.015 mm (6.6666 ± 0.0006 inch)	3.300 ± 0.025 mm (0.1299 ± 0.0010 inch)	0.89 + 0.41 - 0.00 mm (0.035 + 0.016 - 0.000 inch) by 45 degrees
361-5417	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	167.328 ± 0.013 mm (6.58770 ± 0.00051 inch)	5.292 ± 0.013 mm (0.20835 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)
497-9209	0.025 mm to 0.152 mm (0.0010 inch to 0.0060 inch)	169.836 ± 0.013 mm (6.68644 ± 0.00051 inch)	5.444 ± 0.013 mm (0.21433 ± 0.0005 inch)	0.25 ± 0.05 mm (0.010 ± 0.002 inch)

Type 1 Insert Dimensions

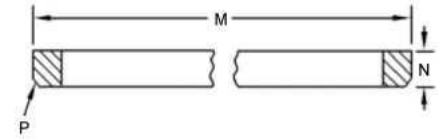

Illustration 105 g01376123

Dimensions for the individual inserts should conform to the following specifications. Refer to Illustration 105 for the dimensions of Type 1 inserts.

Table 25

Dimensions for Type 1 Inserts

Part Number for the Insert	Outside Diameter (M)	Thickness of the Insert (N)	Chamfer (P)
2W-3815	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	1.605 ± 0.010 mm (0.0632 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
5N-0093	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	2.710 ± 0.010 mm (0.1067 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
5P-4173	169.290 ± 0.013 mm (6.6649 ± 0.0005 inch)	5.210 ± 0.010 mm (0.2051 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
5P-4174	147.320 ± 0.013 mm (5.8000 ± 0.0005 inch)	5.210 ± 0.010 mm (0.2051 ± 0.0004 inch.)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
6I-4361	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	0.772 ± 0.010 mm (0.0304 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
6I-4362	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	0.872 ± 0.010 mm (0.0343 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
6I-4363	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	1.555 ± 0.010 mm (0.0612 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
6I-4364	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	1.655 ± 0.010 mm (0.0652 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
6I-4365	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	2.660 ± 0.010 mm (0.1047 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
6I-4366	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	2.760 ± 0.010 mm (0.1087 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
8N-6938	191.160 ± 0.013 mm (7.5260 ± 0.0005 inch)	1.595 + 0.020 − 0.000 mm (0.0628 + 0.0008 − 0.0000 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
8N-6939	191.160 ± 0.013 mm (7.5260 ± 0.0005 inch)	3.246 + 0.020 − 0.000 mm (0.1278 + 0.0008 − 0.0000 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch× 45°)
9Y-3368	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	0.822 ± 0.010 mm (0.0324 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
101-0524	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	5.160 ± 0.010 mm (0.2031 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
101-0523	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	5.210 ± 0.010 mm (0.2051 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
101-0525	166.000 ± 0.013 mm (6.5354 ± 0.0005 inch)	5.260 ± 0.010 mm (0.2071 ± 0.0004 inch)	0.5 ± 0.1 mm (0.02 ± 0.004 inch) × 45°
104-5511	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	0.772 ± 0.010 mm (0.0304 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5512	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	0.822 ± 0.010 mm (0.0324 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5513	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	0.872 ± 0.010 mm (0.0343 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5515	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	1.555 ± 0.010 mm (0.0612 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5518	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	1.605 ± 0.010 mm (0.0632 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5522	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	1.655 ± 0.010 mm (0.0652 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5526	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	2.660 ± 0.010 mm (0.1047 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5527	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	2.710 ± 0.010 mm (0.1067 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5528	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	2.760 ± 0.010 mm (0.1087 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5529	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	5.160 ± 0.010 mm (0.2032 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5530	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	5.210 ± 0.010 mm (0.2051 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-5531	144.000 ± 0.013 mm (5.6693 ± 0.0005 inch)	5.260 ± 0.010 mm (0.2071 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-7895	145.800 ± 0.013 mm (5.7402 ± 0.0005 inch)	1.605 ± 0.010 mm (0.0632 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-7896	145.800 ± 0.013 mm (5.7402 ± 0.0005 inch)	2.710 ± 0.010 mm (0.1067 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-7903	145.800 ± 0.013 mm (5.7402 ± 0.0005 inch)	1.555 ± 0.010 mm (0.0612 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-7904	145.800 ± 0.013 mm (5.7402 ± 0.0005 inch)	1.655 ± 0.010 mm (0.0652 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
104-7905	145.800 ± 0.013 mm (5.7402 ± 0.0005 inch)	2.660 ± 0.010 mm (0.1047 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)

104-7906	145.800 ± 0.013 mm (5.7402 ± 0.0005 inch)	2.760 ± 0.010 mm (0.1087 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
105-4202	145.800 ± 0.013 mm (5.7402 ± 0.0005 inch)	0.872 ± 0.010 mm (0.0343 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
105-4203	145.800 ± 0.013 mm (5.7402 ± 0.0005 inch)	0.772 ± 0.010 mm (0.0304 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
105-4204	145.800 ± 0.013 mm (5.7402 ± 0.0005 inch)	0.822 ± 0.010 mm (0.0324 ± 0.0004 inch)	0.5 ± 0.1 mm × 45° (0.02 ± 0.004 inch × 45°)
108-1068	169.418 ± 0.013 mm (6.6700 ± 0.0005 inch)	3.300 ± 0.025 mm (0.1299 ± 0.0010 inch)	1.31 + 0.41 - 0.00 mm (0.052 + 0.016 - 0.000 inch) × 45°
361-5417	167.418 ± 0.013 mm (6.59125 ± 0.00051 inch)	5.33 ± 0.025 mm (0.20984 ± 0.00098 inch)	1.0 ± 0.13 mm (0.03937 ± 0.00512 inch) x 30°
497-9209	169.926 ± 0.013 mm (6.68999 ± 0.00051 inch)	5.482 ± 0.025 mm (0.21583 ± 0.00098 inch)	1.0 ± 0.13 mm (0.03937 ± 0.00512 inch) x 30°

Type 2 Inserts

The following specifications apply:

1. The counterbore should be machined into the block according to the dimensions that are given in Table 26.
2. Clean the counterbore and the insert before installation.
3. Do not apply adhesive to the counterbore or to the insert unless Table 26 or Table 27 says to apply.
4. Press the insert into position. Do not drive.
5. Machine the seat for the liner. Obtain a liner projection of 0.10 mm (0.004 inch) to 0.20 mm (0.008 inch.) above the block face.
6. The liner projection should not vary more than 0.03 mm (0.001 inch) between adjacent cylinders.

Dimensions for the Cylinder Block

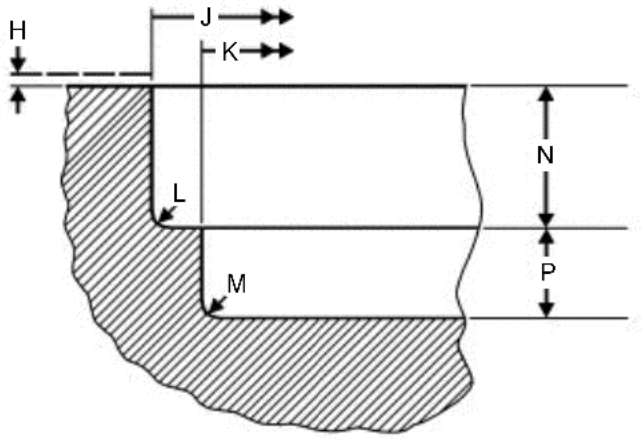

Illustration 106 g01827879

For Type 2 inserts, machine the cylinder block to the dimensions that are shown in Illustration 106.

Table 26

Dimensions for Machining the Cylinder Block for Type 2 Inserts							
Part Number for the Insert	**Projection of Insert after Installation of Insert (H)**	**Bore Diameter**		**Chamfer or Radius**		**Depth of the Bore**	
		(J)	**(K)**	**(L)**	**(M)**	**(N)**	**(P)**
1W-6265[2] 1W-6266[2]1W-6267[2]	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	210.820 ± 0.025 mm (8.3000 ± 0.0010 inch)	205.740 ± 0.025 mm (8.1000 ± 0.0010 inch)	0.5 mm (0.02 inch) Max	0.8 mm (0.03 inch) Max	13.716 ± 0.025 mm (0.5400 ± 0.0010 inch)	9.000 ± 0.025 mm (0.3543 ± 0.0010 inch)
5P-0936[1]	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	198.120 ± 0.076 mm (7.8000 ± 0.0030 inch)	N/A	0.5 mm (0.02 inch) Max	N/A	19.126 + 0.102 − 0.051 mm (0.7530 + 0040 − 0.0020 inch)	N/A
5P-0937	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	172.339 ± 0.080 mm (6.7850 ± 0.0032 inch)	N/A	0.76 mm (0.030 inch)	N/A	19.155 ± 0.080 mm (0.7541 ± 0.0032 inch)	N/A
5P-1620	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	148.670 ± 0.080 mm (5.8531 ± 0.0032 inch)	N/A	0.76 mm (0.030 inch)	N/A	13.445 ± 0.080 mm (0.5293 ± 0.0032 inch)	N/A
5P-1621	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	147.320 ± 0.080 mm (5.8000 ± 0.0032 inch)	N/A	0.76 mm (0.030 inch)	N/A	16.615 ± 0.080 mm (0.6541 ± 0.0032 inch)	N/A
5P-1622	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	147.320 ± 0.080 mm (5.8000 ± 0.0032 inch)	N/A	0.76 mm (0.030 inch)	N/A	16.615 ± 0.080 mm (0.6541 ± 0.0032 inch)	N/A
5P-1623	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	162.814 ± 0.080 mm (6.4100 ± 0.0032 inch)	N/A	0.76 mm (0.030 inch)	N/A	17.555 ± 0.080 mm (0.6911 ± 0.0032 inch)	N/A
5P-1624	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	169.291 ± 0.080 mm (6.6650 ± 0.0032 inch)	N/A	0.76 mm (0.030 inch)	N/A	19.155 ± 0.080 mm (0.7541 ± 0.0032 inch)	N/A
5P-1625[1]	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	184.150 ± 0.076 mm (7.2500 ± 0.0030 inch)	N/A	0.5 mm (0.02 inch) Max	N/A	17.526 + 0.102 − 0.051 mm (0.6900 + 0040 − 0.0020 inch)	N/A
5P-6595[2]	0.000 mm (0.0000 inch) to − 0.076 mm (− 0.0030 inch)	196.850 ± 0.025 mm (7.7500 ± 0.0010 inch)	191.770 ± 0.025 mm (7.54998 ± 0.00098 inch)	0.5 mm (0.02 inch) Max	0.8 mm (0.03 inch) Max	13.716 ± 0.025 mm (0.5400 ± 0.0010 inch)	8.923 ± 0.025 mm (0.3513 ± 0.0010 inch)

(1) Apply 4C-9507 Retaining Compound to the lower end of the outer diameter of the insert.

(2) Apply RTV silicone sealant to the entire lower seat of the counterbore only.

Type 2 Insert Dimensions

Dimensions for the individual inserts should conform to the following specifications.

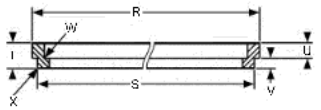

Illustration 107 g01829533

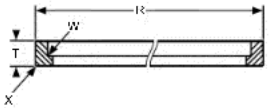

Illustration 108 g01829534

Table 27

Dimensions for Type 2 Inserts							
Part Number of the Insert	**Outside Diameter**		**Thickness of the Insert**			**Chamfer**	
	(R)	**(S)**	**(T)**	**(U)**	**(V)**	**(W)**	**(X)**
1W-6265[2] 1W-6266[2]1W-6267[2]	210.858 ± 0.013 mm (8.3015 ± 0.0005 inch)	205.778 ± 0.013 mm (8.1015 ± 0.0005 inch)	22.580 ± 0.025 mm (0.8890 ± 0.0010 inch)	13.700 ± 0.025 mm (0.5394 ± 0.0010 inch)	8.880 ± 0.025 mm (0.3496 ± 0.0010 inch)	0.40 ± 0.10 mm (0.016 ± 0.004 inch)	N/A
5P-0936[1]	198.247 ± 0.013 mm (7.8050 ± 0.0005 inch)	N/A	19.050 ± 0.030 mm (0.7500 ± 0.0010 inch)	N/A	N/A	0.41 mm (0.016 inch) Max	0.76 ± 0.25 mm × 45° (0.030 ± 0.010 inch × 45°)
5P-0937	172.466 ± 0.013 mm (6.7900 ± 0.0005 inch)	N/A	19.050 ± 0.030 mm (0.7500 ± 0.0010 inch)	N/A	N/A	0.41 mm (0.016 inch) Max	0.76 mm × 45° (0.030 inch × 45°)
5P-1620	148.793 ± 0.013 mm (5.8580 ± 0.0005 inch)	N/A	13.340 ± 0.030 mm (0.5250 ± 0.0010 inch)	N/A	N/A	0.41 mm (0.016 inch) Max	0.76 mm × 45° (0.030 inch × 45°)
5P-1621	147.447 ± 0.013 mm (5.8050 ± 0.0005 inch)	N/A	16.510 ± 0.030 mm (0.6500 ± 0.0010 inch)	N/A	N/A	0.41 mm (0.016 inch) Max	0.76 mm × 45° (0.030 inch × 45°)
5P-1622	147.447 ± 0.013 mm (5.8050 ± 0.0005 inch)	N/A	16.510 ± 0.030 mm (0.6500 ± 0.0010 inhc)	N/A	N/A	0.41 mm (0.016 inch) Max	0.76 mm × 45° (0.030 inch)
5P-1623	162.941 ± 0.013 mm (6.4150 ± 0.0005 inch)	N/A	17.450 ± 0.030 mm (0.6870 ± 0.0010 inch)	N/A	N/A	0.41 mm (0.016 inch) Max	1.14 mm × 30° (0.045 inch × 30°)
5P-1624	169.418 ± 0.013 mm (6.6700 ± 0.0005 inch)	N/A	19.050 ± 0.030 mm (0.7500 ± 0.0010 inch)	N/A	N/A	0.41 mm (0.016 inch) Max	0.76 mm × 45° (0.030 inch × 45°)
5P-1625[1]	184.277 ± 0.013 mm (7.2550 ± 0.0005 inch)	N/A	17.450 ± 0.030 mm (0.6870 ± 0.0010 inch)	N/A	N/A	0.41 mm (0.016 inch) Max	0.76 ± 0.25 mm × 45° (0.030 ± 0.010 inch × 45°)
5P-6595[2]	196.888 ± 0.013 mm (7.7515 ± 0.0005 inch)	191.808 ± 0.013 mm (7.5515 ± 0.0005 inch)	22.554 ± 0.025 mm (0.8880 ± 0.0010 inch)	13.700 ± 0.025 mm (0.5394 ± 0.0010 inch)	8.854 ± 0.025 mm (0.3486 ± 0.0010 inch)	0.40 ± 0.10 mm (0.016 ± 0.004 inch)	N/A

(1) Apply 4C-9507 Retaining Compound to the lower end of the outer diameter of the insert.

(2) Apply RTV silicone sealant to the entire lower seat of the counterbore only.

Installing Liner Seat Inserts on the Top Deck for C15 through C32 Engines Out of Chassis

Inspection

Caterpillar does not recommend counterboring the cylinder block deeper than 5.444 mm (0.21433 inch). Contact your Cat dealer or service representative if damage extends deeper. Remanufactured short blocks are available for 3400 Engines if the block cannot be reconditioned by counterboring per the above specification.

Inserts for the top deck are available if the top of the area for the cylinder liner seat contains erosion. Erosion can be caused by heat, exhaust gases, or coolant that leaked around the liner seal. The inserts fit into a counterbore of the cylinder bore. The counterbore must be machined into the cylinder bore. The top of the insert will have enough clearance above the top deck of the cylinder block to provide the correct liner projection.

Note: Top deck inserts are not to be used as shims. Shims are available to correct liner projection.

Procedure

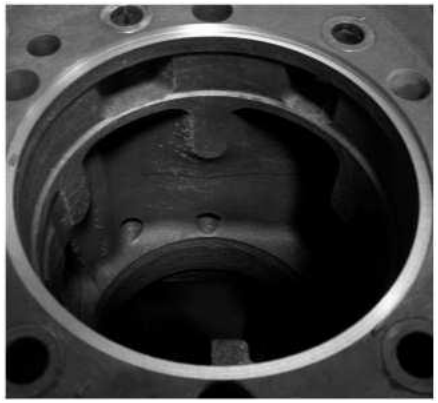

Illustration 109 g01387795

1. Machine a counterbore into the cylinder bores. Refer to Table 24 for the correct dimensions for machining counterbores.

   Note: Also refer to the following: Special Instruction, SMHS7600, "Installation of 8N-6938 or **8N-6939** Insert",Special Instruction, SMHS8222, "Installation of 2W-3815 or **5N-0093** Liner Seat Insert", Special Instruction, SMHS8839, "Using **5P-4175** Boring Tool Group and **5P-1618** Tool Group", Special Instruction, SEHS9564, "3400 Cylinder Head to Block Joint Repair Procedure", and Tool Operating Manual, NEHS0612, " **9U-7990** Counterbore Tool Group for 3176, 3300, and 3400 Engines"

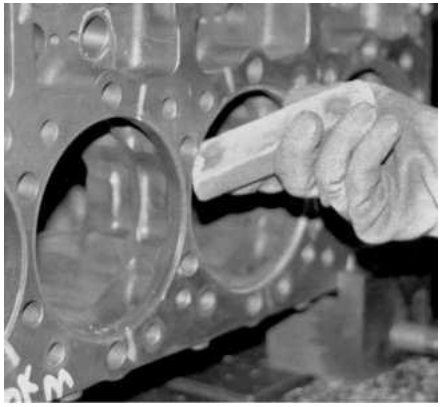

Illustration 110 g01369238

2. Remove all the nicks and high spots from around the counterbore and from the top deck.

Illustration 111 g01369247

3. Use Loctite® 7649 to clean the insert correctly.

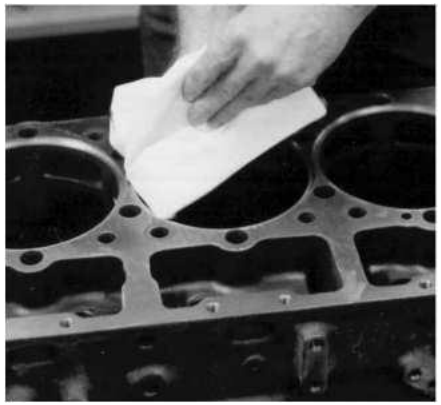

Illustration 112 g01369248

4. Use Loctite® 7649 to clean the surfaces of the cylinder block.

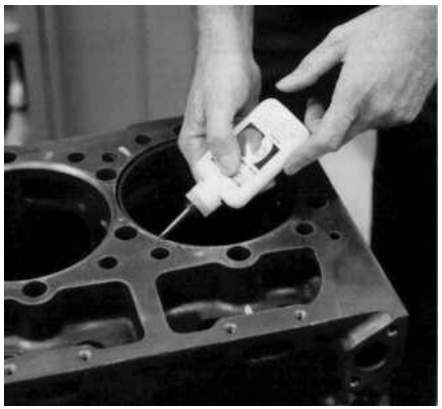

Illustration 113 g01387797

5. Apply Loctite® 620 to the counterbore of the insert.

Illustration 114 g01387798

6. Install the insert in the counterbore. The insert must be installed so the chamfer on the outer diameter is toward the cylinder block.

