Sequence IIIF Engine Oil Certification Test
Engine Assembly Manual

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Revision 04
December 6, 2004

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Section 0

Hardware usage guidelines

All materials used in this test must conform to acceptance guidelines as specified in the ASTM Sequence IIIF Test Procedure 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 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.

Section 01

Revision Update Timeline

Sequence IIIF Engine Assembly Manual Update Revision Timeline

Latest Revision 4

Date 12/6/2004

Contact Person Mike Kasimirsky TMC 412-365-1033
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Date	Sec.	Sheet	Topic	Comments
2/4/02	1	1	New Block and Pre-Hone Prep	Check main bore and cam tunnel alignment
11/6/99	1	2	New Block and Pre-Hone Prep	Dip stick reamer, cam tunnel prep
6/17/02	1	2	New Block and Pre-Hone Prep	Add Rotory Tool Information
11/6/99	1	3	New Block and Pre-Hone Prep	Update drawing, indicated fastener locations
6/17/02	1	3	New Block and Pre-Hone Prep	Change sealer to Perfect Seal #4
2/1/02	1	4	New Block and Pre-Hone Prep	Update etxt, Class 2B Tap & Reamer
11/6/99	1	5	New Block and Pre-Hone Prep	Update drawing
9/5/00	1	5A	New Block and Pre-Hone Prep	Jet Washer parts cleaning procedure
2/1/02	1	5A	New Block and Pre-Hone Prep	Add PDN 50 Soap
2/1/02	1	6	New Block and Pre-Hone Prep	Update text "Add line C" "Main cap side bolts"
11/6/99	1	7	New Block and Pre-Hone Prep	Add head gasket part numbers
12/1/99	2	7	Cylinder Honing	Change note from 0.0005" to 0.005"
10/12/98	3	3	Short Block Assembly	Update 2nd design block & part numbers
11/7/99	3	3	Short Block Assembly	Update part numbers and note 3 (can tunnel de-burring)
6/22/00	3	3	Short Block Assembly	Update part numbers (cam bearings)
11/7/99	3	4	Short Block Assembly	Update oil gallery cleaning
9/7/00	3	4	Short Block Assembly	Update part numbers (engine bearings)
11/6/99	3	5	Short Block Assembly	Update crankshaft cleaning (Mylar Tape Polishing)
6/17/02	3	5	Short Block Assembly	Update "A" polishing of crankshaft
9/5/00	3	5	Short Block Assembly	Update crankshaft cleaning (Mylar Tape Polishing)
9/7/00	3	6	Short Block Assembly	Update part number (engine bearing)
2/1/02	3	6	Short Block Assembly	Update description, Add C, change Z to Y3"
11/13/99	3	8	Short Block Assembly	Update ring gap dimensions
6/20/00	3	8	Short Block Assembly	Update ring gap dimensions
9/7/00	3	8	Short Block Assembly	Update ring gap instructions and part numbers
2/1/02	3	8	Short Block Assembly	Add Starrett Taper Gage
11/7/99	3	9	Short Block Assembly	Update part number (engine bearing)
11/13/99	3	11	Short Block Assembly	Add De-burring operation
6/22/00	3	11	Short Block Assembly	Update part number (0.153" thrust plate)
10/18/00	3	11	Short Block Assembly	Update operation (thrust face de-burring)

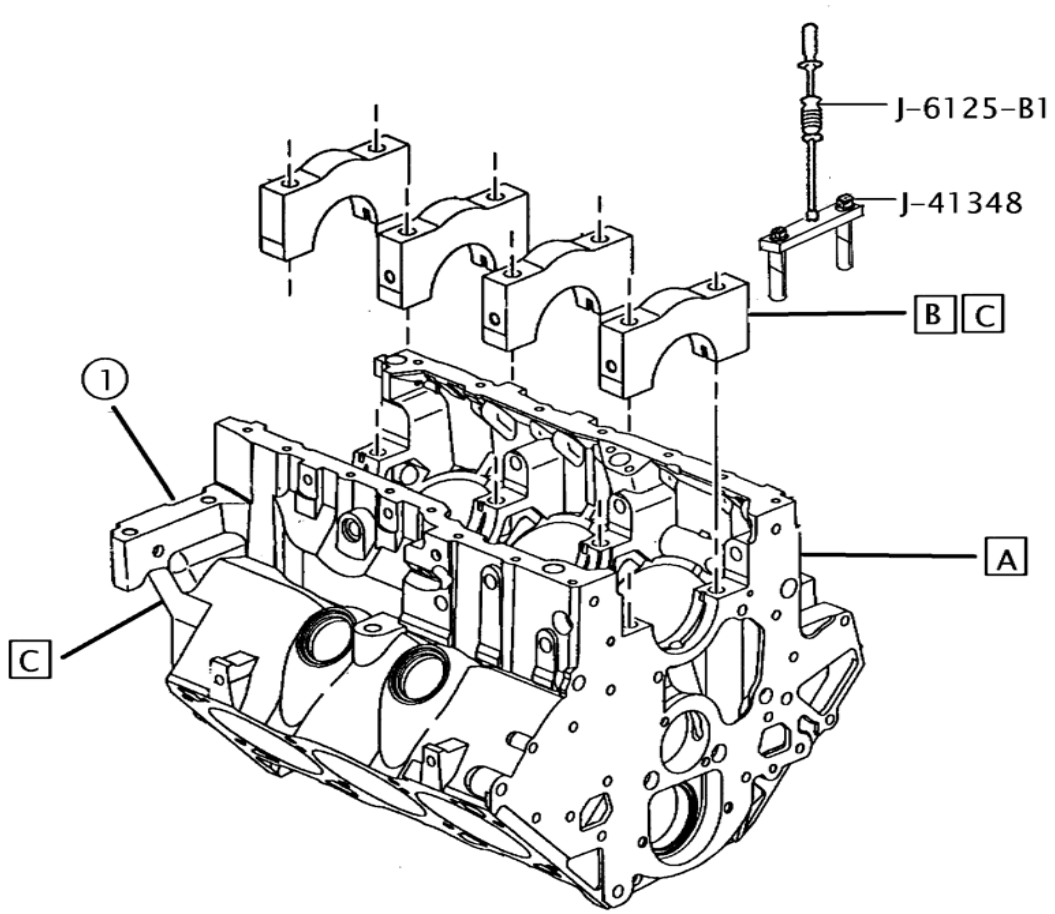
Date	Sec.	Sheet	Topic	Comments
2/1/02	3	11	Short Block Assembly	Add note item #2, 0.152" Thrust Plate & Camshaft Prt. No.
11/7/99	3	13	Short Block Assembly	Update view "A"
6/17/02	3	13	Short Block Assembly	Add inspection of balance shaft drive gear
11/7/99	3	14	Short Block Assembly	Update view "A,B,Z"
2/1/02	3	14	Short Block Assembly	Update torque and replace each test, camshaft bolt
11/6/99	4	1	Front Cover, Rear Cover & Sump	Update view, add adaptor
10/18/00	4	2	Front Cover, Rear Cover & Sump	Update oil pump gear clearance
02/114/02	4	2	Front Cover, Rear Cover & Sump	Add clearance specification
6/17/02	4	2	Front Cover, Rear Cover & Sump	Add inspection of oil gear housing in front cover
12/1/99	4	4	Front Cover, Rear Cover & Sump	Add sealer usage
2/14/02	4	4	Front Cover, Rear Cover & Sump	Add clearance specification
6/17/02	4	4	Front Cover, Rear Cover & Sump	Update view, add info on by-pass valve with reference
12/1/99	4	6	Front Cover, Rear Cover & Sump	Add sealer usage
12/1/99	4	7	Front Cover, Rear Cover & Sump	Add thermocouple information
12/1/99	4	10	Front Cover, Rear Cover & Sump	Add sealer usage
12/1/99	4	12	Front Cover, Rear Cover & Sump	Add sealer usage
2/14/02	4	12	Front Cover, Rear Cover & Sump	Add clearance check
6/22/00	4	13	Front Cover, Rear Cover & Sump	Add new oil pan part number
11/13/99	5	1	Head Assembly	Update part number (valve spring)
12/1/99	5	1	Head Assembly	Update velve spring calibration
2/22/02	5	1	Head Assembly	Update valve spring calibration
11/13/99	6	1	Long Block Assembly	Update lifter part number and installation instructions
6/22/00	6	1	Long Block Assembly	Add ACI test lifter
2/22/02	6	1	Long Block Assembly	Update test lifter part number
6/18/02	6	2	Long Block Assembly	Add oiling of pushrod ball ends
11/13/99	6	4	Long Block Assembly	Remove SPO part number for rocker arm bolts
12/1/99	6	4	Long Block Assembly	Add note on engine rotation
12/1/99	6	6	Long Block Assembly	Update part number (RTV sealer)
2/22/02	6	6	Long Block Assembly	Delete first design intake gasket
11/30/99	6	7	Long Block Assembly	Add exploded view
6/22/00	6	7	Long Block Assembly	Update coolant return line description
2/22/02	6	7	Long Block Assembly	Add Perfect Seal #4
6/17/02	6	7	Long Block Assembly	Change to Permatex #2
6/17/02	6	8	Long Block Assembly	Add "Max. torque"
11/13/99	6	9	Long Block Assembly	Update part number and modification information
2/22/02	6	9	Long Block Assembly	Update throttle body part numbers

Date	Sec.	Sheet	Topic	Comments
6/17/02	6	9	Long Block Assembly	Change part number 2 bolt Mass Air Flow Sensor
11/13/98	6	11	Long Block Assembly	Update part number and view
2/22/01	6	11	Long Block Assembly	Update description, "Procedure Reference"
9/5/00	6	11A	Long Block Assembly	Add injector flow procedure
2/22/02	6	11A	Long Block Assembly	Delete Sheet
2/22/02	7	6	Final Dress	Update throttle body part numbers
2/22/02	8	1	OHT	Update view "Add exhaust sample / pressure"
2/22/02	8	2	OHT	Add warning on RTV Sealer
6/17/02	8	3	OHT	Update view & part numbers
6/17/02	8	3a	OHT	Add Sheet
6/18/02	9	3b	OHT	Add Sheet
2/22/02	8	4	OHT	Change view "inlet air temperature sensor"
5/28/03	4	3	Front Cover, Rear Cover & Sump	Change front cover part number
6/23/03	6	9	Long Block Assembly	Update Mass Air Flow part numbers
6/23/03	7	6	Final Dress	Update Mass Air Flow part numbers
12/15/03	6	6	Long Block Assembly	Update RTV sealer
12/15/03	6	11	Long Block Assembly	Update injector flow testing
12/15/03	7	4	Final Dress	Update part numbers
3/15/04	6	6	Long Block Assembly	Update intake gasket part number
11/4/04	1	1	New Block and Pre-Hone Prep	Change from engineering part # to actual part #
11/4/04	1	5	New Block and Pre-Hone Prep	Change to mineral spirit
12/1/04	1	5A	New Block and Pre-Hone Prep	Change to mineral spirit
11/4/04	1	6	New Block and Pre-Hone Prep	Update torque and fastener usage
12/6/04	2		New Block and Pre-Hone Prep	Update complete honing section per 12/15/2003
12/1/04	3	5	Short Block Assembly	Change to mineral spirit
11/16/04	3	7	Short Block Assembly	Add Powdered Rod part number
11/16/04	3	9	Short Block Assembly	Add torque for Powdered Rods
12/1/04	3	11	Short Block Assembly	Change to mineral spirit
11/3/04	4	1	Front Cover, Rear Cover & Sump	Change front seal part number
11/3/04	4	5	Front Cover, Rear Cover & Sump	Change front seal part number
11/3/04	4	9	Front Cover, Rear Cover & Sump	Change rear seal part number
11/3/04	4	12	Front Cover, Rear Cover & Sump	Change sealer info and pan gasket part number
11/3/04	5	1	Head Assembly	Change exhaust valve part number
12/1/04	5	1	Head Assembly	Change to mineral spirit
12/1/04	6	1	Long Block Assembly	Change to mineral spirit
12/1/04	6	2	Long Block Assembly	Change to mineral spirit

Date	Sec.	Sheet	Topic	Comments
12/1/04	6	4	Long Block Assembly	Change to mineral spirit

Section 1

Cleaning and Pre Hone Preparation



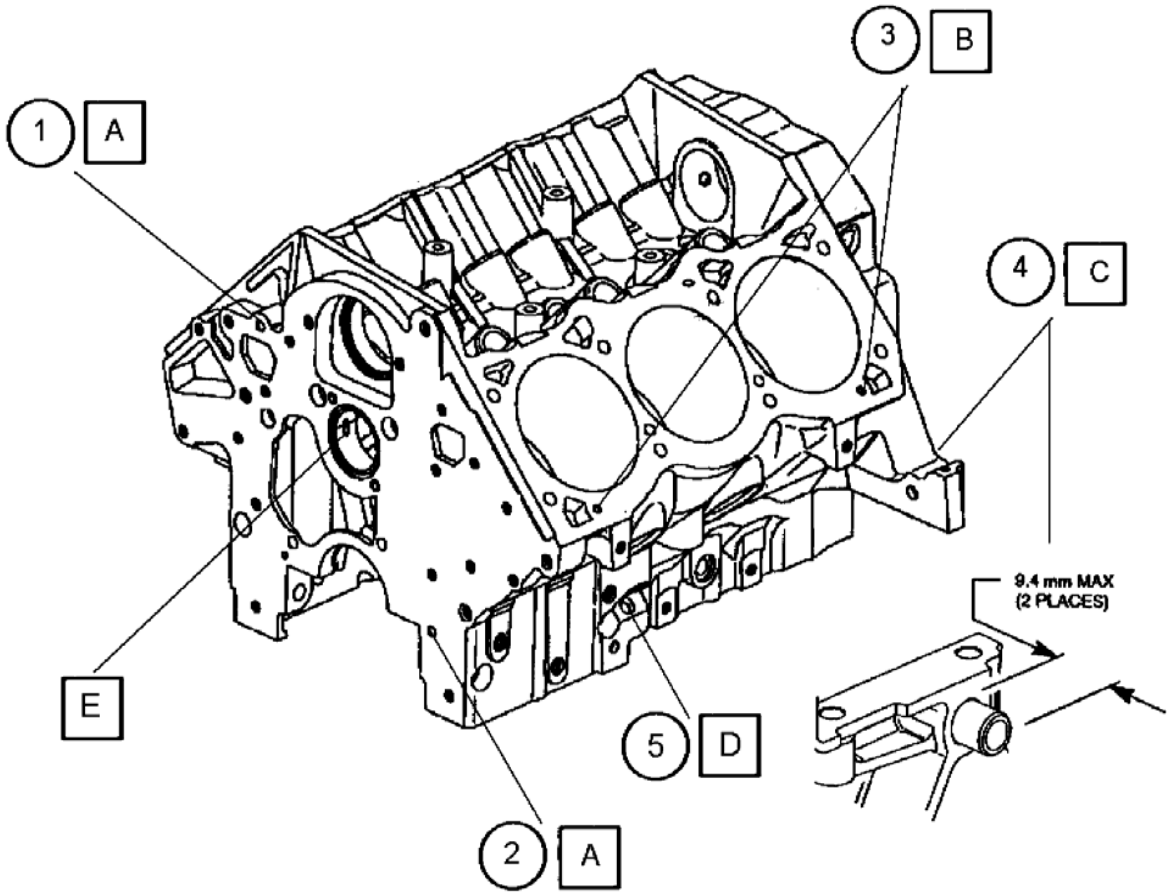
Description of Operation	
A	Upon introduction of a new block into the system, check for any damage to machined surfaces which might have occurred during shipping or handling. Check main bore and camshaft tunnel alignment using appropriate manderals.
B	Remove main cap side & main bolts. Use Kent-Moore 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	02/04/02	Update "A" (check main bore and camshaft tunnel alignment)
3	11/04/04	Change from engineering drawing part # (24506028) to actual part # 24502286

View
Engine Block
New block and pre-hone prep Serial Number Locations

New Block and Pre-Hone Prep	Sequence IIIF	Section	Sheet
		1	1



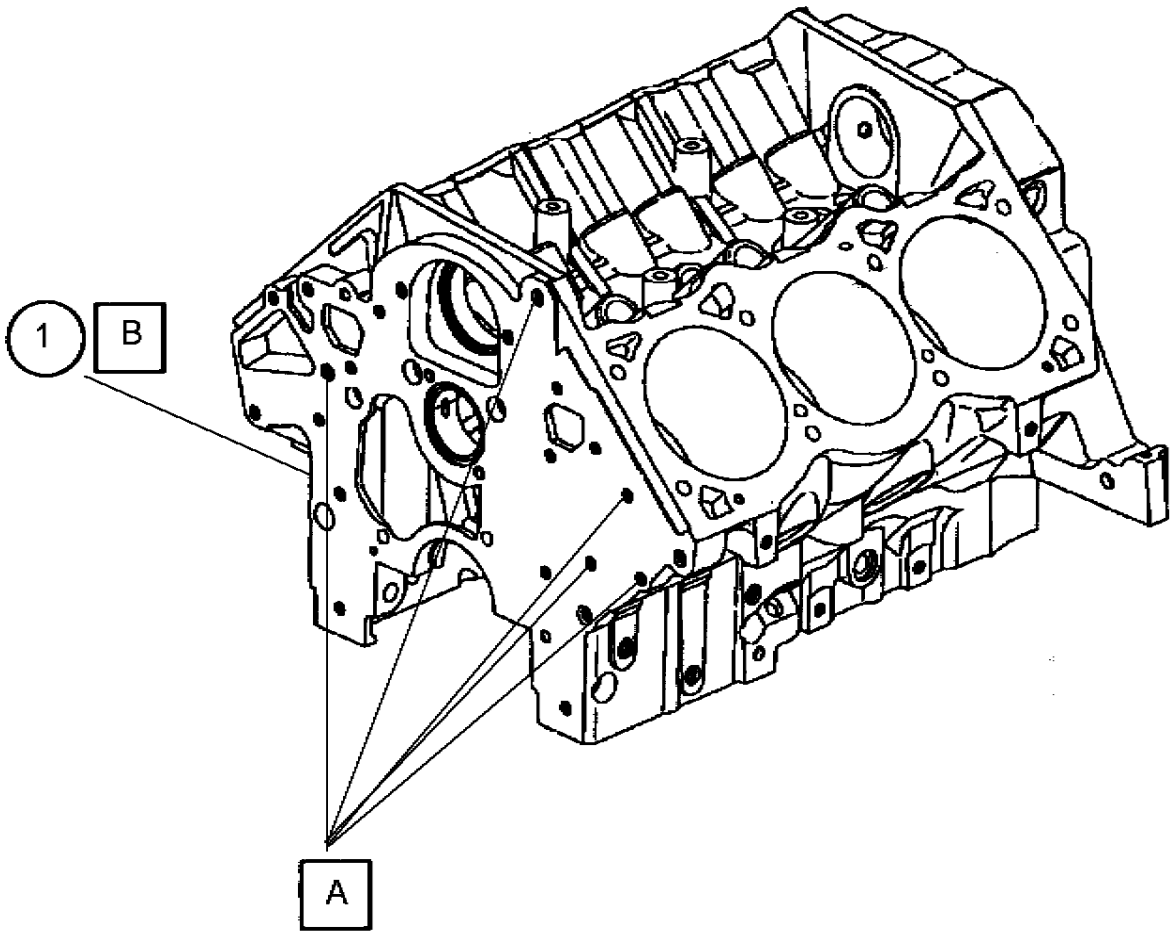
Description of Operation	
A	Install locating pins on front face.
B	Install locating pins on cylinder deck
C	Install locating pins on rear transmission mount face.
D	Use OHT3F-071-1 reamer to size dip stick hole for calibrated dip stick
E	Deburr all leading edges of camshaft tunnel bores and oil gallery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

Specification	
1	24501162 Pin Front Cover Upper
2	25536323 Pin Front Cover Lower
3	25536320 Pin Cyl. Head Location
4	12338076 Pin Trans. Location
5	OHT3F--071-1 Reamer

REV	Date	Revision History
1	12/31/97	Block-2
2	11/6/99	Add Operation "D" & "E" and OHT3F-071
3	6/17/02	Revise operation "E" include rotory tool and accessories

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 IIIF	Section	Sheet
		1	2



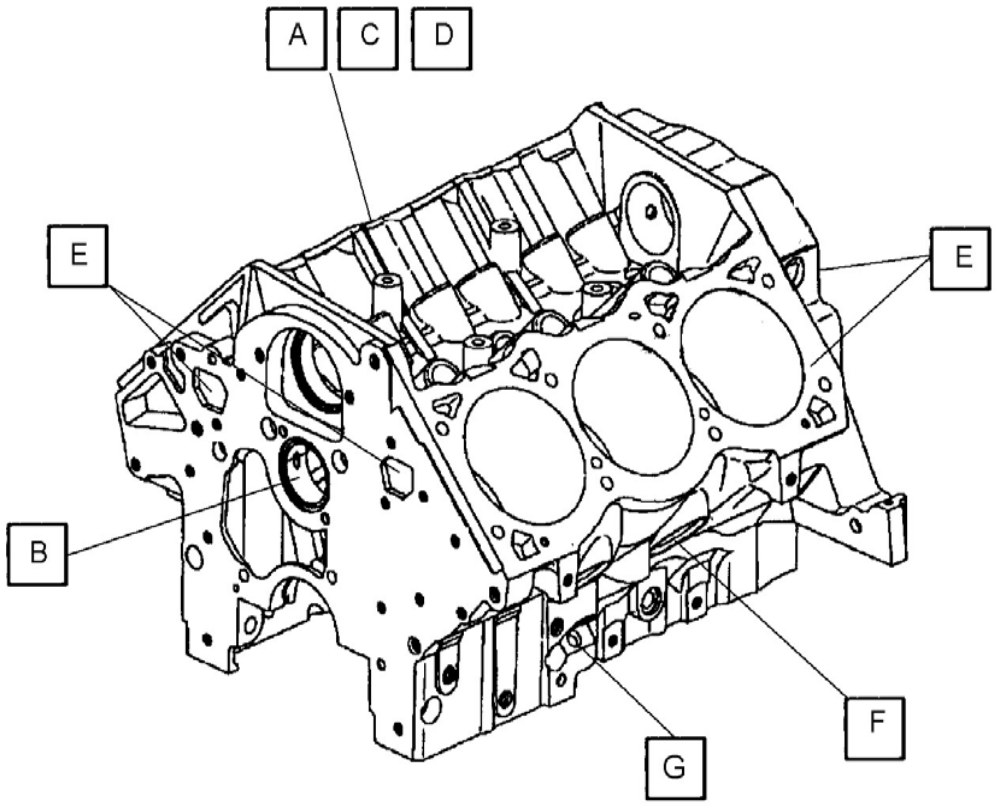
Description of Operation	
A	Install threaded fasteners with #2 Non-Hardening Permatex or Perfect Seal #4 in locations identified in view.
B	Install 1/4NPT plug in main oil gallery on the right front side of engine block. Note: This location is not to be used for temperature control or thermocoupled.

Specification	
1	444777 Plug Auto Hex Socket

REV	Date	Revision History
1	12/31/97	Block-3
2	11/6/99	Change location in group "A"
3	6/17/02	Add Perfect Seal to "A"

View
Engine Block
New block and pre-hone prep Plugged holes in front of engine

New Block and Pre-Hone Prep	Sequence IIIF	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	Install block-off plates over the coolant passages on the front face, rear face, and cylinder deck. (Fabricate in-house)
F	Install coolant Welch plugs.
G	Ream dip stick hole using OHT3F-071-1 reamer for calibrated dip stick.

Specification

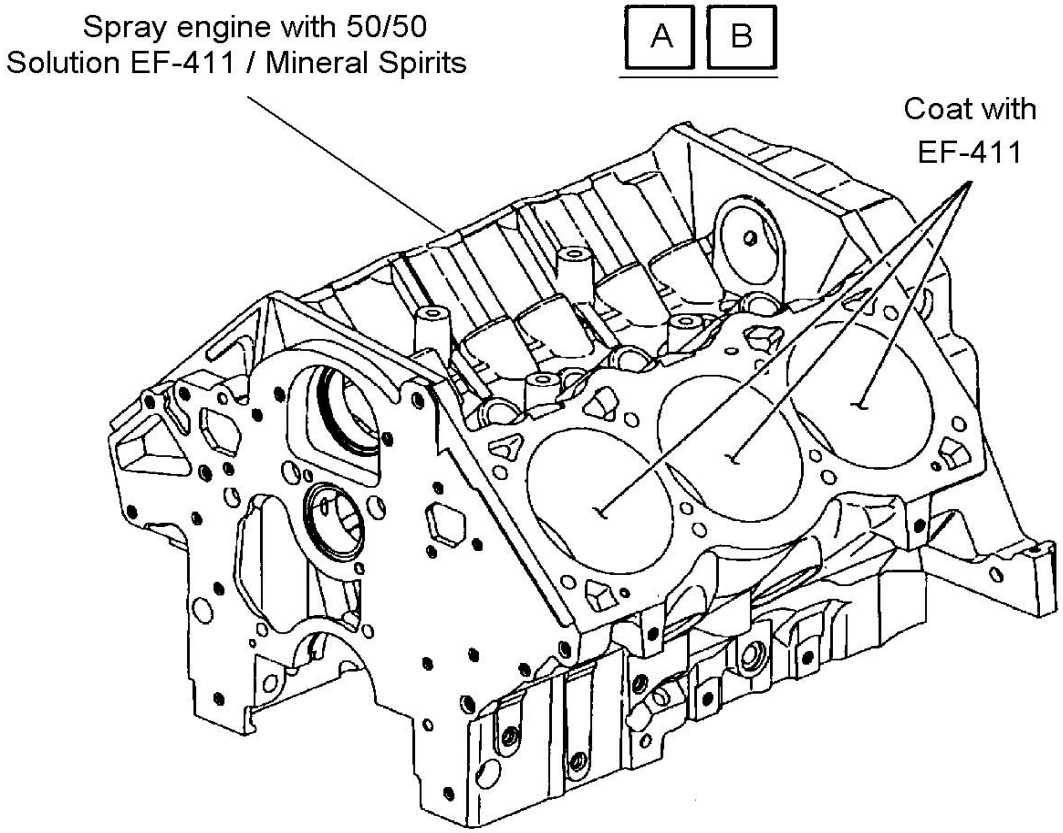
REV	Date	Revision History
1	12/31/97	Block-4
2	2/1/02	Update text "D" Add Class 2B Tap "G" Add reamer operation

View

Engine Block

New block and pre-hone prep

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



Description of Operation	
A	The engine may be cleaned using an automated washing device, however, caution should be used to prevent oxidation flash over of the ferrous surfaces. Note: Do not use caustic chemicals or acid type baths. See 5A
B	The block must be thoroughly cleaned using brushes through the oil galleries, camshaft tunnel, and cylinder bores with mineral spirits to remove any detergent residue before honing.
?	(Step Sec. 1 sheet 6) Repeat step "A & B" after honing. Note: If this is the final cleaning after honing, spray the entire engine block using a 50/50 solution of EF-411 and mineral spirits. Air dry to remove excess solution.
?	(Step Sec. 3 sheet 1)

Specification

REV	Date	Revision History
1	12/31/97	Block-5
2	11/6/99	View update
3	11/4/04	Update, change to mineral spirits

View

Engine Block

Engine block cleaning

New Block and Pre-Hone Prep	Sequence IIIF	Section	Sheet
		1	5

Automatic Parts Washer Procedure for IIIF Engine Blocks

1) Use only NAT-50-S or PDN-50 soap at a concentration of 16 pounds of soap per 100 gallons of water.

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 engine 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 is complete, immediately remove the block from the washer and spray it down with mineral spirits.

