

# NMWR 9-2815-274

---

## NATIONAL MAINTENANCE WORK REQUIREMENTS

FOR  
6.5 Liter  
ENGINES  
With Container

### Detuned 6.5 Liter

NSN 2815-01-406-6675 (1996) – PN 57K3226

NSN 2815-01-453-7404 (1998) – PN 57K3537

NSN 2815-01-439-6664 (2000) – PN 57K3556

### 6.5 Liter Naturally Aspirated

NSN 2815-01-410-9710 (1995, 1996) – PN 57K3223

NSN 2815-01-439-6665 (1997) – PN 57K3524

NSN 2815-01-453-7403 (1998) – PN 57K3536

NSN 2815-01-461-7078 (1999) – PN 57K3543

NSN 2815-01-461-7978 (2000) – PN 57K3555

NSN 2815-01-461-7078 (2001) – PN 57K3566

### 6.5Liter Turbo

NSN 2815-01-420-4180 (1996) – PN 57K3241

NSN 2815-01-453-7402 (1998) – PN 57K3538

NSN 2815-01-439-8164 (2000) – PN 57K3568

This publication is not available through the AG publications centers. This publication is available through U.S. Army TACOM, Warren, MI 48397-5000

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

---

U.S. ARMY TANK-AUTOMOTIVE AND ARMAMENTS COMMAND  
WARREN, MICHIGAN 48397-5000  
As of March 16, 2003



## **WARNING**

### **EXHAUST GASES CAN KILL**

Brain damage or death can result from heavy exposure. Precautions must be followed to ensure personnel safety when the engine is operated for any purpose.

1. **DO NOT** operate your vehicle engine in enclosed area.
2. **BE ALERT** at all times for exhaust odors.
3. **BE ALERT** for exhaust poisoning symptoms. They are:
  - Headache
  - Dizziness
  - Sleepiness
  - Loss of muscular control
4. **If YOU SEE** another person with exhaust poisoning symptoms:
  - Remove person from area
  - Expose to open air
  - Keep person warm
  - Do not permit person to move
  - Administer artificial respiration, if necessary\*
  - Notify a medic

\* For artificial respiration, refer to FM 21-11
5. **BE AWARE**, the field protective mask for nuclear-biological-chemical (NBC) protection will not protect you from exhaust poisoning.

**THE BEST DEFENSE AGAINST EXHAUST POISONING IS ADEQUATE VENTILATION.**

## **WARNING SUMMARY**

- Always wear eye-shields when using compressed air. Failure to wear eye-shields may result in eye injury.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).
- Do not use compressed air to dry bearings. Spinning a dry bearing with compressed air may cause injury to personnel or damage to equipment.
- Improper cleaning methods and use of unauthorized cleaning solutions will injure personnel and damage equipment. See TM 9-247 for correct information.
- Dry-cleaning solvent is flammable and will not be used near an open flame. A fire extinguisher will be kept nearby when the solvent is used. Use only in well-ventilated places. Failure to do this may result in injury to personnel and/or damage to equipment.
- When steam cleaning, protective clothing must be used. Failure to use protective clothing may result in serious injury.
- Diesel fuel is highly flammable. Do not perform this procedure near fire, flame, or sparks. Severe injury or death may result.
- Cylinder block must be supported during removal and installation from engine stand. Failure to support cylinder block may cause injury to personnel or damage to equipment.
- Crankshaft must be supported during removal and installation. Failure to support crankshaft may cause injury to personnel or damage to equipment.
- Do not place hands or arms near nozzle during testing. Penetrating force of oil may cause serious injury or death.
- Direct personnel to stand clear during hoisting operation. Failure to do this may cause injury to personnel.

INSERT LATEST CHANGED PAGES / WORK PACKAGES, DESTROY SUPERSEDED DATA

**LIST OF EFFECTIVE PAGES / WORK PACKAGES**

NOTE: The portion of text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Dates if issue for original and changed pages / work packages are:

Original... as of March 16, 2003

**TOTAL NUMBER OF PAGES FRONT AND REAR MATTERS 14 AND TOTAL NUMBER OF WORK PACKAGES IS 18 CONSISTING OF THE FOLLOWING:**

<b>Page / WP No.</b>	<b>*Change No.</b>	<b>Page / WP No.</b>	<b>*Change No.</b>	<b>Page / WP No.</b>	<b>*Change No.</b>
Cover	0				
Warning	0				
i-ii	0				
WP 0001-1 - WP 0045-4	0				

\*Zero in this column indicates an original page or work package



# NATIONAL MAINTENANCE WORK REQUIREMENTS

FOR  
6.5 Liter  
ENGINES  
With Container

## Detuned 6.5 Liter

NSN 2815-01-406-6675 (1996)

NSN 2815-01-453-7404 (1998)

NSN 2815-01-439-6664 (2000)

## 6.5 Liter Naturally Aspirated

NSN 2815-01-410-9710 (1995, 1996)

NSN 2815-01-439-6665 (1997)

NSN 2815-01-453-7403 (1998)

NSN 2815-01-461-7078 (1999)

NSN 2815-01-461-7978 (2000)

NSN 2815-01-461-7078 (2001)

## 6.5Liter Turbo

NSN 2815-01-420-4180 (1996)

NSN 2815-01-453-7402 (1998)

NSN 2815-01-439-8164 (2000)

### REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028 (Recommended Changes to Publications and Blank Forms), through the Internet, on the Army Electronic Product Support (AEPS) website. The Internet address is <http://aeeps.ria.army.mil>. If you need a password, scroll down and click on "ACCESS REQUEST FORM." The DA Form 2028 is located in the ONLINE FORMS PROCESSING section of the AEPS. Fill out the form and click on SUBMIT. Using this form on the AEPS will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, fax or E-mail your letter or DA Form 2028 direct to: AMSTA-LC-CI Tech Pubs, TACOM-RI, 1 Rock Island Arsenal, Rock Island, IL 61299-7630. The E-mail address is [TACOM-TECH-PUBS@ria.army.mil](mailto:TACOM-TECH-PUBS@ria.army.mil). The fax number is DSN 793-0726 or Commercial (309) 782-0726.

**DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.**

TABLE OF CONTENTS

	<u>WP Sequence No.</u>
WARNING SUMMARY.....	a
LIST OF EFFECTIVE PAGES/WORK PACKAGES.....	A
General.....	0001
Engine Repair.....	0002
Performance Test.....	0003
Container Repair & Parts Disposal.....	0004
Description, Component Location, & Data.....	0005
Engine Injection Pump Timing.....	0006
General Maintenance Instructions.....	0007
Engine Disassembly, Repair, & Assembly Task Summary.....	0008
Engine Replacement in Shipping/Storage Container.....	0009
Mounting Engine on Repair Stand.....	0010
Engine Disassembly into Subassemblies.....	0011
Cylinder Block Repair.....	0012
Crankshaft Repair.....	0013
Connecting Rod & Piston Repair.....	0014
Camshaft, Timing Chain, and Drive Gears Repair.....	0015
Timing Gear Cover Repair.....	0016
Cylinder Head & Valve Repair.....	0017
Valve Train Repair.....	0018
Torsional Damper Repair.....	0019
Flywheel Repair.....	0020
Rocker Arm Cover Repair.....	0021
Oil Pan Repair.....	0022
Oil Filter Adapter & Oil Pressure Sending Unit Repair.....	0023
Exhaust Manifold Repair.....	0024
Intake Manifold Repair.....	0025
Fuel Pump Repair.....	0026
Fuel Injection Pump Repair.....	0027
(6.5L) Fuel Injection Pump (DB2831-5149) Calibration.....	0028
(6.5L) Fuel Injection Pump (DB2831-5209) Calibration.....	0029
(6.5L) Fuel Injection Pump (DB2831-5485 or DB2831-5079).....	0030
6.5L Fuel Injection Pump (DB2831-5149) Calibration Using Fuel Injection Pump Test Stand (FTIS) Model A8022...	0031
Fuel Injection Nozzle Repair	0032

Water Pump Repair.....	0033
Water Crossover Repair.....	0034
Fan Drive Repair.....	0035
Engine Assembly From Subassemblies.....	0036
General.....	0037
Engine Run In.....	0038
General.....	0039
Repair Replacement Standards.....	0040
Supporting Info.....	0041
After Repair Performance Test Report.....	0042
Appendix A.....	0043
Appendix B.....	0044
Mandatory Replacement List.....	0045



---

**GENERAL****0001**

---

**THIS WORK (WP) COVERS:**Scope, Applicable Documents, Definitions

---

**SCOPE**

1. This National Maintenance Work Requirement (NMWR) covers the repair of the General Motors 6.5L engine and container, as appropriate. We use the engine in the High Mobility Multipurpose Wheeled Vehicle (HMMWV). The procedures contained in this NMWR describe disassembly, inspection, component repair, and assembly for 6.5L engine configurations which are serviceable and issuable to all customers without limitation or restriction, Condition Code A.
2. The repair site shall, in accordance with the terms and conditions set forth herein, furnish all equipment, facilities, services required to perform inspections and completely repair the engines.

**APPLICABLE DOCUMENTS**

You can receive copies of the applicable documents upon request by contacting:

Commodity Business Unit  
USA TACOM  
AMSTA-LC-CHL  
[Jody.mcinerney@us.army.mil](mailto:Jody.mcinerney@us.army.mil)  
Warren MI 48397-5000

The following documents form a part of this NMWR to the extent specified herein.

1. TM 9-2815-237-34
2. TM 9-2815-237-34P, Mar 2001
3. TB 9-289
4. MIL-P-14105C
5. PNs And Associated Down-parts:
6. 12460490;12469048;12469087;
7. 12469160; 12469444
8. CID A-A 52486 (Replaced MIL-M-45907)
9. After Test Report, WP0042
10. Appendix A – Supplement
11. 6.5L Crankshaft Bearing Supplement
12. Packaging Instructions

---

**GENERAL - CONTINUED**

---

**0001**

You may also refer to the following:

1. TACOM Drawing Number 12460200

**DEFINITIONS**

1. Repair: Restoring a component to its original performance condition, replacing parts if necessary.
2. Rebuild: Restoring an item to a standard as nearly possible to original or new condition in appearance, performance, and life expectancy. Accomplished by complete disassembly of the item, inspection of parts or components, repair or replacement of worn or unserviceable elements using original manufacturing tolerance and specifications and subsequent reassembly of the item.
3. OEM: The original equipment manufacturer. The company that originally manufactured, fabricated or supplied an engine component or part. OEM may include items manufactured by a subcontractor for an original equipment manufacturer, provided that the name or trademark of the OEM is shown on the item, label, or container.
4. After Market Part: Any part or component that has been manufactured or fabricated by a company other than the original equipment manufacturer or their approved subcontractors and sold as a replacement part for an OEM part or component.
5. Serviceable Part: Any part that is capable of meeting or exceeding the minimum OEM standards for performing the function for which it was originally designed.
6. Nonserviceable Part: Any part that no longer meets minimum OEM standards.

**END OF TASK**

0001 00-2

---

**ENGINE REPAIR**

---

**0002**

---

**THIS WORK (WP) COVERS:**Description

---

**DESCRIPTION**

1. We will provide engine assemblies in various states of disrepair. Some parts may be missing from the engines. You will disassemble, clean, and inspect each engine and its components to determine serviceability of component parts to meet requirements of drawing 12460200 and the performance schedule described in appropriate Engine Run-in Table. This standard will provide a serviceable component, issuable to users without restrictions, Condition Code A.

**NOTE**

Engine component repair parts on Mandatory Replacement List need not be inspected.

2. During the course of repair, any sub-components/parts of the engine assembly showing obvious signs of imminent failure, excessive wear, or deterioration will be replaced with a fully serviceable replacement.

3. Paint only the external steel surfaces of the repaired engine in accordance with MIL-P-14105C, Heat Resistant Paint for Steel.

**END OF TASK**

0002 00-1/2 blank



---

**PERFORMANCE TEST**

---

**0003**

---

**THIS WORK (WP) COVERS:**Performance Test

---

1. You will do a performance test on every engine repaired. A quality assurance/control representative must witness the testing following the instructions contained in **Work Package (WP) 0038**, for testing the engine.
2. As part of the performance test you will complete applicable **WP 0042**, Performance Test Report. After testing, return the completed data sheet to:

Commander  
USA TACOM  
Attn: AMSTA-LC-CHL  
[Harrirob@tacom.army.mil](mailto:Harrirob@tacom.army.mil)  
Warren MI 48397-5000

**NOTE**

Pipe plugs must be removed from oil passages in order to perform the tasks outlined in TM 9-2815-237-34, WP 0012, Cleaning 1.c and Cleaning 2.c. The instructions do not state how to remove these plugs and there is no tool specified to remove the plugs. The contractor shall use the method best suited to remove the pipe plugs. At the contractors option the following method could be used.

Step 1. Drill a hole in the plug. Locate a nut (approximately 1/2" in height), the inner diameter must be bigger than the outer diameter of the plug.

Step 2. Locate a washer with a smaller inside diameter than the nut.

Step 3. Locate a screw, a little smaller than the hole you drilled in the plug, but long enough to go through the nut with a little length to spare.

Step 4. Assemble the screw/washer/nut and pull the plug out of the oil passage.

**END OF TASK**

0003 00-1/2 blank



---

**CONTAINER REPAIR AND DISPOSAL**

---

**0004****THIS WORK (WP) COVERS:**Description and Disposal

---

**DESCRIPTION**

1. Each engine we provide may or may not be in an engine container, NSN 8145-01-231-3747. You will inspect and recondition the containers in accordance with TB 9-289 and drawing package 12338064. You'll notify TACOM, AMSTA-LC-CHL of containers which are determined to be nonrepairable in accordance with TB 9-289, and verified by the government Quality Assurance Representative, for proper disposal. Any engine not provided to you in a metal container must be packaged in a metal container after rebuild. Extra metal containers will be provided upon request.

2. You can use OEM or equivalent parts when repairing the container. When using other than OEM parts, the parts used must meet the requirements specified on the OEM part's drawing.

**DISPOSAL**

1. You are responsible for disposal of any unrepairable or unused parts or assemblies.

**ENDOF TASK**

0004 00-1/2 blank



**DESCRIPTION, COMPONENT LOCATION, AND DATA**

**0005**

**THIS WORK (WP) COVERS:**

Description and Component Location

The engine used in the M998 series vehicles is an eight-cylinder, four-cycle, liquid-cooled, naturally aspirated diesel engine. The 6.5L Detuned engine has a compression ratio of 21.5:1 and develops approximately 150 horsepower (112 kW) at 3600 rpm. The 6.5L engine has a compression ratio of 21.5:1 and develops approximately 160 horsepower (119 kW) at 3400 rpm. For proper orientation, the left and right sides of the engine are as viewed from the rear.

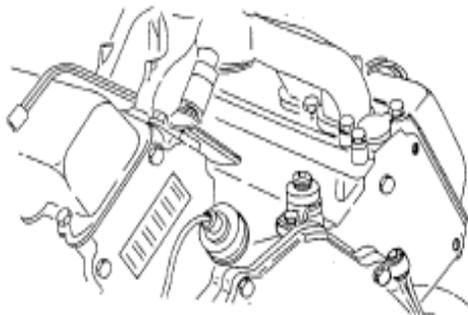
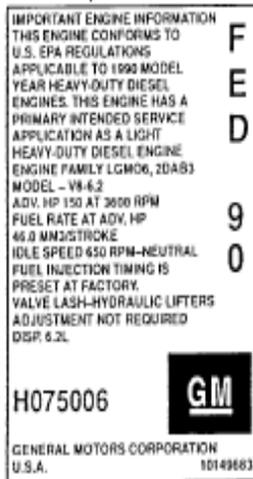
1994 6.5L engines have the following new and revised parts:

**Fuel Injection Pump.** The 1994 fuel injection pump has a TP sensor and a revised calibration procedure.

**\*RPM Sensors.** The 1994 engine is equipped with two rpm sensors. One is for STE-ICE-R and one is for the engine.

**\*Fan Cut-Off Switch.** The 1994 engine is equipped with a fan cut-off switch which replaced the kick-down switch.

The 6.5L engine is identified by a serial number bar code decal.

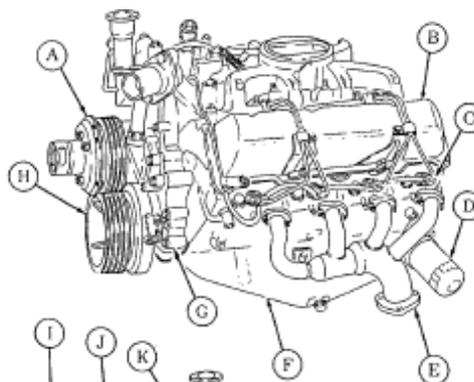


**DESCRIPTION, COMPONENT LOCATION, AND DATA - CONTINUED**

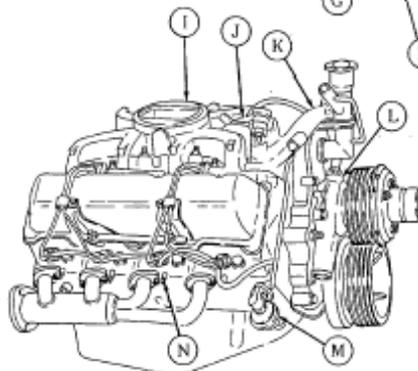
**0005**

The locations of components described below are common to all engines in the M998 series vehicles. Special differences are described in this WP 0005, pages 0005-1 and 0005-2.

- (A) FAN CLUTCH
- (B) ROCKER ARM COVERS (2)
- (C) FUEL INJECTORS (8)
- (D) OIL FILTER
- (E) EXHAUST MANIFOLDS (2)
- (F) OIL PAN
- (G) TIMING GEAR COVER
- (H) CRANKSHAFT PULLEY



- (I) INTAKE MANIFOLD
- (J) FUEL INJECTION PUMP
- (K) WATER CROSSOVER
- (L) WATER PUMP
- (M) FUEL PUMP
- (N) GLOW PLUGS (8)



**DESCRIPTION, COMPONENT LOCATION, AND DATA - CONTINUED**

**0005**

Engine tabulated data is listed in table 2. This information includes only those data applicable to direct support and general support maintenance.

**TABLE 1 TABULATED DATA ABBREVIATIONS**

<b>MEASUREMENT</b>	<b>ABBREVIATION</b>	<b>MEASUREMENT</b>	<b>ABBREVIATION</b>
Quart . . . . .	qt	Celsius . . . . .	C
Kilogram . . . . .	kg	Liter . . . . .	L
Inch . . . . .	in.	Centimeter . . . . .	cm
Pound . . . . .	lb	Millimeter . . . . .	mm
Pounds Per Square Inch . . . . .	psi	Kilopascal . . . . .	kPa
Revolutions Per Minute . . . . .	rpm	Newton Meter . . . . .	N•m
Pound-Feet . . . . .	lb-ft	Horsepower . . . . .	hp
Cubic Inch . . . . .	cu-in.	Kilowatt . . . . .	kW
Fahrenheit . . . . .	F		

**DESCRIPTION, COMPONENT LOCATION, AND DATA - CONTINUED**

**0005**

**Table 2 Tabulated Data (6.5 L)**

**NOTE**

Standard and metric measurements will be used in this table. A list of their abbreviations is provided on previous page.

Manufacturer . . . . . Detroit Diesel Allison  
 Model . . . . . 6.5L  
 Type . . . . . Four-cycle, liquid-cooled, naturally aspirated

	<b>STANDARD</b>	<b>METRIC</b>
<b>Dimensions:</b>		
Length.....	35 in.	89 cm
Width.....	28 in.	71 cm
Height.....	28 in.	71 cm
New weight, dry.....	650 lbs	295 kg
<b>Cylinders:</b>		
Number.....	Eight	
Arrangement.....	90° V	
Firing order.....	1-8-7-2-6-5-4-3 (clockwise)	
Bore.....	4.06 in.	10.3 cm
Stroke (nominal).....	3.82 in.	9.7 cm
Displacement.....	395 cu-in.	6.5 L
Compression ratio.....	21.5:1	
Maximum Torque (gross).....	285 lb-ft @ 2000	386 N • m @ 2000 rpm
<b>Governed Speed:</b>		
Full load.....	3400 rpm	
No load.....	3650 rpm	
Idle speed.....	725±25 rpm	
<b>Lubrication System:</b>		
Type.....	Pressure feed	
Operating pressure (normal).....	40-50 psi	276-345 kPa
Operating pressure (at idle).....	10 psi	69 kPa
System capacity (including filter).....	8 qts	7.6 L
Operating temperature (normal).....	180°-260°F	82°-127°C
Oil pump.....	Gear-driven	
<b>Cooling system:</b>		
Operating temperature (normal).....	190°-230°F	88°-110°C

Mount, Resilient -- applies to engines involved as part of the Recap program.