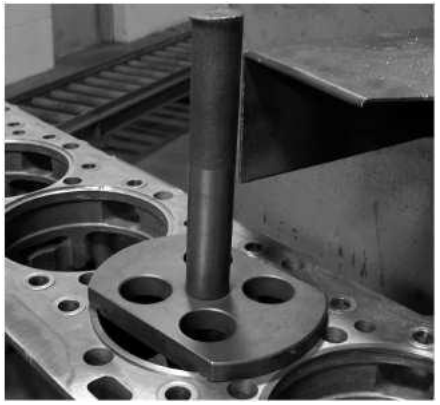

Illustration 115 g01387799

7. Use the correct driver to install the insert. Refer to Illustration 115 for the correct driver.

Note: 1W-6265, 1W-6266, 1W-6267, 5P-0936, 5P-1625, and 5P-6595 inserts are pressed into the counterbore. These inserts are not driven.

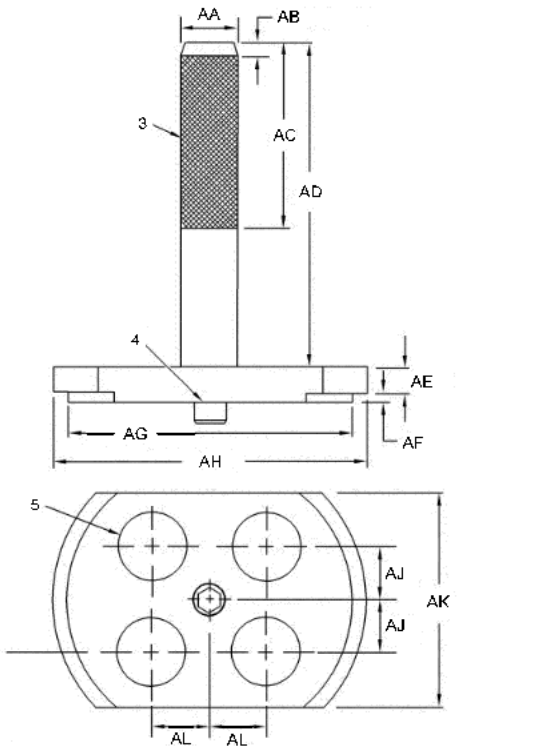

Illustration 116 g01879543

Driver
(3) Knurl the handle.
(4) Drill and Tap for 1/2 × 13 Bolt
(5) Lightening Holes with 38 mm (1.5 inch.) Diameter

Table 28

Dimensions for the Driver	
Dimension	**Measurement**
(AA)	31.7 mm (1.25 inch)
(AB)	6.3 mm × 15° (0.25 in × 15°)
(AC)	102 mm (4.0 inch)
(AD)	203 mm (8.0 inch)
(AE)	19.0 mm (0.75 inch)
(AF)	4.6 mm (0.18 inch)
(AG)	158.75 + 1.30 −0.00 mm (6.250 + 0.051 − 0.000 inch)
(AH)	175 mm (6.9 inch)
(AJ)	28.4 mm (1.11811 inch)

(AK)	120.6 mm (4.75 inch)
(AL)	31.7 mm (1.25 inch)

The top deck of the cylinder block will need to be machined after the inserts on the top deck and the inserts for the coolant passages are installed. Machine the least possible material from the top deck. Never machine the top deck out of specifications. Machining the top deck will also ensure the correct flatness of the top deck.

Counterboring for Liner Seat Shims

If the block is being machined in chassis cover all open bores to the crankshaft, lifter bores (if applicable), oil passages, etc. Care should be taken not to contaminate the cylinder block with machining chips. Use plastic plugs to cover the crankshaft and oil passages. Using the 9U-7990 Counterbore Tool Group machine the cylinder block. Use a depth gauge to measure progress when nearing the depth needed to install the thinnest shim. Reduce machine depth to 0.025 mm (0.001 inch) per cut until reaching the final depth. Measure to verify actual shim thickness and install shim so that it is flush with the top of the block within 0.013 mm (0.0005 inch). Measure the machined counterbore in four places to ensure that it is level. Check to see that it is also free of tool chatter marks. If there are chatter marks the counterbore must be machined to remove the chatter marks. If counterboring to the depth of the thinnest shim does not clean up 100 percent of the erosion/crack damage, machine to the depth of the next shim. When machining is complete, deburr both edges of the counterbore with emery paper or #400 wet-dry sandpaper. Use a wet-dry vacuum to remove cuttings from cylinder bores, water jacket, and head bolt holes. Remove plastic bore plugs, foam inserts, paper towels, tape, and all other protective covers. If necessary, run threaded tap down head bolt holes to remove burrs and thoroughly clean out head bolt holes. Wash down cylinder block with solvent and use pressure air to ensure block/crankshaft/lifter bore cleanliness. Install shims dry (no sealant) with chamfer facing down.

Reconditioning the Lower Cylinder Bore for 3400 and C15 through C32 Engines

Inspection

Illustration 117 g06238803
Erosion in the lower cylinder bore

Illustration 118 g06238807
Erosion in the lower cylinder bore

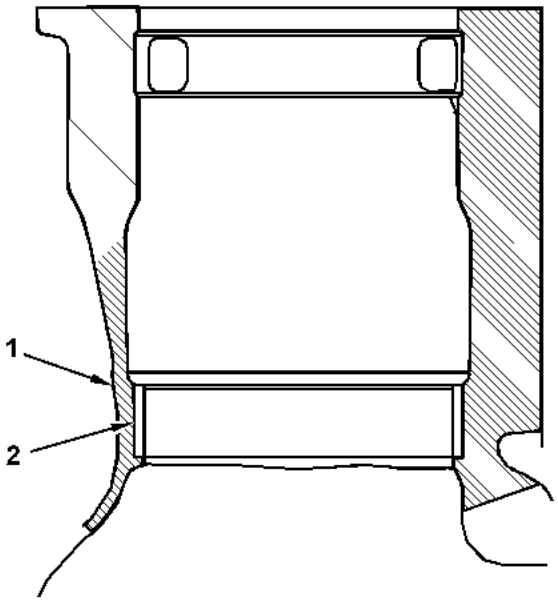

Illustration 119 g06238611

(1) Block Casting
(2) Sleeve

The area in the block where the seals are located can become corroded. The “Step Bore Operation” is the correct procedure to repair corrosion near the seals.

Procedure of Step Bore Operation

The lower liner bore can be salvaged using a standard liner sleeve or an oversized liner sleeve. The oversized sleeve allows for more material to be removed to salvage a damaged sleeved block or a non-sleeved block with greater than normal wear.

Note: If the block has already been sleeved, then inspect the block and sleeve area first. If the sleeved block can be reused as is, then do not remove the existing sleeve but reuse the block as is.

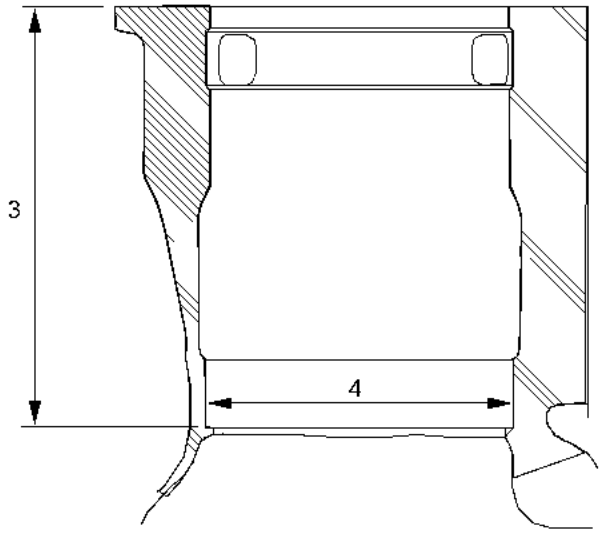

Illustration 120 g02336556

Lower liner bore machining dimensions.

Table 29

Sleeve Part Number	Sleeve	Counter-bore Depth (3)	Counter-bore Diameter (4)
4W-6061	Cylinder Liner Sleeve (Standard)	224.190 ± 0.25 mm (8.826 ± 0.010 inch)	158.00 ± 0.025 mm (6.221 ± 0.001 inch)
462-3212	Cylinder Liner Sleeve (Oversize)	224.190 ± 0.25 mm (8.826 ± 0.010 inch)	158.610 ± 0.025 mm (6.245 ± 0.001 inch)

1. Freeze the liner sleeve to ease in assembly.

Illustration 121 g06238796

Lower liner bore being machined.

Illustration 122 g06238797
Lower liner bore machined with step remaining.

2. Machine the lower cylinder bore.

   Machine the bore to a diameter (4) and to a depth (3). The step shown in Illustration 120 is not critical but will aid in assembly. Refer to Illustrations 120,121, and 122 for machining references.

3. Use **169-5464** Quick Cure Primer to clean the lower bore and the sleeve.

Illustration 123 g06238810

4. Apply **4C-9507** Retaining Compound to the lower cylinder bore.

Illustration 124 g06238811

5. Start the sleeve into the cylinder bore.

Note: The sleeve will need to be frozen to fit onto the cylinder bore.

Illustration 125 g06238813

6. Press the sleeve into the lower cylinder bore.

Illustration 126 g06238815

7. Machine the inside of the sleeve to 153.90 ± 0.05 mm (6.059 ± 0.002 inch).

Illustration 127 g06238817

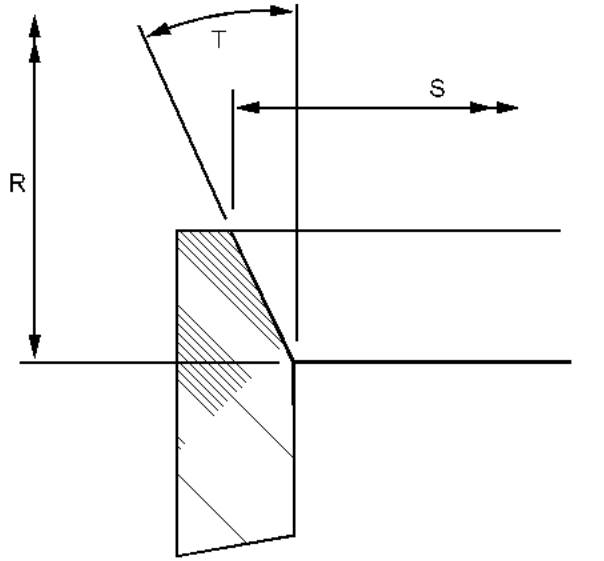

Illustration 128 g06238821

(R) Depth of chamfer from top deck
(S) Diameter of chamfer
(T) Angle of chamfer

8. Machine a chamfer on the top edge of the sleeve. Refer to Illustration 128 and Table 30 for the correct dimensions.

Table 30

Dimensions for the Chamfer	
Depth (R)	193.19 ± 0.25 mm (7.606 ± 0.010 inch)
Diameter (S)	158.34 ± 0.51 mm (6.234 ± 0.020 inch)
Angle (T)	25 ± 7 degrees

9. Remove any burrs or metal shavings from the sleeve after machining.

Center Mounted Cylinder Liner Seats for C9 and C-10 Engines

The C9 and C-10 engines should be machined with a machining center. At the time of this publication the Counterbore Tool Group will not fit these engines.

Inspection

Inspect the seat of the liner for cracks or damage. If the seat for the liner contains any cracks or damage, the seat can be counterbored to salvage the cylinder block. The seat for the liner will be machined more than the specifications. Shims are then added to the seat to obtain the correct depth.

Note: The part numbers for the shims are listed in Tool Operating Manual, NEHS0612, " **9U-7990** Counter Bore Tool Group for 3176, 3300 and 3400 Series Engines" and Tool Operating Manual, NEHS0733, "159-9404 Counterbore Tool Group for C-10 and C-12 Engines".

Procedure

Follow the procedure listed in "Center Mounted Cylinder Liner Seats for C11 through C13 Engines" to set up the machining center for C9 and C-10 Engines.

Center Mounted Cylinder Liner Seats for C11 through C13 Engines

Inspection

Inspect the seat of the liner for cracks or damage. If the seat for the liner contains any cracks or damage, the seat can be counterbored to salvage the cylinder block. The seat for the liner will be machined more than the specifications. Shims are then added to the seat to obtain the correct depth.

Note: The part numbers for the shims are listed in Tool Operating Manual, NEHS0612, " **9U-7990** Counter Bore Tool Group for 3176, 3300and 3400 Series Engines" and Tool Operating Manual, NEHS0733, "159-9404 Counterbore Tool Group for C-10 and C-12 Engines".

Procedure

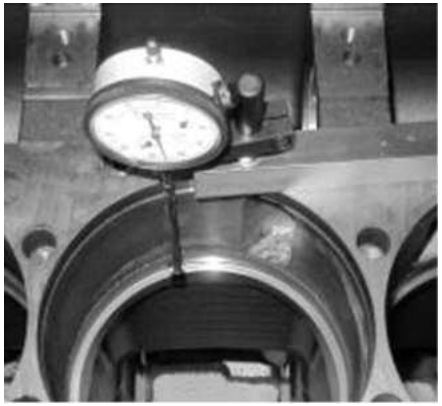

Illustration 129 g01354527

1. Measure the depth of the cylinder liner seat at four 90 degree locations with **9U-7993** Depth Gauge Assembly.

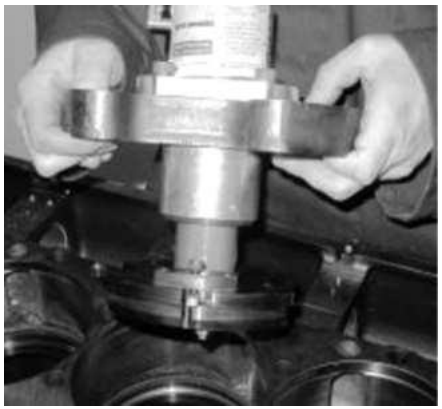

Illustration 130 g01354542

2. Position the counterboring tool in the cylinder bore and secure the tool with bolts. Make sure that the cutting plate rotates freely.

Note: Use of **1U-8265** Penetrating Oil will help the cutting plate rotate freely in the cylinder bore.

Illustration 131 g01354547

3. Adjust the cutting plate by rotating the two set collars on the tooling.

Illustration 132 g01354548

4. Cut the counterbore. Maintain a constant down pressure on the tooling while the counterbore is cut.

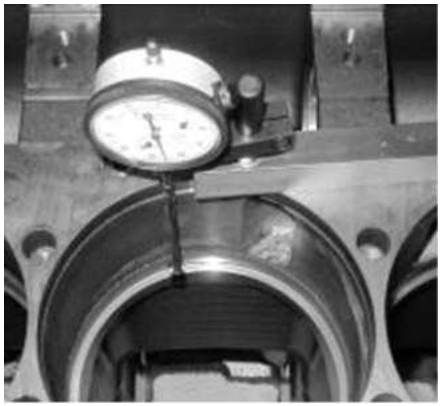

Illustration 133 g01354527

5. Remove the counterboring tool and measure the depth of the cylinder liner seat.

Illustration 134 g01354554

6. Install shims into the cylinder bore to achieve the correct depth.

   Note: The part numbers for the shims are listed in Tool Operating Manual, NEHS0612, " **9U-7990** Counter Bore Tool Group for 3176, 3300and 3400 Series Engines" and Tool Operating Manual, NEHS0733, "159-9404 Counterbore Tool Group for C-10 and C-12 Engines".

Reworking the Cylinder Block for Better Alignment of the Lifter Follower Clip

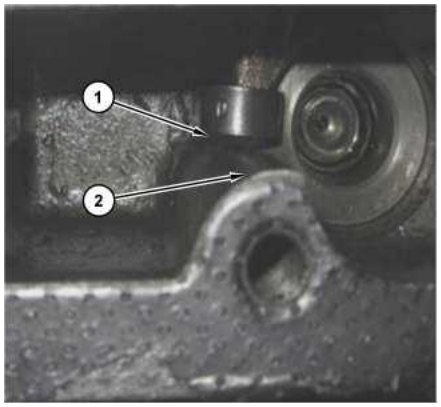

Illustration 135 g02784097

Early cylinder blocks without the clearance cut (2) that allows the designed amount rotational movement of the lifter clip in area (1).

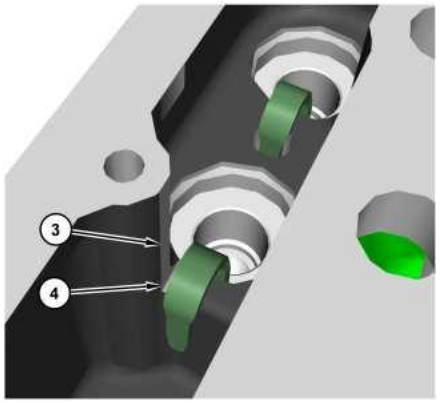

Illustration 136 g02784157

Later cylinder blocks included clearance cut (3) allowing the designed amount rotational movement of lifter clip in area (4).

Earlier C9 series engine blocks did not include a clearance cut for the lifter follower clip. A quick visual inspection of the cylinder block will identify if the cylinder block is an earlier model without the clearance cut.

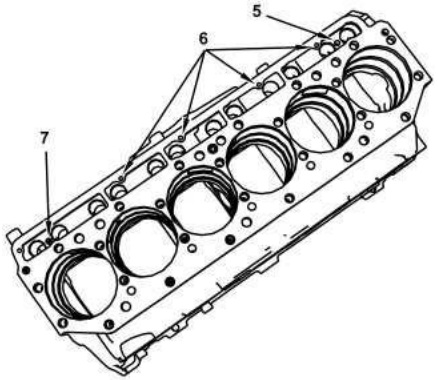

Illustration 137 g06238835

This procedure will involve adding clearance cuts to four bosses at locations (6) and drilling the two lifter follower clip holes at locations (5) and (7) deeper.