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

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

Description of Operation

Specification

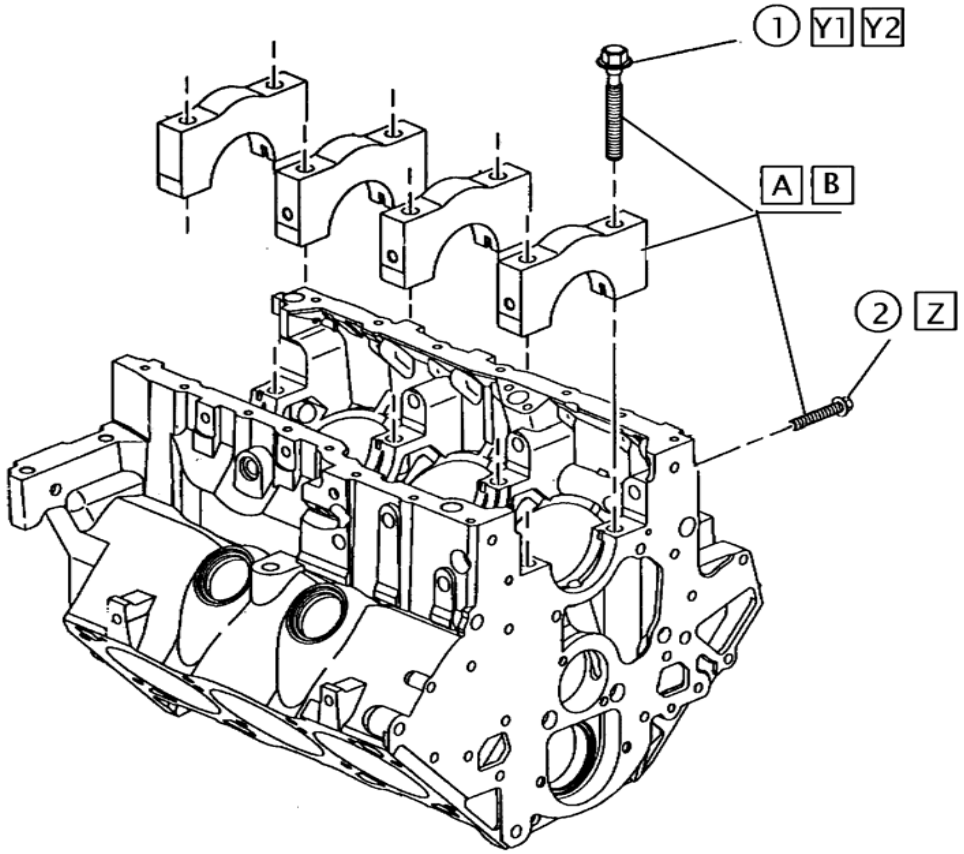
REV	Date	Revision History
1	9/5/00	Procedure for Better Engineering Jet Washer usage
2	2/1/02	Update line item 1. "Add PDN-50 soap"
3	12/1/04	Update change to mineral spirits

View

Engine Block

Engine block cleaning procedure for automated type jet washers

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



Description of Operation	
A	Clean and oil all main cap bolts (EF-411) and install main caps.Note: Do not use air tools to run main caps down.
B	Install main cap with fasteners as guides and tap into position with plastic mallet or use very light pressure by hand with speed handle and socket in crisscross pattern to draw the main cap down.
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.
Y2	Torque & Angle 20Nm then 40Nm + 35°+35°+35° (repeat 40Nm + 35° 3 times from center out)(use used fasteners for honing)
Z	Torque & Angle 15Nm + 45°

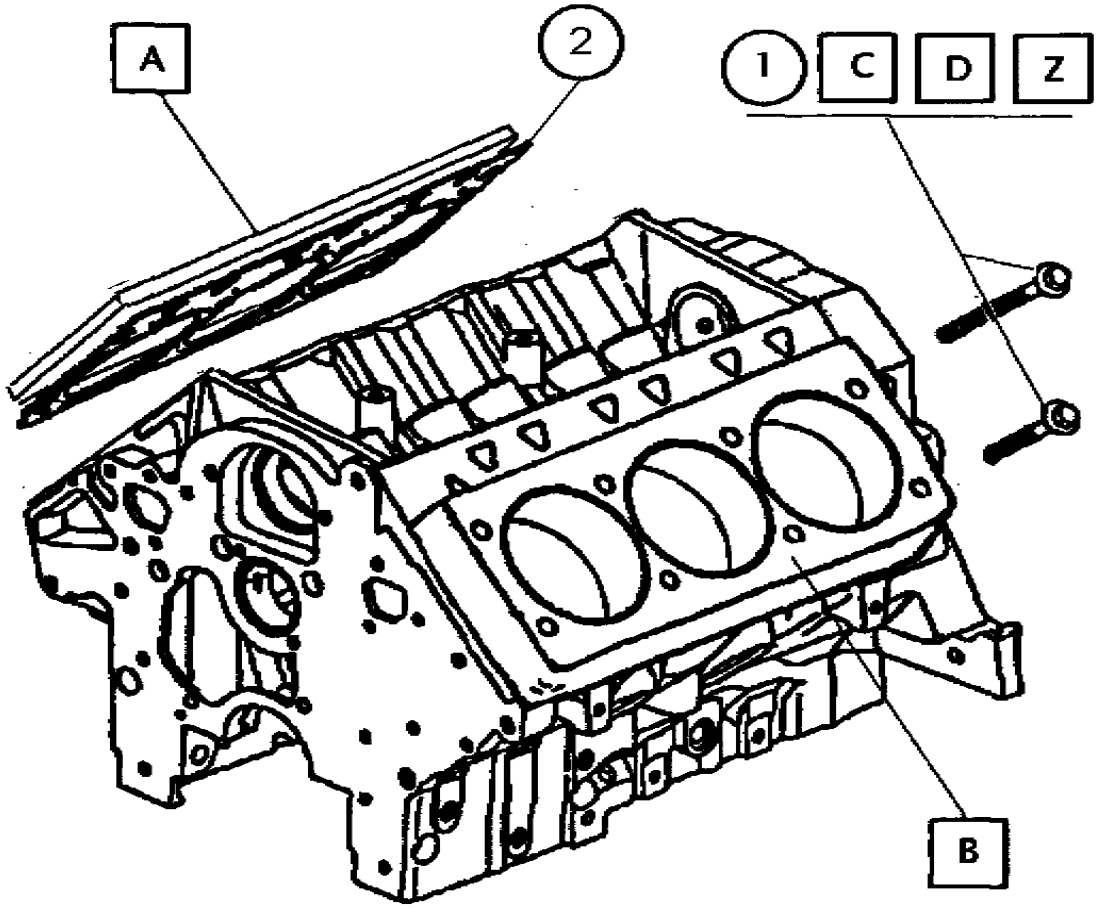
Specification	
1	24503056 Bolt (8) see note Y (Tighten before Z)
2	24505576 Bolt (6) see note Z (Tighten after Y)

REV	Date	Revision History
1	1/10/98	Block-6
2	2/1/02	Update text, "Add line C"
3	11/4/04	Clarification, add 40Nm + 35° 3 times… and (use used fasteners for honing) to Y2

View
Engine Block
Main cap installation

New Block and Pre-Hone Prep | **Sequence IIIF**

Section	Sheet
1	6



Description of Operation	
A	Remove cylinder deck block off plates.
B	Install B-H-J Torque Plates w/gaskets (GM-3.8/3E-R-S-T-HT)
C	Note: When installing torque plates, 1) move the bottom row of fasteners to the top, 2) discard the top row of fasteners, 3) use the post test fasteners from the last teardown in the bottom row on the torque plates.
D	Use the Torque Sensor 1 wrench set on soft joint for gasketed applications.
Z	30Nm-50Nm-80Nm - JCS-TEL to yield.
	(Step Sec.2 sheet 1)

Specification	
1	25527831 Bolt Cyl. Head (8)(Long) See note Z Use in upper and lower position with double hardened washers on lower row. Obtain washers from B-H-J.
2	24503801 Gasket RH. 24503802 Gasket LH.

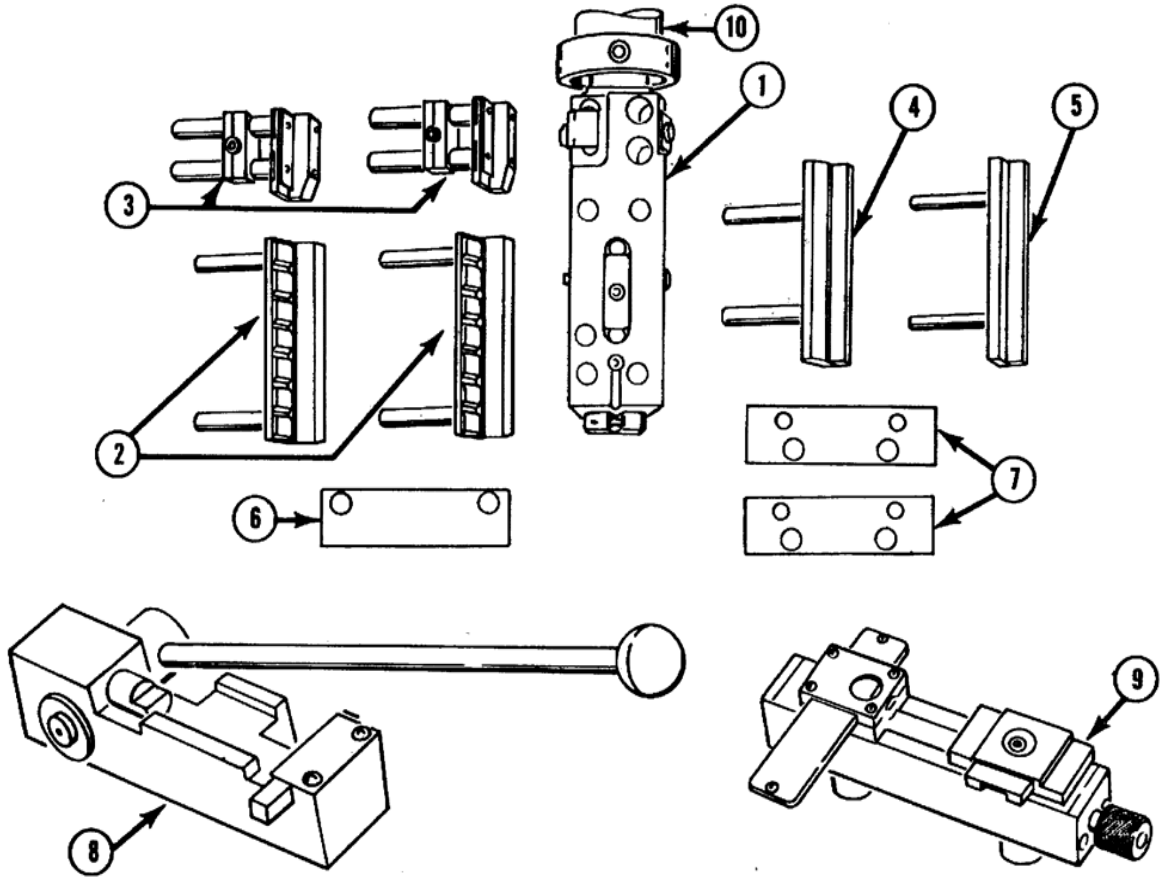
REV	Date	Revision History
1	1/1/98	Block-7
2	11/6/99	Add head gasket part numbers

View
Engine Block
B-H-J Torque Plate installation

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

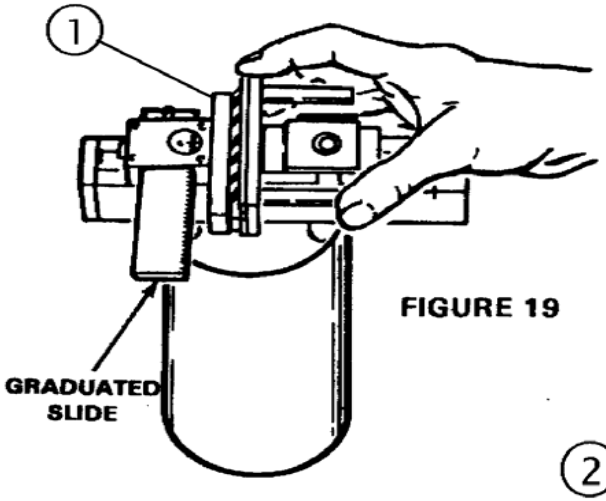


FIGURE 19

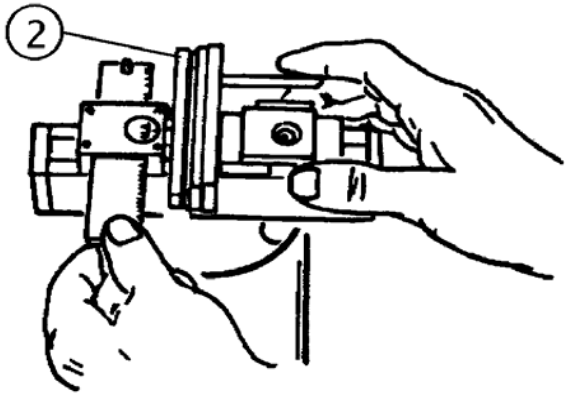


FIGURE 20

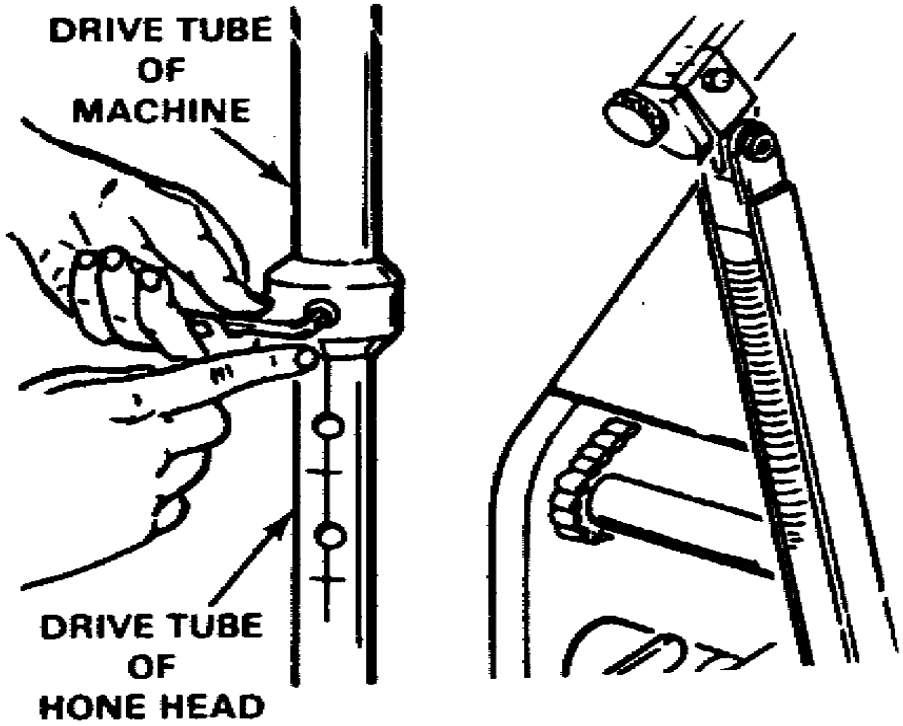
Description of Operation	
	Set the turret block to the standard position and adjust the setting block snugly in the cylinder bore.
19	Place the stone assembly in the setting gage with the slide scale set at "0". Add shims as necessary to adjust to 1 - 2 on the slide scale for the stone and guide assemblies.
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 IIIF	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 IIIF	Section	Sheet
		2	3

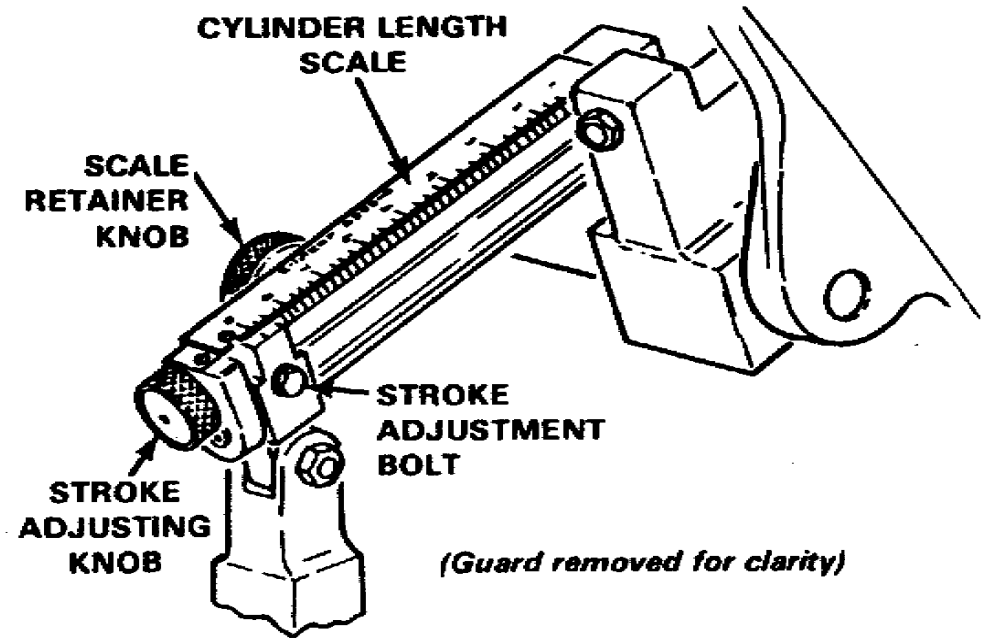


FIGURE 23

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 IIIF	Section	Sheet
		2	4

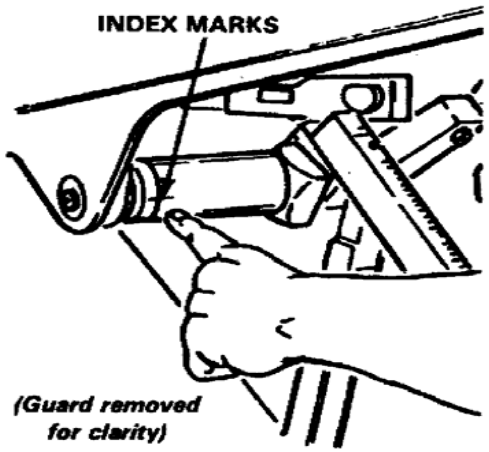


FIGURE 24

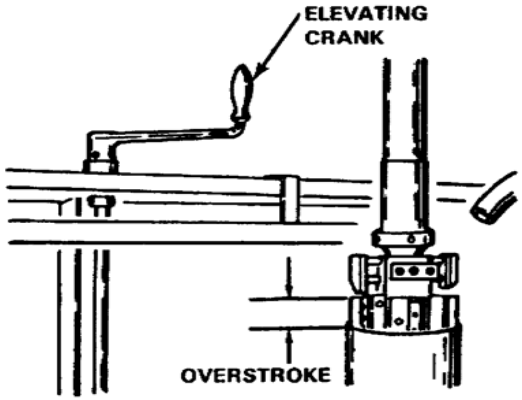


FIGURE 25

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

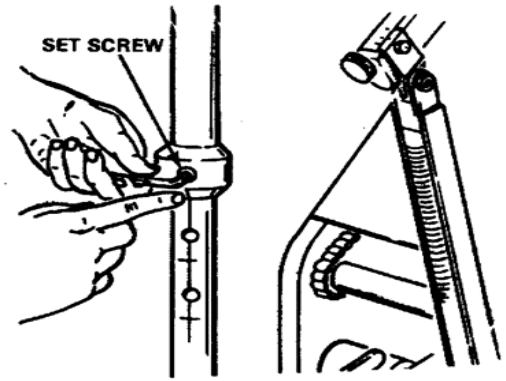


FIGURE 26

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

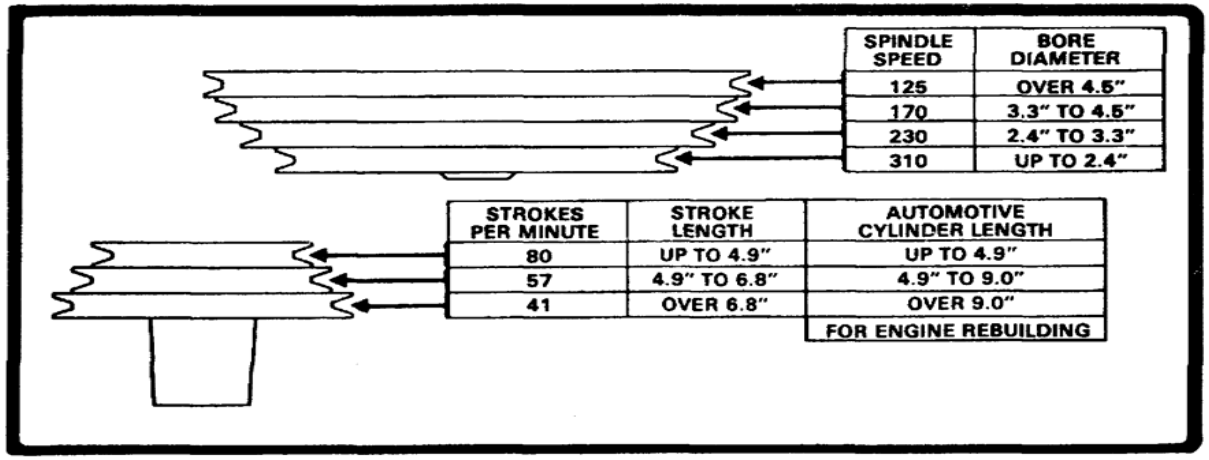
REV	Date	Revision History
1	1/7/98	Hone 4 & 5

View

Overstroke

Overstroke adjustment

Cylinder Honing	Sequence IIIF	Section	Sheet
		2	5



SPINDLE SPEED	BORE DIAMETER
125	OVER 4.5"
170	3.3" TO 4.5"
230	2.4" TO 3.3"
310	UP TO 2.4"

STROKES PER MINUTE	STROKE LENGTH	AUTOMOTIVE CYLINDER LENGTH
80	UP TO 4.9"	UP TO 4.9"
57	4.9" TO 6.8"	4.9" TO 9.0"
41	OVER 6.8"	OVER 9.0"
		FOR ENGINE REBUILDING

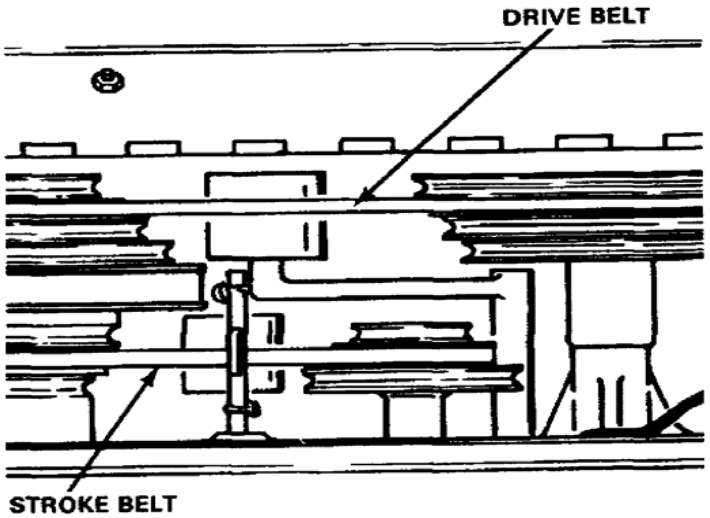


FIGURE 28

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 IIIF	Section	Sheet
		2	6

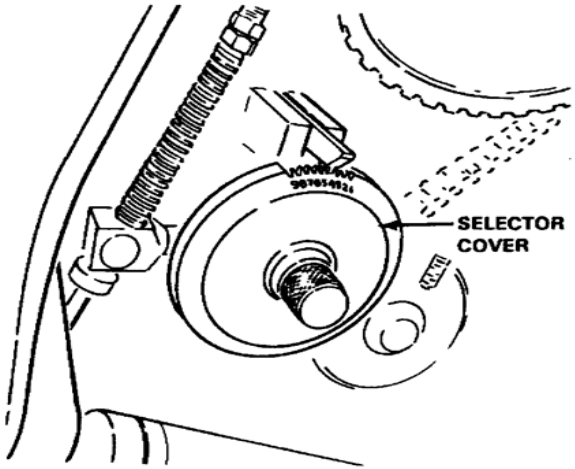


FIGURE 29

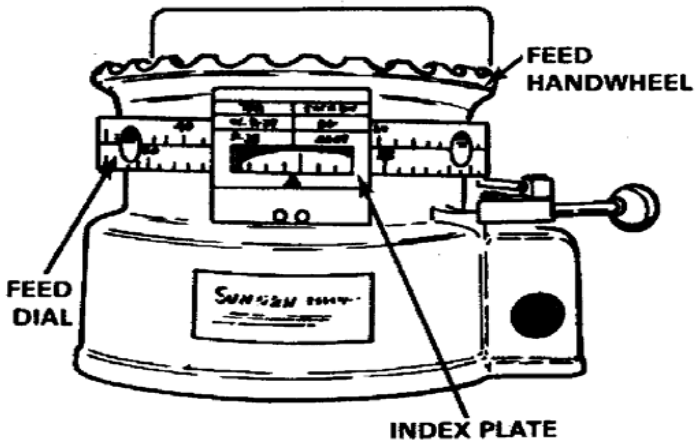


FIGURE 30

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 C30-PHT-731 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

View

Ratchet Feed & Index Plate

Cylinder Honing	Sequence IIIF	Section	Sheet
		2	7

Honing Operations Guide

EHU-512 Stones (**Ratchet Feed Set to 1**)

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 honer over fifteen strokes
3 Set mode switch to timed mode and set controller to 15 seconds (15 seconds = 15 strokes)
4 Start the honer and adjust the load to 15 units, maintaining 15 units load by hand 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 Unit load will oscillate during normal operation. The intent is to hold 15 units as a minimum load during the honing process.

Note:2 <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.

C30-PHT-731 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.

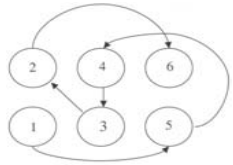
Note:3 Proper ratchet feed setting is required to establish desired cylinder surface parameters using the C30-PHT-731 Plateau Hone Tool. After setting the initial load, the ratchet feed system will increase the load during the remaining time. <u>Operaters should not release load during this operation.</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

View

Fluid and Operations Guide

Cylinder Honing	Sequence IIIF	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 IIIF	Section	Sheet
		2	9

Honer Calibration

All CV-616 honers must be calibrated on-site by a qualified Sunnen Technician using the Hydraulic Pump and Reservoir Dynamometer. All CV-616 honers 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

View

Honer Calibration

Cylinder Honing	Sequence IIIF	Section	Sheet
		2	10

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, Honer maintenance

View: Honer Maintenance

Cylinder Honing	Sequence IIIF	Section	Sheet
		2	11

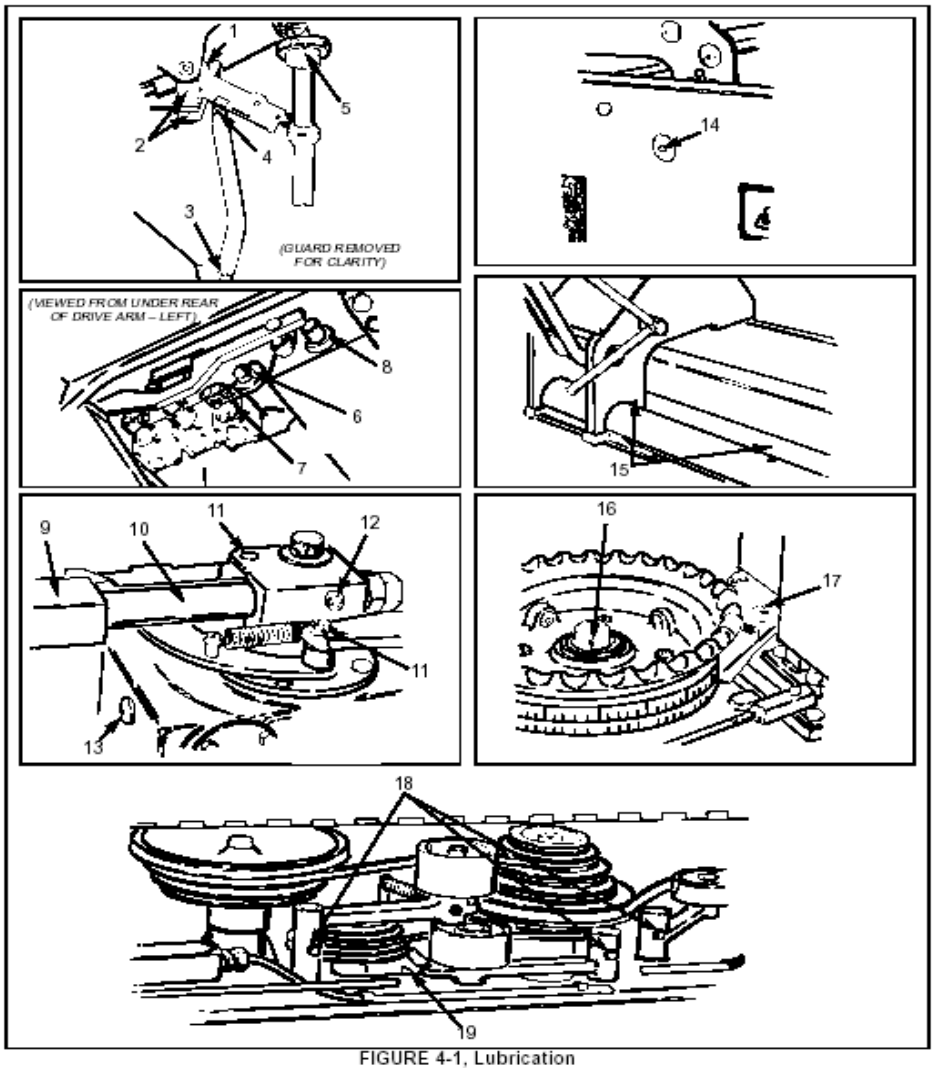


FIGURE 4-1, Lubrication

Description of Operation

Specification

View

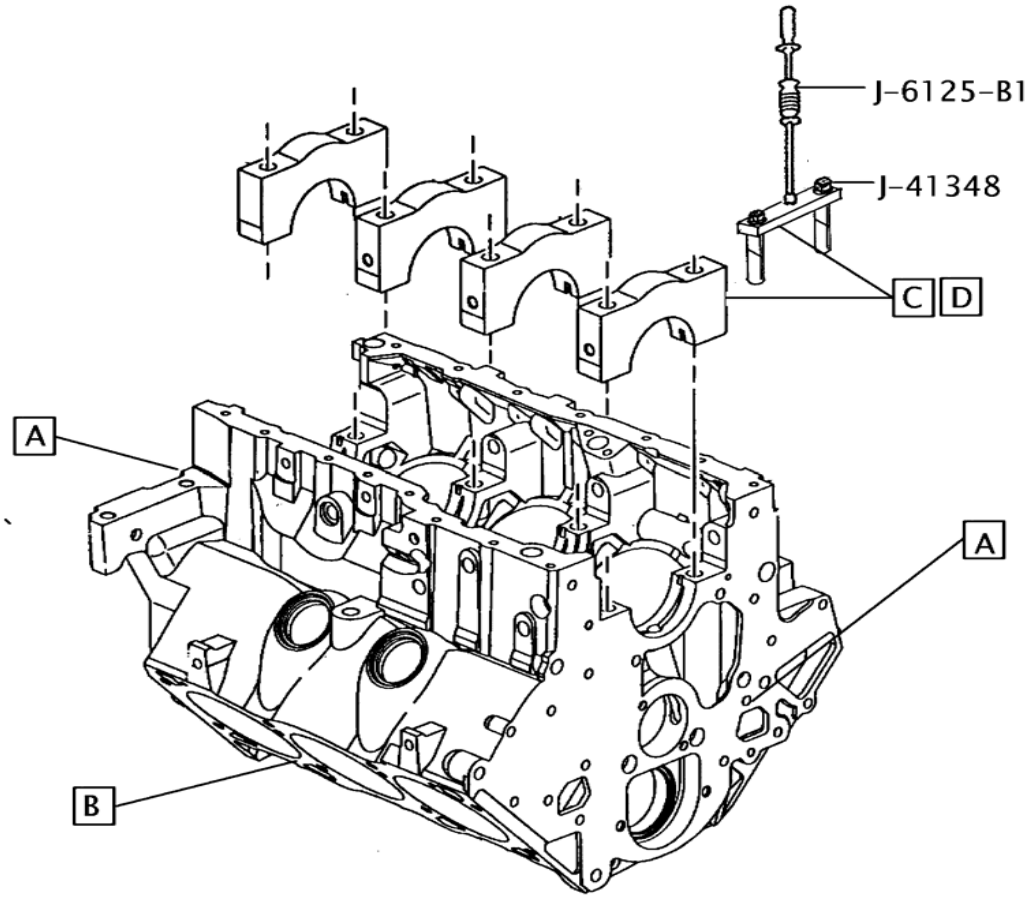
Lubrication Guide

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

Cylinder Honing	Sequence IIIF	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. 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