**END OF TASK**

---

**ENGINE INJECTION PUMP TIMING**

---

**0006****THIS WORK (WP) COVERS:**Timing Check and Timing Adjustment

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive -- NSN 5180-00-177-7033

**Special Tools**Timing bracket gauge: NSN 6620-01-231-3671; PN MT95  
Dynamic timing meter: NSN 5180-01-186-3114; PN J 33127**Materials/Parts**Metallic wool: NSN 5350-00-242-4404 – 1  
Pound Package**General Safety Instructions**Never adjust timing while engine is running.

---

**TIMING CHECK****NOTE**

Magnetic pickup receptacle on timing bracket must be correctly positioned or timing meter will not register correctly.

1. Insert timing bracket gauge into magnetic pickup receptacle (8) on timing bracket (1).
2. Rotate timing bracket gauge so pointer on gauge fits into TDC notch (9) in timing bracket (1).

---

**ENGINE INJECTION PUMP TIMING - CONTINUED**

---

**0006**

3. If pointer on gauge does not fit exactly into TDC notch (9), bend magnetic pickup receptacle (8) until pointer on gauge fits exactly into TDC notch (9).
4. Remove timing bracket gauge from pickup receptacle (8) on timing bracket (1).

**NOTE**

End of magnetic pickup must be .06 in. (1.5 mm) from torsional damper.

5. Install magnetic pickup (7) into magnetic pickup receptacle (8) and connect pickup lead (6) to timing meter.

**NOTE**

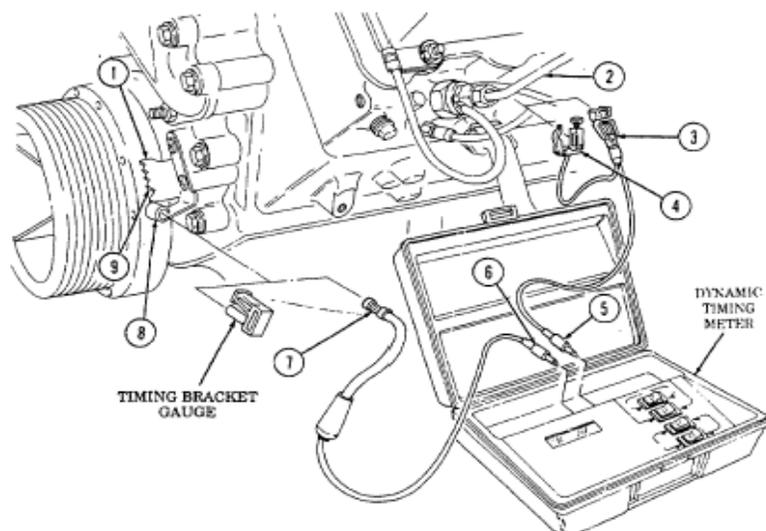
Clamp-on pickup must be used on a straight section of tube no further than 4 in. (10 cm) from injection nozzle.

6. Clean cylinder number one injection line (2) with metallic wool.

**CAUTION**

Do not overtighten clamp-on pickup or damage to pickup will result.

7. Install pickup (4) on injection line (2).
8. Connect ground clip (3) to fuel injection line (2) and connect pickup lead (5) to timing meter.
9. Route red power lead of timing meter to 24 Volt power source.
10. Connect black ground lead to negative ground. Display should light up and read: SE-1 20.0.

**CAUTION**

Ensure all cables and wires are clear from fan, belts, and exhaust manifolds before starting engine, or damage to equipment will result.

**NOTE**

If sensor light is not blinking, check clamp-on pickup fuel injection line for proper installation.

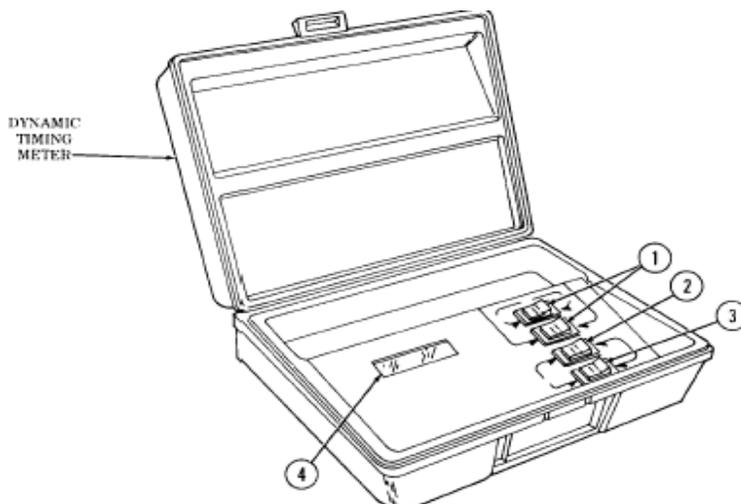
11. Depress offset adjustment switch (3) and hold.
12. Operate increase/decrease switch (2) until offset adjustment reads 30.5 for 6.5L engines on display (4). Release offset adjustment switch (3). Display (4) should not read: 0000 ... 0.0.
13. Start engine and warm up to operating temperature.
14. Position sensor switches (1) to clamp-on and magnetic pickup positions.

**NOTE**

For vehicles with 1990 engines and above, timing must be 5° before top dead center.

15. Raise engine speed to 1300 rpm and read injection pump timing on display (4). Timing must be 4° before top dead center. If timing is not 4° before top dead center, stop engine (TM 9-2320-280-10) and adjust timing (see Timing Adjustment).

16. Disconnect timing meter.

**TIMING ADJUSTMENT****WARNING**

Never adjust injection pump timing with engine running or injury to personnel and damage to equipment may result.

---

**ENGINE INJECTION PUMP TIMING - CONTINUED**

---

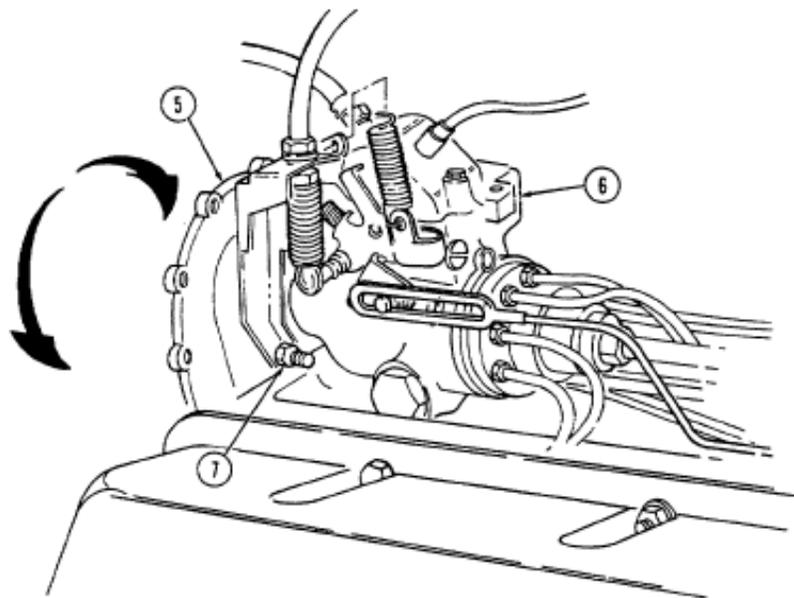
**0006**

1. Loosen three nuts (7) securing injection pump (6) to timing chain cover (5).

**NOTE**

Moving injection pump .03 in. (.8 mm) is equal to approximately 1° of injection pump timing.

2. Move injection pump (6) clockwise to retard timing or counterclockwise to advance timing.
3. Tighten three nuts (7) securing injection pump (6) to timing chain cover (5) and recheck timing (see Timing Check).

**END OF TASK**



---

**GENERAL MAINTENANCE INSTRUCTIONS**

---

**0007****THIS WORK PACKAGE (WP) COVERS:**Cleaning, Inspection, Repair, and Assembly

---

**CLEANING**

1. **General Instructions.** Cleaning procedures will be the same for the majority of parts and components which make up engine subassemblies. General cleaning procedures are detailed in steps 2-9.
2. **The Importance of Cleaning.** Great care and effort are required in all cleaning operations. The presence of dirt and foreign material is a constant threat to satisfactory engine operation and maintenance.

The following will apply to all cleaning operations:

- (a) Hands must be kept free of any accumulation of grease which can collect dust and grit.
- (b) Clean all parts before inspection, after repair, and before assembly.
- (c) After cleaning, all parts must be covered or wrapped in plastic or paper to protect them from dust and/or dirt.

---

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

3. **External Engine Cleaning.** All electrical equipment and other parts that could be damaged by steam cleaning or moisture must be removed, and all openings covered before cleaning. Dry with compressed air.
4. **Disassembled Parts Cleaning.** Place all disassembled parts in wire baskets for cleaning.
  - (a) Dry and cover all cleaned parts.
  - (b) Place on or in "racks" and hold for inspection or repair.
  - (c) All parts subject to rusting must be lightly oiled and wrapped.
  - (d) Keep all related parts and components together. Do not mix parts.

---

**GENERAL MAINTENANCE INSTRUCTIONS - CONTINUED**

---

**0007**

---

**WARNING**

---

Improper cleaning methods and use of unauthorized cleaning solutions will injure personnel and damage equipment. See TM 9-247 for correct information.

**5. Castings.**

- (a) Clean inner and outer surfaces of castings and all areas subject to grease and oil with cleaning solvents. Refer to TM 9-247.
- (b) Use a stiff brush to remove sludge and gum deposits.
- (c) Use compressed air to blow out all tapped capscrew holes and dry castings after cleaning.

**6. Oil Passages.** Particular attention must be given to all oil passages in castings and machined parts. Oil passages must be clean and free of any obstructions.

- (a) Clean passages with wire probes to breakup any sludge or gum deposits.
- (b) Wash passages by flushing with solvents. See TM 9-247,
- (c) Dry passages with compressed air.

---

**CAUTION**

---

Do not allow drycleaning solvents to come in contact with seals, cables, or flexible hoses. These cleaners cause leather, rubber, and synthetic materials to dry out, rot, and lose pliability making them unserviceable.

**7. Nonmetallic Parts.** Clean hoses and other nonmetallic parts with soap and water.**8. Bearings.**

---

**WARNING**

---

Do not use compressed air to dry bearings. Spinning a dry bearing with compressed air may cause injury to personnel or damage to equipment.

---

**GENERAL MAINTENANCE INSTRUCTIONS - CONTINUED**

---

0007

- (a) Bearings require special cleaning. After removing surface oil and gum deposits wipe bearings dry with a lint-free cloth; do not use compressed air.
- (b) See TM 9-214 for information and care of bearings.

**9. Electrical Components.**

- (a) Clean electrical components with clean cloth dampened with dry-cleaning solvent. Care must be taken not to damage protective insulation.

---

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (b) Use compressed air on dry electrical components.

**INSPECTION**

1. **General Instructions.** Procedures for inspections will be the same for many parts and components which make up the engine subassemblies. General procedures are detailed in steps 2-11. Dimensional standards for parts have been fixed at extremely close tolerances, so use specification tables. Use specified inspection equipment for inspection where cracks and other damage cannot be spotted visually. Exercise extreme care in all phases of inspection. Repair or replace all unserviceable components; refer to this WP, 0007, pgs 0007-5 and 0007-6.

**2. Castings.**

(a) Inspect all ferrous and nonferrous castings for cracks. See MIL-I-6866, Inspection, Penetrant Methods, and MIL-I-6868, Inspection Process, Magnetic Particles. Particularly check areas around studs, pipe plugs, threaded inserts, and sharp comers. Replace cracked castings.

(b) Inspect machined surfaces for nicks, burrs, and raised metal. Mark damaged areas for repair or replacement.

(c) Inspect all pipe plugs, pipe plug openings, capscrews, and capscrew openings for damaged and stripped threads. Replace if damaged or threads are stripped.

(d) Check all gasket mating surfaces, flanges on housings, and supports for warpage with a straight edge or surface plate. Inspect mating flanges for discolorations which may indicate leakage. Replace if warped.

(e) Check all castings for conformance to applicable repair standards.

**3. Bearings.****CAUTION**

All engine connecting rod and main bearings will be replaced if one or more bearings fail. Check all bearings for conformance to applicable repair standards.

**4. Bushings and Bushing-Type Bearings.**

(a) Check all bushings and bushing-type bearings for secure fit, evidence of heating, wear, burrs, nicks, and out-of-round conditions.

(b) Check for dirt in lubrication holes or grooves. Holes and grooves must be clean and free from damage.

**5. Machined Parts.**

(1) Check machined parts for cracks, distortion, and damage.

(2) Check all surfaces for nicks, burrs, and raised metal.

---

**GENERAL MAINTENANCE INSTRUCTIONS - CONINTUED**

---

**0007**

6. **Studs, Bolts, and Capscrews.** Replace if bent, loose, stretched, or threads are damaged.
7. **Gears.**

**NOTE**

When gear teeth wear limits are not established good judgment is required to determine if gear replacement is necessary.

- (a) Inspect all gears for cracks and missing teeth. Replace if cracked or teeth are missing.
- (b) Inspect gear teeth for wear, sharp fins, burrs, and galled or pitted surfaces.
- (c) Inspect splines for wear, burrs, and galled or pitted surfaces.
- (d) Check keyway slots for wear and/or damage.

8. **Oil Seals.** Oil seals are mandatory replacement items.
9. **Casting Plugs.** Inspect for leakage. Replace plugs when leakage is present.
10. **Springs.** Inspect for damaged, distorted, and collapsed coils.
11. **Snaprings, Retaining Rings, and Washers.** Many of these parts are mandatory replacement items. Inspect all others for obvious damage.

**REPAIR**

1. **General Instructions.** Repair of most parts and components is limited to general procedures outlined in applicable maintenance instructions and the following detailed procedures "b" through "h".

**CAUTION**

Repaired items must be thoroughly cleaned to remove metal chips and abrasives to prevent them from entering working parts of the engine.

**2. Castings.**

- (a) All cracked castings will be replaced.
- (b) Only minor repairs to machined surfaces, flanges, and gasket mating surfaces are permitted. Remove minor nicks, burrs, and/or scratches with:
  - (1) Fine mill file.
  - (2) Abrasive crocus cloth dipped in cleaning solvent.
  - (3) Lapping across a surface plate.
  - (4) Remachining of machined surfaces to repair damage, warpage, or uneven surfaces is not permitted. Replace castings.
- (c) Repair damaged threaded pipe plug and/or capscrew holes with a thread tap or repair oversize holes with threaded inserts.

**3. Bearings.** See TM 9-214.**4. Studs.** Replace all bent and stretched studs. Repair minor thread damage with a thread restorer file. Replace studs having stripped or damaged threads as outlined below:

- (a) Remove, using a stud remover. Back studs out slowly to avoid heat buildup and seizure, which can cause stud to break off.
- (b) If studs break off too short to use with a stud remover, use extractor to remove.
- (c) Replacement studs have a special coating and must have a small amount of antiseize compound applied on threads before stud is installed. Install replacement stud slowly to prevent heat buildup and snapping off.

**5. Gears.**

- (a) Remove gears using pullers, as required.
- (b) Use the same methods described in step 2 (b) for castings to remove minor nicks, burrs, or scratches on gear teeth.
- (c) If keyways are worn or enlarged, replace gear.

**6. Bushings and BushingType Bearings.** When bushings and bushing-type bearings seize to a shaft and spin in the bore, the associated part must also be inspected and replaced, as required.**7. Oil Seals.**

- (a) Remove oil seals, being careful not to damage casting or adapter bore.
- (b) Always install new seal in bore using proper seal replacing tool.

**8. Cylinder Block or Cylinder Head.** Repair of cylinder block and cylinder head is limited to procedures outlined in WP's 0012 and 0017. Cylinder block or cylinder head must be replaced if measurements are outside tolerance limits listed in WP 0044, table 1.

---

**GENERAL MAINTENANCE INSTRUCTIONS - CONINTUED**

---

**0007****ASSEMBLY**

1. Cleanliness is essential in all component assembly operations. Dirt and dust, even in minute quantities, are abrasive. Parts must be cleaned as specified, and kept clean. Wrap or cover parts and components when assembly procedures are not immediately completed.
2. Coat all bearings and contact surfaces with engine oil (MIL-L-2104) to ensure lubrication of parts during initial operation after repair.
3. Use new gaskets and preformed packings during assembly of all components.

**END OF TASK**



**ENGINE DISASSEMBLY, REPAIR, AND ASSEMBLY TASK SUMMARY****0008****THIS WORK PACKAGE (WP) COVERS:**

Task Summary

<b>TASK PAGE</b>	<b>PROCEDURES</b>	<b>WP NO.</b>
0009 00-1	Engine Replacement in Shipping/Storage Container	0009
0010 00-1	Mounting Engine on Repair Stand	0010
0011 00-1	Engine Disassembly into Subassemblies	0011
0012 00-1	Cylinder Block Repair	0012
0013 00-1	Crankshaft Repair	0013
0014 00-1	Connecting Rod and Piston Repair	0014
0015 00-1	Camshaft, Timing Chain, and Drive Gears Repair	0015
0016 00-1	Timing Gear Cover Repair	0016
0017 00-1	Cylinder Head and Valve Repair	0017
0018 00-1	Valve Train Repair	0018
0019 00-1	Torsional Damper Repair	0019
0020 00-1	Flywheel Repair	0020
0021 00-1	Rocker Arm Cover Repair	0021
0022 00-1	Oil Pan Repair	0022
0023 00-1	Oil Filter Adapter and Oil Pressure Sending Unit Repair	0023
0024 00-1	Exhaust Manifold Repair	0024
0025 00-1	Intake Manifold Repair	0025
0026 00-1	Fuel Pump Repair	0026
0027 00-1	Fuel Injection Pump Repair (All Models)	0027
0028 00-1	(6.5L) Fuel Injection Pump (DB2831-5149) Calibration	0028
0029 00-1	(6.5L) Fuel Injection Pump (DB2831-5209) Calibration	0029
0030 00-1	(6.5L) Fuel Injection Pumps (DB2831-5485 or DB2831-5079) Calibration	0030
0031 00-1	6.5L Fuel Injection Pumps (DB2831-5149) Calibration Using Fuel Injection Pump Test Stand (FTIS) Model A8022	0031
0032 00-1	Fuel Injection Nozzle Repair	0032
0033 00-1	Water Pump Repair	0033
0034 00-1	Water Crossover Repair	0034
0035 00-1	Fan Drive Repair	0035
0036 00-1	Engine Assembly from Subassemblies	0036

**END OF TASK**

0008 00-1/2 blank



---

**ENGINE REPLACEMENT IN SHIPPING/STORAGE CONTAINER**

---

**0009****THIS WORK PACKAGE (WP) COVERS:**Removal, and Installation

---

**INITIAL SETUP:****Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Special Tools**

Engine lifting sling:

NSN 4910-01-193-7808; PN J33139

**Materials/Parts**

Eight lock-washers:

NSN 5310-00-637-9541; PN MS35338-46

**General Safety Instructions**Direct personnel to stand clear during hoisting operation.

---

**REMOVAL**

1. If engine container (5) is closed and sealed, press air-release button (1) located at center of breather valve (2) before opening engine container (5).
2. Remove twenty-six nuts (19), washers (18), capscrews (16), and upper container (4) from lower container (13).
3. Position engine lifting sling on engine assembly (6) and install sling on right cylinder head (25) with two capscrews (24).
4. Install sling bracket (21) to engine lifting sling with pin (22) and on left cylinder head (20) with two capscrews (23). Tighten capscrews (23).
5. Remove four capscrews (14), lockwashers (8), and washers (7) from two engine mounts (12). Discard lockwashers (8).
6. Remove four capscrews (9), lockwashers (8), and washers (7) from two rear engine mounts (10). Discard lockwashers (8).

---

**ENGINE REPLACEMENT IN SHIPPING/STORAGE CONTAINER**

---

**0009****WARNING**

Direct personnel to stand clear during hoisting operation.  
Failure to do this may cause injury to personnel.

7. Attach hoist to engine lifting sling and remove engine assembly (6) from lower container (13).
8. Position engine on repair stand (WP 0010).

**INSTALLATION**

1. Install engine assembly (6) in lower container (13).
2. Install engine assembly (6) on two rear engine mounts (10) with four washers (7), lockwashers (8), and capscrews (9).
3. Install engine assembly (6) on two engine mounts (12) with four washers (7), lockwashers (8), and capscrews (14).
4. Remove pin (22) from sling bracket (21).
5. Remove two capscrews (24) and lifting sling from right cylinder head (25).
6. Remove two capscrews (23) and sling bracket (21) from left cylinder head (20).
7. Visually check humidity indicator (17) for discolorization. If indicator (17) is dark purple, replace desiccant (3).

