# Sequence IIIG Engine Oil Certification Test
# Engine Assembly Manual

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**Revision 11**
**April 10, 2012**

Table of Contents

# Section 0

## Hardware usage guidelines

All materials used in this test must conform to acceptance guidelines as specified in the ASTM Sequence IIIG Test Method D 7320 accompanied by the direction and information contained in this Assembly Manual.

Any changes in procedures or substitutions of qualified parts or materials, must be approved by the Sequence IIIF / G Surveillance Panel prior to their use in non-reference and reference oil tests.

Any parts or materials specified in this document that are found to be unacceptable for testing, both pre and post test, must be reported to the Test Sponsor, the appropriate Critical Parts Distributor, and the ASTM Test Monitoring Center.

Unless otherwise directed, all parts and materials required for testing should be stored and used on a first in – first out basis following the guidelines outlined in the ASTM Test Monitoring Center Sequence IID and IIIE Information Letter #60 June 21, 1991.

# Sequence IIIG Engine Assembly Manual Update Revision Timeline

Latest Revision 11

Date 4/10/2012

Contact Person Rich Grundza TMC 412-365-1031
Bruce Matthews GM Pontiac 248-830-9197

| Date | Sec. | Sheet | Topic | Comments | Info Letter |
|---|---|---|---|---|---|
| 4/28/03 | 1 | 5A | Cleaning instructions | Removal of NAT50 / PDN50 soap residue | |
| 4/28/03 | 3 | 8 | Ring Color Code | Addition of color code identification | |
| 4/28/03 | 4 | 1 | Front Cover usage | Change to OHT epoxy impregnated front cover part #. | |
| 4/28/03 | 4 | 12 | Pan Gasket | Change to 2003 gasket part #. | |
| 4/28/03 | 6 | 9 | MAF part # | Add new mass airflow sensor part #. | |
| 6/23/03 | 6 | 9 | MAF part # | Add remanufactured part # 88961007 | |
| 6/23/03 | 7 | 6 | MAF part # | Add remanufactured part # 88961007 | |
| 9/10/03 | 3 | 8 | Ring Gap | Correct typo for top ring gap (0.064 to 0.64) | |
| 9/10/03 | 5 | 1 | Valve Spring Calibration | Change +/- load from 22N to 44N (5lbf. To 10lbf.) | IIIG-03-2 |
| | | | | | |
| 12/15/03 | 1 | 1 | Block part # | Change block part # from drawing # to 24502286 | IIIG-03-3 |
| 12/15/03 | 1 | 5 | Solvent specification | Update to mineral spirit | |
| 12/15/03 | 1 | 5A | Solvent specification | Update to mineral spirit | |
| 12/15/03 | 1 | 6 | Fastener | Update fastener usage | |
| 12/15/03 | 2 | 7 | Honer | Update ratchet feed setting | |
| 12/15/03 | 2 | 8 | Honer | Update honing procedure | |
| 12/15/03 | 2 | 9 | Honer | Update revised loads and target sizing | |
| 12/15/03 | 2 | 10 | Honer | New page, honer calibration requirements | |
| 12/15/03 | 2 | 11 | Honer | New page, honer maintenance requirements | |
| 12/15/03 | 2 | 12 | Honer | New page, honer maintenance requirements | |
| 12/15/03 | 3 | 5 | Solvent specification | Update to mineral spirit | |
| 12/15/03 | 3 | 6 | Fastener | Update fastener usage | |
| 12/15/03 | 3 | 8 | Rings | Update paint removal and solvent usage | |
| 12/15/03 | 3 | 11 | Camshaft | Update solvent usage and lubrication requirements | |
| 12/15/03 | 4 | 5 | Sealer | Update approved sealer specification | |
| 12/15/03 | 4 | 12 | Sealer | Update approved sealer specification | |
| 12/15/03 | 5 | 1 | Solvent specification | Update to mineral spirit | |
| 12/15/03 | 6 | 1 | Solvent specification | Update to mineral spirit | |
| 12/15/03 | 6 | 2 | Solvent specification | Update to mineral spirit | |
| 12/15/03 | 6 | 6 | Sealer | Update approved sealer specification | |

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|---|---|---|---|---|---|
| 12/15/03 | 6 | 11 | Text | Update text block (injector flow testing) reference procedure | |
| 12/15/03 | 7 | 4 | Part # | Add new shield 24508586 | |
| | | | | | |
| 3/15/04 | 4 | 12 | Silicone Sealer | Update sealer part numbers | IIIG-04-1 |
| 3/15/04 | 6 | 6 | Sealer & Gasket | Update sealer and intake gasket part numbers | |
| | | | | | |
| 11/3/04 | 3 | 7 | Con Rod part numbers | Update to include Cast and PM part numbers | IIIG-04-3 |
| 11/3/04 | 3 | 9 | Con Rod Torques | Update to include Cast and PM torque values | |
| 11/3/04 | 4 | 1 | Front Oil Seal | Update to new OHT part number | |
| 11/3/04 | 4 | 5 | Front Oil Seal | Update to new OHT part number | |
| 11/3/04 | 4 | 9 | Rear Oil Seal | Update to new OHT part number | |
| 11/3/04 | 4 | 12 | Oil Pan Gsket | Update to new OHT part number | |
| 11/3/04 | 5 | 1 | Exhaust Valve | Update to new SPO part number | |
| | | | | | |
| The following updates cover information letters IIIG-05 through IIIG-06- | | | | | |
| | | | | | |
| 6/22/06 | All Sections | | Global text change from Mineral Spirits to Degreasing Solvent | | |
| 6/22/06 | 1 | 1 | Bore alignment check | Change alignment check to optional | |
| 6/22/06 | 1 | 6 | Fastener Installation | Remove plastic mallet from usage text | |
| 6/22/06 | 1 | 7 | Torque Wrench | Add ETW-E180 torque wrench information | |
| 6/22/06 | 2 | 8 | Honing | Update according to S.P. direction 6/6/06 | |
| 6/22/06 | 3 | 2 | Data recording | Add data recording Annex A.14 | |
| 6/22/06 | 3 | 5 | Update | Update text and part numbers | |
| 6/22/06 | 3 | 6 | Update | Update view, fastener prep, and clearance spec. | |
| 6/22/06 | 3 | 7 | Piston & Rod | Update cleaning and rod orientation information | |
| 6/22/06 | 3 | 8 | Update and expand | Expand view and add additional sheet (8A) | |
| 6/22/06 | 3 | 8A | New sheet | New sheet with expanded view and BC6 second ring info. | |
| 6/22/06 | 3 | 9 | Cast Rods | Remove cast rod information | |
| 6/22/06 | 3 | 11 | Fastener usage | Update fastener usage and inspection information | |
| 6/22/06 | 3 | 12 | Part number update | Update balance shaft part number | |

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| Date | Sec. | Sheet | Topic | Comments | Info Letter |
|---|---|---|---|---|---|
| 6/22/06 | 4 | 2 | Front Cover | Add usage information | |
| 6/22/06 | 4 | 4 | Oil filter adapter | Update sealer usage information | |
| 6/30/06 | 4 | 7 | Front Cover Assembly | Update view and part numbers | |
| 6/30/06 | 4 | 8 | Front Cover | Update fastener information | |
| 7/20/06 | 4 | 9 | Rear Cover | Update part numbers for rear cover and crankshaft seal | |
| 7/20/06 | 4 | 10 | Rear Cover | Update fastener usage | |
| 2/1/06 | 4 | 11 | Part number update | Update gasket part number | |
| 2/5/06 | 4 | 13 | Part number update | Update fastener part number information | |
| 6/30/06 | 5 | 1 | Valve & Springs | Update cleaning procedure and valve part number | |
| 7/20/06 | 5 | 3 | Cyl. Head fastener | Update part number information | |
| 7/20/06 | 6 | 1 | Lifter installation | Update cleaning info and installation information | |
| 7/20/06 | 6 | 2 | Pushron installation | Update cleaning info and degreasing solvent | |
| 7/20/06 | 6 | 3 | Rocker retainer | Update usage information | |
| 7/20/06 | 6 | 6 | Update | Upate intake gasket part number | |
| | | | | | |
| The following updates cover changes through April 1, 2007 | | | | | |
| | | | | | |
| 3/30/07 | 1 | 7 | Cylinder Head Fastener Torque | Fastener torque procedure for honing deck plates | |
| 3/30/07 | 3 | 9 | Rod Bolt Torque | Connecting rod torque + angle update for PM rods | |
| 3/30/07 | 3 | 11 | Pre-test Camshaft Lubrication | Updated procedure for EF-411 vs test oil lubricating process | |
| 3/30/07 | 4 | 6 | Front Cover Gasket | Update gasket part number changes | |
| 3/30/07 | 5 | 3 | Cylinder Head Fastener Torque | Fastener torque procedure for cylinder head installation | |
| 3/30/07 | 6 | 5 | Rocker Cover | Update rocker cover part number change | |
| 3/30/07 | 6 | 8 | Upper Intake Gasket | Update upper intake gasket part number change | |
| | | | | | |
| The following updates cover changes through February 22, 2010 | | | | | |
| | | | | | |
| 2/22/10 | 1 | 5A | Block Cleaning | Changed washer temp to metric value and added tolerance | |
| 2/22/10 | 1 | 7 | Stress Plates | Updated head gasket and bolt p/n, added source for bolts | |
| 2/22/10 | 2 | 10 | Honing Machine | Changed wording from calibrated to verified | |

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| Date | Sec. | Sheet | Topic | Comments | Info Letter |
|---|---|---|---|---|---|
| 2/22/10 | 3 | 6 | Thread Lubrication | Deleted note prohibiting thread lubrication | |
| 2/22/10 | 3 | 8 | Ring Gap Measurement | Deleted OHT3F-gages, added measurement in block | |
| 2/22/10 | 4 | 9 | Seal Installation | Added Kenmore J38196 tool for rear seal installation | |
| 2/22/10 | 4 | 10 | Rear Seal Housing | Allowed bolts to be used along as they remain servicable | |
| 2/22/10 | 5 | 3 | Head Assembly | Corrected short bolt p/n | |
| 2/22/10 | 6 | 8 | Upper Intake | Deleted stud, 24502453 and increased to 2 bolt 24505205 | |
| | | | | | |
| The following updates cover changes through July 1, 2011 | | | | | |
| | | | | | |
| 7/1/11 | 1 | 2 | New Block and Pre-Hone Prep | Updated part number for upper front cover pin | |
| 7/1/11 | 1 | 4 | New Block and Pre-Hone Prep | Revised notes E and F | |
| 7/1/11 | 1 | 5 | New Block and Pre-Hone Prep | Revised note A | |
| 7/1/11 | 1 | 6 | Main Cap Installation | Removed notes Y2 and Z, changed Y1 to Y and edited | |
| | | | | notes A, B and C | |
| 7/1/11 | 1 | 7 | Torque Plate Installation | Revised notes A, B, C and D and deleted note Z | |
| 7/1/11 | 1 | 4 | Fluid and Operations Guide | Corrected typos, deleted note 1, renumbered notes 2 and 3 | |
| | | | | and clarified step 4 | |
| 7/1/11 | 3 | 2 | Engine block cleanliness | Revised note B | |
| 7/1/11 | 3 | 3 | Main Cap Installation | Added new sheet 3 | |
| 7/1/11 | 3 | 4 | Camshaft bearing positioning | Moved from sheet 6 | |
| 7/1/11 | 3 | 5 | Upper main bearing inspection | Renumbered as sheet 5 | |
| | | | Installation | | |
| 7/1/11 | 3 | 6 | Crankshaft cleaning, inspection | Renumbered as sheet 6 | |
| | | | and installation | | |
| 7/1/11 | 3 | 7 | Lower Main installation | Renumbered sheet 6 as sheet 7 | |
| 7/1/11 | 3 | 8 | Piston Pin and conneting rod | Updated connecting rod part number renumber sheet 7 as 8 | |
| 7/1/11 | 3 | 9 | Piston installation and clearances | Renumbered sheet 8 as sheet 9 | |
| 7/1/11 | 3 | 9A | Piston ring installation | Removed BC-6 from piston orientation and added orientation | |
| | | | orientation and clearances | for oil ring expander renumber sheet 8A as 9A | |
| 7/1/11 | 3 | 10 | Piston and rod assembly install | Updated connecting rod and connecting rod bolt part number | |

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| Date | Sec. | Sheet | Topic | Comments | Info Letter |
|---|---|---|---|---|---|
| | | | | Renumbered sheet 9 as 10 | |
| 7/1/11 | 3 | 11 | Oil gallery plugs and timing chain | Renumbered sheet 10 as 11 | |
| | | | Damper | | |
| 7/1/11 | 3 | 12 | Camshaft cleaning, etc | Revised note D, renumbered sheet 11 as sheet 12 | |
| 7/1/11 | 3 | 13 | Balance shaft inspect & install | Removed balance shaft part number 24503588 | |
| | | | | Renumbered sheet 12 as 13 | |
| 7/1/11 | 3 | 14 | Timing gear set | Renumbered sheet 13 as 14 | |
| 7/1/11 | 3 | 15 | Timing gear set alignment & torque | Renumbered sheet 14 as 15 | |
| 7/1/11 | 4 | 10 | Rear cover installation | Updated part number | |
| 7/1/11 | 4 | 12 | Oil pan gasket installation | Updated sealer information | |
| 7/1/11 | 4 | 13 | Oil pan installation | Removed bolt number 24502791 | |
| 7/1/11 | 5 | 1 | Valve & spring assembly | Updated cylinder head part number | |
| 7/1/11 | 5 | 3 | Cylinder head installation | Clarified torque sequence | |
| 7/1/11 | 6 | 1 | Lifter pre-oiling and installation | Corrected typo in description B 2. | |
| 7/1/11 | 6 | 5 | Rocker cover installation | Deleted bolt with washer, part number 25534748 and added | |
| | | | | grommet, part number 25534749 | |
| 7/1/11 | 6 | 6 | Intake gasket installation | Updated RTV sealer | |
| 7/1/11 | 6 | 7 | Lower intake manifold install | Revised intake manifold description and part number and | |
| | | | | added torque sequence | |
| 7/1/11 | 6 | 8 | Upper intake manifold install | Revised description and updated part number | |
| 7/1/11 | 6 | 9 | Throttle body installation | Updated part number | |
| 7/1/11 | 6 | 11 | Injector assembly installation | Updated part number for fuel injector and added second | |
| | | | | pressure regulator | |
| 7/1/11 | 7 | 1 | Coolant out and sensor | Added part number for coolant outlet gasket | |
| 7/1/11 | 7 | 4 | Crankshaft sensor shield | Revised part number | |
| 7/1/11 | 7 | 6 | Throttle body modification | Removed part numbers 88961007 and 12568877 | |
| The following updates cover changes through April 10, 2012 | | | | | |
| 4/10/12 | 1 | 5A | New Block and Pre-Hone Prep | Revised length of time cleaning solution can be used | |
| 4/10/12 | 1 | 6 | New Block and Pre-Hone Prep | Revised the sequence of main bolt installation | |
| 4/10/12 | 3 | 3 | Piston installation and clearances | Revised the sequence of main bolt installation | |

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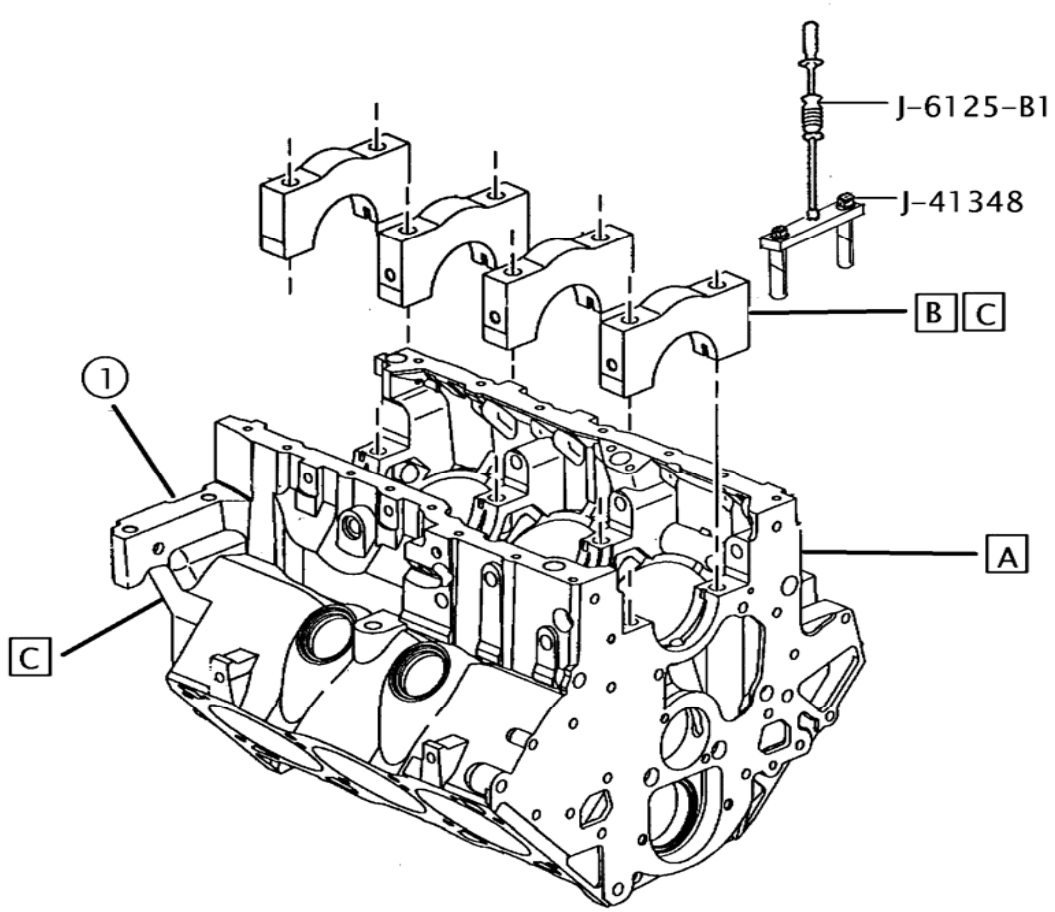
| Date | Sec. | Sheet | Topic | Comments | Info Letter |
|---|---|---|---|---|---|
| 4/10/12 | 3 | 9 | Piston installation and clearances | Revised target bore value for 12/2 pistons | |

# Section 01

# Revision Update Timeline

# Section 1

# Cleaning and Pre Hone Preparation



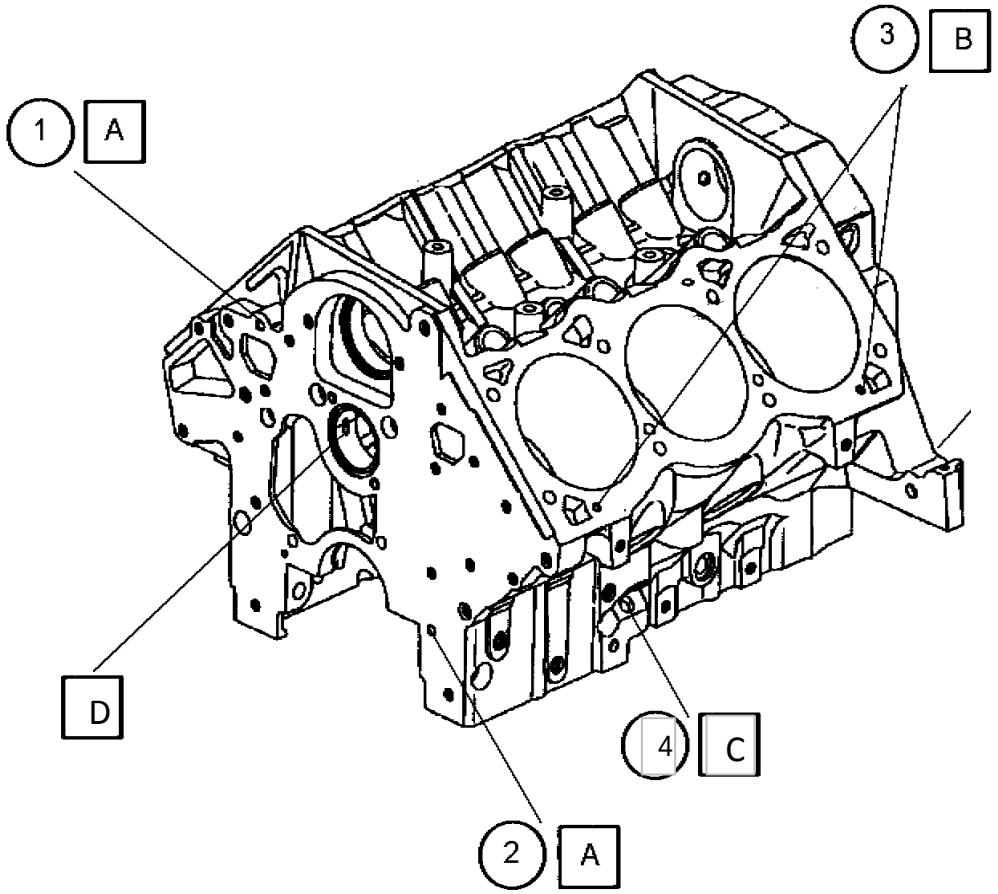

| Description of Operation | |
|---|---|
| A | Upon introduction of a new block into the system, check for any damage to machined surfaces which might have occurred during shipping or handling.<br><br>Optional: Check crankshaft main bore alignment using appropriate mandrel. |
| B | Remove main cap side & main bolts. Use Kent-Moore J-41348 main bearing cap puller (12Nm) & J-6125-1B slide hammer to remove main caps. **Note: Main bearing caps are press fit. Do not hammer caps back and forth during removal. Damage to the caps may result in damage to engine bearings during test.** |
| C | Record engine serial number and or assign a laboratory number and mark necessary identification on engine block and crankshaft main caps. **Note: Do not use stamped tool set for marking identification on main caps.** |

| Specification | |
|---|---|
| 1 | 24502286 Block Assembly |

| REV | Date | Revision History |
|---|---|---|
| 1 | 12/31/97 | Block-1 |
| 2 | 12/15/03 | Change from engineering drawing part # (24506028) to actual part # 24502286 |
| 3 | 06/22/06 | Change main bore alignment check to optional |
| | | |
| | | |

| View |
|---|
| **Engine Block** |
| New block and pre-hone prep<br>Serial Number Locations |

| New Block and Pre-Hone Prep | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 1 | 1 |



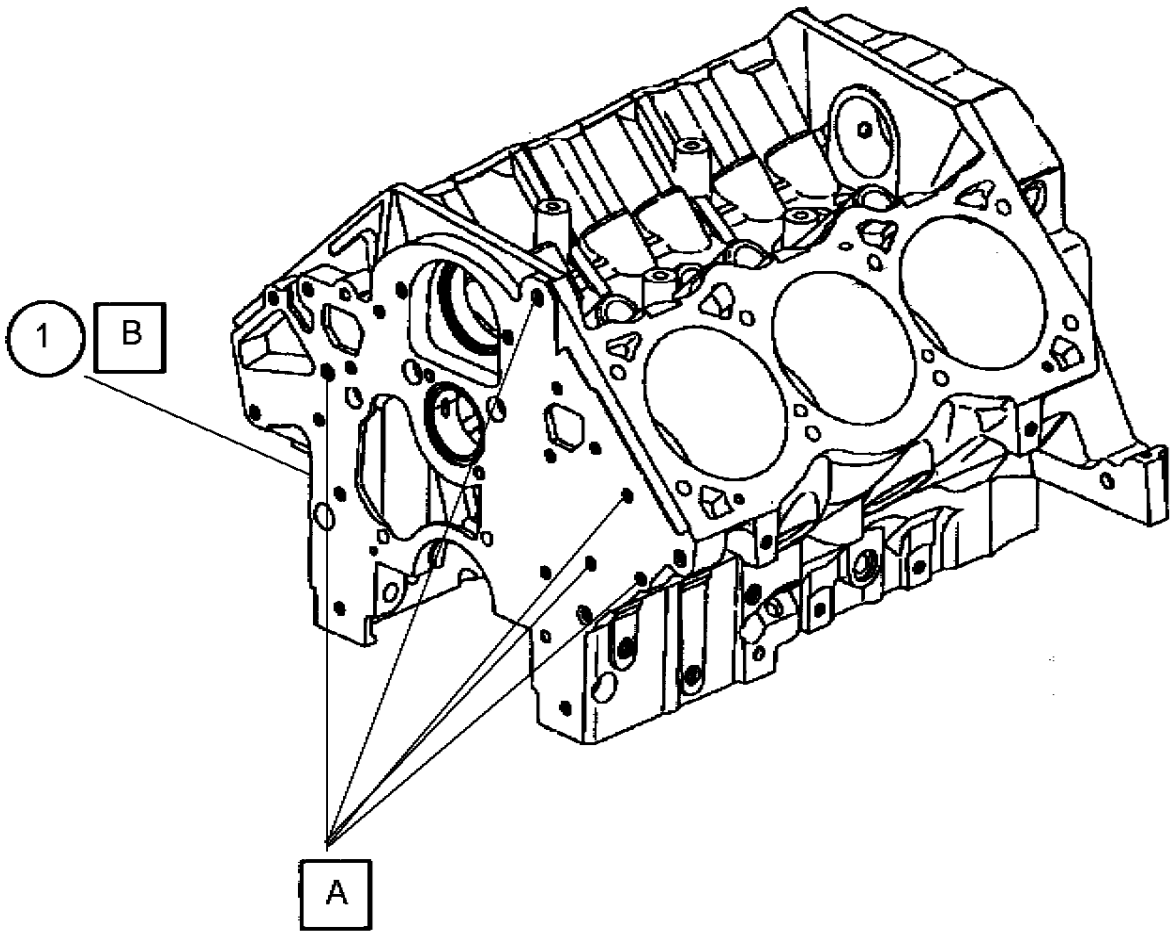

| Description of Operation | |
|---|---|
| A | Install locating pins on front face. |
| B | Install locating pins on cylinder deck |
| C | Use OHT3F-071-1 reamer to size dip stick hole for calibrated dip stick |
| D | Deburr all leading edges of camshaft tunnel bores and oil gallery cross drilled intersections through tunnel bores using emery cloth, rotary tool with carbide cutters, stones, or wire wheels as necessary to remove sharp edges. |

| Specification | |
|---|---|
| 1 | Modify 25536323 Pin Frt Cover Upper |
| 2 | 25536323 Pin Fr+Al139t Cover Lower |
| 3 | 25536320 Pin Cyl. Head Location |
| 4 | OHT3F-071-1 Reamer |

| REV | Date | Revision History |
|---|---|---|
| 1 | 12/31/97 | Block-2 |
| 2 | 7/1/11 | Updated Part Number for Upper front cover pin and deleted transmission pin |
| | | |
| | | |
| | | |

| View |
|---|
| Engine Block |
| New block and pre-hone prep |
| Locating pin installation |
| Camshaft tunnel and dip stick prep |

| New Block and Pre-Hone Prep | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 1 | 2 |



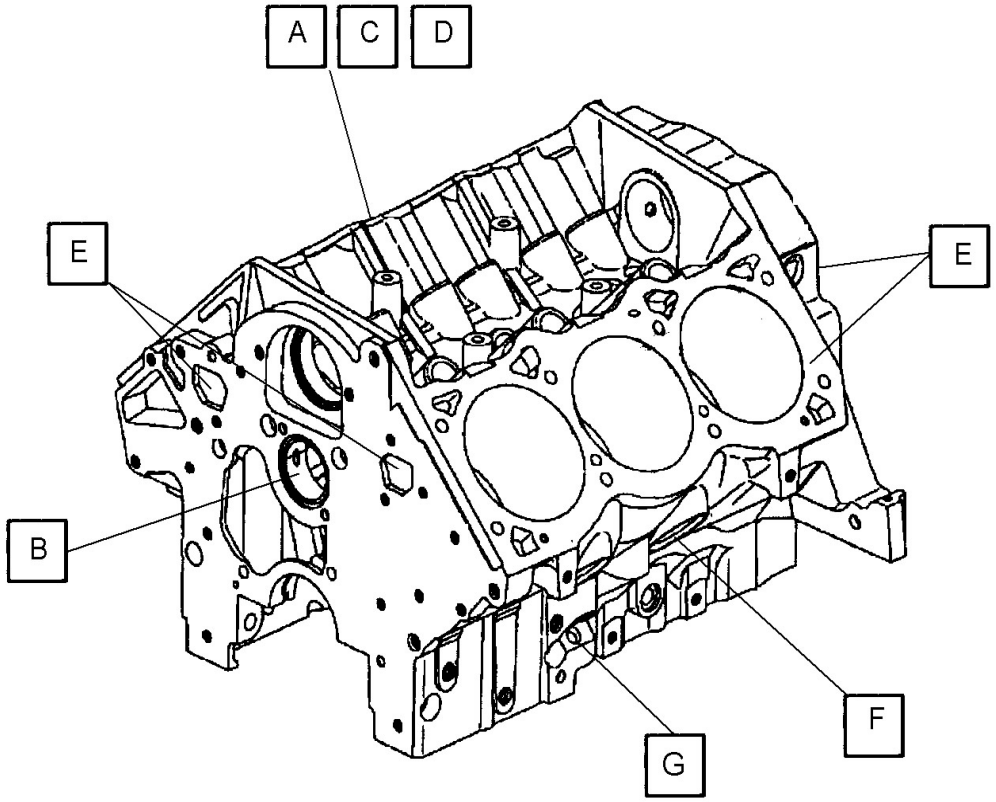

| Description of Operation | |
|---|---|
| A | Install threaded fasteners with #2 Non-Hardening Permatex or Perfect Seal #4 in locations identified in view. |
| B | Install 1/4NPT plug in main oil gallery on the right front side of engine block.<br><br>Note: This location is not to be used for temperature control or thermocoupled. |

| Specification | |
|---|---|
| 1 | 444777 Plug Auto Hex Socket |

| REV | Date | Revision History |
|---|---|---|
| 1 | 12/31/97 | Block-3 |
| | | |
| | | |
| | | |
| | | |

| View |
|---|
| **Engine Block** |
| New block and pre-hone prep<br>Plugged holes in front of engine |

| New Block and Pre-Hone Prep | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 1 | 3 |




| Description of Operation | |
|---|---|
| A | Remove all casting slag and core sand deposits from the coolant passages on new blocks and check for core sand deposits on used blocks |
| B | Remove all camshaft bearings and oil gallery plugs. |
| C | Clean all gasket surfaces. |
| D | Chase all threaded holes for the main caps and cylinder head fasteners using a Class 2B Tap. |
| E | Remove bearings, and oil gallery plugs and main caps prior to cleaning. |
| F | Install coolant core plugs, GM part #24500867. |
| G | Ream dip stick hole using OHT3F-071-1 |

**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 12/31/97 | Block-4 |
| 2 | 7/1/11 | Revised Note E and F |
| | | |
| | | |
| | | |

| View |
|---|
| **Engine Block** |
| New block and pre-hone prep |

| New Block and Pre-Hone Prep | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 1 | 4 |

Automatic Parts Washer Procedure for IIIG Engine Blocks

1) Use only NAT-50-S or PDN-50 soap at a concentration of 16 pounds of soap per 380 Liters of water. Change the cleaning solution after no more than 25 hours of use.

2) Set the temperature of the water to 140 degrees F.

3) Do not pre-condition the water that is being used in any way.

4) Prior to installing the block in the parts washer, ensure that all coolant passages are blocked off to prevent cleaning solutions from entering the passages.

5) Allow the block to run through the cleaning cycle for a period of 30 to 40 minutes.

6) After the cycle(s) are complete, immediately remove the block from the washer and spray it down with degreasing solvent.

7) Wipe cylinder bores out with a lint free towel.

8) Spray engine block with a mixture of 50/50 EF-411 and degreasing solvent.