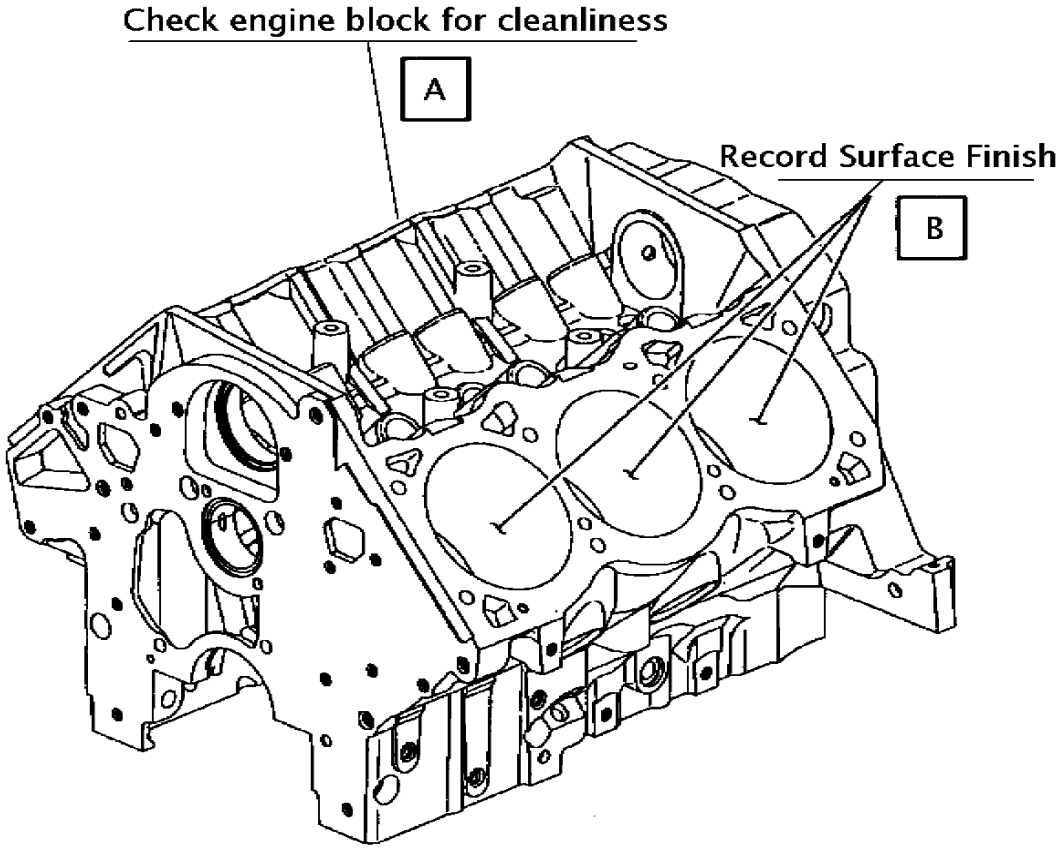
REV	Date	Revision History
1	01/01/98	Block-8

View

Short Block

Block off plate, torque plate and main cap removal

Short Block Assembly	Sequence IIIF	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.

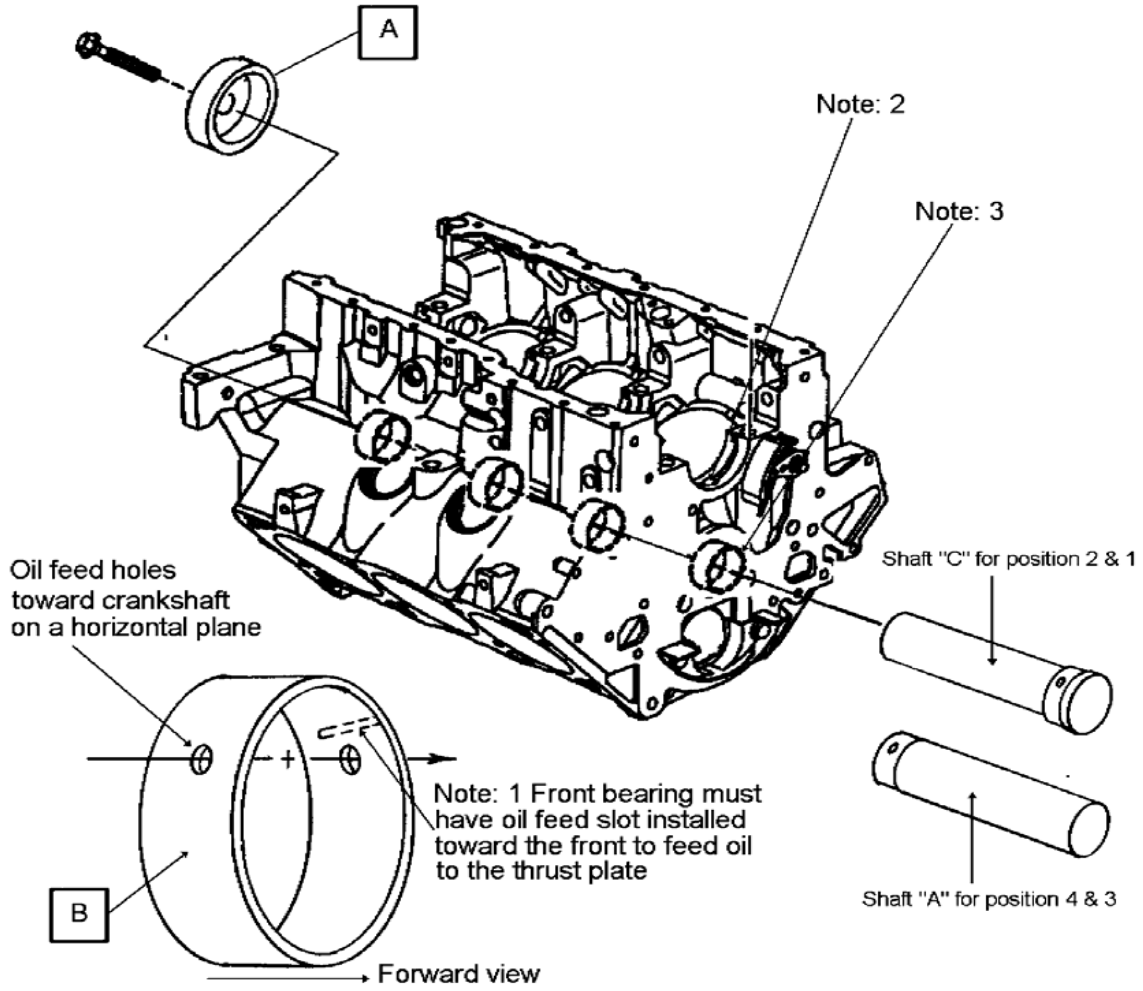
Specification

REV	Date	Revision History
1	01/02/98	Block-9

View

Engine block cleanliness inspection and cylinder surface finish/size recording

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	2



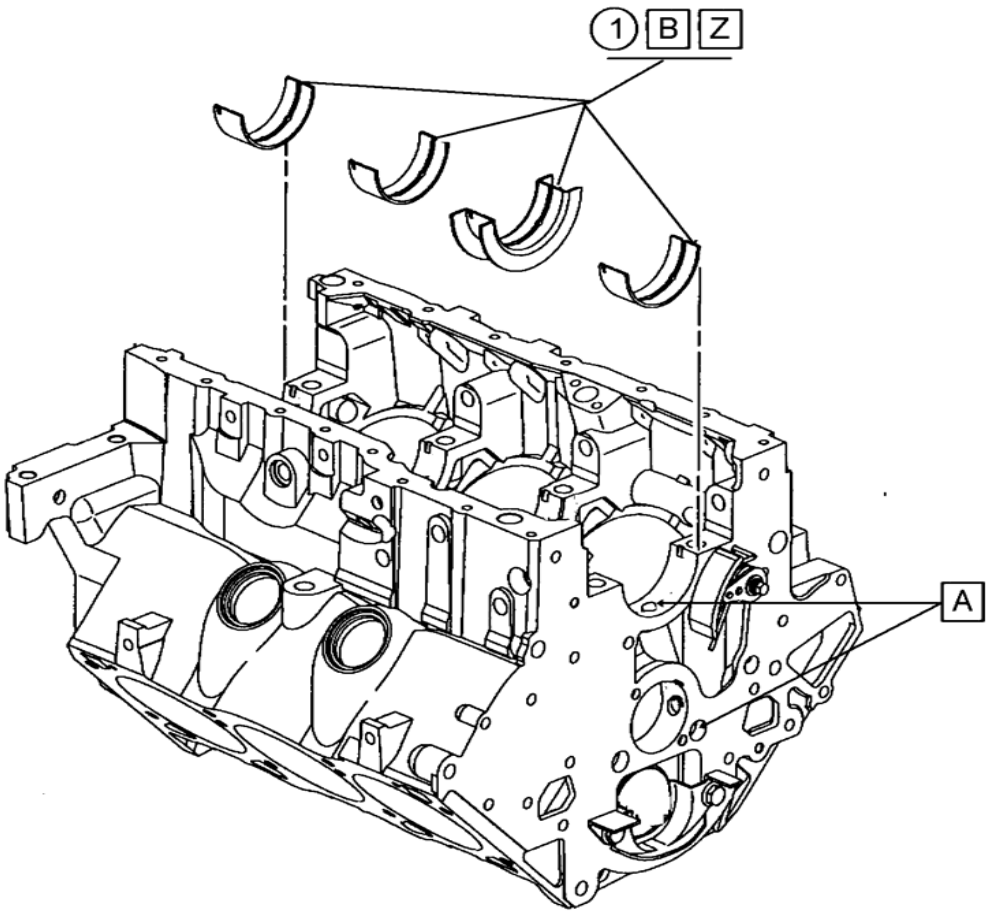
Description of Operation	
A	Install camshaft bearings using OHT3F-019-1 camshaft bearing installation tool. Sections: A for #4 rear & #3 intermediate C for #2 intermediate and #1 front
B	Lubricate bearing bore and bearing OD. with EF-411. Install bearings with the oil feed holes positioned toward the crankshaft on a horizontal plane. See view "B" and Note: 1 Note: 2 Use a pen light to check intersection of oil feed hole when viewed through main bearing oil gallery. Note: 3 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 OHT3F-028-09
2	Bearing camshaft #2 & #3 OHT3F-028-10 Both bearings are included in OHT3F-042-2

REV	Date	Revision History
1	01/02/98	Block-10
2	10/12/98	Update 2nd design block requires bearings 19581 & 19582
3	11/07/99	Update part numbers and note 3
4	6/22/00	Update part numbers

View
Short Block
Camshaft bearing positioning and installation

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	3



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	11/07/99	Revise drawing, add to "A"
3	9/7/00	Revise OHT3F-042-2

View

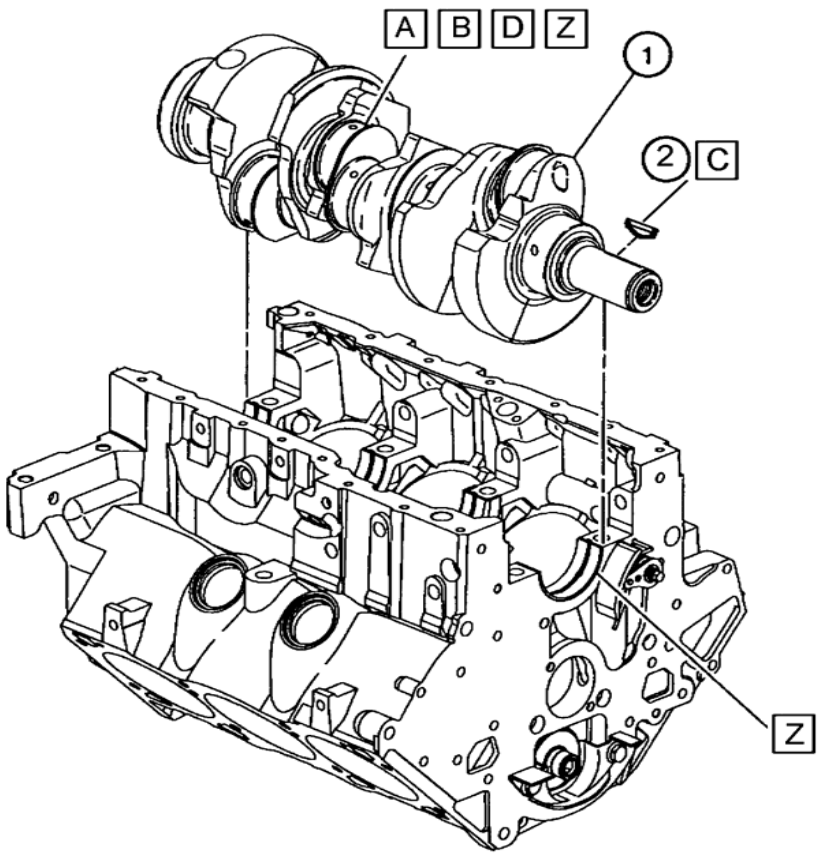
Short Block

Upper main bearing inspection and installation

Short Block Assembly

Sequence IIIF

Section	Sheet
3	4



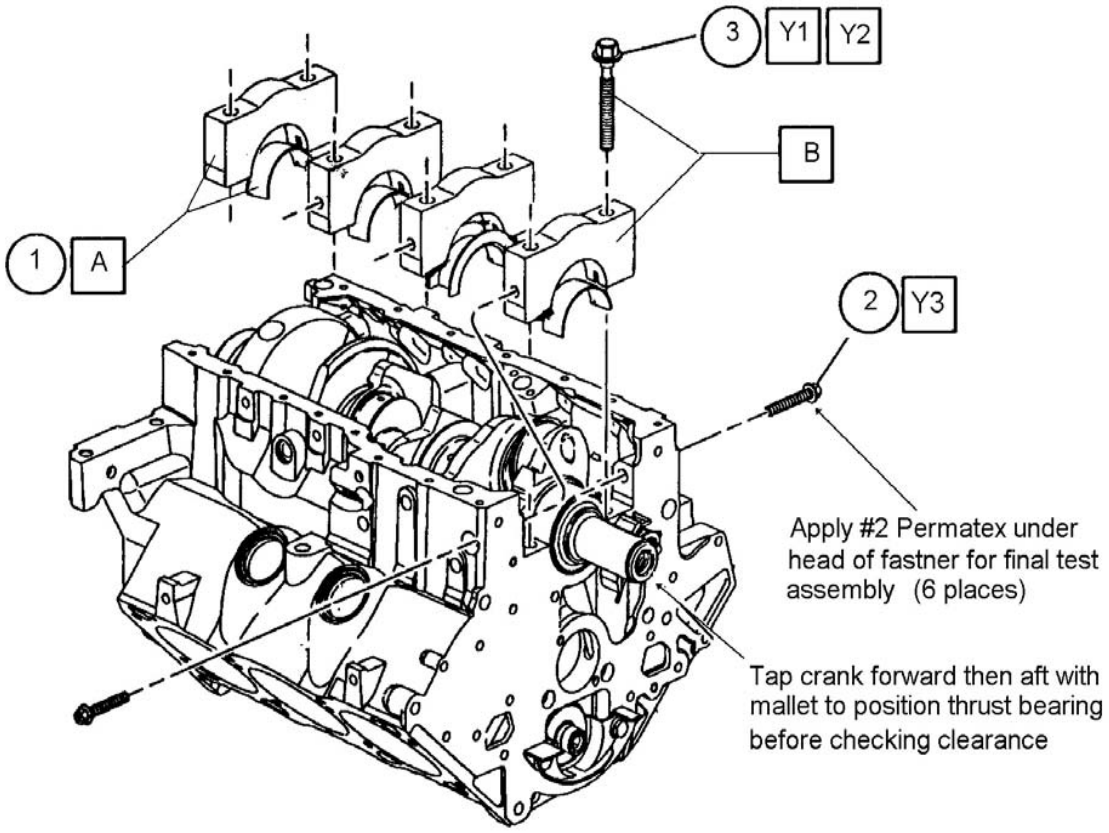
Description of Operation	
A	Clean the crankshaft using an approved commercial cleaning agent followed by mineral spirits and Mylar strip polishing cloth (use Mylar polishing cloth only if journals are nicked or oxidized, Do Not use to remove varnish). The final step should be mineral spirits and nylon bristle brushing of the oil galleries. Spray crankshaft with 50/50 solution and blow excess with compressed air.
B	Check journal diameters. Mains 63.470 - 63.495mm Rods 57.1170 - 57.1475mm
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	25534912 Key

REV	Date	Revision History
1	01/03/98	Block-12
2	11/06/99	Update for polishing with mylar tape and add key
3	9/5/00	Update Mylar tape polishing only if nicked or oxidized
4	06/17/02	Update "A" "Do Not use to remove varnish"
5	12/01/04	Change to mineral spirits

View
Short Block
Crankshaft cleaning, inspection, and installatic

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	5



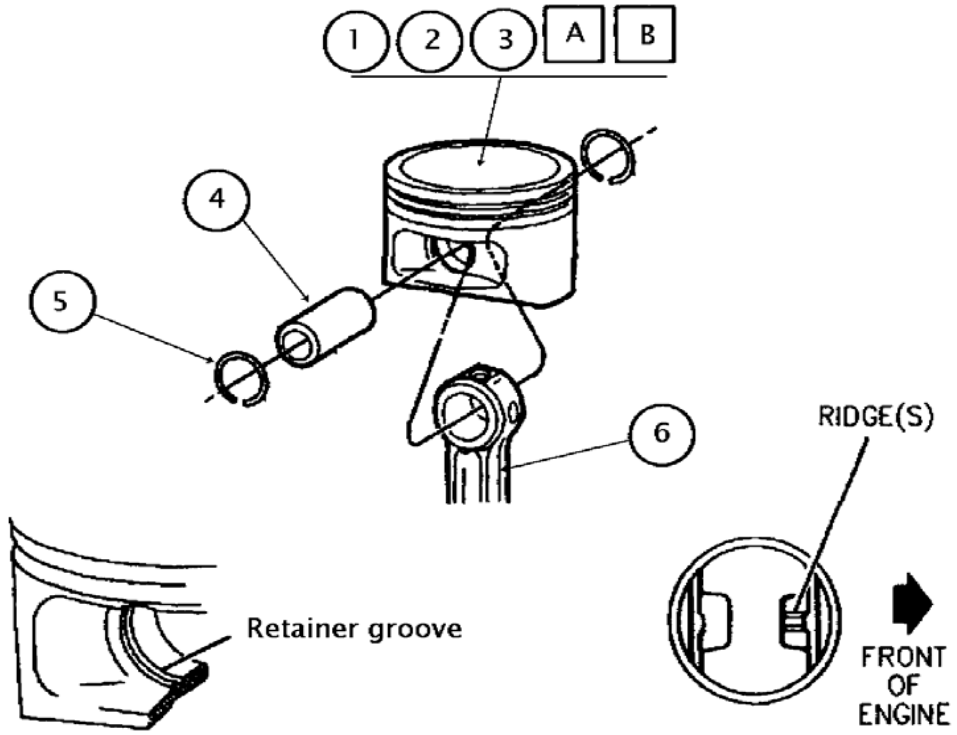
Description of Operation	
A	Install lower main bearings into main caps. Clean and oil all main cap bolts (EF-411) and install main caps. Note: Do not use air tools to run main caps down.
B	Install main cap with fasteners as guides and tap into position with plastic mallet or use very light pressure by hand with speed handle and socket in crisscross pattern to draw the main cap down.
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. Check crankshaft end play 0.076 - 0.276mm
Y2	Torque & Angle 20Nm then 40Nm + 35°+35°+35° (repeat 3 times from center out)
Y3	Torque & Angle 15Nm + 45° (See note on sealer usage)

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

REV	Date	Revision History
1	01/10/98	Block-13
2	9/7/00	Revise part number OHT3F-042-2
3	02/01/02	Update Description add "C" change "Z to Y3"

View
Short Block
Lower main bearing and crankshaft final test installation

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	6



Description of Operation	
A	Confirm run number and proper grade piston selections.
B	Lubricate piston pin and connecting rod with EF-411. Install one piston pin retainer clip into the retaining groove. Install the con rod with the dimple to the rear and piston pin. 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	25531956 Bolt Cast Rod 11589085 Bolt PM Rod

REV	Date	Revision History
1	01/03/98	Block-14
	11/16/04	Add part numbers for "Cast" and "Powdered Metal" Rods See "6"

View
Piston, Pin and Connecting Rod
Piston pin and Connecting Rod assembly

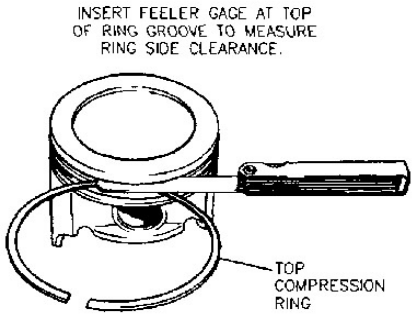
Short Block Assembly	Sequence IIIF	Section	Sheet
		3	7

Hard Metric Piston & Ring Sizes

Grade/Run	Bore Size	Gage	Target Ring Gap (+/-0.0254mm)	Piston Size
12/1st	96.52	96.53	Top 1.067 2nd 0.965	96.482 - 96.497
12/2nd	96.54	96.53	Top 1.067 2nd 0.965	96.482 - 96.497
34/3rd	96.56	96.57	Top 1.067 2nd 0.965	96.522 - 96.537
34/4th	96.58	96.57	Top 1.067 2nd 0.965	96.522 - 96.537
56/5th	96.60	96.61	Top 1.067 2nd 0.965	96.562 - 96.577
56/6th	96.62	96.61	Top 1.067 2nd 0.965	96.562 - 96.577

All gaps to be +/- 0.0254mm,

As measured in Ring Gage using Starrett Taper Gage # 270



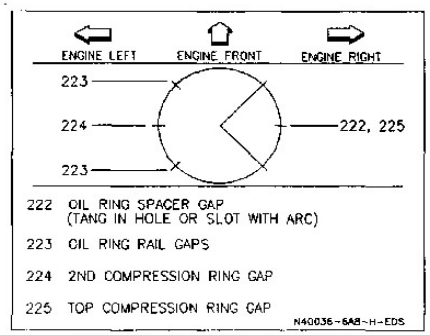


Figure 64 - Piston Ring Gap Location

Description of Operation

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

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 stagger chart.