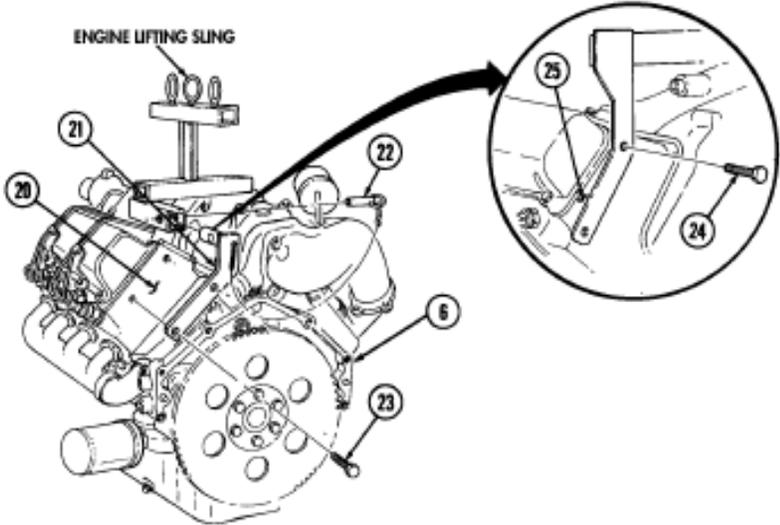
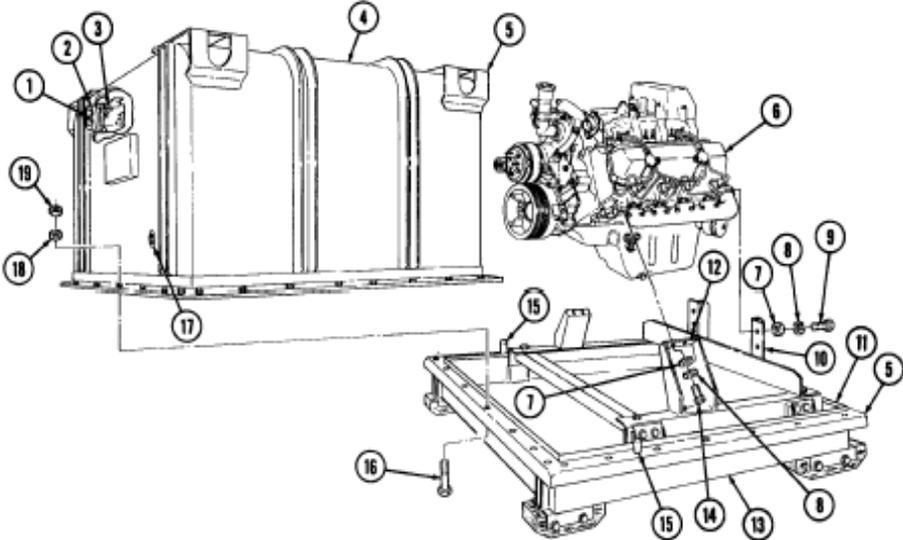
**NOTE**

Ensure gasket is seated properly.

8. Using alignment pins (15), position upper container (4) on gasket (11) and lower container (13).
9. Install upper container (4) on lower container (13) with twenty-six capscrews (16), washers (18), and nuts (19).

ENGINE REPLACEMENT IN SHIPPING/STORAGE CONTAINER

0009



END OF TASK



---

**MOUNTING ENGINE ON REPAIR STAND**

**0010**

---

**THIS WORK PACKAGE (WP) COVERS:**

Installation, and Removal

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Special Tools**

Engine repair stand:

NSN 4910-00-506-0037; PN 1725A

Engine lifting sling:

NSN 4910-01-193-7808; PN J33139

---

**INSTALLATION**

**NOTE**

Do not perform step 1 if engine lifting sling has been previously installed.

1. Position engine lifting sling on engine (4) and secure to right cylinder head (10) with two bolts (11). Finger tighten bolts (11).
2. Install sling bracket (2) to engine lifting sling with pin (3) and on left cylinder head (1) with two bolts (9). Tighten bolts (9) and (11).

**WARNING**

Direct personnel to stand clear during hoisting operation. Failure to do this may cause injury to personnel.

3. Attach hoist to engine lifting sling and hoist engine (4) into position over engine repair stand.
4. Loosen four capscrews (5) securing repair stand arms (6) on engine repair stand and align arms (6) with holes in rear of engine (4).

---

**MOUNTING ENGINE ON REPAIR STAND - CONTINUED**

---

**0010**

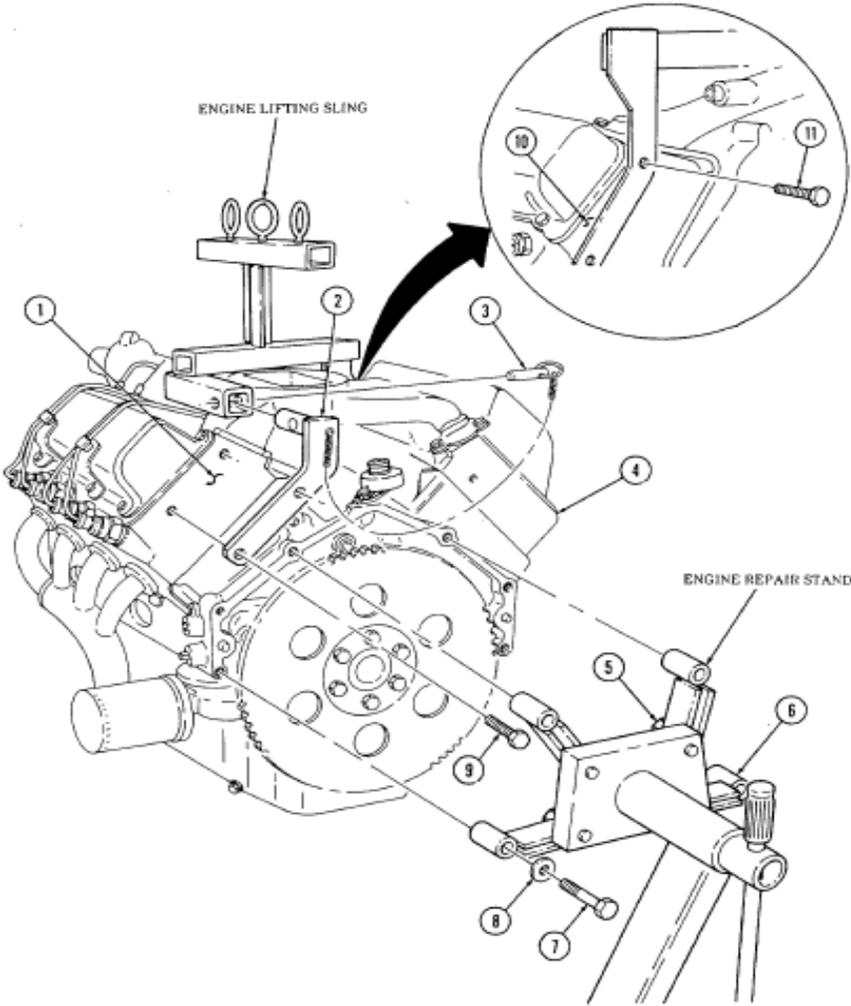
5. Install repair stand arms (6) to engine (4) with four washers (8) and capscrews (7).
6. Tighten capscrews (5) and (7).
7. Disconnect hoist and remove two bolts (11) and (9), engine lifting sling, and bracket (2) from engine (4).

**REMOVAL**

1. Position engine lifting sling on engine (4) and secure to right cylinder head (10) with two bolts (11). Finger tighten bolts (11).
2. Install sling bracket (2) to engine lifting sling with pin (3) and on left cylinder head (1) with two bolts (9). Tighten bolts (9) and (11).
3. Attach hoist to engine lifting sling and hoist engine (4) to relieve pressure on engine repair stand.
4. Remove four capscrews (7) and washers (8) from repair stand arms (6) and hoist engine away from engine repair stand.

MOUNTING ENGINE ON REPAIR STAND - CONTINUED

0010



END OF TASK



---

**ENGINE DISASSEMBLY INTO SUBASSEMBLIES****0011**

---

**THIS WORK PACKAGE (WP) COVERS:**

(a) Fan Drive and Water Pump Pulley, (b) Crankshaft Pulley, (c) Torsional Damper, (d) Wastegate Actuator, (e) Wastegate Housing, (f) Manifold to Turbocharger Exhaust Pipe, (g) Turbocharger, (h) Exhaust Manifolds, (i) Intake Manifolds, (j) Water Crossover, (k) Fuel Injection Lines, (l) Full Supply and Return Lines, (m) Rocker Arm Covers, (n) Rocker Arm Safts & Pushrods, (o) Fuel Injection Nozzels, (p) Glow Plugs, (q) Cylinder Heads, (r) Valve Filters, (s) Water Pump and Adapter Plate, (t) Fuel Injection Pump, (u) Timing Gear Cover, (v) Timing Chain and Drive Sprockets, (w) Oil, Filter, Adapter, and Oil Pressure Sending Unit, (x) Oil Pan, (y) Oil Pump, (z) Fuel Pump, (aa) Oil Pump Drive, (bb) Camshaft, (cc) Pistions & Connecting Rods, (dd) Flywheel, (ee) Crankshaft and Main Bearings

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive	NSN 5180-00-177-7033
Puller:	NSN 5120-00-595-9305
Cylinder ridge reamer:	NSN 5110-00-237-8598
Dial indicator:	NSN 5210-00-277-8840

**Special Tools**

Hydraulic valve lifter remover:	NSN 5120-01-209-6870; PN J29834
Injection nozzle socket:	NSN 5120-01-171-5233; PN J29873
Glow plug socket:	NSN 5120-00-277-1463; PN FUS121
Hex-head driver, 6 mm:	NSN 5120-01-055-1308; PN FAM 6
Hex-head driver, 8 mm:	NSN 5120-01-053-4159; PN FAM 8
Hex-head driver, 5/16-in.:	NSN 5120-00-683-8602; FA10B

**Equipment Condition**

Engine mounted on repair stand (WP0010).

**General Safety Instructions**

- Do not perform this procedure near fire, flame, or sparks.
-

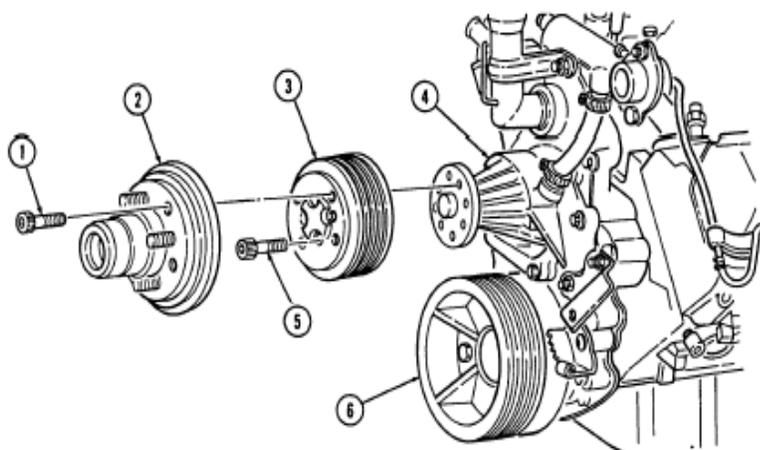
**NOTE**

- Work area should be clean, well-ventilated, and free from blowing dirt and dust.
- In some cases, flanged head fasteners may be present instead of standard fasteners and washers. In all cases, washers should be used when replacing a flanged head fastener with a standard fastener.

**a. FAN DRIVE AND WATER PUMP PULLEY****NOTE**

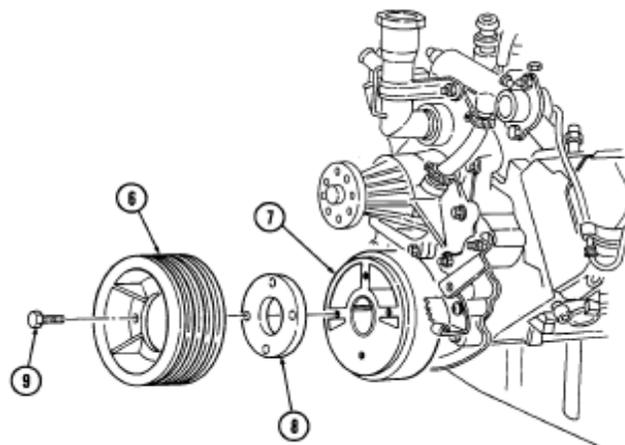
It may be necessary to apply compressed air to fan drive fitting. This disengages fan drive and allows access to socket head capscrews.

1. Position pry bar between water pump pulley (3) and crankshaft pulley (6) and apply pressure.
2. Using a 5/16-in. hex-head driver, remove four socket-head screws (1) and fan drive (2) from water pump pulley (3).
3. Using a 6-mm hex-head driver, remove four socket-head screws (5) and water pump pulley (3) from water pump (4).



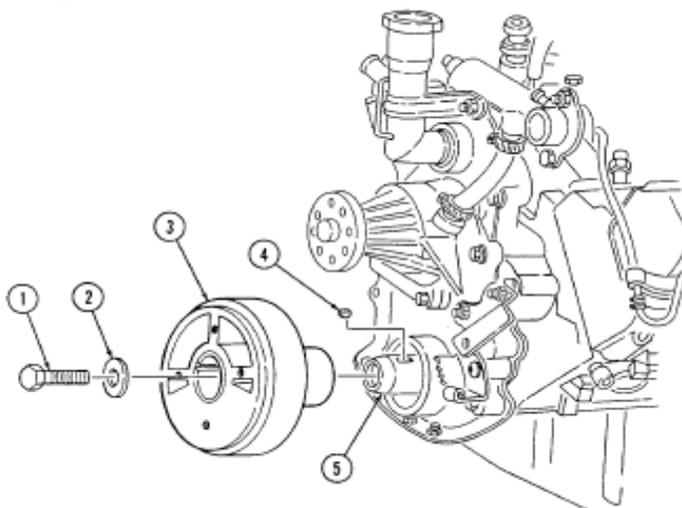
**b. CRANKSHAFT PULLEY**

Remove four capscrews (9), crankshaft pulley (6), and spacer (8) (if installed) from torsional damper (7).



**c. TORSIONAL DAMPER**

1. Hold flywheel stationary with pry bar.
2. Remove capscrew (1) and washer (2) from torsional damper (3) and crankshaft (5).
3. Reinstall capscrew (1) and remove torsional damper (3) with puller.
4. Remove capscrew (1) and woodruff key (4) from crankshaft (5). Discard woodruff key (4).

**NOTE**

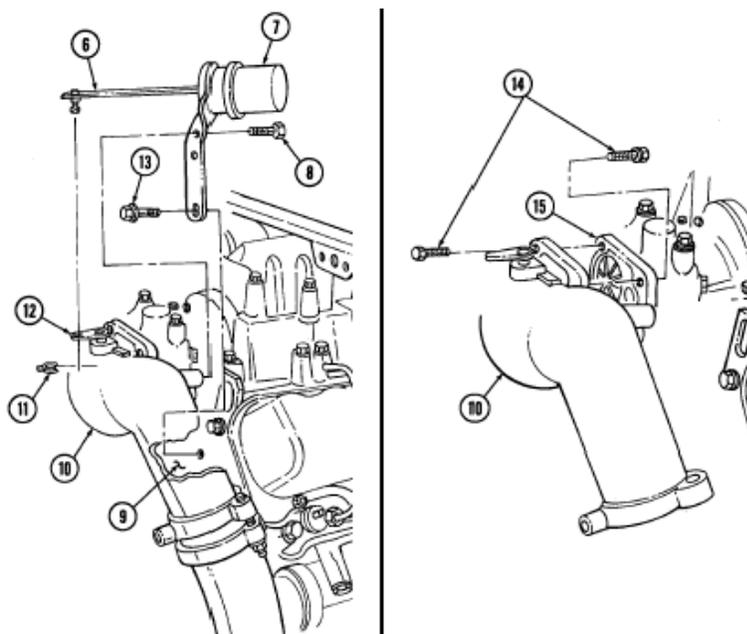
Perform tasks d.1 through d.3 and e.1 for 6.5L turbo engines only.

**d. WASTEGATE ACTUATOR**

1. Remove clip (11) and actuator rod (6) from wastegate bellcrank (12).
2. Remove two capscrews (8) from wastegate actuator (7) and wastegate housing (10).
3. Remove capscrew (13) and wastegate actuator (7) from cylinder head (9).

**e. WASTEGATE HOUSING**

Remove four capscrews (14) and wastegate housing (10) from turbocharger (15).

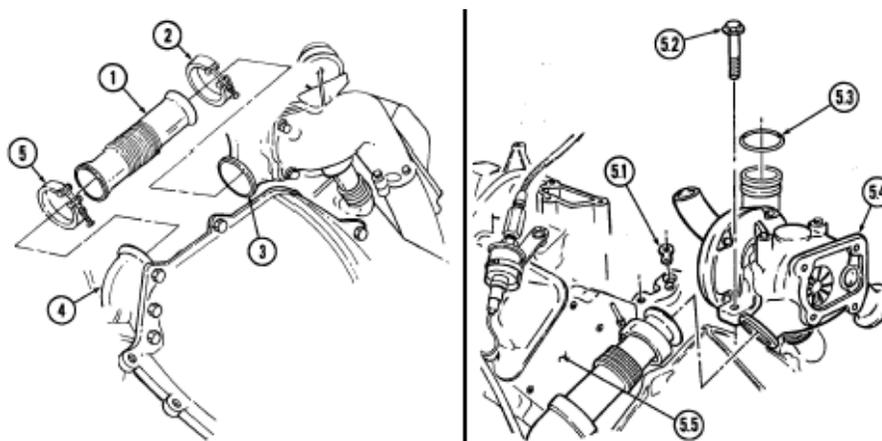
**f. MANIFOLD-TO-TURBOCHARGER EXHAUST PIPE**

1. Loosen clamp (5) and remove exhaust pipe (1) from exhaust manifold (4). Slide clamp (5) onto exhaust pipe (1).
2. Loosen clamp (2) and remove exhaust pipe (1) from turbocharger (3). Slide clamp (2) onto exhaust pipe (1).
3. Remove clamps (2) and (5) from exhaust pipe (1).
4. Repeat steps 1 through 3 for opposite side of engine.

**g. TURBOCHARGER****NOTE**

Center inlet manifold must be removed before removing turbocharger.

1. Remove two capscrews (5.2) and turbocharger (5.4) from engine block (5.5).
2. Remove turbocharger oil gasket (5.1) from engine block (5.5). Discard gasket (5.1).
3. Remove O-ring (5.3) from turbocharger (5.4) outlet. Discard O-ring (5.3).

**h. EXHAUST MANIFOLDS****NOTE**

Early production vehicles may have a socket-head screw in place of stud.

**ENGINE DISASSEMBLY INTO SUBASSEMBLIES - CONTINUED****0011**

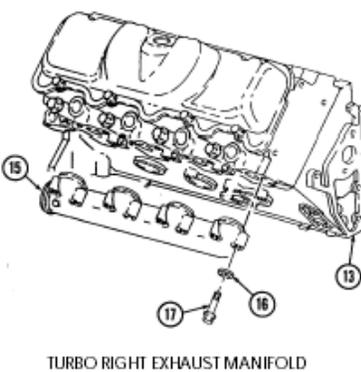
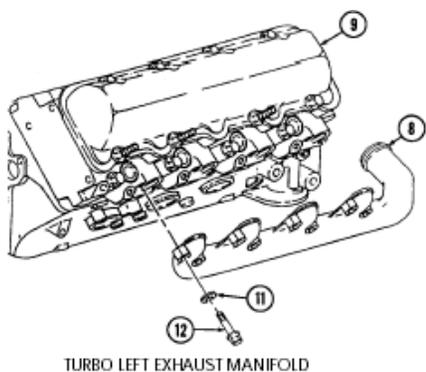
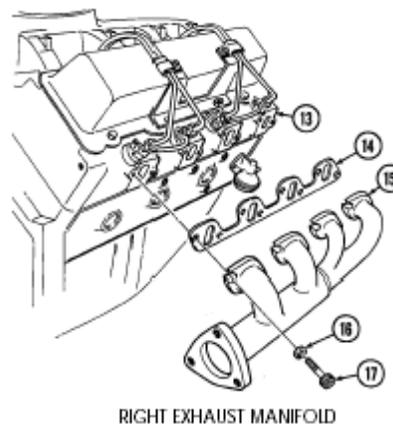
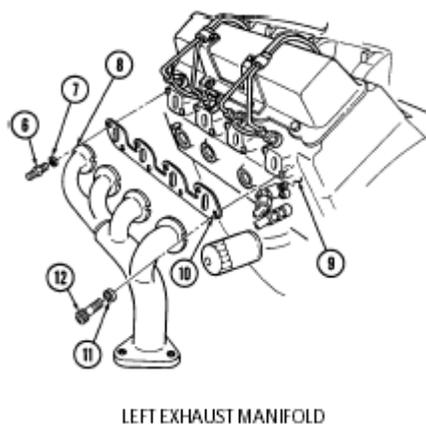
1. Remove stud (6) and washer (7) securing left exhaust manifold (8) to cylinder head (9).