**Description of Operation**

**Specification**

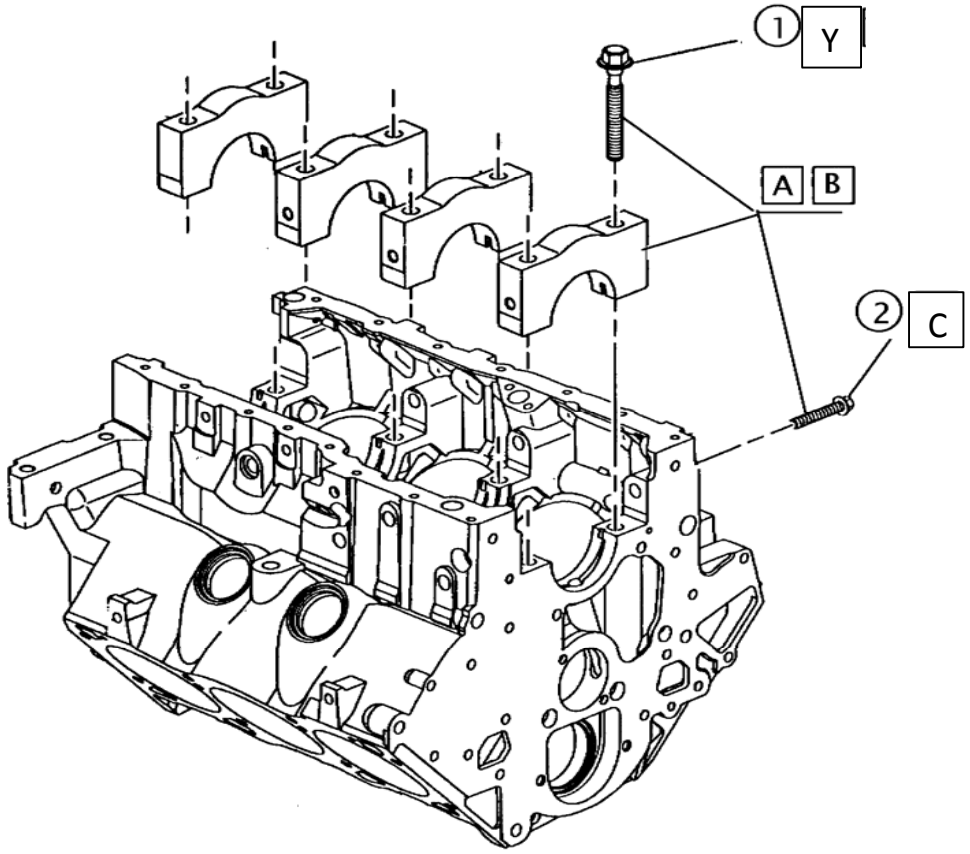
| REV | Date | Revision History |
|---|---|---|
| 1 | 9/5/00 | Procedure for Better Engineering Jet Washer usage |
| 2 | 12/15/03 | Update change to mineral spirits |
| 3 | 6/22/06 | Update text change to degreasing solvent |
| 4 | 4/10/12 | Revised the cleaning solution replacement frequency to not exceed 25 hours |
| | | |

**View**

**Engine Block**

Engine block cleaning procedure for automated type jet washers

| New Block and Pre-Hone Prep | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 1 | 5A |



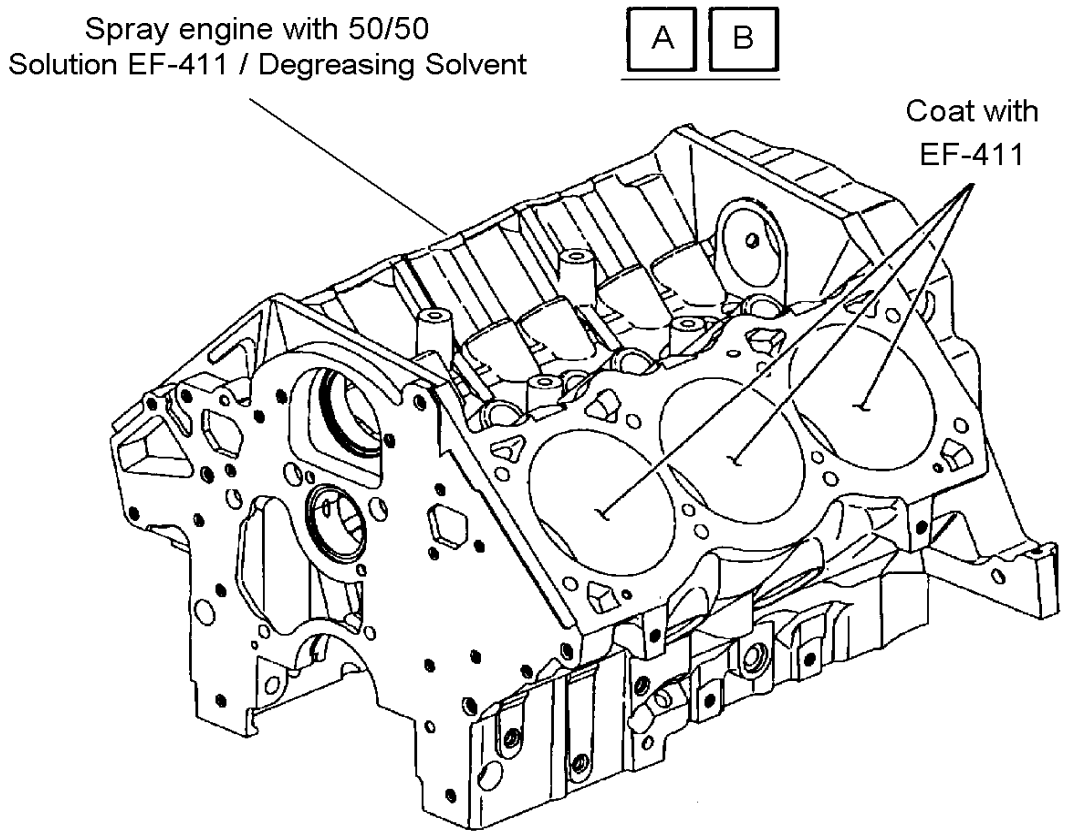

| Description of Operation | |
|---|---|
| A | Clean and oil all main cap fasteners (EF-411) and install main caps (use used fasteners for honing).Note: Do not use air tools to run main caps down. |
| B | Install main cap with fasteners as guides and draw into position with speed handle and socket in crisscross pattern. |
| Y | 1.)Tighten all main fasteners to 70 N·m to fully seat main caps<br>2.) Loosen the fasteners 360° counterclockwise.<br>3.) Starting from the center of the block and moving out torgue the fasteners 20 N·m, then 40 N·m<br>4.) Starting from the center of th block and moving out for each of the steps shown below tighten fasteners in the following steps: 35º, another 35º and finally to another 35º |
| C | Install main cap side fasteners, torque to 15 N·m, and then an additional 45º |

| Specification | |
|---|---|
| 1 | 24503056 Bolt (8) see note Y (Tighten before Z) |
| 2 | 24505576 Bolt (6) see note Z (Tighten after Y) |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/10/98 | Block-6 |
| 2 | 12/15/03 | Clarification, add 40Nm + 35° 3 times… and (use used fasteners for honing) to Y2 |
| 3 | 6/22/06 | Remove use of plastic mallet from "B" |
| 4 | 7/1/11 | Removed notes Y2 and Z, edited Y1 and changed to Y, edited notes A, B and C |
| 5 | 4/10/12 | Corrected the order of bolt installation moved note Y to before note C |

| View |
|---|
| Engine Block |
| Main cap installation |

| New Block and Pre-Hone Prep | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 1 | 6 |




| Description of Operation | |
|---|---|
| A | The engine shall be cleaned using an automated washing device, however, caution should be used to prevent oxidation flash over of the ferrous surfaces. Note: Only use specified cleaning materials, refer to section 7.5 of ASTM D7320 for approved cleaning materials. |
| B | The block must be thoroughly cleaned using brushes through the oil galleries, camshaft tunnel, and cylinder bores with degreasing solvent to remove any detergent residue before honing. |
| ? | (Step Sec. 1 sheet 6)<br>Repeat step "A & B" above after honing.<br><br>Note: If this is the final cleaning after honing, spray the entire engine block using a 50/50 solution of EF-411 and degreasing solvent. Air dry to remove excess solution. |
| ? | |

**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 12/31/97 | Block-5 |
| 2 | 12/15/03 | Update, change to mineral spirits |
| 3 | 6/22/06 | Update change to degreasing solvent |
| 4 | 7/1/11 | Revised Note A |
| | | |

**View**

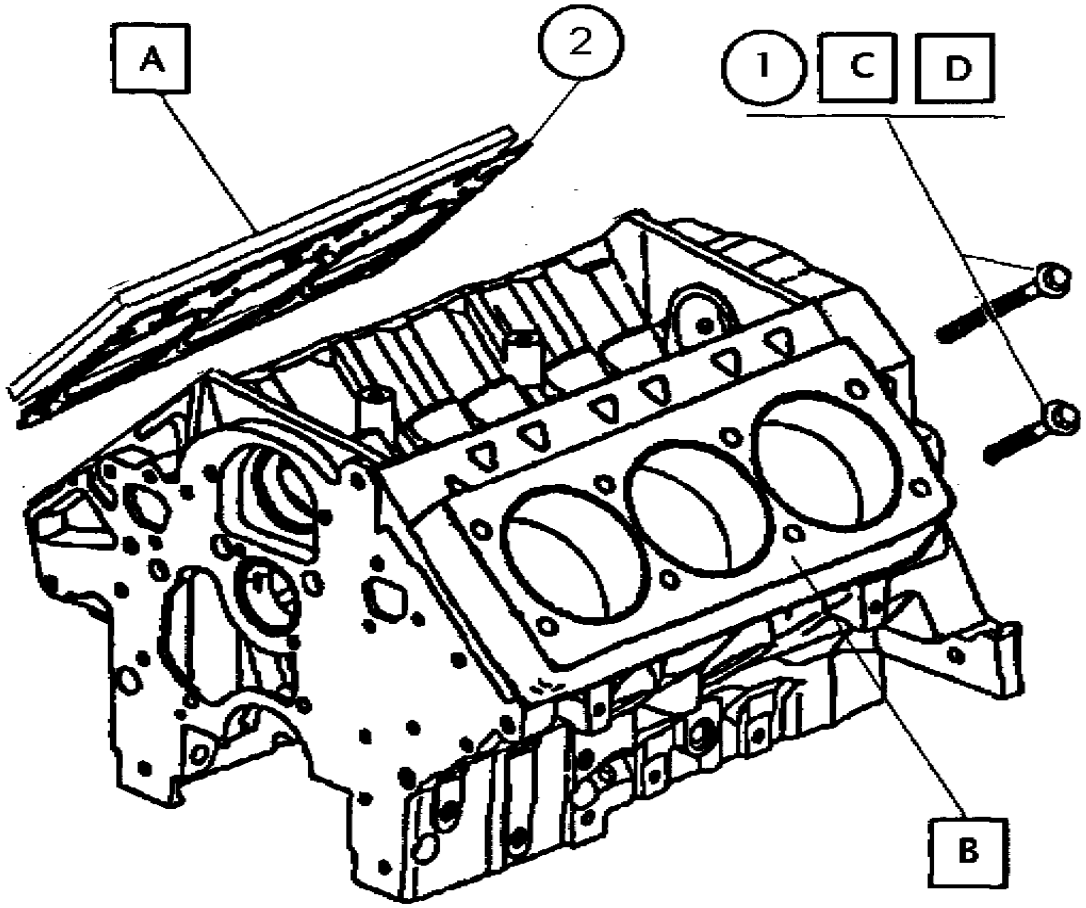
**Engine Block**

Engine block cleaning

## New Block and Pre-Hone Prep

## Sequence IIIG

| Section | Sheet |
|---|---|
| 1 | 5 |




| Description of Operation | |
|---|---|
| A | Remove cylinder deck block off plates, coolant passage plates shall stay on during this process. |
| B | Install B-H-J Torque Plates (GM-3.8/3E-R-S-T-HT) with the proper hardened washers (supplied with the honing torque plates), single washer on top row and double washers on bottom row, to establish proper fastener depth with new gaskets. Refer to D7320 Table A2.1 for gasket part numbers. |
| C | Note: When installing torque plates, 1) move the bottom row of fasteners (long hed bolts)to the top, 2) discard the top row of fasteners, 3) use the post test fasteners (long head bolts)from the last teardown in the bottom row on the torque plates. Lightly lubricate with EF411 |
| D | Torque Fasteners in steps as shown in Section 5, sheet 3. 1st 30 N·m, 2nd 50 N·m, 3rd 80 N·m and final 123±9N·m |

| Specification | |
|---|---|
| 1 | 25527831K Bolt Cyl. Head (8)(Long) Use in upper and lower position with double hardened washers on lower row. Obtain washers from B-H-J. Obtain bolts from GM Racing |
| 2 | 24503802 Gasket LH.<br>24503801 Gasket RH. |

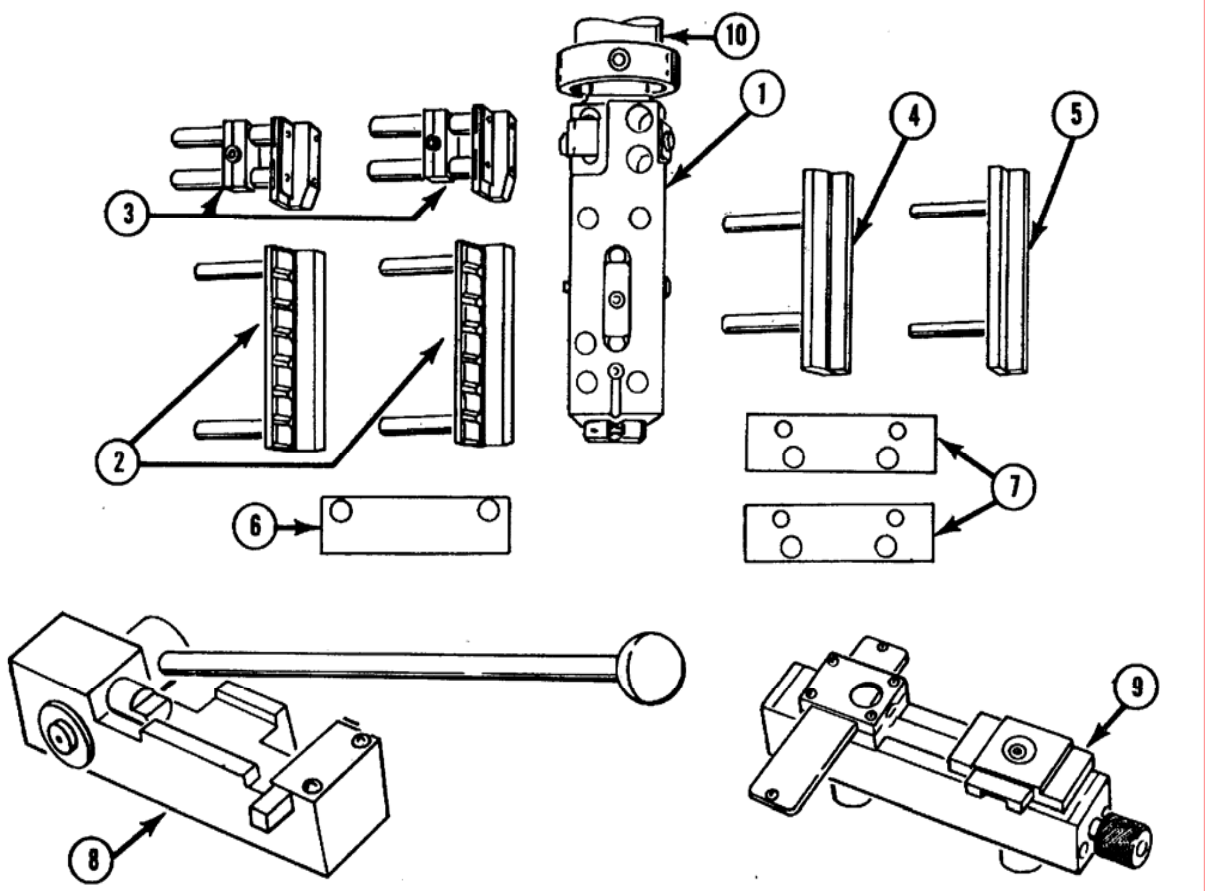
| REV | Date | Revision History |
|---|---|---|
| 1 | 1/1/98 | Block-7 |
| 2 | 6/22/06 | Update torque wrench information |
| 3 | 3/30/07 | Update fastener torquing procedure to 123Nm ± 9Nm final torque |
| 4 | 2/22/10 | Updated bolt number and source, corrected head gasket part numbers |
| 5 | 7/1/11 | Revised Notes A, B, C and D, Deleted Note Z |

| View |
|---|
| Engine Block |
| B-H-J Torque Plate installation |

| New Block and Pre-Hone Prep | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 1 | 7 |

# Section 2

# Cylinder Block Honing




| Description of Operation | |
|---|---|
| 1 | Hone Head |
| 2 | Stone Assemblies |
| 3 | Alignment Guides |
| 4 | Main Guide |
| 5 | Centering Guide |
| 6 | Stone Shims |
| 7 | Guide Shims |
| 8 | Stone Inserter |
| 9 | Setting Gage |
| 10 | Drive Tube |

**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/7/98 | Hone-1-1 |
| | | |
| | | |
| | | |
| | | |

**View**

**Hone Unit Details**

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 1 |

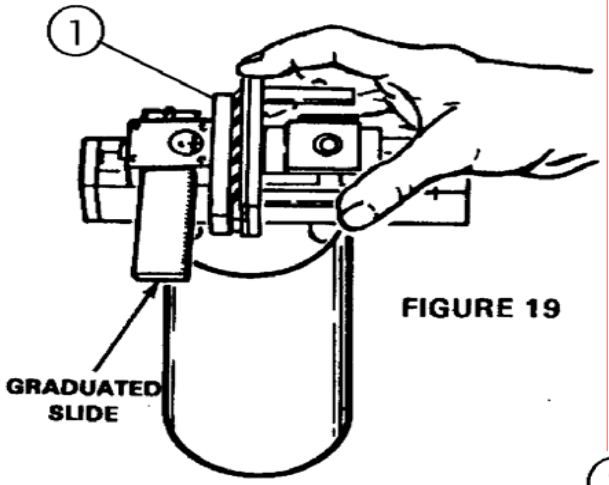



FIGURE 19

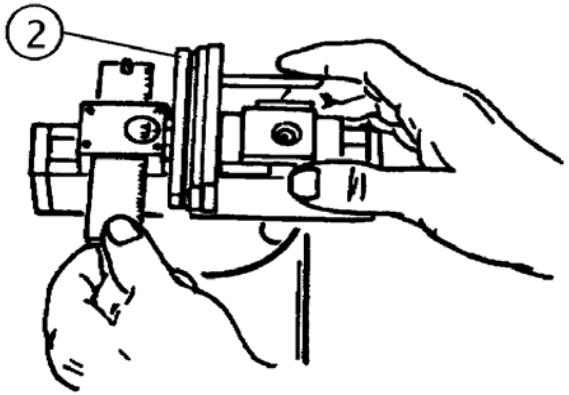



FIGURE 20

**Description of Operation**

Set the turret block to the standard position and adjust the setting block snugly in the cylinder bore.

19 Place the stone assembly in the setting gage with the slide scale set at "0". Add shims as necessary to adjust to 1 - 2 on the slide scale for the stone and guide assemblies.

20 Place the plateau honing tool in the setting gage with the slide scale set at "0". Add shims as necessary to adjust to 3 - 4 on the slide scale.

Note: The alignment guides are not used during honing of IIIF blocks.

**Specification**

1 EHU 512 Stone

2 C30-PHT-731 Plateau Honing Tool

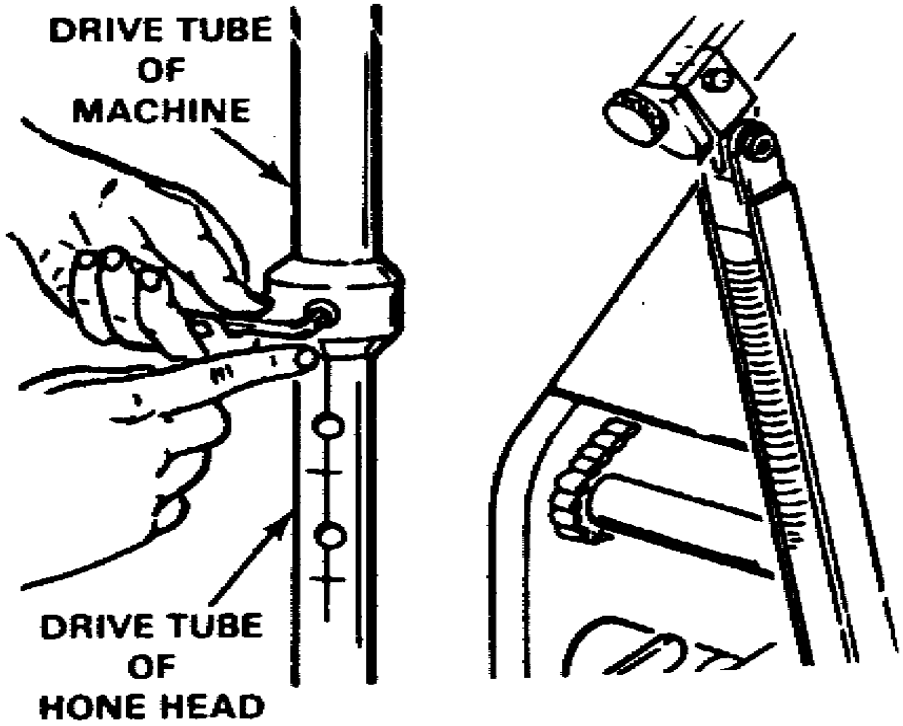
| REV | Date | Revision History |
|---|---|---|
| 1 | 1/7/98 | Hone-3-1 & 3-2 |
| | | |
| | | |
| | | |
| | | |

**View**

**Stones & Guides**

Stone and guide adjustment

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 2 |




**Description of Operation**

Slip the Drive Tube of the Hone Head into the Drive Tube of the CV-616-46 and tighten the set screw with the first set of index marks in line.

**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/7/98 | Hone-2-2 |
| | | |
| | | |
| | | |
| | | |

**View**

**Drive Tube**

Drive tube adjustment

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 3 |

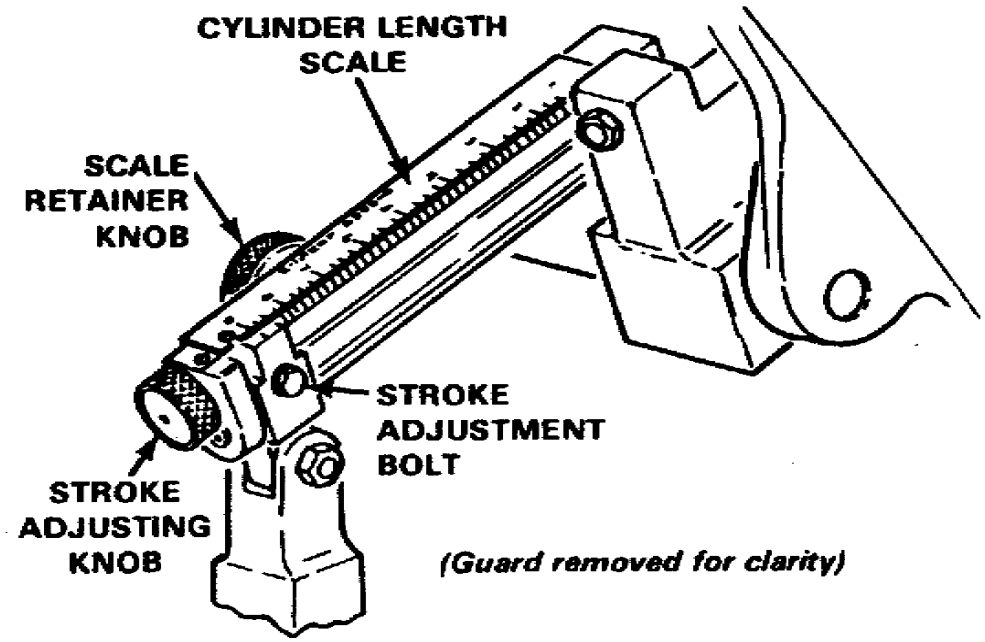



FIGURE 23

**Description of Operation**

Loosen stroke adjustment bolt and set stroke length at 5 3/8"

Note; to change the Stroke Scale to Metric, order PNP 1275M.

**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/7/98 | Hone-4 |
| | | |
| | | |
| | | |
| | | |

**View**

**Stroke Length**

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 4 |

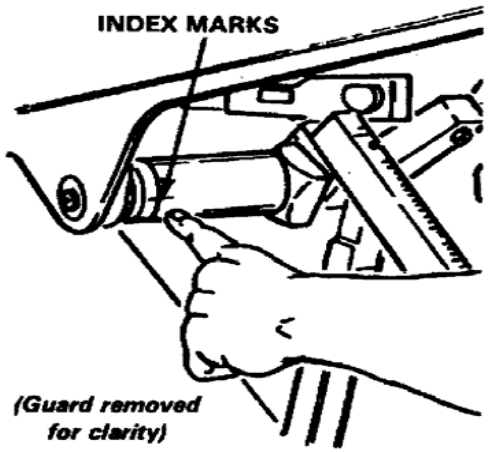



FIGURE 24

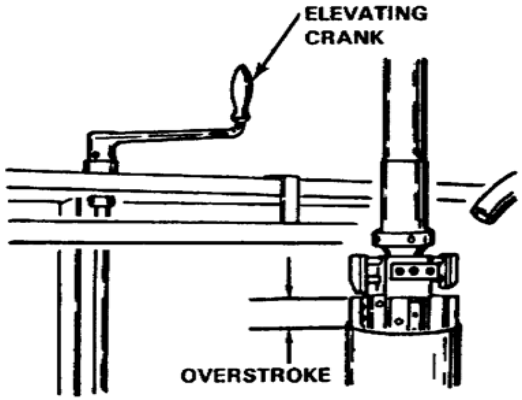



FIGURE 25

| Stone Length | | Top Overstroke Setting | |
|---|---|---|---|
| Inches | mm | Inches | mm |
| 2-3/4'' | 70 mm | 3/8'' | 9,5 mm |
| 3-1/2'' | 89 mm | 5/8'' | 16 mm |
| 4-1/2'' | 115 mm | 13/16'' | 21 mm |
| 6'' | 152 mm | 1-1/16'' | 27 mm |

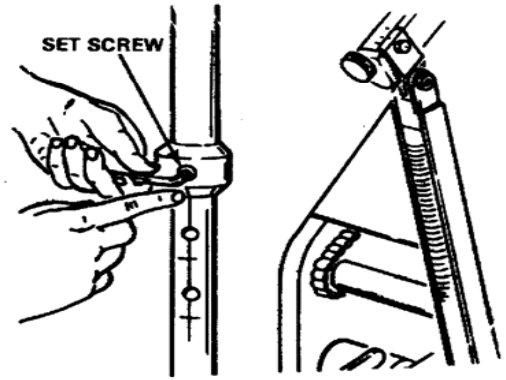



FIGURE 26

**Description of Operation**

With the hone head in the cylinder and the index marks lined up as shown in figure 24, use the elevating crank to adjust the overstroke length to 3/8" as indicated in figure 26 for 2 3/4" stone length.

Note: Drive tube should be set at first set of index marks.

**Specification**

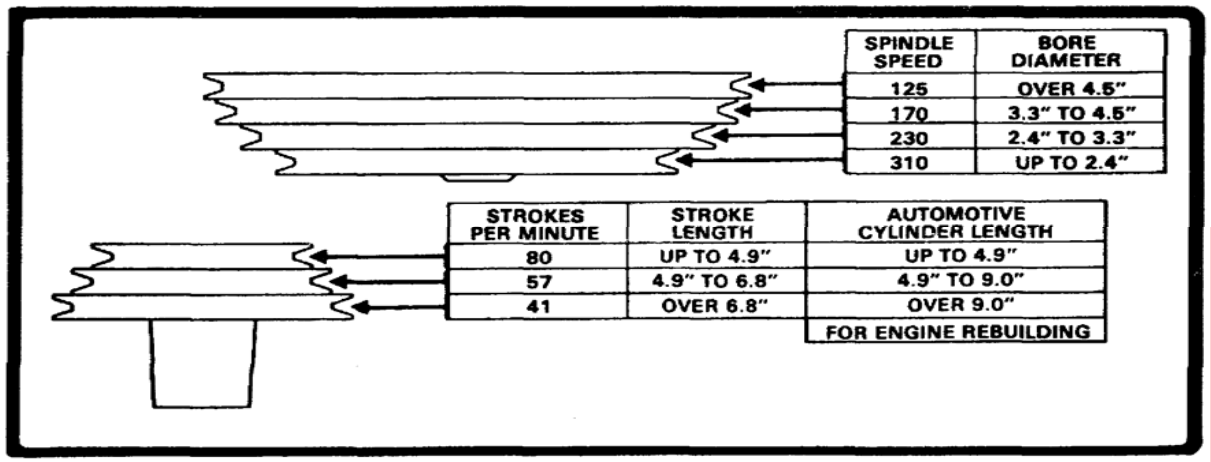
| REV | Date | Revision History |
|---|---|---|
| 1 | 1/7/98 | Hone 4 & 5 |
| | | |
| | | |
| | | |
| | | |

**View**

**Overstroke**

Overstroke adjustment

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 5 |



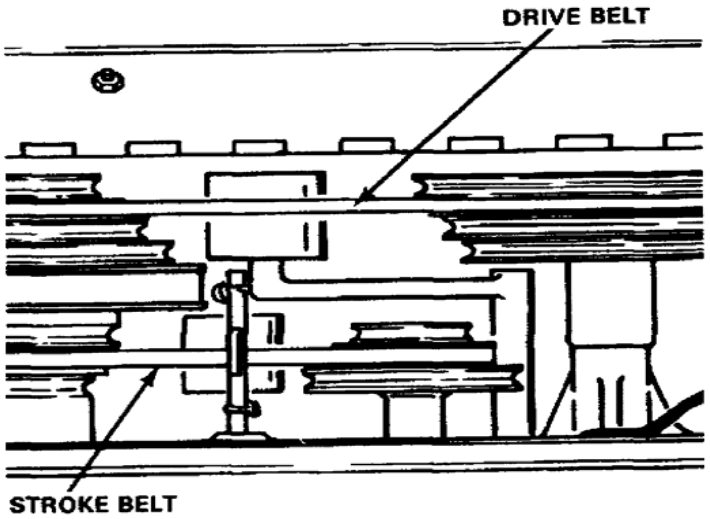




FIGURE 28

**Description of Operation**

Open the left side of the belt cover and set the spindle speed at 170 and the strokes per minute at 57.

**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/7/98 | Hone-6 |
| | | |
| | | |
| | | |
| | | |

**View**

**Speed & Stroke**

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 6 |

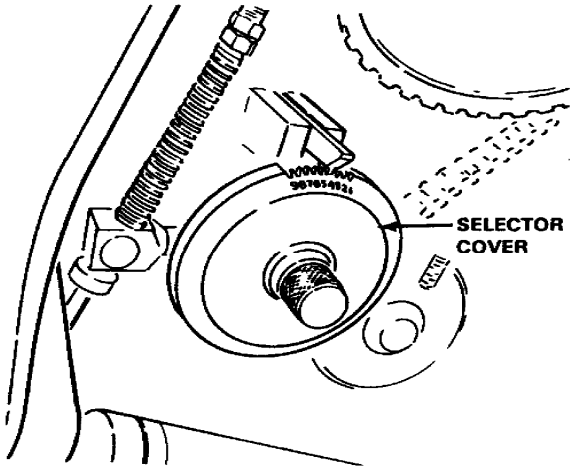



FIGURE 29

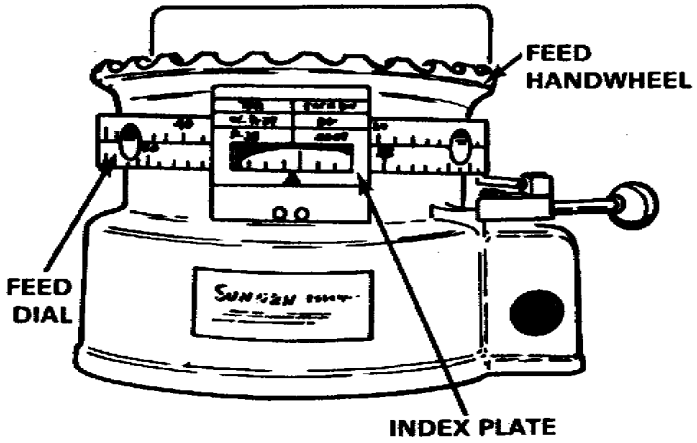



FIGURE 30

**Description of Operation**

Set the ratchet feed rate on the selector cover to 1 for the EHU 512 Stones. change the ratchet feed rate to 4 for the OHT3G-096-1 Plateau Hone Brushes. See figure 29

Use the index plate for the lower scale identified as P28 .005 per division.

Note: to change the Hand Wheel Assembly and Stroke Plate to Metric, order CV-215MA.

**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/7/98 | Hone-7 |
| 2 | 12/1/99 | Change note from .0005 to .005 |
| 3 | 12/15/03 | Update ratchet feed changes for stones and brushes |
| 4 | 7/1/11 | Update honing brushes |
| | | |

**View**

**Ratchet Feed & Index Plate**

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 7 |

## Honing Operations Guide

EHU-512 Stones (**Ratchet Feed Set to 1**) **(Block must be at room temperature before honing)**

1 Insert hone head into cylinder and rotate feed handle to the left while shaking the hone head until a slight resistance is felt.
2 Adjust the feed dial to a point where it will not shut off the hone over fifteen strokes
3 Set mode switch to timed mode and set controller to 15 seconds (15 seconds = 15 strokes)
4 Start the hone and adjust the load to a minimum of 15 units, but not to exceed 20 units load during honing.
Apply no more than 15 strokes per cylinder at a time. (4 strokes minimum during final sizing).
Switch stone positions in the hone head between each cylinder.
Do not dwell machine when cylinder is within 0.01mm of target size.

Note 1: <u>During final sizing, if less than 15 strokes are desired, set timer to desired seconds or operate in zero shut-off mode and never dwell machine or run less than 4 strokes / cylinder.</u>

5 Follow recommended honing sequence (1,5,4,-3,2,6) do not hone adjacent cylinders
6 Size cylinders, 15 strokes / cylinder maximum, switching stone positions in hone head between each cylinder. Do not chase taper (dwell machine) when cylinder size is within 0.01mm of target.
Stop honing with the EHU-512 stones when cylinder size is within 0.005mm of target size.
Allow block to cool for fifteen minutes to confirm final size before brush honing.

OHT3G-096-1 Plateau Honing Tool (**Ratchet Feed Set to 4**)

1 Insert hone head into cylinder and rotate feed handle to the left while shaking the hone head until a slight resistance is felt.
2 Adjust feed dial so it will not shut the machine off before the control panel timer.
3 Set mode switch to timed mode and set controller to 45 seconds.
4 Start honer and increase unit load to 20 units and allow to run until system shuts off.

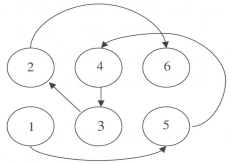
Note:2 Proper ratchet feed setting is required to establish desired cylinder surface parameters using the OHT3G-096-1 Plateau Hone Tool. After setting the initial load, the ratchet feed system will increase the load during the remaining time. <u>Operaters should not release load during this operation.</u>

### Description of Operation

Use LP8X-55 Chlorine free fluid set at 7L/min. flow rate. Use dual canister filtration system with honing mats CV-1100. Change filters, fluid, and mats every 15 hours of operation.

See Section 2 Sheets 10 and 11 for honer calibration and maintenance requirements.

Honing Sequence




Note: When honing first run blocks, stroke limitations due not apply until cylinder size is within 0.0254mm (0.001in) of target size.

### Specification

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/7/98 | |
| 2 | 12/15/03 | Update honing information according to Surveillance Panel direction 12/15/03 |
| 3 | 6/22/06 | Update honing information according to Surveillance Panel direction 6/6/06 |
| 4 | 7/1/11 | Addressed typos, deleted note 1 and renumberd notes 2 and 3 and clarified step 4 |
| | | |

### View

**Fluid and Operations Guide**

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 8 |

## Cylinder Sizing Specifications

| | Metric mm | Inch |
|---|---|---|
| First Run Target Bore Size | 96.52 | 3.8000 |
| Hone with EHU-512 @ 15 units load to | 96.515 | 3.7998 |
| Hone with C30-PHT-731 @ 20 units load for 45 sec. | 96.52 | 3.8000 |
| Second run Target Bore Size | 96.54 | 3.8008 |
| Hone with EHU-512 @ 15 units load to | 96.535 | 3.8006 |
| Hone with C30-PHT-731 @ 20 units load for 45 sec. | 96.54 | 3.8008 |
| Third Run Target Bore Size | 96.56 | 3.8016 |
| Hone with EHU-512 @ 15 units load to | 96.555 | 3.8014 |
| Hone with C30-PHT-731 @ 20 units load for 45 sec. | 96.56 | 3.8016 |
| Fourth Run Target Bore Size | 96.58 | 3.8024 |
| Hone with EHU-512 @ 15 units load to | 96.575 | 3.8022 |
| Hone with C30-PHT-731 @ 20 units load for 45 sec. | 96.58 | 3.8024 |
| Fifth Run Target Bore Size | 96.60 | 3.8031 |
| Hone with EHU-512 @ 15 units load to | 96.595 | 3.8030 |
| Hone with C30-PHT-731 @ 20 units load for 45 sec. | 96.60 | 3.8031 |
| Sixth Run Target Bore Size | 96.62 | 3.8039 |
| Hone with EHU-512 @ 15 units load to | 96.615 | 3.8037 |
| Hone with C30-PHT-731 @ 20 units load for 45 sec. | 96.62 | 3.8039 |

**Intent is to have finished cylinders within +/- 0.005mm (0.0002in.) of target size**

**Do not chase taper when cylinder size is within 0.01mm (0.0004in.) of target size**

**Maximum allowable taper = 0.0254mm (0.001in.)**

**Description of Operation**

**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/8/98 | Cylinder sizing chart |
| 2 | 12/15/03 | Revised target load values, added target sizing and taper information |
| | | |
| | | |
| | | |

**View**

**Cylinder Size**

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 9 |

## Honer Calibration

All CV-616 hones must be verified on-site by a qualified Sunnen Technician using the Hydraulic Pump and Reservoir Dynamometer. All CV-616 hones should be maintained according to the attached lubrication schedule each time the fluid and filters are changed.