Lubricate assembly with EF-411

To check ring gap, use OHT3F - 050, 051, and 052 Ring Gage with Starrett Taper Gage #270

Specification

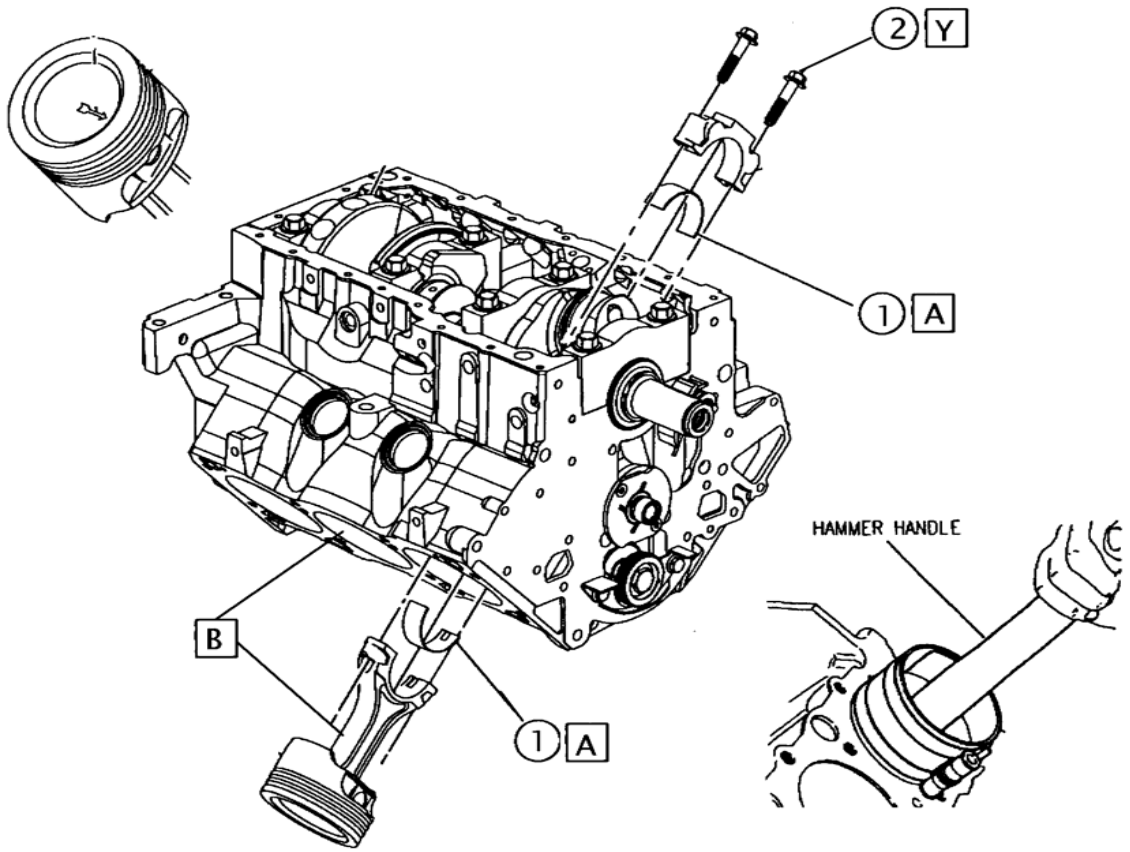
1	OHT3F-050 Ring set run 1
2	OHT3F-050 Ring set run 2
3	OHT3F-051 Ring set run 3
4	OHT3F-051 Ring set run 4
5	OHT3F-052 Ring set run 5
6	OHT3F-052 Ring set run 6

REV	Date	Revision History
1	01/03/98	Block-15
2	11/13/99	Update reverse ring gap dimensions
3	6/20/00	Update reverse ring gap dimensions
4	9/7/00	Update text box (Ring Gap Instructions & Part Numbers)
5	02/01/02	Update picture to include Starrett Taper Gage

View

Piston Ring

Piston ring installation and clearance



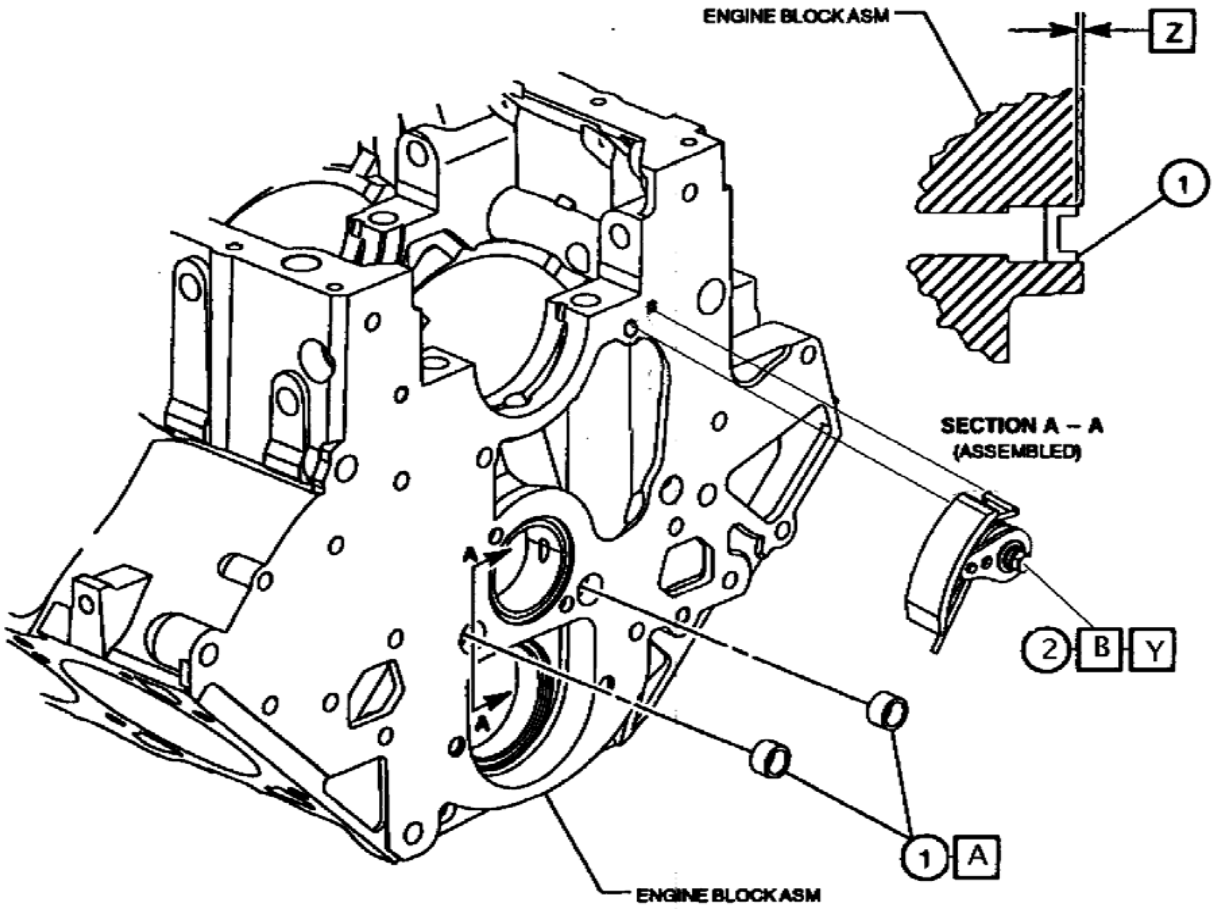
Description of Operation	
A	Install connecting rod bearings and lubricate assembly with EF-411.
B	Clean cylinder bores and lubricate with EF-411. Install piston assembly using suitable piston ring compressor and soft ended installation tool.
Y	Cast Rod (24501696) Torque & Angle 27Nm + 50° Powdered Metal Rod (12574505) Torque & Angle 20Nm + 75°
C	Check connecting rod side clearance 0.102 - 0.508mm

Specification	
1	OHT3F-042-2 Con rod bearing OH-106
2	25531956 Bolt Cast Rod 11589085 Bolt PM Rod

REV	Date	Revision History
1	1/3/98	Block-16
2	11/7/99	Update OHT part number
3	11/16/04	Add torque values for "Cast Rod" and "Powdered Metal Rod" See "Y" for details

View
Short Block
Piston and rod assembly installation

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	9



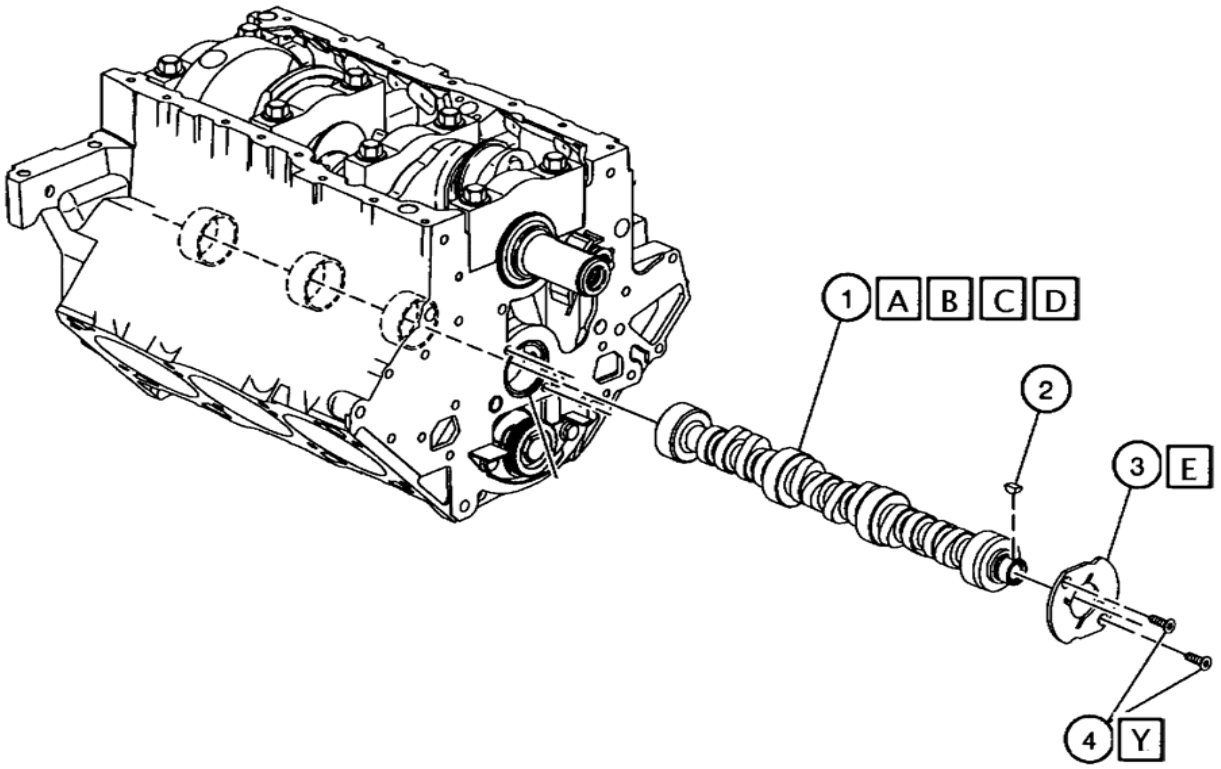
Description of Operation	
A	Install oil gallery plugs, see cross section A - A.
B	Install damper assembly
Y	Torque 22Nm
Z	Locate cup plug 1.5 +/- 0.75mm below front face of block.

Specification	
1	3835577 Plug, oil gallery
2	24503893 Damper assembly

REV	Date	Revision History
1	1/3/1998	Block-17

View
Short Block
Oil gallery plugs and timing chain damper

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	10



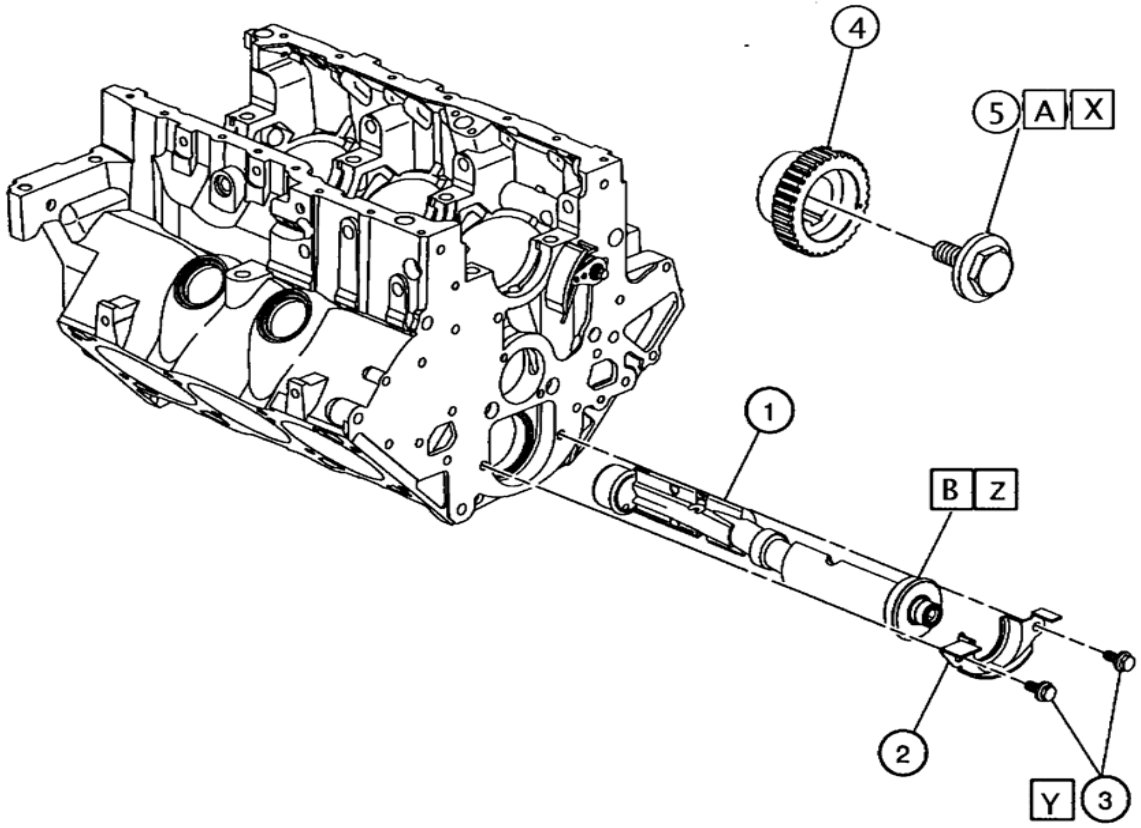
Description of Operation	
A	Check and de-burr if necessary, the front thrust surface of the camshaft.
B	Clean camshaft with mineral spirits and very clean shop towel. Note: make sure all grinding residue is removed before continuing.
C	Make pre-test measurements at the rear side of each lobe and record to the nearest 0.001mm.
D	Lubricate the camshaft journals and lobes with EF-411 and install.
E	Lubricate thrust plate and install
Y	Torque 15Nm

Specification	
1	OHT3F-008-6 Camshaft
2	24500618 Key (Replace each test)
3	OHT3F-011-2 Thrust plate (0.152")
4	25519242 Bolt/screw

REV	Date	Revision History
1	1/13/98	Block-18
3	6/22/00	Change part number for 0.153" Thrust Plate
4	10/18/00	Update Description of Operation
5	2/1/2002	Add note item #2 (replace each test) #3 (0.152") & OHT3F-008-6
6	12/1/04	Change to mineral spirits

View
Short Block
Camshaft cleaning, measurement, and installation

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	11



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	24502388	Shaft Assembly
2	24500374	Retainer
3	24500055	Bolt
4	24503524	Gear
5	24501367	Bolt

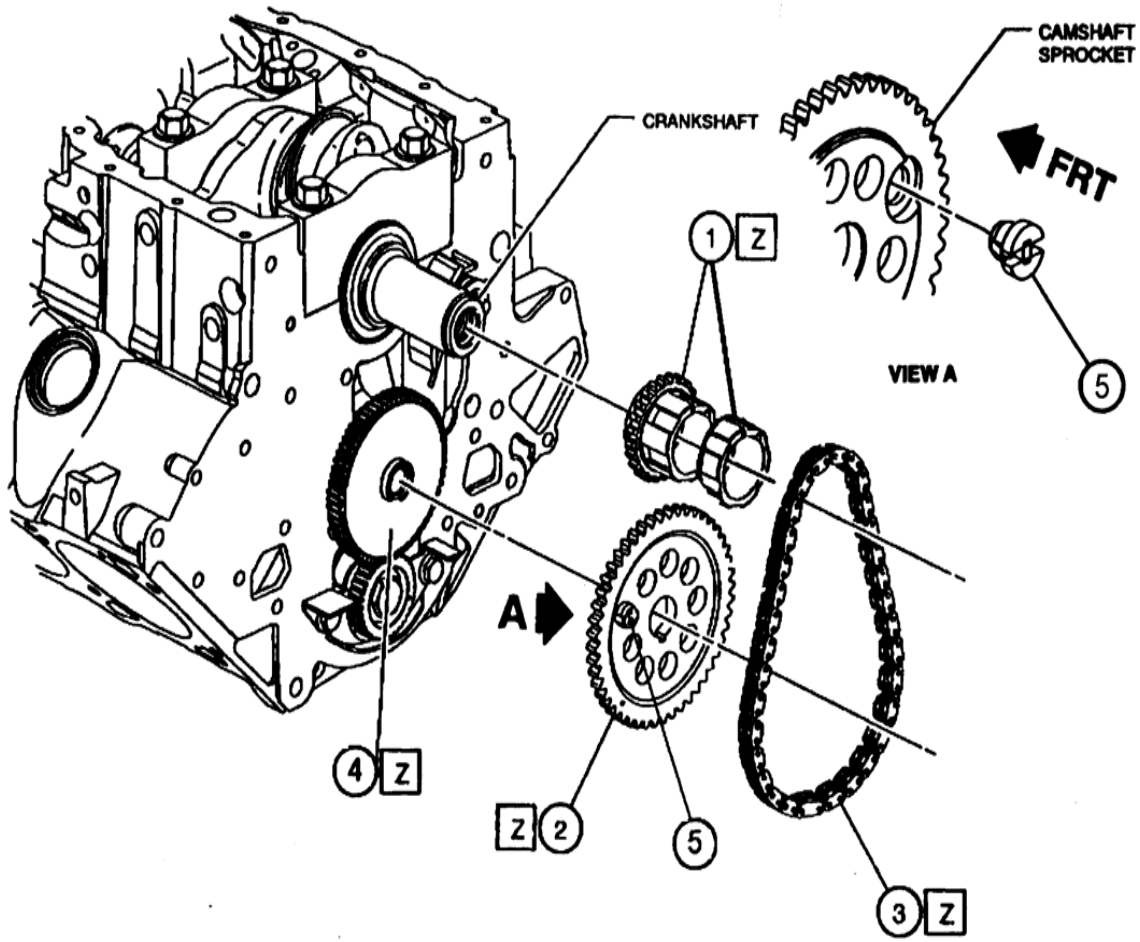
REV	Date	Revision History
1	1/5/1998	Block-19

View

Short Block

Balance shaft inspect & install

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	12



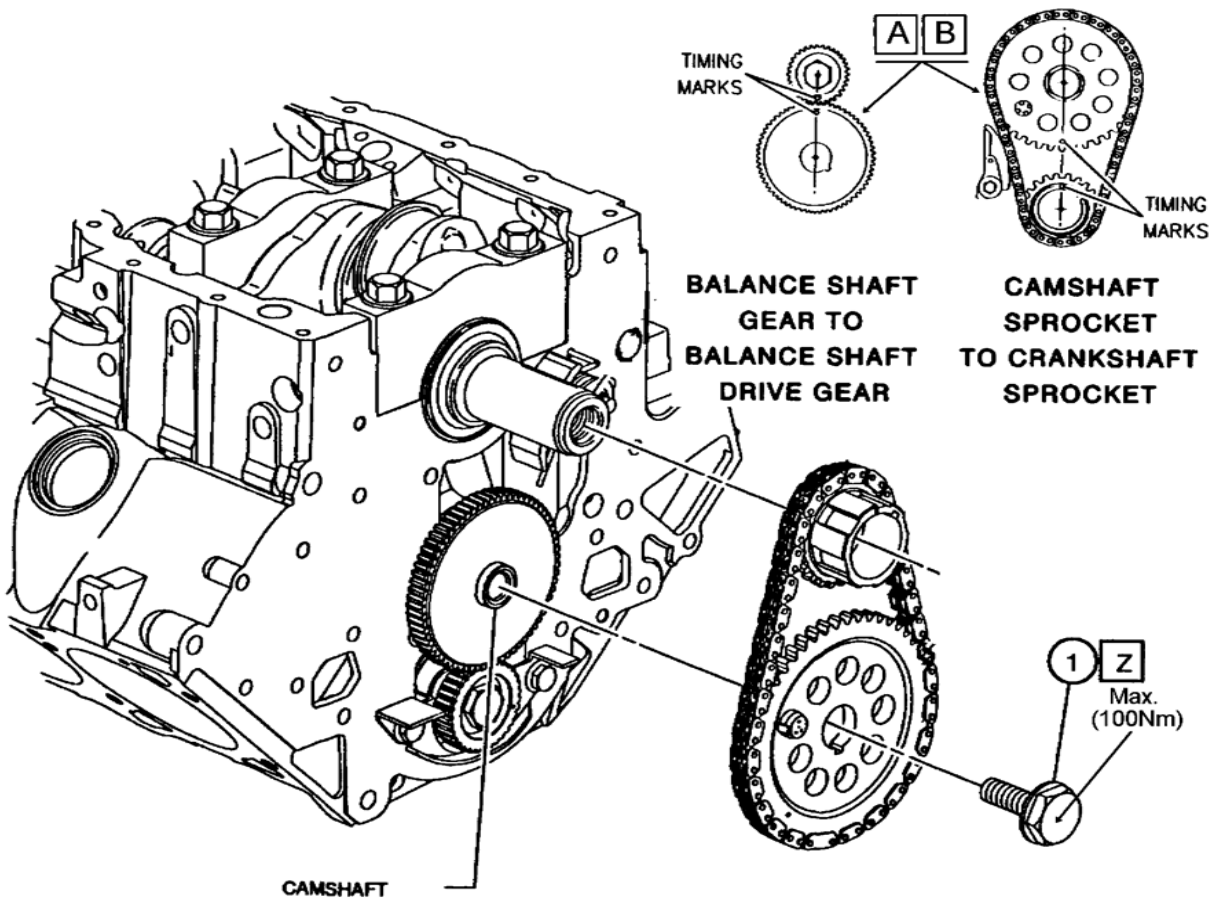
Description of Operation	
	Timing gear set. See part number information.
A	Install magnet See view "A"
Z	Lubricate with EF-411
	Note: Inspect balance shaft and replace as necessary if damage to gear teeth and / or thrust surface is evident.

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	1/5/1998	Block-20
2	11/7/99	Update view "A"
3	6/17/02	Add note to description about inspecting balance shaft drive gear.

View
Short Block
Timing gear set

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	13



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

Specification	
1	24501366 Bolt, camshaft sprocket **(Replace fastener each application)**

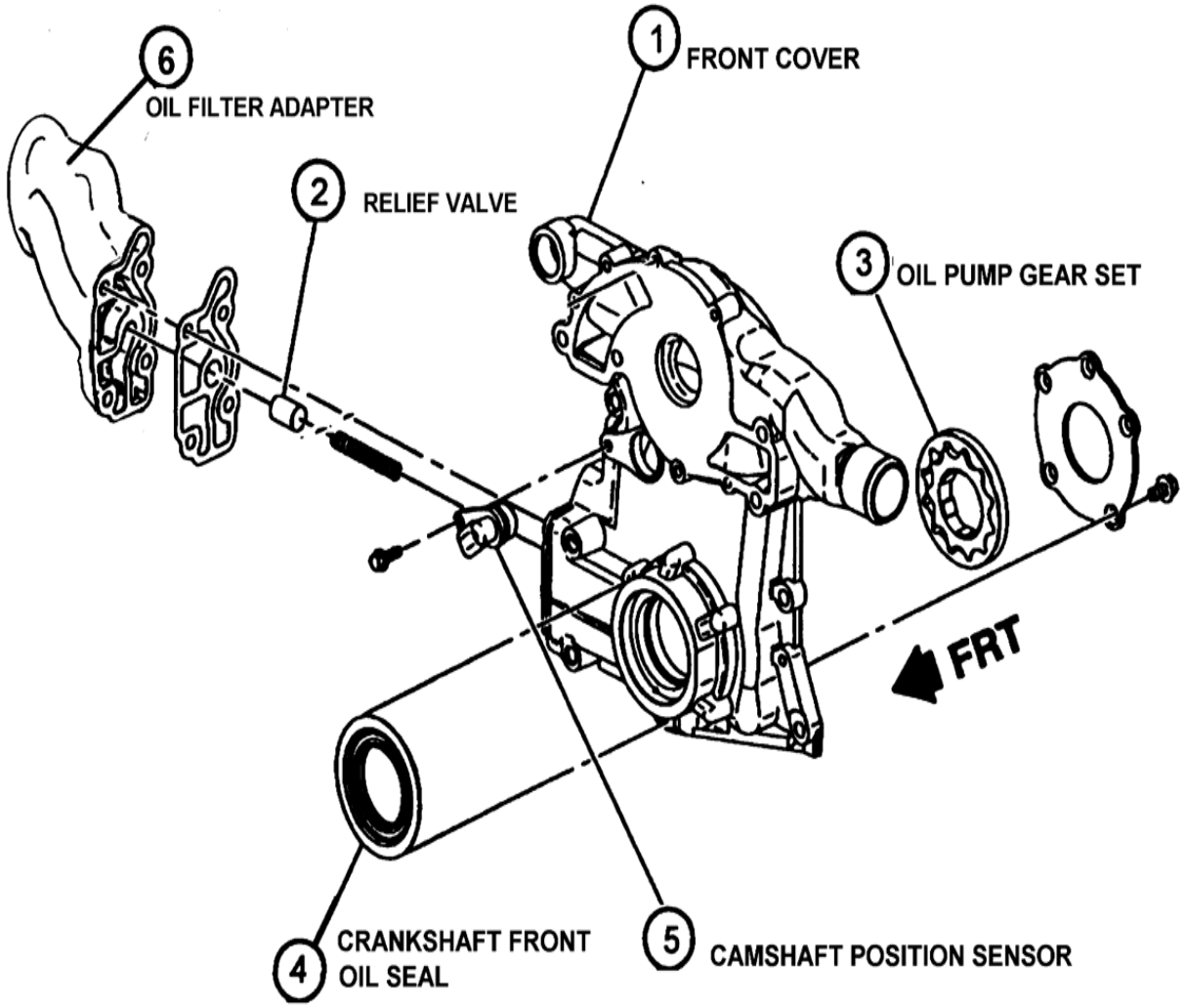
REV	Date	Revision History
1	1/5/1998	Block-21
2	11/7/99	Update view "A,B,Z"
3	2/1/2002	Update "Z" torque and #1 "Replace fastener each application"

View
Short Block
Timing gear set alignment & torque

Short Block Assembly	Sequence IIIF	Section	Sheet
		3	14

Section 4

Front Cover, Rear Cover, and Sump



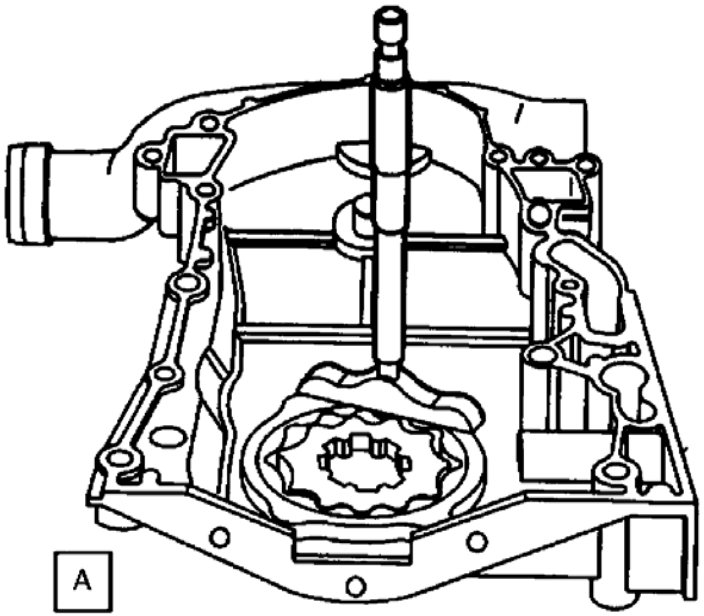
Description of Operation
Assembly view

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	24501300 Adapter, oil filter

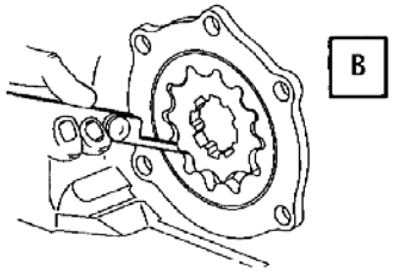
REV	Date	Revision History
1	01/05/98	Block-22
2	11/06/99	Update view, add 24501300 Adapter
3	4/28/03	Change front cover over to OHT part number
4	11/03/04	Change front seal from 24504098 to OHT3G-092-1

View
Front Cover
Front cover assembly view

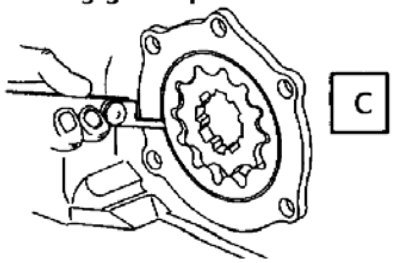
Front Cover, Rear Cover, & Sump	Sequence IIIF	Section	Sheet
		4	1



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

Specification

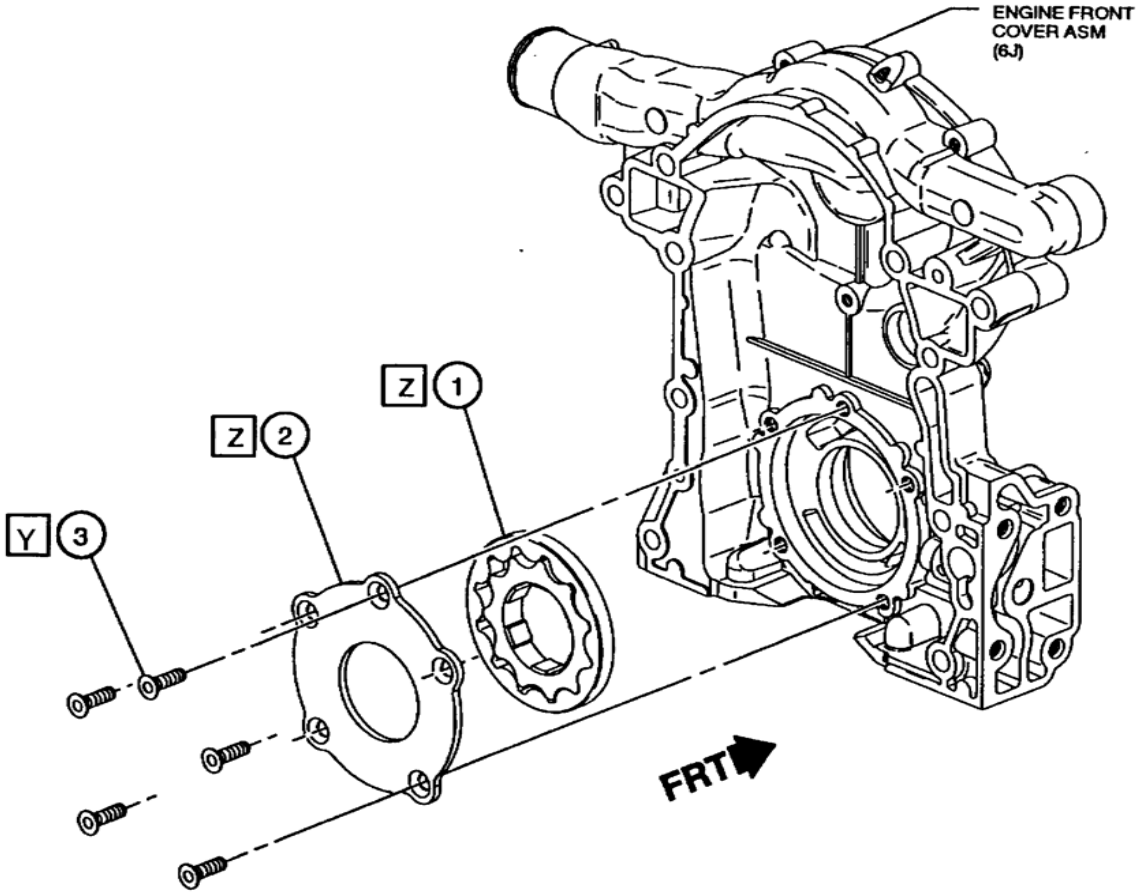
REV	Date	Revision History
1	01/05/98	Block-23
2	10/18/00	Update outer gear diameter clearance specification
3	02/14/02	Add "B" clearance specification
4	06/17/02	Add note to description to inspect oil gear housing for evidence of wear