**NOTE**

Turbo exhaust manifolds use hex-head capscrews and do not have gaskets as indicated in steps 2 and 3.

2. Using 8-mm hex-head driver, remove seven socket-head screws (12), washers (11), left exhaust manifold (8), and gasket (10) from cylinder head (9). Discard gasket (10).

3. Using 8-mm hex-head driver, remove eight socket-head screws (17), washers (16), right exhaust manifold (15), and gasket (14) from cylinder head (13). Discard gasket (14).



**i. INTAKE MANIFOLD**

1. Remove fuel filter line clamp (1) from stud (2).

**NOTE**

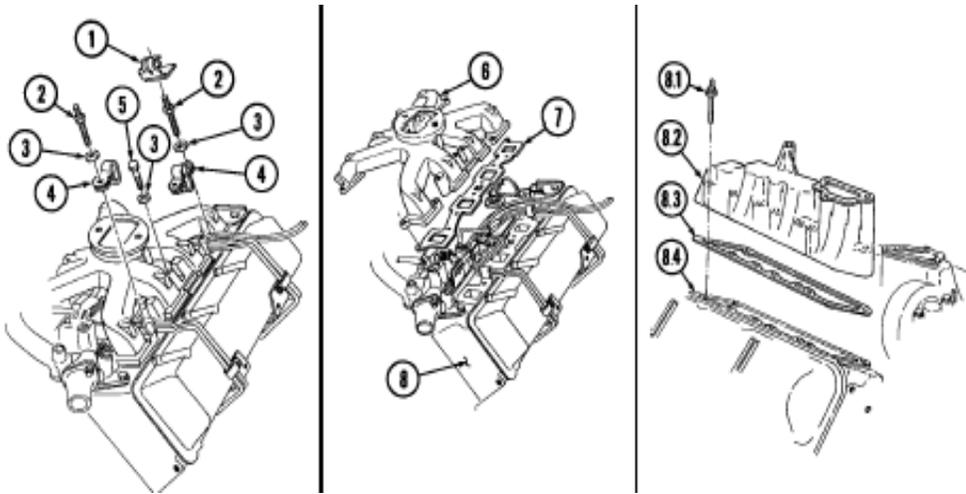
Note location of studs for installation.

2. Remove four intake manifold capscrews (5), twelve studs (2), and sixteen washers (3).
3. Remove four injection line clips (4).
4. Remove intake manifold (6) and two gaskets (7) from cylinder heads (8). Discard gaskets (7).

**NOTE**

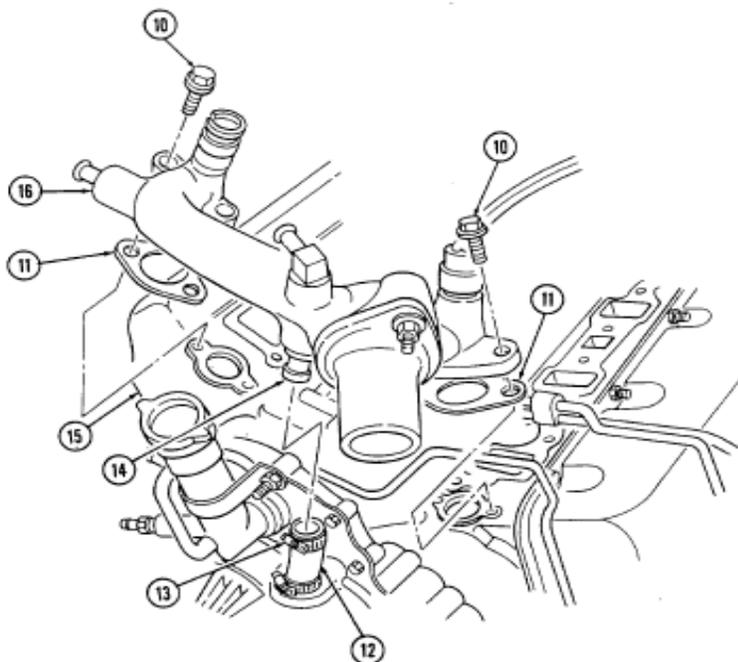
- Perform steps 5 through 7 for turbo engines.
- Outer intake manifold is removed before engine is removed from vehicle.

5. Remove eight intake manifold studs (8.1) from intake manifold (8.2).
6. Remove intake manifold (8.2) and gasket (8.3) from cylinder head (8.4). Discard gasket (8.3).
7. Repeat steps 6 and 7 for opposite side.



### j. WATER CROSSOVER

1. Remove four capscrews (10) securing water crossover (16) to cylinder heads (15).
2. Loosen hose clamp (13) and disconnect thermostat bypass hose (12) from water crossover nipple (14).
3. Remove water crossover (16) and two gaskets (11). Discard gaskets (11).

**k. FUEL INJECTION LINES****WARNING**

Diesel fuel is highly flammable. Do not perform this procedure near fire, flame, or sparks. Severe injury or death by result.

1. Loosen and disconnect eight fuel injection line nuts (4) at injection nozzles (3).
2. Remove four screw-assembled washers (5) and clamps (6) from support brackets (2).

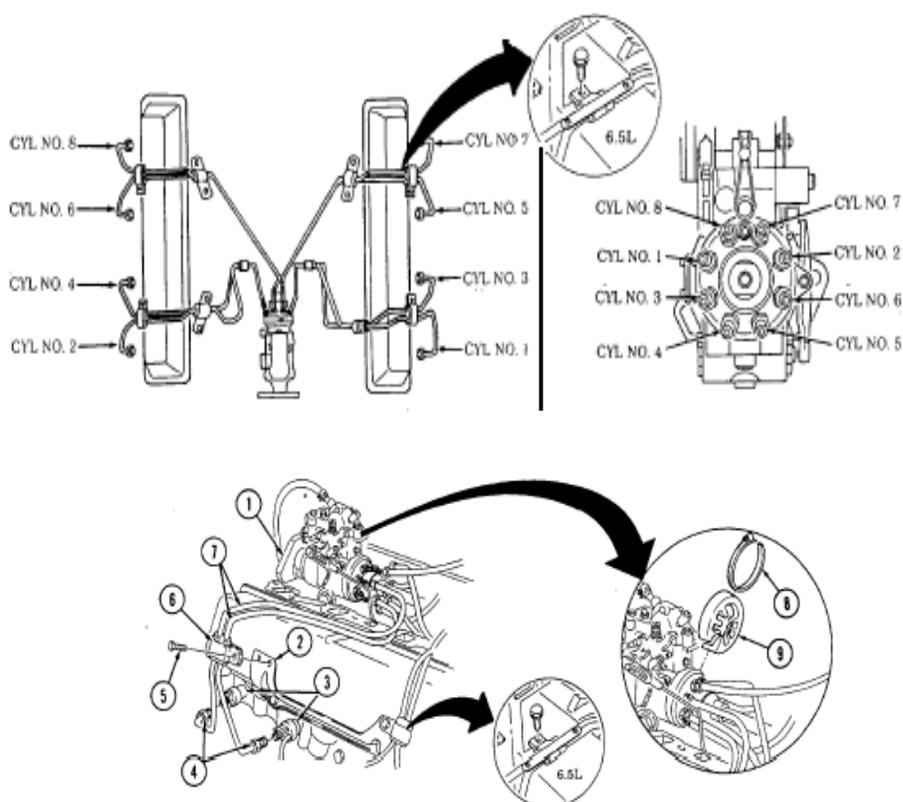
**CAUTION**

Plug fuel injection pump openings to prevent contamination.

**NOTE**

Tag lines by cylinder number for assembly.

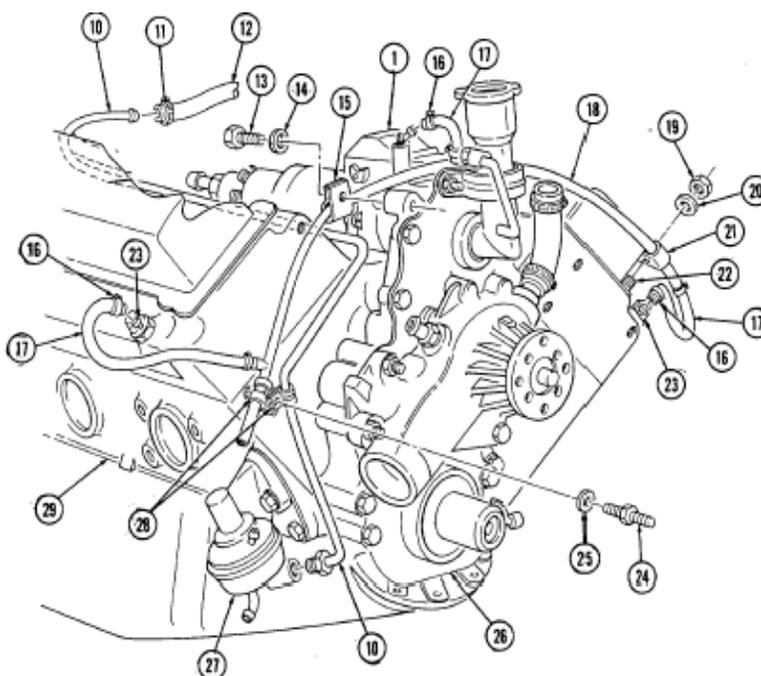
3. Remove clamp (8) and boot (9) from fuel injection pump (1). Disconnect and remove eight fuel injection lines (7) at fuel injection pump (1).

**I. FUEL SUPPLY AND RETURN LINES**

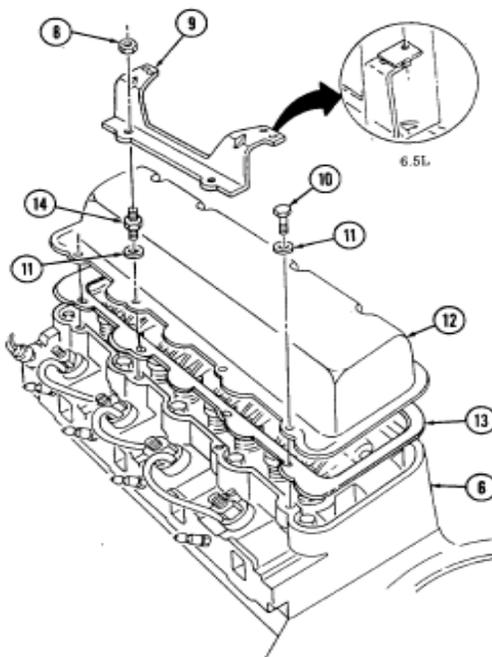
1. Loosen clamp (11) and remove fuel filter inlet hose (12) from fuel supply line (10).
2. Disconnect fuel supply line (10) at fuel pump (27).
3. Remove stud (24), washer (25), two clamps (28) and fuel supply line (10) from fuel return line (18) and cylinder block (29).

**ENGINE DISASSEMBLY INTO SUBASSEMBLIES - CONTINUED****0011**

4. Remove nut (19), washer (20), and clamp (21) from fuel return line (18) and rocker arm cover stud (22).
5. Remove capscrew (13), washer (14), and clamp (15) from fuel return line (18) and timing gear cover (26).
6. Loosen three clamps (16) and disconnect three hoses (17) at fuel injection pump (1) and front fuel injection nozzles (23).
7. Remove fuel return line (18).

**m. ROCKER ARM COVERS**

1. Remove two nuts (8) and injection line support bracket (9) from rocker arm cover studs (14).
2. Remove a combination of three capscrews (10), five studs (14), eight washers (11), rocker arm cover (12), and gasket (13) (if applicable) from cylinder head (6).
3. Repeat steps 1 and 2 for opposite side.



#### n. ROCKER ARM SHAFTS AND PUSHRODS

1. Remove four capscrews (3) and four retainers (2) from rocker arm and shaft assembly (4) and cylinder head (5).

#### NOTE

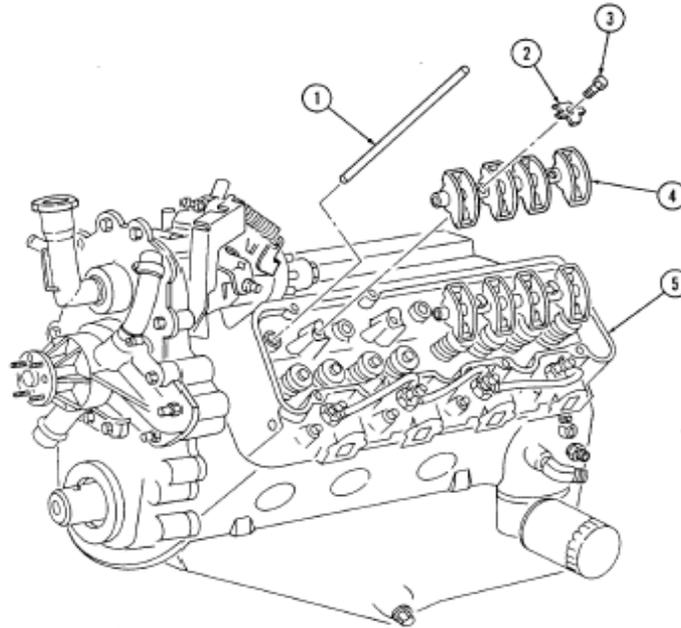
Tag rocker arm and shaft assembly for assembly.

2. Remove two rocker arm and shaft assemblies (4).

#### NOTE

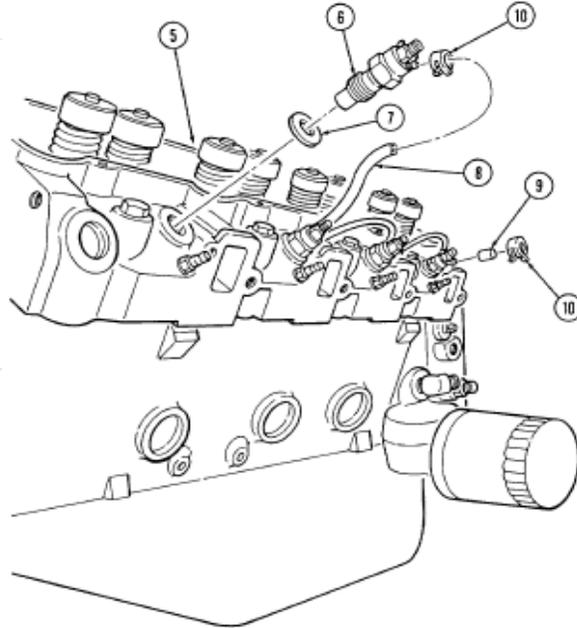
Tops of pushrods are hardened and must be tagged for assembly.

3. Remove eight pushrods (1).
4. Repeat steps 1 through 3 for opposite side.



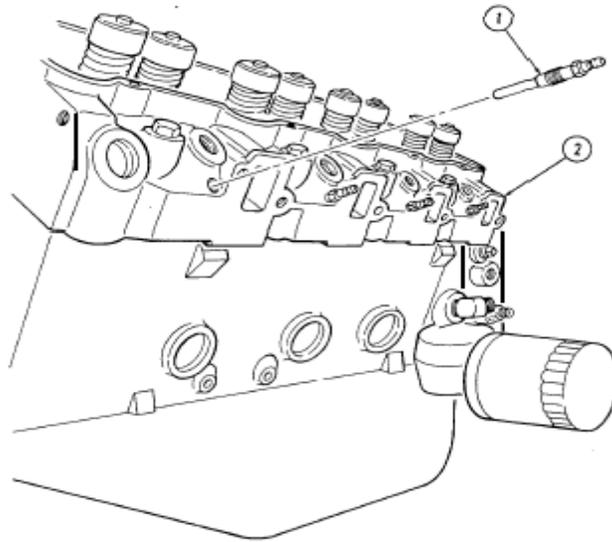
#### **o. FUEL INJECTION NOZZLES**

1. Remove seven clamps (10), one cap (9), and three hoses (8) from fuel injection nozzles (6).
2. Using injection nozzle socket, remove four fuel injection nozzles (6) and gaskets (7) from cylinder head (5). Discard gaskets (7).
3. Repeat steps 1 and 2 for opposite side.



**p. GLOW PLUGS**

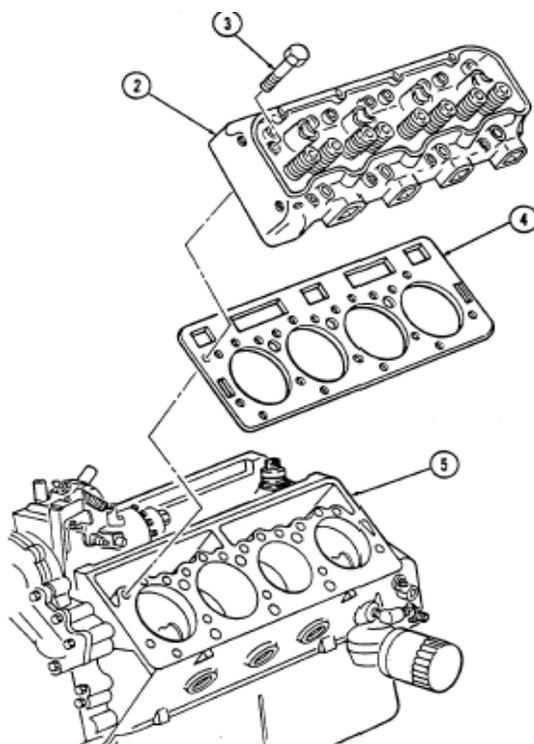
1. Using glow plug socket, remove four glow plugs (1) from cylinder head (2).
2. Repeat step 1 for opposite side.



#### q. CYLINDER HEADS

1. Remove seventeen cap screws (3), cylinder head (2), and cylinder head gasket (4) from cylinder block (5). Discard cylinder head gasket (4).

2. Repeat step 1 for opposite side.



#### r. VALVE LIFTERS

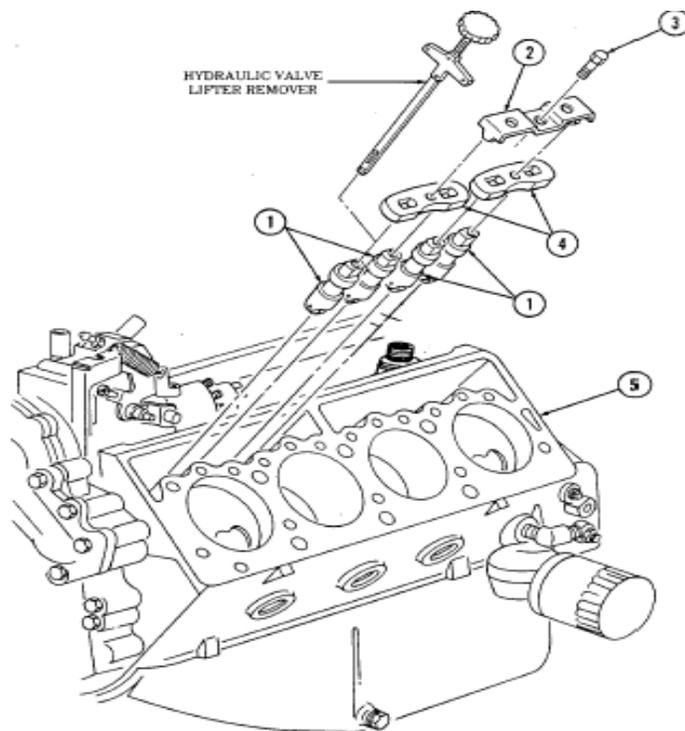
1. Remove two capscrews (3), guide plate clamps (2), and four guide plates (4) from cylinder block (5).

#### NOTE

Tag lifters for assembly.