Contact the Test Sponsor, ASTM Test Monitoring Center, Surveillance Panel Chairman, or Operations and Hardware Subpanel Leader for information on Sunnen calibration requirements.


**Description of Operation**

**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/1/98 | Hone-10 |
| 2 | 12/15/03 | Update honer calibration information |
| 3 | 2/22/10 | Changed "All CV-616 honers must be calibrated" to "All CV-616 hones must be verified" |
| | | |
| | | |

**View**

**Honer Calibration**

## Lubrication Point Table

| | | | |
|---|---|---|---|
| 1 | Connecting Rod Needle Bearings | #2 Grease | 2 Pumps |
| 2 | Stroke Rocker Arm (two points) | #2 Grease | 2 Pumps |
| 3 | Lower Drive Arm to Carriage Connecting Strap Bearing | #2 Grease | 2 Pumps |
| 4 | Upper Drive Arm to Carriage Connecting Strap Bearing | #2 Grease | Remove plug from bolt and fitting. 2 pumps, and replace plug. |
| 5 | Upper Rod-feed Universal Joint | SAE 20 Oil | Coat Universal |
| 6 | One Way Roller on Solenoid Energizer Switch | SAE 20 Oil | 1 Sqirt |
| 7 | Electrical Limit Shaft Bearings | SAE 20 Oil | 1 Sqirt |
| 8 | Solenoid Plunger Bushing | SAE 20 Oil | 1 Sqirt |
| 9 | Top of Connecting Rod where the Stroke Release Pawl rides | #2 Grease | Brush on area |
| 10 | Connecting Rod Shaft | #2 Grease | Coat |
| 11 | Stroke Release Pawl Pivots (two points) | SAE 20 Oil | 1 Sqirt |
| 12 | Stroke Release Block | #2 Grease | 1 Pump |
| 13 | Gear Reducer | Gear Oil 140 | Drain and refill |
| 14 | Carriage Traverse Shaft (both ends) | #2 Grease | 2 Pumps each |
| 15 | Carriage Traverse Shaft (two points) | SAE 20 Oil | 2 Sqirts |
| 16 | Handwheel Gears (not shown) | Lubriplate Low-Temp | Remove the handwheel and repack handwheel gears. |
| 17 | Feed Pawls | SAE 20 Oil | Fill Oiler |
| 18 | Idler Arm Shafts (three points) | #2 Grease | 1 Pump each |
| 19 | Gear Reducer Pully Shaft | #2 Grease | 1 Pump |

### Description of Operation

Use LP8X-55 Chlorine free fluid set at 7 L/min. flow rate. Use dual canister filtration system with honing mats CV-1100. Change filters, fluid, and mats every 15 hours of operation.

Perform recommended lubrication as outlined in lubrication table each time the fluid and filters are changed.

See Sheet 12 for lubrication guide.

### Specification

| REV | Date | Revision History |
|---|---|---|
| 1 | 12/15/03 | New sheet, Hone maintenance |
| | | |
| | | |
| | | |
| | | |

**View:** Honer Maintenance

**Cylinder Honing** | **Sequence IIIG**

| Section | Sheet |
|---|---|
| 2 | 11 |

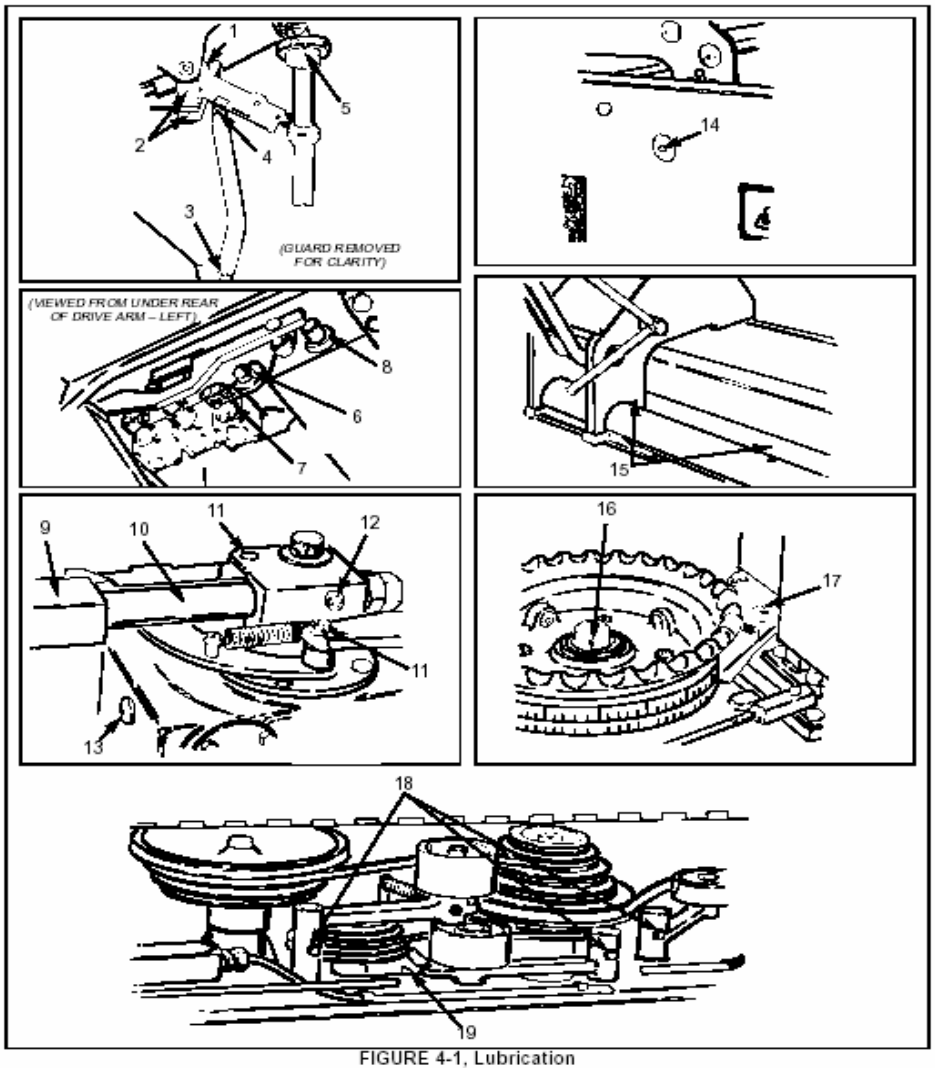



FIGURE 4-1, Lubrication

**Description of Operation**

**Specification**

**View**

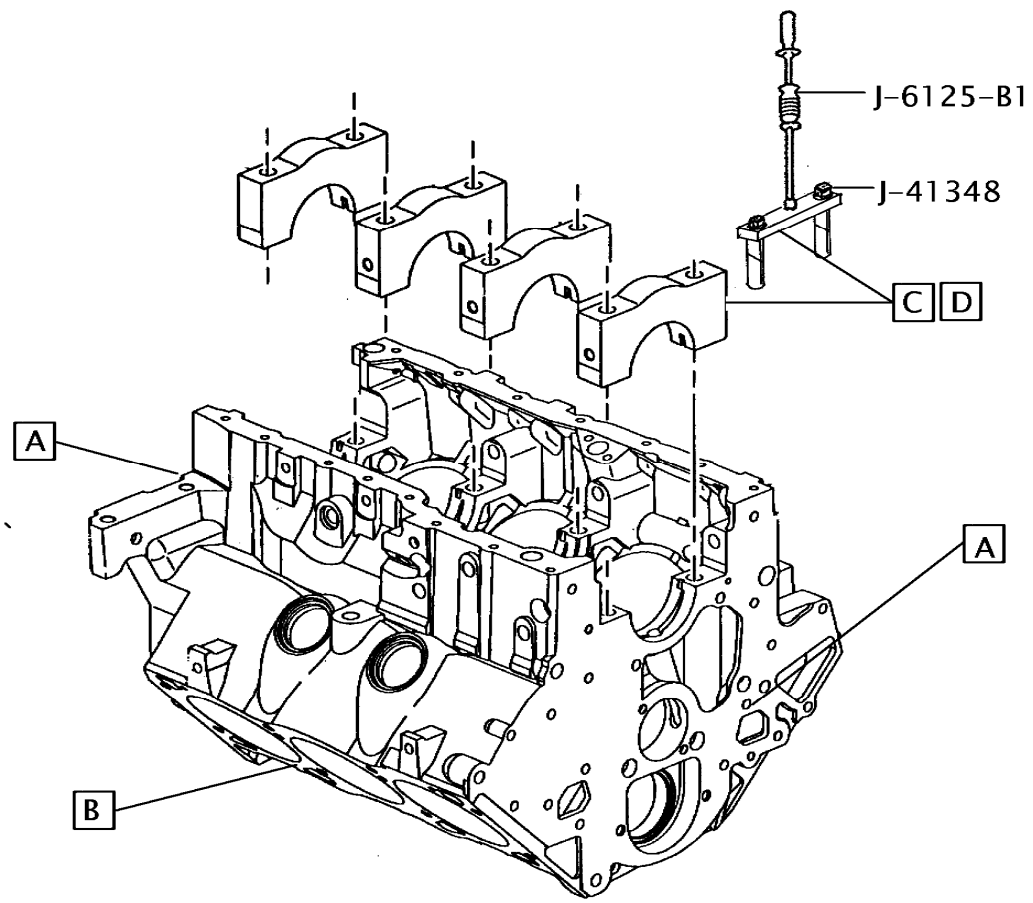
**Lubrication Guide**

| REV | Date | Revision History |
|---|---|---|
| 1 | 12/15/03 | New sheet, Lubrication points, visual guide |
| | | |
| | | |
| | | |
| | | |

| Cylinder Honing | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 2 | 12 |

# Section 3

# Short Block Assembly




| Description of Operation | |
|---|---|
| A | Remove all block off plates |
| B | Remove torque plates |
| C | Remove main cap side & main bolts. |
| D | Use Kent-Moore J-41348 main bearing cap puller & J-6125-1B slide hammer to remove main caps.<br><br>Note: Main bearing caps are press fit. Do not hammer caps back and forth during removal. Damage to the caps may result in damage to engine bearings during test. |

**Specification**

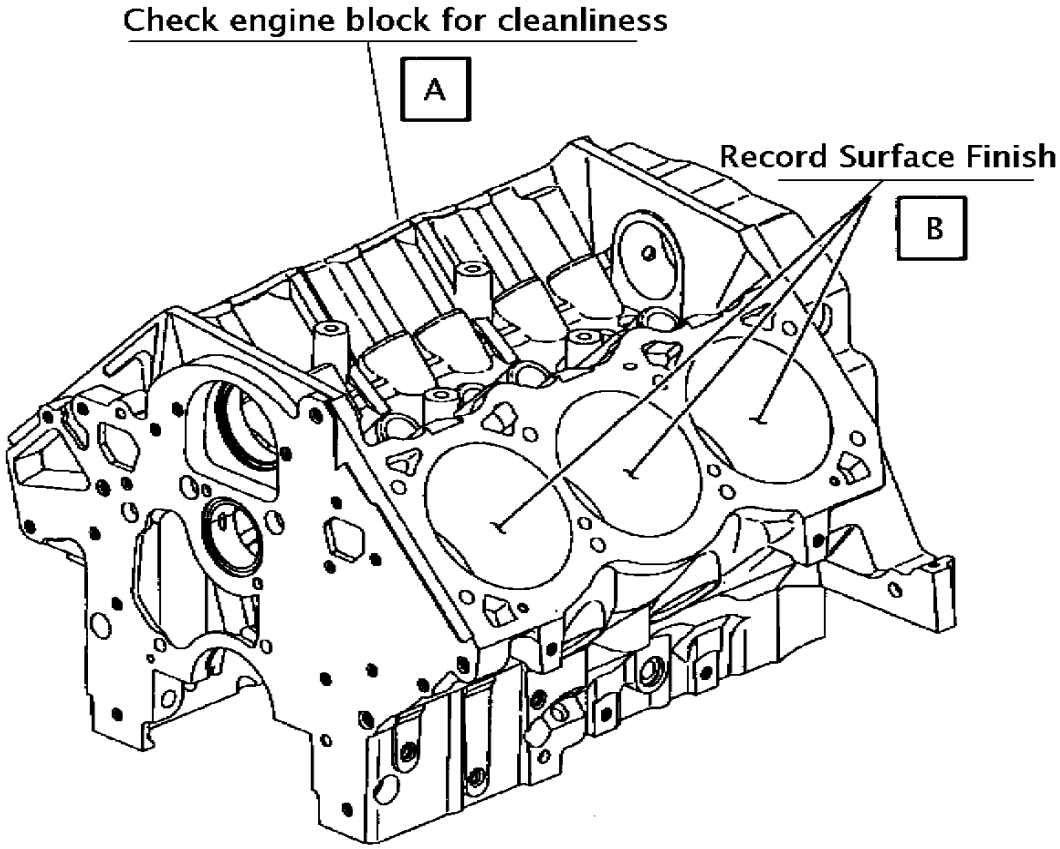
| REV | Date | Revision History |
|---|---|---|
| 1 | 01/01/98 | Block-8 |
| | | |
| | | |
| | | |
| | | |

**View**

**Short Block**

Block off plate, torque plate and main cap removal

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 1 |




| | Description of Operation |
|---|---|
| A | Check engine block, camshaft tunnel, lifter bores, oil galleries, gasket surfaces, and cylinder bores for cleanliness. |
| B | Check and record cylinder bore surface finish Ra and confirm bore diameters / run number. The optional method is to wipe the cylinder with a lint free towel and record cylinder bore surface finish Ra and confirm bore diameters at the completion of honing. Allow the block to cool for a minimum of ten minutes before taking final bore measurements. |
| C | Record appropriate data on form shown in Annex A.14 of IIIG test procedure. |

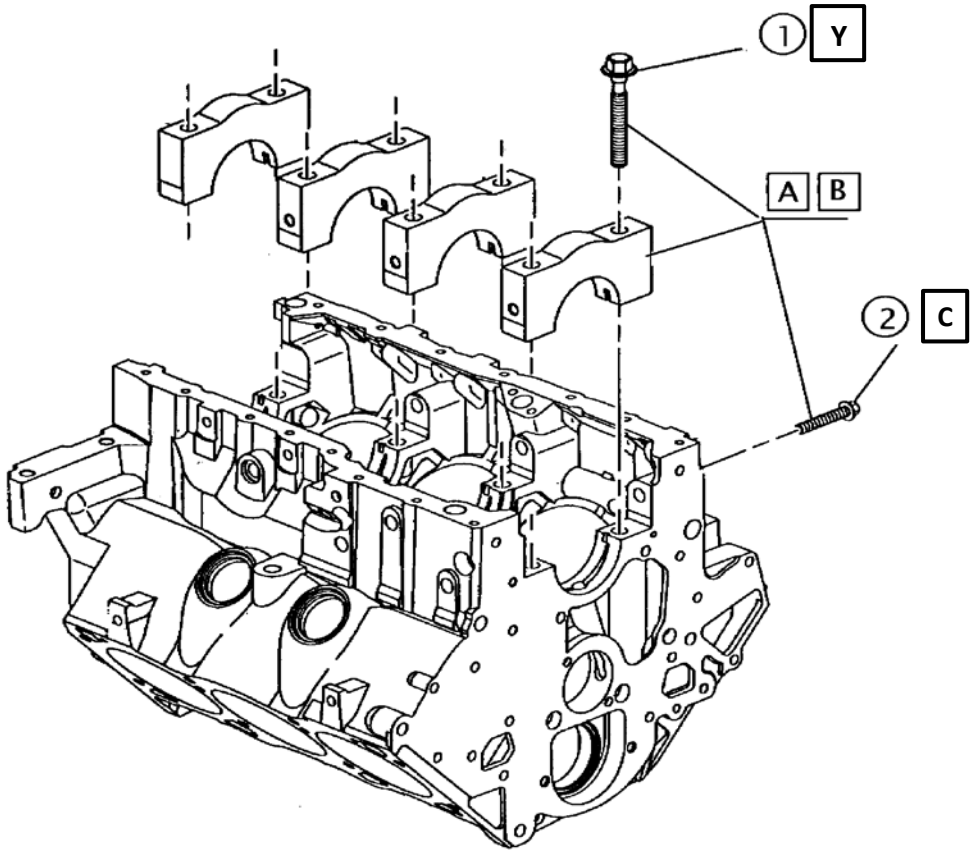
**Specification**

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/02/98 | Block-9 |
| 2 | 06/22/06 | Add item "C" |
| 3 | 07/01/11 | Revised note B |
| | | |
| | | |

**View**

Engine block cleanliness inspection and cylinder surface finish/size recording

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 2 |




**Description of Operation**

A Clean and oil all main cap fasteners (EF-411 and install main caps (use used fasteners for honing) Do not use air tools to run maincaps down

B Install main cap with fasteners as guides and draw into position with speed handle and socket in criss cross pattern

Y
1.) Tighten all main fasteners to 70 N·m to fully seat main caps
2. ) Loosen fasteners 360° counterclockwise
3.) Starting from the center oif the block and moving out torque the fasteners 20N·m then 40N·m
4.) Starting from the center of the block and moving out for each of the steps show below tighten fasteners in the following steps: 35°, another 35° then finally to another 35°.

C Install main cap side fasteners, torque to 15 N·m, then an additional 45°

Specification

1 24503056 Bolt (8) see note Y (Tighten before Z)

2 24505576 Bolt (6) see note Z (Tighten after Y)

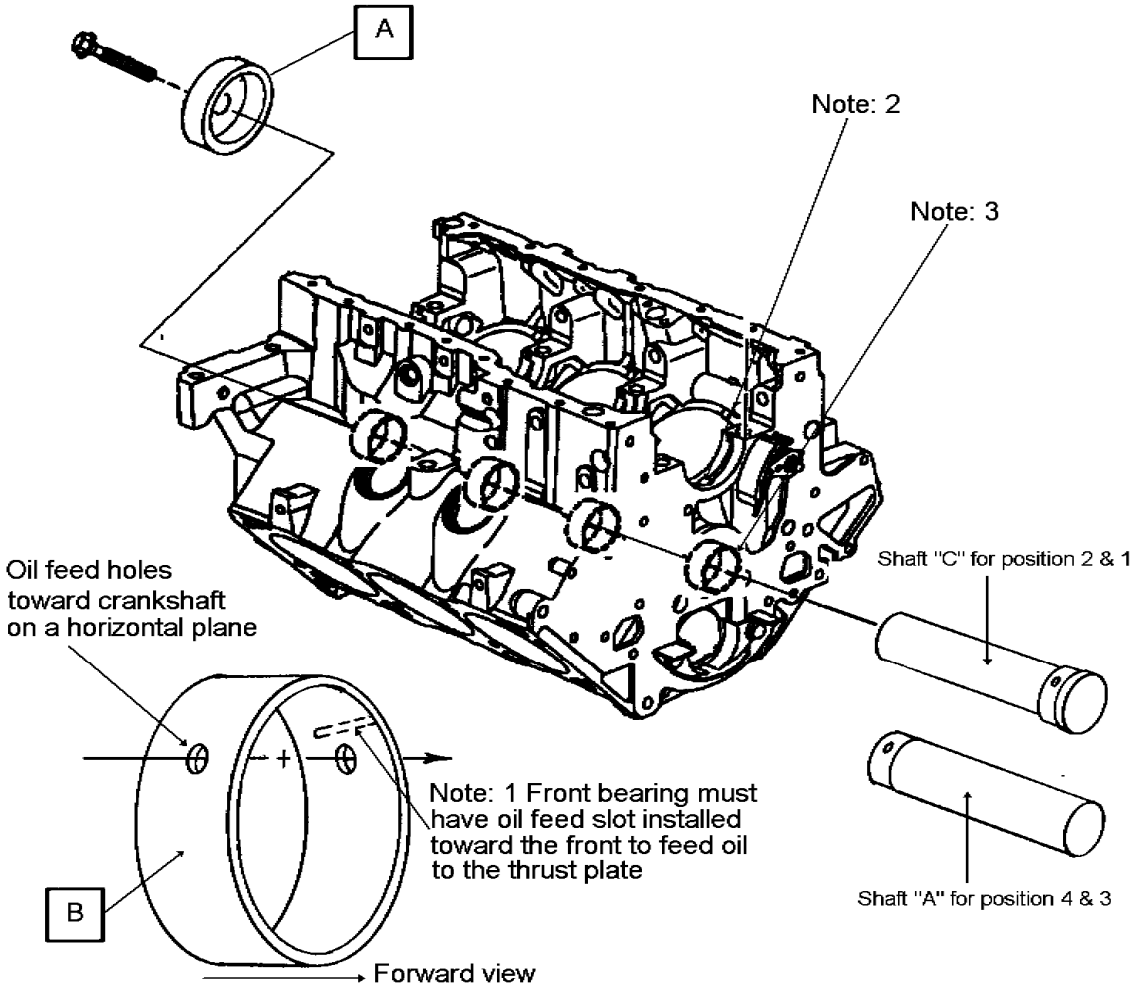
| REV | Date | Revision History |
|---|---|---|
| 1 | 7/1/11 | Added as Sheet 3 |
| 1 | 4/10/12 | Revised order of main bolt installation |
| | | |
| | | |
| | | |

**View**

**Engine Block**

Main cap installation

| New Block and Pre-Hone Prep | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 3 |



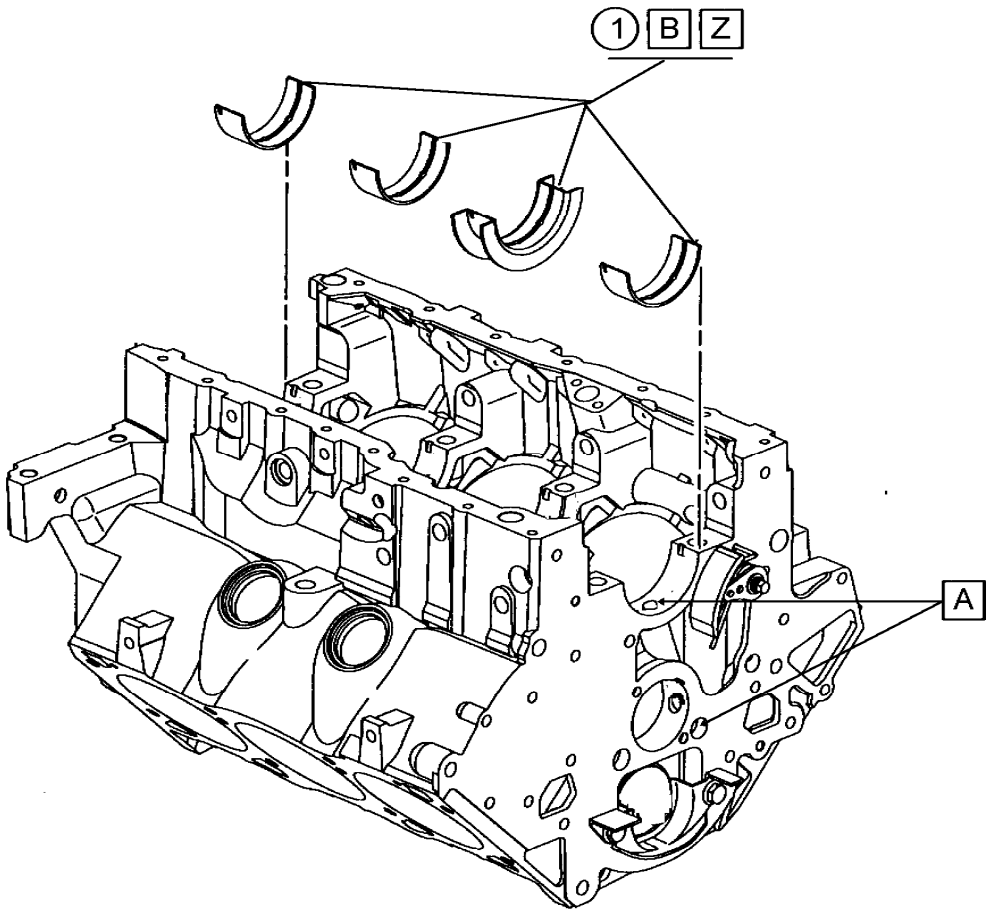

| Description of Operation | |
|---|---|
| A | Install camshaft bearings using OHT3F-019-1 camshaft bearing installation tool, Sections:<br>A for #4 rear & #3 intermediate<br>C for #2 intermediate & #1 front |
| B | Lubricate bearing bore and bearing OD with EF-411. Install bearings with the oil feed holes positioned toward the crankshaft on a horizontal plane.<br>See view "B" and Note: 1<br><br>Note: 2<br>Use a light pen to check the intersection of oil feed hole when viewed through main bearing oil gallery<br><br>Note:3<br>Check bearing bores to remove sharp edge or burrs in leading edge and/or bore before installation. See Sec.1 Sheet 2 |

| Specification | |
|---|---|
| 1 | Bearing camshaft #1 & #4<br>OHT3F-028-09 |
| 2 | Bearing camshaft #2 & #3<br>OHT3F-028-10<br>Both bearings are included in<br>OHT3F-042-2 |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/02/98 | Block-10 |
| 2 | 07/01/11 | Renumbered as sheet 4 |
| | | |
| | | |
| | | |

| View |
|---|
| **Short Block** |
| Camshaft bearing positioning and installation |

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 4 |




| Description of Operation | |
|---|---|
| A | Using compressed air, blow through each oil gallery feed from the main bearing support through the camshaft bearings to dislodge any babbit material that might have come off the camshaft bearings during installation. Use an inspection light to ensure proper alignment of the camshaft bearings and that all debris has been removed from the main and lifter oil galleries. |
| B | Check the upper main bearing bores for cleanliness and install the upper main bearings in the engine block. |
| Z | Lubricate with EF-411 |

**Specification**

1 OHT3F-042-2
OH-101 (1,3,4, Upper)
OH-102 (1,3, Lower)
OH-103 (4 Lower)
OH-104 (2 Lower)
OH-105 (2 Upper)

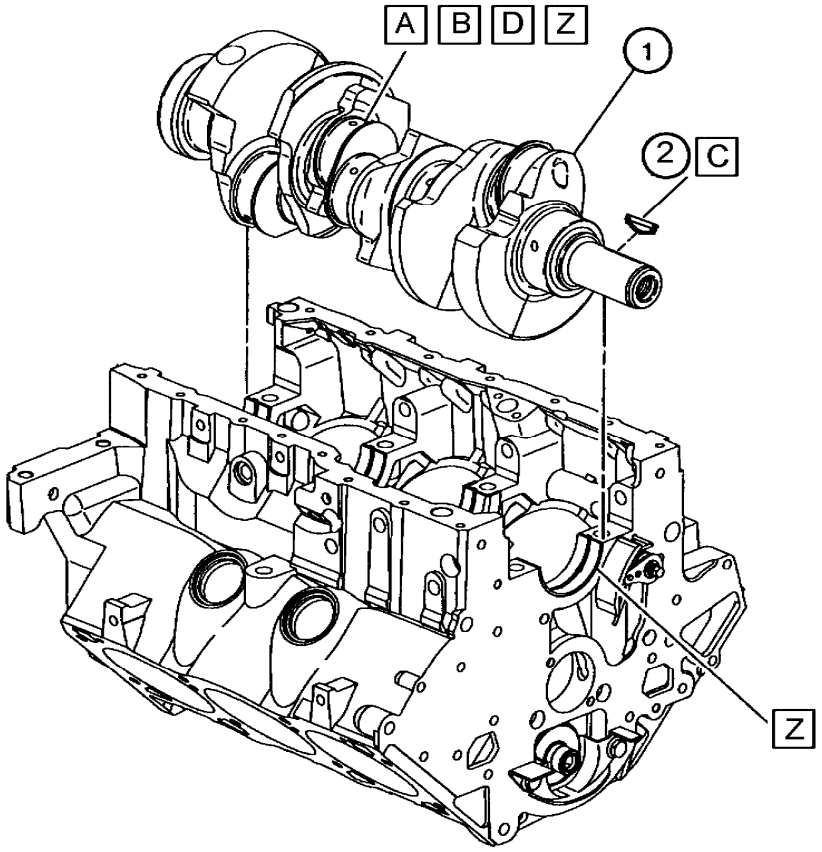
| REV | Date | Revision History |
|---|---|---|
| 1 | 01/03/98 | Block-11 |
| 2 | 07/01/11 | Renumbered as sheet 5 |
| | | |
| | | |
| | | |

**View**

**Short Block**

Upper main bearing inspection and installation

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 5 |




| Description of Operation | |
|---|---|
| A | Clean the crankshaft using an approved commercial cleaning agent followed by degreasing solvent and Mylar strip polishing cloth (use Mylar polishing cloth only if journals are nicked or oxidized, Do Not use to remove varnish). |
| B | Check journal diameters.<br>Mains 63.470 - 63.495 mm<br>Rods 57.1170 - 57.1475 mm |
| C | Install key |
| D | Install crankshaft in engine block using care to not move the upper main bearings. |
| Z | Lubricate with EF-411 |

**Specification**

1 24502168 Crankshaft
2 12563282 Key
Mylar Tape
Q135 Metalite 3µ 1½ wide roll

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/03/98 | Block-12 |
| 2 | 12/01/04 | Change to mineral spirits |
| 3 | 06/22/06 | Update text, add mylar tape part number, change key from (25534912 to 12563282) |
| 4 | 07/01/11 | Renumbered as sheet 6 |
| | | |

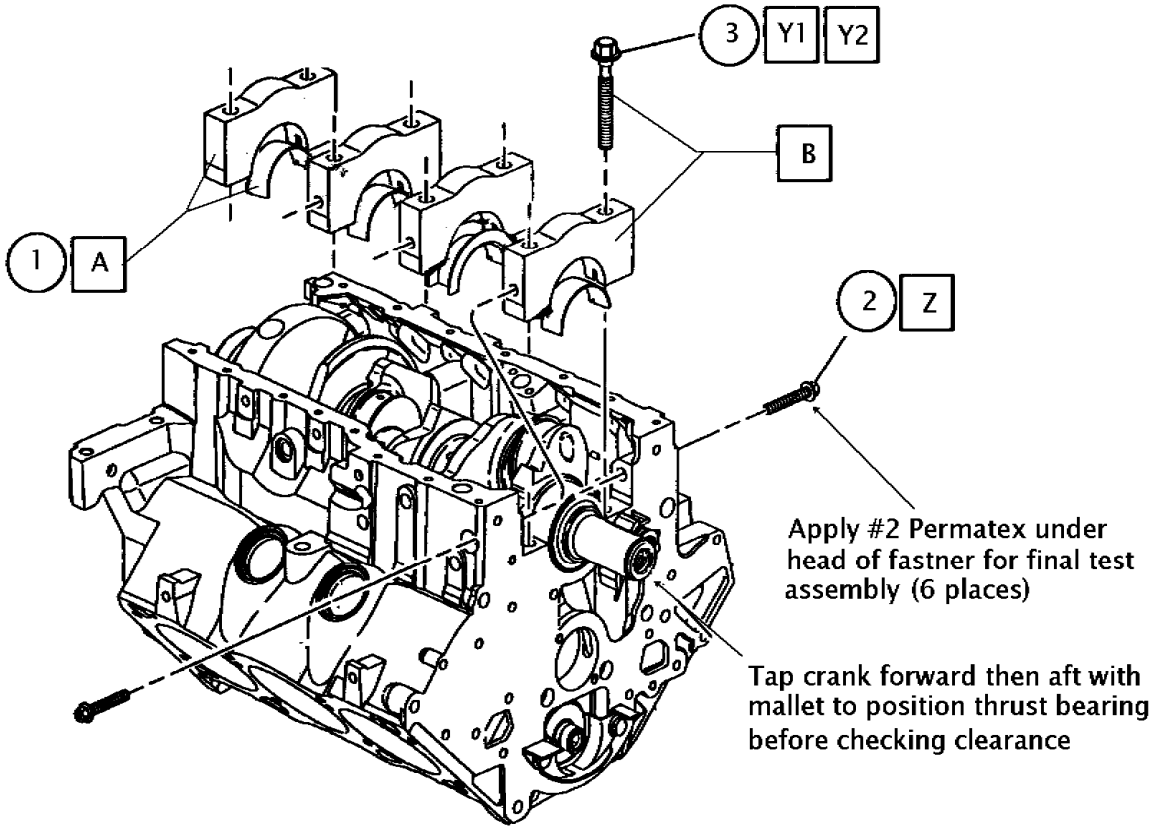
**View**

**Short Block**

Crankshaft cleaning, inspection, and installatio

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 6 |

Use new fasteners for each test. Wire wheel sealer from under side of fastener head. Do not wire wheel threads.