View

Front Cover

Oil pump gear clearance

Front Cover, Rear Cover, & Sump	Sequence IIIF	Section	Sheet
		4	2



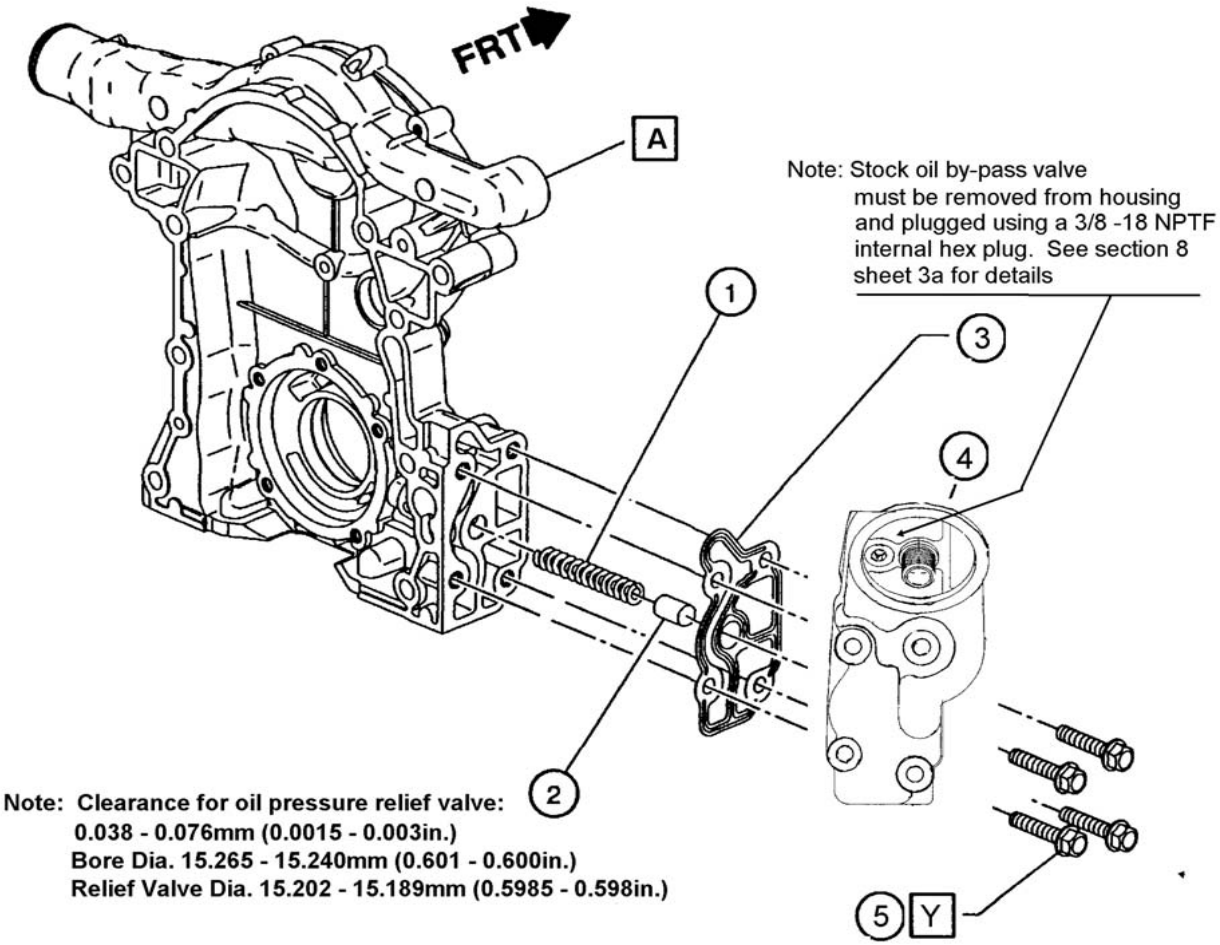
Description of Operation	
Y	Torque 11Nm
Z	Lubricate with EF-411

Specification	
1	24505433 Gear set
2	OHT3F-085-1 Front Cover
3	25519242 Bolt

REV	Date	Revision History
1	01/05/98	Block-24
2	5/28/03	Change to OHT front cover

View
Front Cover
Front cover oil gear install

Front Cover, Rear Cover, & Sump	Sequence IIIF	Section	Sheet
		4	3



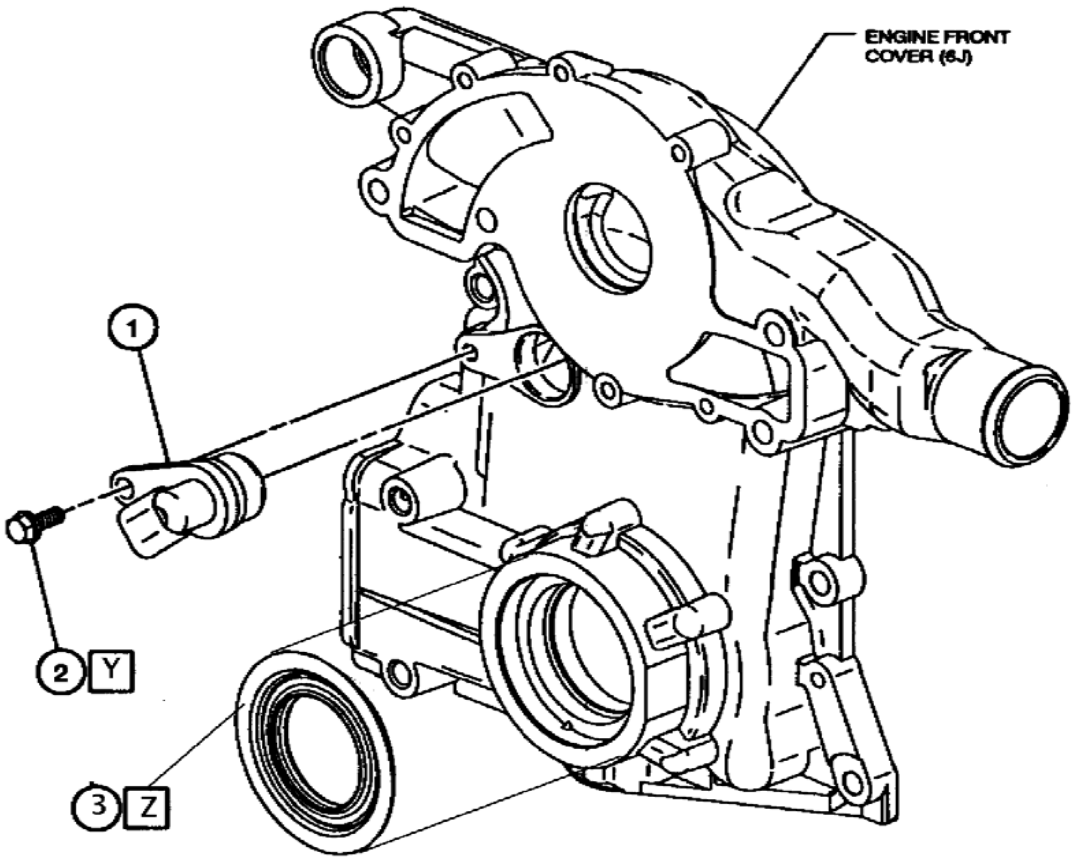
Description of Operation	
A	Front cover oil filter adapter assembly
Y	Torque 30Nm May use Perfect Seal #4 on threads of fasteners and gasket

Specification	
1	1262505 Spring
2	25530949 Valve
3	25534742 Gasket
4	24501300 Adapter, oil filter Modified OHT3F-080-1
5	24504713 Bolt

REV	Date	Revision History
1	01/05/98	Block-25
2	12/01/99	Add sealer usage
3	2/4/02	Add clearance note in drawing for pressure relief valve
4	06/17/02	Add note to replace stock by-pass valve with 3/8 -18 NPTF internal hex plug

View
Front Cover
Front cover oil filter adapter assembly

Front Cover, Rear Cover, & Sump	Sequence IIIF	Section	Sheet
		4	4



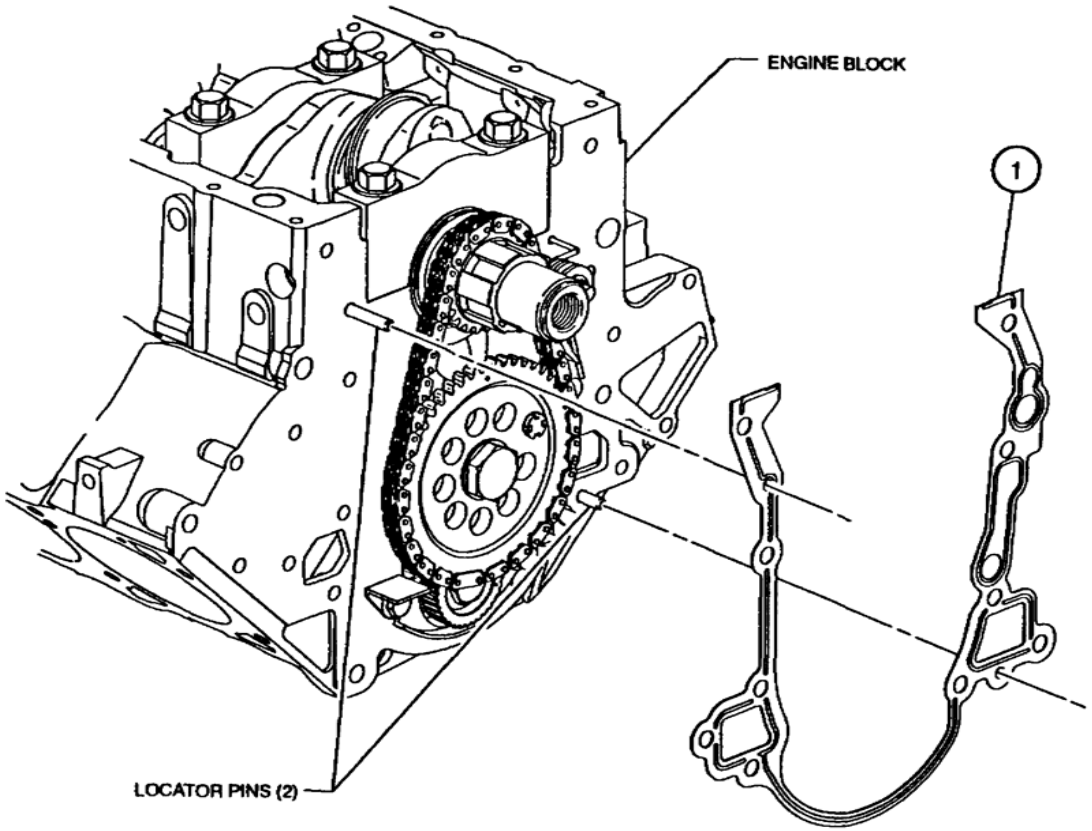
Description of Operation	
Y	Torque 30Nm
Z	Use a light application of #4 Permatex or RTV, GM part number 12346193 or Dow Corning 3154 around the rear side of the seal where it contacts the front cover.

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

View
Front Cover
Front cover camshaft sensor and seal install

Front Cover, Rear Cover, & Sump	Sequence IIIF	Section	Sheet
		4	5



Description of Operation

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

Specification

1	24502252	Gasket

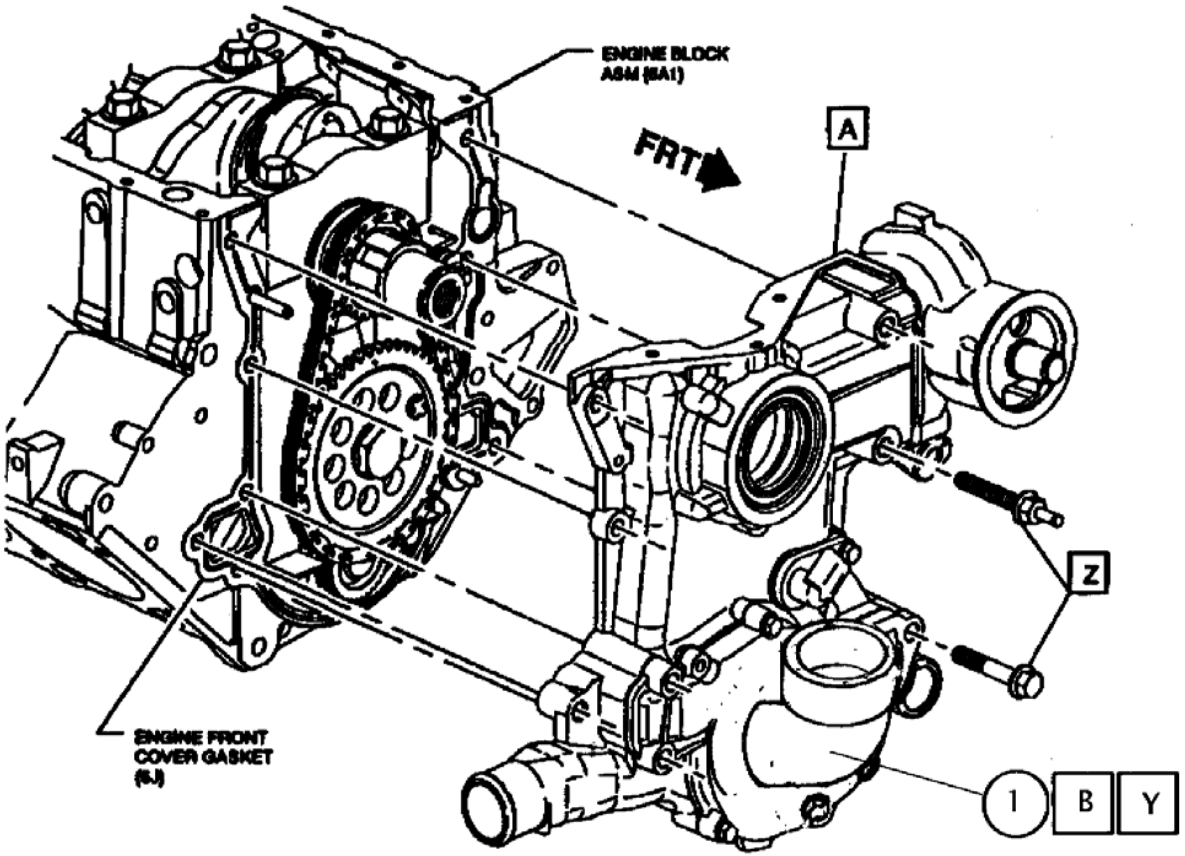
REV	Date	Revision History
1	01/05/98	Block-26
2	12/01/99	Add Note on Perfect seal

View

Front Cover

Front cover gasket install

Front Cover, Rear Cover, & Sump	Sequence IIIF	Section	Sheet
		4	6



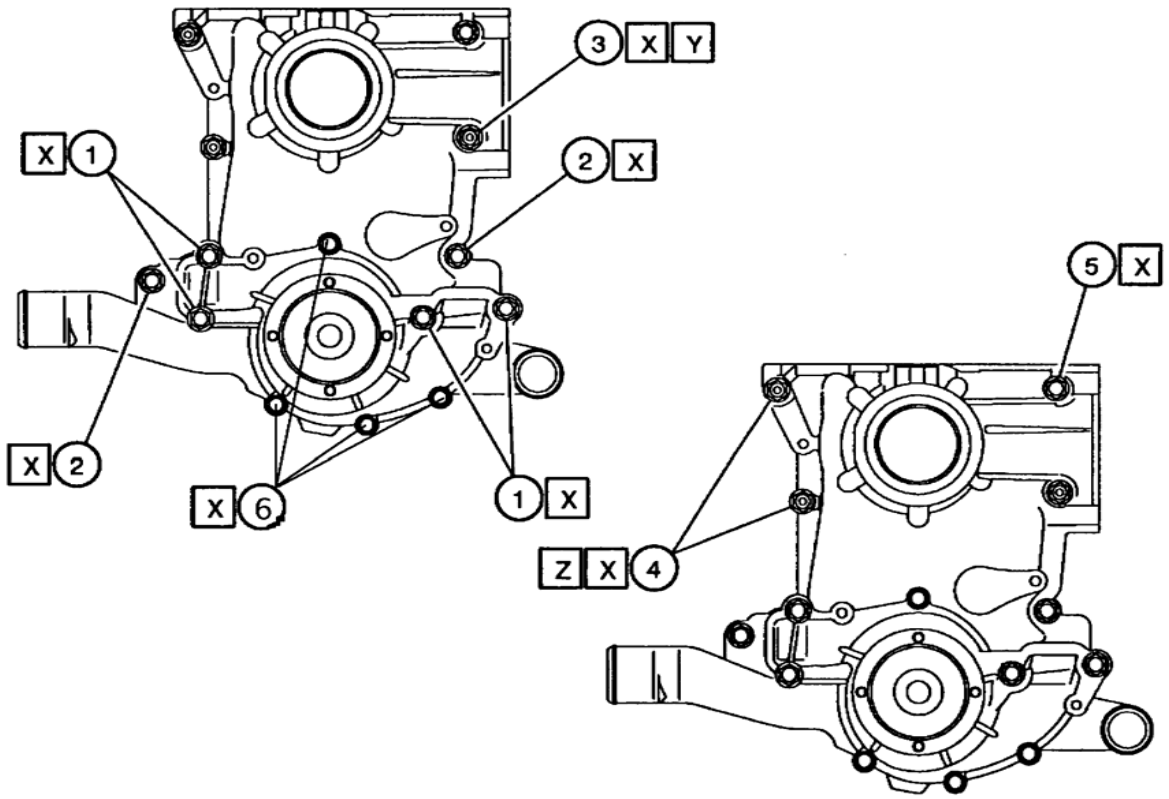
Description of Operation	
A	Front cover assembly
B	Install coolant inlet adapter with front cover
Y	Torque 30Nm Install thermocouple in OHT3F-031 with sensing tip centered in flow.

Specification	
1	OHT3F-031-3 Bolts included on print

REV	Date	Revision History
1	01/05/98	Block-30
2	12/01/99	Add thermocouple information

View
Front Cover
Front cover install

Front Cover, Rear Cover, & Sump	Sequence IIIF	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	OHT Kit
2	24504713 Bolt (2)
3	24504718 Stud (2)
4	24504717 Stud (2)
5	24504712 Bolt
6	OHT Kit

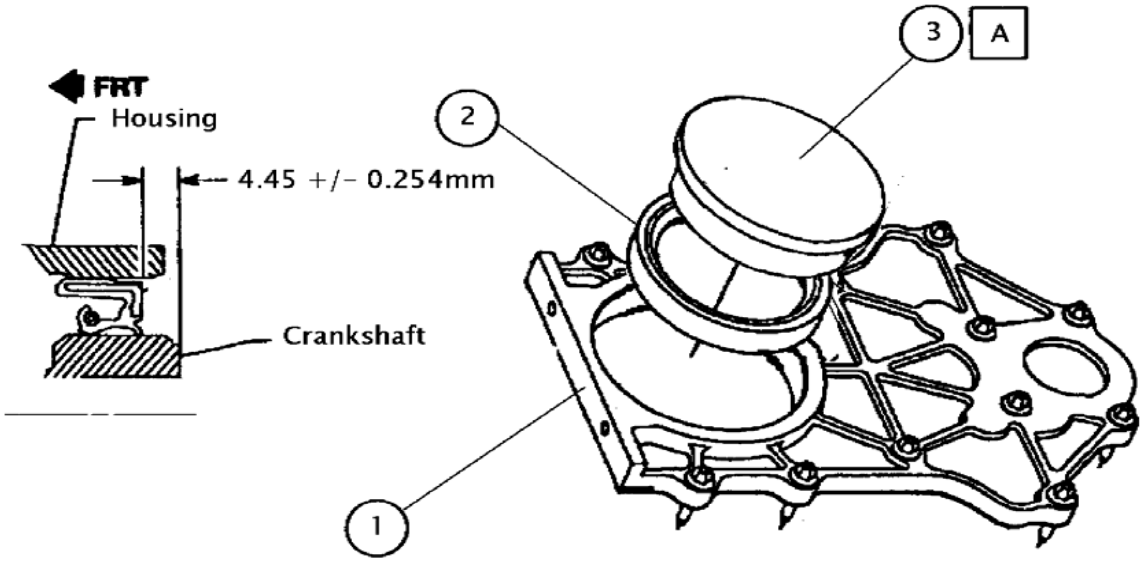
REV	Date	Revision History
1	01/05/98	Block-28

View
Front Cover
Front cover bolt placement

Front Cover, Rear Cover, & Sump

Sequence IIIF

Section	Sheet
4	8



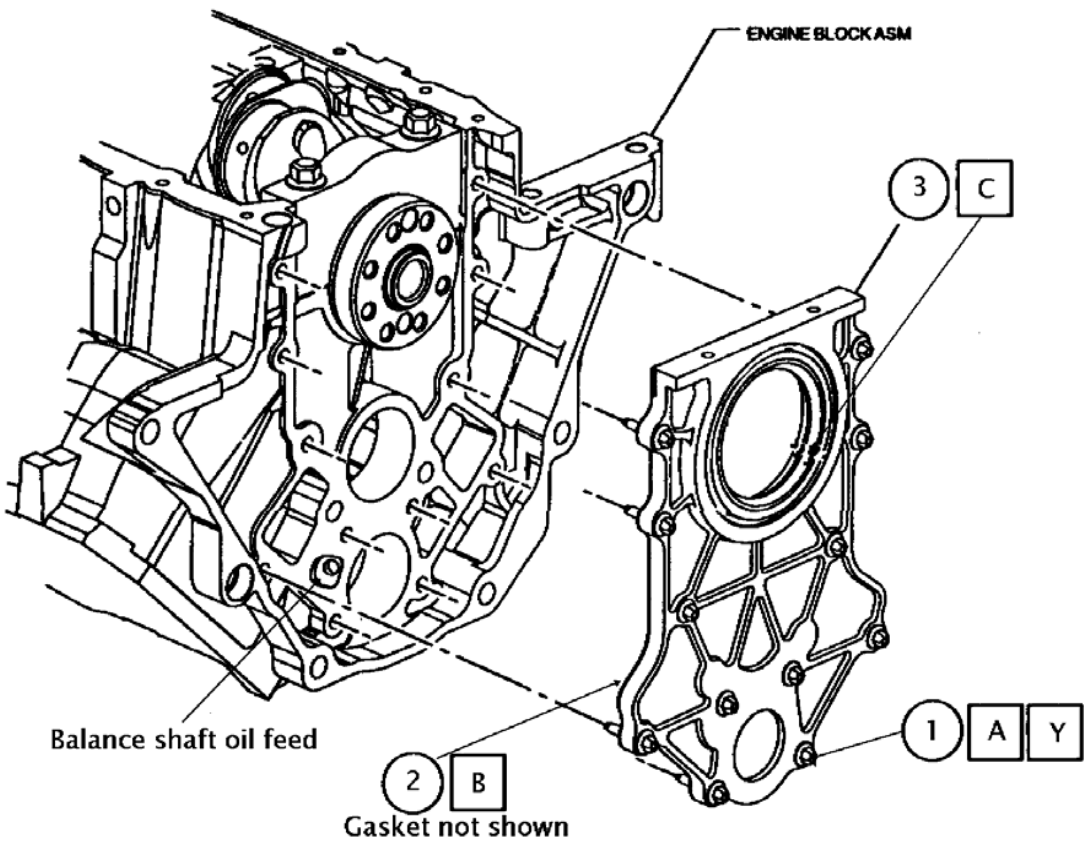
Description of Operation	
A	Install rear main lip seal using GM R&D supplied installation tool and a light duty bench press until seal bottoms in housing.

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

REV	Date	Revision History
1	01/05/98	Block-31
2	11/03/04	Change rear seal part number to OHT3G-091-1

View
Rear Cover
Rear seal installation

Front Cover, Rear Cover, & Sump	Sequence IIIF	Section	Sheet
		4	9



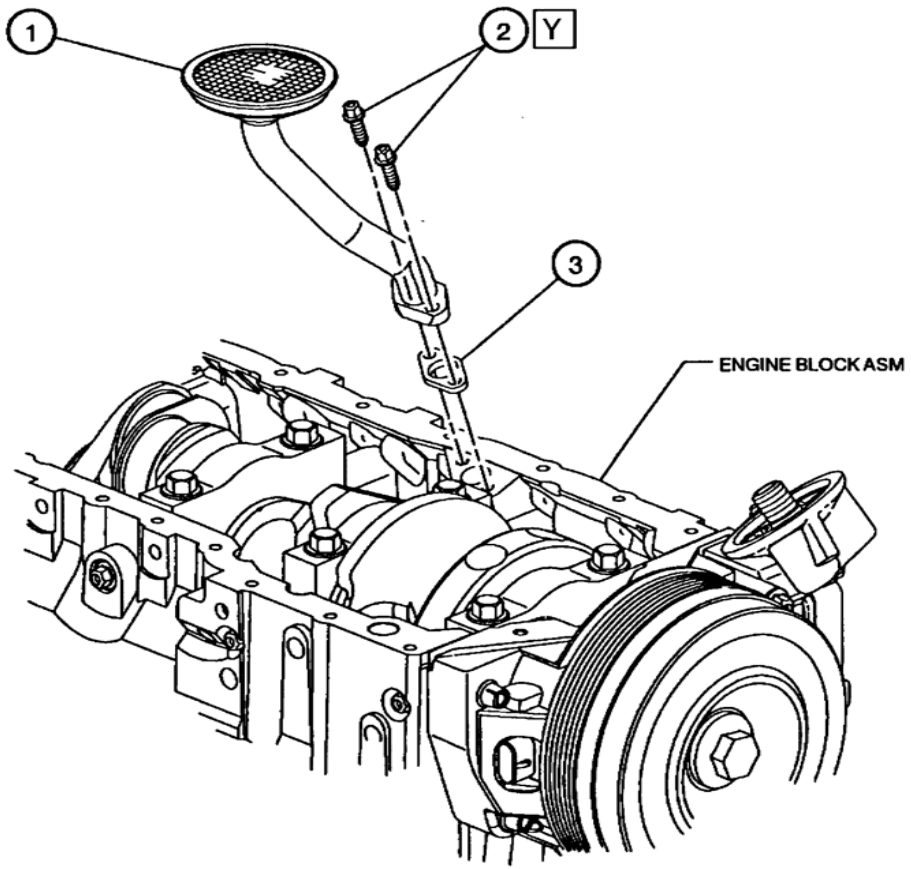
Description of Operation	
A	Install new bolts with nylon positioning collar for each run.
B	Install gasket (not shown in view) **Note: Position rear cover plate gasket so that rear balance shaft oil feed is lined up with correct side of cover plate.**
C	Lubricate rear lip seal with EF-411and use extreme 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	24503970	Bolt
2	24506644	Gasket
3	24502297	Housing assembly

REV	Date	Revision History
1	01/05/98	Block-32
2	12/01/99	Add Perfect seal note.