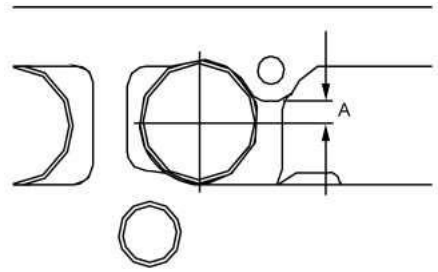

Illustration 138 g06238878
Top view of clearance cut on cylinder block next the lifter bore

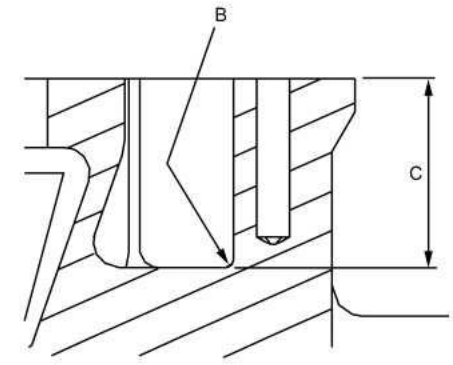

Illustration 139 g06238881
Side view of the clearance cut on cylinder block next the lifter bore

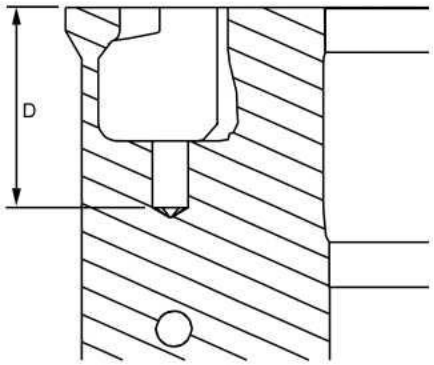

Illustration 140 g06238886
Depth of the lifter follower clip holes

Table 31

Clearance Cut and Hole Dimensions		
Item	**Description**	**Distance**
A	Depth of clearance cut from center of lifter bore	5.25 mm (0.207 inch)
B	Radius	1.5 mm (0.06 inch) max
C	Depth of clearance cut from the top deck of the block	37 ± 1 mm (1.5 ± 0.04 inch)
D	Depth of hole from the top deck of the block	55.5 mm (2.19 inch)

Procedure to Repair Lifter Bores for C9 Series Engines

Illustration 141 g03837950
Lifter bore spacing for 8.8L C9 engines.

Illustration 142 g03837951

Lifter bore spacing for 9.3L C9 engines.

Measuring and Inspection

Carefully inspect the lifter bore for wear patterns. The bore must have a normal wear pattern and the diameter of the bore must be 29.555 mm (1.1636 inch) or less to be reused. If the bore is larger than 29.555 mm (1.1636 inch) or showing irregular wear, it must be machined and have the **466-2803** Sleeve.

A bore with only a rough surface can be used again after the surface is made smooth with a honing stone or crocus cloth. Remove the rough sections with crocus cloth or by honing. The bores are ready to be used again as long as they are not larger than 29.555 mm (1.1636 inch).

Visual Inspection

Use the bore again if the diameter of the bore is 29.555 mm (1.1636 inch) or less.

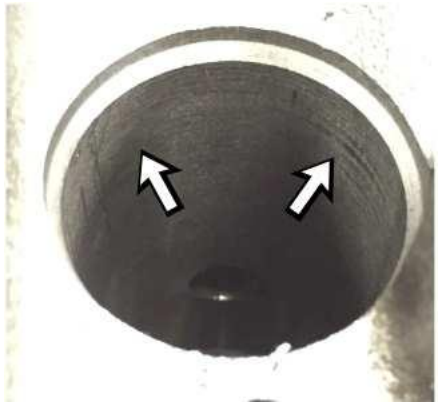

Illustration 143 g03817527

An example of normal wear in the bore. The original machining marks are still visible.

A damaged bore must be salvaged by the installation of a **466-2803** Sleeve before the bore can be reused. Illustration 144 shows a damaged bore.

Illustration 144 g03817461
A damaged bore

Install the **466-2803** Sleeve before reusing this bore.

If the bore has been damaged or worn past 29.555 mm (1.1636 inch), use the procedure "Block Machining and Sleeve Installation for 8.8L, 9.3L C9 Engines" to install a **466-2803** Sleeve . Illustration 144 shows an example of a damaged bore.

Damaged bores should be repaired by using **466-2803** Sleeve.

Block Machining and Sleeve Installation for 8.8L, 9.3L C9 Engines

Note: If there is damage in two adjacent lifter bores in 9.3L C9 Engines, the block cannot be salvaged as there will not be enough material between the two lifter bores.

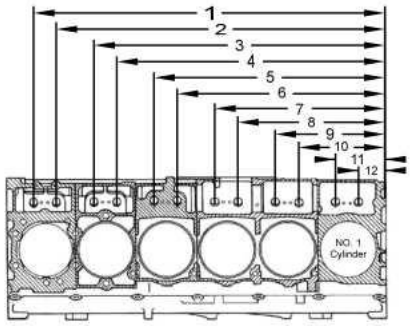

Illustration 145 g03816987
Figure 145 for illustrative purposes only.

Center line of the lifter bores from the front of the block for the 8.8L, 9.3L C9 Engine

Table 32

Center line of the lifter bores		
Callout	8.8L Dimensions	9.3L Dimensions

(1)	780 mm (30.709 inch)	765 mm (30.118 inch)
(2)	731 mm (28.779 inch)	731 mm (28.779 inch)
(3)	647 mm (25.472 inch)	632 mm (24.882 inch)
(4)	598 mm (23.543 inch)	598 mm (23.543 inch)
(5)	514 mm (20.236 inch)	499 mm (19.646 inch)
(6)	465 mm (18.307 inch)	465 mm (18.307 inch)
(7)	381 mm (15.000 inch)	366 mm (14.409 inch)
(8)	332 mm (13.071 inch)	332 mm (13.071 inch)
(9)	248 mm (9.764 inch)	233 mm (9.173 inch)
(10)	199 mm (7.835 inch)	199 mm (7.835 inch)
(11)	115 mm (4.526 inch)	100 mm (3.937 inch)
(12)	66 mm (2.598 inch)	66 mm (2.598 inch)

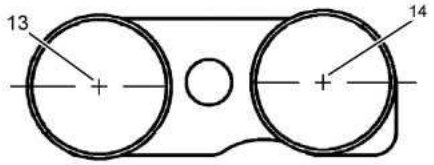

Illustration 146 g03816990

Center of lifter bores from the center line of the crankshaft main bearing bore.

Table 33

Center line of the lifter bores		
Callout	8.8L Dimensions	9.3L Dimensions
(13)	Center of the exhaust lifter bore 105 ± 0.25 mm (4.13385 ± 0.0098 inch)	Center of the exhaust lifter bore 105.306 mm (4.146 inch)
(14)	Center of the intake lifter bore 106 ± 0.25 mm (4.17322 ± 0.0098 inch)	Center of the intake lifter bore 106 mm (4.173 inch)

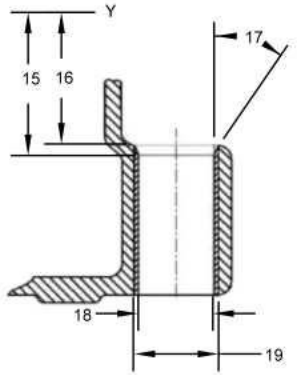

Illustration 147 g03816992

The dimension of the lifter bores for the C9 Engines

Table 34

Center line of the lifter bores		
Callout	8.8L Dimensions	9.3L Dimensions
(15)	40.5 ± 1.0 mm (1.595 ± 0.039 inch)	45.5 mm (1.791 in.)
(16)	37.0 mm (1.457 inch)	43.8 mm (1.724 in.)
(17)	30°	
(18)	29.525 mm (1.1624 inch)	
(19)	33.013 ± 0.013 mm (1.300 ± 0.0005 inch)	
(Y)	Top of the block	

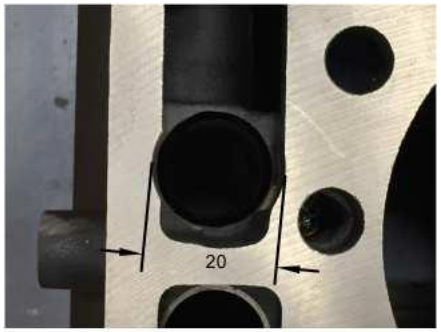

Illustration 148 g03816994

Top deck of block must be machined to machine the lifter bores.

(20) 33.78200 ± 0.01270 mm (1.330 ± 0.0005 inch)

1. Place the engine block in a suitable machining center. Clamp and locate the block.

Illustration 149 g03816997
Machining the top deck

2. Machine the top deck above the lifter bore to (20)

Illustration 150 g06344985

3. Machine the damaged lifter bore to the specifications listed in Illustration 150.
4. Clean the bore and the sleeve with **222-3117** Brake Cleaner.
5. Measure the machined bore to ensure that the bore is sized to (18).

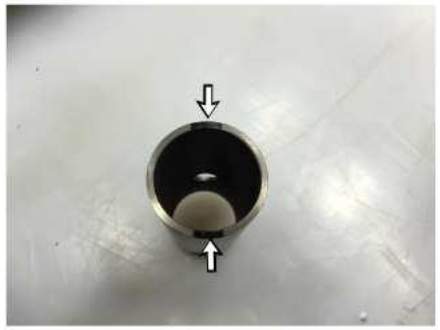

Illustration 151 g03816999

6. Mark the orientation of the lubrication ports on the sleeve. This aids in installation.

Note: Measure the outside diameter of the sleeve before lowering the temperature of the sleeve. Make sure that the press fit is between 0.059 mm (0.0023 inch) and 0.017 mm (0.0007 inch).

7. Cool the sleeve to −80° C (−112° F) to −110° C (−166° F)

Illustration 152 g03817000

8. Remove the cylinder block from the machining center. Place the cylinder block on a press. The weight of the bare cylinder block is 211 kg (465 lb).

Illustration 153 g03817001
Applying Loctite 620 to the lifter bore.

9. Apply a thin coat of Loctite 620 to the lifter bore.

Illustration 154 g03817002

10. Place a sleeve onto one of the machined lifter bore holes. Orientate the lubrication ports on the sleeve with the lifter lubrication ports in the cylinder block.

Illustration 155 g03817004

Illustration 156 g03817006

11. Use FT3295 to press the sleeve into the cylinder block. Be sure that the lubrication holes in the sleeves are in alignment with the lubrication holes in the block.

Illustration 157 g03817008

12. Inspect the alignment of the oil hole between all sleeves and the block after installation. The oil holes must be orientated properly to ensure proper lubrication to the lifters.
13. Use a 10 mm (0.394 inch) gun drill to machine the lube ports in the sleeved bores. This will ensure that the lube port in the sleeve is aligned with the lube port in the block. The tool should be able to reach 419 mm (16.5 inch).

Illustration 158 g03817009

14. Machine the lifter bore to 29.525 ± 0.025 mm (1.1624 ± 0.001 inch). The surface of the bore must be smoother than 3.2 µm (126 µinch).

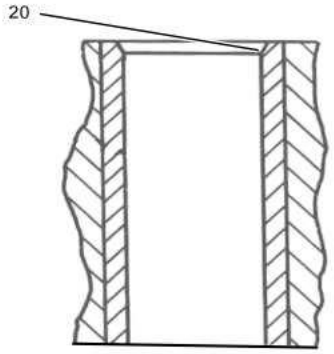

Illustration 159 g03817010

Chamfer dimensions on the sleeve.
(20) 30°

15. Machine a chamfer on the sleeve. Refer to Illustration 145 for the correct dimensions.

16. Clean the block thoroughly.

Repairing the Lifter Clip Spring Guide Bore

There are two bores at the ends of the block that locate the lifter clip spring guides. If these bores become damaged, they can be oversized and have **178-5649** Spacer installed into the bore.

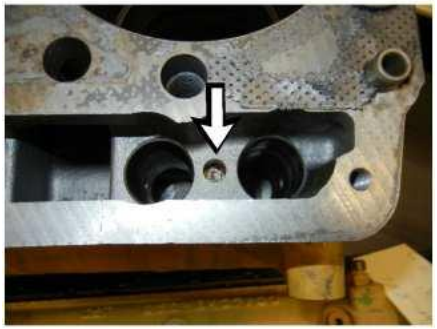

Illustration 160 g06039112
Lifter clip spring guide bore on 8.8L C9.

Illustration 161 g06039124
Lifter clip spring guide bore on 9.3L C9. Lifter clip spring guide bores next to lifter bores that are sleeved cannot be repaired as there will not be enough material between the two bores.

Illustration 162 g03816997

Illustration 163 g06091723

1. Bore the cylinder block to accept the spacer. The spacer has an outside diameter of 12.00 ± 0.50 mm (0.472 ± 0.020 inch).Bore the hole so that there will be a 0.025 mm (0.001 inch) interference fit.
2. Cool the spacer to −80° C (−112° F) to −110° C (−166° F).
3. Apply a thin coat of Loctite 620 to the spring guide bore.

Illustration 164 g06091730

4. Drive the spacer into the block using a brass drift until the sleeve is flush with the top of the spring guide bore.

Illustration 165 g06091733

5. Machine the inside diameter of the spacer to 10 mm (0.394 inch).

Procedure to Repair Lifter Bores for 3300 and 3400 Series Engines

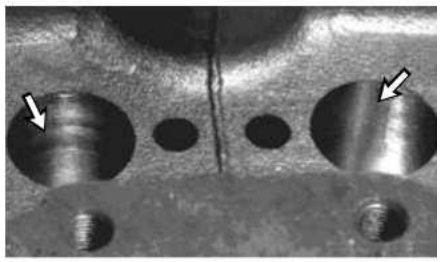

Illustration 166 g01299519
The bore has a rough surface.

A bore with only a rough surface can be used again after the surface is made smooth with a honing stone or crocus cloth. Refer to Illustration 166.

Remove the rough sections with crocus cloth or by honing. The bores are ready to be used again.

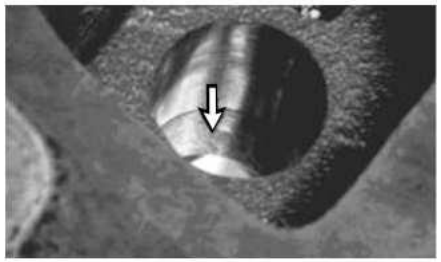

Illustration 167 g01299521
A damaged bore

A more heavily damaged bore must be salvaged by the installation of a sleeve before the bore can be reused. Illustration 167 shows a damaged bore.

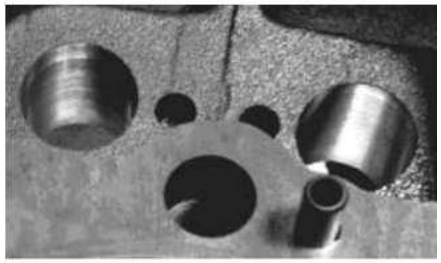

Illustration 168 g01299522
An example of normal wear in the bore.

Carefully inspect the lifter bore for wear patterns. The bore must have a normal wear pattern and the diameter of the bore must be 27.983 mm (1.10169 inch) or less to be used again. Illustration 168 shows normal wear in the bore.

If the bore has been damaged, use the procedure "Sleeve Installation" to install a sleeve. Illustration 169 shows an example of a damaged bore.

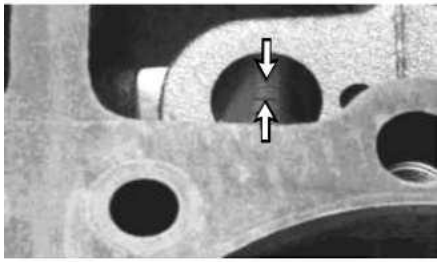

Illustration 169 g01299714
An example of a damaged bore

Sleeve Installation

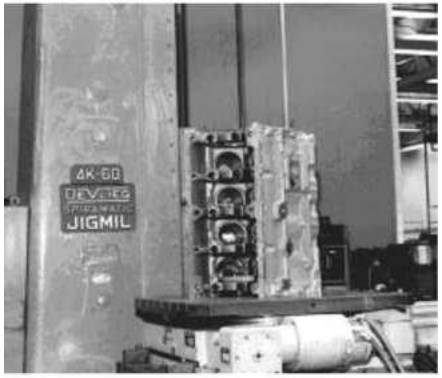

Illustration 170 g01299726
Cylinder block on a boring machine

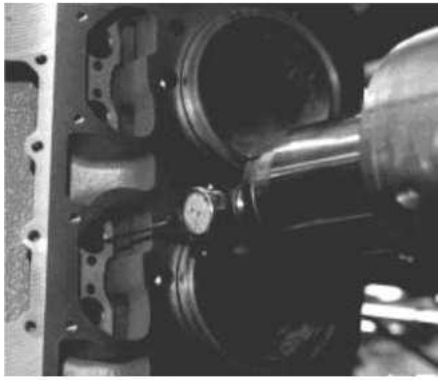

Illustration 171 g01299727
Use a dial indicator to get the bore and the centerline of the spindle in correct alignment.

Note: The centerline of the lifter bore on the 3406 Engines is 84° 30' from the top deck of the block. On the 3408 and 3412 Engines, the centerlines are 80° 30' from the top of the deck of the block.

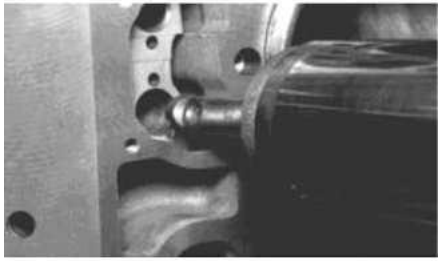

Illustration 172 g01299730
Machining the damaged bore

1. Install the block on a boring machine. Refer to Illustration 170. Use a bore that is in good condition to adjust the centerlines correctly. Use a dial indicator to make sure that the centerline of the bore is in alignment with the centerline of the spindle. Move the dial indicator along a horizontal and a vertical axis to center the boring machine. Refer to Illustration 171.
2. When the lifter bore is in correct alignment, check for the necessary dimension to adjust the spindle for the boring machine. This procedure must be done before machining the damaged lifter bore. For maximum accuracy, refer to Illustrations 180 through 187. The illustrations show the necessary dimensions to adjust the spindle of the boring machine before the damaged lifter bore is machined.

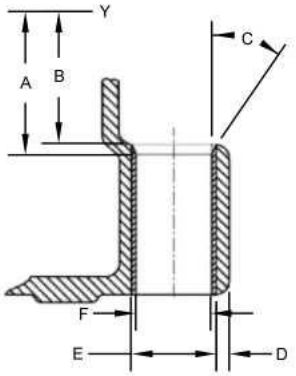

Illustration 173 g01299731
The dimension of the lifter bores for the 3300 Engines
(A) 181.8 ± 0.5 mm (7.15747 ± 0.01969 inch)
(B) 177.3 ± 0.5 mm (6.98030 ± 0.01969 inch)
(C) 25° ± 7°
(D) 1.78 mm (0.07008 inch) Minimum Wall Thickness
(E) 37.356 ± 0.013 mm (1.47071 ± 0.00051 inch)
(F) 33.39 ± 0.05 mm (1.31456 ± 0.00197 inch)
(Y) Top of the block

Note: Use a 1 7/16 in core drill for machining the 3300 Engines. Note the reference line (Y), it represents the top of the block.