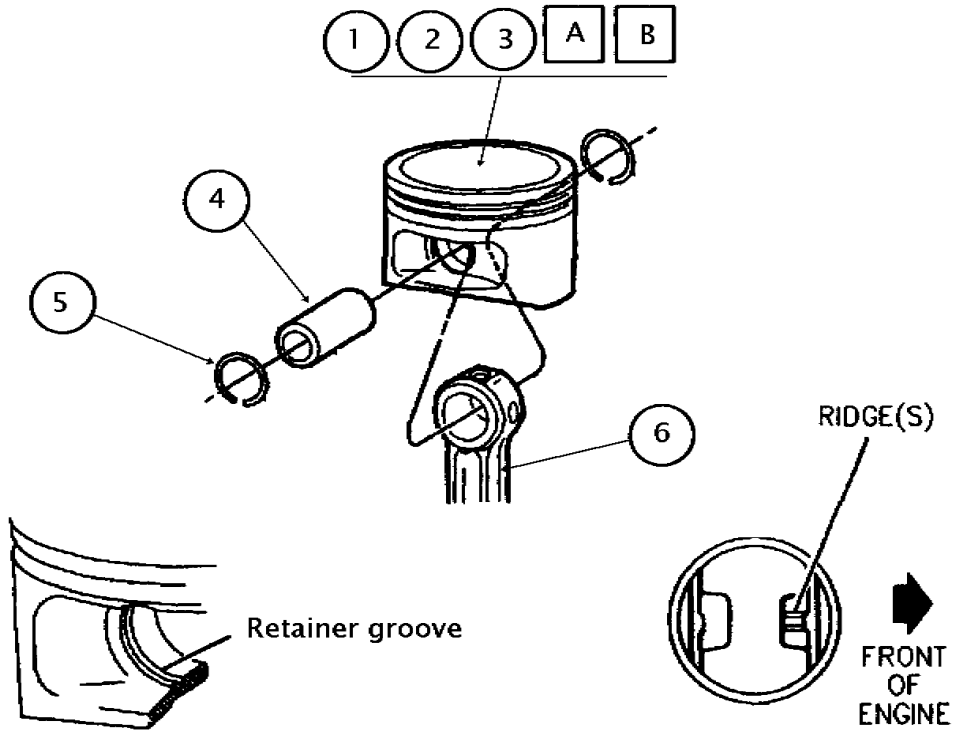

| Description of Operation | |
|---|---|
| A | Install lower main bearings into main caps. |
| B | Install main cap with new fasteners, oil all main cap fasteners (EF-411) and as guides and draw into position using very light pressure by hand with speed handle and socket in crisscross pattern. |
| C | Install main cap side bolts |
| Y1 | Tighten all main bolts to 70 Nm to fully seat main caps and then loosen the bolts 360° counterclockwise. Tap crankshaft with mallet to position thrust bearing.* |
| Y2 | Torque & Angle<br>20Nm then 40Nm + 35°+35°+35° (repeat 3 times from center out) Check crankshaft end play 0.076 - 0.279mm |
| Y3 | Torque & Angle 15Nm + 45° (See note on sealer usage) |

| Specification | |
|---|---|
| 1 | OHT3F-042-2 Bearing kit |
| 2 | 24505576 Bolt side (6)<br>See note on sealer usage |
| 3 | 24503056 Bolt main cap (8) |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/10/98 | Block-13 |
| 2 | 06/22/06 | Update view, fastener usage and prep, also clearance spec. |
| 3 | 02/22/10 | Update view, fastener usage and prep. |
| 4 | 07/01/11 | Renumbered as sheet 7 and revised note B |
| | | |

| View |
|---|
| **Short Block** |
| Lower main bearing and crankshaft final test installation |

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 7 |




| Description of Operation | |
|---|---|
| A | Confirm run number and proper grade piston selections.<br><br>Clean pistons with degreasing solvent followed by air dry and wipe with lint-free cloth.<br><br>Clean rods by soaking in degreasing solvent for two hours followed by spray with 50/50 EF411 and degreasing solvent. |
| B | Lubricate piston pin and connecting rod with EF-411. Install one piston pin retainer clip into the retaining groove. Install the con rod and piston pin. (Note: dimple on con rod is for manufacturing only) Install the second retainer clip. Make sure both retainer clips are properly seated in their grooves. |

| Specification | |
|---|---|
| 1 | OHT3F-053-1 Grade 12 test piston set |
| 2 | OHT3F-054-1 Grade 34 test piston set |
| 3 | OHT3F-055-1 Grade 56 test piston set |
| 4 | OHT3F-014-1Piston pin set |
| 5 | OHT3F-012-1 Retainer clip set |
| 6 | 12593374 Rod Powdered Metal |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/03/98 | Block-14 |
| 2 | 11/03/04 | Add part numbers for "Cast" and "Powdered Metal" Rods See "6" |
| 3 | 01/31/06 | Removed Cast Rod information |
| 4 | 06/22/06 | Update piston and rod cleaning procedure and assembly note on dimple |
| 5 | 07/01/11 | Updated Connecting Rod part number and renumbered as sheet 8 |

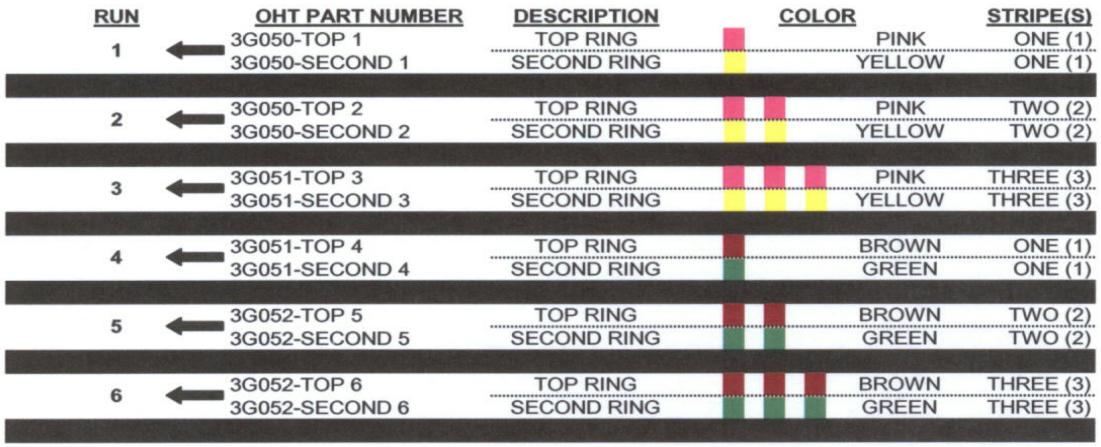
| View |
|---|
| **Piston, Pin and Connecting Rod** |
| Piston pin and Connecting Rod assembly |

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 8 |

## Sequence IIIG
## Piston, Cylinder Bore, & Ring Gap Information

| Piston Grade / Run | Target Bore Size | Master Ring Gage | Target Ring Gap | Piston Size |
|---|---|---|---|---|
| 12 / 1 | 96.52 | 96.53 | Top 0.635 2nd 1.067 | 96.482 - 96.497 |
| 12 / 2 | 96.54 | 96.53 | Top 0.635 2nd 1.067 | 96.482 - 96.497 |
| 34 / 3 | 96.56 | 96.57 | Top 0.635 2nd 1.067 | 96.522 - 96.537 |
| 34 / 4 | 96.58 | 96.57 | Top 0.635 2nd 1.067 | 96.522 - 96.537 |
| 56 / 5 | 96.60 | 96.61 | Top 0.635 2nd 1.067 | 96.562 - 96.577 |
| 56 / 6 | 96.62 | 96.61 | Top 0.635 2nd 1.067 | 96.562 - 96.577 |

**All piston ring gaps to be ± 0.051mm**
**As measured in cylinder bore using Starrett Taper Gage #270**




**NOTE: PAINT IDENTIFICATION MUST BE REMOVED FROM RING PRIOR TO GAP MEASUREMENT**

### Description of Operation

Confirm correct ring grade and gaps for the engine run / piston grade. No piston ring gap adjustments are allowed.

To check ring gap, use Starrett Taper Gage #270 and measure the gap in the finnished cylinder bore

### Specification

| | |
|---|---|
| 1 | OHT3G-050-RN1-1 |
| 2 | OHT3G-050-RN2-1 |
| 3 | OHT3G-051-RN3-1 |
| 4 | OHT3G-051-RN4-1 |
| 5 | OHT3G-052-RN5-1 |
| 6 | OHT3G-052-RN6-1 |

| REV | Date | Revision History |
|---|---|---|
| 1 | 06/18/02 | IIIG Block-15 |
| 2 | 4/28/03 | Update color coding |
| 3 | 09/10/03 | Correct top ring gap typo from 0.064 to 0.635mm |
| 4 | 06/22/06 | Expand drawings and add section 3 sheet 8A for additional information |
| 5 | 02/22/10 | Deleted OHT ring gages and allowed measurement in cylinder block |
| 6 | 04/10/12 | Revised target bore size for 12/2 piston and updated ring part numbers |

### View
**Piston Ring**

Piston ring installation and clearance

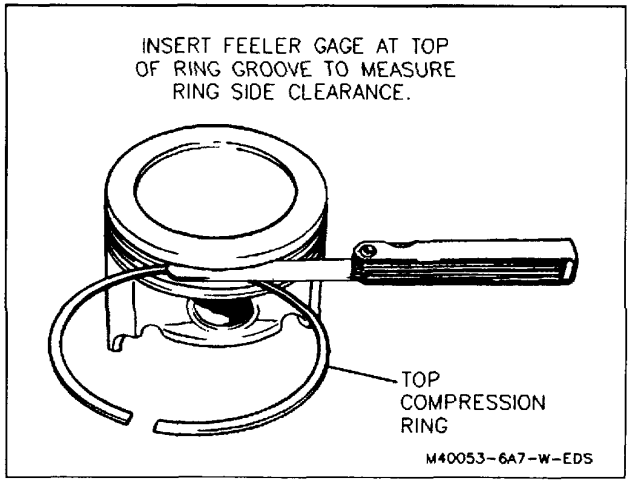



Figure 69 - Measuring Piston Ring Side Clearance

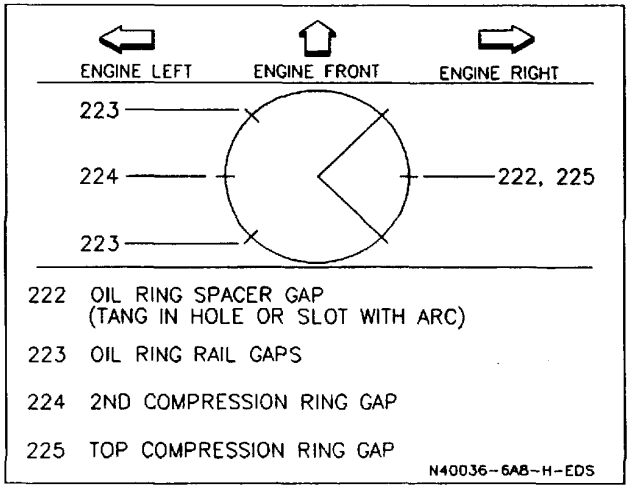
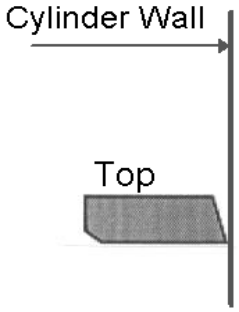



Figure 64 - Piston Ring Gap Location




Note: BC-6 second ring does not have an identification mark for top. Second ring must be installed with the sharp edge of the taper face down toward the bottom of the piston as shown in view.

**Description of Operation**

Check for proper ring side clearance.
Top & 2nd. 0.033 - 0.079mm
Oil control 0.023 - 0.201mm

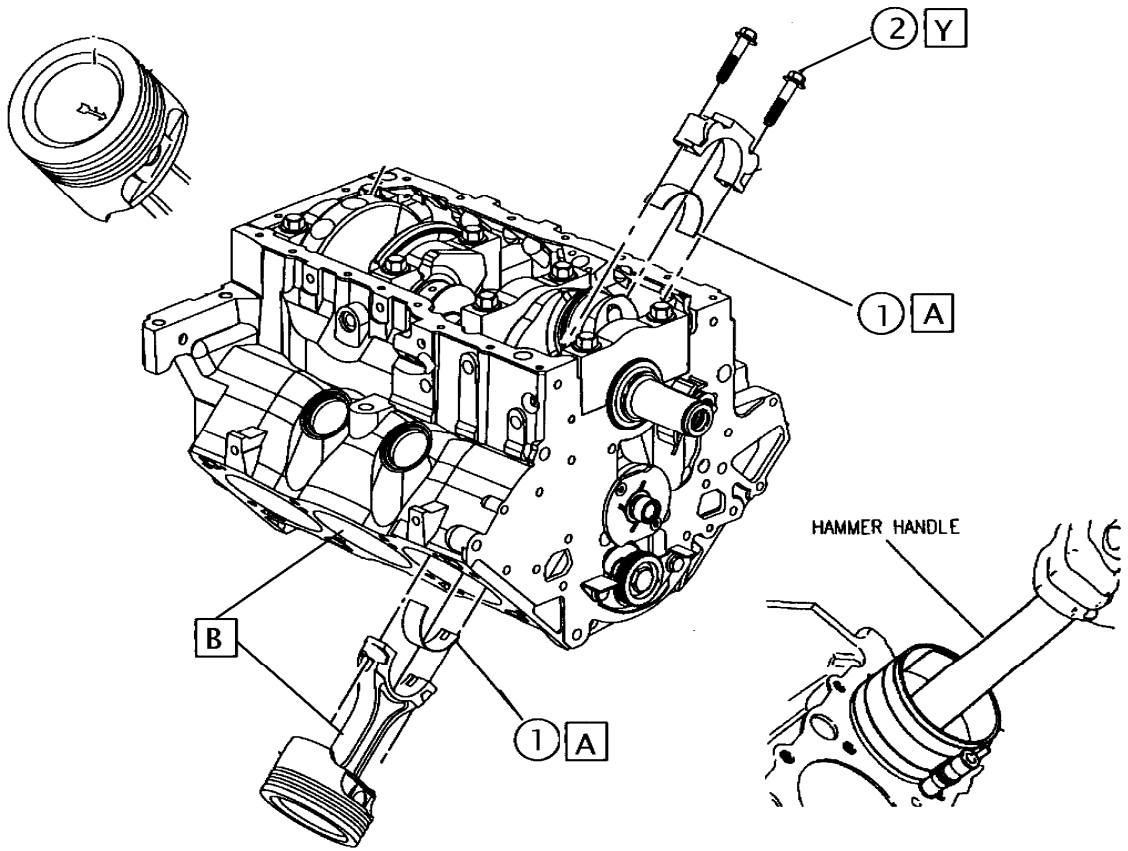
Position rings on piston according to ring gap stagger chart. Orientation of second ring must be taper down as shown in view. Although orientation of oil control ring rails and expander are unidirectional, install the oil ring expanders with the gaps facing up.

Lubricate assembly with EF-411

**Specification**

| REV | Date | Revision History | View |
|---|---|---|---|
| 1 | 6/22/06 | Ring orientation | |
| 2 | 7/1/11 | Removed BC-6 from piston orientation and added orientation for oil ring expander | Piston ring installation, orientation, and clearance information |
| | | Renumbered as 9A | |
| | | | |
| | | | |

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 9A |



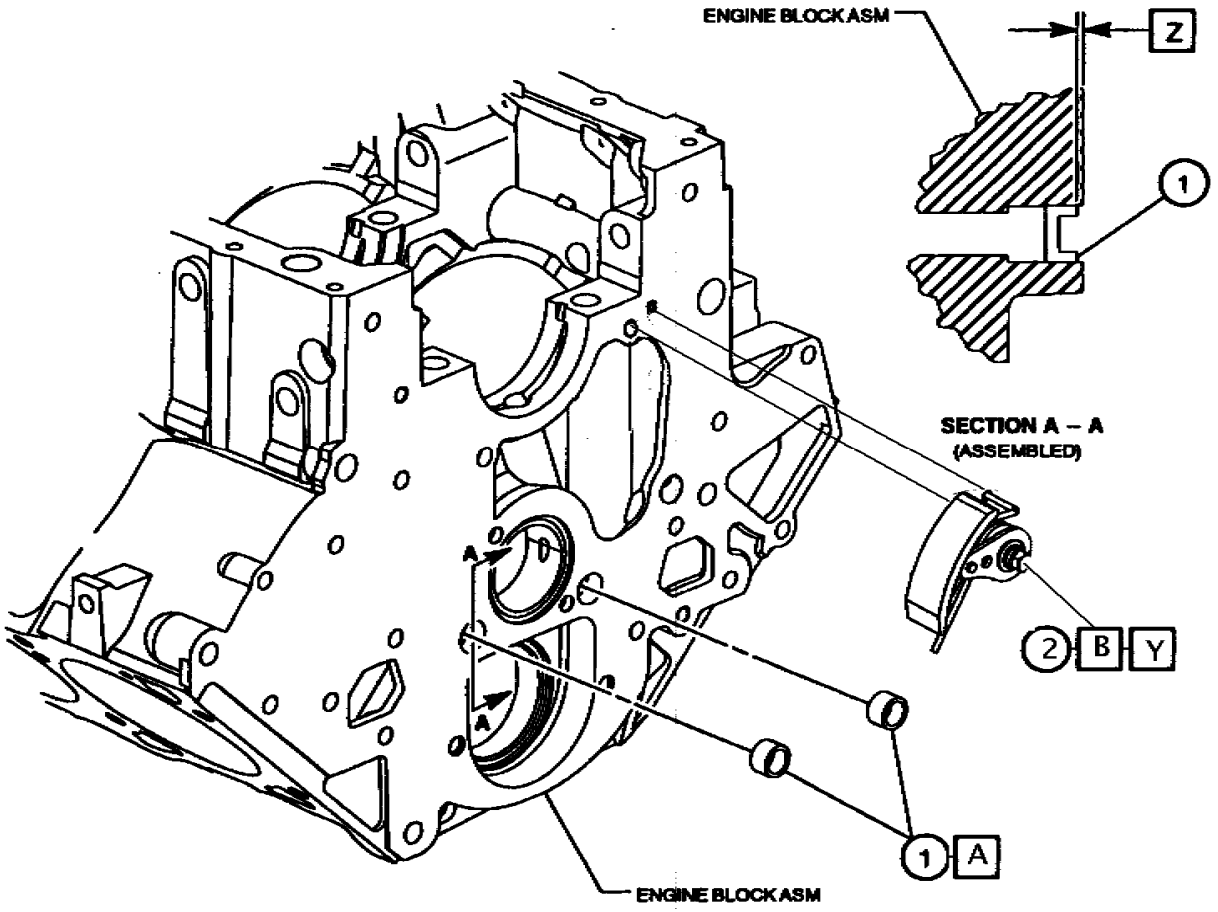

| Description of Operation | |
|---|---|
| A | Install connecting rod bearings and lubricate assembly with EF-411. |
| B | Clean cylinder bores and lubricate with EF-411. Install piston assembly using suitable piston ring compressor and soft ended installation tool. |
| Y | Powdered Metal Rod (12593374)<br>Torque & Angle<br>20Nm + 70° |
| C | Check connecting rod side clearance<br>0.102 - 0.508mm |

| Specification | |
|---|---|
| 1 | OHT3F-042-2 Con rod bearing<br>OH-106 |
| 2 | 11610158 Bolt PM Rod |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/3/98 | Block-16 |
| 2 | 11/3/04 | Add torque values for "Cast Rod" and "Powdered Metal Rod" See "Y" for details |
| 3 | 1/31/06 | Removed Cast Rod information |
| 4 | 3/30/07 | Update rod fastener torque from 20Nm + 75° to 20Nm + 70° |
| 5 | 7/1/11 | Updated Connecting Rod and connecting rod bolt part number |

| View |
|---|
| **Short Block** |
| Piston and rod assembly installation |

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 10 |



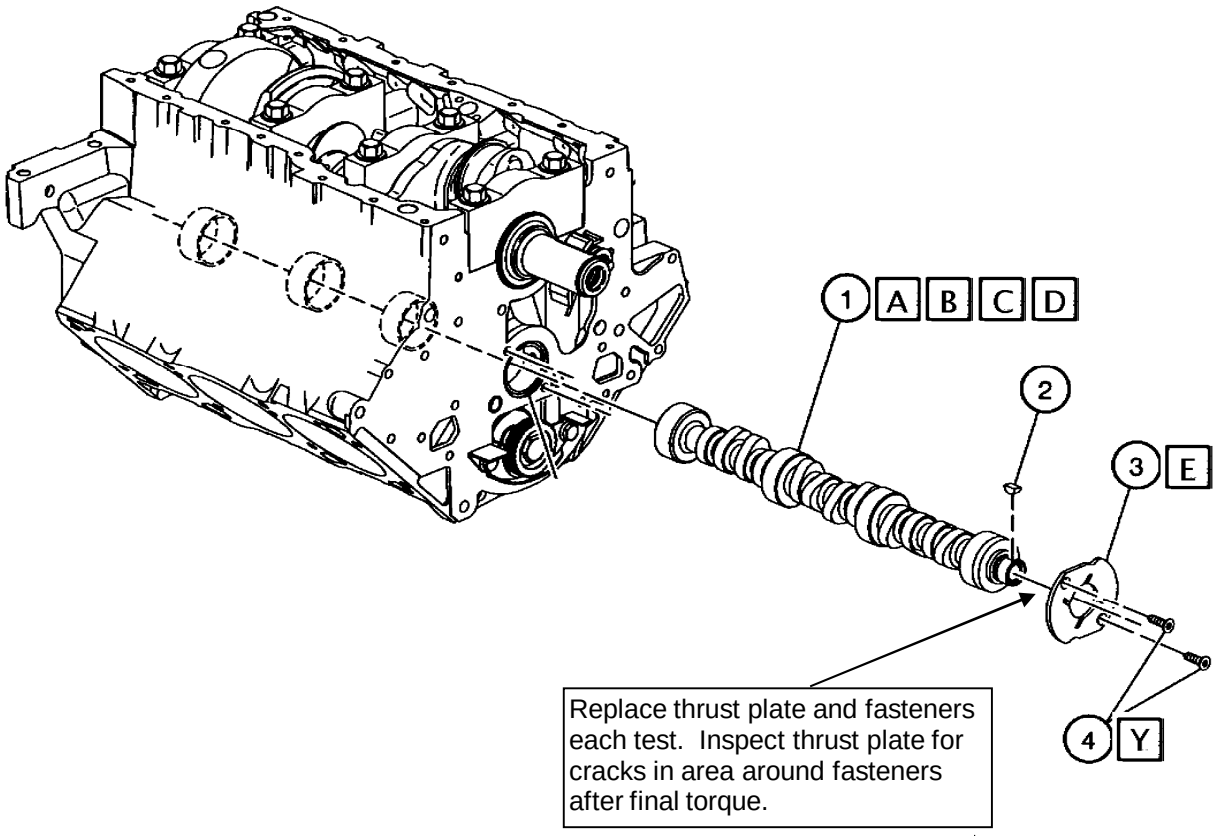

| Description of Operation | |
|---|---|
| A | Install oil gallery plugs, see cross section A - A. |
| B | Install damper assembly |
| Y | Torque 22Nm |
| Z | Locate cup plug 1.5 +/- 0.75mm below front face of block. |

| Specification | |
|---|---|
| 1 | 3835577 Plug, oil gallery |
| 2 | 24503893 Damper assembly |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/3/98 | Block-17 |
| 2 | 7/1/11 | Renumbered as sheet 11 |
| | | |
| | | |
| | | |

| View |
|---|
| **Short Block** |
| Oil gallery plugs and timing chain damper |

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 11 |




| Description of Operation | |
|---|---|
| A | Check and de-burr if necessary, the front thrust surface of the camshaft. |
| B | Clean camshaft with degreasing solvent and very clean shop towel. Note: make sure all grinding residue is removed before continuing. |
| C | Make pre-test measurements at the rear side of each lobe and record to the nearest 0.001mm. |
| D | Lubricate the camshaft journals and lobes with test oil and install.<br><br>Lubricate thrust plate with test oil and install |
| Y | Torque 15Nm |

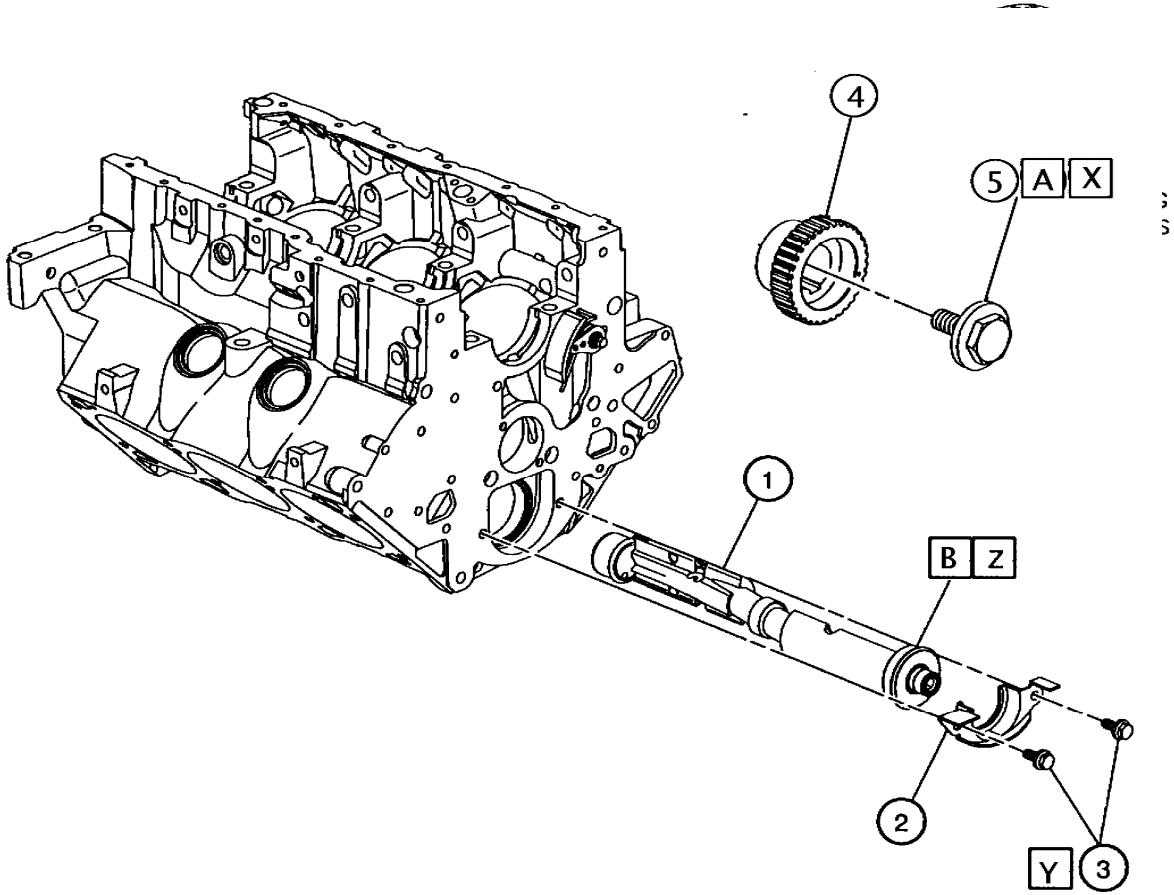
| Specification | |
|---|---|
| 1 | OHT3F-008-8 Phosphated Camshaft **(For Use in IIIG Testing Only)** |
| 2 | 24500618 Key (Replace each test) |
| 3 | OHT3F-011-2 Thrust plate (0.152") |
| 4 | 25519242 Bolt (Replae each test) |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/13/98 | Block-18 |
| 2 | 12/1/04 | Change to mineral spirits |
| 3 | 6/22/06 | Update usage information |
| 4 | 3/30/07 | Update "D" pre-test lubrication directions |
| 5 | 7/1/11 | Update "D" pre-test lubrication directions, renumbered as sheet 12 |

**Short Block**

Camshaft cleaning, measurement, and installation

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 12 |




| Description of Operation | |
|---|---|
| A | Secure balance shaft in a smooth jawed vice and install drive gear and bolt. |
| B | Inspect balance shaft and roller bearing for cleanliness and install. |
| X | Torque & Angle 22Nm + 70° |
| Y | Torque 30Nm |
| Z | Lubricate with EF-411 |

**Specification**

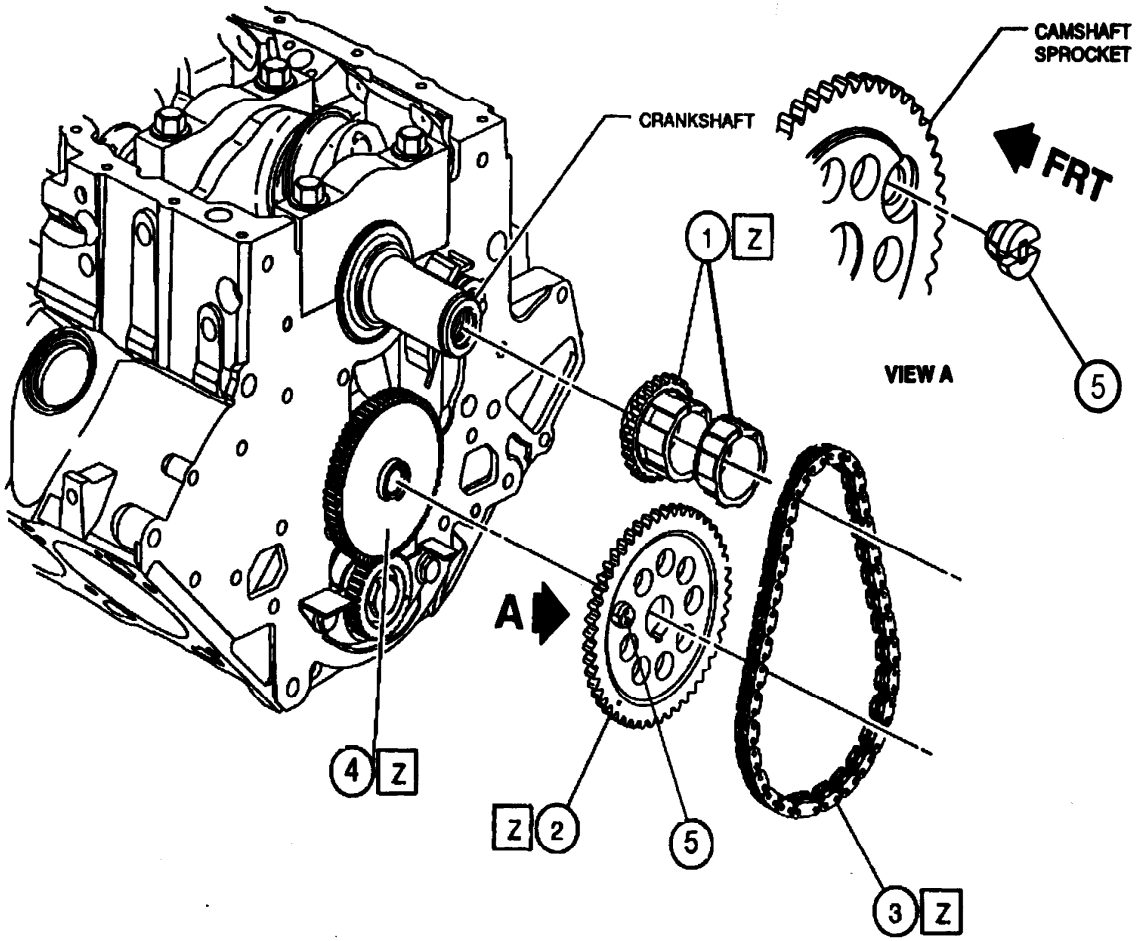
| | |
|---|---|
| 1 | 24506557 Shaft Assembly |
| 2 | 24500374 Retainer |
| 3 | 24500055 Bolt |
| 4 | 24503524 Gear |
| 5 | 24501367 Bolt |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/5/98 | Block-19 |
| 2 | 6/22/06 | Add 24506557 shaft assembly part number |
| 3 | 7/1/11 | Removed balance shaft # 24503588, renumbered as sheet 13 |
| | | |
| | | |

**Short Block**

Balance shaft inspect & install

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 13 |



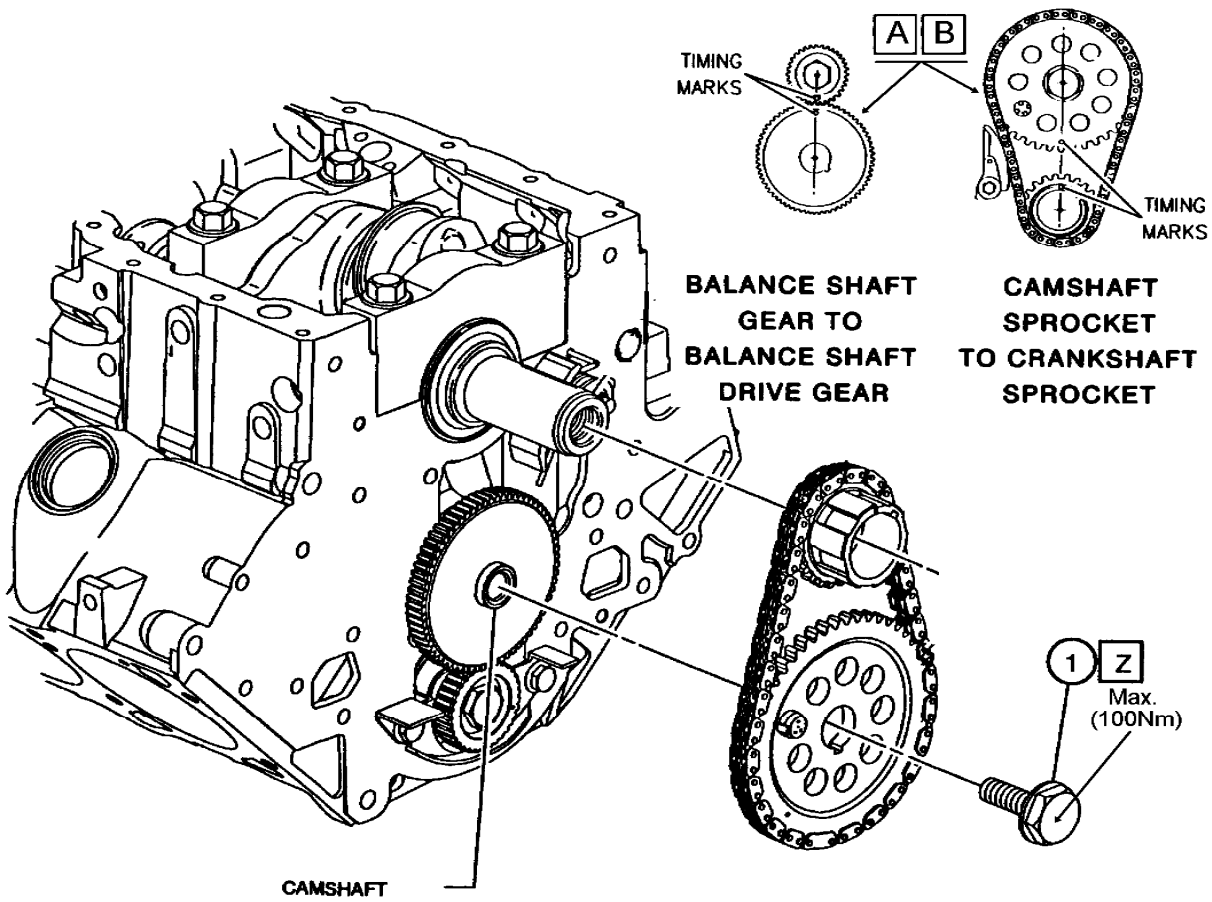

| Description of Operation | |
|---|---|
| | Timing gear set. See part number information. |
| A | Install magnet See view "A" |
| Z | Lubricate with EF-411 |
| | Note: Inspect balance shaft and gears and replace as necessary if damage to gear teeth and / or thrust surface is evident. |

| Specification | | |
|---|---|---|
| 1 | OHT3F-036-1 | Sprocket, 2pc. |
| 2 | 24505306 | Sprocket, camshaft |
| 3 | 24504668 | Chain |
| 4 | 24504792 | Gear |
| 5 | 10456195 | Magnet |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/5/98 | Block-20 |
| 2 | 7/1/11 | Renumbered as sheet 14 |
| | | |
| | | |
| | | |

| View |
|---|
| Short Block |
| Timing gear set |

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 14 |




| Description of Operation | |
|---|---|
| A | Lubricate all gear sets and chain with EF-411 |
| B | Align timing marks on balance drive and driven gears.<br>Align timing marks on camshaft and crankshaft sprockets. |
| Z | Torque 100Nm + 90°<br>**(Hold assembly by the crankshaft during torquing)** |

| Specification | |
|---|---|
| 1 | 24501366 Bolt, camshaft sprocket<br>**(Replace fastener each application)** |