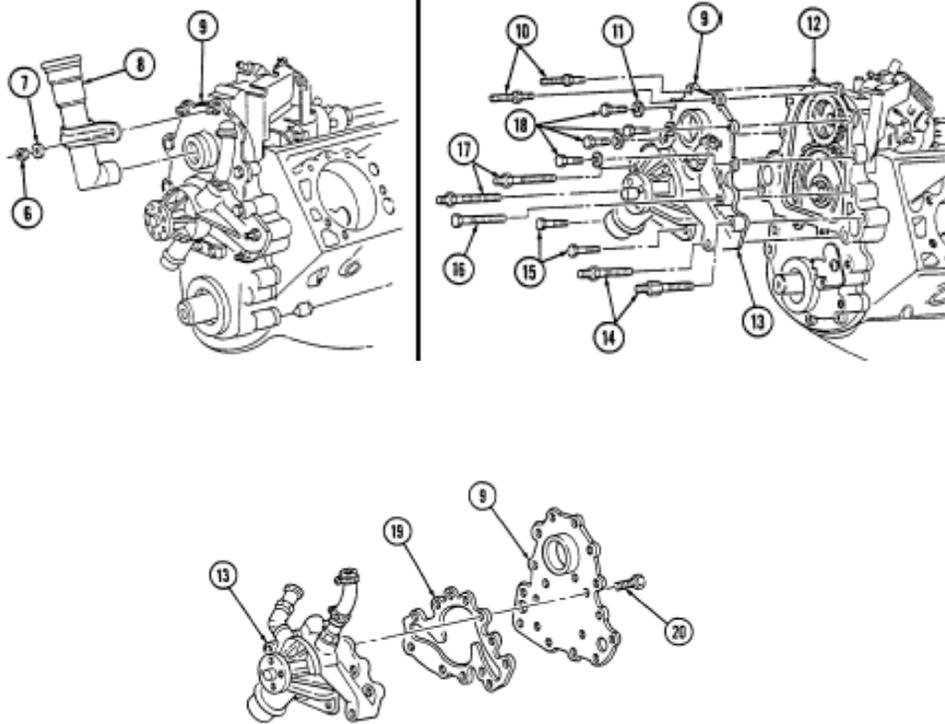
2. Remove eight valve lifters (1) from cylinder block (5) with hydraulic valve lifter remover.

3. Repeat steps 1 and 2 for opposite side.



### s. WATER PUMP AND ADAPTER PLATE

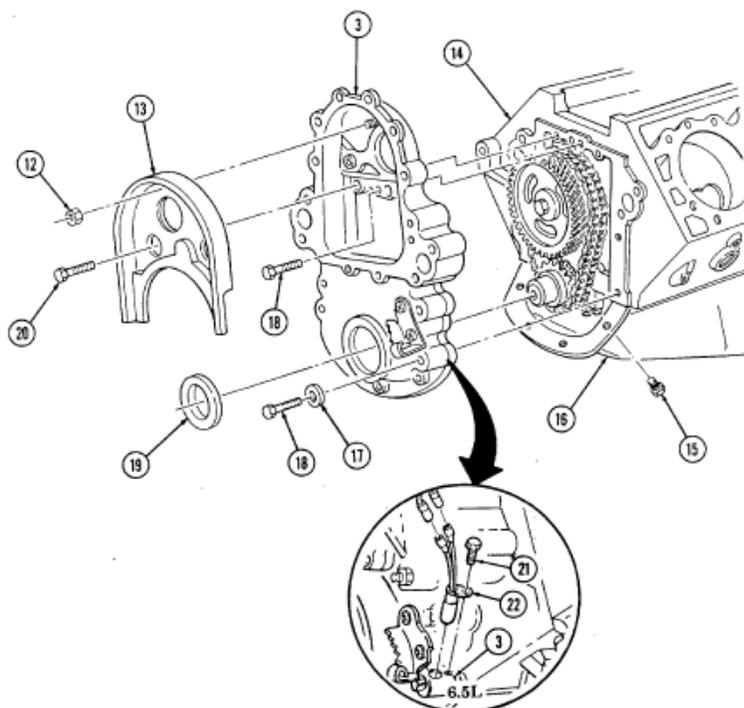
1. Remove two nuts (6), washers (7), and oil fill tube (8) from adapter plate (9).
2. Remove two studs (10), (14), and (17), four capscrews (18), washers (11), two capscrews (15), capscrew (16), water pump (13), and adapter plate (9) from timing gear cover (12).
3. Remove seven capscrews (20) from water pump (13) and separate water pump (13) and gasket (19) from adapter plate (9). Discard gasket (19).



#### t. FUEL INJECTION PUMP

1. Remove three capscrews (1) and pump driven gear (2) from fuel injection pump (5).
2. Remove idle return spring (7) from throttle lever (6).
3. Remove three nuts (8) and washers (9) from fuel injection pump (5) and timing gear cover (3).
4. Remove two capscrews (10) and accelerator cable bracket (11) from fuel injection pump (5).
5. Remove the fuel injection pump (5) and gasket (4) from cover (3). Discard gasket (4).





## v. TIMING CHAIN AND DRIVE SPROCKETS

### NOTE

When measuring timing chain deflection, slack should be removed from one side before measurement is taken on opposite side.

1. Using dial indicator, check timing chain (10) deflection midway between camshaft sprocket (4) and crankshaft sprocket (11). Total deflection must not exceed 0.810-in. (20.6 mm). If deflection exceeds specification, timing chain (10) must be replaced.
2. Using dial indicator, check camshaft end play. Camshaft end play must not be more than 0.012-in. (0.3 mm). If end play exceeds specification, camshaft sprocket (4), thrust plate (7), and spacer must be inspected for wear after removal.
3. Remove capscrew (1), washer (2), and pump drive gear (3) from camshaft (5).

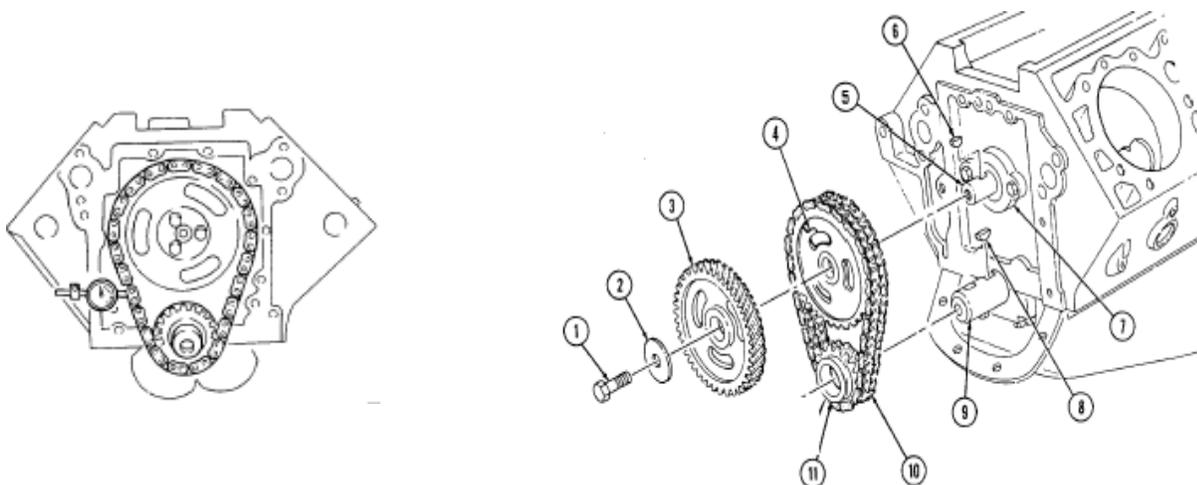
**ENGINE DISASSEMBLY INTO SUBASSEMBLIES - CONTINUED****0011**

- Remove crankshaft sprocket (11), camshaft sprocket (4), and timing chain (10) as an assembly.

**NOTE**

Cover oil pan opening to prevent woodruff key from falling into oil pan.

- Remove woodruff key (8) from crankshaft (9) and woodruff key (6) from camshaft (5). Discard woodruff keys (8) and (6).

**w. OIL FILTER, ADAPTER, AND OIL PRESSURE SENDING UNIT****NOTE**

Have drainage container ready to catch oil.

- Remove oil filter (19) from adapter (15). Discard oil filter (19).
- Remove adapter bolt (17), gasket (16), and adapter (15) from cylinder block (21). Discard gasket (16).
- Remove two O-rings (18) from adapter bolt (17). Discard o-rings (18).

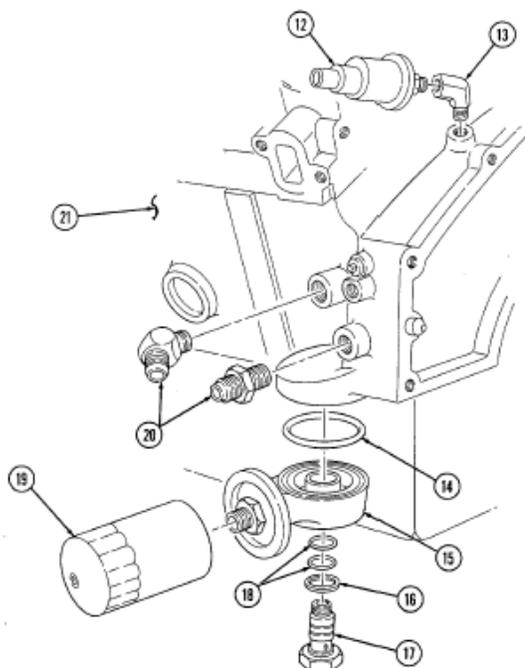
---

**ENGINE DISASSEMBLY INTO SUBASSEMBLIES - CONTINUED**

---

**0011**

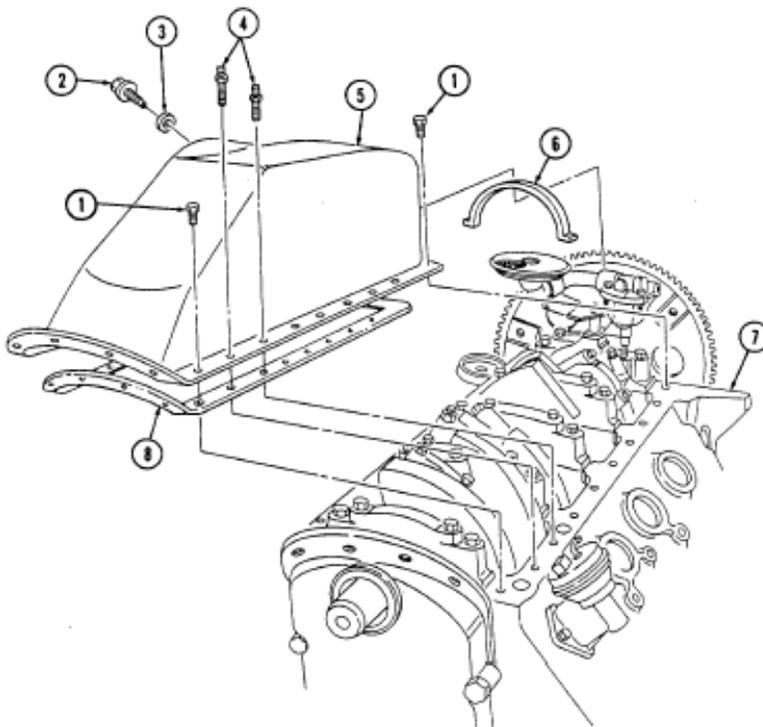
4. Remove O-ring (14) from adapter (15). Discard O-ring (14).
5. Remove two oil cooler line fittings (20) from cylinder block (21).
6. Remove oil pressure sending unit (12) from fitting (13).
7. Remove fitting (13) from cylinder block (21).

**x. OIL PAN****NOTE**

Have drainage container ready to catch oil.

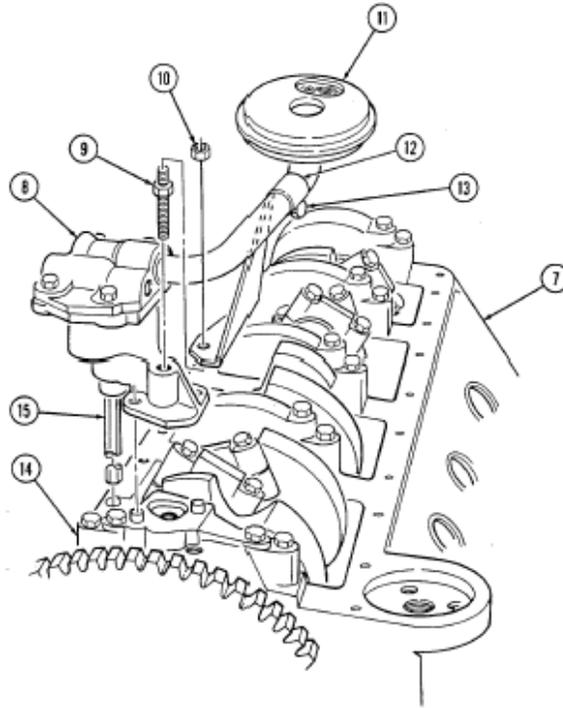
1. Remove oil drainplug (2) and gasket (3) from oil pan (5) and drain oil. Inspect gasket (3) and discard if damaged.
2. Rotate cylinder block (7) 180°.
3. Remove eighteen capscrews (i) and two studs (4) from oil pan (5) and cylinder block (7).

4. Remove oil pan (5), gasket (8) (if installed), and oil pan rear seal (6) from cylinder block (7). Discard seal (6).



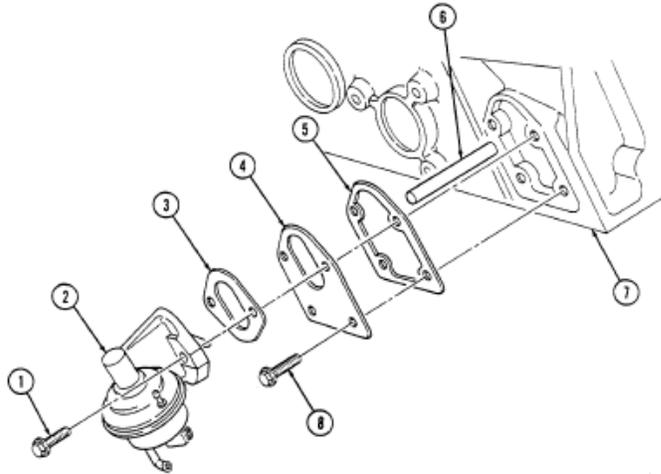
#### y. OIL PUMP

1. Remove nut (10) securing bracket (12) to stud (9).
2. Loosen capscrew (13) from bracket (12) and oil screen (11) and slide bracket (12) off stud (9).
3. Remove stud (9) from oil pump (8) and rear main bearing cap (14).
4. Remove oil pump (8) and shaft (15) from cylinder block (7).

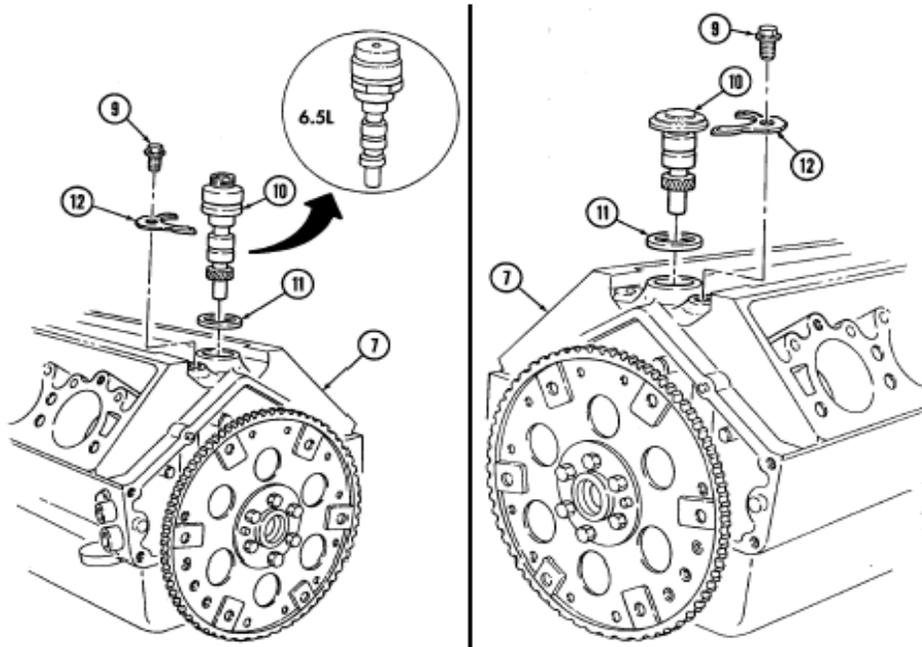


### z. FUEL PUMP

1. Rotate cylinder block (7) 180°.
2. Remove two capscrews (1), fuel pump (2), and gasket (3) from cylinder block (7). Discard gasket (3).
3. Remove two capscrews (8), adapter plate (4), gasket (5), and pushrod (6) from cylinder block (7). Discard gasket (5).

**aa. OIL PUMP DRIVE**

1. Remove capscrew (9) and clamp (12) from cylinder block (7).
2. Remove oil pump drive (10) and gasket (11) from cylinder block (7). Discard gasket (11).

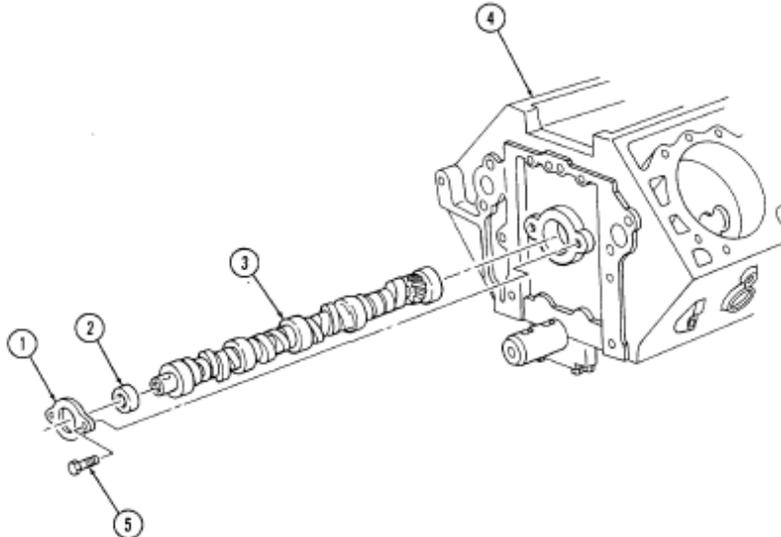
**bb. CAMSHAFT**

1. Remove two capscrews (5), camshaft thrust plate (1), and spacer (2) from cylinder block (4).

**CAUTION**

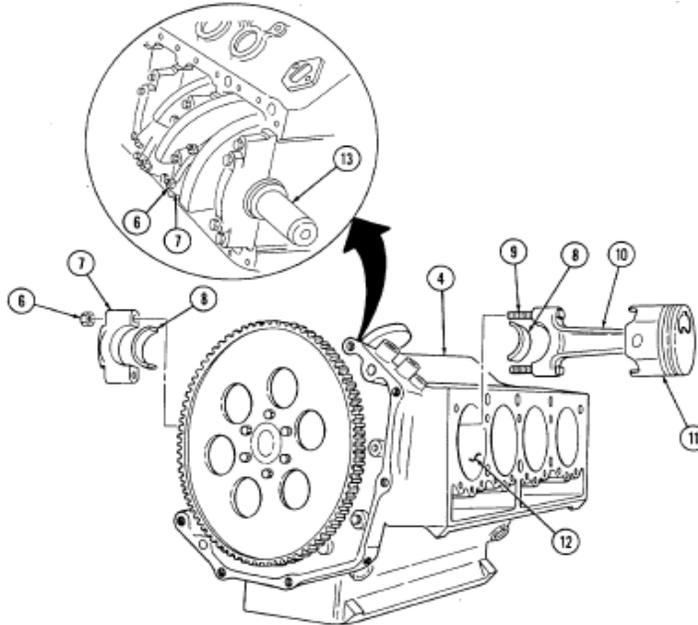
Support camshaft during removal to prevent damage to camshaft bearings.