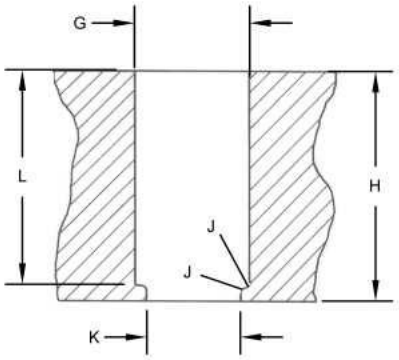

Illustration 174 g01299732

The dimension of the lifter bores for machining the 3400Engines
(G) 34.226 ± 0.025 mm (1.34748 ± 0.00098 inch)
(H) 71.0 ± 0.5 mm (2.79527 ± 0.01969 inch)
(J) 0.25 mm (0.00984 inch) Max Chamfer and Radius
(K) 31.191 ± 0.025 mm (1.22799 ± 0.00098 inch)
(L) 65.0 ± 0.5 mm (2.55905 ± 0.01969 inch)

3. Machine the damaged lifter bore to the specified dimensions. Refer to Illustration 173 for the 3300 Engines. Refer to Illustration 174 for the 3400 Engines.

4. Clean the bore and the sleeve with primer. Proceed to Step 4a for the 3300 Engines and Step 4b for the 3400 Engines.

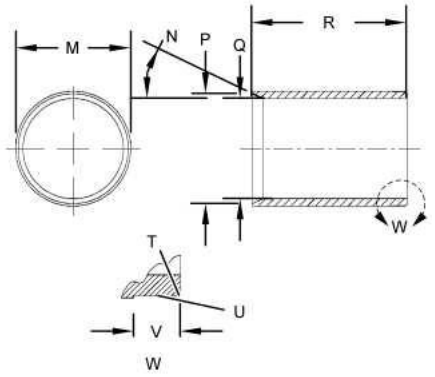

Illustration 175 g01304486

Dimensions of sleeve to machine for the 3300 Engines
(M) 37.419 ± 0.025 mm (1.47319 ± 0.00098 inch) diameter
(N) 25° ± 7°
(P) 35.81 ± 0.08 mm (1.40984 ± 0.00315 inch) diameter
(Q) 32.64 ± 0.08 mm (1.28504 ± 0.00315 inch) diameter
(R) 50.29 ± 0.13 mm (1.97992 ± 0.00512 inch)
(T) C/R 0.80 mm (0.03150 inch)
(U) Step for Relief with a 37.29 ± 0.025 mm (1.46811 ± 0.00098 inch) diameter
(V) 5.08 mm (0.20000 inch)

a. Machine a sleeve from a casting of 172 MPa grade gray iron for the 3300 Engines. Refer to Illustration 175 for the dimensions of the sleeve. After machining a sleeve, lower the temperature of the 3300 sleeve to −84 °C (−120 °F) and put a layer of **7M-7456** Retaining Compound on the inside diameter of the lifter bore. Use of a mechanical fastener or “staking” a 3300 Engine sleeve is not required.

b. For the 3400 Engines, freeze the **4W-4588** Sleeve to −84 °C (−120 °F). Apply Loctite 620 to the lifter bore. Install the **4W-4588** Sleeve with a 25° internal chamfer toward the top of the block.

Note: Measure the outside diameter of the sleeve before lowering the temperature of the sleeve. Make sure that the press fit is 0.064 ± 0.013 mm (0.00252 ± 0.00051 inch). Adjust the dimensions that are in the Illustration 173 and in the Illustration 174 to achieve the correct press fit.

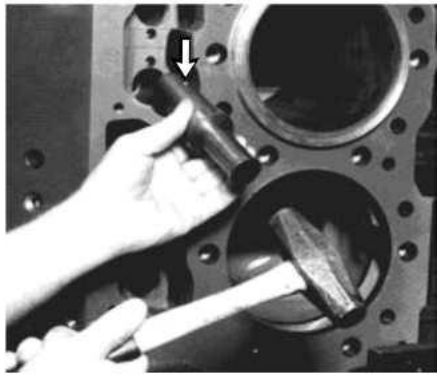

Illustration 176 g01299735

Make sure that lubrication holes in the sleeve and lubrication holes in the block are in alignment.

5. Use the **1P-0510** Driver Group to install the sleeve. Refer to Illustration 176. Make sure that the lubrication holes in the sleeves are in alignment with the lubrication holes in the block.

There is an oil hole for the late produced 3406A Engines and all 3406B Engines that must be drilled out after the sleeve is installed. The oil hole is located 591.44 mm (23.28499 inch) from the end of the engine block. Refer to Illustration 182 and Illustration 183 for the location of the oil hole. Use the existing hole of 8.61 mm (0.33898 inch) in diameter as a guide and an 8.61 mm (0.33898 inch) drill to drill all the way through the sleeve and open the oil passage to the lifter bore.

Note: Inspect the alignment of the oil hole between all sleeves and the block after installation. If the opening is less than 50%, run a 9.5 mm (3/8 inch) drill through the oil passages of the engine block.

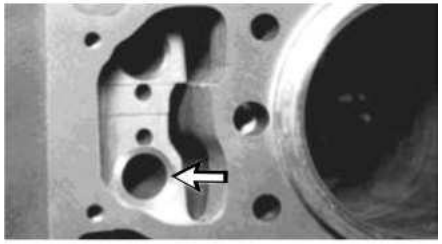

Illustration 177 g01299736

The sleeve must be even with the surface of the block.

6. Use a Spotface Tool to make the sleeve even with the surface of the block. Refer to Illustration 177.

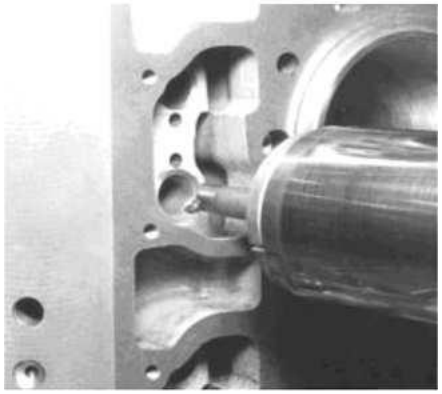

Illustration 178 g01299739
Procedure to machine the lifter bore to the correct size

7. Machine the lifter bore to 27.953 ± 0.019 mm (1.10051 ± 0.00075 inch). The surface of the bore must be smoother than 3.2 µm (126 µinch). Illustration 178 shows the machining procedure.

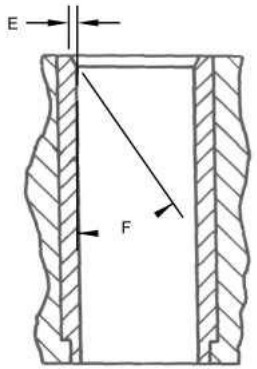

Illustration 179 g01299740
Chamfer dimensions on the sleeve.
(E) 0.76 ± 0.25 mm (0.02992 ± 0.00984 inch)
(F) 30°

8. Machine a chamfer on the sleeve. Refer to Illustration 179 for the correct dimensions.

9. Clean the block thoroughly.

Engine Schematics

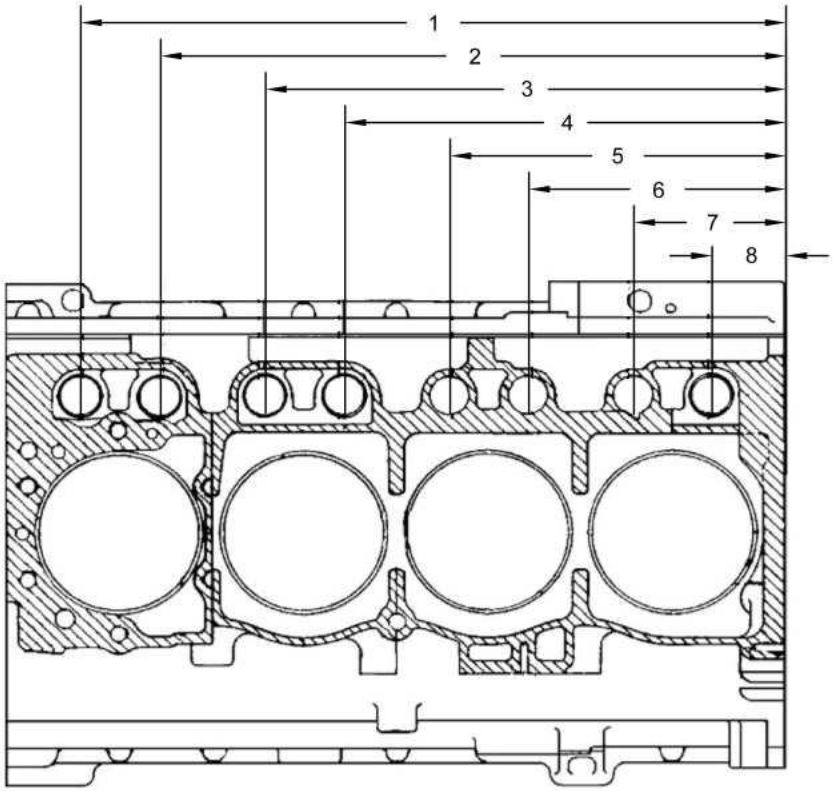

Illustration 180 g01299892

Dimension for the lifter bores of a 3304 Engine

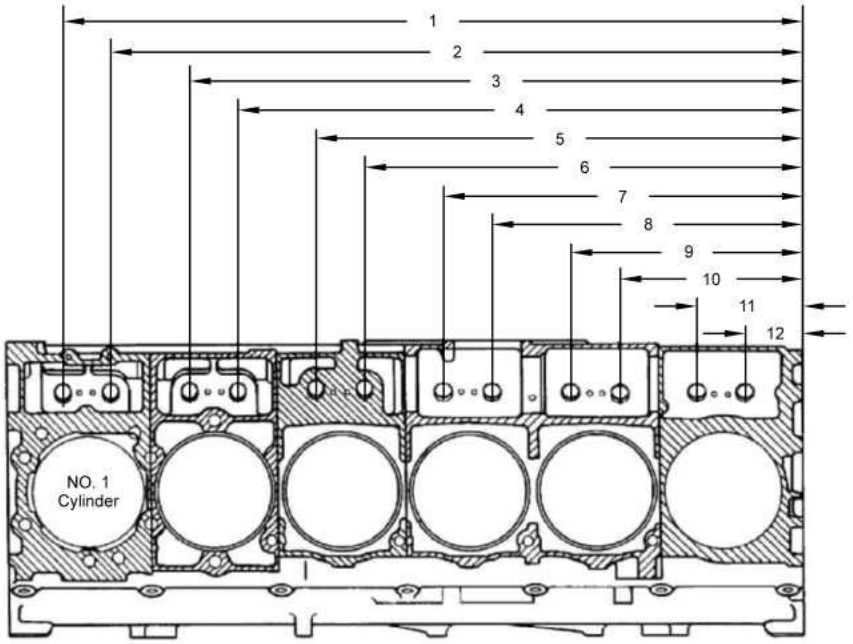

Illustration 181 g01299898

Dimension for the lifter bores of a 3306 Engine

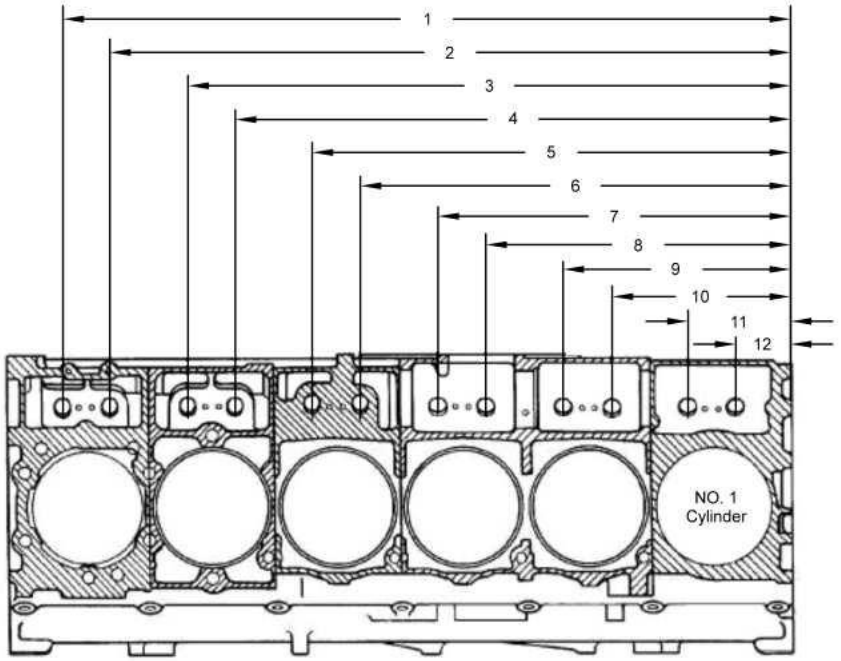

Illustration 182 g01299771

Dimension for the lifter bores of a 3406 Engine

Table 35

Dimensions for the Centerlines of the Lifter Bores			
Callout	**3304 Engine**	**3306 Engine**	**3406 Engine**
1	571.246 mm (22.4899 inch)	869.696 mm (34.2399 inch)	999.87 mm (39.365 inch)
2	507.749 mm (19.9900 inch)	806.196 mm (31.7399 inch)	934.34 mm (36.785 inch)
3	422.021 mm (16.6150 inch)	720.471 mm (28.3649 inch)	828.42 mm (32.615 inch)
4	358.521 mm (14.1150 inch)	656.971 mm (25.8649 inch)	762.89 mm (30.035 inch)
5	272.796 mm (10.7400 inch)	571.246 mm (22.4899 inch)	656.97 mm (25.865 inch)
6	209.296 mm (8.2400 inch)	507.746 mm (19.9899 inch)	591.44 mm (23.285 inch)
7	123.571 mm (4.8650 inch)	422.021 mm (16.6150 inch)	485.52 mm (19.115 inch)
8	60.071 mm (2.3650 inch)	358.521 mm (14.1150 inch)	419.99 mm (16.535 inch)
9	N/A	272.796 mm (10.7400 inch)	314.07 mm (12.365 inch)
10	N/A	209.296 mm (8.2400 inch)	248.54 mm (9.785 inch)
11	N/A	123.571 mm (4.8650 inch)	142.62 mm (5.615 inch)
12	N/A	60.071 mm (2.3650 inch)	77.09 mm (3.035 inch)

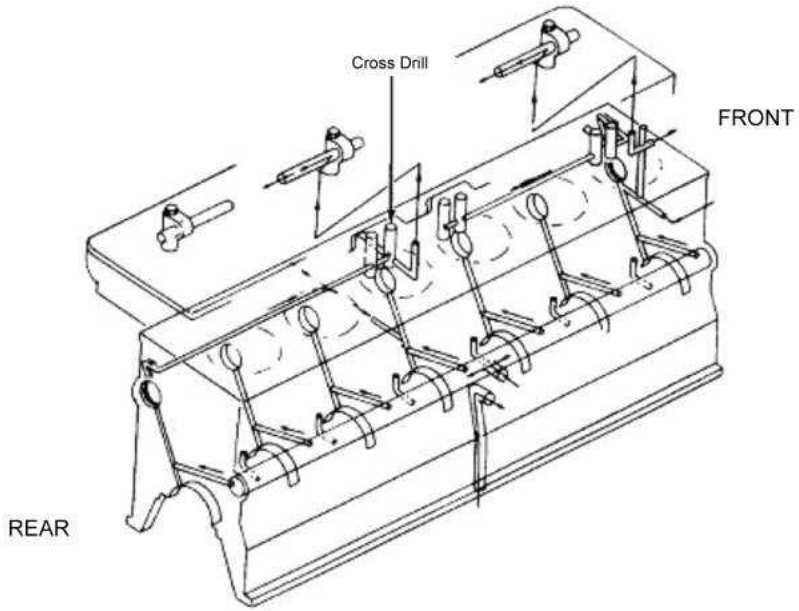

Illustration 183 g01299777

Location of cross-drilled oil holes for a 3406 Engine

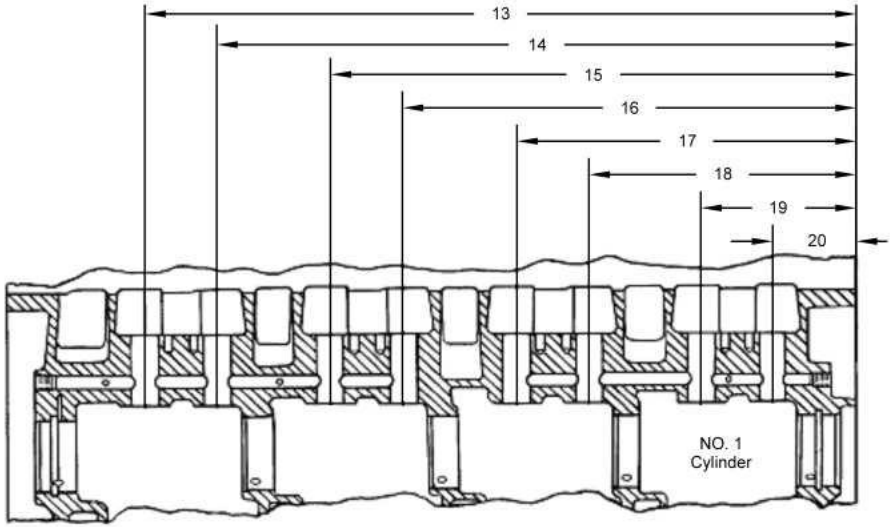

Illustration 184 g01299772

Dimension for the lifter bores on the left side of a 3408 Engine

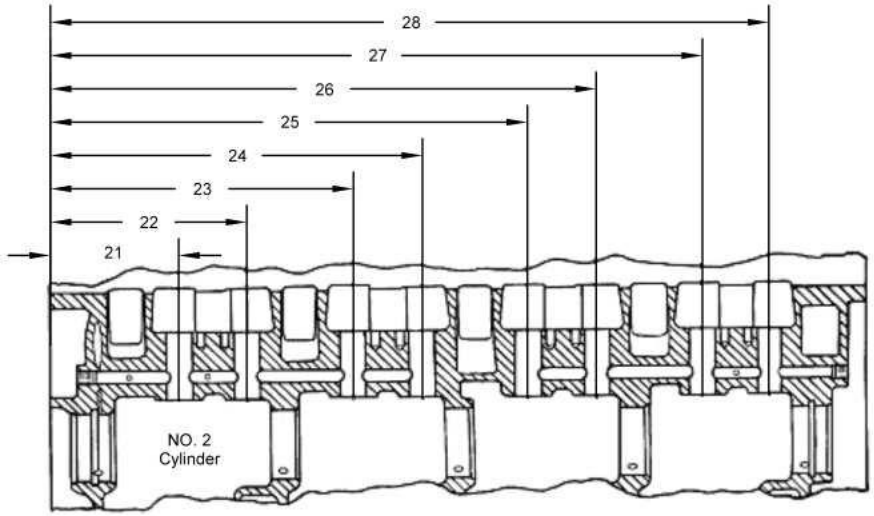

Illustration 185 g01299775

Dimension for the lifter bores on the right side of a 3408 Engine

Table 36

Dimensions for lifter bores for 3408 Engines	
Callout	**Dimension**

13	716.53 mm (28.210 inch)
14	644.65 mm (25.380 inch)
15	532.38 mm (20.960 inch)
16	460.50 mm (18.130 inch)
17	348.23 mm (13.710 inch)
18	276.35 mm (10.880 inch)
19	164.08 mm (6.460 inch)
20	92.20 mm (3.630 inch)
21	128.02 mm (5.040 inch)
22	199.90 mm (7.870 inch)
23	312.17 mm (12.290 inch)
24	384.05 mm (15.120 inch)
25	496.32 mm (19.540 inch)
26	568.20 mm (22.370 inch)
27	680.47 mm (26.760 inch)
28	752.35 mm (29.620 inch)