View
Rear Cover
Rear cover installation

Front Cover, Rear Cover, & Sump	Sequence IIIF	Section	Sheet
		4	10



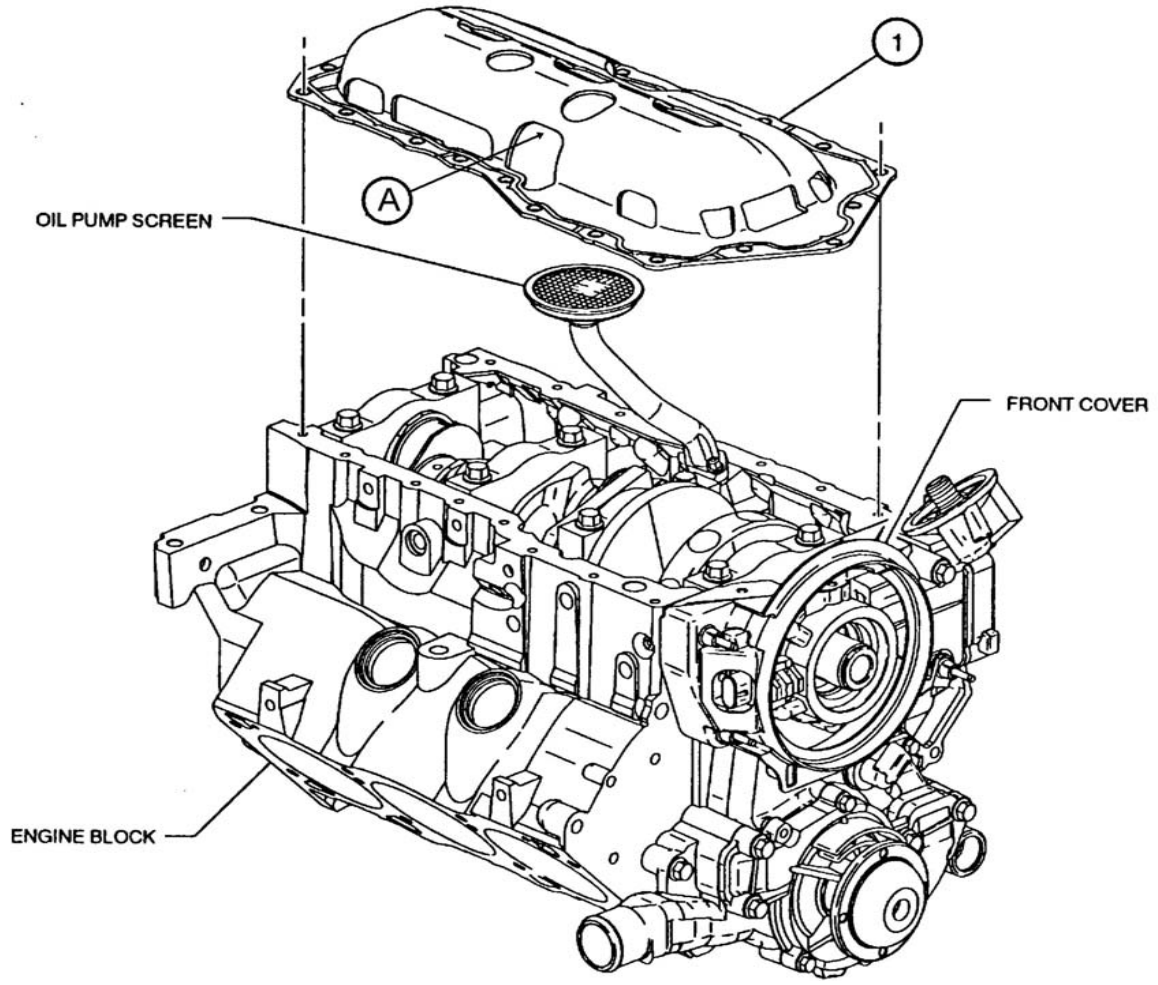
Description of Operation	
	Install oil screen assembly
Y	Torque 15Nm

Specification		
1	24505569	Screen assembly
2	24505570	Bolt
3	24501259	Gasket

REV	Date	Revision History
1	01/05/98	Block-33

View
Sump
Oil pickup tube

Front Cover, Rear Cover, & Sump	Sequence IIIF	Section	Sheet
		4	11



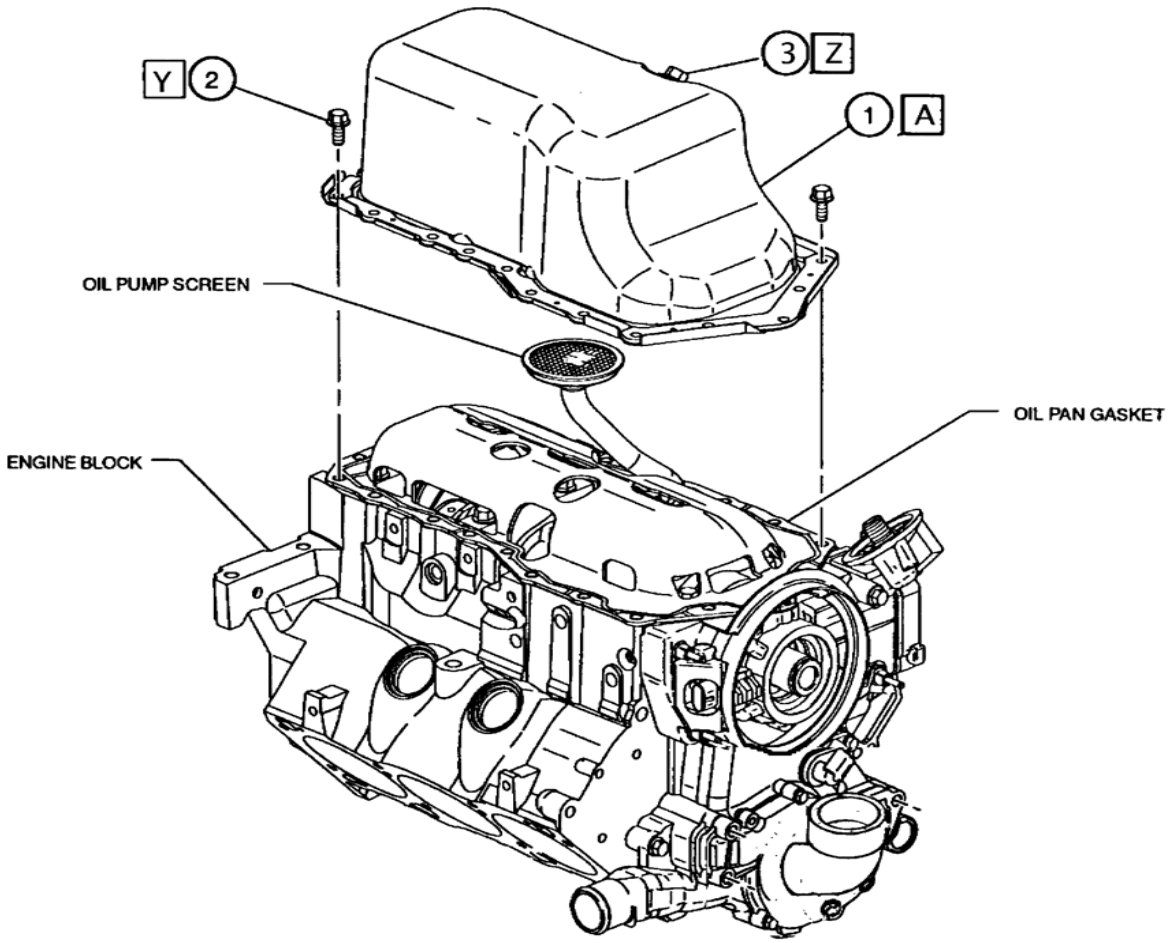
Description of Operation	
	Install oil pan gasket
A	Insure that calibrated oil level dipstick clears windage tray before final assembly
	Note: RTV GM part number 12346193 may be used at corners of front and rear covers to aid in sealing.
	GM Silicone Sealer New numbers: 12346141 Tube 12551715 Cartridge Old numbers: (Still acceptable for test) 12346192 Tube 12346193 Cartridge

Specification	
1	OHT3G-093-1 Gasket

REV	Date	Revision History
1	01/05/98	Block-34
2	12/01/99	Revise description, allow use of RTV
3	02/14/02	Add "A" dipstick clearance check
4	03/15/04	Update Sealer information
5	11/03/04	Change oil pan gasket to OHT3G-093-1

View
Sump
Oil pan gasket install

Front Cover, Rear Cover, & Sump	Sequence IIIF	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	24502791 Bolt
3	OHT3F-063-1 Modified drain plug

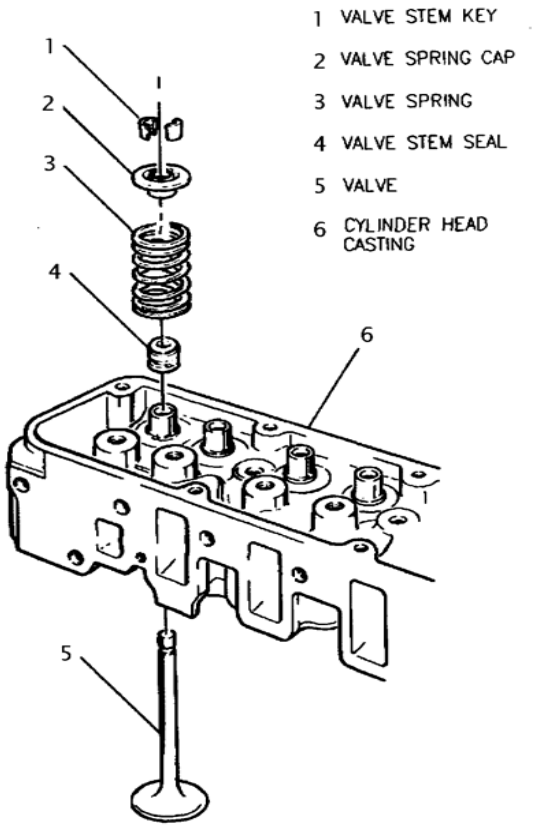
REV	Date	Revision History
1	01/05/98	Block-35
2	6/22/00	Add OHT Special Nickel Plated Oil Pan

View
Sump
Oil pan installation

Front Cover, Rear Cover, & Sump	Sequence IIIF	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 obtaining proper load.

Description of Operation

Clean cylinder head with mineral spirits and spray with 50/50 solution of EF-411 and mineral spirits. 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 801N +/- 22N @ 9.5mm (180lbf +/- 5lbf @ 0.375in.) travel.

Specification

1	1016634 Valve stem key
2	24502257 Valve spring cap
3	OHT3F-059-5 Valve spring (Yellow)
4	OHT3F-060-1 Seal int.
	OHT3F-061-1 Seal exh. White stripe
5	24502254 Valve int.(STD)
	12579949 Valve exh.(STD)
6	24502259 Head, GM Raceshop

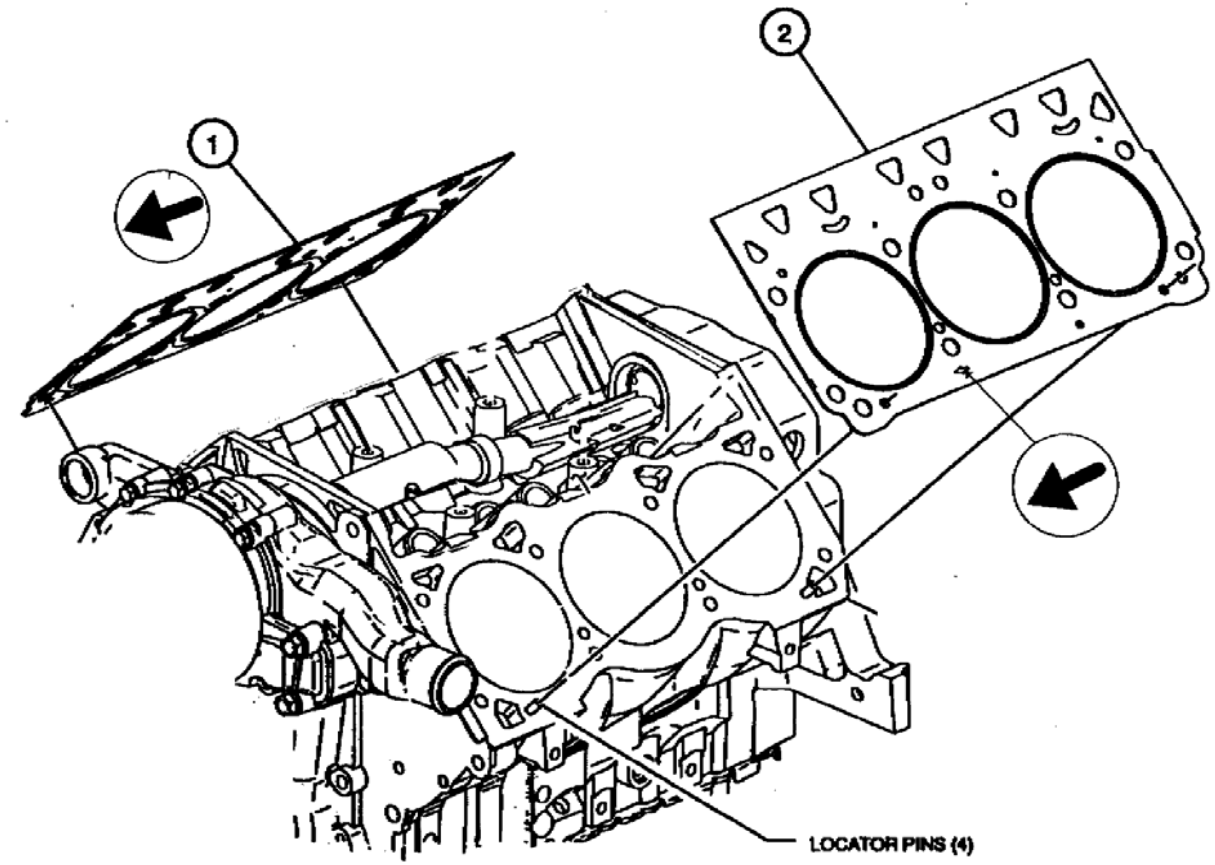
REV	Date	Revision History
1	01/06/98	Block-36
3	12/01/99	Update valve spring calibration
4	2/22/02	Update valve spring calibration
5	11/03/04	Change part number for exhaust valve from 24507423 to 12579949
6	12/01/04	Change to mineral spirits

View

Head Assembly

Valve & spring assembly

Head Assembly	Sequence IIIF	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

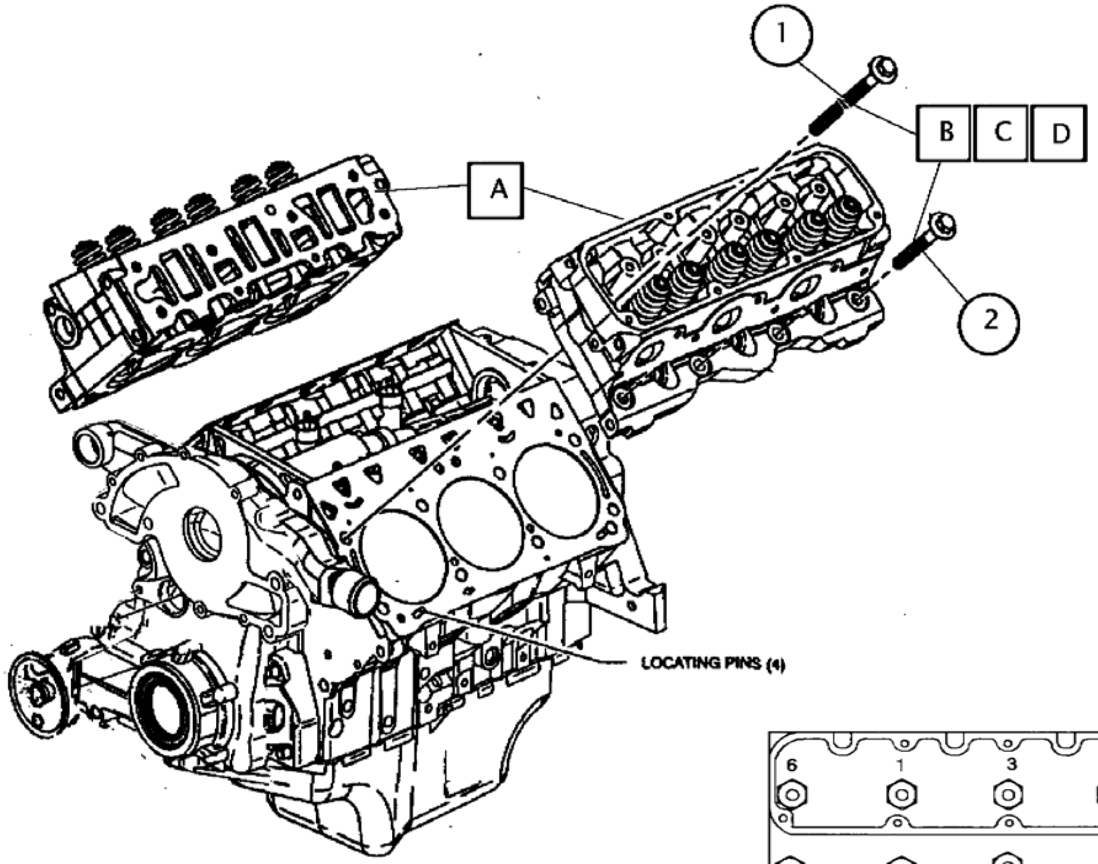
REV	Date	Revision History
1	01/06/98	Block-37

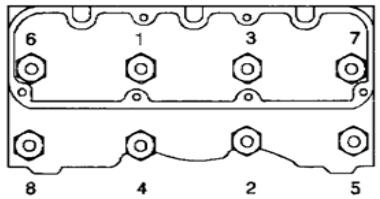
View

Head Gaskets

Head gasket install

Head Assembly	Sequence IIIF	Section	Sheet
		5	2





Description of Operation	
A	Carefully install cylinder heads.
B	Clean all Teflon type 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 with the Torque Sensor 1 wrench set on soft joint for gasketed applications. 30Nm-50Nm-80Nm - JCS-TEL to yield.

Specification	
1	25527831 Bolt Cyl. Head (8) Long
2	25533811 Bolt Cyl. Head (8) Short

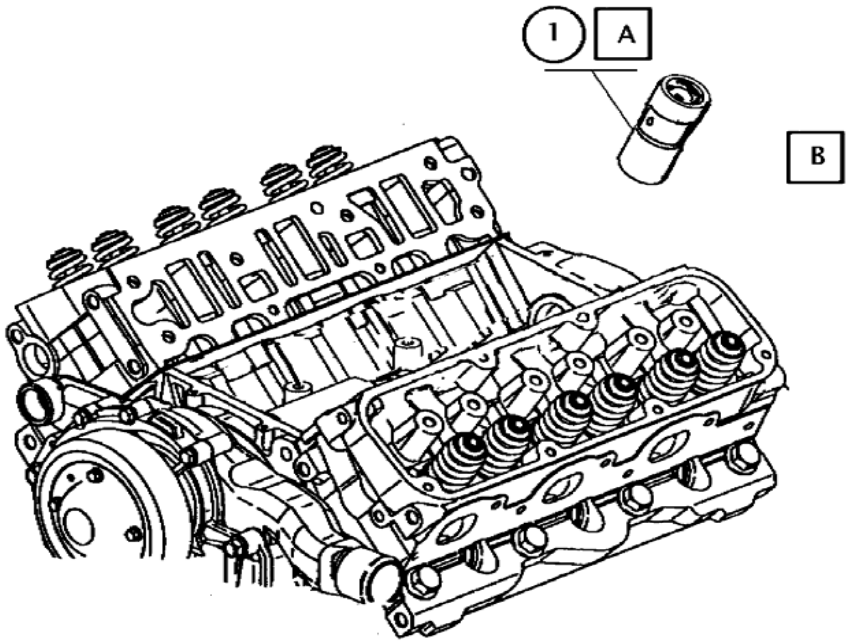
REV	Date	Revision History
1	01/06/98	Block-38 & 50

View
Cylinder Head
Cylinder head installation

Head Assembly	Sequence IIIF	Section	Sheet
		5	3

Section 6

Long Block Assembly



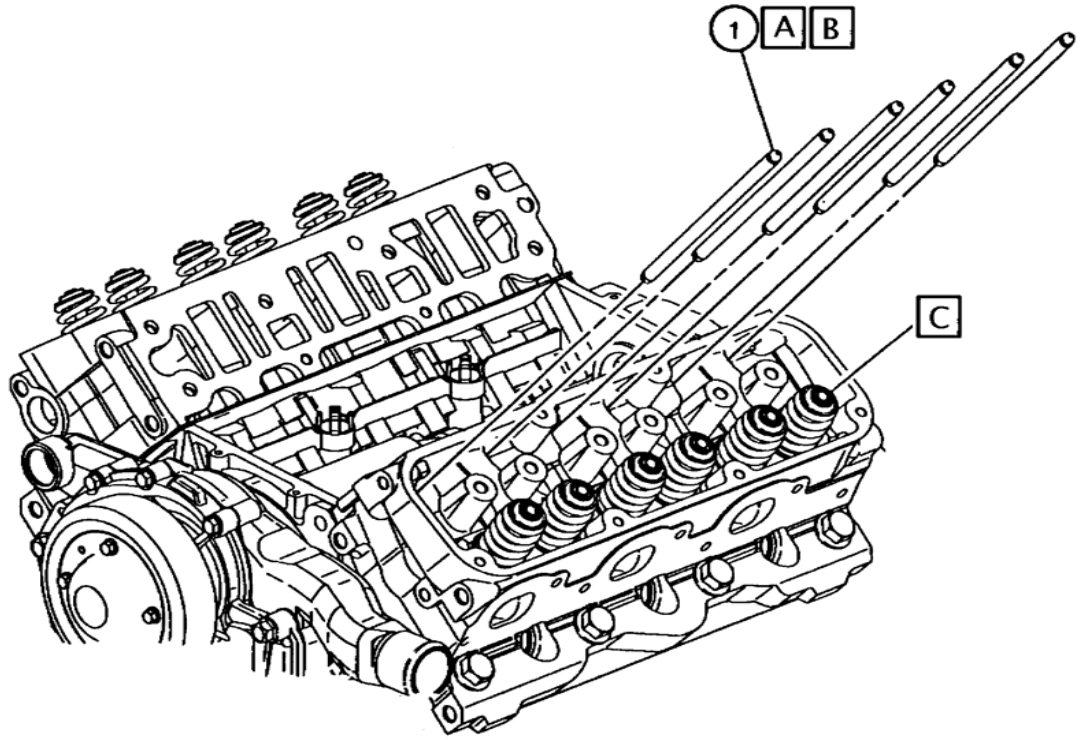
Description of Operation	
A	Measure and record pre-test lifter foot height to the nearest 0.001mm
B	Installation: 1) Clean each lifter using a lightly soaked cloth with mineral spirits (Do not disassemble, spray, or submerse the lifter in solvent). 2) Dip each lifter foot in test oil and install the lifter set less pushrods. 2) Rotate engine crankshaft 720° slowly with no load on lifters. 3) Remove each lifter, one at a time, dip each foot in test oil, and re-install with the ground flat facing inboard.

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

REV	Date	Revision History
1	1/6/1998	Block-39
2	11/13/99	Update lifter part number, description, and installation instructions
3	6/22/00	Add OHT part number for ACI test lifter
4	2/22/02	Remove OHT3F-029-2 52100 wear test Lifter
5	12/1/04	Change to mineral spirits

View
Lifter Installation
Lifter pre-oiling and installation

Long Block Assembly	Sequence IIIF	Section	Sheet
		6	1



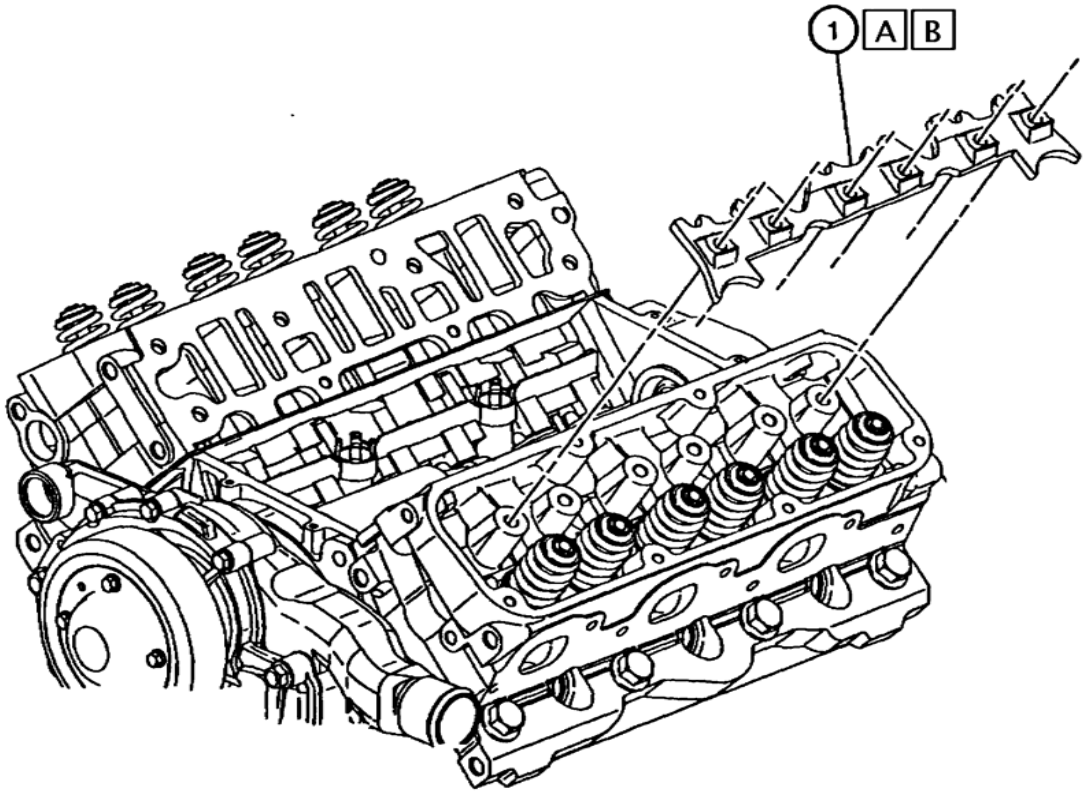
Description of Operation	
A	Clean all pushrods with minearl spirits and spray with a 50/50 solution of EF-411 and mineral spirits. Remove excess with compressed air. Lubricate each pushrod end, pushrod seat, and rocker arm ball socket with EF-411 prior to installation.
B	Install pushrods
C	Lubricate 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	6/18/02	Add lubrication of pushrod ball ends "A"
3	12/1/04	Change to mineral spirits

View
Pushrods
Pushrod installation

Long Block Assembly	Sequence IIIF	Section	Sheet
		6	2



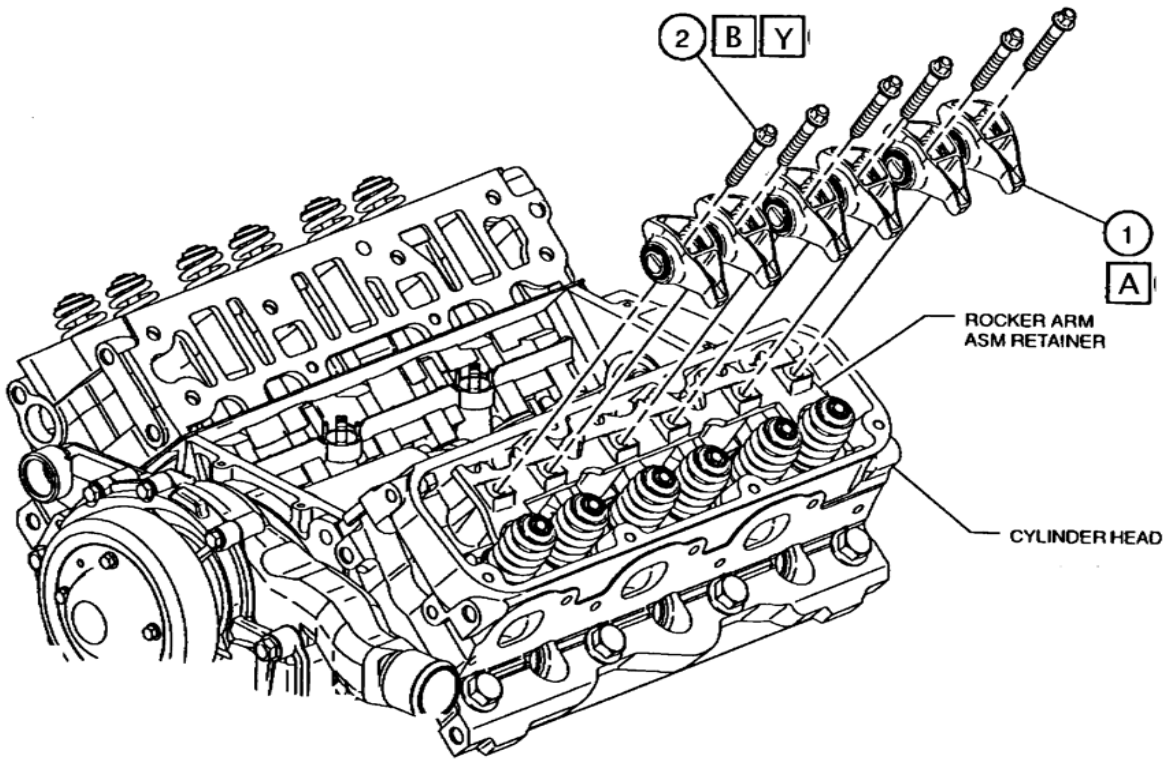
Description of Operation	
A	Clean and inspect for wear.
B	Install pushrod guide / rocker bearing retainer.