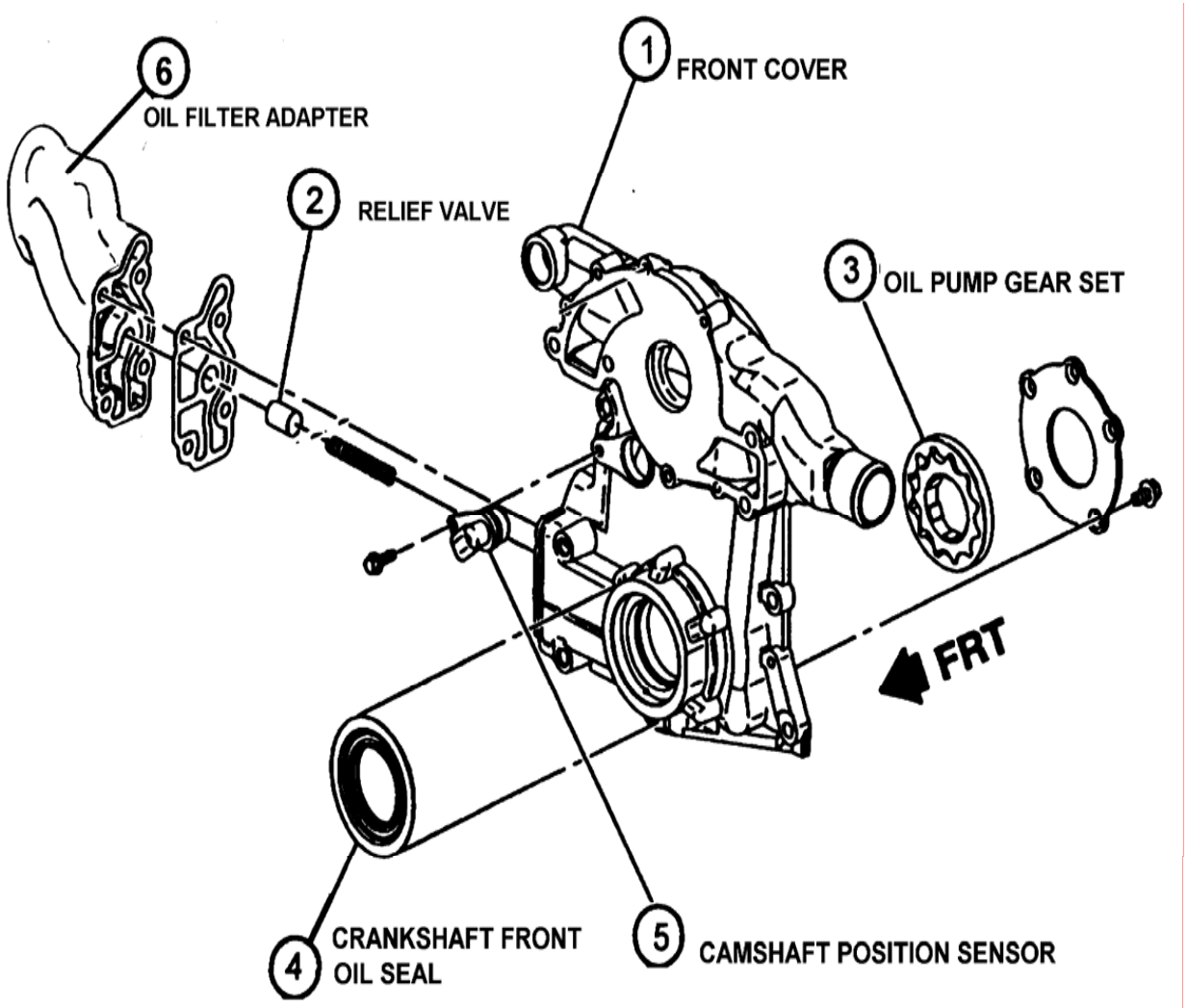
| REV | Date | Revision History |
|---|---|---|
| 1 | 1/5/98 | Block-21 |
| 2 | 7/1/11 | Renumbered as sheet 14 |
| | | |
| | | |
| | | |

| View |
|---|
| **Short Block** |
| Timing gear set alignment & torque |

| Short Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 3 | 15 |

# Section 4

# Front Cover, Rear Cover, and Sump



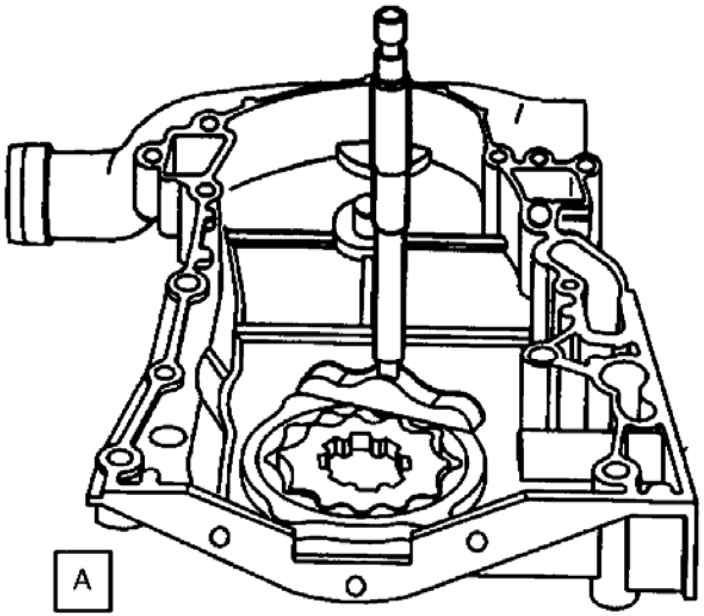

| Description of Operation |
|---|
| Assembly view |

| Specification | |
|---|---|
| 1 | OHT3F-085-1 Front Cover |
| 2 | 25530949 Valve, oil pressure relief |
| 3 | 24505433 Oil pump gear set |
| 4 | OHT3G-092-1 Seal |
| 5 | 10456148 Camshaft position sensor |
| 6 | OHT3F-080-1 Adapter, oil filter |

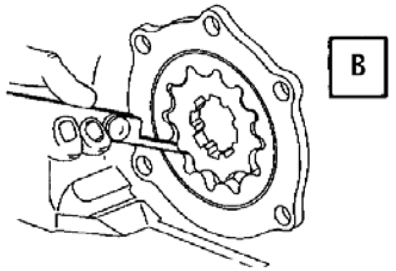
| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-22 |
| 2 | 4/28/03 | Change front cover over to OHT part number |
| 3 | 11/03/04 | Change front seal from 24504098 to OHT3G-092-1 |
| | | |
| | | |

| View |
|---|
| **Front Cover** |
| Front cover assembly view |

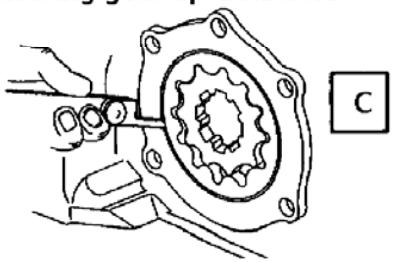
| Front Cover, Rear Cover, & Sump | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 4 | 1 |




Measuring gear end clearance drop in housing




Measuring gear tip clearance




Measuring outer gear dia. clearance

| Description of Operation | |
|---|---|
| A | Measure gear drop in housing<br>0.025 - 0.089mm |
| B | Measure gear tip clearance;<br>0.076 - 0.127mm (0.003 - 0.007in) as measured with gear teeth in mesh with opposite side. |
| C | Measure outer gear diameter clearance<br>0.025 - 0.127mm (0.001 - 0.005in) |
| | Note: Inspect front cover oil gear housing for evidence of wear from previous test. Replace after six tests or as necessary if wear is evident. |

**Specification**

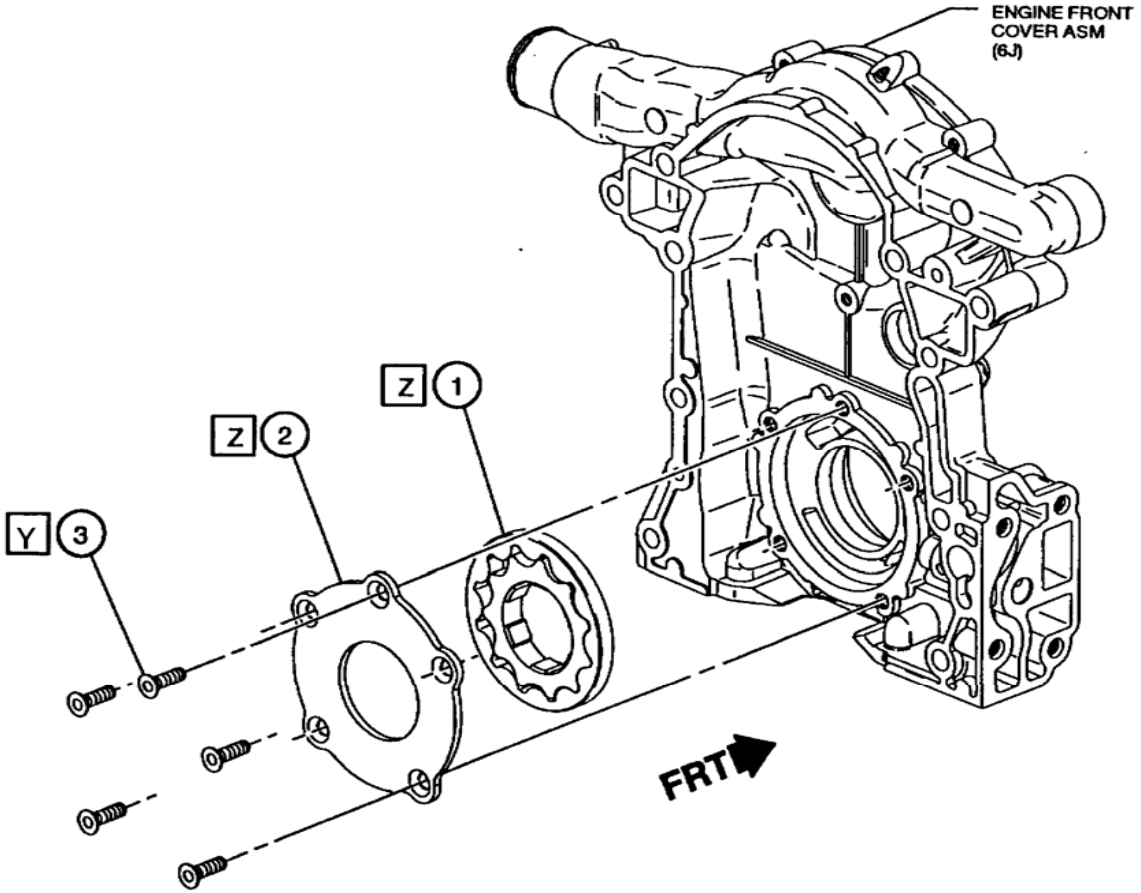
| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-23 |
| 2 | 06/22/06 | Add usage information |
| | | |
| | | |
| | | |

**View**

**Front Cover**

Oil pump gear clearance

| Front Cover, Rear Cover, & Sump | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 4 | 2 |




| Description of Operation | |
|---|---|
| Y | Torque 11Nm |
| Z | Lubricate with EF-411 |

| Specification | |
|---|---|
| 1 | 24505433 Gear set |
| 2 | 25521935 Cover, Gearotor |
| 3 | 25519242 Bolt |

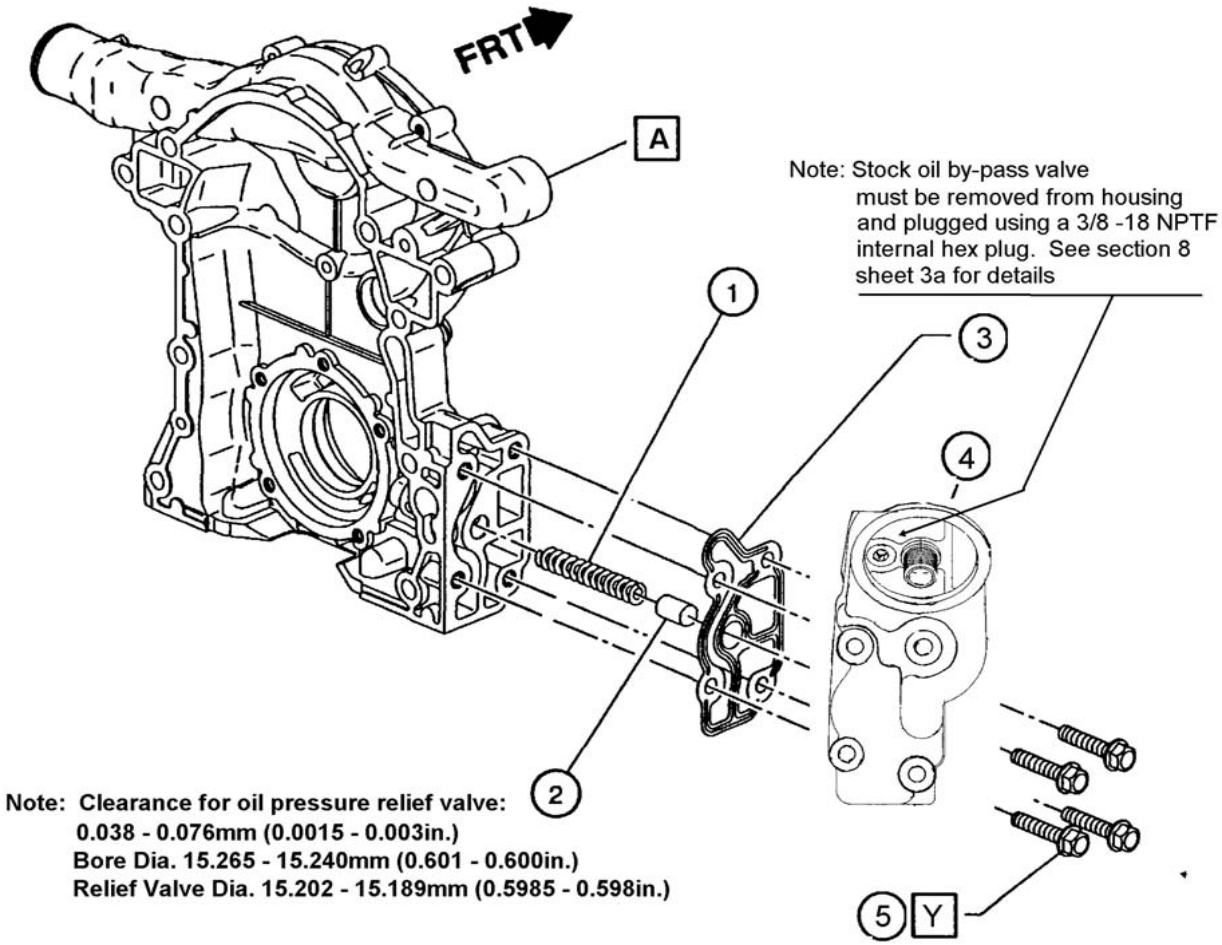
| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-24 |
| | | |
| | | |
| | | |
| | | |

| View |
|---|
| Front Cover |
| Front cover oil gear install |

# Front Cover, Rear Cover, & Sump

## Sequence IIIG

| Section | Sheet |
|---|---|
| 4 | 3 |



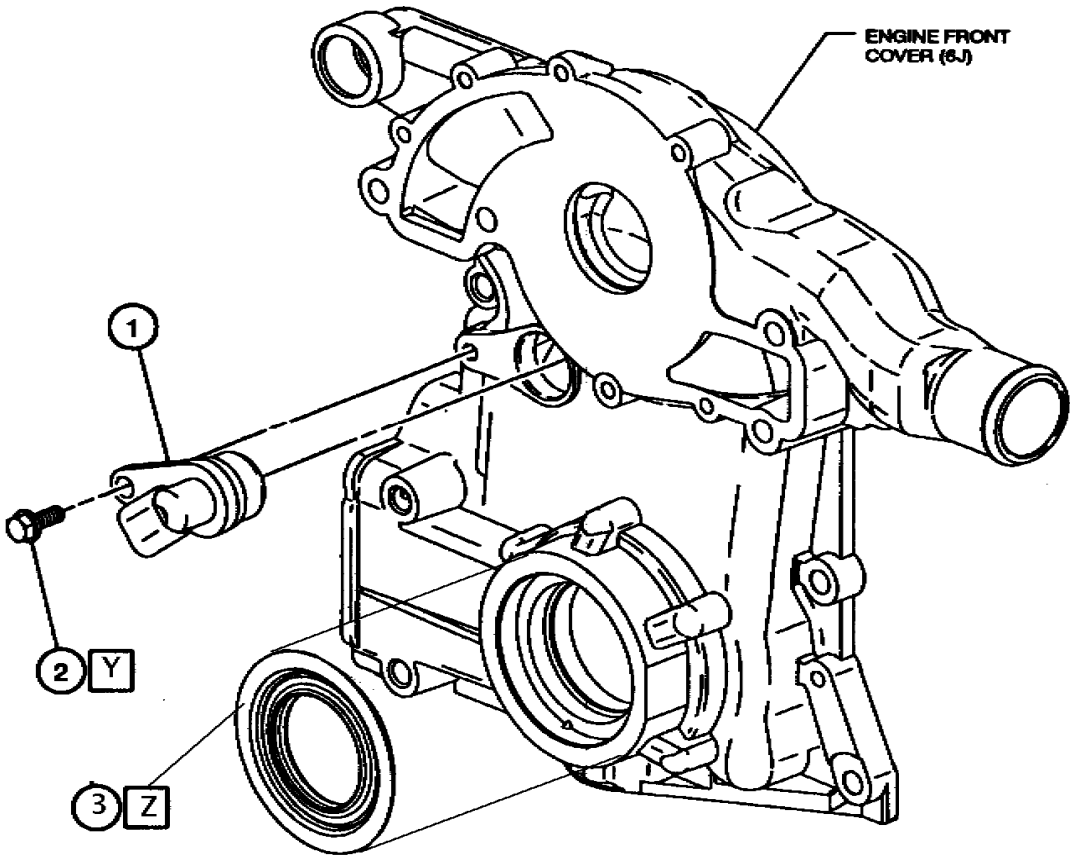

| Description of Operation | |
|---|---|
| A | Front cover oil filter adapter assembly |
| Y | Torque 30Nm<br><br>May use Permatex #2 or Perfect Seal #4 on fasteners and gasket |

| Specification | |
|---|---|
| 1 | 1262505 Spring (New each test) |
| 2 | 25530949 Valve |
| 3 | 25534742 Gasket |
| 4 | 24501300 Adapter, oil filter<br>Modified OHT3F-080-1 |
| 5 | 24504713 Bolt |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-25 |
| 2 | 06/22/06 | Update sealer usage information |
| 3 | 08/04/06 | Update spring usage, use new spring each test |
| | | |
| | | |

| View |
|---|
| **Front Cover** |
| Front cover oil filter adapter assembly |

| Front Cover, Rear Cover, & Sump | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 4 | 4 |



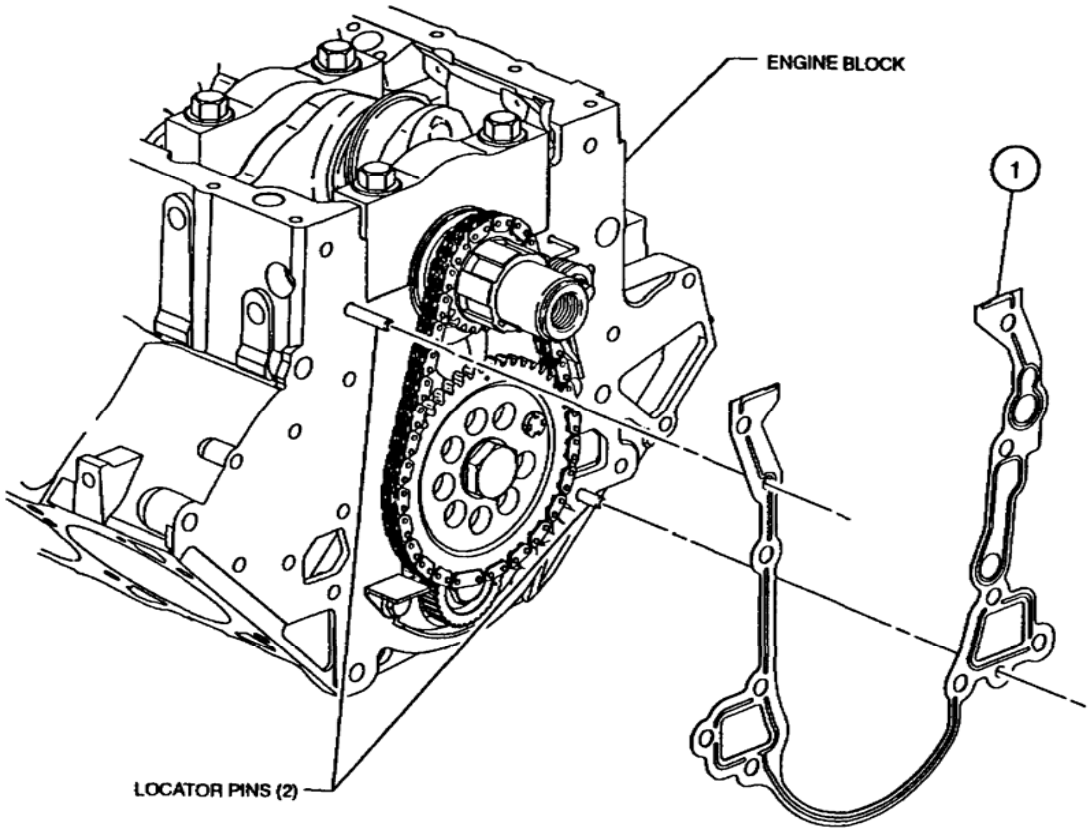

| Description of Operation | |
|---|---|
| Y | Torque 30Nm |
| Z | Use a light application of #4 Permatex or RTV, Dow Corning®3145 RTV MIL-A-46146 Adhesive/Sealant or GM, (see part number info) around the rear side of the seal where it contacts the front cover.<br>GM Silicone Sealer<br>New numbers:<br>12378577 Tube<br>12551715 Cartridges |

| Specification | |
|---|---|
| 1 | 10456148 Camshaft sensor |
| 2 | 25526395 Bolt |
| 3 | OHT3G-092-1 Seal |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-29 |
| 2 | 12/15/03 | Add approved silicone sealers |
| 3 | 11/03/04 | Change front seal part number to OHT3G-092-1 |
| 3 | 07/01/11 | Updated Sealant information |
| | | |

| View |
|---|
| **Front Cover** |
| Front cover camshaft sensor and seal install |

| Front Cover, Rear Cover, & Sump | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 4 | 5 |




**Description of Operation**

Note:
Perfect seal #4 may be used around coolant passages on gasket.

**Specification**

| | |
|---|---|
| 1 | 12587003 Gasket |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-26 |
| 2 | 03/03/07 | Update new gasket 12587003 old number 24502252 |
| | | |
| | | |
| | | |

**View**

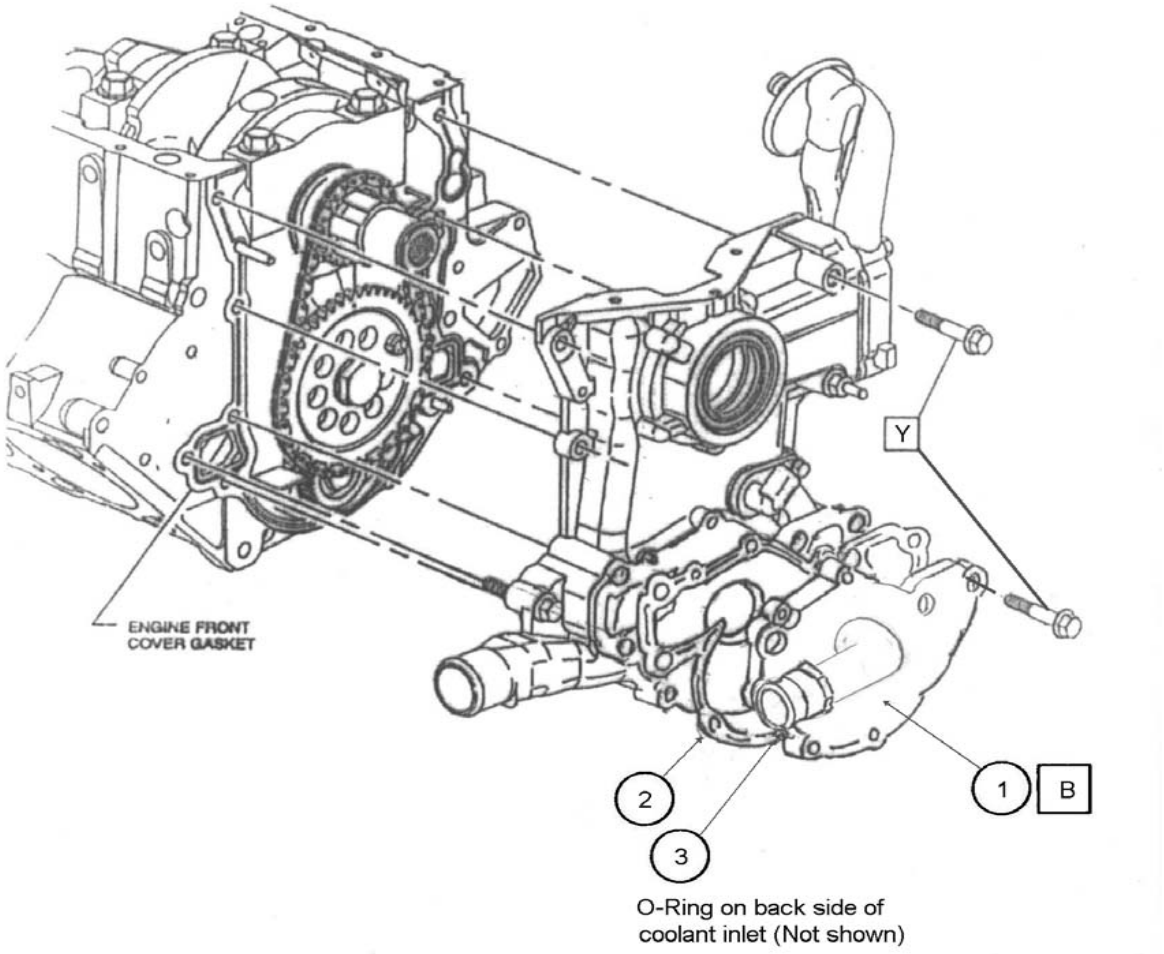
**Front Cover**

Front cover gasket install

# Front Cover, Rear Cover, & Sump

## Sequence IIIG

| Section | Sheet |
|---|---|
| 4 | 6 |



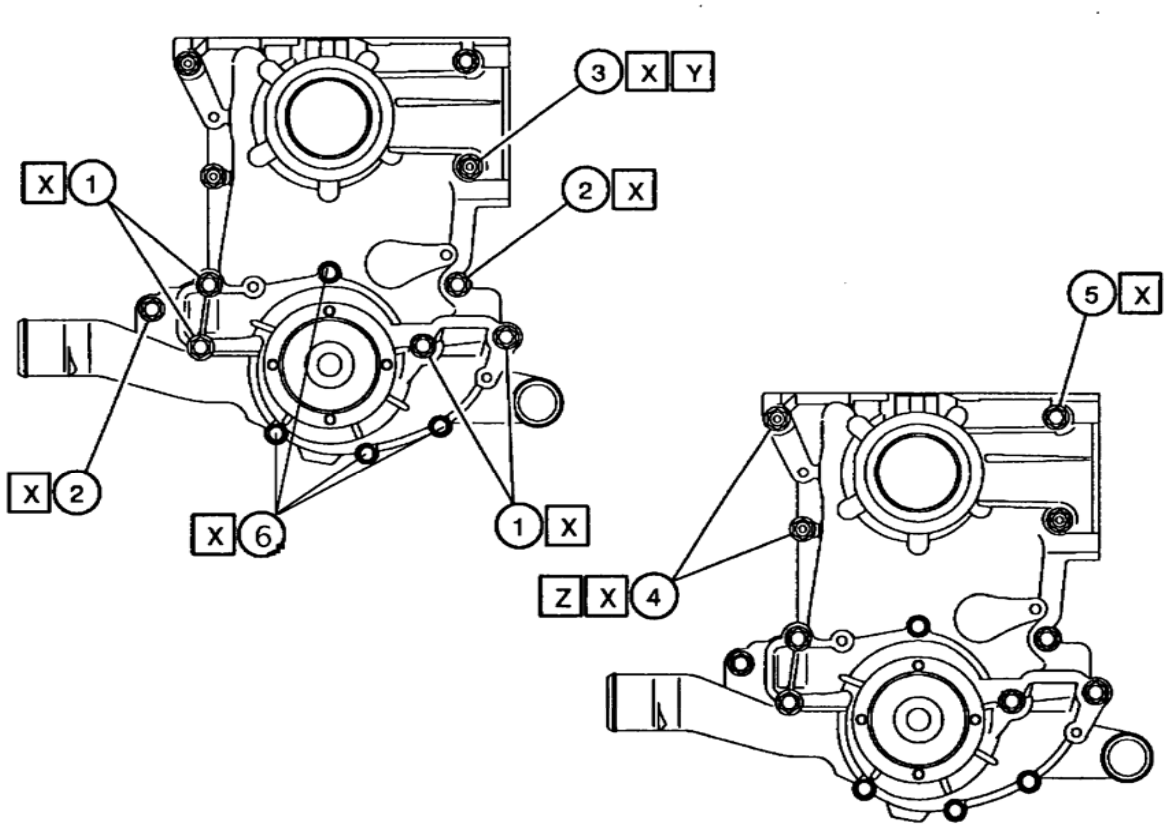

| Description of Operation | |
|---|---|
| A | Front cover assembly |
| B | Install coolant inlet adapter with front cover |
| Y | Torque 30Nm |
| | Install thermocouple in OHT3F-031 with sensing tip centered in flow. |

| Specification | |
|---|---|
| 1 | OHT3F-031-3<br>Bolts included on print |
| 2 | 24501565 Gasket |
| 3 | O-Ring 3F-031-2 |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-30 |
| 2 | 12/01/99 | Add thermocouple information |
| 3 | 06/30/06 | Update view, add gasket and O-ring part numbers |
| | | |
| | | |

| View |
|---|
| **Front Cover** |
| Front cover install |

| Front Cover, Rear Cover, & Sump | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 4 | 7 |



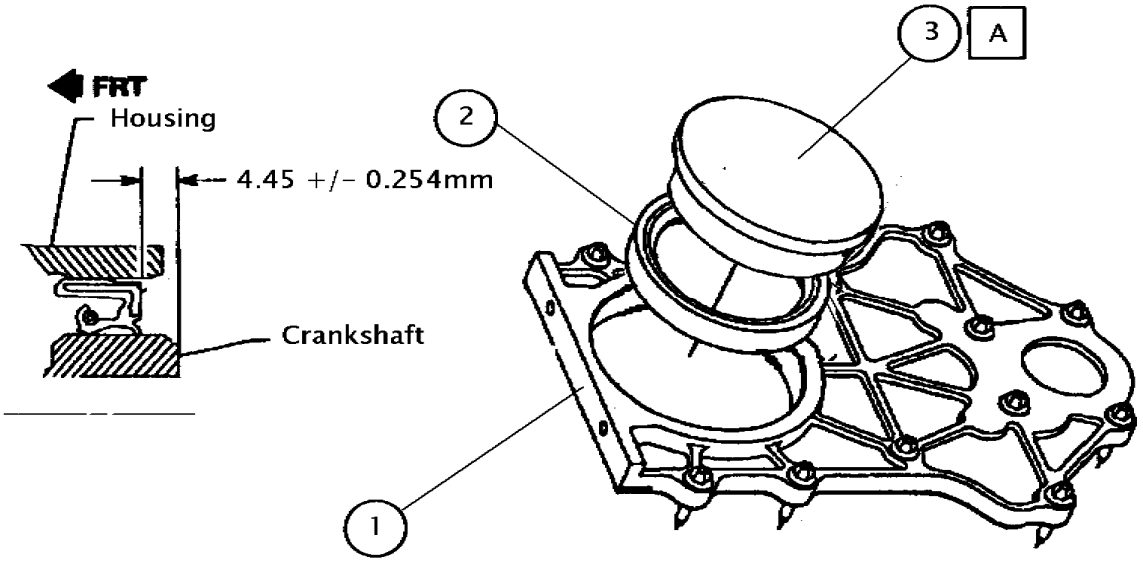

| Description of Operation | |
|---|---|
| X | Torque 30Nm |
| Y | Stud also holds crankshaft sensor shield |
| Z | Studs also hold crankshaft sensor shield and sensor |

| Specification | | |
|---|---|---|
| 1 | 5/16-18x3.5 (3) plus 3F031-03 Stud (1) |
| 2 | 24504713 Bolt (2) |
| 3 | 24504718 Stud (2) |
| 4 | 24504717 Stud (2) |
| 5 | 24504712 Bolt |
| 6 | 1/4-20x1.75 |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-28 |
| 2 | 06/30/06 | Update items 1 & 6 fastener information |
| | | |
| | | |
| | | |

| View |
|---|
| **Front Cover** |
| Front cover bolt placement |

| Front Cover, Rear Cover, & Sump | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 4 | 8 |




| Description of Operation | |
|---|---|
| A | Install rear main lip seal using GM R&D supplied installation tool or Kentmore J38196 and a light duty bench press until seal bottoms in housing. |