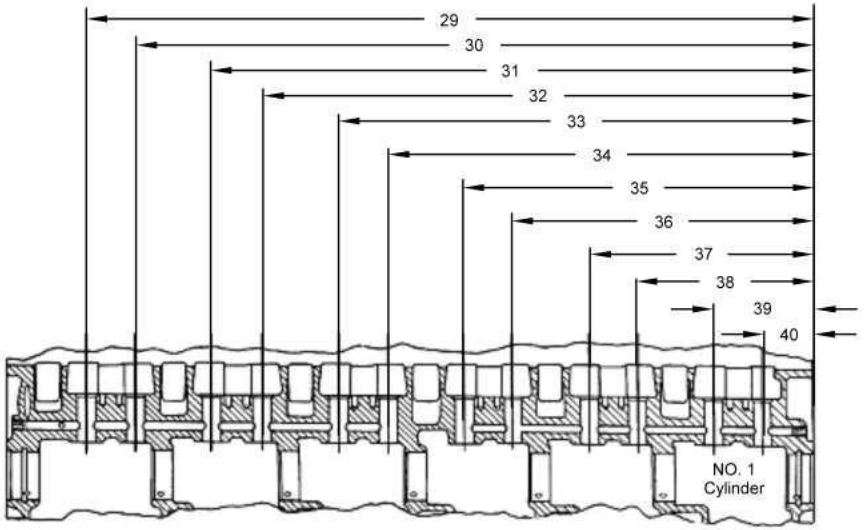

Illustration 186 g01299773

Dimension for the lifter bores on the left side of a 3412 Engine

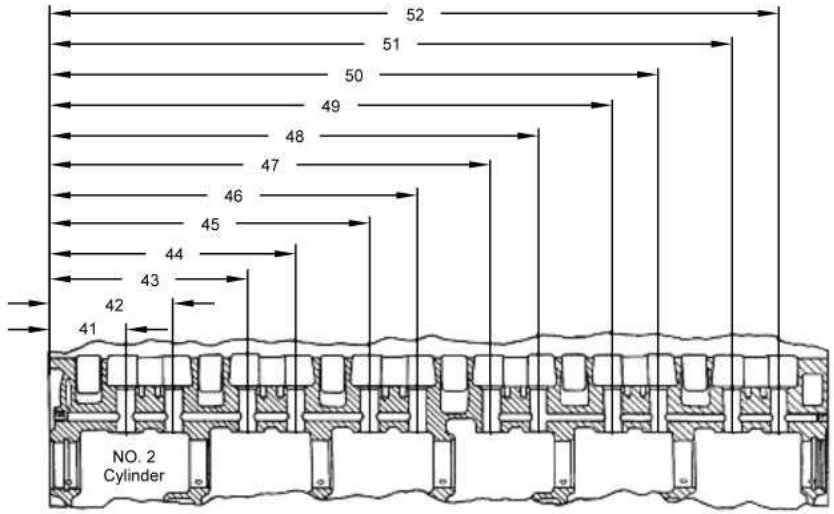

Illustration 187 g01299776

Dimension for the lifter bores on the right side of a 3412 Engine

Table 37

Dimensions for lifter bores for 3412 Engines	
Callout	**Dimension**
29	1070.74 mm (42.155 inch)
30	998.86 mm (39.325 inch)
31	886.59 mm (34.905 inch)
32	814.70 mm (32.075 inch)
33	702.44 mm (27.655 inch)
34	630.56 mm (24.825 inch)
35	518.29 mm (20.405 inch)
36	446.40 mm (17.575 inch)
37	334.14 mm (13.155 inch)
38	262.26 mm (10.325 inch)
39	149.99 mm (5.905 inch)
40	78.11 mm (3.075 inch)
41	113.92 mm (4.485 inch)
42	185.80 mm (7.315 inch)
43	298.07 mm (11.735 inch)
44	369.95 mm (14.565 inch)
45	482.22 mm (18.985 inch)

46	554.10 mm (21.815 inch)
47	666.37 mm (26.235 inch)
48	738.25 mm (29.065 inch)
49	850.52 mm (33.485 inch)
50	922.40 mm (36.315 inch)
51	1034.67 mm (40.735 inch)
52	1106.55 mm (43.565 inch)

Procedure to Repair Lifter Lock Bores for 3400 Series Engines

Illustration 188 g02946536
Damaged bore for lifter lock

The 3408 and 3412 series engines sometimes have lifter lock failure which can lead to damage to the bore for the lifter lock. The bore for the hook of the lifter lock can be salvaged by reaming the block by using a fabricated drilling fixture and inserting a modified dowel. Use the following procedure to fabricate the drilling fixture and repair the damaged area.

Illustration 189 g02946998

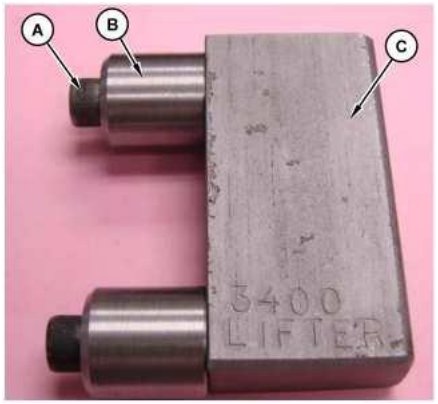

Illustration 190 g02946999

(A) Socket head cap screws
(B) Locating dowels installed in lifter bores
(C) Flat bar steel

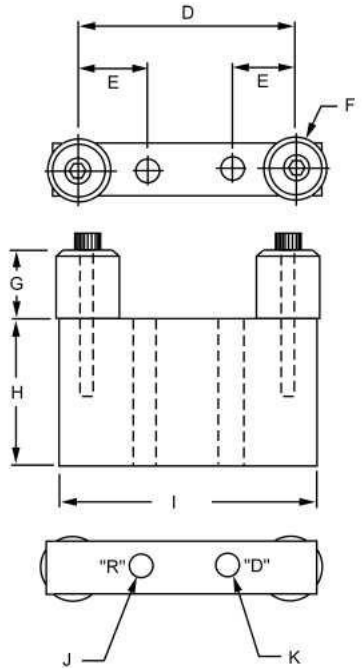

Illustration 191 g06238891

1. Fabricate the drilling fixture by using the information provided.

Table 38

Parts List for Fixture Fabrication

(A)	3/8 - 16 x 2 inch socket head cap screws
(B)	1 1/8 x 1 1/4 cold rolled round[1]
(C)	1 x 3 x 3 3/4 inch flat bar[1]

(1) Machine to dimensions shown

Table 39

Dimensions for Fabricating the Fixture	
Item	**Value**
D	Early 3406 Engines 65.53 mm (2.580 inch)
	3408 and 3412 Engines 71.88 mm (2.830 inch)
E	23.063 mm (0.908 inch)
F	27.89 mm (1.098 inch) Finished Diameter
G	28.10 mm (1.14 inch)
H	48.0 mm (1.9 inch)
I	95.3 mm (3.75 inch)
J	12.7 mm (0.500 inch) Finished REAM Diameter
K	11.9 mm (0.47 inch) DRILL Diameter

Illustration 192 g02948956
Fabricated tool installed in the lifter bores

Illustration 193 g02949102
Lifter lock bore drilled and reamed

2. Position the drilling fixture in the cylinder block, placing the smaller drilling hole "D" over the damaged bore for the lifter lock hook that is to be repaired. The two round parts of fixture are inserted into the lifter bore.
3. Drill the damaged bore, then rotate the drilling fixture so that the reaming hole "R" is located over the bore that was drilled.

Illustration 194 g02949478

4. Obtain a **7F-3606** Sleeve and cut the sleeve to match the depth of the drilled and reamed hole. Apply Loctite® 620 onto the modified **7F-3606** Sleeve and press the sleeve into the cylinder block, as shown. Stake the sleeve into position.

Miscellaneous Repairs

C9.3 Coolant Diverter

C9.3 cylinder blocks include a coolant diverter. This is located inside the coolant passage where the power train oil cooler manifold is mounted. Be sure that after any work to the C9.3 cylinder block that the diverter is in place. A missing diverter can cause high powertrain temperatures and/or NRS cooler cracking.

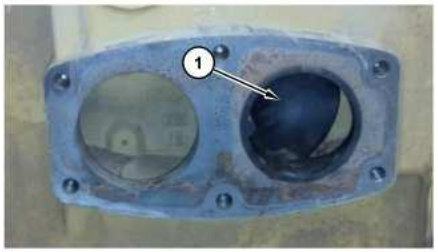

Illustration 195 g03692955

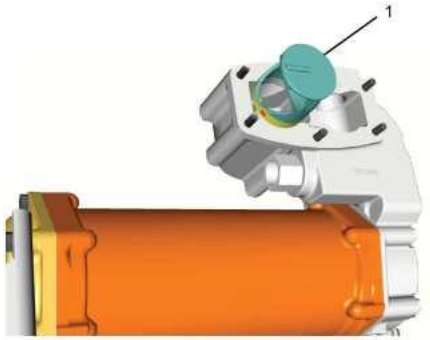

Illustration 196 g03692994

(1) Coolant Diverter in the proper location within the C9.3 cylinder block.

Threaded Holes and Cracks

Illustration 197 g06238897

Inspect all the tapped holes. Tapped holes that are damaged can be repaired, even if the tapped holes extend into the cooling passages.

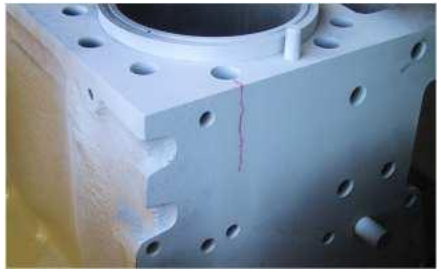

Illustration 198 g06238899

Inspect the cylinder block for any cracks. If the cylinder block is cracked, the cylinder block can be repaired. For more information on repairing cracks, refer to the "Lock-n-Stitch" section in this guideline.

Lock-n-Stitch

Lock-n-Stitch is the preferred method for repairing a failure in a cylinder block. Kits are available from Caterpillar and kits are available directly from Lock-n-Stitch. Lock-n-Stitch can be contacted by using the following information:

http://www.locknstitch.com/

LOCK-N-STITCH Inc.
1015 S. Soderquist Rd.
Turlock, CA -- 95380
209-632-2345
800-736-8261

Lock-n-Stitch repair kits are available from Caterpillar. The kits are used to repair single failures that are caused by a connecting rod. The kits are also used to repair cracks that are in a casting. These repairs should not be made in structural areas. The repair method that is utilized can achieve a permanent repair. The detailed instructions and the part numbers for the kits can be found in the Reuse and Salvage Guidelines, SEBF8882, "Using Lock-n-Stitch Procedures for Casting Repair".

Top Deck Threaded Hole Repair In 3400 Engines

The threaded holes in the top deck of cylinder blocks can be damaged during an engine rebuild. Damaged threads can cause improper torque of the head bolts, resulting in possible failure. Using this threaded insert repair procedure, bolt holes can be repaired to "like new" condition. Use this guideline as the only source of reference when installing the Kent- Moore® threaded insert.

To repair stripped or cracked head bolt holes, use the PT-2801 Porta-Thread Basic Kit, with the PT-2801-3 Service Kit. A thin-wall solid steel insert with a sealed bottom prevents coolant leakage from the cylinder head bolt holes. This insert can often repair cracked blocks that, until now, would be scrapped.

Cylinder block repair is made easy using a base plate and drill jig to maintain perfect alignment during reaming and tapping operations.

Tooling and Equipment

Table 40

Required Tools	
Part Number	**Part Description**
PT-2801	Basic Kit (Jig fixture)
PT-2801-3	Service Kit

Table 41

Threaded Inserts	
Part Number	**Part Description**
PT-8704-A	Threaded insert used in 3406, 3408and 3412 Engines

Note: These tools can be ordered direct from:

Kent-Moore
28635 Mound Rd.
Warren MI, 48092-3499
Phone (800) 345-2233
Fax 1-800-578-7375

Nomenclature

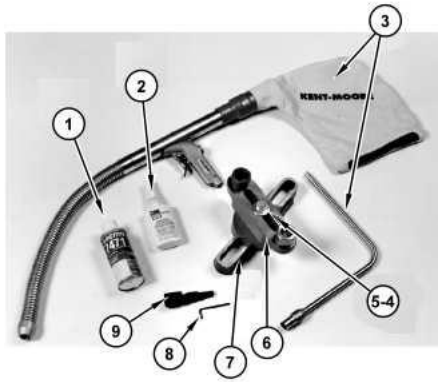

Illustration 199 g02119154

Basic Kit (PT-2801)
(1) PT-7270 Loctite Compound (50 cc)
(2) PT-7260 Loctite Primer T [178 mL (6 oz)]
(3) PT-2900-6 Super Chip Vacuum and PT-2900-2 90 Degrees Extension
(4) RS-13300-250 Washer (5/8 in SAE)
(5) RS-9103-100 Hex Head Bolt (5/8-18 x 3 in, Grade 5)
(6) PT-2800-32 Drill Jig
(7) PT-2800-33 Base Plate
(8) RS-15100-175 Allen Wrench (1/8 in)
(9) PT-1000-20 Universal Drive
(A) J-34970 Storage Box (not shown)
(B) PT-2801-22 Foam Insert (not shown)

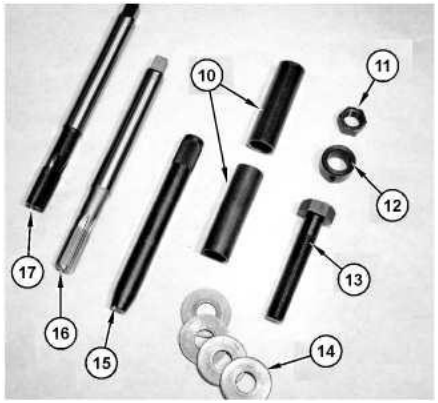

Illustration 200 g06304381

Service Kit (PT-2801-3)
(10) PT-2800-24 Stud Adapter
(11) PT-2800-30 Installing Nut
(12) PT-2800-26 Stop Collar Assembly
(13) PT-2800-41 Installing Bolt
(14) RS-13-300 Washer (7/8 in SAE)
(15) PT-2800-29 Locating Pin
(16) PT-2800-38 Special Reamer
(17) PT-2800-39 Special Tap
(C) PT-2800-40 Spacer (not shown)

Repair Procedure

Use the following procedure to carry out repair operation:

1. File the top deck to remove all burrs and high spots. Thoroughly clean the area for proper tool location.
2. Attach the drill jig (6) to the base plate (7) using the hex head bolt (5) and the washer (4). Place the drill jig on the cylinder block, aligning the base plate over two holes across from each other. Use the cylinder head bolts, washers, and the stud adapters (10) to secure the base plate (7) to the cylinder block. Torque the bolts to 41 N·m (30 lb ft).
3. Loosen the hex head bolt (5) and position the drill jig (6) over the hole to be repaired. Insert the locating pin (15) through the drill bushing and into the bolt hole. Tighten the bolt (5) to 40 N·m (30 lb ft) and remove the locating pin. Refer to Illustration 201.
4. Insert special reamer (16) through drill bushing into top of bolt hole.
5. Install the universal drive (9) in the chuck of an electric drill (slow speed drill is best) and begin reaming the damaged bolt hole. Stop after reaming to a depth of about one in. Refer to Illustration 201
6. Remove the reamer and clean out shavings with a chip removing unit. Continue reaming to the bottom of the hole. Remove the reamer and thoroughly clean out all shavings from hole.

NOTICE

To avoid damage to the tooling, keep the reamer shank and drill bushing free of metal shavings.

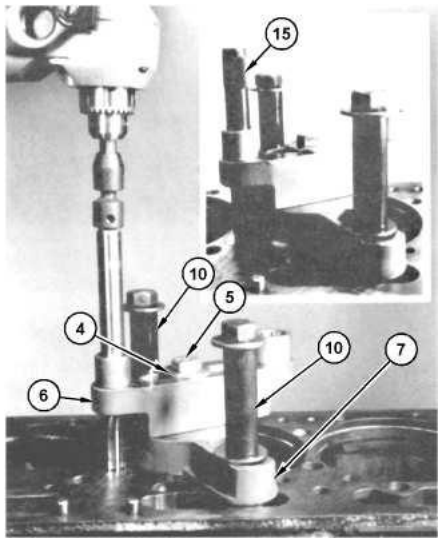

Illustration 201 g06304389

Position drill jig (6) over damaged bolt hole.

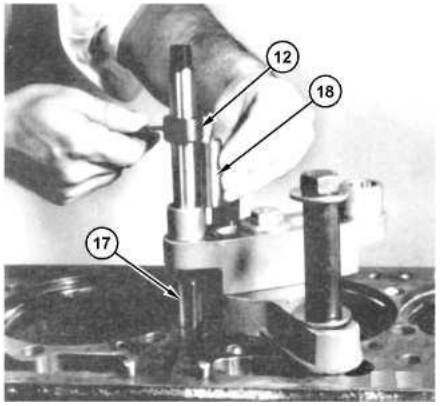

Illustration 202 g06304392

Insert tap.
(18) Threaded insert.

7. Insert the special tap (17) through the drill bushing, allowing it to set on top of the hole. Using a threaded insert (18), adjust the depth stop collar (12) on tap, as shown in the Illustration 202.

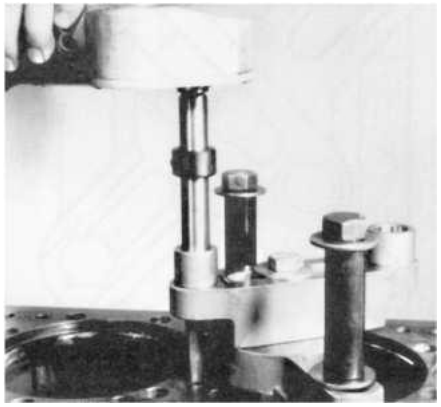

Illustration 203 g06304394

Tap the hole.

8. Using a low speed drill or tap handle, tap the hole. If using a drill, stop when there is a 3.0 mm (0.12 in) gap between the stop collar and guide bushing. Finish tapping the hole by hand.

Illustration 204 g06304396

Remove all debris from hole using the chip vacuum or compressed air.

9. Remove the tap and the drill jig fixture from the cylinder block. Clean the hole thoroughly with a chip removing unit.