2. Remove camshaft (3) from cylinder block (4).

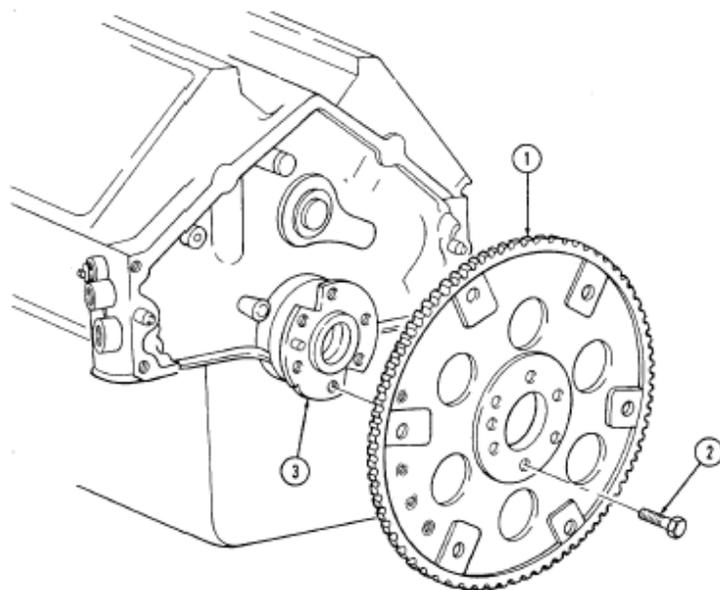


### cc. PISTONS AND CONNECTING RODS

1. Remove ridge from upper inside wall of each cylinder (12) with ridge reamer.
2. Rotate cylinder block (4) approximately 90°.
3. Rotate crankshaft (13) to gain access to two nuts (6).
4. Check sides of connecting rod (10) and rod cap (7) for matching identification numbers. If no numbers are present, stamp connecting rod (10) and rod cap (7) with cylinder number for assembly.
5. Remove two nuts (6) securing rod cap (7) to connecting rod (10) and remove rod cap (7) and two bearings (8). Discard bearings (8).
6. Cover connecting rod bolts (9) with 3/8-in. rubber hose.
7. Push connecting rod (10) and piston (11) out from the inside and remove from cylinder block (4).
8. Remove rubber hose from connecting rod bolts (9) and install rod cap (7) on connecting rod (10) and secure with nuts (6).
9. Repeat steps 3 through 8 for remaining pistons and connecting rods.

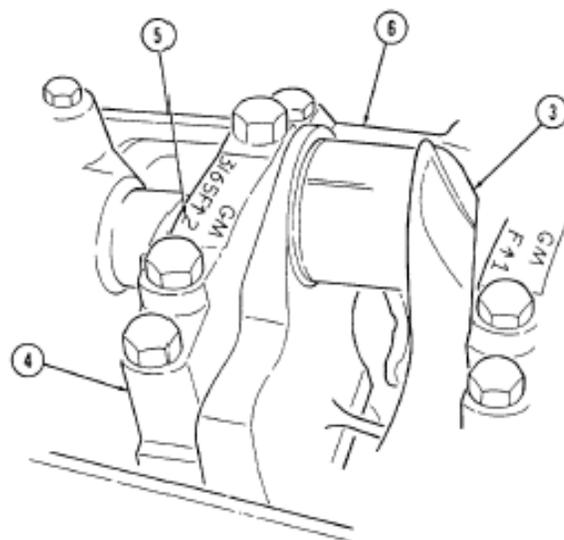
**dd. FLYWHEEL**

Keep crankshaft (3) from rotating and remove six cap screws (2) and flywheel (1) from crankshaft (3).



### ee. CRANKSHAFT AND MAIN BEARINGS

1. Rotate cylinder block (6) so crankshaft (3) faces upward.
2. Check location numbers (5) on main bearing caps (4). If location numbers (5) are not clear, stamp main bearing caps (4) for assembly.



---

**ENGINE DISASSEMBLY INTO SUBASSEMBLIES - CONTINUED**

---

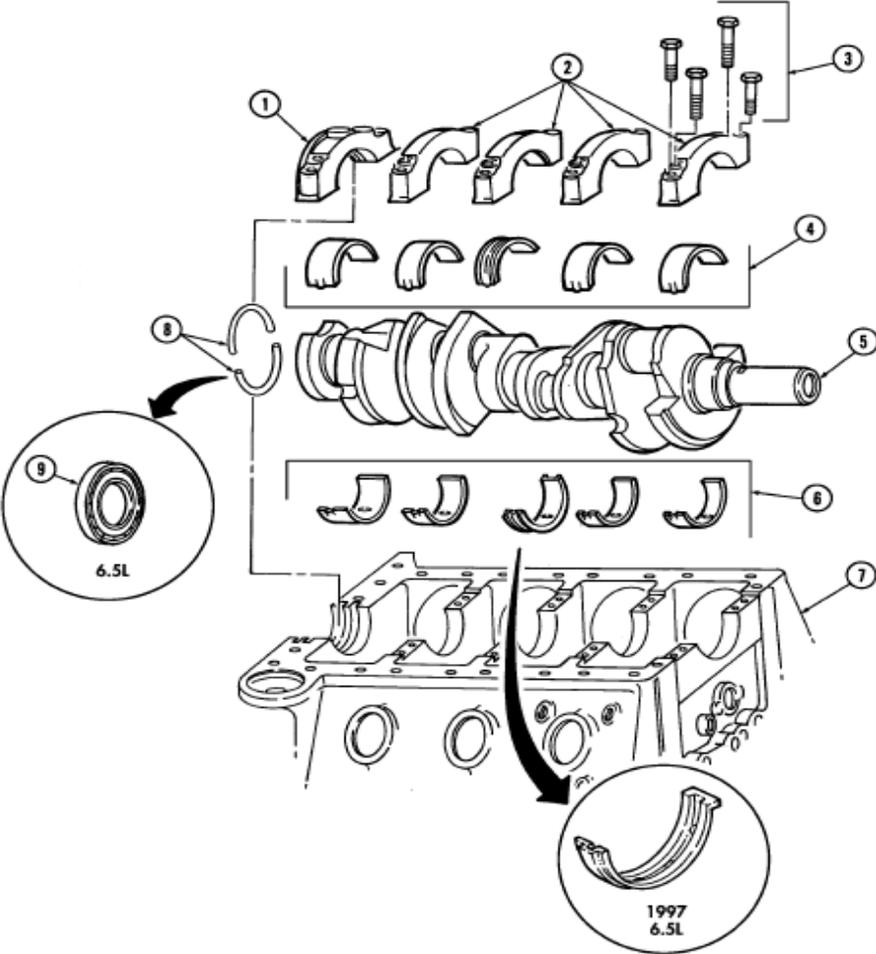
**0011**

3. Remove one-piece crankshaft rear oil seal (9) from rear main bearing cap (1) and cylinder block (7). Discard one-piece crankshaft rear oil seal (9).
4. Remove four capscrews (3) securing main bearing cap (2) to cylinder block (7) and remove cap (2) and bearing (4). Discard bearing (4).
5. Repeat step (4) for remaining main bearing caps (2), rear main bearing cap (1), and bearings (4).

**WARNING**

Crankshaft must be supported during removal and installation.  
Failure to support crankshaft may cause injury to personnel or  
damage to equipment.

6. Remove crankshaft (5) and bearings (6) from cylinder block (7). Discard bearings (6).
7. Remove two-piece crankshaft rear oil seal (8) from rear main bearing cap (1) and cylinder block (7). Discard two-piece crankshaft rear oil seal (8).
8. Install bearing caps (1) and (2) on cylinder block (7) and secure with twenty capscrews (3).



END OF TASK

---

**CYLINDER BLOCK REPAIR**

---

**0012**

---

**THIS WORK PACKAGE (WP) COVERS:**Pre-inspection, Cleaning, Inspection, Repair

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive	NSN 5180-00-177-7033
Straightedge:	NSN 6675-00-224-8807
Feeler gauge:	NSN 5210-01-045-3526
Cylinder bore gauge:	NSN 5210-00-494-1774
Micrometer:	NSN 5210-00-554-7134
Cylinder boring machine:	NSN 4910-00-473-6361
Cylinder honing unit:	NSN 5130-00-991-0699

**Special Tools**

Camshaft bearing remover and installer:	NSN 5120-01-206-3818; PN J35178
-----------------------------------------	---------------------------------

**Materials/Parts**

Six protective dust caps	NSN 5348-00-449-6408; PN 10000462
Lubricating oil OE/HDO	NSN 9150-00-189-6727 – 1 QT. Can NSN 9150-00-186-6618 – 5 Gallon Drum NSN 9150-00-191-2772 – 55 Gallon Drum
Pipe sealing compound	NSN 8030-01-054-0740
Sealing compound, anaerobic	NSN 8030-00-148-9833 – 10 CC Bottle
Sealing compound, high temperature	NSN 8030-01-268-5917 – 50 CC Bottle

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

**General Safety Instructions**

- Compressed air for cleaning purposes will not exceed 30 psi (207 kPa).
- Protective clothing must be used with steam cleaning.
- Wear eyeshields when using compressed air.

---

**CYLINDER BLOCK REPAIR - CONTINUED**

---

**0012****PREINSPECTION**

1. Inspect camshaft bearings (2) for chips, cracks, or scoring. If any bearing (2) is chipped, cracked, or scored, remove all camshaft bearings (2) (see Repair 4) and hot tank clean cylinder block (1) (see Cleaning 1).
2. Measure inside diameter of all camshaft bearings (2). Number one through number four camshaft bearings must be 2.167-2.170 in. (55.041-55.118 mm) and number five camshaft bearing (rear) must be 2.009-2.012-in. (51.028-51.104 mm). If any camshaft bearings (2) do not meet specifications, replace all camshaft bearings (2) (see Repair 4) and hot tank clean cylinder block (1) (see Cleaning 1).
3. If all bearings (2) are to be reused, steam clean cylinder block (1) (see Cleaning 2).

**CLEANING**

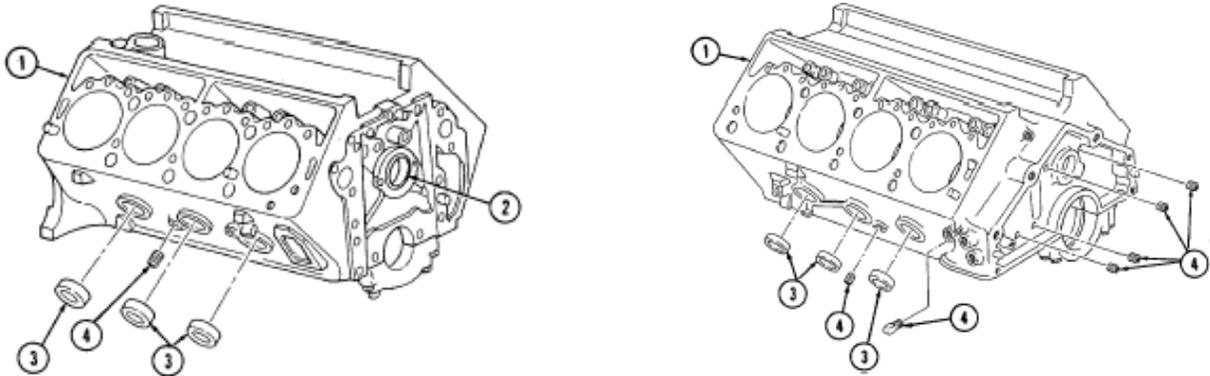
1. Hot tank cleaning.
  - a. Remove six protective dust caps (3) and plugs (4) from cylinder block (1).
  - b. Clean cylinder block (1) by submerging in tank of heated cleaning solution.
  - c. Run rods with brushes through all oil passages and repeat step 1.b.

---

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- d. Blow all dirt and cleaning solution from capscrew holes and oil passages with compressed air.
- e. Refer to WP 0007 for additional cleaning instructions.
- f. Coat all cylinder bores, lifter bores, and machined surfaces with OE/HDO.
- g. Apply pipe sealing compound to six protective dust caps (3) and plugs (4) and install in cylinder block (1).



## 2. Steam cleaning.

- a. Remove six protective dust caps (3) and plugs (4) from cylinder block (1).

### **WARNING**

When steam cleaning, protective clothing must be used. Failure to use protective clothing may result in serious injury.

- b. Thoroughly steam clean cylinder block (1).
- c. Run rods with brushes through all oil passages and repeat step b.

### **WARNING**

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personnel protective equipment (goggles/shield, gloves, etc.).

- d. Blow all dirt and cleaning solution from capscrew holes and oil passages with compressed air.
- e. Refer to WP 0007 for additional cleaning instructions.

---

**CYLINDER BLOCK REPAIR - CONTINUED**

---

**0012**

- f. Coat all cylinder bores, lifter bores, and machined surfaces with OE/HDO.
- g. Apply pipe sealing compound to six protective dust caps (9) and plugs (10) and install in cylinder block (1).

**INSPECTION****NOTE**

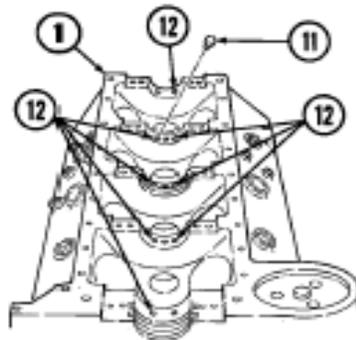
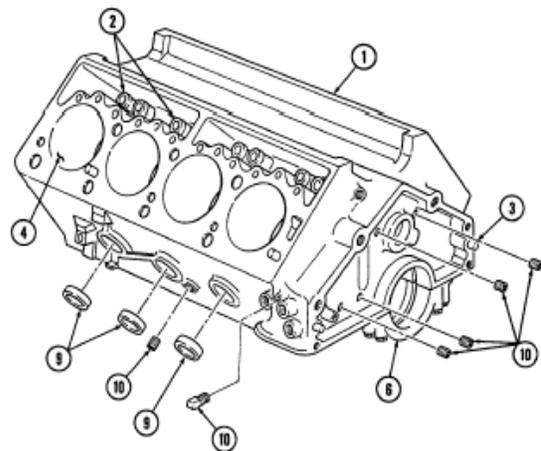
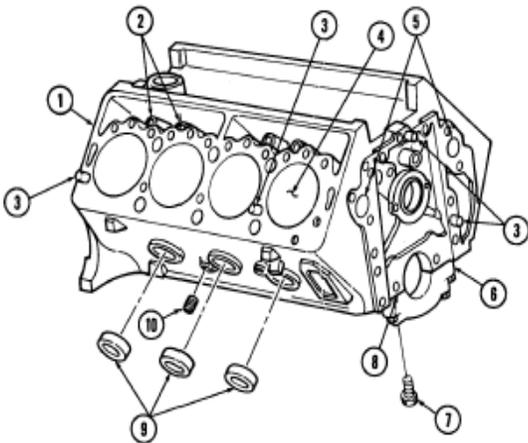
- For general inspection instructions, refer to WP 0007.
- If cylinder block inspection indicates that cylinder block is suitable for continued use, except for out-of-round, taper, or minor nicks or scratches, it can be conditioned by honing or boring. The cylinder block can then be fitted with a Hi-Limit or oversized piston (refer to WP 0040, table 2).

1. Inspect all surfaces and general overall condition of the cylinder block (1).
2. Visually check the cylinder block (1) for pitting in cylinder walls (4) and lifter bores (2). Replace engine if pitted or distorted.
3. Inspect the cylinder block (1) for cracks in cylinder walls (4), water jacket (5), lifter bores (2), and main bearing webs (8). Replace engine if cracked.
4. Inspect main bearing caps (6) for cracks, scoring, or damage. Replace engine if any are cracked, scored, or damaged.
5. Inspect main bearing cap bolts (7) for damage. Replace if damaged.
6. Inspect dowel pins (3) for damage. Replace if damaged.
7. Using a straightedge and feeler gauge, check flatness of cylinder head sealing surfaces on cylinder block (1). Flatness on cylinder block (1) must not vary more than 0.002 in. (0.051 mm) in a distance of 6 in. (15.2 mm) or more than 0.006 in. (0.152 mm) overall. Repair cylinder or replace engine if flatness does not meet above specifications.

**NOTE**

Perform step 7.1 for 1997 6.5L engines only.

7.1. Inspect piston oil nozzles (11) and bores (12) for damage. Replace piston oil nozzles (11) if damaged.



1997  
6.5L

**NOTE**

If cylinder bores are found to have less than 0.005 in. (0.127 mm) wear, taper, or out-of-round, they may be honed oversize (refer to Repair 1) and fitted with "Hi-Limit" standard size pistons.

8. Using cylinder bore gauge, measure all cylinder bores (2) for taper. Measurements must be taken at point "A" (4) at top and bottom of cylinder bore (2). If any cylinder exceeds specifications (WP 0044, table 1) by 0.005 in. (0.127 mm) or more, repair cylinder or replace engine.

9. Using cylinder bore gauge, measure all cylinder bores (2) for out-of-round. Measurement must be taken at point "A" (4) and point "B" (3) at top and bottom of cylinder bore (2). If any cylinder exceeds specifications (WP 0044, table 1) by 0.005 in. (0.127 mm) or more, repair cylinder or replace engine.

10. Using cylinder bore gauge, measure all cylinder bores (2) for bore diameter. Measurement must be taken at point "A" (4) 2-1/2 in. (64 mm) from top of cylinder bore (2). If any cylinder exceeds specifications (WP 0040, table 1) by 0.005 in. (0.127 mm) or more, repair cylinder or replace engine.

**REPAIR****NOTE**

If cylinder block inspection indicated that the cylinder block was suitable for continued use except for out-of-round, taper, or minor nicks or scratches, it can be conditioned by honing or boring.

**1. Boring.**

a. Before using any type of boring bar, the top of the cylinder block should be filed off to remove any dirt or burrs. This is very important. If not checked, the boring bar may be tilted, which would result in the rebored cylinder wall not being at right angles to the crankshaft.

b. Measure piston diameter of the piston to be used at the skirt across the center line of the piston pin.

c. Using a boring bar, bore the cylinder to the same diameter as the piston. Hone the cylinder to get proper piston-to-bore clearance.

d. Repeat steps b. and c. for remaining cylinders.

**2. Honing.**

- a. Using cylinder bore gauge, measure cylinder bore (2) for cylinder bore diameter. Measurement must be taken at point "A" (4) 2-1/2 in. (64 mm) from top of cylinder bore (2).
- b. Measure "piston diameter" of piston (5) removed from corresponding cylinder using a micrometer at piston skirt (7) across center line of piston pin (6).
- c. Subtract "piston diameter" from "cylinder bore diameter" to determine "piston-to-bore clearance".
- d. Repeat steps a. through c. for remaining cylinder bores and pistons.

**NOTE**

- Cylinders can be conditioned with a hone or boring bar and fitted with a standard "Hi-Limit" piston or oversized piston, if necessary.
- If a cylinder is pitted or worn such that it cannot be honed and fitted with a "Hi-Limit" piston or oversized piston, a cylinder sleeve may be used to repair the engine block.

e. If all cylinder bores (2) have proper "piston-to-bore clearance" of 0.004-0.005 in. (0.102-0.127 mm) or if proper "piston-to-bore clearance" may be obtained using a standard "Hi-Limit" piston or oversized piston, go to step f. If not, engine may be repaired using a cylinder sleeve (see Repair 3).

**NOTE**

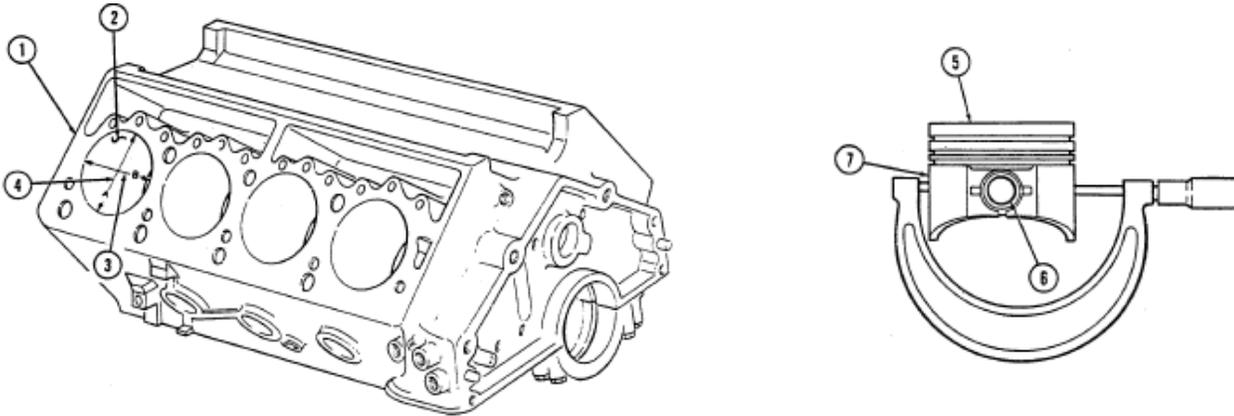
Occasionally during the honing operation, cylinder bore should be thoroughly cleaned, and the piston-to-bore clearance checked for correct fit.

- f. Using cylinder hone, refinish cylinder bore (2). Hone should be moved up and down at sufficient speed to obtain very fine uniform surface finish marks, in a cross-hatch pattern of approximately 45° to 65° included angle. The finish marks should be clean, not sharp, and free from imbedded particles and torn or folded material.
- g. If a "Hi-Limit" piston or oversized piston (5) was fitted to a cylinder bore (2), permanently mark the piston (5) for the cylinder bore (2) to which it has been fitted.