Specification		
1	24502278	Retainer

REV	Date	Revision History
1	1/6/1998	Block-41

View
Retainer
Rocker bearing retainer installation

Long Block Assembly	Sequence IIIF	Section	Sheet
		6	3



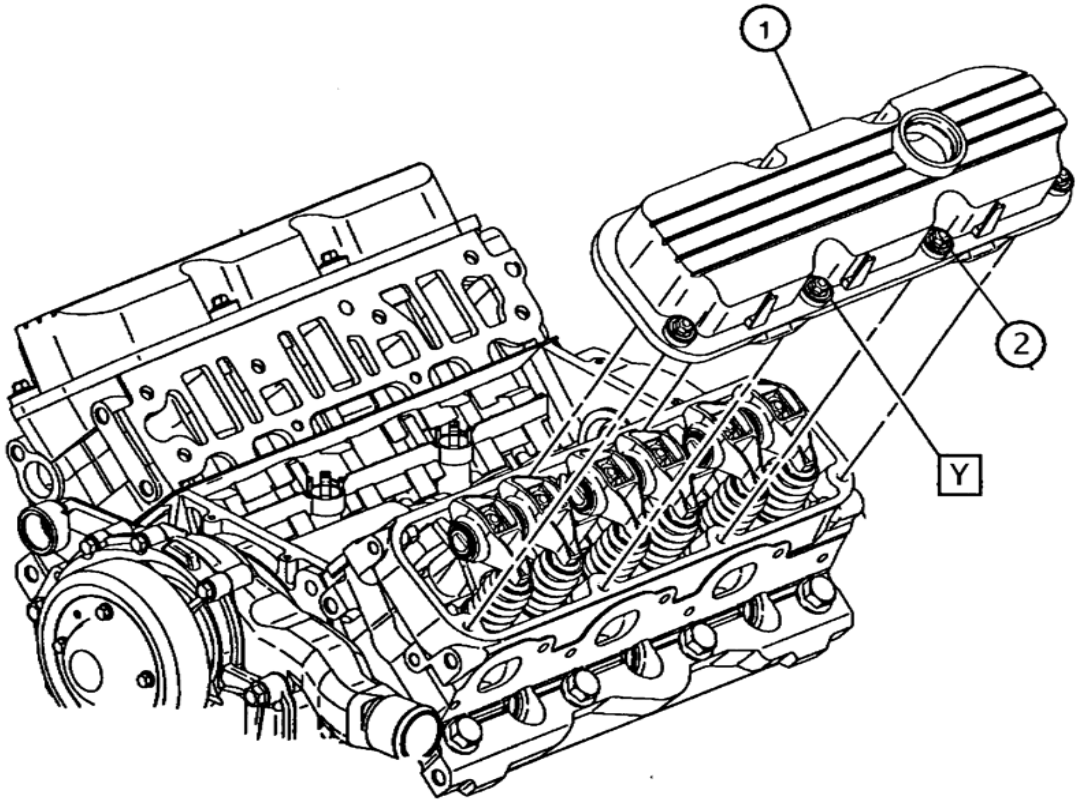
Description of Operation	
A	Lubricate rocker arms with EF-411 and install. **Note: Rocker arm assemblies are replaced every test. Do not dip or spray with mineral spirits. Needle roller bearings will retain solvents.**
B	Lubricate bolts with EF-411 and install.
Z	Torque & Angle 25Nm + 70° Note: Do not 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	11/13/99	Remove SPO part number for furnished rocker arm bolts
3	12/1/99	Add note on rotation
4	12/1/04	Change to mineral spirits

View
Rocker Arm
Rocker arm installation

Long Block Assembly	Sequence IIIF	Section	Sheet
		6	4



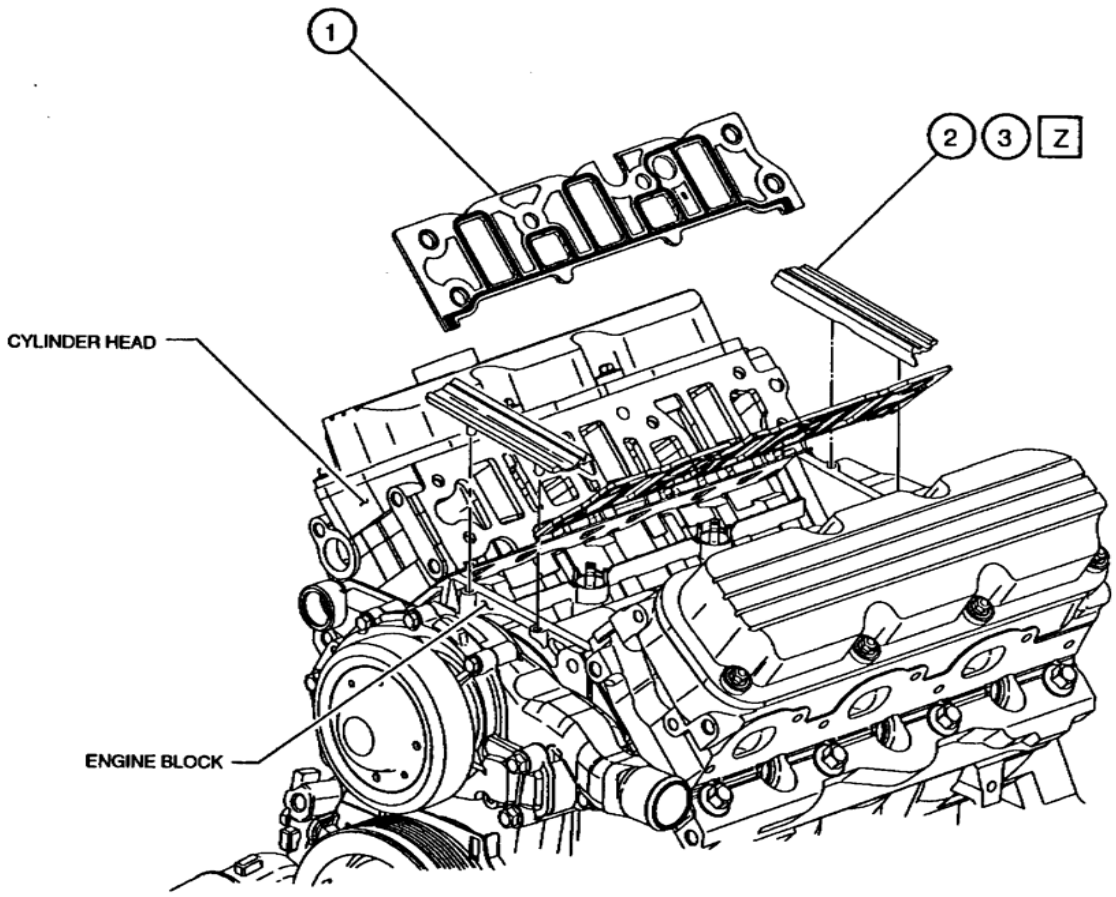
Description of Operation	
	Install rocker covers
Y	Torque 10Nm

Specification		
1	25534751	Cover, Valve Lt (2)
2	24502164	Bolt
	25534748	Bolt w/washer

REV	Date	Revision History
1	1/6/1998	Block-43

View
Rocker Cover
Rocker cover installation

Long Block Assembly	Sequence IIIF	Section	Sheet
		6	5



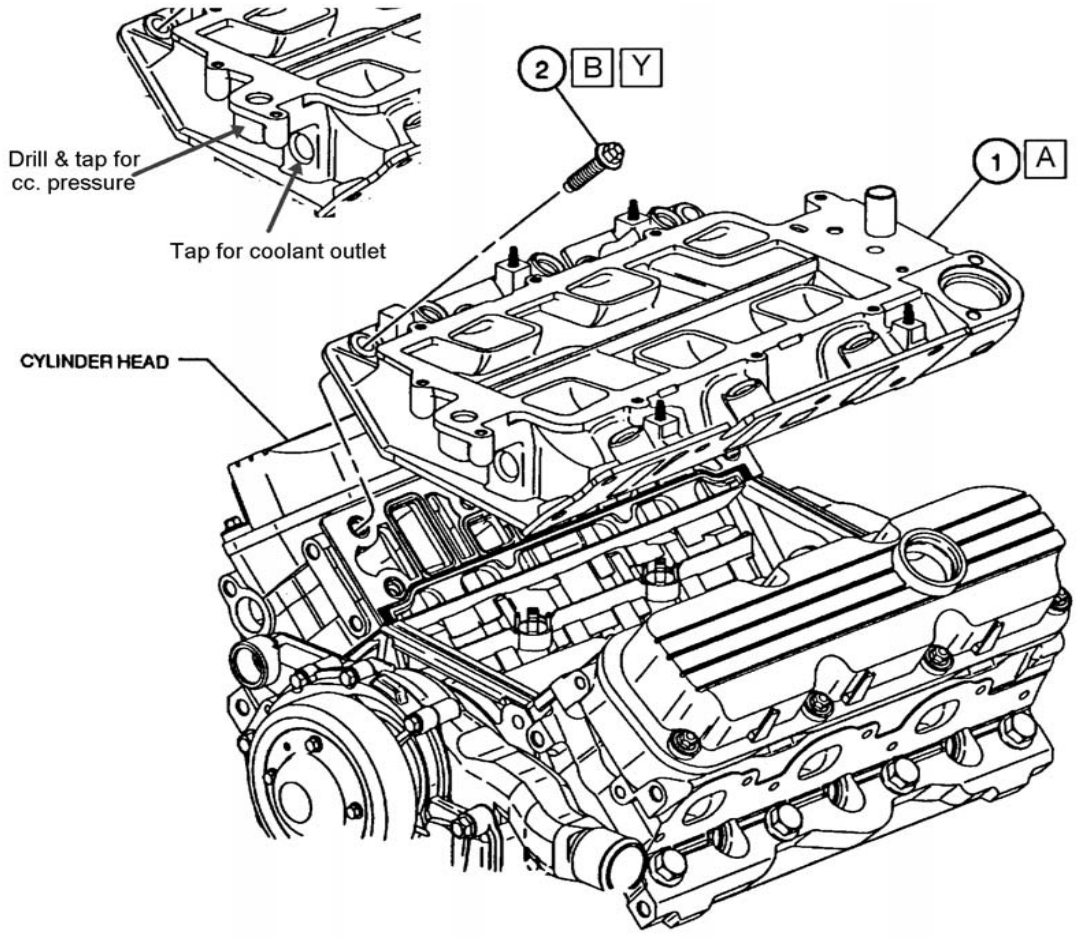
Description of Operation	
	2nd design gasket kit uses locating pins for front and rear seals
Z	Apply RTV, GM (see part number info) or Dow Corning 3154 sealer to both ends. GM Silicone Sealer New numbers: 12346141 Tube 12551715 Cartridge Old numbers: (Still acceptable for test) 12346192 Tube 12346193 Cartridge

Specification	
1	89017399 (New) 12480830 (Old) 12539093 (Old) 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	12/1/99	Add sealant part number
3	2/22/02	Delete first design intake gasket
4	12/15/03	Update RTV sealer
5	3/15/04	Update Intake Gasket Part Number and Silisone Sealer Information

View
Intake Gaskets
Intake gasket installation

Long Block Assembly	Sequence IIIF	Section	Sheet
		6	6



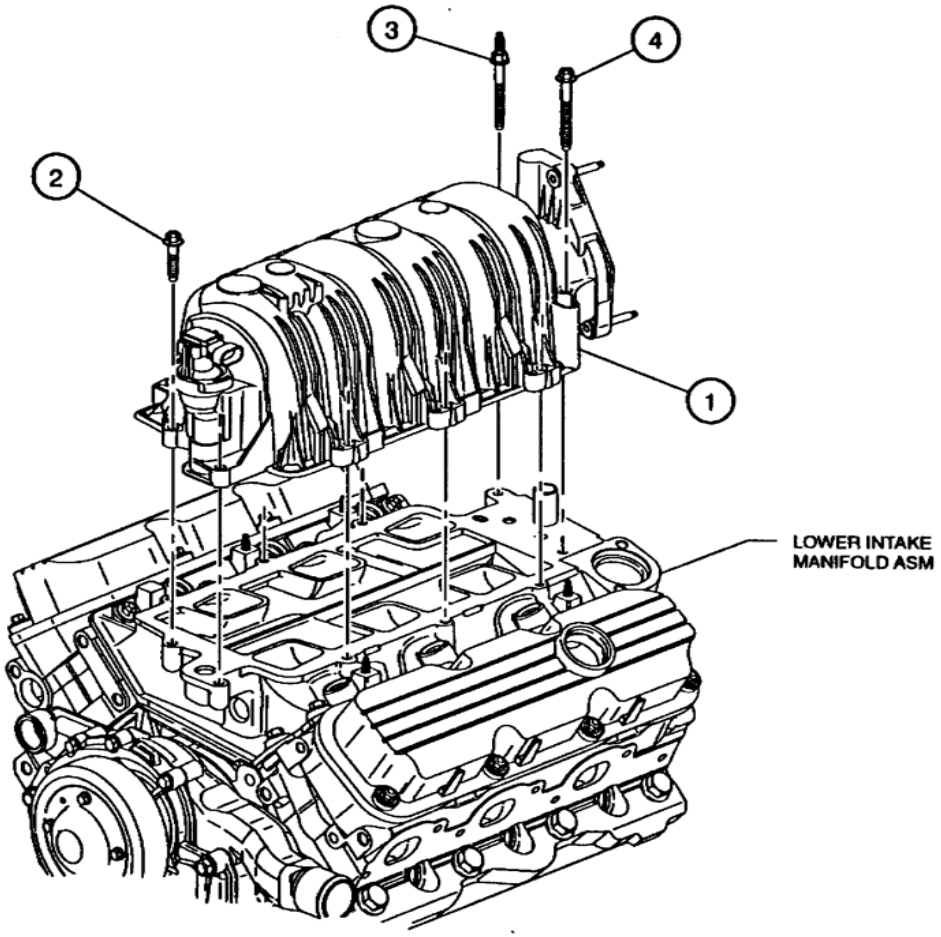
Description of Operation	
A	Install modified intake manifold
B	Clean and lubricate bolts with Permatex #2 and install.
Y	Torque 15Nm
	Drill and tap as indicated for the crankcase pressure line . Also tap coolant outlet port for coolant return line to process controller. Use a 3/4" I.D. unrestricted line for the return. Do not install shut off valves in the return line.

Specification		
1	24505728	Manifold assembly
2	24504090	Bolt (12)

REV	Date	Revision History
1	1/6/1998	Block-45
2	11/30/99	Add exploded view for c.c. and coolant lines.
3	6/22/00	Update coolant return line description
4	2/22/02	Add Perfect Seal #4
5	6/17/02	Change "B" from Perfect Seal #4 to Permatex #2

View
Lower Intake
Lower intake manifold installation

Long Block Assembly	Sequence IIIF	Section	Sheet
		6	7



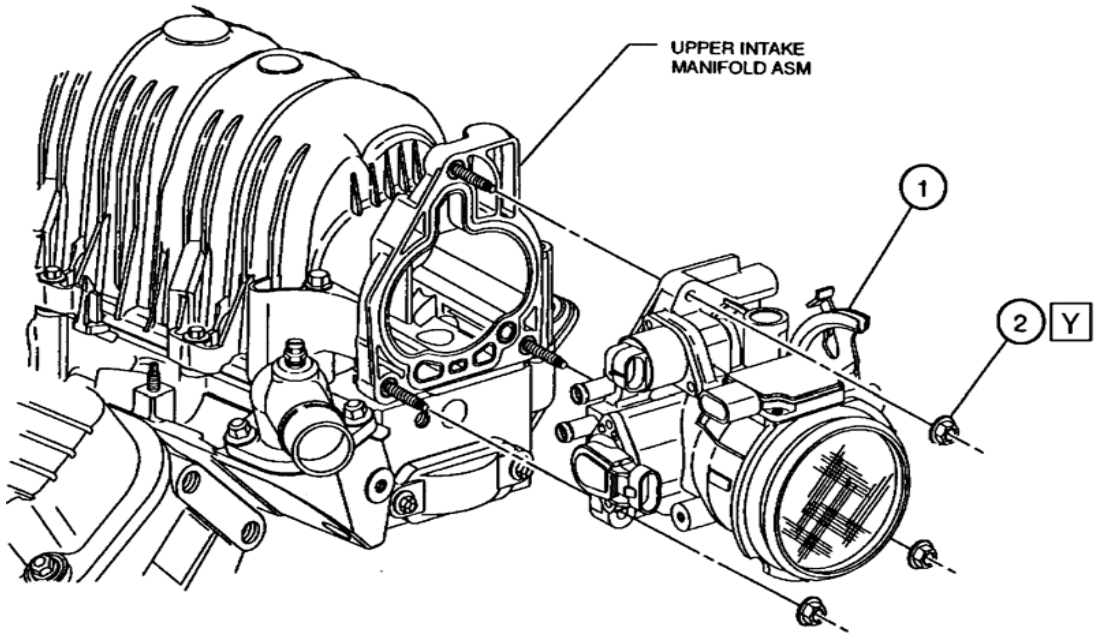
Description of Operation	
	Install upper intake and gasket assembly.
Y	Torque 10Nm (Max. torque)

Specification	
1	17096162 Manifold assembly 17113137 Gasket Kit
2	24506498 Bolt (8)
3	24502453 Stud
4	24505205 Bolt
	See note Y for torque

REV	Date	Revision History
1	1/6/1998	Block-46
2	6/17/02	Add "Max. torque" to "Y"

View
Upper Intake
Upper intake installation

Long Block Assembly	Sequence IIIF	Section	Sheet
		6	8



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

Specification

1 24507235 Throttle Body
(2 bolt Mass Air Flow Sensor)
Use 1256 or
May be superseded with
remanufactured part# 88961007
24507230 Throtle Body
(3 bolt Mass Air Flow Sensor 24504302)

2 24506469 Nut

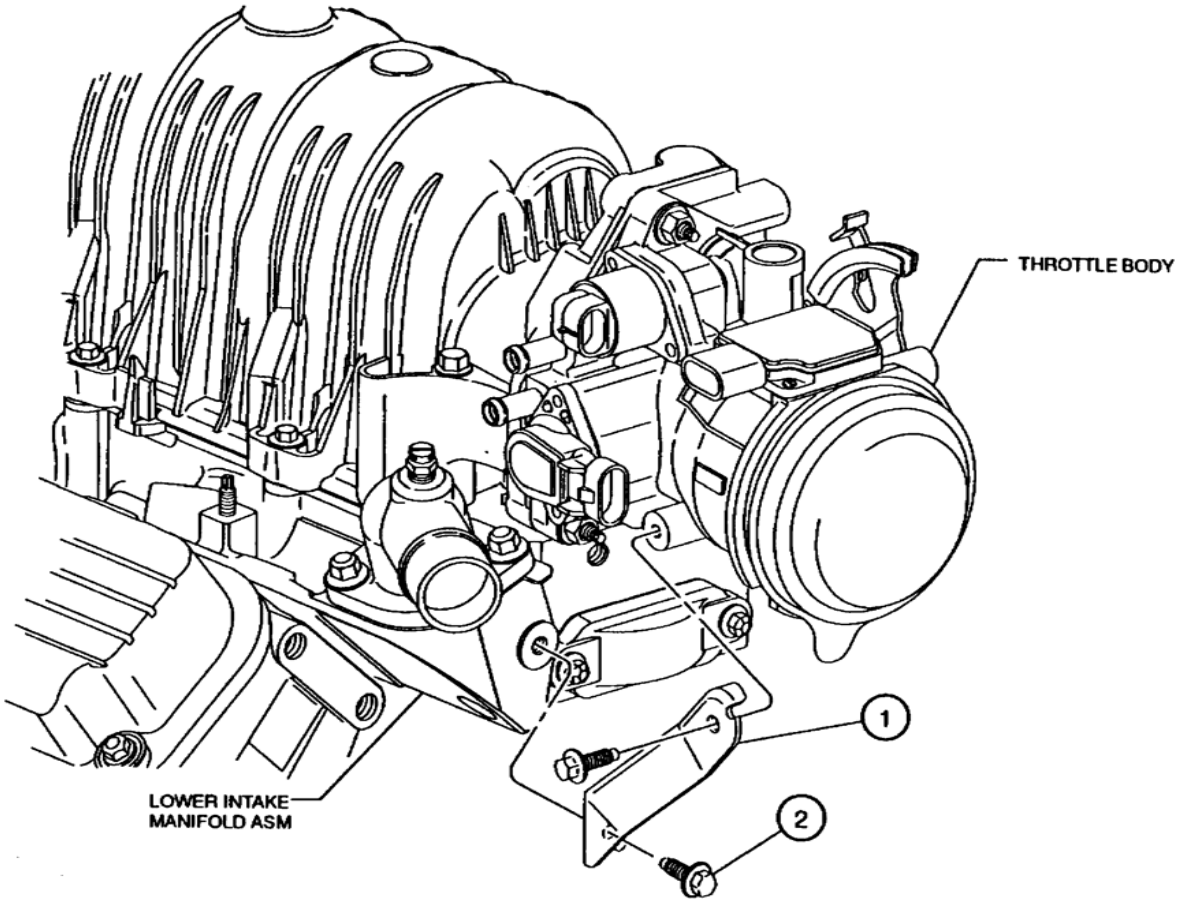
REV	Date	Revision History
1	1/6/1998	Block-47
2	11/13/99	Update part number and add note for modification see section 7 sheet 5
3	2/22/02	Update Throttle Body Part Numbers
4	6/17/02	Update 2 bolt Mass Air Flow Sensor Part Number
5	6/23/03	Add 88961007 remanufactured from 12568877

View

Throttle Body

Throttle body installation

Long Block Assembly	Sequence IIIF	Section	Sheet
		6	9



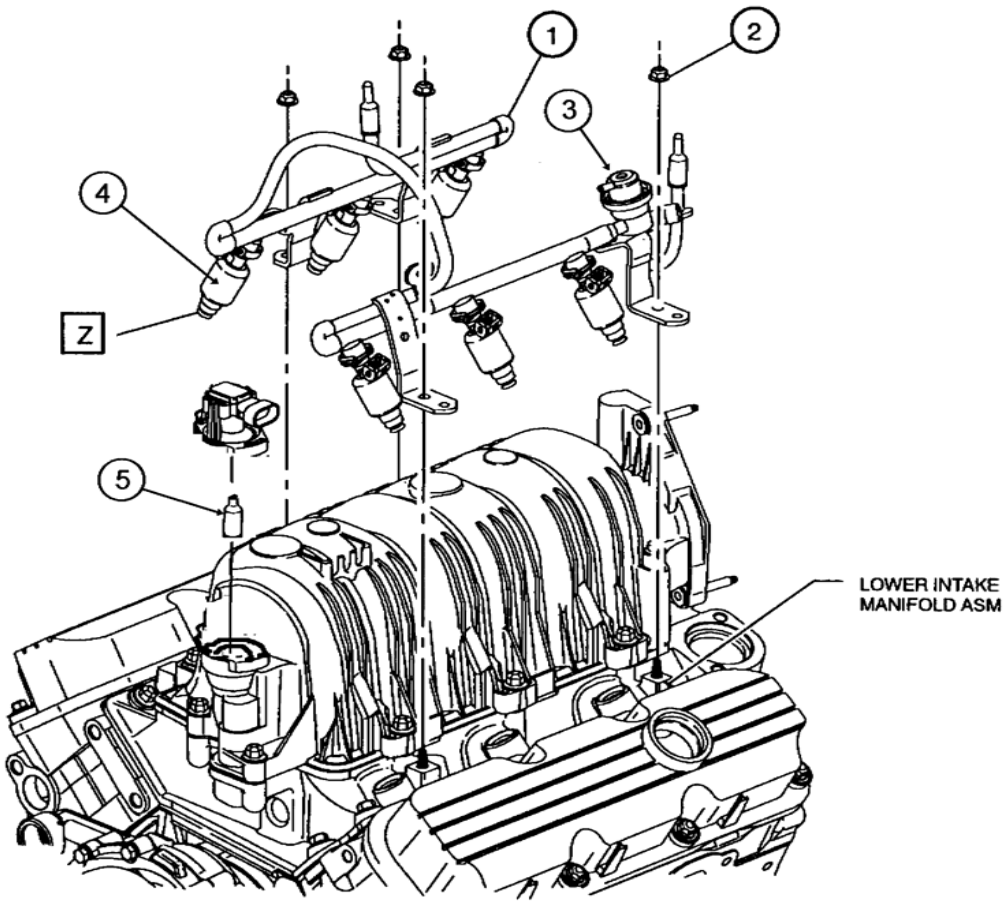
Description of Operation	
	Install support bracket
Y	Torque 10Nm

Specification	
1	24504697 Support
2	24503644 Bolt (2) 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 IIIF	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	17098211 Fuel Rail
2	24506469 Nut
3	17113346 Regulator
4	17120601 Injector
5	OHT3F-002-1 PCV Dummy

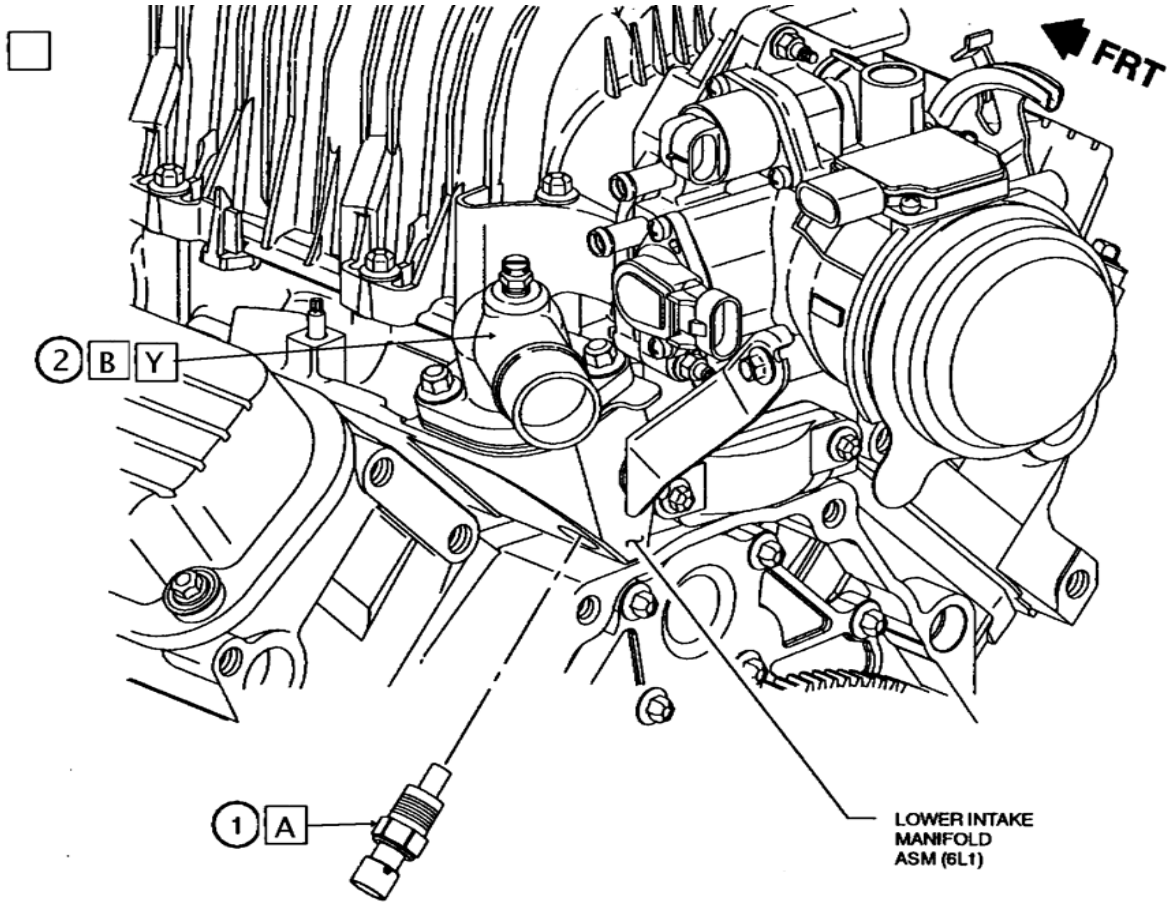
REV	Date	Revision History
1	1/6/1998	Block-49
2	11/13/99	Update part numbers and view
3	2/22/02	Update Text Box (Procedure Reference)
4	12/15/03	Update text on reference to procedure for injector flow testing requirements

View
Injector Assembly
Injector assembly installation

Long Block Assembly	Sequence IIIF	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
Y	Torque 27Nm

Specification

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

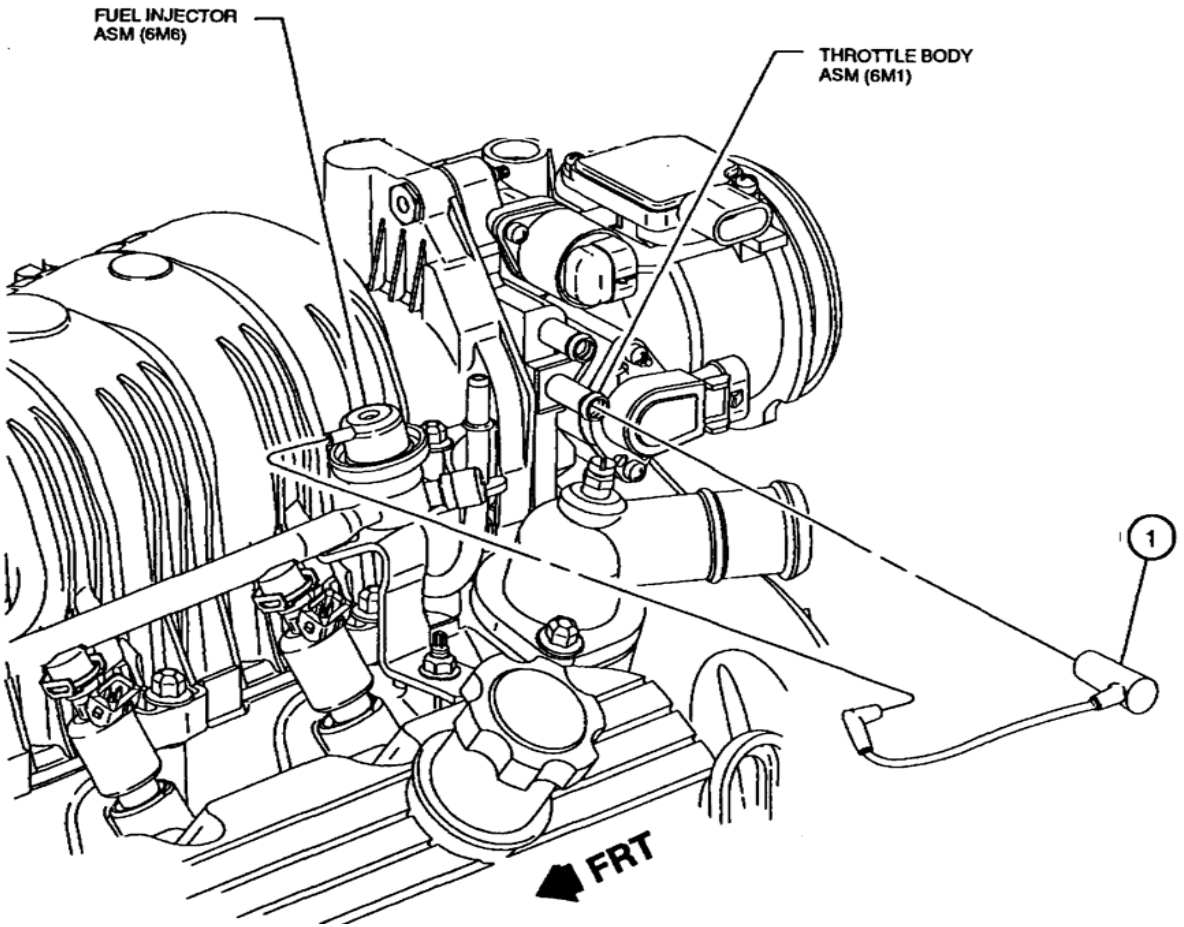
2 OHT3F-034-1 Coolant Outlet
(Not to detail on sheet)