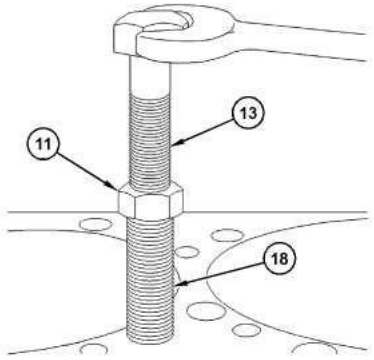

Illustration 205 g06304397

Attach installing bolt (13) to threaded insert and install insert.
(11) PT-2800-30 Installing Nut
(13) PT-2800-41 Installing Bolt
(18) Threaded insert.

10. Thread the special installing nut (11) onto a cylinder head bolt or installing bolt (13). Install the nut to end of threads, then back off the nut about 1/4 turn.

11. Screw threaded insert onto installing bolt (or head bolt, if used) until it touches the nut. Clean the outside diameter threads of the insert with **4C-9500** Quick Cure Primer (2). Let dry, then coat with **9S-3263** Thread Lock Compound (1). Using a wrench on the installing bolt, screw the threaded insert into the block until installing nut bottoms on top of block.

12. With another wrench, hold the bolt and loosen the nut from the threaded insert, then remove the bolt.

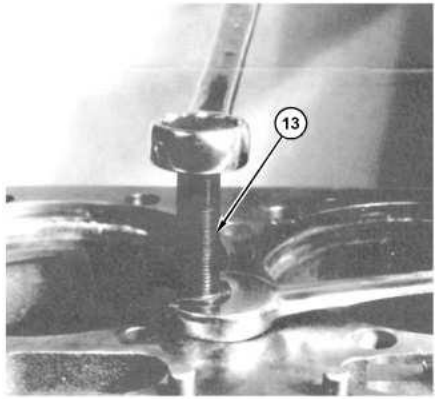

Illustration 206 g06304400

Remove installing bolt (13).

Cast Iron Welding

Depending on the type of weld that is required, cast iron cylinder blocks can be welded. Welding cast iron requires preheating. For more information on welding cast iron, refer to Reuse and Salvage Guidelines, SEBF8882, "Using Lock-n-Stitch Procedures for Casting Repair" and Special Instruction, SEHS8919, "Reuse and Salvage for Cast Iron Cylinder Blocks".

Belzona Ceramic Metal

Belzona can be used to repair porosity or pitting of the cylinder block. Instructions can be found in Special Instruction, SEHS8869, "Cylinder Block Salvage Procedure for Using Belzona Ceramic R Metal".

Main Bearing Bolt Hole Repair in C-15, C-16, C-18, and 3400 Engines

The threaded holes in the main bearing bore of cylinder blocks can be damaged during an engine rebuild. Damaged threads can cause improper torque of the main bearing bolts, resulting in possible failure. Using this threaded insert repair procedure, bolt holes can be repaired to "like-new" condition.

To repair stripped or cracked main bearing bolt holes, use the items described in the Tooling and Equipment section of this guideline. An open-end solid steel insert is used for main bearing bolt hole reinforcement. These inserts can often repair blocks, which, until now, would be scrapped.

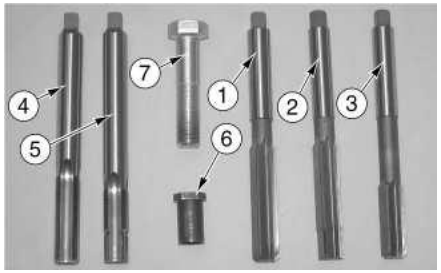

Illustration 207 g02165017

Table 42

Thread Repair Tooling		
Item	**Part Number**	**Description**
(1)	178-2349	First Operation Reamer

(2)	178-2350	Second Operation Reamer
(3)	178-2351	Third Operation Reamer
(4)	178-2353	First Operation Tap
(5)	178-2356	Second Operation Tap
(6)	178-2467	Insert Installation Sleeve
(7)	N/A	Main Bearing Cap Bolt
(8)[1]	178-2501	Insert 3400 Series Engines

(1) This item is not shown.

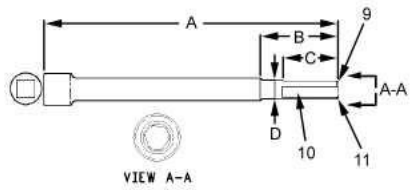

Illustration 208 g02165047

Table 43

Modification Dimensions	
Callout	**Dimension**
(A)	New Length 127.0 mm (5.00 inch)
(B)	50.8 mm (2.00 inch)
(C)	38.1 mm (1.50 inch)
(D)	12.7 + 0.3 - 0.0 mm (0.50 + 0.01 - 0.0 inch)
(9)	0.3 x 45° C/R
(10)	Three Flats that are Equally Spaced
(11)	Remove male square drive

Repair Procedure

Illustration 209 g02166213
Ream the damaged bolt hole

1. Insert the first reamer, **178-2349** Reamer into the damaged hole.
2. Using the modified **8H-8559** Extension between the electric drill and the reamer, begin reaming the damaged bolt hole. Stop after reaming to a depth of about 25.4 mm (1 inch).
3. Remove the reamer and clean out shavings. Continue reaming the bottom of the hole. Remove the reamer and thoroughly clean all shavings from the hole.

   Note: To avoid damage to the tooling, keep the flutes of the reamer free from metal shavings.
4. Repeat Steps 1 through 3 with the second reamer **178-2350** Reamer, and the third reamer, **178-2351** Reamer.
5. Optional: Chamfer the hole using a metal chamfering tool or **4C-3845** Mounted Point.

Illustration 210 g02166275

Note: 3400 Series Engines require two tapping operations.

6. Use a tap handle, extension, and the first tap **178-2353** Tap. Thread the hole. Use a lightweight lubricating oil or tapping fluid to ensure smooth threads.
7. Remove the tap from the cylinder block. Clean the hole thoroughly using compressed air.
8. Repeat Step 6 and Step 8 for the second tap **178-2356** Tap.
9. Clean the hole using **138-8441** Brake Cleaner and compressed air.

Illustration 211 g02166426
Installing Sleeve

10. Thread the hex end first of the **178-2467** Installing Sleeve onto a main bearing bolt. Install the sleeve up to the end of the threads. Back off the sleeve approximately ¼ to ½ turn.

Illustration 212 g02166693
Threaded Insert

11. Screw the **178-2501** Threaded Insert onto the main bearing bolt until the insert contacts the sleeve. Clean the outside diameter threads of the insert with **169-5464** Quick Cure Primer. Allow to dry, then coat the outside of the insert with **154-9731** Thread Lock Compound.

Illustration 213 g02167156

Sleeve and threaded insert

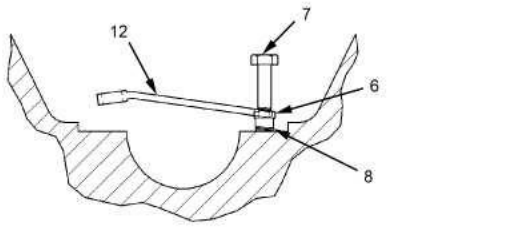

Illustration 214 g02167314

Using the installing bolt and sleeve, screw the threaded insert into the block until it bottoms.
(12) Wrench

12. Using the wrench on the installing sleeve, screw the threaded insert into the blocks until it reaches the bottom in the tapped hole. After the insert reaches the bottom, tighten the installing sleeve an additional 30°.

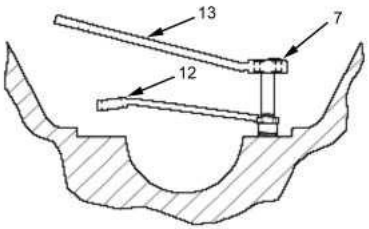

Illustration 215 g02167873

(13) Wrench

13. Hold the main cap bolt with wrench (13) and loosen the sleeve from the threaded insert.
14. Remove the main cap bolt.
15. Use a file to remove and burrs and high spots from the mating face of the block and the cap.

Oil Pump Mounting Pad on 3406B, 3406C, 3406E, C15, and C-15 Engines

The mounting pad for the oil pump on the cylinder block can break when objects become trapped between the oil pump drive gears. In many cases, this method of retaining the oil pump housing can be used instead of replacing the cylinder block. This method can be used only if 40 % or more of the oil pump mounting pad can be supported on the broken cylinder block mounting pad.

Fabricated Support Block

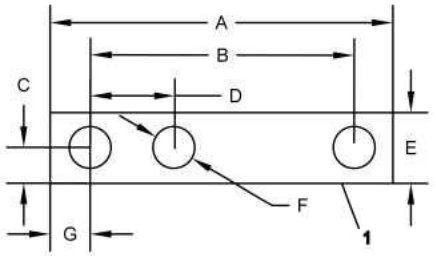

Illustration 216 g06344924

Dimensions for the support block (1).

Table 44

Dimensions for Support Block (1)	
Callout	**Description**
(A)	90.4 mm (3.56 inch)
(B)	69.44 mm (2.734 inch)
(C)	9.52 mm (0.375 inch)
(D)	22.0 mm (0.87 inch)
(E)	19.1 mm (0.75 inch)
(F)	10.5 mm (0.41 inch) Diameter (3 holes)
(G)	10.5 mm (0.41 inch)

1. Fabricated support block (1), from 12.7 mm (0.50 inch) thick mild steel. Refer to the Illustration 216.

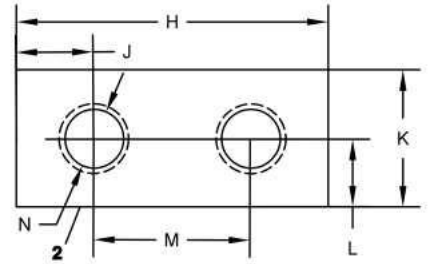

Illustration 217 g06344926

Dimensions for the tapped block (2).

Table 45

Dimensions for Tapped Block (2)	
Item	**Description**
(H)	43.7 mm (1.72 inch)
(J)	10.9 mm (0.43 inch)
(K)	19.1 mm (0.75 inch)

(L)	9.52 mm (0.375 inch)
(M)	22.0 mm (0.87 inch)
(N)	Drill two 8.20 mm (0.323 inch) diameter holes and tap for 3/8-16 thread.

2. Fabricate tapped block (2), from 12.7 mm (0.50 inch) thick mild steel. Refer to the Illustration 217.

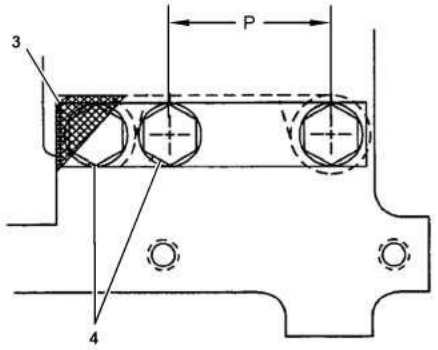

Illustration 218 g06344927

Location to drill new hole (4) in remaining oil pump mounting pad on cylinder block.
(3) Area of broken block.
(4) Two 10.5 mm (0.41 inch) diameter holes in block for 0L-1352 Bolts.
(P) 47.44 mm (1.868 inch)

3. Drill a new 10.5 mm (0.41 inch) diameter hole (4) through the oil pump mounting pad on the cylinder block. Refer to the Illustration 218.

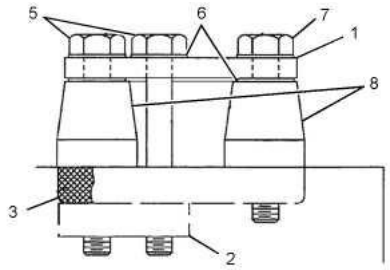

Illustration 219 g06344929

Location of oil pump mounting components.

Table 46

Oil Pump Mounting Components	
Item	**Description**
(1)	Support block
(2)	Tapped block
(3)	Area of broken block

(5)	**0L-1352** Bolt
(6)	**5M-2894** Hard Washer
(7)	**0L-1143** Bolt
(8)	Oil Pump

4. Install oil pump (8), as shown in the Illustration 219. To install the pump, use two **0L-1352** Bolts (5), five **5M-2894** Hard Washers (6), and one **0L-1143** Bolt (7).

Flame Spray and Arc Spray

If the top contact surface needs to be milled to remove any damage, the measurements must be within original specifications. If the damage is not removed and the measurement is not within original specifications, the cylinder block will need to be welded up to original specifications. Use the following process to build the cylinder block up to original specifications.

Note: Wear a pair of clean cotton gloves when you handle the cylinder block. Contaminants will not allow the thermal spray to bond properly.

Illustration 220 g06238572

1. Mill the cylinder block to a minimum of 0.51 mm (0.020 inch) below the lower limit on the tolerance.

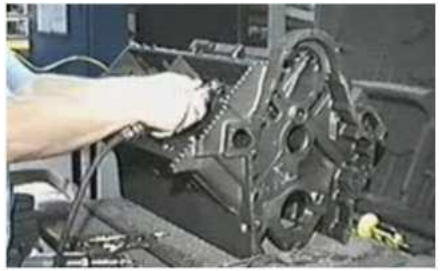

Illustration 221 g06238588

2. Apply a 1.5 mm (0.06 inch) chamfer to all the edges of the cylinder block. Use a die grinder for the straight edges. Use an air drill and a chamfer tool for the holes.

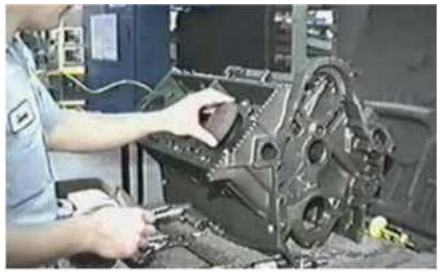

Illustration 222 g06238589

3. Plug all the threaded holes. Plug the cylinder bores.
4. Degrease the top deck of the cylinder block.

Illustration 223 g06238593

5. Shot blast the top deck of the cylinder block immediately prior to the application of thermal spray. The top deck of the cylinder block should have a roughness of 5.1 µm to 7.6 µm (200.00 µinch to 300.00 µinch).

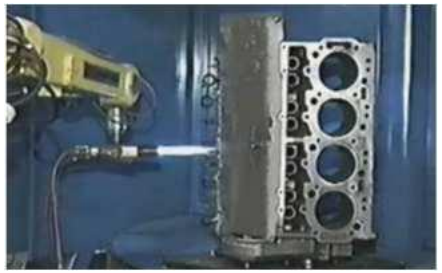

Illustration 224 g06238595

6. Preheat the cylinder block to an approximate temperature of 93 °C (200.0 °F).

Illustration 225 g06238596

7. Apply the thermal spray 0.64 mm (0.025 inch) above the upper limit on the tolerance. Apply the thermal spray in several thin layers.
8. Mill the thermal spray so that the height of the cylinder block is between the nominal dimension and the upper limit.

   Note: The weld must have a minimum thickness of 0.38 mm (0.015 inch) to avoid flaking.

For additional information, refer to "Thermal Spray Procedures for Top Surface Deck".

Thermal Spray Procedures for Top Surface Deck

Spraying Under Top Supported Liner

Listed below are the arc and flame spray procedures for providing a sufficient thermal spray coating on top decks. Based on complexity and process variables, arc spray is the preferred technology for this process.

Arc spray is the only validated and approved process for spraying under top supported liner flanges. Flame spray should only be used for deck height recovery with the use of inserts under the liner flanges.

Arc Spray Equipment and Procedure

Table 47

Minimum Surface Texture Before Spray	3.2 µm (125.9843 µinch)
Reason for Spraying	Restore deck height to specification
Arc Spray Equipment Type	SmartArc by Oerlikon Metco, TAFA 8830 MHU, or TAFA 8835 MHU
Wire	TAFA 75B Wire or equivalent Nickel Aluminum Wire
Max Spray Thickness	2.0 mm (0.08 inch) (Should Target 0.60 mm (0.024 inch) to 1.20 mm (0.05 inch) Spray Thickness)
Spray Angle	90°
Substrate Pre-Heat Temperature	22.2 °C (72.00°F) to 66°C (150.8°F) Do not direct arc on area to be sprayed.
Substrate Temperature During Spraying Not to Exceed	148°C (300°F)
Surface Preparation Method	Grit blast - If the entire mating surface is to be arc sprayed, some shops prefer to pre-machine the surface. This process removes any major damage, allows for a recommended minimum 0.25 mm (0.010 inch) coating, reduces technique dependency in producing an even coating, and can reduce material cost and finish machining time.
	Precautions and care must be taken to properly mask and remove all grit from block surface and cavities. **Time between surface preparation and thermal spray application should be minimal. Allowing excessive time between preparation and thermal spray will result in unacceptable coating performance.**
Machining Method	Milling

Equipment Required	Rottler 99Y or similar
Recommended Cutting Tool	Sandvik R245 12T 3MPM 1010
Blast Media Recommendation	Pressure Type Only (Aluminum Oxide Grit)
Finishing Equipment Type	Milling
Finishing Equipment	Rottler 99Y or similar

Table 48

Arc Spray	Procedure		Check List
Clean Part	Pre-machine block and degrease block deck surface.		
	Visual inspection for imbedded oils or other contaminants should be conducted during preheat.		
Undercut	Must not exceed 2.0 mm (0.08 inch) spray thickness		
Chamfer	All edges must have at least 0.25 mm (0.010 inch) to 0.50 mm (0.020 inch) chamfer.		
Remove Oxide	Use fiber flap brush or Clean/strip disc		
Clean Spray Area	Commercial degreaser (Methyl Alcohol or Acetone)		
Mask for Grit Blast	Grit blast - If the entire mating surface is to be arc sprayed, some shops prefer to pre-machine the surface. This process removes any major damage, allows for a recommended minimum 0.25 mm (0.010 inch) coating, reduces technique dependency in producing an even coating and can reduce material cost and finish grinding time.		
	Precautions and care must be taken to properly mask and remove all grit from block surface and cavities.		
Grit Blast Equipment	Pressure type only		
Grit Type and Size	24 mesh aluminum oxide		
Blast Air Pressure	690 kPa (100.0 psi)		
Blast Nozzle to Work Distance	51 mm (2.0 inch) to 150 mm (6.0 inch)		
Remove Blast Mask	Make sure that surface is clean		
	Precautions and care must be taken to properly mask and remove all grit from block surface and cavities. **Time between surface preparation and thermal spray application should be minimal. Allowing excessive time between preparation and thermal spray will result in unacceptable coating performance.**		
Mask for Metal Spray	Tape, Metal Shield, Rubber, Metco Antibond, etc.		
Metal Spray Equipment Type	**Smart Arc by Oerlikon Metco**	**TAFA**	
Consumable	**TAFA 75B or Equivalent**	**TAFA 75B or Equivalent**	
Clamp Pressure	275 kPa (40 psi)		
Air Jets/Pressure	415 kPa (60 psi)	415 kPa (60 psi)	
Arc Load Volts	30V	30V	
Amps	125 Amps	150 Amps	
Gun to Work Distance	152.4 mm (6.0 inch)	152.4 mm (6.0 inch)	

(Standoff)			
Approx. Spray Rate/Pass	0.08 mm (0.003 inch)/pass	0.08 mm (0.003 inch)/pass	
Gun Fixturing Method	Machine mount or hand held		
Traverse Rate of Gun	395.00 mm/s (1.296 Ft/s)		
Finishing Equipment	Rottler 99Y or similar		
Part/Cutter Rotation (Roughing)	Roughing 50 SMPM (150 SFPM)		
Part/Cutter Rotation (Finishing)	Finishing 75 SMPM (250 SFPM)		
Traverse Speed	0.30 mm (0.012 inch) per revolution		
Depth of Rough Cut	0.51 mm (0.020 inch) per side max First pass should remove at least 0.178 mm (0.007 inch) to get below the peaks of the spray.		
Depth of Finish Cut	0.25 mm (0.010 inch) per side max		

Flame Spray Equipment and Procedure

NOTICE

Flame spray is not a validated or approved process for spraying under top supported liner flanges.