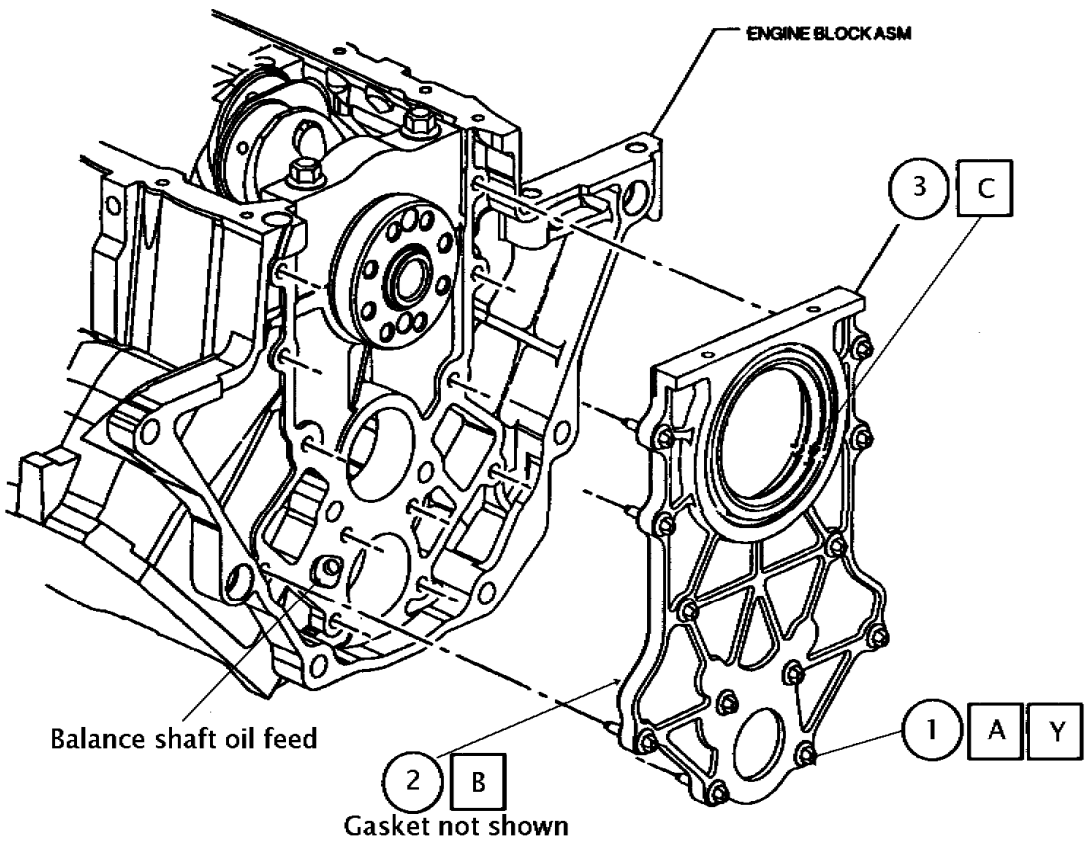
| Specification | |
|---|---|
| 1 | 24502297 Rear cover housing |
| 2 | OHT3G-091-1 Seal |
| 3 | GM R&D Seal Installation Tool or Kentmore J38196 |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-31 |
| 2 | 11/03/04 | Change rear seal part number to OHT3G-091-1 |
| 2 | 02/22/10 | Added Kentmore J38196 tool |
| | | |
| | | |

| View |
|---|
| Rear Cover |
| Rear seal installation |

**Front Cover, Rear Cover, & Sump** | **Sequence IIIG**

| Section | Sheet |
|---|---|
| 4 | 9 |




| Description of Operation | |
|---|---|
| A | Bolts may be run for as long as they remain serviceable. |
| B | Install gasket (not shown in view) **Note: Position rear cover plate gasket so that rear balance shaft oil feed is lined up with correct side of cover plate.** |
| C | Lubricate rear lip seal with EF-411and use extreme care not to damage rear lip seal during rear cover plate installation. |
| Y | Torque & Angle 15Nm + 50° |
| | Note: Perfect Seal #4 sealer may be used around coolant passages on gasket. |

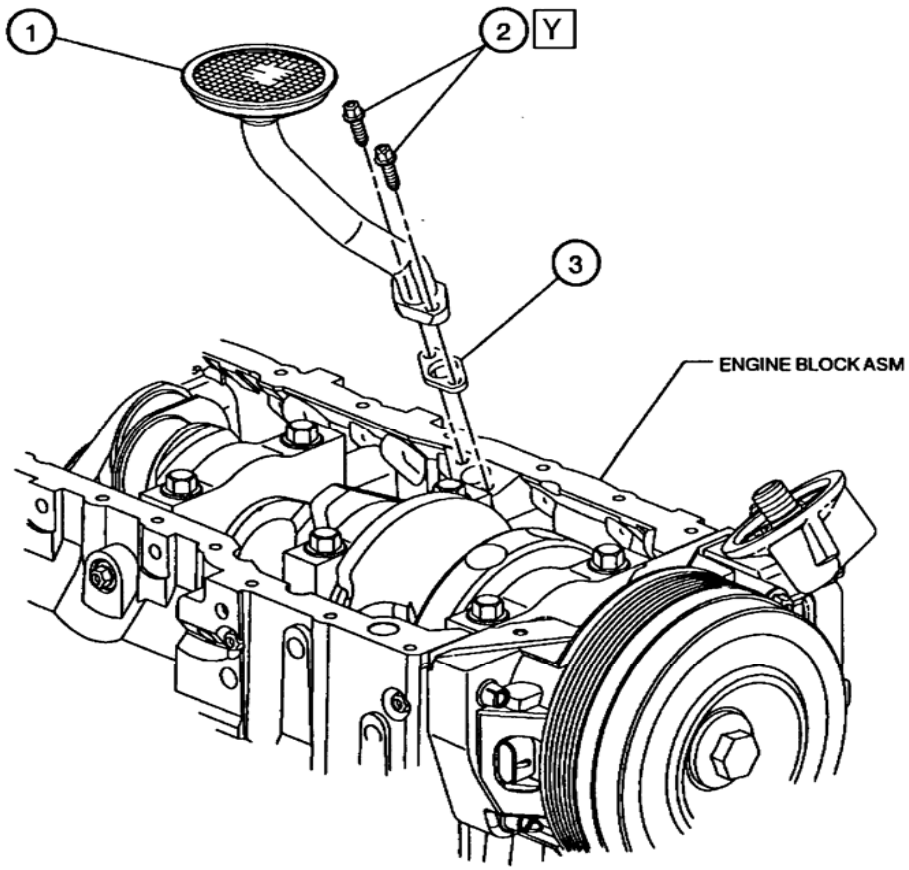
| Specification | |
|---|---|
| 1 | 11518075 Bolt |
| 2 | 24507388 Gasket |
| 3 | OHT3G-088-1Rear cover housing |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-32 |
| 2 | 12/01/99 | Add Perfect seal note. |
| 3 | 02/05/06 | Change to OHT Rear Cover w/24507388 gasket |
| 4 | 07/20/06 | Update fastener usage (remove nylon collar) |
| 5 | 03/05/10 | Update fastener usage (allowed use for multiple tests) |
| 6 | 07/01/11 | Revised part number for bolt, was 24503970, changed to 11518075 |

| View |
|---|
| **Rear Cover** |
| Rear cover installation |

**Front Cover, Rear Cover, & Sump** | **Sequence IIIG**

| Section | Sheet |
|---|---|
| 4 | 10 |



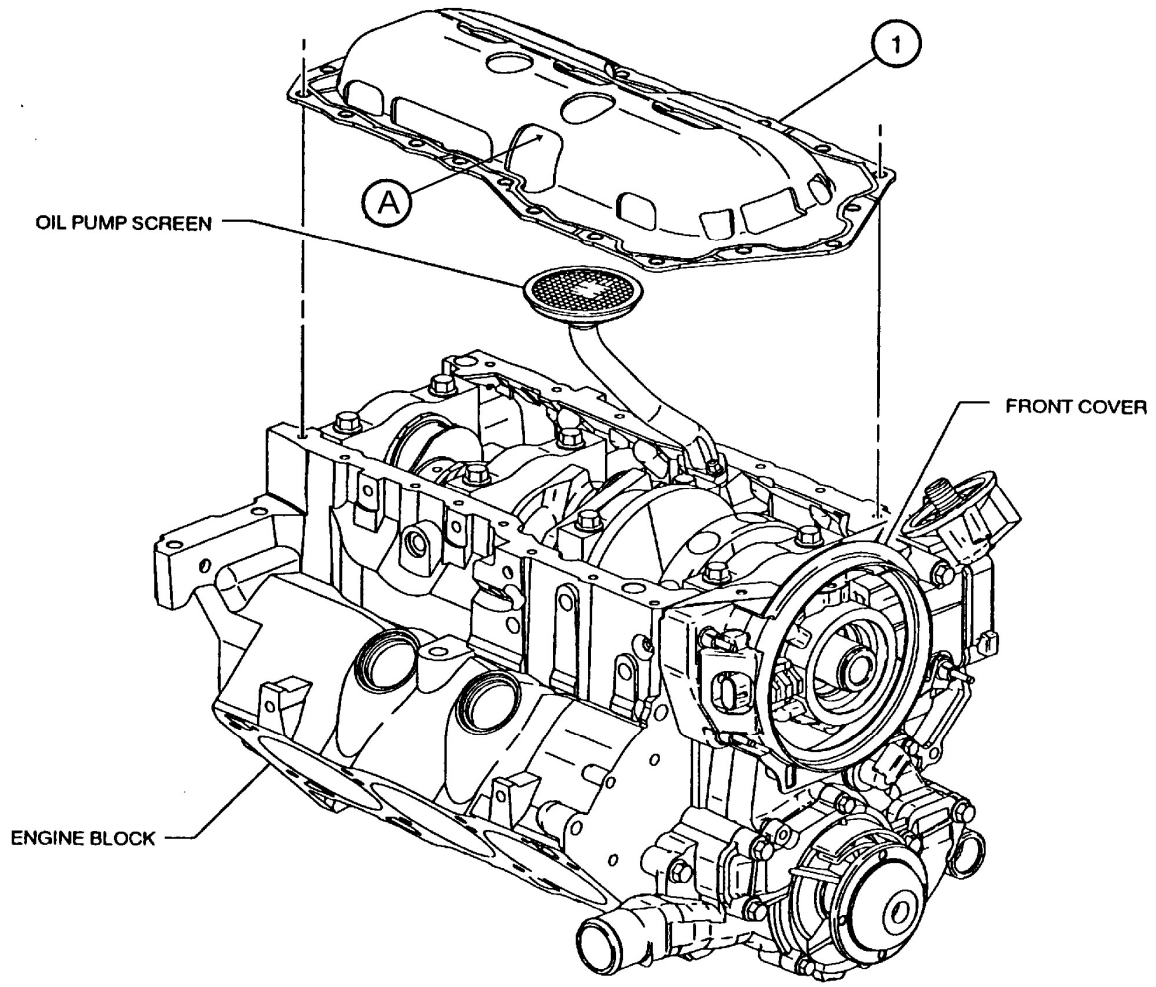

| Description of Operation | |
|---|---|
| | Install oil screen assembly |
| Y | Torque 15Nm |

| Specification | | |
|---|---|---|
| 1 | 24505569 | Screen assembly |
| 2 | 24505570 | Bolt |
| 3 | 12581570 | Gasket |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-33 |
| 2 | 02/01/06 | Change gskt. From 24501259 to 12581570 |
| | | |
| | | |
| | | |

| View |
|---|
| Sump |
| Oil pickup tube |

| Front Cover, Rear Cover, & Sump | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 4 | 11 |



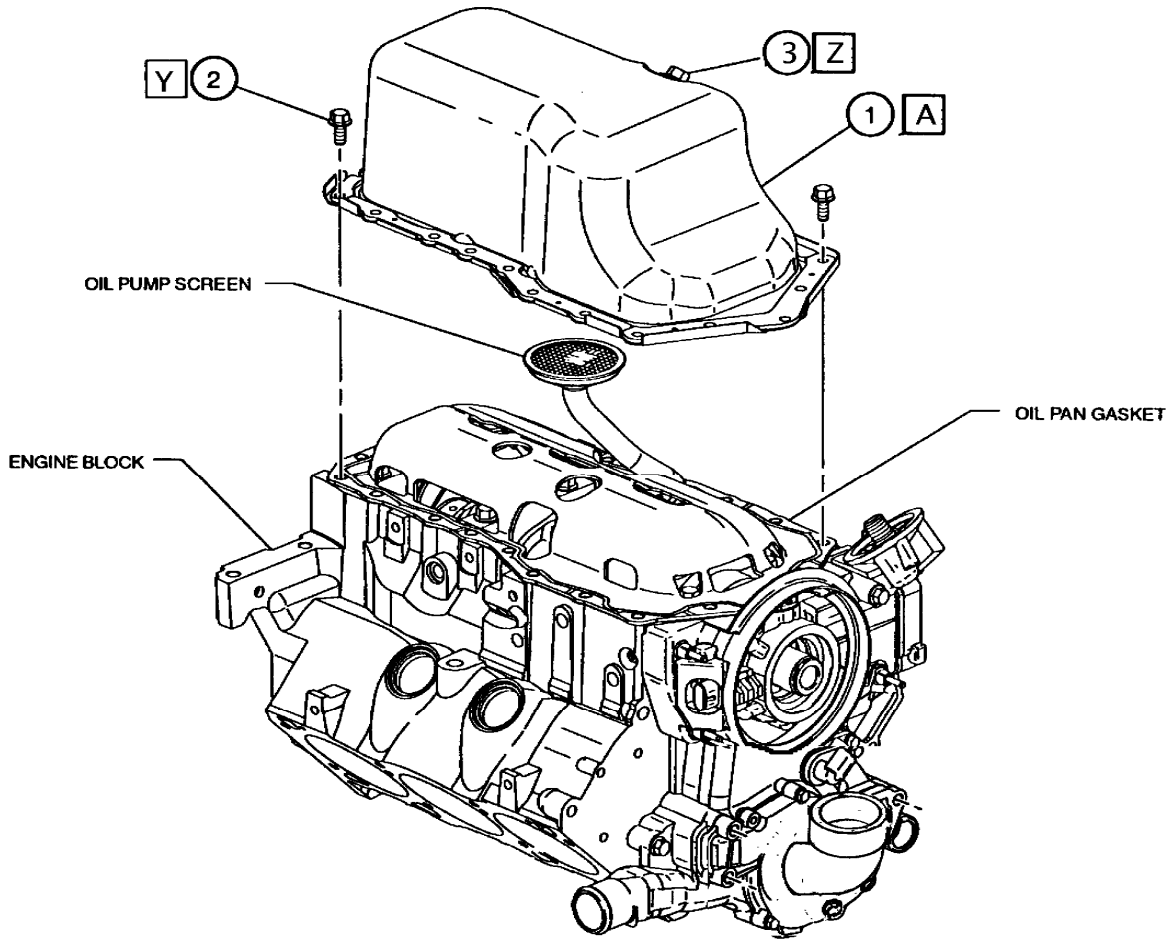

| | |
|---|---|
| | Install oil pan gasket |
| A | Insure that calibrated oil level dipstick clears windage tray before final assembly<br><br>Note: Dow Corning®3145 RTV MIL-A-46146 Adhesive/Sealant or GM, (see part number info) or may be used at corners of front and rear covers to aid in sealing.<br><br>GM Silicone Sealer<br>New numbers:<br>12378577 Tube<br>12551715 Cartridges |

| Specification |
|---|
| 1 OHT3G-093-1 Gasket |

| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-34 |
| 2 | 4/28/03 | Change part number from 24502397 to 12574776 |
| 3 | 12/15/03 | Add approved silicone sealers |
| 4 | 03/15/04 | Update Sealer information |
| 5 | 11/03/04 | Change oil pan gasket to OHT3G-093-1 |
| 6 | 07/01/11 | Update sealer information |

| View |
|---|
| Sump |
| Oil pan gasket install |

| Front Cover, Rear Cover, & Sump | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 4 | 12 |




| Description of Operation | |
|---|---|
| A | Install oil pan |
| Y | Torque 14Nm |
| Z | Oil drain plug to be thermocoupled |

| Specification | |
|---|---|
| 1 | Oil pan OHT3F-073-1 |
| 2 | 11610052 Bolt |
| 3 | OHT3F-063-1 Modified drain plug |

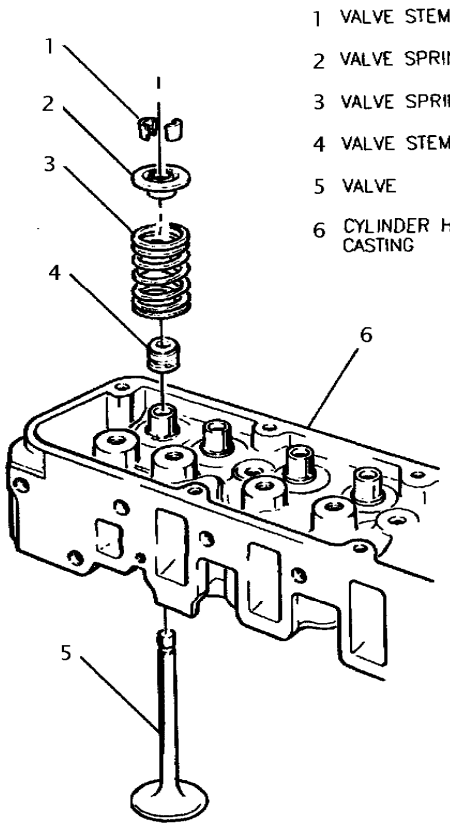
| REV | Date | Revision History |
|---|---|---|
| 1 | 01/05/98 | Block-35 |
| 2 | 02/05/06 | Add 11610052 Bolt |
| 3 | 07/01/11 | Removed bolt # 24502791 |
| | | |
| | | |

| View |
|---|
| Sump |
| Oil pan installation |

| Front Cover, Rear Cover, & Sump | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 4 | 13 |

# Section 5

# Cylinder Head and Valves




During calibration, use OHT3F-070-1 Sleeve to protect seals from being cut and OHT3F-072, 006", 010", 015", & 020" shims to assist in

## Description of Operation

Clean cylinder head by automated parts washer (see section 1 sheet 5A) or with degreasing solvent and spray with 50/50 solution of EF-411 and degreasing solvent. Remove excess solution using compressed air.

Lubricate valve stems and guides with EF-411 during assembly. Ensure valve stem moves freely in guide before installing valve seal. Use a protective sheath over the valve stem that extends downward past the keeper grooves when installing the valve stem seals.

Install the valve springs, retainers, and keepers.

Calibrate the valve spring load to 912N +/- 44N @ 9.5mm (205lbf +/- 10lbf @ 0.375in.) travel.

## Specification

| | |
|---|---|
| 1 | 10166345 Valve stem key |
| 2 | 24502257 Valve spring cap |
| 3 | OHT3G-059-1 Valve spring (Pink) |
| 4 | OHT3F-060-1 Seal int. |
| | OHT3F-061-1 Seal exh. White stripe |
| 5 | 12569550 Valve Int. (STD) |
| | 12579949 Valve Exh.(STD) |
| 6 | 24502260B Head, GM Raceshop |

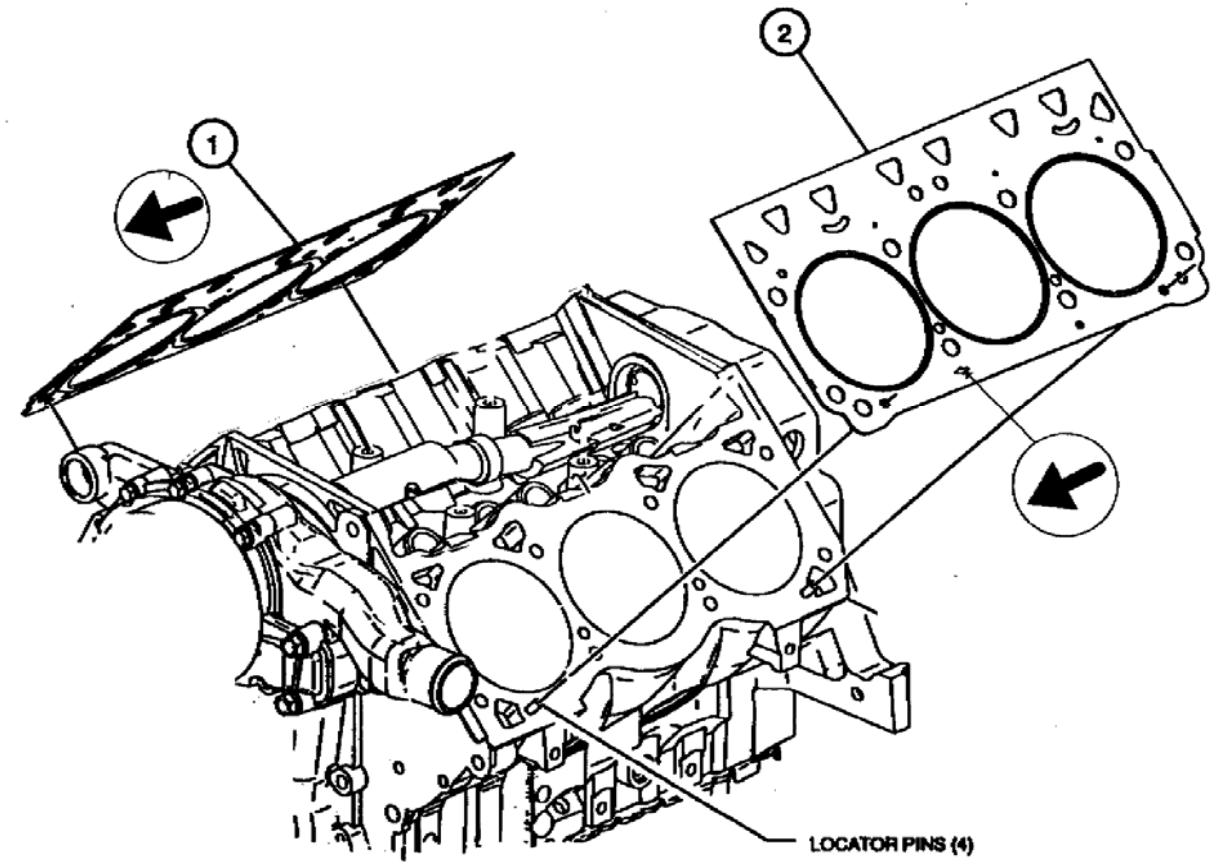
| REV | Date | Revision History |
|---|---|---|
| 1 | 01/06/98 | Block-36 |
| 2 | 9/9/03 | Change calibration from +/- 5lbf to +/- 10lbf |
| 3 | 12/15/03 | Update, change to mineral spirits |
| 4 | 11/03/04 | Change part number for exhaust valve from 24507423 to 12579949 |
| 5 | 06/30/06 | Change intake part number from 24502254 to 12569550 and cleaning procedure update |
| 6 | 07/01/11 | Update cylinder head part number |

**View**

**Head Assembly**

Valve & spring assembly

| Head Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 5 | 1 |




**Description of Operation**

Head gaskets are not interchangeable. Installing the head gasket with the arrow pointing to the rear will cause gasket failure and possible engine failure.

Install the head gasket with the arrow pointing toward the front of the engine.

Do not use any sealers on the head gaskets.

**Specification**

| | | |
|---|---|---|
| 1 | 24503801 | Gasket RH |
| 2 | 24503802 | Gasket LH |

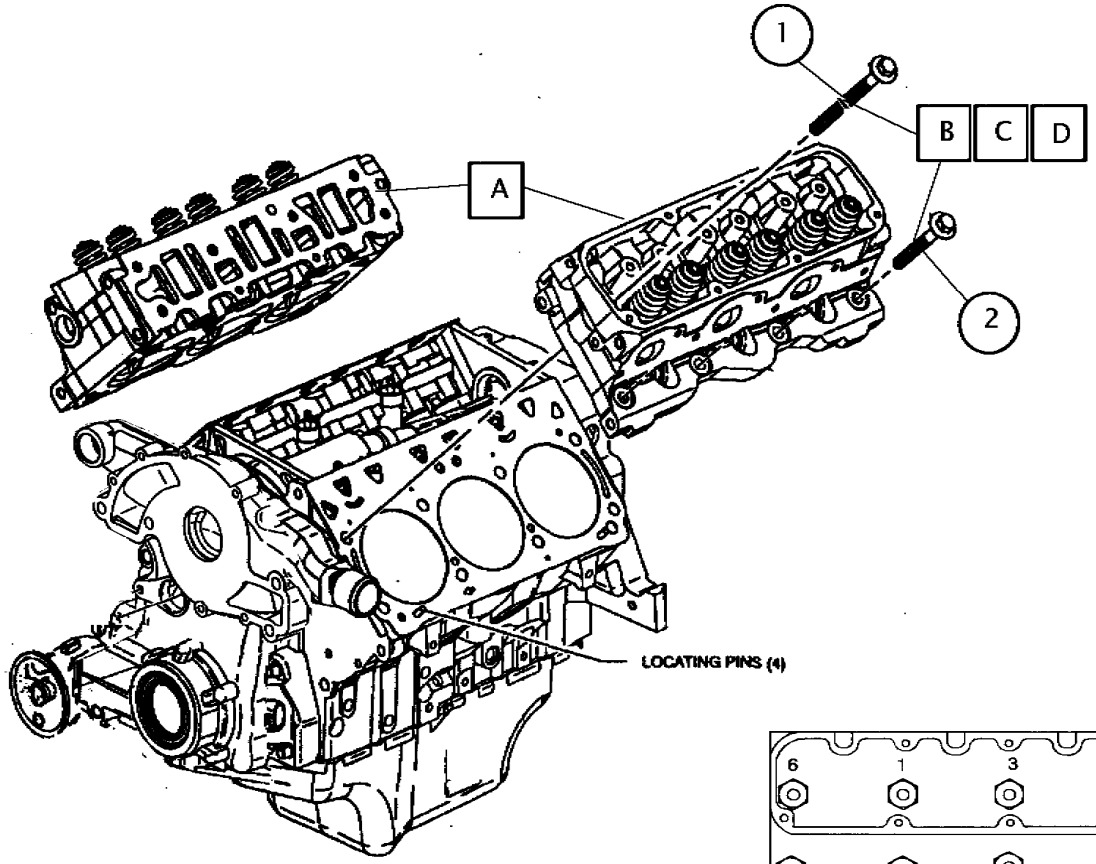
| REV | Date | Revision History |
|---|---|---|
| 1 | 01/06/98 | Block-37 |
| | | |
| | | |
| | | |
| | | |

**View**

**Head Gaskets**

Head gasket install

| Head Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 5 | 2 |







| Description of Operation | |
|---|---|
| A | Carefully install cylinder heads. |
| B | Clean all sealer from new bolt threads and underside of head. |
| C | Install #2 Permatex on threads and underside of fastener head. |
| D | Torque fasteners from center out using a crisscross pattern in the following sequence.<br>First - 30 N·m<br>Second - 50 N·m<br>Third - 80 N·m<br>Final - 145±7 N·m |

| Specification | |
|---|---|
| 1 | 25527831K Bolt Cyl. Head (8) Long |
| 2 | 25533811K Bolt Cyl. Head (8) Short<br>Available through GM Race Shop |

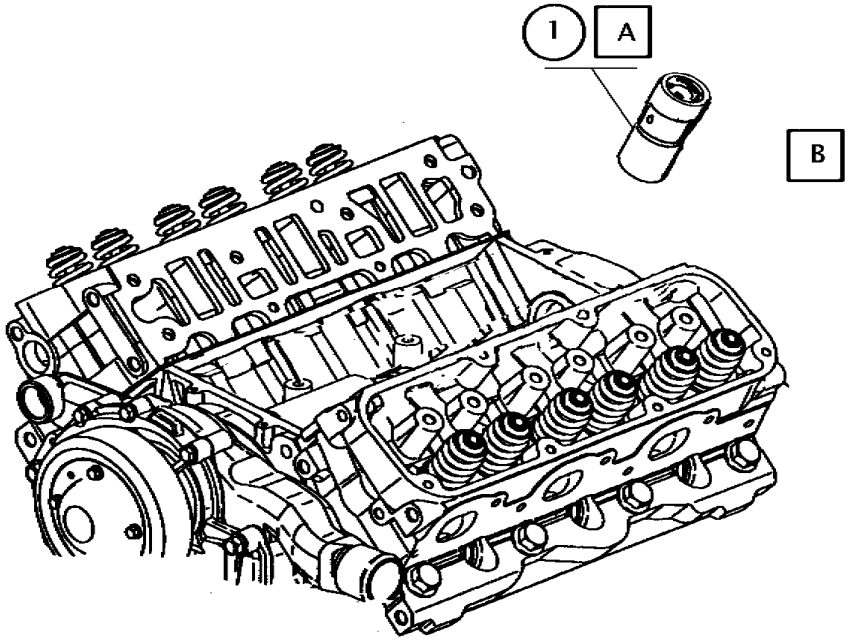
| REV | Date | Revision History |
|---|---|---|
| 1 | 01/06/98 | Block-38 & 50 |
| 2 | 07/20/06 | Update part number, change 25533811 to 88891770 |
| 3 | 03/30/07 | Update fastener torque to 30Nm-50Nm-80Nm-145Nm±7Nm |
| 4 | 02/22/10 | Corrected short head bolt number |
| 5 | 07/01/11 | Clarified torque sequence, updated head bolt info |

| View |
|---|
| **Cylinder Head** |
| Cylinder head installation |

| Head Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 5 | 3 |

# Section 6

# Long Block Assembly



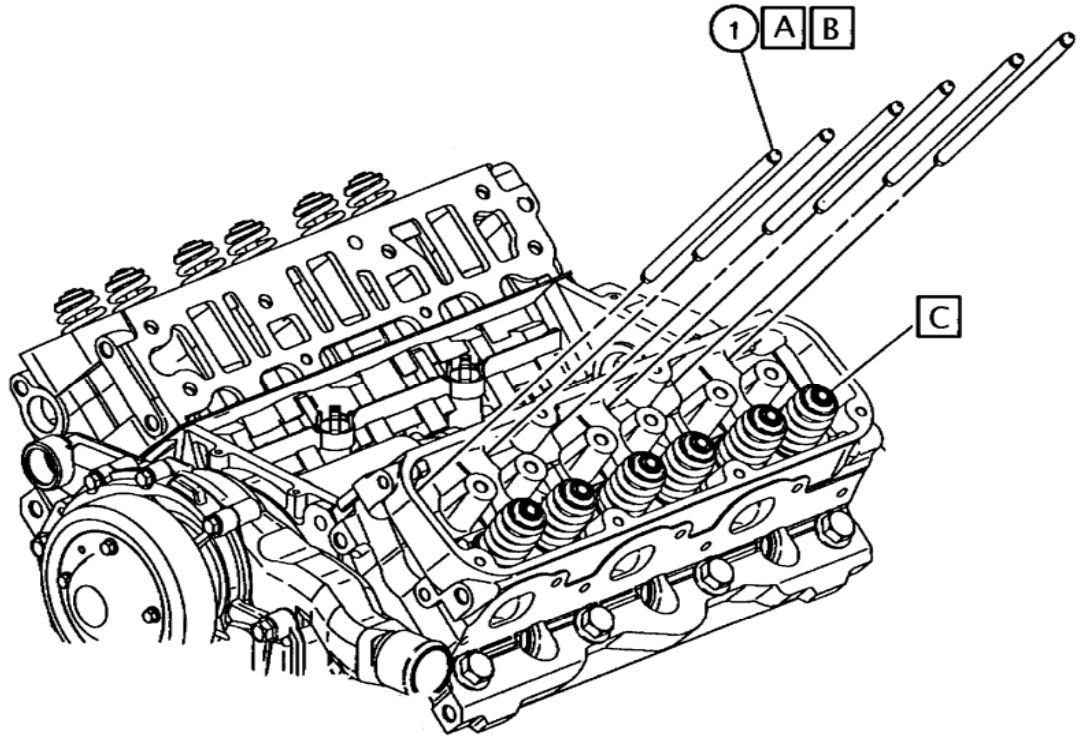

| Description of Operation | |
|---|---|
| A | Measure and record pre-test lifter foot height to the nearest 0.001mm |
| B | Installation:<br>1) Clean each lifter using a lightly soaked cloth with clean (new) degreasing solvent (Do not disassemble, spray, or submerse the lifter in solvent). Dry each lifter foot using a clean dry cloth or terry towel.<br><br>2) Use 118ml (4 oz.) of test oil, dip each lifter foot in test oil and install the lifter set less pushrods.<br><br>3) Rotate engine crankshaft 720° slowly with no load on lifters.<br><br>4) Remove each lifter, one at a time, and again dip each foot in test oil and re-install with the ground flat facing inboard.<br><br>5) With the oil pan on the engine, pour the remainder of the 118ml in the valley. |

| Specification | |
|---|---|
| 1 | OHT3f-029-3 ACI Test Lifter (with flats ) |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-39 |
| 2 | 12/15/03 | Update, change to mineral spirits |
| 3 | 7/20/06 | Update operation and change to degreasing solvent |
| 4 | 7/1/11 | Corrected typo in description B 2. |
| | | |

| View |
|---|
| **Lifter Installation** |
| Lifter pre-oiling and installation |