**CYLINDER BLOCK REPAIR - CONTINUED****0012**

h. Repeat steps f. and g. for remaining cylinder bores.

i. Thoroughly clean the cylinder block (1) with hot water and detergent. Scrub cylinder bores (2) with a stiff brush and rinse thoroughly with hot water. The cylinder bores (2) should be coated with OE/HDO and wiped with a clean, dry cloth.

**3. Installation of cylinder sleeves.****CAUTION**

Do not use cylinder sleeves to repair a cracked engine block.

**NOTE**

Cylinders that still show damage or wear after being honed to a maximum oversize of 0.030 in. (0.762 mm) will require sleeves.

a. Identify cylinders that require sleeves.

b. Using micrometer, measure outside diameter of cylinder sleeve (1).

**NOTE**

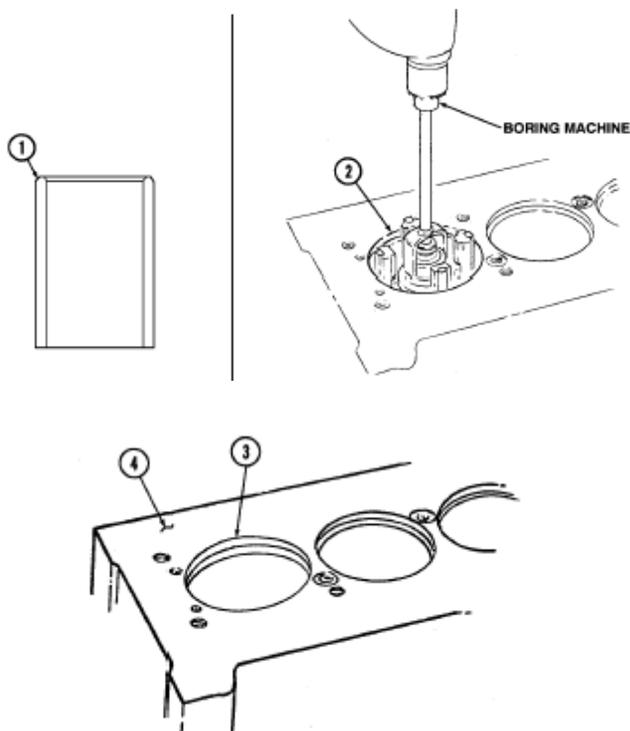
- Before using any type of boring bar, the top of the cylinder block should be filed off to remove any dirt or burrs. This is very important. If not checked, the boring bar may be tilted, which would result in the rebored cylinder wall not being at right angle to crankshaft.
- The cylinder must be bored to within 0.125 in. (3.18 mm) of the rod relief in the bottom of the cylinder. Ensure the depth of the bore does not exceed the length of the sleeve. Ensure to cut the bottom of the bore square. This will provide a stop, or ledge, for the sleeve to bottom out on.

c. Using cylinder boring machine, bore cylinder (2) to diameter of sleeve (1) less 0.002 to 0.003 in. (0.051 to 0.076 mm) to create an interference fit between sleeve (1) and cylinder (2).

**NOTE**

Store the sleeve in a freezer at a temperature of 28 to 30°F (-2.2 to -1.1°C) for several hours before installing it into the engine block.

- d. Apply bead of high temperature sealing compound to top and bottom of cylinder (2) bore. Press frozen sleeve (1) into cylinder (2) until it bottoms out on ledge at bottom of cylinder (2) bore.
- e. Remove any excess sleeve material protruding above the head deck surface (4). Finish the sleeve (1) flush with deck of block (3), taking care not to damage deck surface (4).
- f. Using cylinder boring machine, bore the sleeved cylinder (1) to appropriate piston size.
- g. Finish cylinder surface (refer to Repair 1).



#### 4. Camshaft bearing replacement.

### **WARNING**

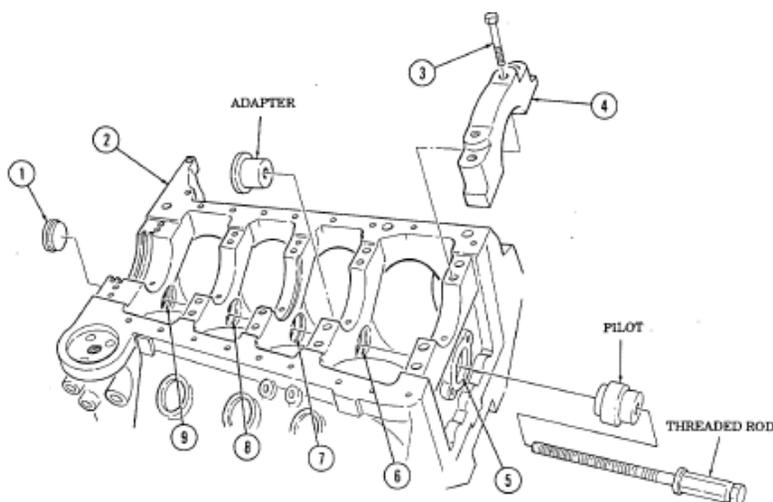
Cylinder block must be supported during removal and installation from engine stand. Failure to support cylinder block may cause injury to personnel or damage to equipment.

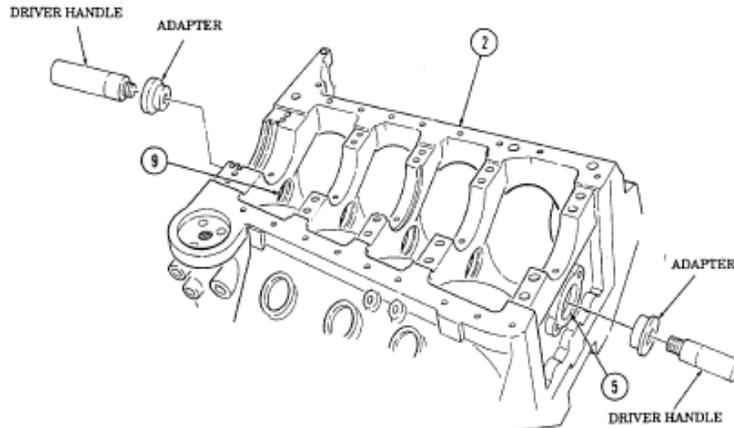
### **NOTE**

The following steps are to be performed only if camshaft bearings are to be replaced.

- a. Remove cylinder block (2) from engine stand.
- b. Remove twenty capscrews (3) and five main bearing caps (4) from cylinder block (2).

- c. Drive camshaft rear plug (1) from cylinder block (2). Discard plug (1).
- d. Install adapter J 6098-11 in camshaft bearing number two (6).
- e. Install pilot in number one camshaft bearing (5). Insert threaded rod through pilot and into adapter thread.
- f. Hold threaded rod stationary and tighten long hex nut to remove camshaft bearing (6) from cylinder block (2). When camshaft bearing (6) has been completely removed from cylinder block (2), remove threaded rod, pilot, and adapter. Discard bearing (6).
- g. Repeat steps d. through f. for number three camshaft bearing (7).
- h. Repeat steps d. through f., working from rear of cylinder block (2), for number four camshaft bearing (8).
- i. Using driver handle and adapter J6098-11, remove number one camshaft bearing (5) from cylinder block (2). Discard bearing (5).
- j. Using driver handle and adapter J 6098-12, remove number five camshaft bearing (9) from cylinder block (2). Discard bearing (9).





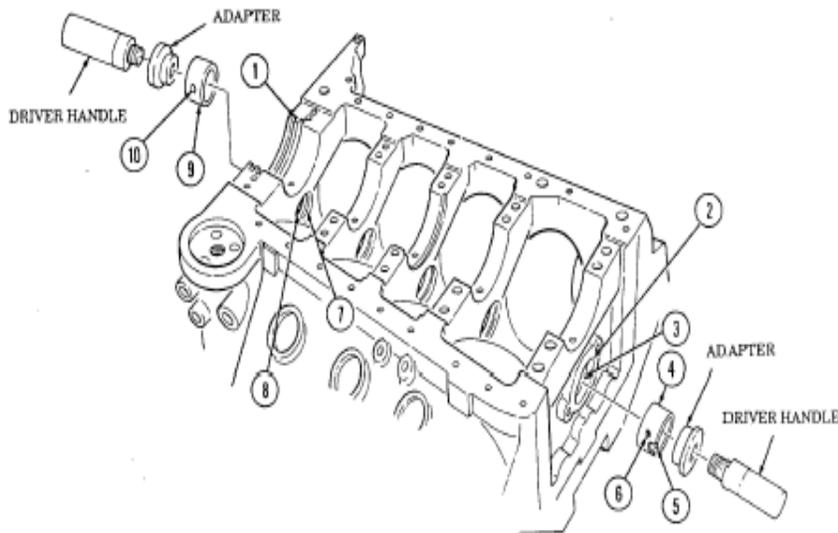
### **CAUTION**

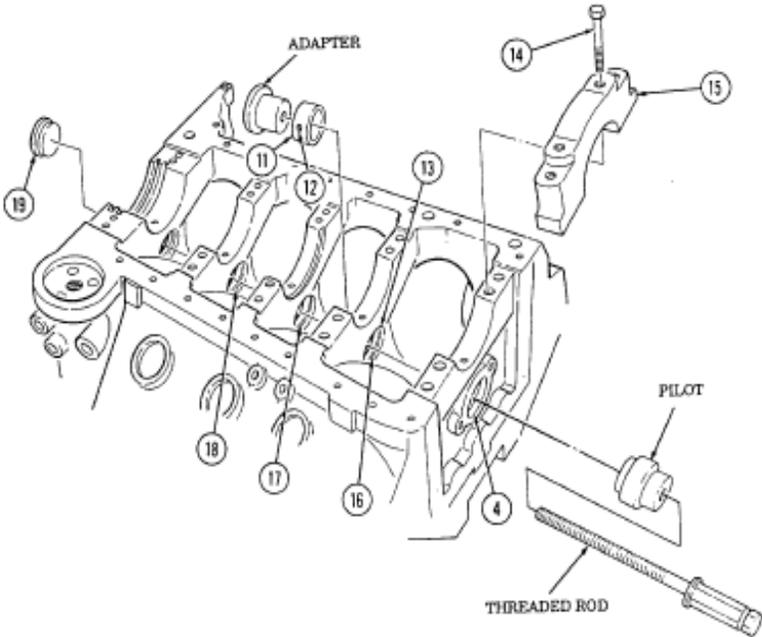
- All five bearings must have an oil hole at the approximate ten o'clock position, when viewed from the front with the block in an upside down position, or engine damage will result.
- The seam in the bearing must always be located in the lower half of the block face, when viewed with the block in an upside down position, or engine damage will result.
- The front bearing has an additional oil hole which will be located between the six and seven o'clock positions. This bearing also has a notch which must be positioned toward the front of the block, or engine damage will result.
- All oil holes in camshaft bearings must be aligned with grooves in camshaft bearing bores after installation, or engine damage will result.

k. Using driver handle and adapter J 6098-11, align number one camshaft bearing (4) so oil hole (5) is facing down and oil hole (6) is at or near the ten o'clock position and install into cylinder block (1). Remove installation tools and check to be sure oil holes (5) and (6) align with groove (3) in bearing bore (2).

**CYLINDER BLOCK REPAIR - CONTINUED****0012**

- l. Using driver handle and adapter J 6098-12, align number five camshaft bearing (9) so oil hole (10) is at or near the ten o'clock position and install into cylinder block (1). Remove installation tools and check to be sure oil hole (10) is aligned with groove (7) in bearing bore (8).
- m. Install number two camshaft bearing (11) on adapter J 6098-11 and position in cylinder block (1) so oil hole (12) is at or near the ten o'clock position. Install pilot in number one camshaft bearing (4) and install threaded rod through pilot and thread into adapter.
- n. Hold threaded rod stationary and tighten long hex nut to install camshaft bearing ( 11) in cylinder block (1), remove installation tools, and check to be sure oil hole (12) is aligned with groove (16) in bearing bore (13).
- o. Repeat steps m. and n. for number three camshaft bearing (17).
- p. Working from rear of cylinder block (1), repeat steps m. and n. for number four camshaft bearing (18).
- q. Apply anaerobic sealing compound to outside diameter of rear plug (19) block (1) until flush or 1/32-in. (0.79 mm) deep. and install in cylinder
- r. Install five main bearing caps (15) on cylinder block (1) and secure with twenty capscrews (14).
- s. Install cylinder block (1) on engine stand.





END OF TASK

---

**CRANKSHAFT REPAIR****0013**

---

**THIS WORK PACKAGE (WP) COVERS:**Cleaning, Inspection, Repair

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

Micrometer:

NSN 5210-00-554-7134

**Materials/Parts**

Abrasive crocus cloth:

NSN 5350-00-221-0872 – 50 Sheet Package

NSN 5350-00-268-3116 – 50 Yard Roll

**Equipment Condition**Engine disassembled (WP 0011) into subassemblies

---

**CLEANING**

1. Clean all drilled oil passages (5) with a rod and cloth.
2. Refer to **WP 0007** for additional cleaning information.

**INSPECTION****NOTE**For general inspection instructions, refer to **WP 0007**.

1. Inspect crankshaft (1) for scratches, nicks, and cracks. Replace if scratched, nicked, or cracked.
2. Check main bearing journals (4) and connecting rod journals (6) for taper, out-of-round, and diameter using an outside micrometer. Replace crankshaft (1) if any bearing journal is tapered, out-of-round, or out of specifications (WP 0044, table 1).

0013 00-1

---

**CRANKSHAFT REPAIR - CONTINUED**

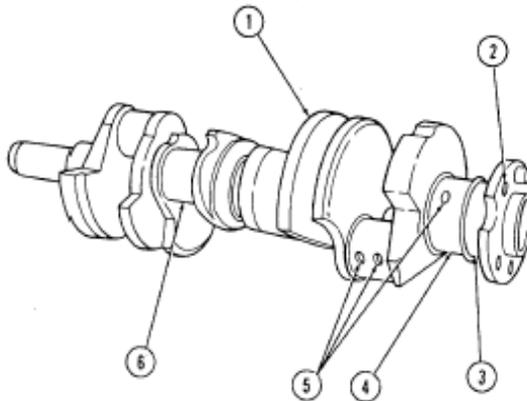
---

**0013**

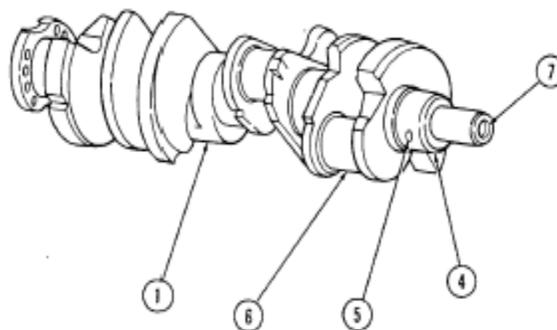
3. Inspect rear seal area (3) for roughness, scoring, grooving, flaking, pitting, and galling. Replace crankshaft (1) if rough, scored, grooved, flaked, pitted, or galled.
4. Inspect threaded holes (2) and (7) in crankshaft (1) for damage. Replace crankshaft (1) if threads are damaged.

**REPAIR**

Buff all minor nicks and scratches using abrasive crocus cloth.



Note: If equipment is available, repair is authorized if out of specification falls within under and oversize bearing specifications.

**END OF TASK**

---

**CONNECTING ROD AND PISTON REPAIR**

---

**0014****THIS WORK PACKAGE (WP) COVERS:**Disassembly, Cleaning, Inspection, Repair

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive	NSN 5180-00-177-7033
Feeler gauge:	NSN 5210-01-045-3526
Micrometer:	NSN 5210-00-554-7134
Piston ring expander:	NSN 5120-00-857-3190

**Materials/Parts**

Sixteen snaprings:	NSN 5365-01-234-0447; PN 23500298
Eight piston ring sets:	NSN 2815-01-163-7838; PN 15537018 NSN 2815-01-163-9999; PN 15537020
Lubricating oil OE/HDO:	NSN 9150-00-189-6727 – 1 QT. Can NSN 9150-00-186-6618 – 5 Gallon Drum NSN 9150-00-191-2772 – 55 Gallon Drum

---

**DISASSEMBLY**

1. Remove top compression ring (1), second compression ring (2), and oil ring (3) from piston (4). Discard rings (1), (2), and (3).
2. Remove two snaprings (5), piston pin (15), and connecting rod (13) from piston (4). Discard snaprings (5).
3. Remove two nuts (11) and rod cap (12) from connecting rod (13).
4. Repeat steps 1 through 3 for remaining pistons and connecting rods.

**CLEANING**Clean all components in accordance with **WP 0007**.

**INSPECTION****NOTE**

- For general inspection instructions, refer to **WP 0007**.
- To identify correct piston size for standard and oversize pistons, check code stamped on face of piston, and determine correct piston size. Refer to WP 0040, table 2 for piston-cylinder specifications.
- 6.5L engines do not have Hi-Limit pistons.

1. Inspect piston (4) for cracks at ring lands (6), skirt (7), and pin bosses (16). Replace piston (4) if cracked.
2. Inspect piston (4) for scoring, galling, and scuffing. Replace if scored, galled, or scuffed.
3. Measure piston (4) at center (8) and bottom (9) of piston skirt (7) using micrometer. If measurement at bottom (9) is smaller than measurement at center (8), piston skirt (7) is collapsed and piston (4) must be replaced.
4. Inspect connecting rod (13) and rod cap (12) for distortion or damage. Replace connecting rod (13) if either are damaged or distorted.
5. Inspect connecting rod bolts (10) and nuts (11) for damage. Replace if damaged.
6. Inspect bronze bushing (14) in small end of connecting rod (13) for damage. Replace connecting rod (13) if damaged.
7. Inspect piston pin (15) for galling, scoring, and damage. Replace piston (4) if scored, galled, or damaged.

---

**CONNECTING ROD AND PISTON REPAIR – CONTINUED**

---

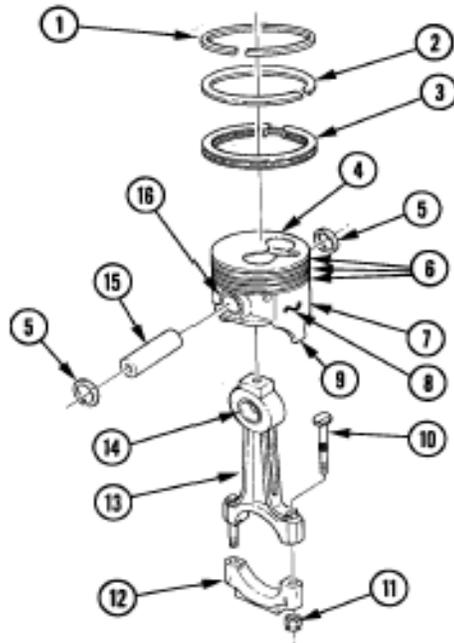
**0014**

8. Measure pin boss (16) inside diameter and piston pin (15) outside diameter to determine if clearance is within specifications (WP 0040, table 1). If measurement exceeds specifications, replace piston (4).

9. Measure piston pin (15) outside diameter and bushing (14) inside diameter to determine if fit to rod is within specifications (WP 0040, table 1). If measurement exceeds specifications, replace connecting rod (13).

10. Check ring groove clearance. If measurement exceeds specifications (WP 0040, table 1), replace piston (4).

11. Repeat steps 1 through 10 for remaining pistons and rods.



**ASSEMBLY****NOTE**

- For general assembly instructions, refer to **WP 0007**.
- Top compression ring is thicker than second compression ring.
- If proper end gap cannot be obtained, refer to **WP 0040** table 2, for piston-to-cylinder applications. Refer to **WP 0012** Repair, for cylinder block repair.

1. Place top compression ring (1) in cylinder bore (13) in which it will be used.
2. Slide piston ring (1) 1 in. (25.4 mm) into cylinder bore (13). Be sure piston ring (1) is square with cylinder bore (13).
3. Check gap in piston ring (1) using feeler gauge.
4. Top compression ring (1) end gap must be 0.012-0.022 in. (0.30-0.55 mm). If not, replace ring (1) and check gap.
5. Repeat steps 1 through 3 using second compression ring (2). End gap must be 0.030-0.039 in. (0.75-1.00 mm). If not, replace ring (2) and check gap.