Table 49

Minimum Surface Texture Before Spray	3.2 µm (125.9843 µinch)
Reason for Spraying	Wear, erosion, center line distance too short to rework
Oerlikon Metco Equipment Type	6P-II by Oerlikon Metco
Metco Material	Metco 453
Finish Thickness	As required 0.25 mm (0.010 inch) to 0.38 mm (0.015 inch)
Finishing Allowance	Machine 0.64 mm (0.025 inch)
Spray Angle	90°
Substrate Pre-Heat Temperature	22.2°C (72.00°F) to 66°C (150°F)
Substrate Temperature During Spraying Not to Exceed	204°C (400°F)
Surface Preparation Method	Grit blast - If the entire mating surface is to be flame sprayed, some shops prefer to pre-machine the surface. This process removes any major damage, allows for a recommended minimum 0.25 mm (0.010 inch) coating, reduces technique dependency in producing an even coating, and can reduce material cost and finish machining time.
	Precautions and care must be taken to properly mask and remove all grit from block surface and cavities. **Time between surface preparation and thermal spray application should be minimal. Allowing excessive time between preparation and thermal spray will result in unacceptable**

	coating performance.
Finishing Method	Machine
Grinding Equipment Type	Standard head and block grinder
Recommended Wheel	Norton 23A30E12VBEP or SGL abrasive HSA24F13-VKP
Machining Equipment Type	Mill
Recommended Cutter Grade	Sandvik 310-K-10 LNCX

NOTICE

Precautions and care must be taken to properly mask and remove all grit from block surface and cavities.

Time between surface preparation and thermal spray application should be minimal. Allowing excessive time between preparation and thermal spray will result in unacceptable coating performance.

Table 50

Flame Spray Process (6P-II)	Procedure	Check List
Clean Part	Pre-machine block and degrease block deck surface.	
	Visual inspection for imbedded oils or other contaminants should be conducted during preheat.	
Undercut	Must not exceed 1.5 mm (0.06 inch) spray thickness	
Chamfer	All edges must have at least 0.25 mm (0.010 inch) to 0.50 mm (0.020 inch) chamfer.	
Remove Oxide	Use fiber flap brush or Clean/strip disc	
	Visual inspection for imbedded oils or other contaminants should be conducted during preheat.	
Clean Spray Area	Metco cleaning solvent or equivalent	
Mask for Grit Blast	Grit blast - If the entire mating surface is to be flame sprayed, some shops prefer to pre-machine the surface. This process removes any major damage, allows for a recommended minimum 0.25 mm (0.010 inch) coating, reduces technique dependency in producing an even coating, and can reduce material cost and finish machining time.	
	Precautions and care must be taken to properly mask and remove all grit from block surface and cavities. **Time between surface preparation and thermal spray application should be minimal. Allowing excessive time between preparation and thermal spray will result in unacceptable coating performance.**	
Grit Blast Equipment	Pressure type only	
Grit Type and Size	24 mesh aluminum oxide	
Blast Air Pressure	690 kPa (100.0 psi)	
Blast Nozzle to Work Distance	50 mm (2.0 inch) to 150 mm (6.0 inch)	
Remove Blast Mask	Remove mask, make sure that surface is clean	
	Visual inspection for imbedded oils or other contaminants should be conducted during preheat.	
Mask for Metal	Tape, Metal Shield, Rubber, Metco Antibond, etc.	

Spray		
Metal Spray Equipment Type	6P-II Hand Held Thermo Spray System by Oerlikon Metco	
Nozzle	6P-C7A-K "K" Nozzle	
Air Capacity/Pressure	6P-3/Cooling Air 140 kPa (20.0 psi) to 170 kPa (25.0 psi)	
Oxygen Pressure	210 kPa (30.0 psi)	
Oxygen Flow	1190 L/h (42.0 cfh)	
Fuel Gas Pressure	100 kPa (15.0 psi)	
Fuel Gas Flow	1415 L/h (50.0 cfh)	
Carrier Gas Pressure	380 kPa (55.0 psi)	
Carrier Gas Flow	1050 L/h (37.0 cfh)	
Spray Rate/Build Up	5.5 kg (12.00 lb) per hour 0.10 mm (0.004 inch) to 0.15 mm (0.006 inch) per pass	
Gun to Work Distance	178 mm (7.0 inch)	
Traverse Rate of Gun	36 SMPM (120.0 SFPM)	
Gun Fixturing Method	Machine mount or hand held	
Per Pass Thickness	0.10 mm (0.004 inch) to 0.15 mm (0.006 inch) per pass	
Finishing Equipment	Standard head and block grinder, Milling machine	
Part/Cutter Rotation	92.0 SMPM (300.00 SFPM)	
Traverse Speed	Rough 203 mm (8.0 inch) per minute finish 38.1 mm (1.5 inch) to 51.0 mm (2.01 inch) per minute	
Depth of Rough Cut	0.03 mm (0.001 inch) to 0.05 mm (0.002 inch) 0.25 mm (0.010 inch) to 0.38 mm (0.015 inch)	
Depth of Finish Cut	0.03 mm (0.001 inch) 0.13 mm (0.005 inch) to 0.25 mm (0.010 inch)	

Thermal Spray Procedures for Crankshaft Main Bearing Saddle Area

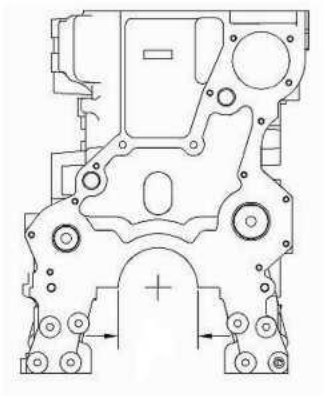

Illustration 226 g06370992

Part Description

Table 51

Base Metal	Cast Iron
Hardness	N/A

Arc Spray Equipment and Procedure

Table 52

Maximum Surface Texture	1.6 µm (62.99213 µinch)
Reason for Spraying	Bearing Failure
Mating Part Contact Area & Material	Crankshaft main bearing
Arc Spray Equipment Type	SmartArc by Oerlikon Metco, TAFA 8830 MHU, or TAFA 8835 MHU
Wire	TAFA 30T Wire Top Coat, TAFA 75B Wire Bond Coat
Finish Thickness	As required
Spray Angle	90°
Substrate Pre-Heat Temperature	66.0° C (150° F) Do not direct arc on area to be sprayed
Substrate Temperature During Spraying Not to Exceed	148.0° C (300° F)
Auxiliary Cooling	Filtered shop air
Rotation/Traverse Device	Hand held
Surface Preparation Method	Undercut and grit blast
Machining Method	Line bore
Recommended Cutting Tool	ISCAR DNMG 432 TFIC507
Blast Media Recommendation	Pressure Type Only (Aluminum Oxide Grit)
Finishing Equipment Type	Line boring machine

Table 53

Arc Spray	Procedure		Check List
Clean Part	Degrease in hot caustic solution		
Undercut	Not required		
Chamfer	All edges - 45° to 0.08 mm (0.0030 inch)		
Remove Oxide	Use fiber flap brush or Clean/strip disc		
Clean Spray Area	Commercial degreaser		
Mask for Grit Blast	Use a metal mask or duct tape		
Grit Blast Equipment	Pressure type only		
Grit Type and Size	20 mesh aluminum oxide		
Blast Air Pressure	690 kPa (100.0 psi)		
Blast Nozzle to Work Distance	51 mm to 150 mm (2.0 inch to 6.0 inch)		
Remove Blast Mask	Make sure that surface is clean		
Mask for Metal Spray	Antibond or Blue Layout Dye		
Metal Spray Equipment Type	**Smart Arc by Oerlikon Metco**	**TAFA**	
Consumable (Bondcoat)	**TAFA 75B**	**TAFA 75B**	
Clamp Pressure	275 kPa (40 psi)		
Air Jets/Pressure	415 kPa (60 psi)	415 kPa (60 psi)	
Arc Load Volts	30V	30V	
Amps	125 Amps	150 Amps	
Gun to Work Distance (Standoff)	128 mm (5.0 inch)	128 mm (5.0 inch)	
Spray Rate/Bond Pass	0.038 mm (0.0015 inch)/pass	0.038 mm (0.0015 inch)/pass	
Consumable (Topcoat)	**TAFA 30T**	**TAFA 30T**	
Clamp Pressure	275 kPa (40 psi)		
Air Jets/Pressure	415 kPa (60 psi)	415 kPa (60 psi)	
Arc Load Volts	31V	31V	
Amps	150 Amps	175 Amps	
Gun to Work Distance (Standoff)	166 mm (6.5 inch)	166 mm (6.5 inch)	
Spray Rate/Build Up	0.0023 mm (0.00009 inch)/pass	0.0023 mm (0.00009 inch)/pass	
Traverse Rate of Gun	11 SMPM (36 SFPM)		
Gun Fixturing Method	Hand held		
Finishing Equipment	Line boring machine		
Part/Cutter Rotation (Roughing)	Roughing 50 SMPM (150 SFPM)		
Part/Cutter Rotation (Finishing)	Finishing 75 SMPM (250 SFPM)		
Coolant	Oil based synthetic - 40:1 ratio		

Traverse Speed	0.30 mm (0.012 inch) per revolution	
Depth of Rough Cut	0.51 mm (0.020 inch) per side max	
Depth of Finish Cut	0.25 mm (0.010 inch) per side max	
Additional Finish Method	Flex hone if necessary	

Flame Spray Equipment and Procedure

Table 54

Maximum Surface Texture	1.6 µm (62.99213 µinch)
Reason for Spraying	Bearing failure
Mating Part Contact Area & Material	Crankshaft main bearing
Oerlikon Metco Equipment Type	6P-II by Oerlikon Metco
Metco Material	Metco 453 Grind 463
Finish Thickness	As required
Finishing Allowance	0.51 mm (0.020 inch) per side
Spray Angle	90° to bore
Substrate Pre-Heat Temperature	38° C (100° F)
Substrate Temperature During Spraying Not to Exceed	149° C (300° F)
Auxiliary Cooling	If desired
Rotation/Traverse Device	Hand held
Rotation/Traverse Speed	15 SMPM (50 SFPM)
Surface Preparation Method	Grit Blast
Finishing Method	Machine
Recommended Wheel	Norton 23A30E12VBEP or SGL abrasive HSA24F13-VKP
Machining Equipment Type	Line Boring Machine
Recommended Cutter Grade	ISCAR DNMG 432 TFIC507

Table 55

Flame Spray Process (6P-II)	Procedure	Check List
Clean Part	Degrease in hot caustic solution	
Undercut	Not required	
Chamfer	All edges - 45° to 0.08 mm (0.030 inch)	
Remove Oxide	Use die grinder or flapper wheel	
Clean Spray Area	Metco cleaning solvent or equivalent	
Mask for Grit Blast	Use metal mask or duct tape	
Grit Blast Equipment	Pressure type only	
Grit Type and Size	24 mesh aluminum oxide	

Blast Air Pressure	690 kPa (100.0 psi)	
Blast Nozzle to Work Distance	51 mm to 150 mm (2.0 inch to 6.0 inch)	
Remove Blast Mask	Remove mask, make sure that surface is clean	
Mask for Metal Spray	Metco Anti-Bond or blue layout dye	
Metal Spray Equipment Type	6P-II Hand Held Thermo Spray System by Oerlikon Metco	
Auxiliary Cooling	If desired	
Nozzle	6P-7CA-K "K" Nozzle	
Air Capacity/Pressure	6P-3/Cooling Air 140 - 170 kPa (20.0 - 25.0 psi)	
Oxygen Pressure	210 kPa (30.0 psi)	
Oxygen Flow	1190 L/h (42.0 cfh)	
Fuel Gas Pressure	100 kPa (15.0 psi)	
Fuel Gas Flow	1415 L/h (50.0 cfh)	
Carrier Gas Pressure	380 kPa (55.0 psi)	
Carrier Gas Flow	1050 L/h (37.0 cfh)	
Spray Rate/Build Up	5.5 kg (12.00 lb) per hour 0.10 - 0.15 mm (0.004 - 0.006 inch) per pass	
Gun to Work Distance	230 mm (9.0 inch)	
Rotation Speed of Part (RPM)	N/A	
Rotation Speed of Part	N/A	
Traverse Rate of Gun	15 SMPM (50.00 SFPM)	
Gun Fixturing Method	Hand held	
Bond Pass/Thickness	0.13 mm (0.005 inch)	
Top Coat/Thickness	As required	
Finishing Equipment	Line boring machine	
Part/Cutter Rotation	46 to 55 SMPM (150.0 to 180.0 SFPM)	
Traverse Speed	0.08 mm (0.003 inch) or less	
Depth of Rough Cut	0.25 mm to 0.51 mm (0.010 inch to 0.020 inch)	
Depth of Finish Cut	0.13 mm to 0.25 mm (0.005 inch to 0.010 inch)	
Additional Finish Method	Flex hone if necessary	

Thermal Spray Procedures for Main Bearing Cap

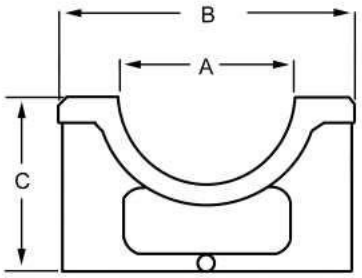

Illustration 227 g03513357

This is an example of a standard bearing cap. (A) is the bore dimension of the bearing cap, (B) is the width of the bearing cap, and (C) is the height of the bearing cap.

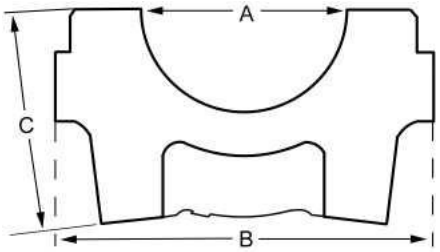

Illustration 228 g03334317

This is an example of a V bearing cap. (A) is the bore dimension of the bearing cap, (B) is the width of the bearing cap, and (C) is the height of the bearing cap.

Table 56

Main Bearing Cap Specifications			
Engine Model	**Dimension A**	**Dimension B**	**Dimension C**
C-7	95.000 ± 0.013 mm (3.7401 ± 0.0005 inch)	159.995 ± 0.025 mm (6.2990 ± 0.0010 inch)	88.000 ± 0.500 mm (3.4646 ± 0.0200 inch)
C-9	112.000 ± 0.013 mm (4.4094 ± 0.0005 inch)	175.000 ± 0.020 mm (6.8897 ± 0.0005 inch)	104.000 ± 0.500 mm (4.0945 ± 0.0200 inch)
C-10, C-11, C-12, C-13, C-15, SBF214, SUF557, 3196	115.950 ± 0.025 mm (4.5649 ± 0.0010 inch)		105.000 ± 0.500 mm (4.1338 ± 0.0200 inch)
C-12, C-15, C-16, C15, C-18, G3406, 3406C, 3306, 3406, HT400, 3406B, 3456	129.891 ± 0.013 mm (5.1138 ± 0.0005 inch)	215.900 ± 0.025 mm (8.5000 ± 0.0010 inch)	122.000 ± 0.060 mm (4.8031 ± 0.0020 inch)
C-27 (1)		215.900 ± 0.025 mm (8.5000 ± 0.0010 inch)	132.100 ± 0.500 mm (5.2008 ± 0.0200 inch)
C-32 (1)			127.100 ± 0.500 mm (5.0039 ± 0.0200 inch)
3176 3176B	108.000 ± 0.013 mm (4.25196 ± 0.00051 inch)	175.000 ± 0.02 mm (6.88975 ± 0.00079 inch)	105.000 ± 0.500 mm (4.13385 ± 0.01969 inch)

G3304, G3306, 3304, 3304B, G3306, 3306, 3306B, G3306C, 3306HB	96.926 ± 0.013 mm (3.8160 ± 0.0005 inch)	165.095 ± 0.020 mm (6.4998 ± 0.0007 inch)	94.500 ± 0.500 mm (3.7205 ± 0.0200 inch)
G3406, 3406, 3406B, 3406C, 3406E, 3456	129.891 ± 0.013 mm (5.1138 ± 0.0005 inch)	215.900 ± 0.025 mm (8.5000 ± 0.0010 inch)	128.300 ± 0.500 mm (5.0510 ± 0.0200 inch)
G3408, G3408C, G3412, SPS342, SCT673, SPT342, 3412, 3408, 3408B, 3408C, 3412, 3412C, 3412D, (1)			134.100 ± 0.020 mm (5.2795 ± 0.0010 inch)

(1) Bearing Cap is a "V" style, but the mating face is flat and does not have an angle dimension

Part Description

Table 57

Base Metal	Hardness
Cast Iron	28 - 34 Rc

Arc Spray Equipment and Procedure

Table 58

Maximum Surface Texture	1.6 µm (62.99213 µinch)
Reason for Spraying	Wear and/or bearing failure
Mating Part Contact Area & Material	Bearing sleeve and press fit
Arc Spray Equipment Type	SmartArc by Oerlikon Metco,TAFA 8830 MHU, or TAFA 8835 MHU
Wire	TAFA 30T Wire Top Coat, TAFA 75B Wire Bond Coat
Finish Thickness	As required
Spray Angle	90°
Substrate Pre-Heat Temperature	66° C (150° F) Do not direct arc on area to be sprayed
Substrate Temperature During Spraying Not to Exceed	148° C (300° F)
Auxiliary Cooling	Filtered shop air
Rotation/Traverse Device	Lathe or headstock/tailstock arrangement, rotary turntable
Rotation/Traverse Speed	11 SMPM (36.00 SFPM)
Surface Preparation Method	Undercut and grit blast
Machining Method	Machine
Equipment Required	Mill, Line boring machine
Recommended Cutting Tool	ISCAR DNMG 432 TFIC507
Blast Media Recommendation	Pressure Type Only (Aluminum Oxide Grit)
Remarks	Badly discolored caps (heavily burned due to bad bearing failure) should not be rebuilt

Table 59

Arc Spray	Procedure	Check List
Clean Part	Degrease in hot caustic solution	
Undercut	Not required	