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 1 |



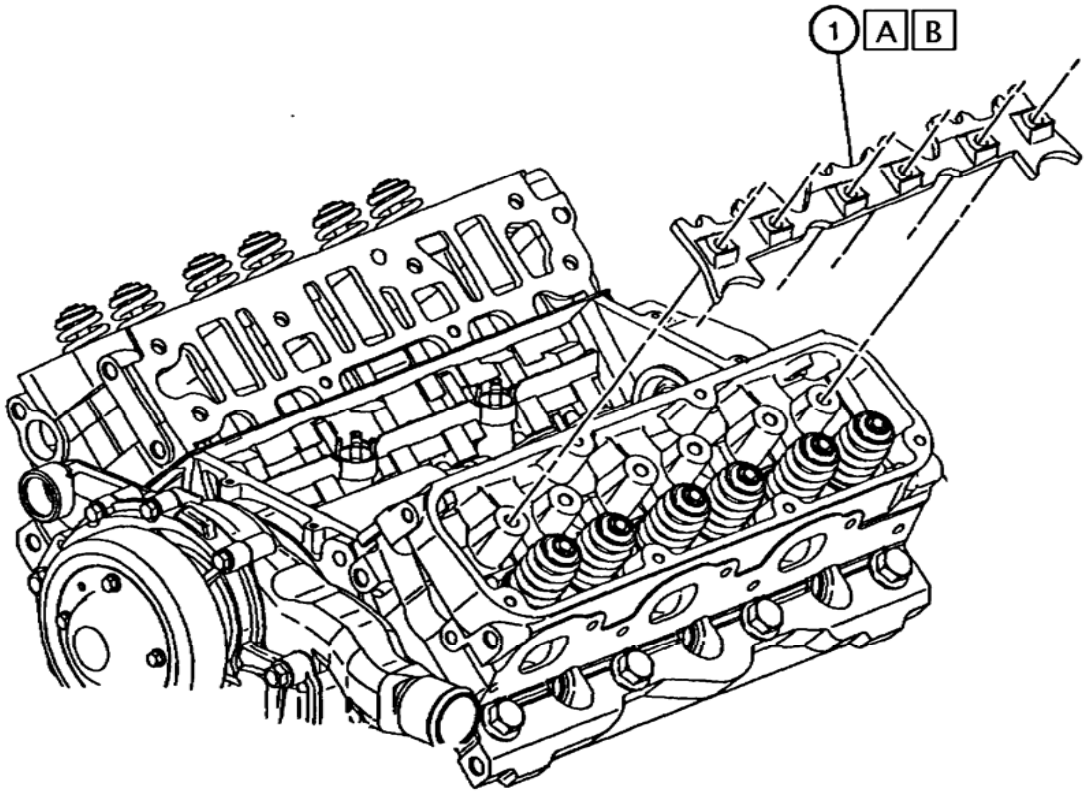

| Description of Operation | |
|---|---|
| A | Clean all pushrods with clean lint free towel and degreasing solvent and spray with a 50/50 solution of EF-411 and degreasing solvent. Remove excess with compressed air. Lubricate each pushrod end, pushrod seat, and rocker arm ball socket with EF-411 prior to installation. |
| B | Install pushrods |
| C | Lubricate each valve stem seal and tip with EF-411. |

| Specification | |
|---|---|
| 1 | OHT3F-007-1 Pushrod (Special Length) |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-40 |
| 2 | 12/15/03 | Update, change to mineral spirits |
| 3 | 7/20/06 | Update change to degreasing solvent and clean towel for cleaning |
| | | |
| | | |

| View |
|---|
| **Pushrods** |
| Pushrod installation |

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 2 |



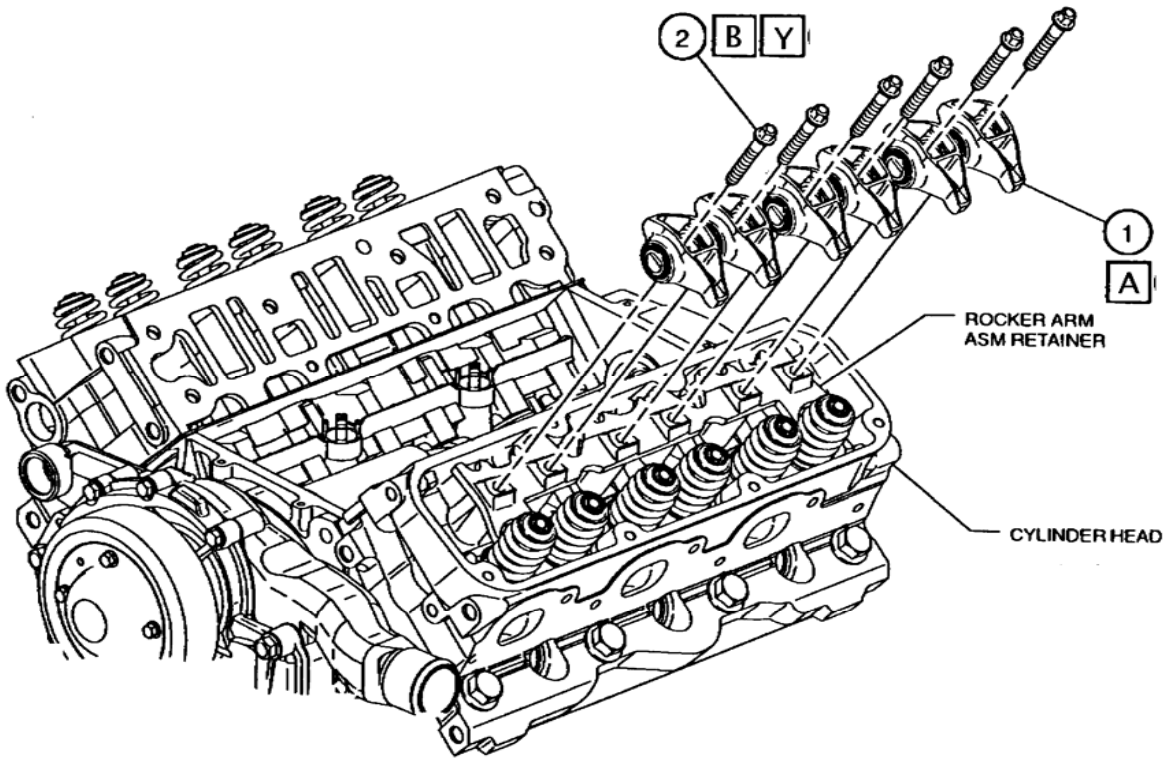

| Description of Operation | |
|---|---|
| A | Clean and inspect for wear. (Replace Retainer after 6 tests) |
| B | Install pushrod guide / rocker bearing retainer. |

| Specification | | |
|---|---|---|
| 1 | 24502278 | Retainer |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-41 |
| 2 | 7/20/06 | Update usage, replace after 6 tests |
| | | |
| | | |
| | | |

| View |
|---|
| Retainer |
| Rocker bearing retainer installation |

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 3 |



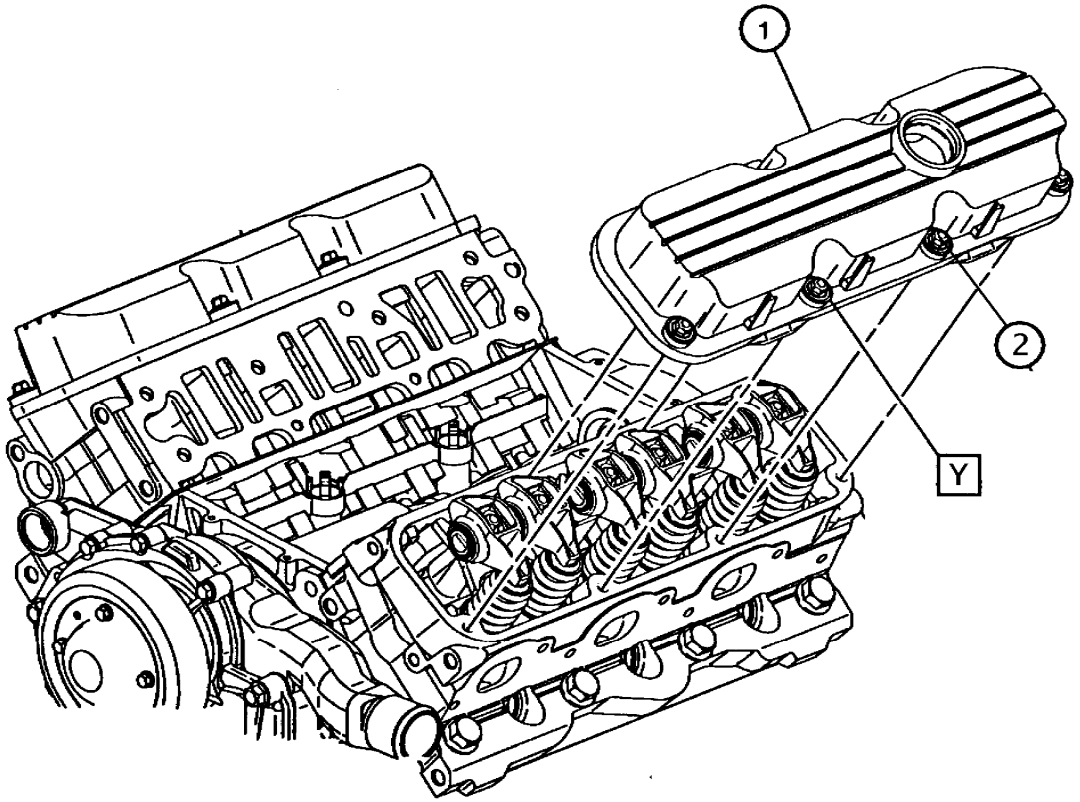

| Description of Operation | |
|---|---|
| A | Lubricate rocker arms with EF-411 and install. **Note: Rocker arm assemblies are replaced every test. Do not dip or spray with degreasing solvent. Needle roller bearings will retain solvents.** |
| B | Lubricate bolts with EF-411 and install. |
| Y | Torque & Angle<br>25Nm + 70°<br><br>Note: Do not rotate engine after final valvetrain loading. |

| Specification | |
|---|---|
| 1 | OHT3F-058-1 Rocker Arm Assembly |
| 2 | Furnished less sealers with OHT Kit |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-42 |
| 2 | 12/15/03 | Update, change to mineral spirits |
| 3 | 7/20/06 | Update, change to degreasing solvent |
| | | |
| | | |

| View |
|---|
| **Rocker Arm** |
| Rocker arm installation |

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 4 |




| Description of Operation | |
|---|---|
| | Install rocker covers |
| Y | Torque 10Nm |

**Specification**

1 12590366 Cover, Valve Lt (2)

2 24502164 Bolt
25534749 Grommet

3 25532619 Gasket (Not Shown)

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-43 |
| 2 | 3/30/07 | Update Rocker Cover part number new 12590366 old 25534751 |
| 3 | 7/1/11 | Deleted bolt with washer, part number 25534748 and added Grommet, P/N 25534749 |
| | | |
| | | |

**View**

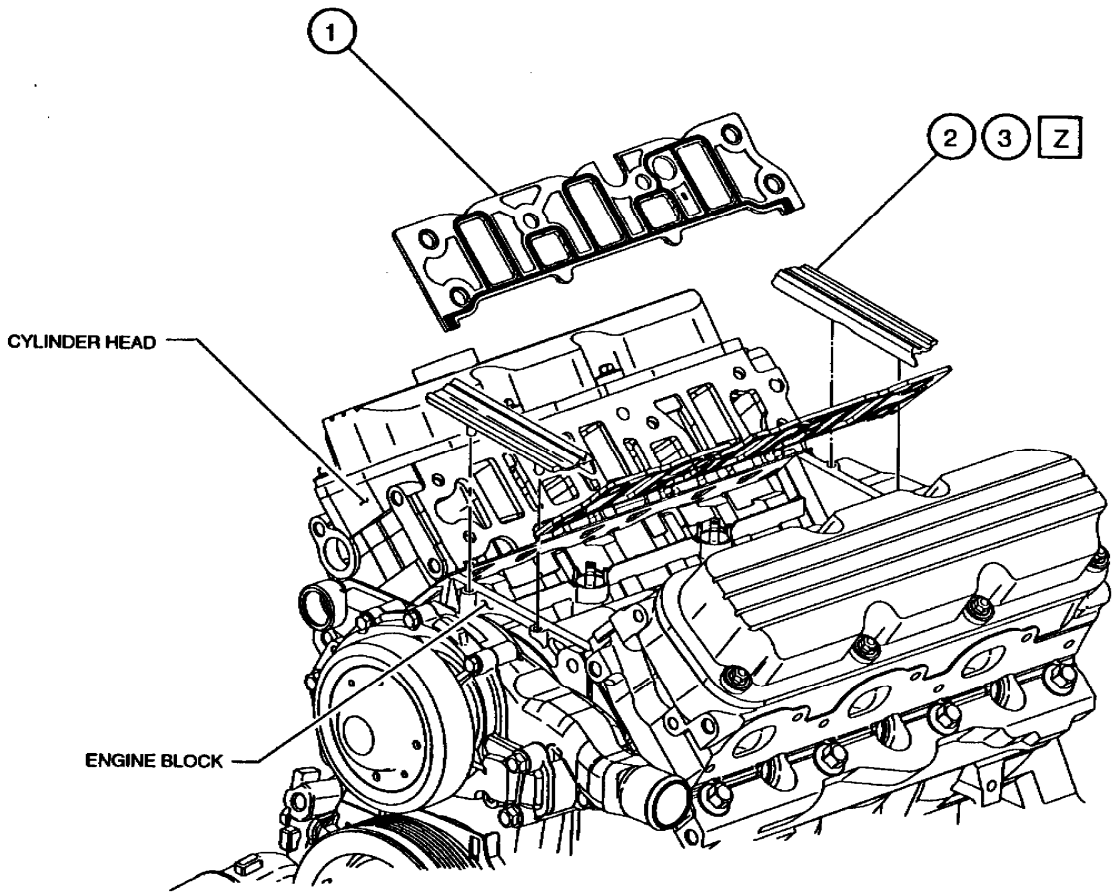
**Rocker Cover**

Rocker cover installation

## Long Block Assembly

## Sequence IIIG

| Section | Sheet |
|---|---|
| 6 | 5 |



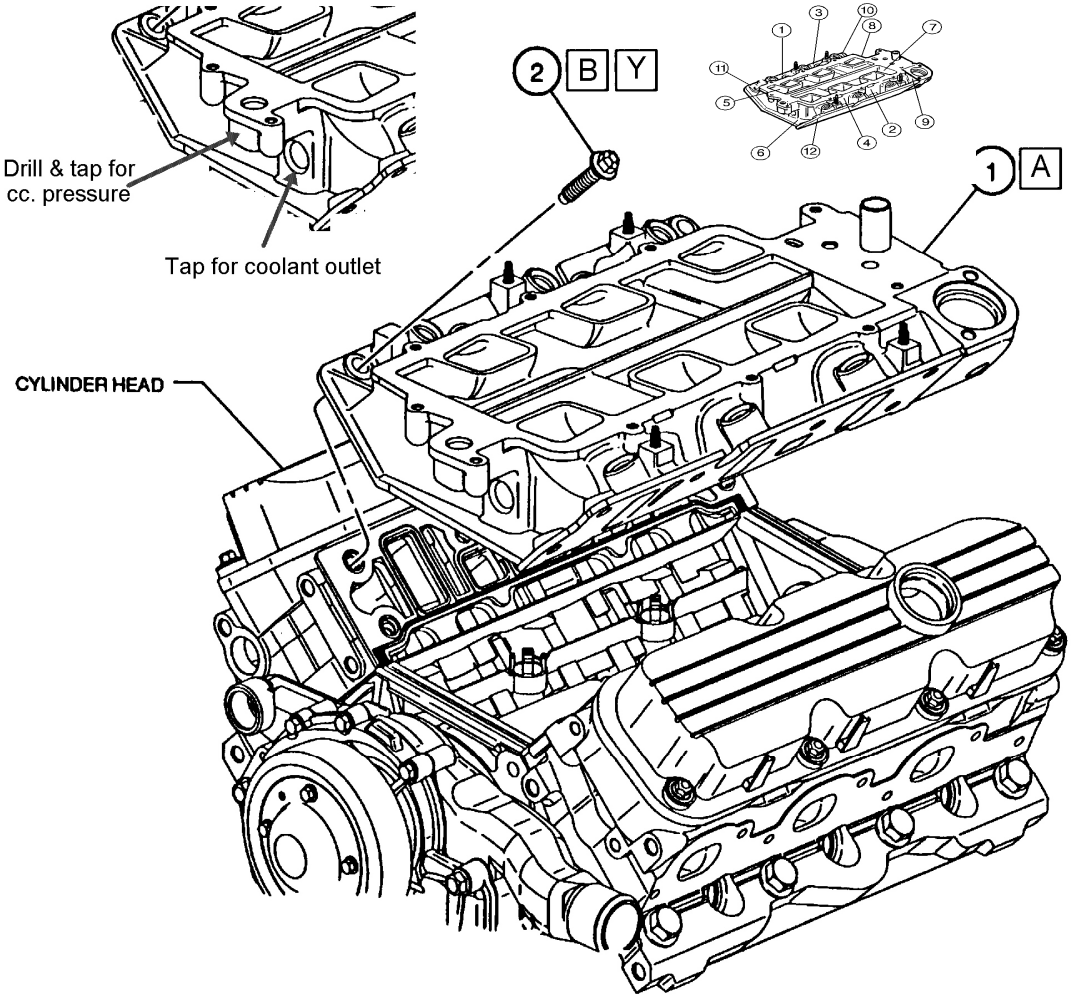

| Description of Operation | |
|---|---|
| | 2nd design gasket kit uses locating pins for front and rear seals |
| Z | Apply RTV, GM (see part number info) or Dow Corning® 3154 RTV MIL-A46146 adhesive/Sealer to both ends.<br><br>GM Silicone Sealer<br>New numbers:<br>12378577 Tube<br>12551715 Cartridges |

| Specification | |
|---|---|
| 1 | 89017816<br>89017399 (Old)<br>12480830 (Old)<br>All part numbers are good |
| 2 | Seal / part of kit |
| 3 | Sealant (see note Z) |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-44 |
| 2 | 12/15/03 | Update RTV sealer |
| 3 | 3/15/04 | Update Intake Gasket Part Number and Silisone Sealer Information |
| 4 | 7/20/06 | Update Intake Gasket Part Number |
| 5 | 7/1/11 | Update RTV sealer |

| View |
|---|
| **Intake Gaskets** |
| Intake gasket installation |

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 6 |



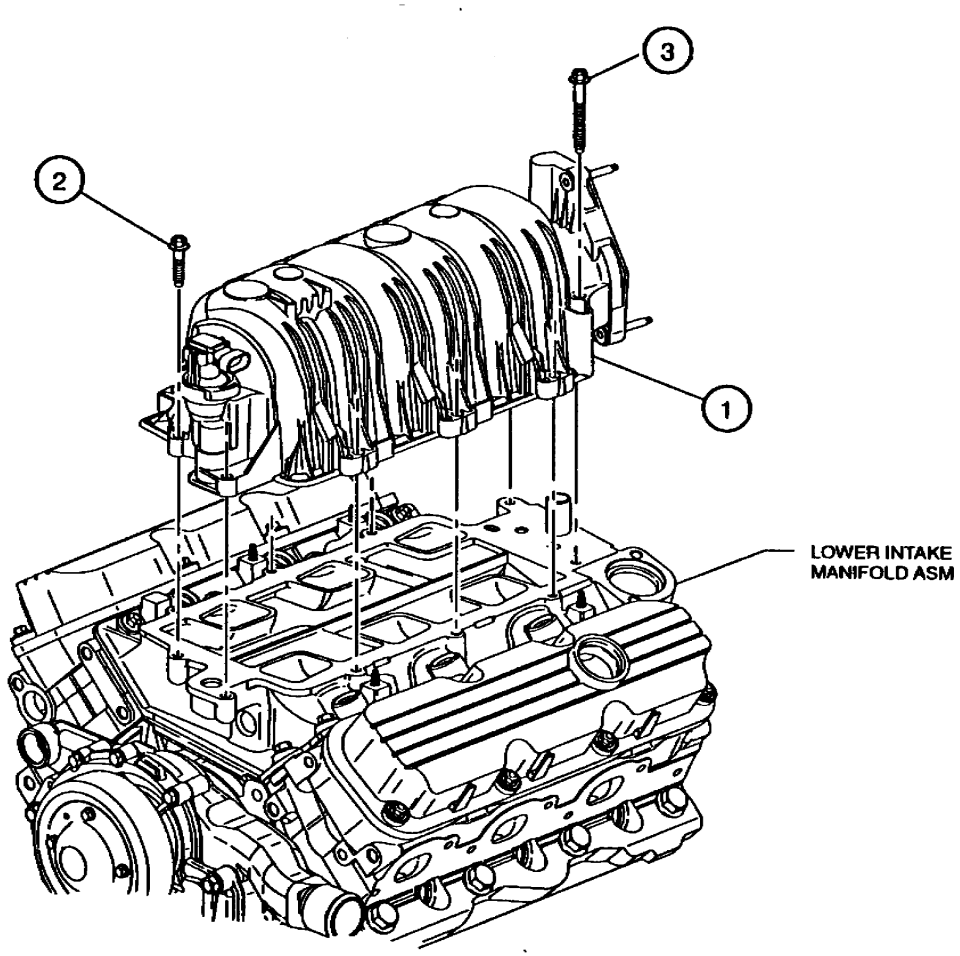

| Description of Operation | |
|---|---|
| A | Install modified intake manifold |
| B | Clean and lubricate bolts with Permatex #2 or RTV (see sec. 6 sheet 6 for RTV information) and install. |
| Y | Torque 15Nm<br><br>Drill and tap as indicated for the crankcase pressure line . Also tap coolant outlet port for coolant return line to process controller. Use a 3/4" I.D. unrestricted line for the return. Do not install shut off valves in the return line. |

| Specification | |
|---|---|
| 1 | 24508923 Manifold, lower intake |
| 2 | 9440227 Bolt (12) |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-45 |
| 2 | 7/1/2011 | Revised Intake Manifold description and part number and add torque sequence |
| | | |
| | | |
| | | |

| View |
|---|
| **Lower Intake** |
| Lower intake manifold installation |

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 7 |



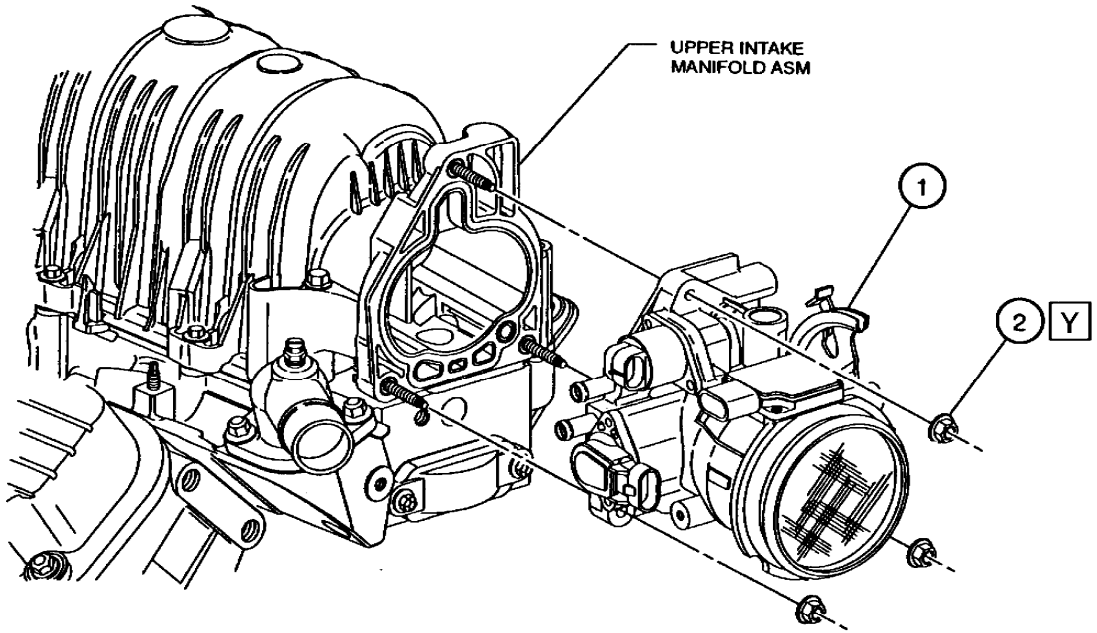

| Description of Operation | |
|---|---|
| | Install upper intake and gasket assembly. |
| Y | Torque 10Nm (Max. torque) |

| Specification | |
|---|---|
| 1 | 89017272 Manifold kit, Upper Intake<br>89017556 Gasket Kit |
| 2 | 24506498 Bolt (8) |
| 3 | 24505205 Bolt (2) |
| | See note Y for torque |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-46 |
| 2 | 3/30/07 | Update upper intake gasket part number new 89017556 old 17113137 |
| 3 | 2/20/10 | Removed stud (number 3) and renumbered 4 as 3 |
| 4 | 7/1/11 | Revised description and updated part number |
| | | |

| View |
|---|
| Upper Intake |
| Upper intake installation |

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 8 |



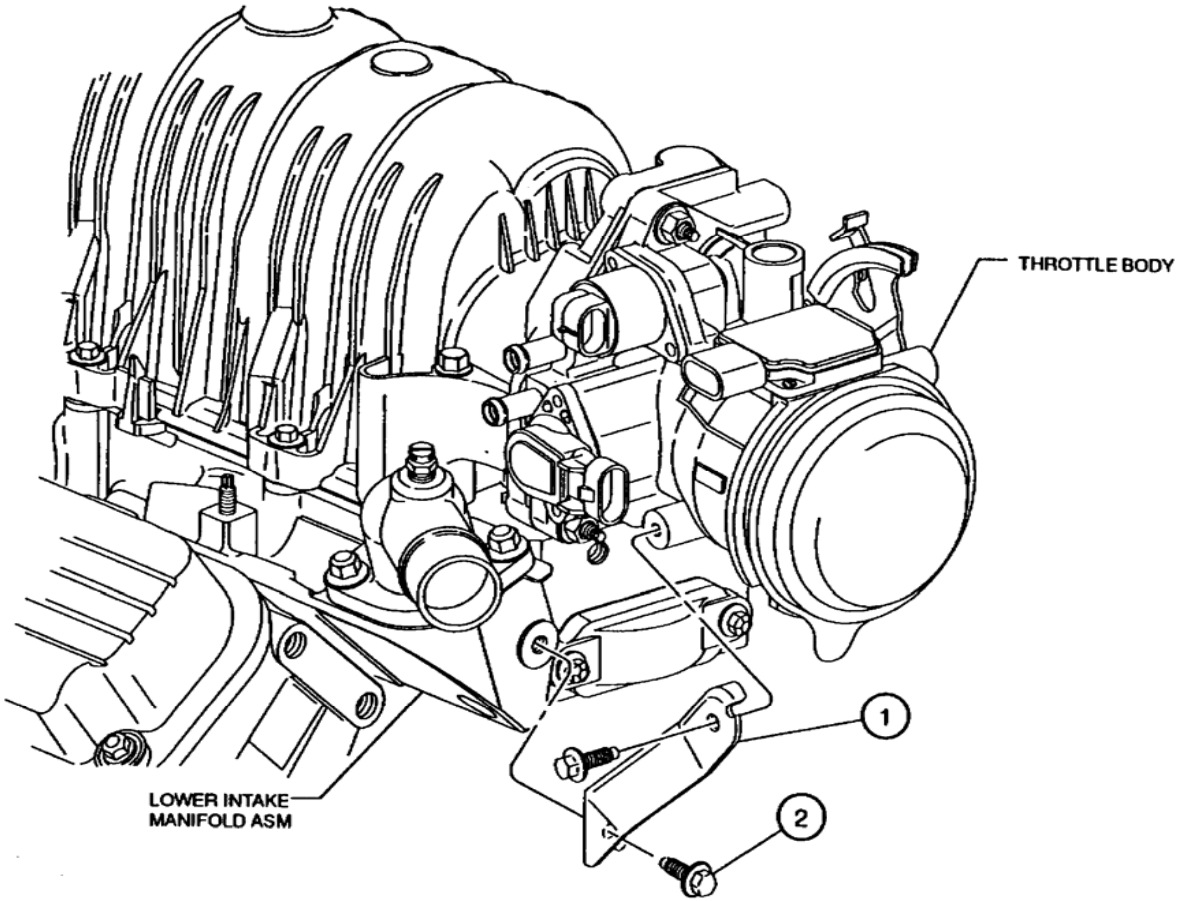

| Description of Operation | |
|---|---|
| | Install modified throttle body<br><br>**Note: See section 7 sheet 5 for modifications** |
| Y | Torque 10Nm |

| Specification | |
|---|---|
| 1 | 24507235 Throttle Body |
| 2 | 24506469 Nut |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-47 |
| 2 | 4/28/03 | Add new mass airflow part number 12568877 |
| 3 | 6/23/03 | Add 88961007 remanufactured from 12568877 |
| 4 | 7/1/11 | Removed 88961007 remanufactured from 12568877 |
| | | |

| View |
|---|
| **Throttle Body** |
| Throttle body installation |

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 9 |




| Description of Operation | |
|---|---|
| | Install support bracket |
| Y | Torque 10Nm |

**Specification**

| | |
|---|---|
| 1 | 24504697 Support |
| 2 | 24503644 Bolt (2)<br>See note Y for torque |

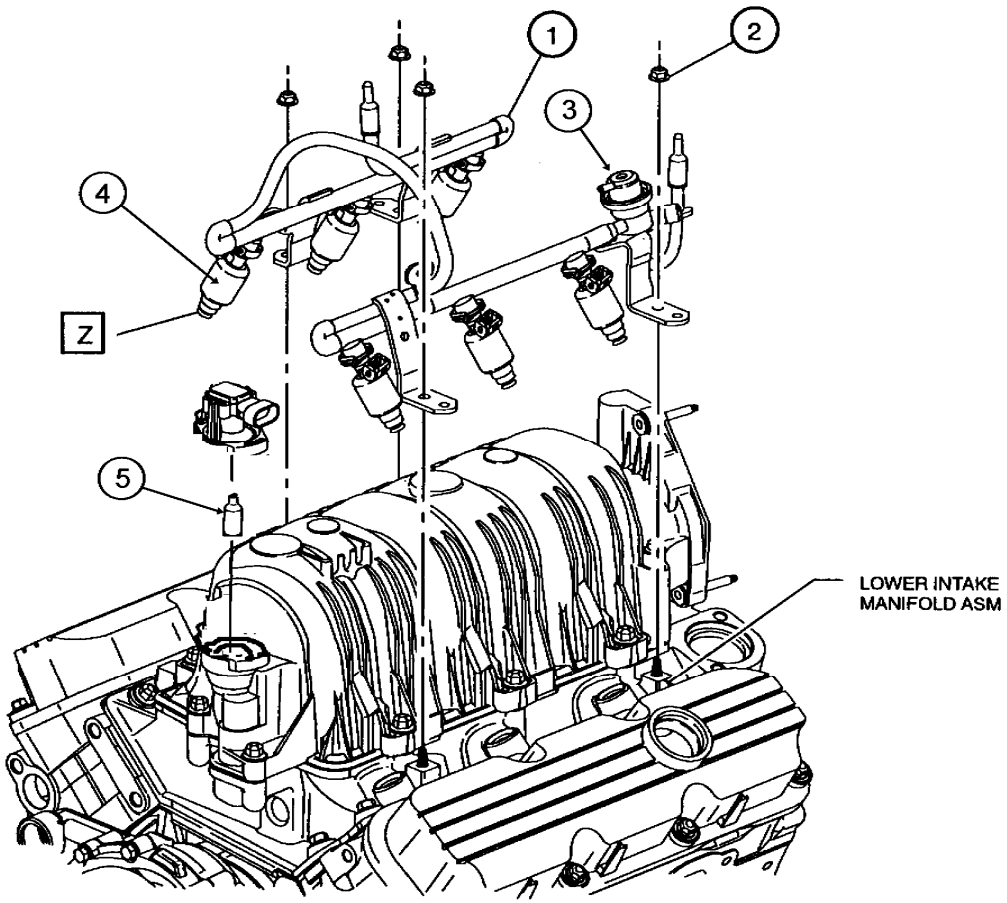
| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-48 |
| | | |
| | | |
| | | |
| | | |

**View**

**Throttle Body Support**

Throttle body support installation

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 10 |




| Description of Operation | |
|---|---|
| | Install injector assembly (See sec. 6.14.1 of the test procedure for injector flow testing requirements). |
| Y | Torque 10Nm |
| Z | Lubricate O-ring with EF-411 |

| Specification | |
|---|---|
| 1 | 12587077 Rail, Fuel Injector |
| 2 | 24506469 Nut |
| 3 | 89017530 or 89060416 Regulator |
| 4 | 17120601 Injector |
| 5 | OHT3F-002-1 PCV Dummy |

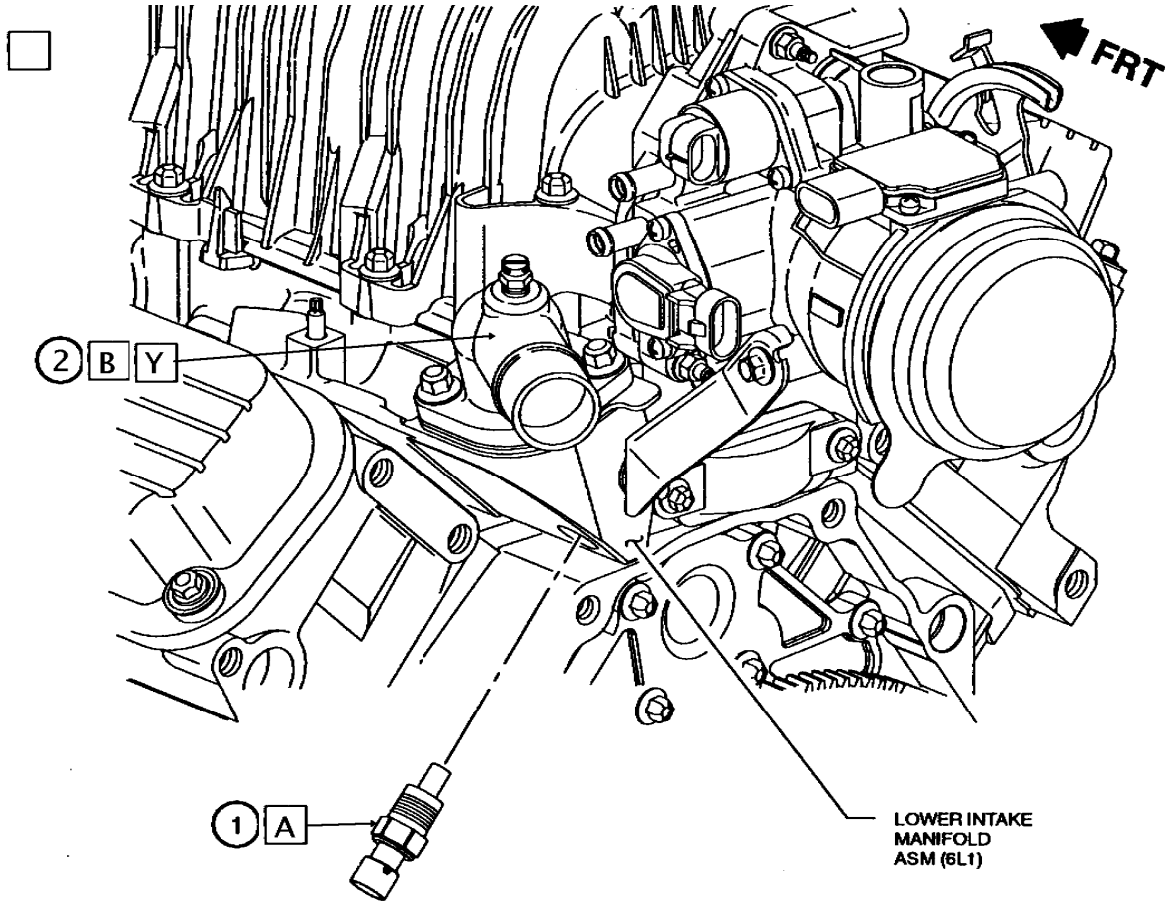
| REV | Date | Revision History |
|---|---|---|
| 1 | 1/6/1998 | Block-49 |
| 2 | 12/15/03 | Update text on reference to procedure for injector flow testing requirements |
| 3 | 7/1/11 | Updated part number for fuel injector rail and added second pressure regulator |
| | | |
| | | |

| View |
|---|
| Injector Assembly |
| Injector assembly installation |

| Long Block Assembly | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 6 | 11 |

# Section 7

# Final Dress




| Description of Operation | |
|---|---|
| A | Install production sensor as a plug only. **Do not use for connection to harness. Disable connector.** |
| B | Install coolant outlet using gasket 24502433 |
| Y | Torque 27Nm |

**Specification**

1 10096181 Sensor
(Used for plug only, disable connector)