REV	Date	Revision History
1	1/10/98	Block-51

View

Coolant Out & Sensor

Final Dress	Sequence IIIF	Section	Sheet
		7	1



Description of Operation

Specification

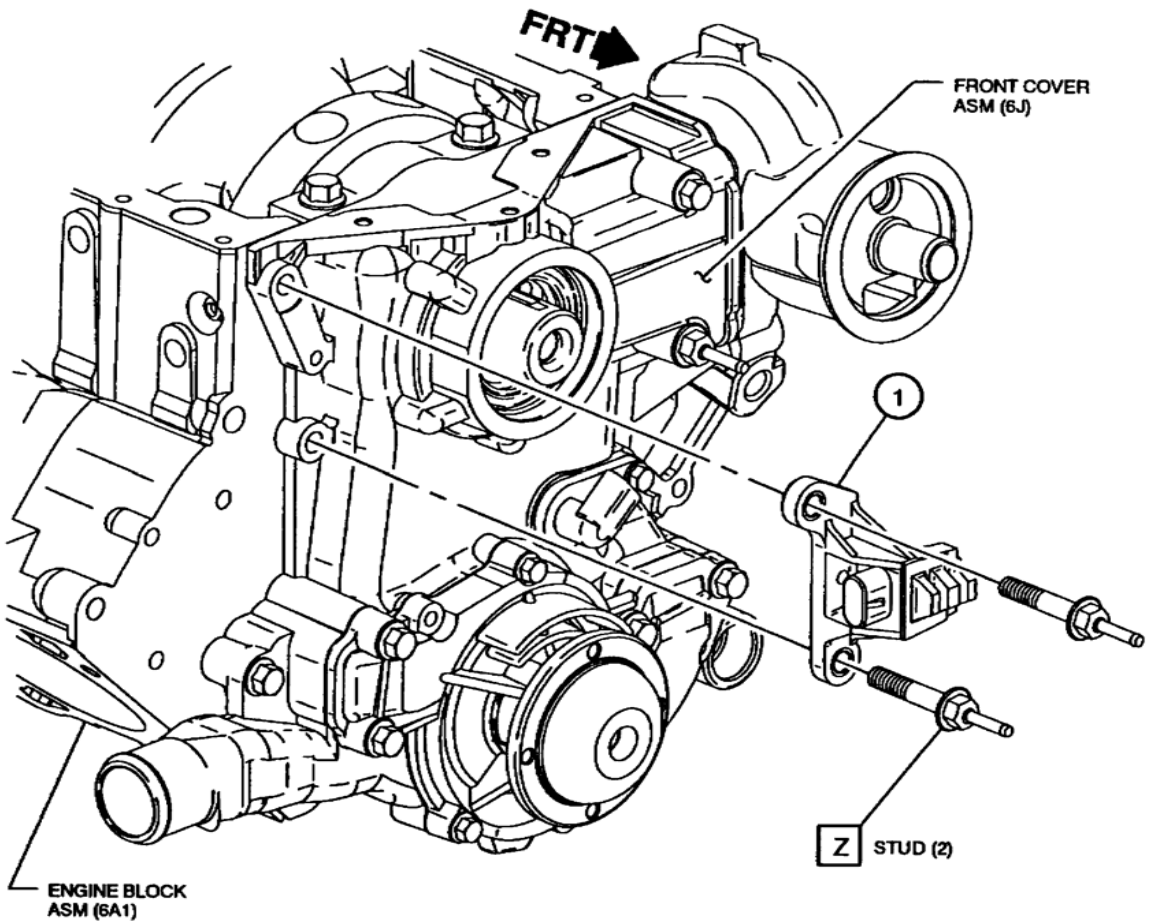
1 24505671 Tube

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

View

Vacuum Hose

Final Dress	Sequence IIIF	Section	Sheet
		7	2



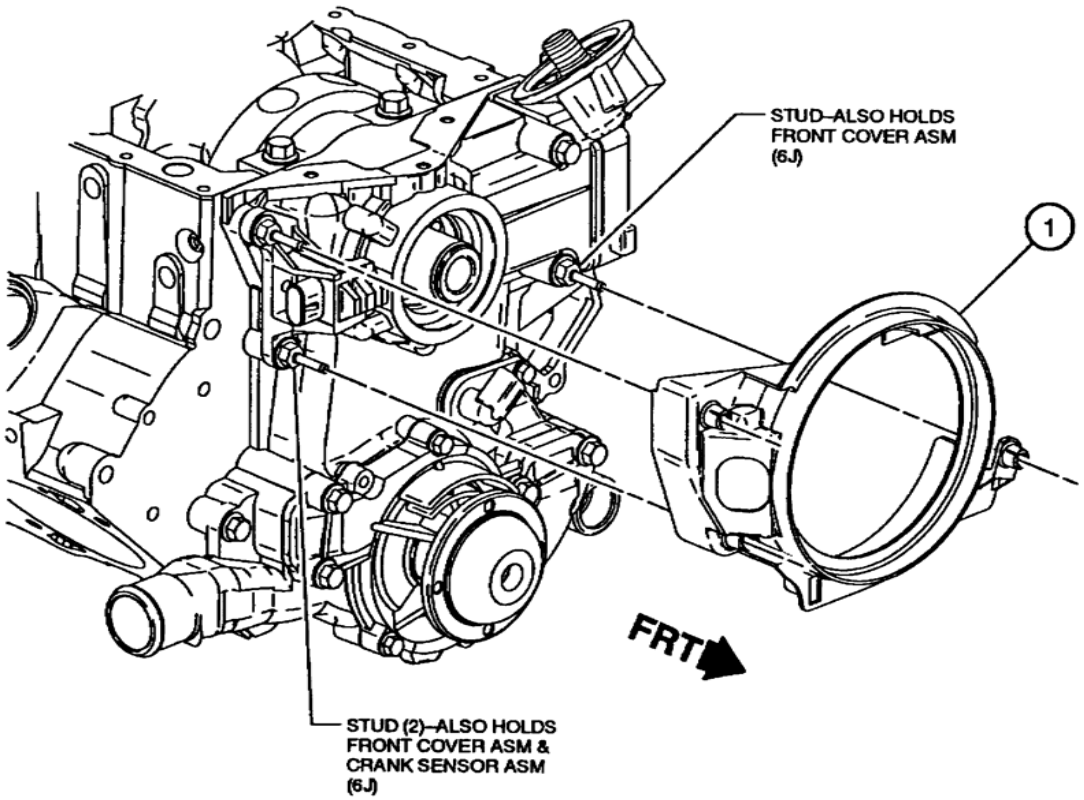
Description of Operation	
Z	See front cover section for bolt part numbers and torque.

Specification		
1	10456161	Sensor

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

View
Crankshaft Sensor

Final Dress	Sequence IIIF	Section	Sheet
		7	3



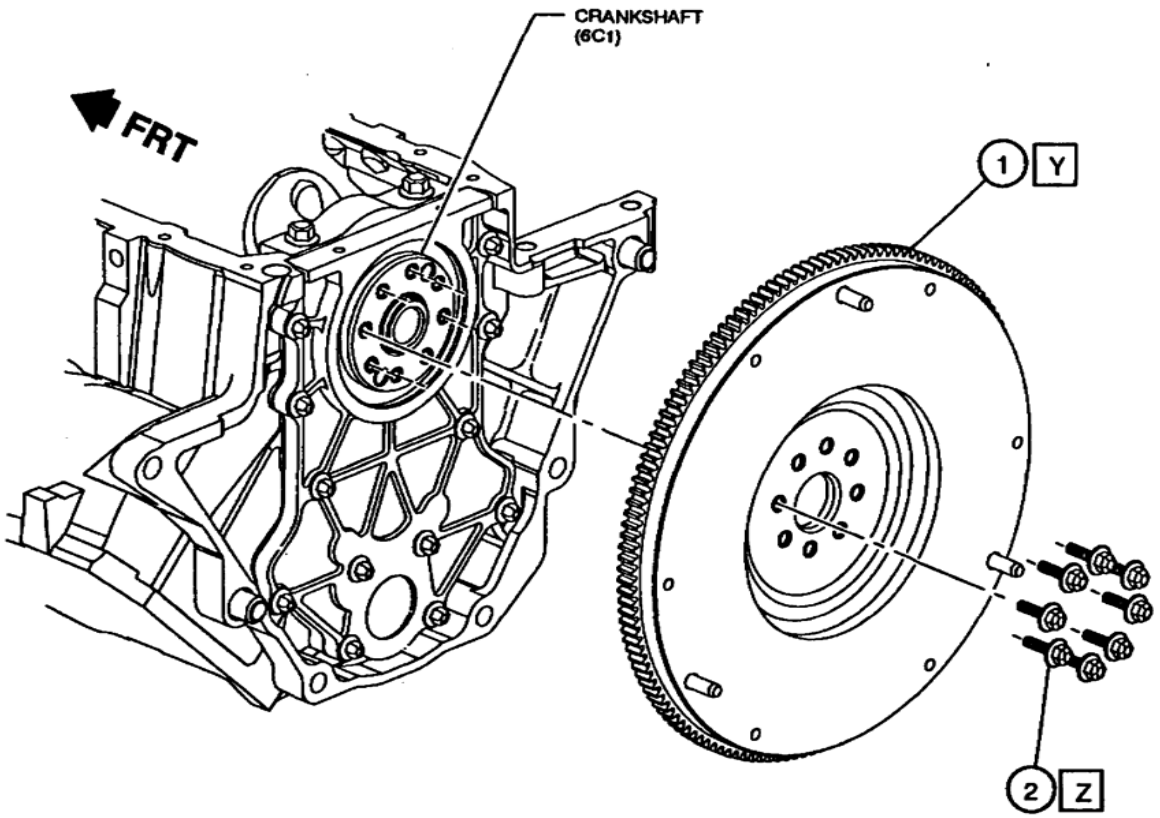
Description of Operation	

Specification	
1	24506440 or 24508586 Shield

REV	Date	Revision History
1	1/10/98	Block-54
2	12/15/03	Add 24508586

View
Crankshaft Sensor Shield

Final Dress	Sequence IIIF	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°

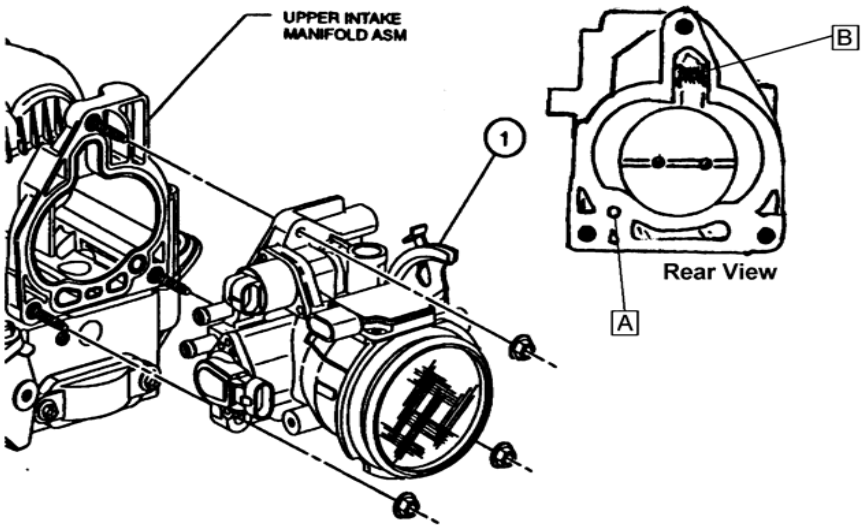
Specification	
1	OHT3F-020-2 Flywheel (Modified 24503285)
2	24505092 Bolt

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

View

Flywheel

Final Dress	Sequence IIIF	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. 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)
Use 12568877
or
May be superseded with
remanufactured part# 88961007

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

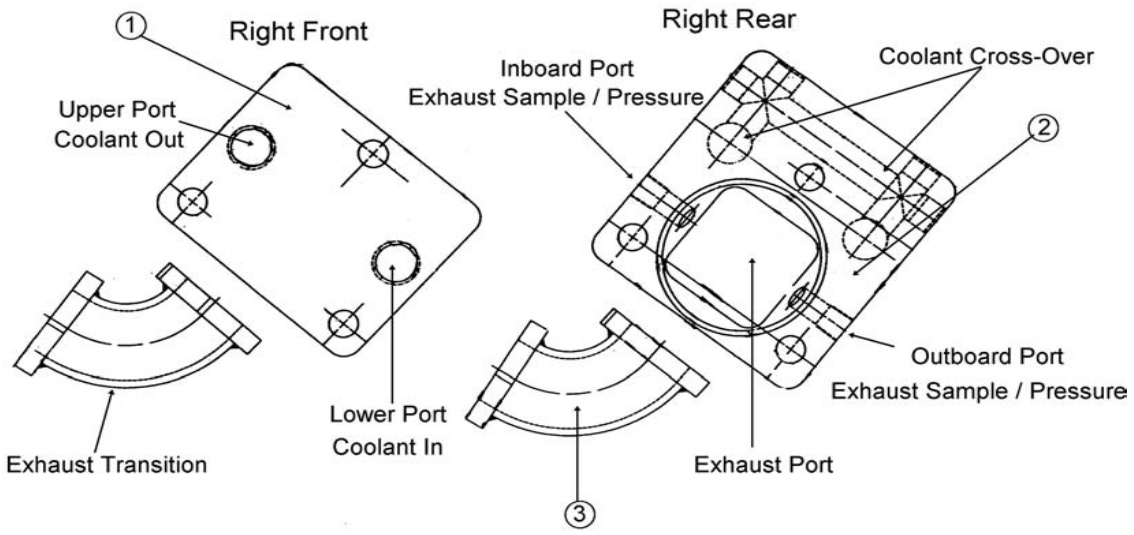
View

Throttle Body Modification

Final Dress	Sequence IIIF	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

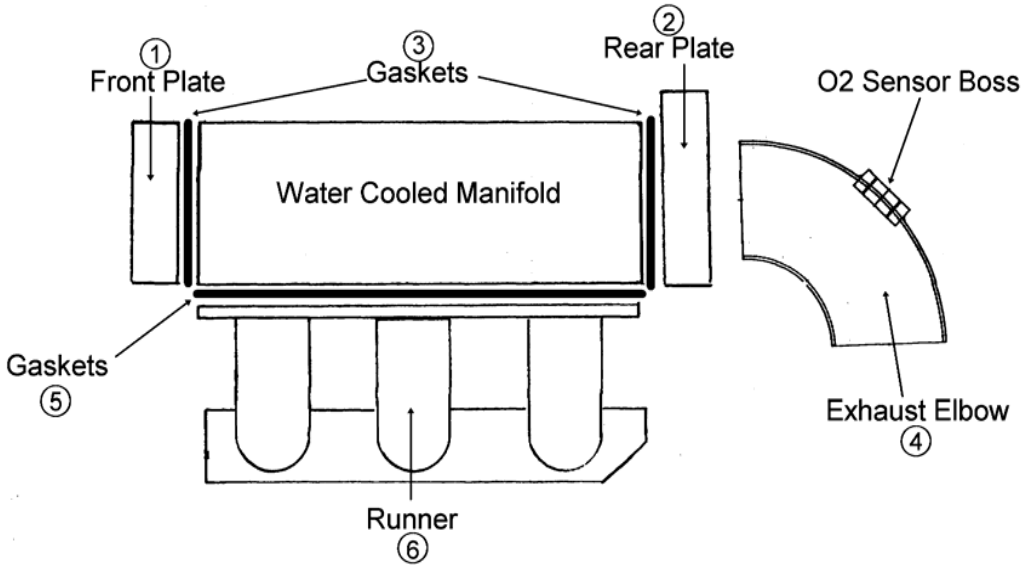
1 OHT3F-006-1 Plate, Rear Exhaust
2 OHT3F-005-1 Plate, Front Ehhaust
3 OHT3F-004-1 Runner, Exh. Man.

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 IIIF	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

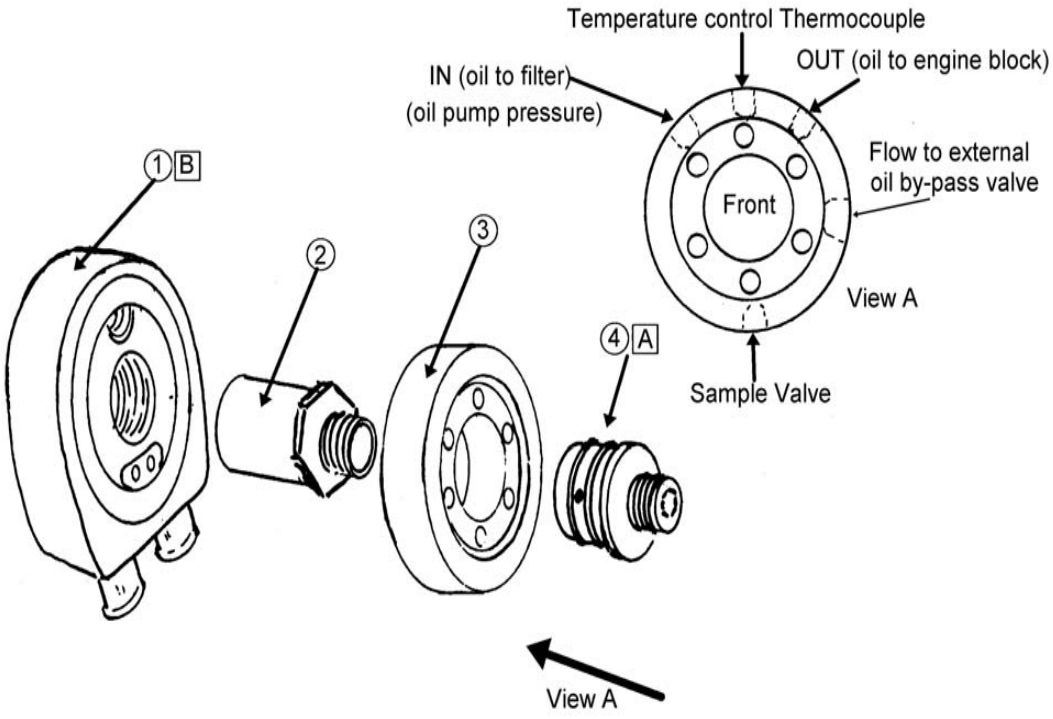
1 OHT3F-005-1 Plate, Front Ehhaust
2 OHT3F-006-1 Plate, Rear Exhaust
3 OHT3F-009-1 Gasket, End Plate
4 OHT3F-005A-1 Elbow, Exh. Modified
5 OHT3F-018-1 Gasket Flange, Metal
6 OHT3F-004-1 Runner, Exh. Man.

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 IIIF	Section	Sheet
		8	2



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

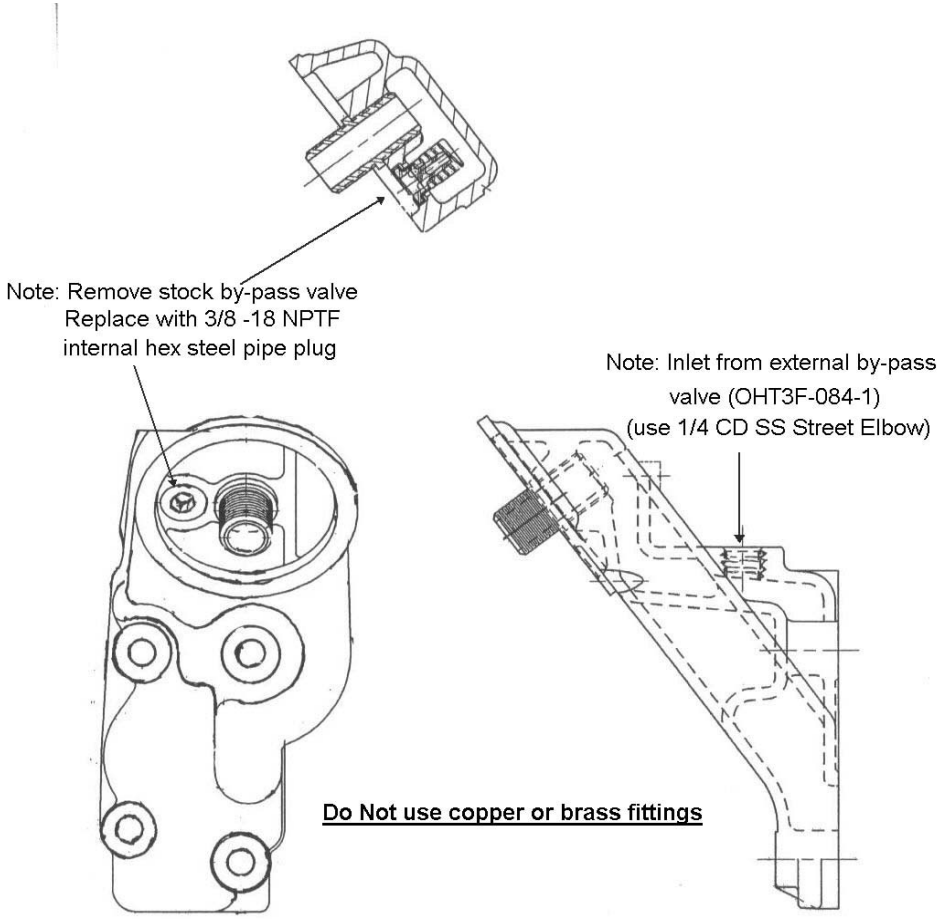
Description of Operation	
A	Replace "O"-rings every test. Note: View A Viewed from front or oil filter side, passages are, IN (oil pump pressure to filter), center port for temperature control thermocouple, OUT (oil flow out of filter in to engine block), Side outlet to external oil by-pass valve, and 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 IIIF	Section	Sheet
		8	3



Description of Operation

Special part modification information.

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

Specification

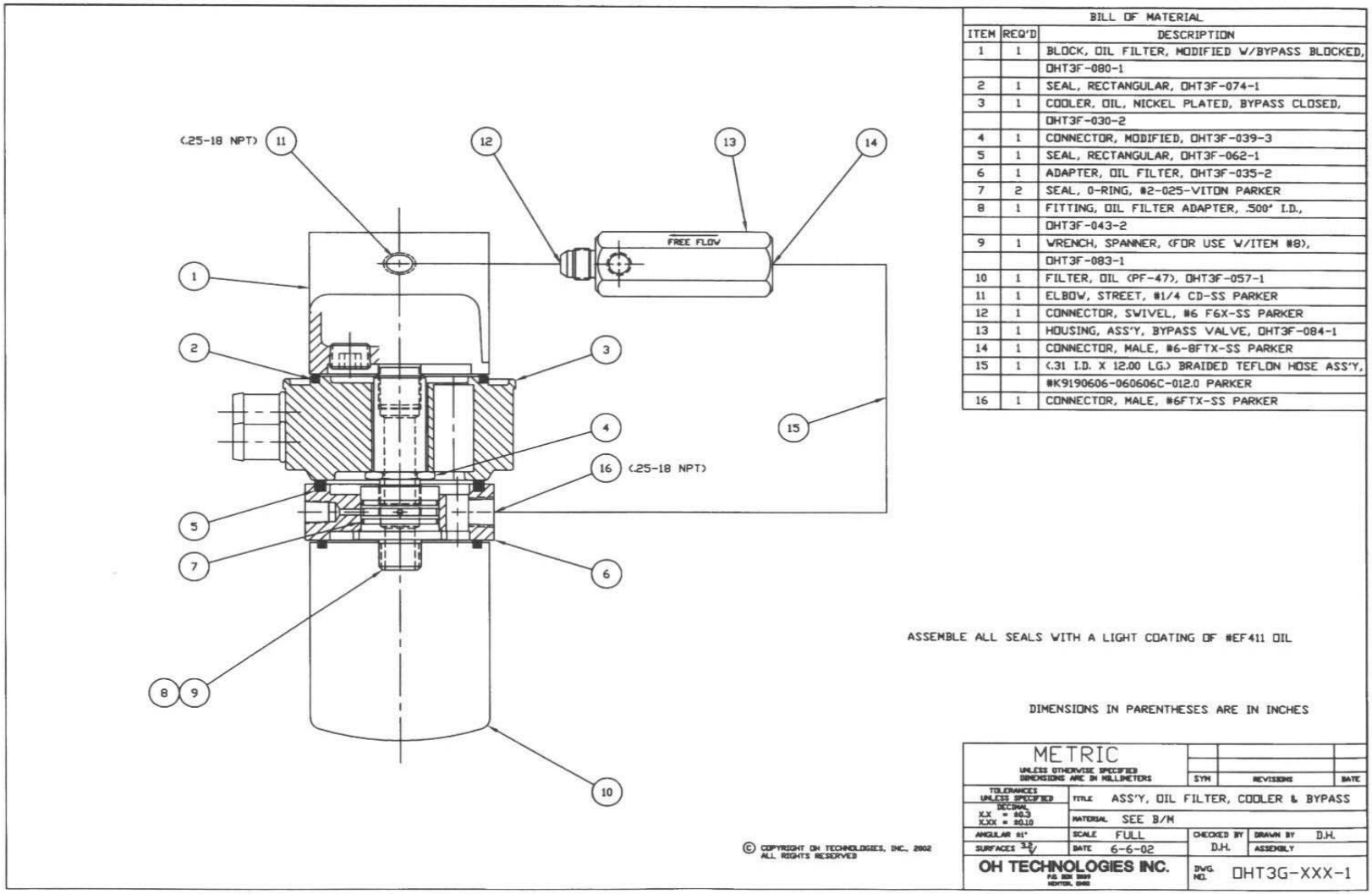
1 24501300 Adapter, oil filter
OHT3F-080-1 Modified

REV	Date	Revision History

View

Oil Filter Adapter Modification

OHT	Sequence IIIF	Section	Sheet
		8	3A

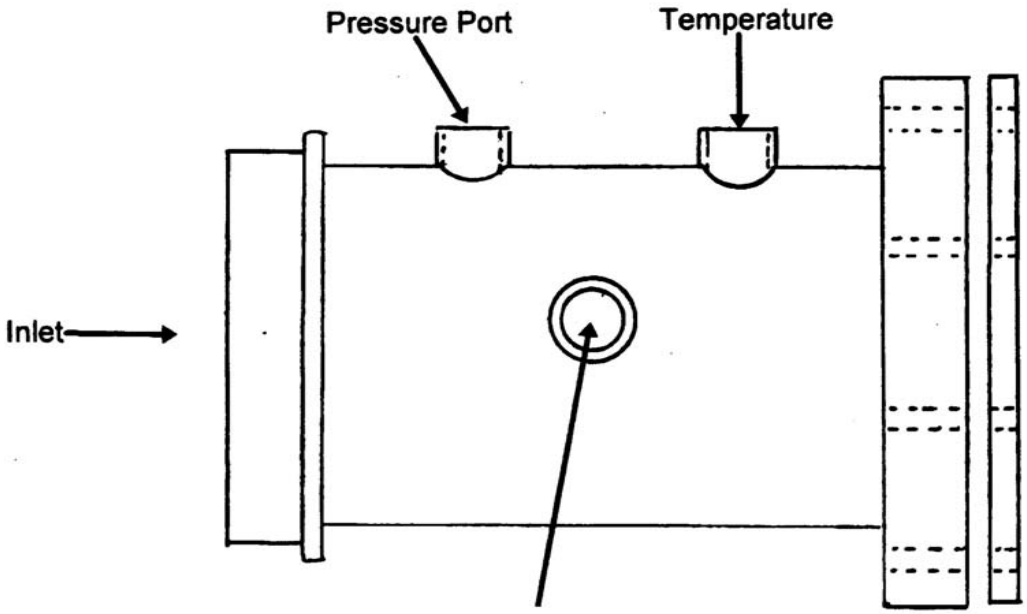


BILL OF MATERIAL

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

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

OHT	Sequence IIIF	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 IIIF	Section	Sheet
		8	4