Chamfer	All edges - 45° x .76 mm (.030 inch)		
Remove Oxide	Emery paper or glass beading (mating face), Flapper wheel - 60 grit (bearing sleeve)		
Mask for Grit Blast	Metal mask type only		
Grit Blast Equipment	Pressure type only		
Grit Type and Size	20 mesh aluminum oxide		
Blast Air Pressure	690 kPa (100.0 psi)		
Blast Nozzle to Work Distance	51 to 150 mm (2.0 to 6.0 inch)		
Remove Blast Mask	Make sure that surface is clean		
Mask for Metal Spray	Use metal mask or METCO Anti-bond		
Metal Spray Equipment Type	**Smart Arc by Oerlikon Metco**	**TAFA**	
Consumable (Bondcoat)	**TAFA 75B**	**TAFA 75B**	
Clamp Pressure	275 kPa (40 psi)		
Air Jets/Pressure	415 kPa (60 psi)	415 kPa (60 psi)	
Arc Load Volts	30V	30V	
Amps	125 Amps	150 Amps	
Gun to Work Distance (Standoff)	128 mm (5.0 inch)	128 mm (5.0 inch)	
Spray Rate/Bond Pass	0.038 mm (0.0015 inch) per pass	0.038 mm (0.0015 inch) per pass	
Consumable (Topcoat)	**TAFA 30T**	**TAFA 30T**	
Clamp Pressure	275 kPa (40 psi)		
Air Jets/Pressure	415 kPa (60 psi)	415 kPa (60 psi)	
Arc Load Volts	31V	31V	
Amps	150 Amps	175 Amps	
Gun to Work Distance (Standoff)	166 mm (6.5 inch)	166 mm (6.5 inch)	
Spray Rate/Build Up	0.058 mm (0.00228 inch) per pass	0.058 mm (0.00228 inch) per pass	
Rotation Speed of Part (RPM)	RPM varies depending on diameter		
Rotation Speed of Part	92 SMPM (300.00 SFPM)		
Traverse Rate of Gun	11 SMPM (36.00 SFPM)		
Gun Fixturing Method	Machine mounted or hand held		
Finishing Equipment	Milling machine, line boring machine		
Part/Cutter Rotation (Roughing)	50 SMPM (150 SFPM)		
Part/Cutter Rotation (Finishing)	75 SMPM (250 SFPM)		
Coolant	Oil based synthetic - 40:1 ratio		
Traverse Cut	0.30 mm (0.012 inch) per revolution		
Depth of Rough Cut	0.51 mm (0.020 inch) per side max		

Depth of Finish Cut	0.25 mm (0.010 inch) per side max	
Additional Finish Method	Flex hone if necessary	

Flame Spray Equipment and Procedure

Table 60

Maximum Surface Texture	1.6 µm (62.99213 µinch)
Reason for Spraying	Bearing failure
Mating Part Contact Area & Material	Crankshaft main bearing sleeve
Oerlikon Metco Equipment Type	6P-II by Oerlikon Metco
Metco Material	Metco 453
Finish Thickness	As required
Finishing Allowance	0.51 mm (0.020 inch) per side
Spray Angle	90° to bore
Substrate Pre-Heat Temperature	66° C (150.8° F) Do not direct flame on area to be sprayed
Substrate Temperature During Spraying Not to Exceed	148° C (298.4° F)
Auxiliary Cooling	A J Unit
Rotation/Traverse Device	Hand held
Rotation/Traverse Speed	15 SMPM (50.00 SFPM)
Surface Preparation Method	Grit Blast
Finishing Method	Machine
Machining Equipment Type	Line Boring Machine
Recommended Cutter Grade	C-2, 883 Carboloy, or equivalent
Remarks	Badly discolored caps (heavily burned due to bad bearing failure) should not be rebuilt

Table 61

Flame Spray Process (6P-II)	Procedure	Check List
Clean Part	Degrease in hot caustic solution	
Undercut	Not required	
Chamfer	All edges 45° x 0.76 mm (0.030 inch)	
Remove Oxide	Flapper wheel - 60 grit	
Mask for Grit Blast	Use metal mask or duct tape	
Grit Blast Equipment	Pressure or suction blast	
Grit Type and Size	24 mesh aluminum oxide	
Blast Air Pressure	690 kPa (100.0 psi)	
Blast Nozzle to Work Distance	51 to 150 mm (2.0 to 6.0 inch)	
Remove Blast Mask	Remove mask, make sure that surface is clean	

Mask for Metal Spray	Metco Anti-Bond or blue layout dye	
Metal Spray Equipment Type	6P-II Hand Held Thermo Spray System by Oerlikon Metco	
Auxiliary Cooling	METCO A J Siphon Air Jet	
Nozzle	6P7-CK "K" Nozzle	
Air Capacity/Pressure	6P-3/Cooling Air 140 kPa (20.0 psi)	
Oxygen Pressure	210 kPa (30.0 psi)	
Oxygen Flow	1190 L/h (42.0 cfh)	
Fuel Gas Pressure	100 kPa (15.0 psi)	
Fuel Gas Flow	1415 L/h (50.0 cfh)	
Carrier Gas Pressure	380 kPa (55.0 psi)	
Carrier Gas Flow	1050 L/h (37.0 cfh)	
Spray Rate/Build Up	5.5 kg (12.00 lb)/hr or 90 gr (3.2 oz)/min	
Gun to Work Distance	230 mm (9.0 inch)	
Rotation Speed of Part	91.4 m (299.869 ft)	
Traverse Rate of Gun	15.24 m (50.0 ft)	
Gun Fixturing Method	Hand held	
Bond Pass/Thickness	0.13 mm (0.005 inch)	
Top Coat/Thickness	As required	
Finishing Equipment	Line boring machine	
Part/Cutter Rotation	Standard	
Traverse Speed	Standard	
Depth of Rough Cut	0.25 to 0.51 mm (0.010 to 0.020 inch) per side	
Depth of Finish Cut	0.13 mm (0.005 inch) or less per side	
Additional Finish Method	Flex hone if necessary	

-Do not direct flame on area to be sprayed.

-Excessive heat will cause cap draw in.

Thermal Spray Procedures for 3400 Engine Fuel Pump Mounting Surface

Specifications

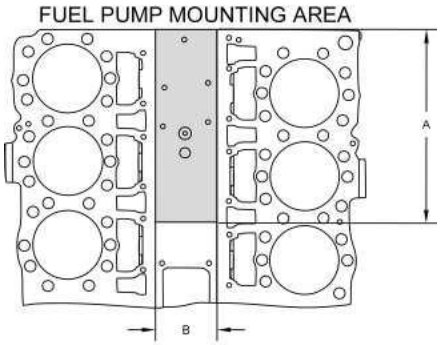

Illustration 229 g06370802

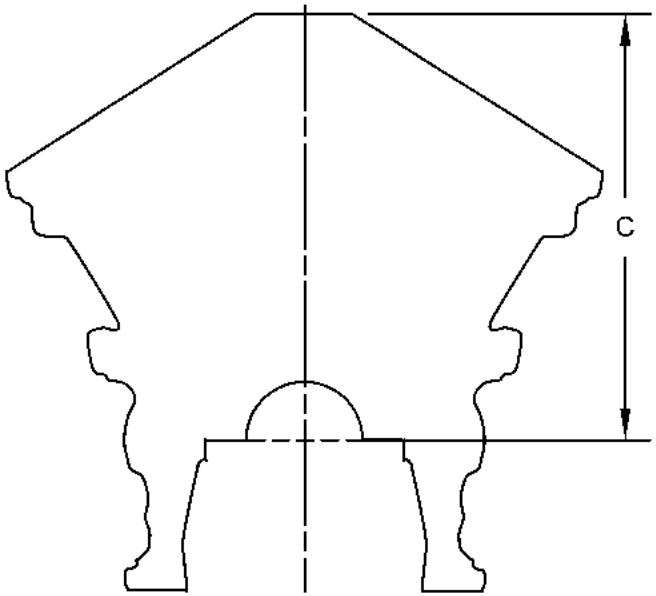

Illustration 230 g06370803

Table 62

3400 Engine - Fuel Pump Mounting			
Model	**A**	**B**	**C**
3408 3408E 3412 3412C	368.3 mm (14.50 inch)	104.7 mm (4.12 inch)	463.68 mm (18.255 inch)
3412 3412C	355.0 mm (13.98 inch)	104.7 mm (4.12 inch)	463.68 mm (18.255 inch)

3412E			

Part Description

Table 63

Base Metal	Gray Iron
Hardness	N/A

Arc Spray Equipment and Procedure

Table 64

Maximum Surface Texture	3.2 µm (125.9843 µinch)
Reason for Spraying	Wear, erosion, fretting
Mating Part Contact Area & Material	Fuel Pump Housing Flange
Arc Spray Equipment Type	SmartArc by Oerlikon Metco,TAFA 8830 MHU, or TAFA 8835 MHU
Wire	TAFA 30T Wire Top Coat, TAFA 75B Wire Bond Coat
Finish Thickness	As Required
Finishing Allowance	0.51 to 0.64 mm (0.020 to 0.025 inch)
Spray Angle	90°
Substrate Pre-Heat Temperature	66° C (150° F) Do not direct arc on area to be sprayed
Substrate Temperature During Spraying Not to Exceed	148° C (300° F)
Auxiliary Cooling	Filtered shop air
Rotation/Traverse Speed	11.0 SMPM (40.00 SFPM)
Surface Preparation Method	Undercut and Grit blast If the entire surface is to receive an arc spray coating, some shops prefer to pre-grind the block. Grinding removes major damage, allows for a recommended minimum 0.25 mm (0.010 inch) coating, produces an even coating, reduces material cost, and finish grinding time.
Machining Method	Grind or Machine
Equipment Required	Standard Head and Block Grinder
Recommended Abrasive	Norton 23A 30E12VBEP or equivalent
Remarks	A "low spot only" repair should not be considered unless at least 0.05 - 0.08 mm (0.002 - 0.003 inch) can be removed from the block thickness during grinding.

Table 65

Arc Spray	Procedure	Check List
Clean Part	Degrease in hot caustic solution	
Undercut	If the entire surface is to receive an arc spray coating, some shops prefer to pre-grind the block. This removes major damage, allows for a recommended minimum 0.25 mm (0.010 inch) coating, produces an even coating, reduces material cost, and finish grinding time.	
Chamfer	All edges must have at least 0.79 - 1.58 mm (0.031 - 0.062 inch) chamfer. Use die grinder with stones or a hand brace with countersink.	
Remove Oxide	Use fiber flap brush or Clean/strip disc or glass bead	

Mask for Grit Blast	Use plastic cap plugs (cut to fit) for masking oil and bolt holes. Use clean, oil free rags to mask oil cavity. Casting relief areas, water holes, bolt holes and dowel pin holes can be masked with Metco Anti-bond, silicon rubber, bulk ceramic fiber, or a combination of these materials.		
Grit Blast Equipment	Pressure type only		
Grit Type and Size	20 mesh aluminum oxide		
Blast Air Pressure	690 kPa (100.0 psi)		
Blast Nozzle to Work Distance	51 to 150 mm (2.0 to 6.0 inch)		
Remove Blast Mask	Remove mask, make sure that surface is clean		
Mask for Metal Spray	Use a 6.35 mm (0.25 inch) steel plate machined to counter bore I.D. size less 0.51 mm (0.020 inch) clearance fit for masking counter bore ledges.		
Metal Spray Equipment Type	**Smart Arc by Oerlikon Metco**	**TAFA**	
Consumable (Bondcoat)	**TAFA 75B**	**TAFA 75B**	
Clamp Pressure	275 kPa (40 psi)		
Air Jets/Pressure	415 kPa (60 psi)	415 kPa (60 psi)	
Arc Load Volts	30V	30V	
Amps	125 Amps	150 Amps	
Gun to Work Distance (Standoff)	128 mm (5.0 inch)	128 mm (5.0 inch)	
Spray Rate/Bond Pass	0.038 mm (0.0015 inch)/pass	0.038 mm (0.0015 inch)/pass	
Consumable (Topcoat)	**TAFA 30T**	**TAFA 30T**	
Clamp Pressure	275 kPa (40 psi)		
Air Jets/Pressure	415 kPa (60 psi)	415 kPa (60 psi)	
Arc Load Volts	31V	31V	
Amps	150 Amps	175 Amps	
Gun to Work Distance (Standoff)	166 mm (6.5 inch)	166 mm (6.5 inch)	
Spray Rate/Build Up	0.058 mm (0.0023 inch)/pass	0.058 mm (0.0023 inch)/pass	
Traverse Rate of Gun	11 SMPM (40 SFPM)		
Gun Fixturing Method	Hand held		
Finishing Equipment	Standard head and block grinder/ Milling Machine		
Part/Cutter Rotation Roughing	Grind - Refer to wheel specifications, Machine - 50 SMPM (150.00 SFPM)		
Part/Cutter Rotation Finishing	Grind - Refer to wheel specifications, Machine - 75 SMPM (250.00 SFPM)		
Coolant	Oil base synthetic - 40:1 ratio		
Traverse Speed	Grind - Refer to wheel specifications, Machine - 0.30 mm (0.012 inch) per revolution		

Depth of Rough Cut	Grind - 0.04 mm (0.0015 inch) Machine - 0.51 mm (0.020 inch)	
Depth of Finish Cut	Grind - 0.01 mm (0.0005 inch) Machine - 0.25 mm (0.010 inch)	
Additional Finish Method	Grind - Coating should be ground back to base on edges where possible	

Flame Spray Equipment and Procedure

Table 66

Maximum Surface Texture	3.2 µm (125.9843 µinch)
Reason for Spraying	Wear, erosion, fretting
Mating Part Contact Area & Material	Fuel Pump Housing Flange
Oerlikon Metco Equipment Type	6P-II by Oerlikon Metco
Oerlikon Metco Material	Metco 453
Finish Thickness	As Required 0.25 to 0.38 mm (0.010 to 0.015 inch)
Finishing Allowance	0.51 to 0.64 mm (0.020 to 0.025 inch) per side
Spray Angle	90°
Substrate Pre-Heat Temperature	66° C (150° F) Do not direct flame on area to be sprayed
Substrate Temperature During Spraying Not to Exceed	148° C (300° F)
Auxiliary Cooling	If desired
Rotation/Traverse Speed	15.0 SMPM (50.00 SFPM)
Surface Preparation Method	Undercut and Grit Blast If the entire surface is to be built-up, some shops prefer to pre-grind the block. This removes major damage, allows for a recommended minimum 0.25 mm (0.010 inch) coating, reduces technique dependency in producing even coating and reduce the material cost and finish grinding time.
Finishing Method	Grind or Machine
Grinding Equipment Type	Standard Head and Block Grinder
Recommended Wheel	Norton 23A 30E12VBEP or SGLH5A24F13-VKP
Machining Equipment Type	Milling Machine
Recommended Cutter Grade	Sandvick 310 K-10 LNCX1806 AZR-11
Remarks	A "low spot only" repair should not be considered unless at least 0.05 - 0.08 mm (0.002 - 0.003 inch) can be removed from the block thickness during grinding or unless the repair will be finished by hand using a file to blend the coating.

Table 67

Flame Spray Process (6PII)	Procedure	Check List
Clean Part	Degrease in hot caustic solution	
Undercut	If the entire surface is to be built-up, some shops prefer to pre-grind the block. This removes major damage, allows for a recommended minimum 0.25 mm (0.010 inch) coating, reduces technique dependency in producing even coating and reduce the material cost and finish grinding time.	
Chamfer	All edges must have at least 0.79 to 1.58 mm (0.031 to 0.062 inch) chamfer. Use a die grinder with stones or a hand brace with countersink.	

Remove Oxide	Use fiber flap brush or Clean/strip disc	
Mask for Grit Blast	Use plastic cap plugs (cut to fit) for masking oil and bolt holes. Use clean, oil free rags to mask oil cavity. Casting relief areas, water holes, bolt holes and dowel pin holes can be masked with Metco Anti-bond, silicon rubber, bulk ceramic fiber, or a combination of these materials.	
Grit Blast Equipment	Pressure type only	
Grit Type and Size	G-16 steel angular grit	
Blast Air Pressure	620 kPa (90.0 psi)	
Blast Nozzle to Work Distance	50 mm (2.0 inch)	
Remove Blast Mask	Remove mask, make sure that surface is clean	
Mask for Metal Spray	Use a 6.35 mm (0.25 inch) steel plate machined to counter bore I.D. size less 0.51 mm (0.020 inch) clearance fit for masking counter bore ledges.	
Metal Spray Equipment Type	6P-II Hand Held Thermo Spray System by Oerlikon Metco	
Auxiliary Cooling	N/A	
Nozzle	6P-C7A-K "K" Nozzle	
Air Capacity/Pressure	6P-3/Cooling Air 140 - 170 kPa (20.0 - 25.0 psi)	
Oxygen Pressure	210 kPa (30.0 psi)	
Oxygen Flow	1190 L/h (42.0 cfh)	
Fuel Gas Pressure	100 kPa (15.0 psi)	
Fuel Gas Flow	1415 L/h (50.0 cfh)	
Carrier Gas Pressure	380 kPa (55.0 psi)	
Carrier Gas Flow	1050 L/h (37.0 cfh)	
Spray Rate/Build Up	5.5 kg (12 lb) per hour or 90 gr (3.2 oz) per min	
Gun to Work Distance	230 mm (9.0 inch)	
Traverse Rate of Gun	36.60 SMPM (120.000 SFPM)	
Gun Fixturing Method	Hand held	
Top Coat/Thickness	As required	
Finishing Equipment	Standard head and block grinder/ Milling Machine	
Part/Cutter Rotation	Grind - Refer to wheel specifications/ Machine - 70 RPM	
Traverse Speed	Grind - Refer to wheel specifications/ Machine - Rough 203 mm (8.0 inch) per min., Finish - 38.1 to 51.0 mm (1.50 to 2.00 inch) per min	

Depth of Rough Cut	Grind 0.03 to 0.05 mm (0.001 to 0.002 inch) / Machine - 0.38 to 0.51 mm (0.015 to 0.020 inch)	
Depth of Finish Cut	Grind 0.03 mm (0.001 inch) / Machine - 0.25 to 0.38 mm (0.010 to 0.015 inch)	
Additional Finish Method	Grind - Sparkout (Coating should be ground back to base on edges where possible) /Machining none	

Storage Procedures

Proper protection of the cylinder block from corrosion is important. Corrosion will start in as little as one hour after the cylinder block has been cleaned.

When the cylinder block will not be inspected for one hour or less the cylinder block should be coated with a rust or corrosion inhibitor or coated with clean engine oil. The cylinder block should be individually wrapped to prevent contamination, and should be stored in a protected area to avoid damage. See Illustration 231.

When the cylinder block will not be inspected in two days or more the cylinder block should be coated with a rust or corrosion inhibitor or coated with clean engine oil and should be placed in a container which is clean and structurally solid. The container should be covered or wrapped in plastic to prevent damage and contamination to the cylinder block. See Illustration 232.

Refer to SEHS9031Special Instruction, "Storage Procedure for Caterpillar Products" for more information.

Illustration 231 g06278538
Example of protection for a component that is stored for a shorter term

Illustration 232 g06278539
Example of protection for a component that is stored for a longer period