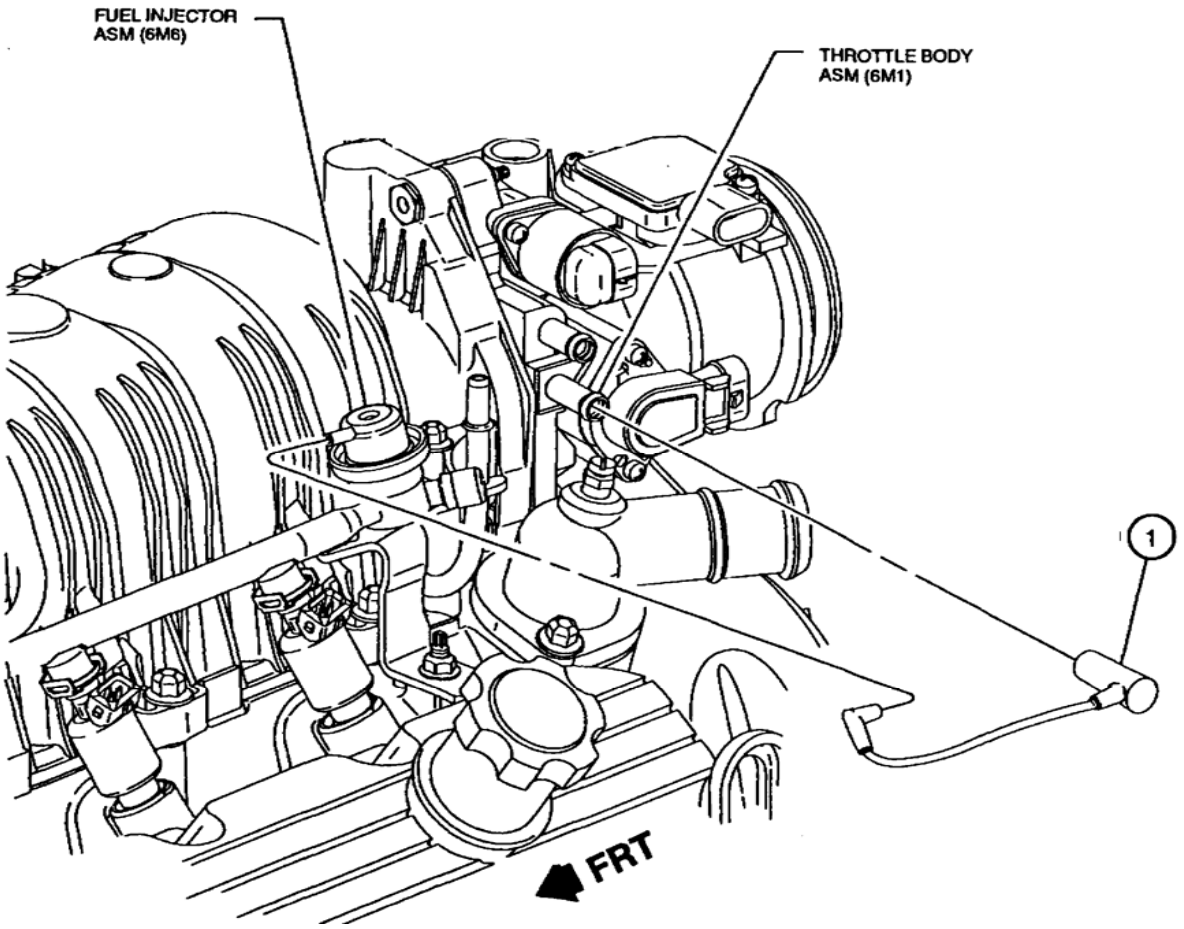
2 OHT3F-034-1 Coolant Outlet and Gasket 24502433
(Not to detail on sheet)

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/10/98 | Block-51 |
| 2 | 7/1/11 | Added coolant outlet gasket part number |
| | | |
| | | |
| | | |

**View**

**Coolant Out & Sensor**

| Final Dress | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 7 | 1 |




**Description of Operation**

**Specification**

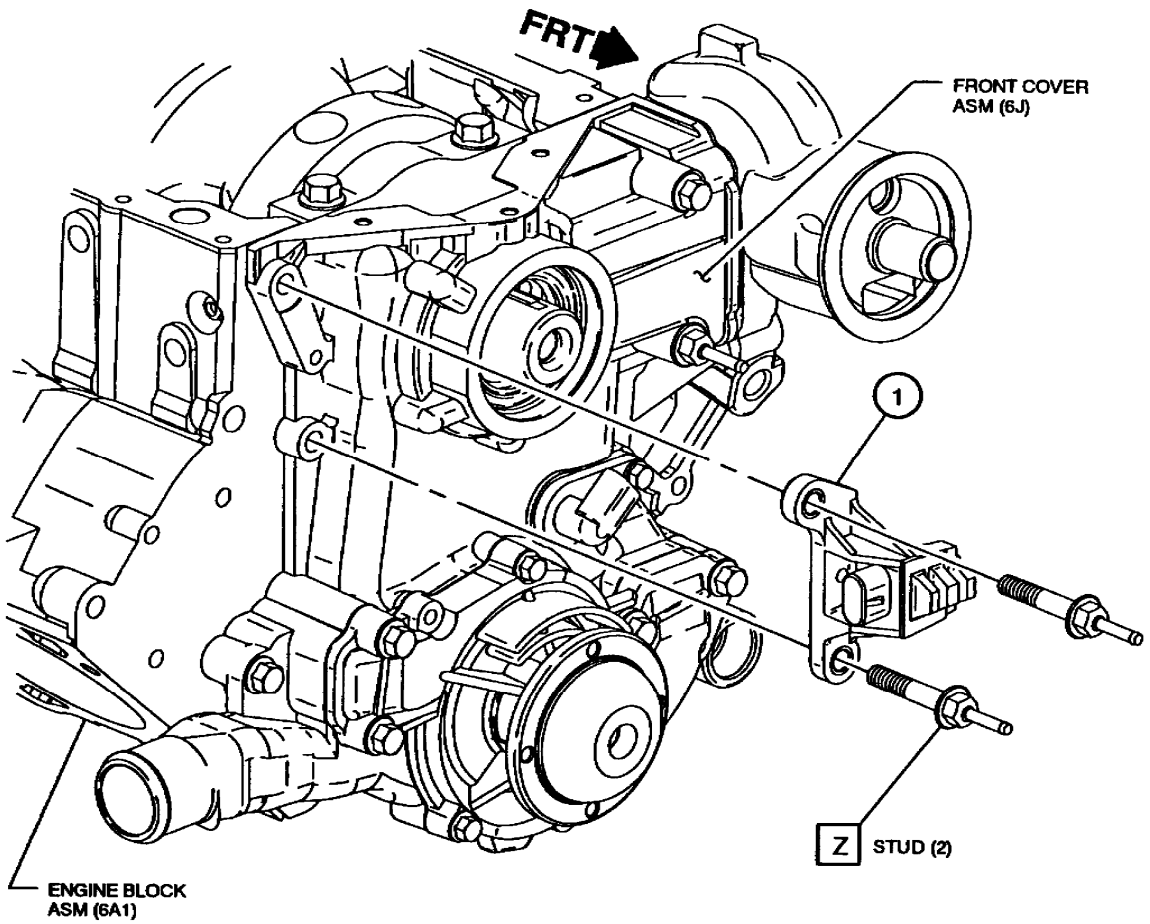
1 24505671 Tube

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/10/98 | Block-52 |
| | | |
| | | |
| | | |
| | | |

**View**

**Vacuum Hose**

| Final Dress | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 7 | 2 |




| Description of Operation | |
|---|---|
| Z | See front cover section for bolt part numbers and torque. |

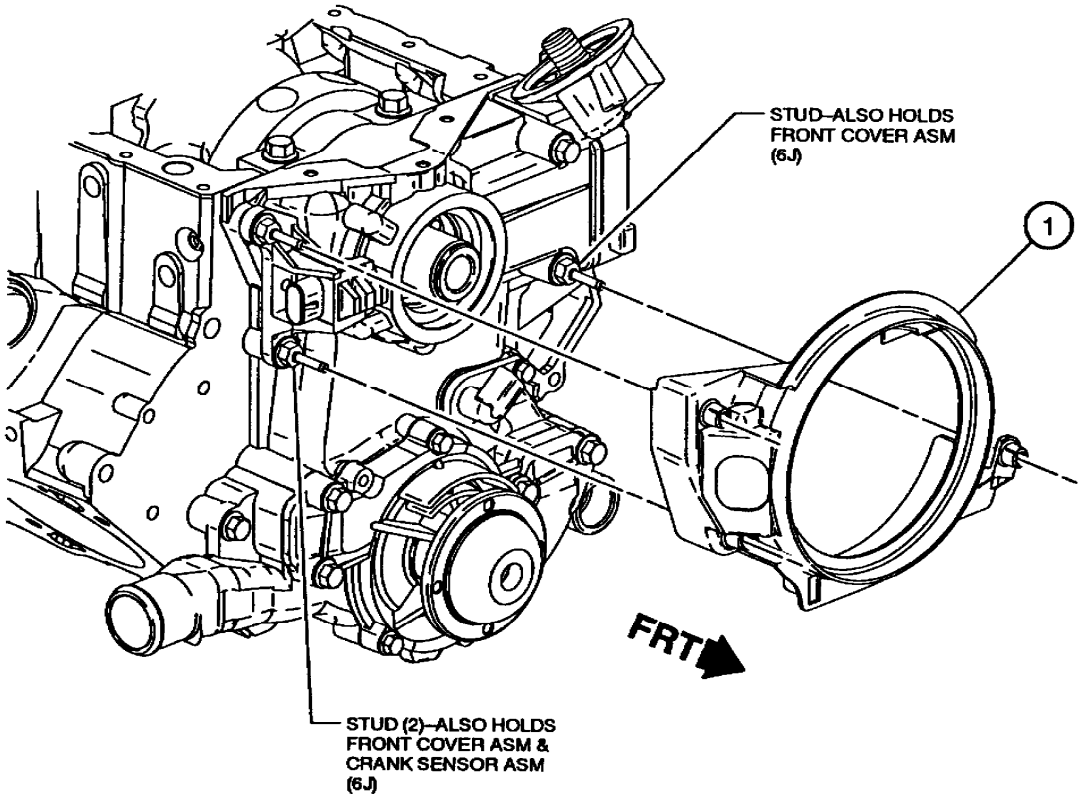
| Specification | | |
|---|---|---|
| 1 | 10456161 | Sensor |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/10/98 | Block-53 |
| | | |
| | | |
| | | |
| | | |

**View**

**Crankshaft Sensor**

| Final Dress | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 7 | 3 |



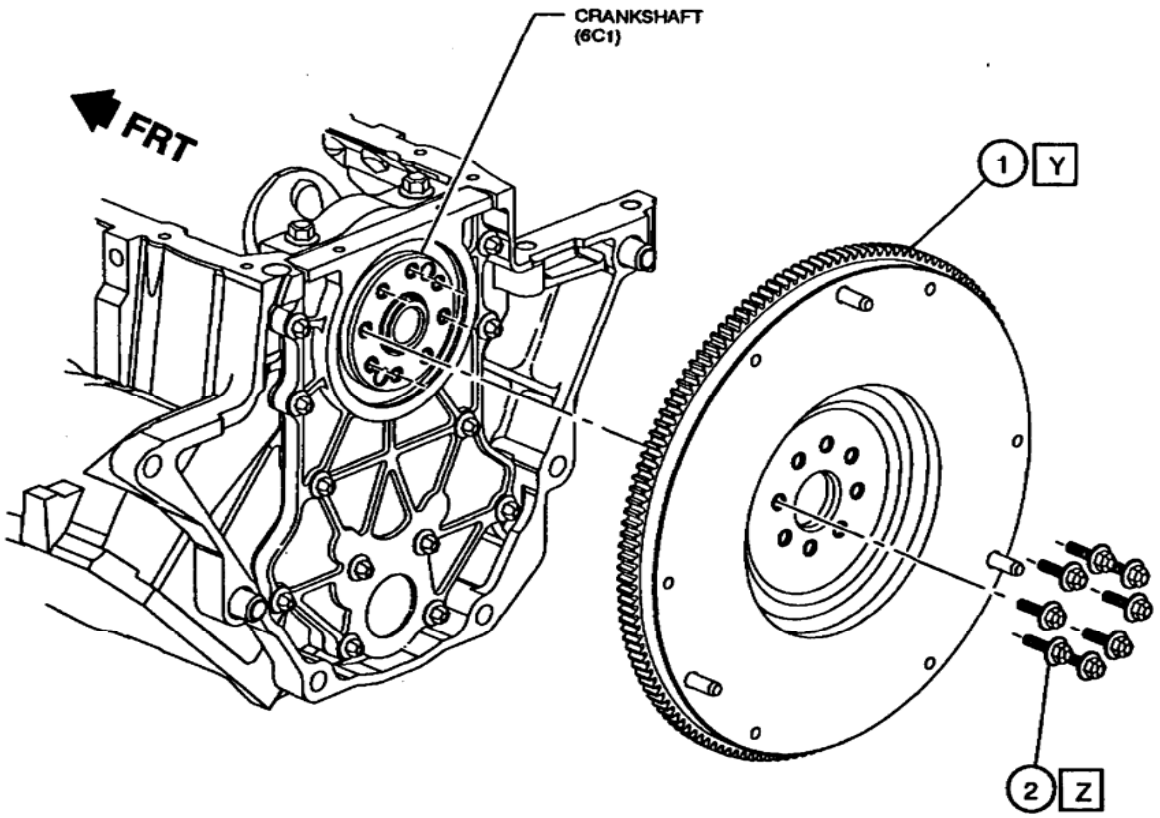

| Description of Operation | |
|---|---|
| | |

| Specification | |
|---|---|
| 1 | 24506440 or 12591982 Sheild |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/10/98 | Block-54 |
| 2 | 12/15/03 | Add 24508586 |
| 3 | 7/1/11 | Part Number Change 12591982 replaces 24508586 |
| | | |
| | | |

| View |
|---|
| Crankshaft Sensor Shield |

| Final Dress | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 7 | 4 |



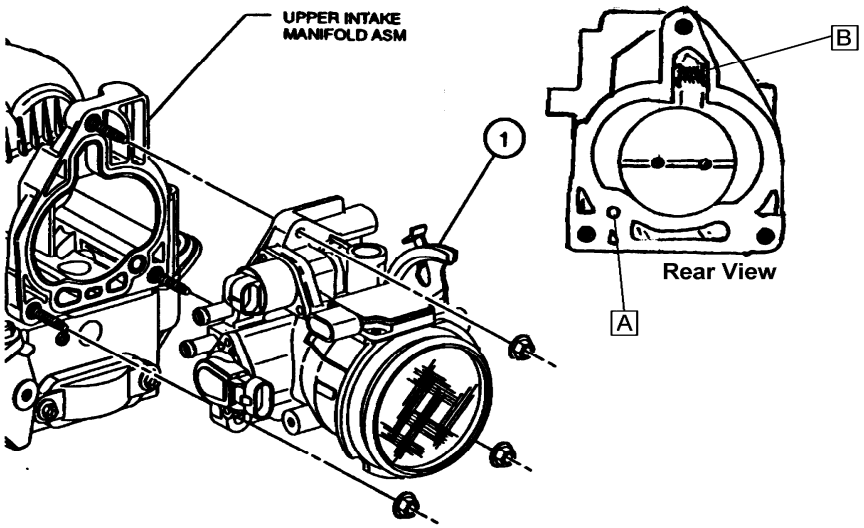

| Description of Operation | |
|---|---|
| Y | OHT-020-2 modified to fit offset balance and adapter plate for Dana 1550 four bolt yoke. |
| Z | Torque & Angle 15Nm + 50° |

| Specification | |
|---|---|
| 1 | OHT3F-020-2 Flywheel (Modified 24503285) |
| 2 | 24505092 Bolt |

| REV | Date | Revision History |
|---|---|---|
| 1 | 1/10/98 | Block-55 |
| | | |
| | | |
| | | |
| | | |

| View |
|---|
| Flywheel |

| Final Dress | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 7 | 5 |




| Description of Operation | |
|---|---|
| A | Drill and tap to receive a hex head plug |
| B | Use power to PCM with engine not running and throttle blade open to drive Idle Air Control motor closed. Disconnect harness connecter and adjust idle screw to obtain 800 RPM base idle.<br><br>As an alternative, the IAC may be removed and both ports plugged using epoxy and welch type plugs. |

**Specification**

1 24507235 Throttle Body
(2 bolt Mass Air Flow Sensor)

| REV | Date | Revision History |
|---|---|---|
| 1 | 11/13/99 | Block-48 |
| 2 | 5/28/03 | Add 12568877 |
| 3 | 6/23/03 | Add 88961007 remanufactured from 12568877 |
| 4 | 7/1/11 | Removed 88961007 and 12568877 |
| | | |

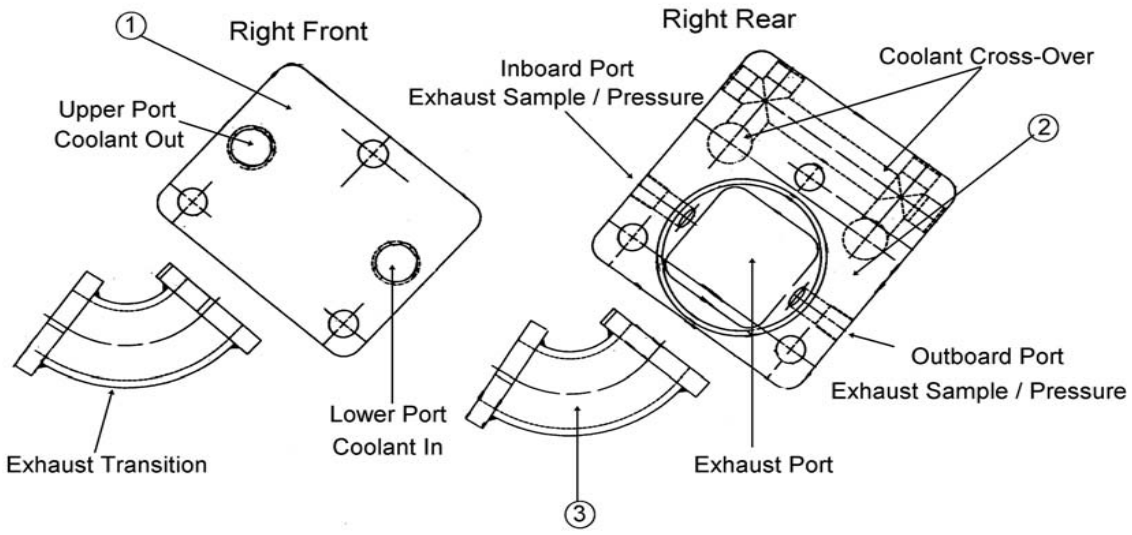
**View**

**Throttle Body Modification**

| Final Dress | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 7 | 6 |

# Section 8

# OH Technologies Special Engine Dress




## Description of Operation

Water cooled exhaust manifold end plates and exhaust manifold transitions. Note: both views are right side showing the cooling water inlet is the lower port and the outlet is the higher port. Also, the inboard exhaust sample port is typically for the gas analysis and the outboard is for the back pressure connection.

Tha transition should be connected with shilded gaskets not shown but identified by part number. Two required per side.

Thermocouples for exhaust coolant in and out should be installed in the fittings attached to the front plate and centered in the coolant flow.

## Specification

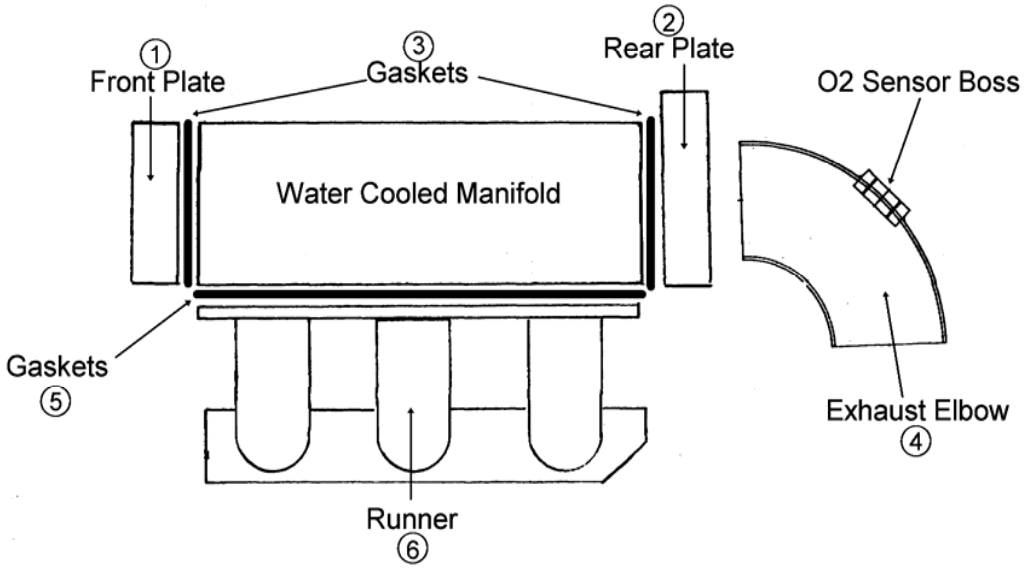
1 OHT3F-006-1 Plate, Rear Exhaust
2 OHT3F-005-1 Plate, Front Ehhaust
3 OHT3F-004-1 Runner, Exh. Man.

| REV | Date | Revision History |
|---|---|---|
| 1 | 11/13/99 | Block-60 |
| 2 | 2/22/02 | Update View Exhaust sample / pressure locations |
| | | |
| | | |
| | | |

**View**

**Water Cooled Exh. Man. End Plates**

| OHT | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 8 | 1 |




**Description of Operation**

Water cooled exhaust manifold

Not to scale

**Note: Do Not Use RTV Sealer on O2 sensor or other exhaust system components upstream of O2 sensor.**

**Specification**

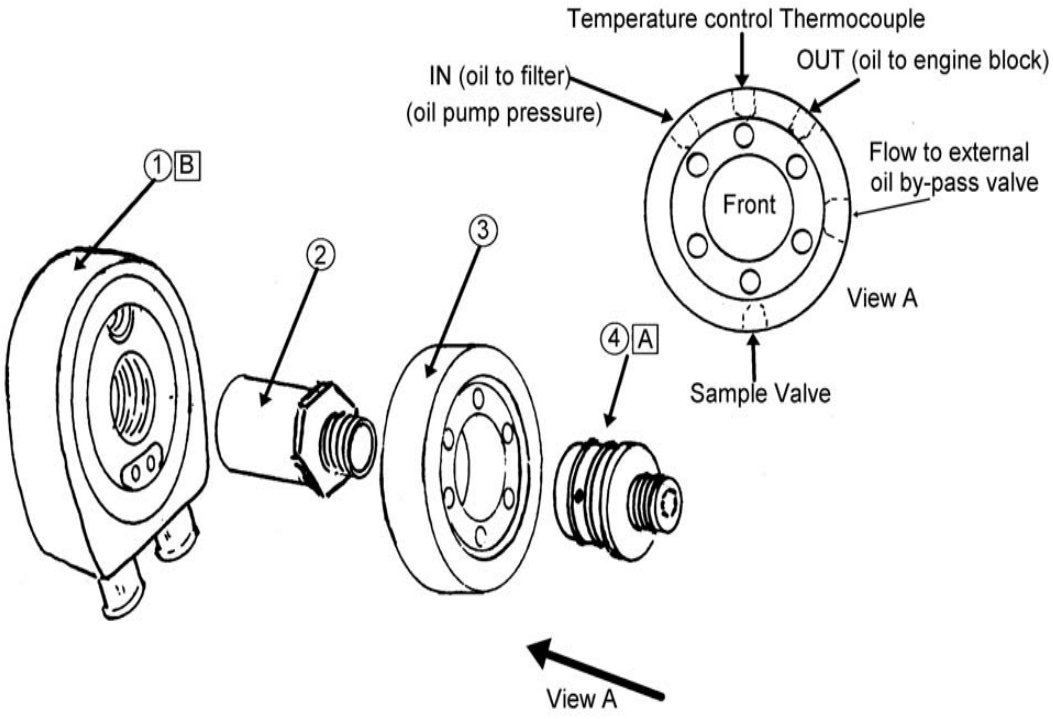
1 OHT3F-005-1 Plate, Front Ehhaust
2 OHT3F-006-1 Plate, Rear Exhaust
3 OHT3F-009-1 Gasket, End Plate
4 OHT3F-005A-1 Elbow, Exh. Modified
5 OHT3F-018-1 Gasket Flange, Metal
6 OHT3F-004-1 Runner, Exh. Man.

| REV | Date | Revision History |
|---|---|---|
| 1 | 11/13/99 | Block-61 |
| 2 | 2/22/02 | Update text, include warning on usage of RTV sealer |
| | | |
| | | |
| | | |

**View**

**Water Cooled Exh. Man. & Elbow**

| OHT | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 8 | 2 |




Note: See section 8 sheet 3a & 3b for additional information

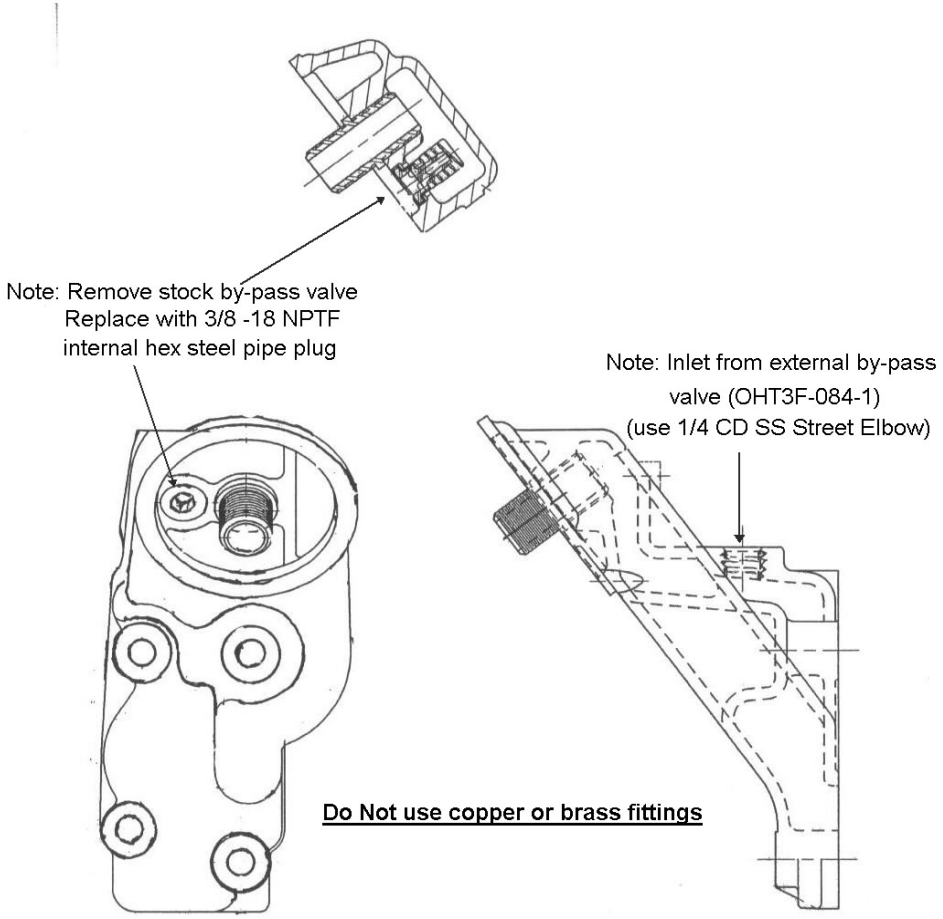
| Description of Operation | |
|---|---|
| A | Replace "O"-rings every test.<br><br>Note: View A<br>Viewed from front or oil filter side, passages are, IN (oil pump pressure to filter), center port for temperature control thermocouple, OUT (oil flow out of filter in to engine block), Side outlet to external oil by-pass valve, and lower port is for oil sample valve. |
| B | Replace oil cooler every test |

| Specification |
|---|
| 1 OHT3F-030-2 Cooler Nickel Plated |
| 2 OHT3F-039-3 Connecter Special Cut |
| 3 OHT3F-035-2 Adapter, Oil Filter |
| 4 OHT3F-043-2 Fitting, Oil Filter Adapter |

| REV | Date | Revision History |
|---|---|---|
| 1 | 11/30/99 | Block 62 |
| 2 | 6/17/02 | Add notes, new part numbers and update view. See next sheet for further details |
| | | |
| | | |
| | | |

| View |
|---|
| Oil Cooler Assembly |

| OHT | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 8 | 3 |




**Description of Operation**

Special part modification information.

Modofied part may be purchased direct from OHT (OHT3F-080-1)

**Specification**

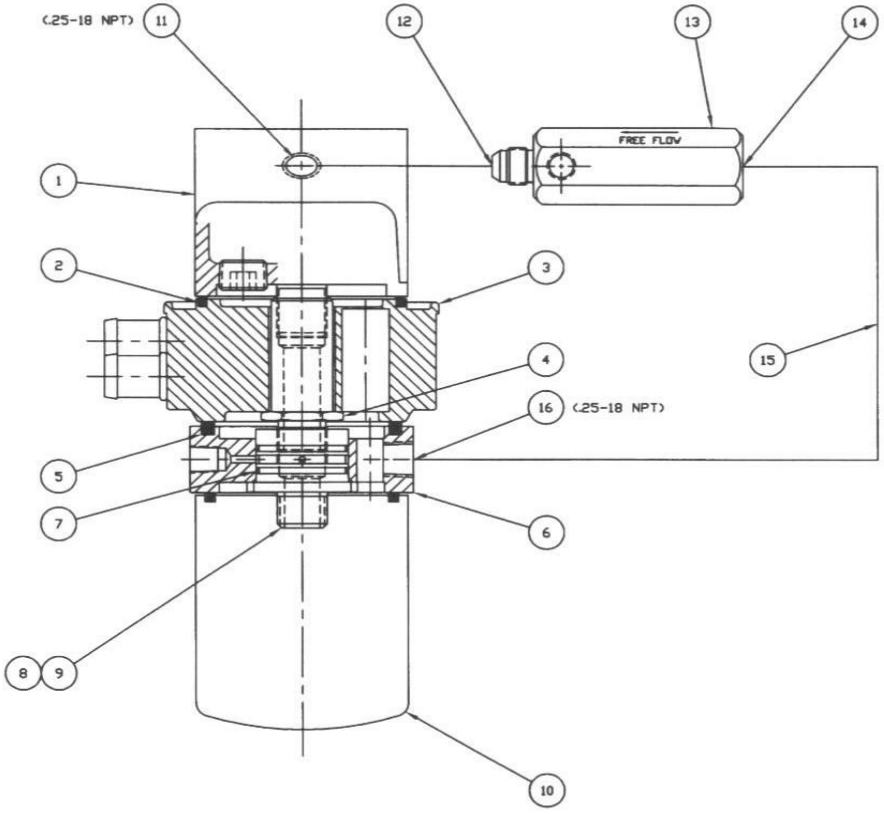
1 24501300 Adapter, oil filter
OHT3F-080-1 Modified

| REV | Date | Revision History |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**View**

**Oil Filter Adapter Modification**

| OHT | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 8 | 3a |




| BILL OF MATERIAL | | |
|---|---|---|
| ITEM | REQ'D | DESCRIPTION |
| 1 | 1 | BLOCK, OIL FILTER, MODIFIED W/BYPASS BLOCKED, |
| | | OHT3F-080-1 |
| 2 | 1 | SEAL, RECTANGULAR, OHT3F-074-1 |
| 3 | 1 | COOLER, OIL, NICKEL PLATED, BYPASS CLOSED, |
| | | OHT3F-030-2 |
| 4 | 1 | CONNECTOR, MODIFIED, OHT3F-039-3 |
| 5 | 1 | SEAL, RECTANGULAR, OHT3F-062-1 |
| 6 | 1 | ADAPTER, OIL FILTER, OHT3F-035-2 |
| 7 | 2 | SEAL, O-RING, #2-025-VITON PARKER |
| 8 | 1 | FITTING, OIL FILTER ADAPTER, .500" I.D., |
| | | OHT3F-043-2 |
| 9 | 1 | WRENCH, SPANNER, (FOR USE W/ITEM #8), |
| | | OHT3F-083-1 |
| 10 | 1 | FILTER, OIL (PF-47), OHT3F-057-1 |
| 11 | 1 | ELBOW, STREET, #1/4 CD-SS PARKER |
| 12 | 1 | CONNECTOR, SWIVEL, #6 F6X-SS PARKER |
| 13 | 1 | HOUSING, ASS'Y, BYPASS VALVE, OHT3F-084-1 |
| 14 | 1 | CONNECTOR, MALE, #6-8FTX-SS PARKER |
| 15 | 1 | (.31 I.D. X 12.00 LG.) BRAIDED TEFLON HOSE ASS'Y, |
| | | #K9190606-060606C-012.0 PARKER |
| 16 | 1 | CONNECTOR, MALE, #6FTX-SS PARKER |

ASSEMBLE ALL SEALS WITH A LIGHT COATING OF #EF411 OIL

DIMENSIONS IN PARENTHESES ARE IN INCHES

METRIC
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS

| SYM | REVISIONS | DATE |
|---|---|---|

TOLERANCES UNLESS SPECIFIED
DECIMAL
X.X = ±0.3
XXX = ±0.10
ANGULAR ±1°
SURFACES 3.2

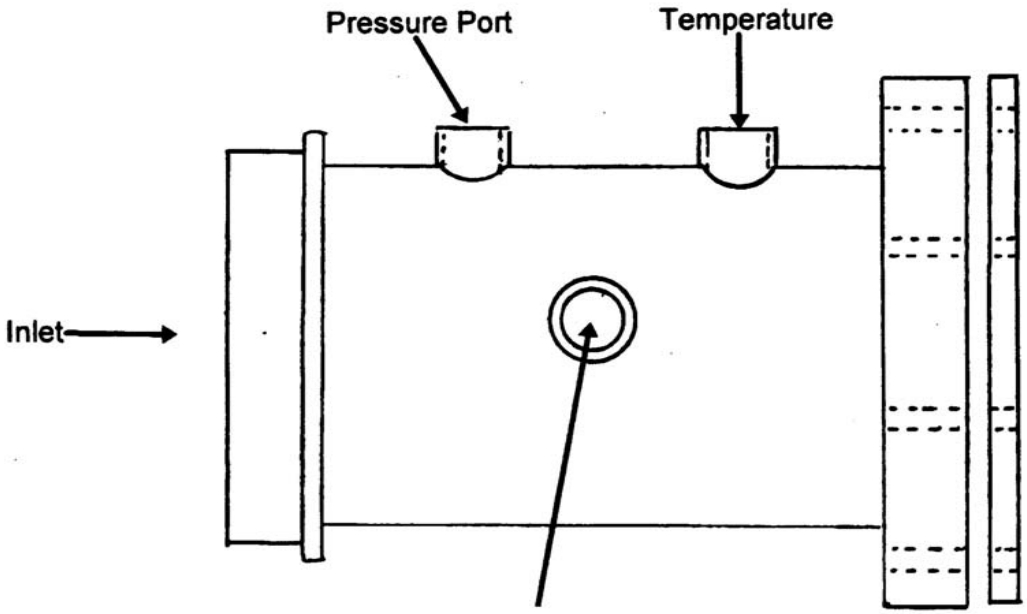
TITLE ASS'Y, OIL FILTER, COOLER & BYPASS
MATERIAL SEE B/M
SCALE FULL
DATE 6-6-02
CHECKED BY D.H.
DRAWN BY D.H.
ASSEMBLY

OH TECHNOLOGIES INC.
DWG. NO. OHT3G-XXX-1



| REV | Date | Revision History | View |
|---|---|---|---|
| 1 | 6/17/02 | OHT Print | **OHT Oil Cooling & By-Pass** |
| | | | Printed by permission OH Technologies |
| | | | |
| | | | |
| | | | |

| OHT | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 8 | 3b |




Inlet Air Temperature Sensor

"Dyno Harness"

**Description of Operation**

Inlte air adapter

Use pressure port for hookup to transducer, temperature for thermocouple (centered in flow), and inlet air pressure sensor port for Dyno Harness sensor.

**Specification**

OHT3F-001-2 Adapter, Throttle Body

| REV | Date | Revision History |
|---|---|---|
| 1 | 11/30/99 | Block-63 |
| 2 | 2/22/02 | Update View, Inlet Air Temp. Sensor |
| | | |
| | | |
| | | |

**View**

**Adapter, Throttle Body**

| OHT | Sequence IIIG | Section | Sheet |
|---|---|---|---|
| | | 8 | 4 |