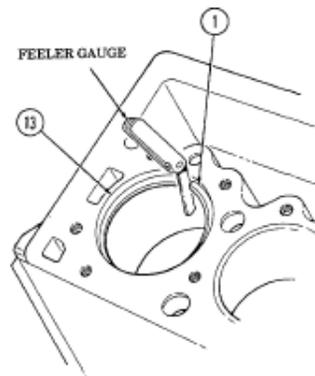
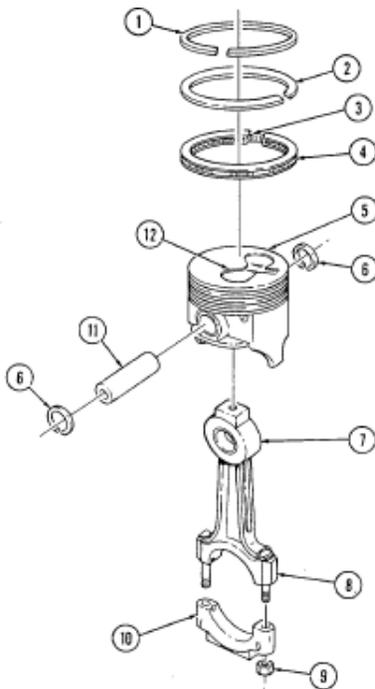
**NOTE**

Spring must be removed from oil ring when checking end gap.

6. Repeat steps 1 through 3 using oil ring (4). End gap must be 0.010-0.020 in. (0.25-0.51 mm). If not, replace ring (4) and check gap. Reinstall spring (3).
7. Repeat steps 1 through 6 for remaining piston rings.

**CONNECTING ROD AND PISTON REPAIR – CONTINUED****0014**

8. Install connecting rod (7) in piston (5) so that identification number (8) and depression (12) on top of piston (5) are on the same side.
9. Coat piston pin (11) with OE/HDO and install in piston (5) and connecting rod (7) and secure with two snaprings (6).
10. Using piston ring expander, install oil ring (4) on piston (5).
11. Using piston ring expander, install second compression ring (2) on piston (5). Be sure marked side of piston ring (2) faces up.
12. Using piston ring expander, install top compression ring (1) on piston (5). Be sure marked side of piston ring (1) faces up.
13. Install rod cap (10) on connecting rod (7) and secure with two nuts (9).
14. Repeat steps 8 through 13 for remaining pistons and connecting rods.

**END OF TASK**

0014 00-5/6 blank



---

**CAMSHAFT, TIMING CHAIN, AND DRIVE GEARS REPAIR**

---

**0015****THIS WORK PACKAGE COVERS:**Cleaning and Inspection

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive	NSN 5180-00-177-7033
Micrometer	NSN 5210-00-554-7134
"V" blocks	NSN 3460-00-725-5076
Dial indicator	NSN 5210-00-277-8840

**Equipment Condition**Engine disassembled into subassemblies (WP 0011).

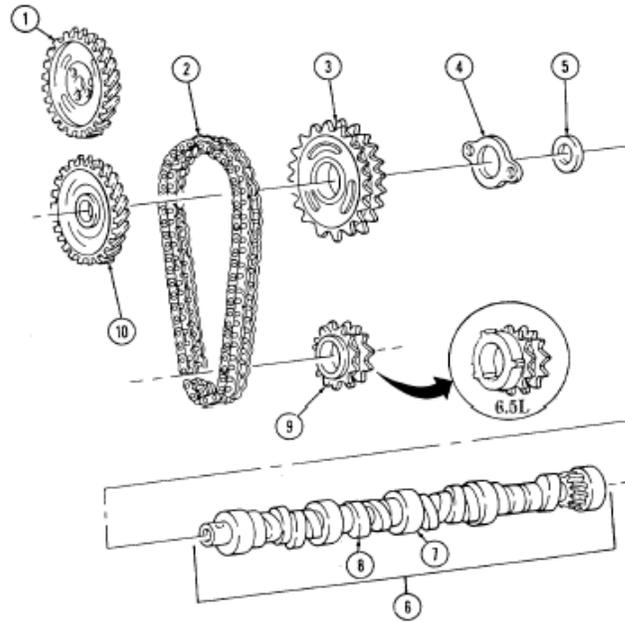
---

**CLEANING**Clean all components in accordance with **WP 0007**.**INSPECTION****NOTE**

- For general inspection instructions, refer to **WP 0007**.
- All lifters must be replaced when replacing camshaft.

1. Inspect camshaft bearing journals (7) and lobes (8) for damage. Replace camshaft (6) if damaged.
2. Measure diameter of bearing journals (7) using outside micrometer. Replace camshaft (6) if any bearing journal (7) is out of specification (WP 0040, table 1).
3. Support camshaft (6) on "V" blocks.
4. Using dial indicator and "V" blocks, measure cam lobe (8) lift. Replace camshaft (6) if any cam lobe (8) is out of specification (WP 0040, table 1).
5. Inspect crankshaft sprocket (9), camshaft sprocket (3), pump drive gear (10), and pump driven gear (1) for damage. Replace any gear or sprocket if damaged.

6. Inspect camshaft thrust plate (4) and spacer (5) for damage. Replace if damaged.



**END OF TASK**

---

**TIMING GEAR COVER REPAIR**

---

**0016**

---

**THIS WORK PACKAGE (WP) COVERS:**Cleaning, Inspection, Repair

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Equipment Condition**Engine disassembled into subassemblies (WP 0011).

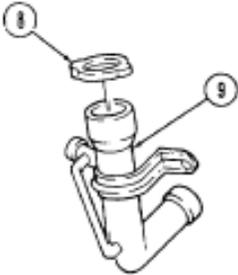
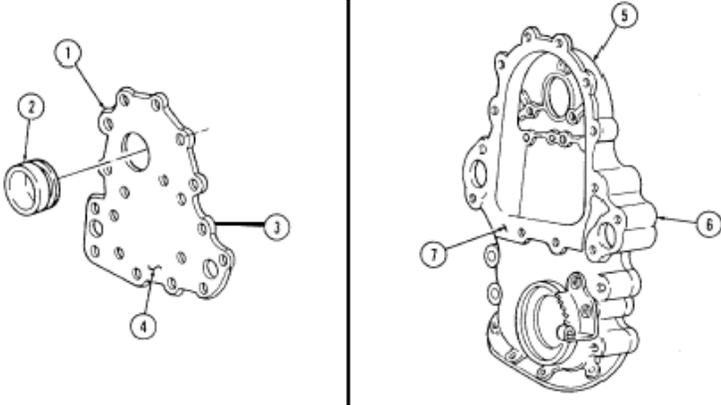
---

**CLEANING**Clean all components in accordance with **WP 0007**.**INSPECTION****NOTE**For general inspection instructions, refer to **WP 0007**.

1. Inspect sealing surfaces (7) and (6) on timing gear cover (5) and sealing surfaces (3) and (4) on water pump adapter plate (1) for deep scratches or dents. Replace either if deeply scratched or dented.
2. Inspect timing gear cover (5) and water pump adapter plate (1) for damage. Replace either if damaged.
3. Inspect oil filler tube grommet (2) for damage. Replace if damaged.
4. Inspect oil filler tube (9) for damage. Replace if damaged.
5. Inspect oil filler tube cap (8) for damage. Replace if damaged.

**TIMING GEAR COVER REPAIR – CONTINUED**

**0016**



**END OF TASK**

---

**CYLINDER HEAD AND VALVE REPAIR****0017**

---

**THIS WORK PACKAGE (WP) COVERS:**Disassembly, Cleaning, Inspection, Refacing Valves, Grinding Valve Seats, Assembly

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive	NSN 5180-00-177-7033
Valve spring compressor:	NSN 5120-00-239-8686
Bench grinder:	NSN 3415-00-517-7744
Rotary wheel wire brush:	NSN 5130-00-473-6444
Electric drill:	NSN 5130-00-889-8993
Rotary end wire brush:	NSN 5130-00-293-2409
Valve spring tester:	NSN 6635-00-641-7346
Straightedge:	NSN 6675-00-224-8807
Feeler gauge:	NSN 5210-01-045-3526
Dial indicator:	NSN 5210-00-277-8840
Valve face grinding machine:	NSN 4910-00540-4679
Valve seat grinding kit:	NSN 4910-00-473-6437

**Materials/Parts**

Sixteen valve seals:	NSN 2805-00-752-0158; PN 3835333
Water jacket cover gasket:	NSN 5330-01-149-0874; PN 10137488
Lubricating oil OE/HDO:	NSN 9150-00-189-6727 – 1 QT. Can NSN 9150-00-186-6618 – 5 Gallon Drum NSN 9150-00-191-2772 – 55 Gallon Drum
Pipe sealing compound:	NSN 8030-01-054-0740 – 10 CC Bottle

**Equipment Condition**Engine disassembled into subassemblies  
(WP 0011).

**NOTE**

The cylinder head and valve repair procedures for 6.5L engines are basically the same. Any differences in procedures are noted. Refer to engine decal model number on left rocker arm cover before ordering replacement parts.

**DISASSEMBLY**

1. Using valve spring compressor, compress intake valve spring (3) and remove valve keys (7). Release valve spring compressor slowly. Discard valve keys (7).
2. Remove valve cap (6), shield (4), valve spring (3), valve spring shim (2), and valve seal (5) from intake valve (16). Discard valve seal (5).

**NOTE**

Valves must be installed in the same location they were removed from. As each valve is removed, place on numbered board or stand.

3. Remove intake valve (16) from cylinder head (1).
4. Repeat steps 1 through 3 for remaining intake valves.
5. Using valve spring compressor, compress exhaust valve spring (13) and remove valve keys (8). Release valve spring compressor slowly. Discard Valve Keys (8).

**NOTE**

- Valve caps on exhaust valves are rotaters.
- Perform step 7 for 6.5L engine. 6.5L engine has another seal as indicated in step 7.

---

**CYLINDER HEAD AND VALVE REPAIR – CONTINUED**

---

**0017**

6. Remove valve cap (9), shield (11), valve spring (13), valve spring shim (14), and valve seal (10) from exhaust valve (15). Discard valve seal (10).
7. Remove seal (17) from cylinder head (1). Discard seal (17).

**NOTE**

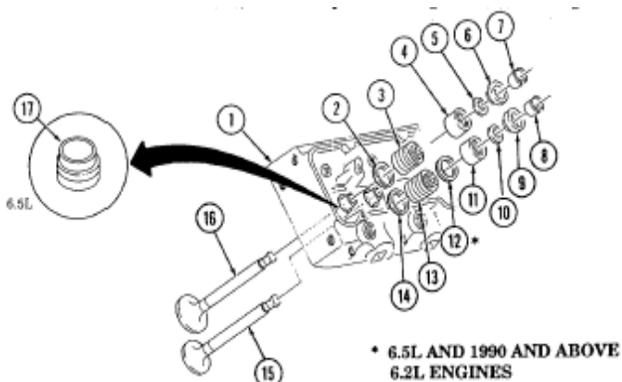
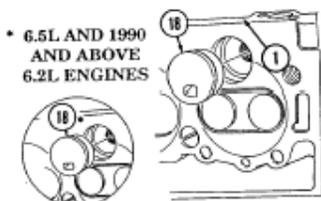
Valves must be installed in the same location they were removed from. As each valve is removed, place on numbered board or stand.

8. Remove exhaust valve (15) from cylinder head (1).
9. Repeat steps 5 through 8 for remaining exhaust valves.

**NOTE**

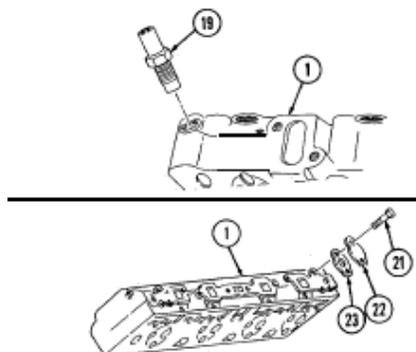
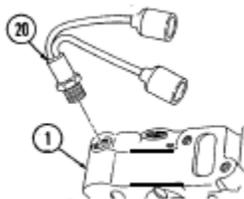
Precombustion chambers must be installed in the same location they were removed from. Mark precombustion chambers for assembly.

10. Remove four precombustion chambers (18) from cylinder head (1).
11. Repeat steps 1 through 10 for opposite cylinder head.
12. Remove engine temperature sending unit (19) from left cylinder head (1)
13. Remove cold start advance switch (20) from right cylinder head (1).
14. Remove two capscrews (21), water jacket cover (22), and water jacket cover gasket (23) from right cylinder head (1). Discard gasket (23).



## CLEANING

1. Using bench grinder and rotary wheel wire brush, clean all valve stems (2) and valve heads (3).
2. Using drill motor and rotary end wire brush, clean all combustion chambers (12) and intake and exhaust ports (13).
3. Refer to WP 0007 for additional cleaning information.
4. Repeat steps 1 through 3 for opposite cylinder head.



**INSPECTION****NOTE**

For general inspection instructions, refer to **WP 0007**.

1. Inspect valves (1) for cracks, scoring, galling, and burned heads (3). Replace valves (1) if cracked, scored, galled, or if heads (3) are burned.
2. Inspect valve springs (8) and dampers (7) for damage. Replace valve spring (8) if either are damaged.
3. Inspect valve caps (5), shields (6), and valve spring shims (9) for damage. Replace if damaged.
4. Remove dampers (7) from valve springs (8). Using valve spring tester, compress valve spring (8) to 1-13/16 in. (46 mm). If pressure is less than 70 lb (311 N), replace valve spring (8). Compress valve spring (8) to 1-25/64 in. (35 mm). If pressure is less than 220 lb (978 N), replace valve spring (8). Test remaining springs in same manner. Install dampers (7) into springs (8).
5. Inspect cylinder head (11) for cracks in valve ports (13) or combustion chambers (12) and external cracks to the coolant chamber (14). Replace cylinder head (11) if cracked.

**NOTE**

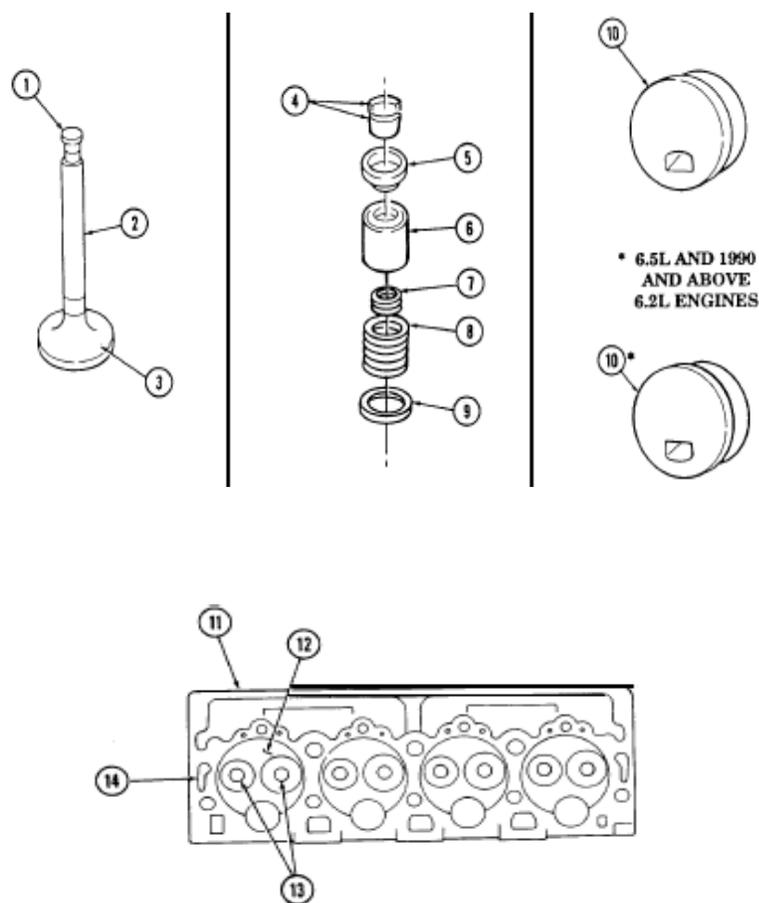
Precombustion chamber is available in standard and oversize. If replacing a precombustion chamber, check for marking "OS" on precombustion chamber. If marking is present, oversize precombustion chamber must be used.

6. Inspect precombustion chambers (10) for cracks or damage. Replace if cracked or damaged.
7. Inspect cylinder head (11) mating surfaces for scratches or dents. Replace cylinder head (11) if scratched or dented deeper than 0.003 in. (0.076 mm).

**CYLINDER HEAD AND VALVE REPAIR – CONTINUED**

**0017**

8. Using a straight edge and feeler gauge, check flatness of cylinder head to block mating surface. Flatness of cylinder head (11) must not vary more than 0.002-in. (0.051 mm) in distance of 6 in. (15.2 cm), or more than 0.006 in. (0.152 mm) overall. Replace cylinder head (11) if flatness does not meet specifications.



9. Install valve (2) in valve guide (4) from which it was removed.

**CAUTION**

Clearance must be 0.001-0.003 in. (0.026-0.076 mm). Excessive valve stem clearance will cause excessive oil consumption and may cause valve breakage.

**NOTE**

- Intake and exhaust valves are available with 0.0035 in. (0.089 mm) and 0.0137 in. (0.349 mm) oversize stems.
- If valve stem clearance is more than 0.0027 in. (0.068 mm), valve guide must be reamed to next size and oversized valve installed. If unable to produce clearance with oversize valve, replace cylinder head.

10. Using dial indicator, measure valve stem clearance. Dial indicator must contact valve stem (1) just above valve guide (4) and at a right angle to the valve stem (1). Drop valve (2) approximately 1/16 in. (1.6 mm) off valve seat (3) and move side-to-side when taking measurement.

11. Repeat steps 9 and 10 for remaining valves (2) and valve guides (4).

12. Inspect cold start advance switch (6) and engine temperature sending unit (5) for damage. Replace if damaged.

**REFACING VALVES**

1. Using valve face grinding machine, grind valve face (7) on all valves (2) to 45 degree.

2. Maintain a minimum of 1/32 in. (0.80 mm) margin (8) on all valves (2). If margin falls below specifications, replace valve.

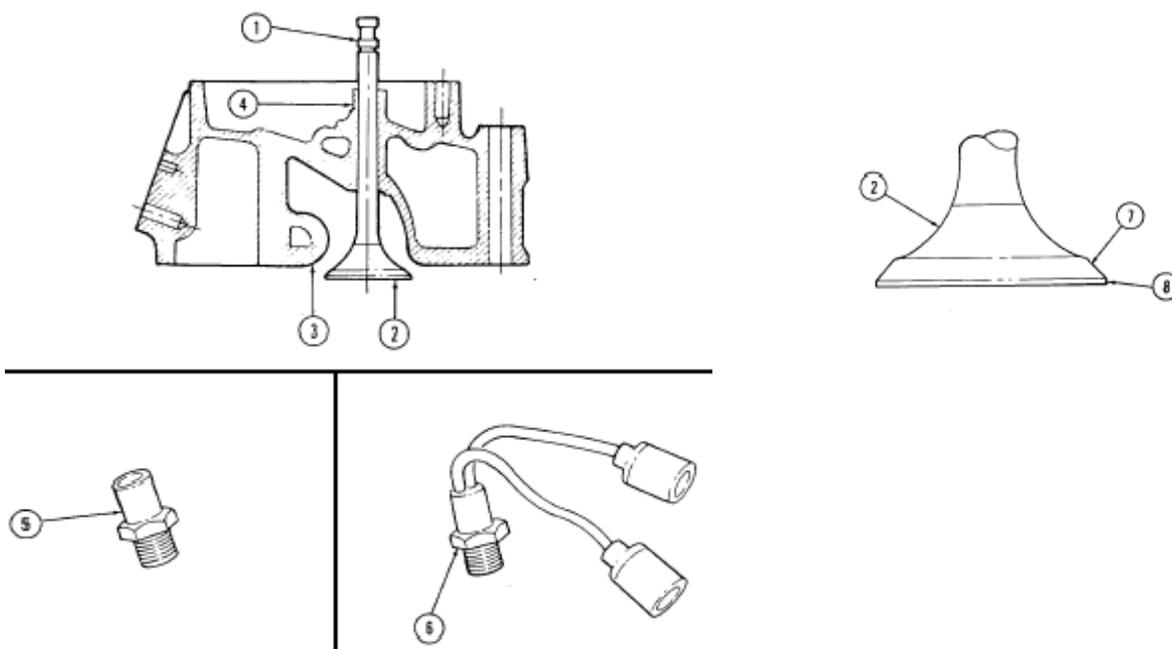
**GRINDING VALVE SEATS**

1. Using valve seat grinding kit, grind all valve seats (3) to 46°.

**NOTE**

If valve seat width exceeds specifications, valve seat width must be narrowed.

2. Measure width of intake valve seats (3). Valve seats (3) must not be wider than 1/16 in. (1.53 mm).
3. Measure width of exhaust valve seats (3). Valve seats (3) must not be wider than 3/32 in. (2.36 mm).



**ASSEMBLY****NOTE**

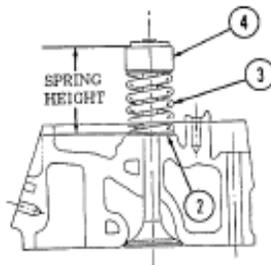
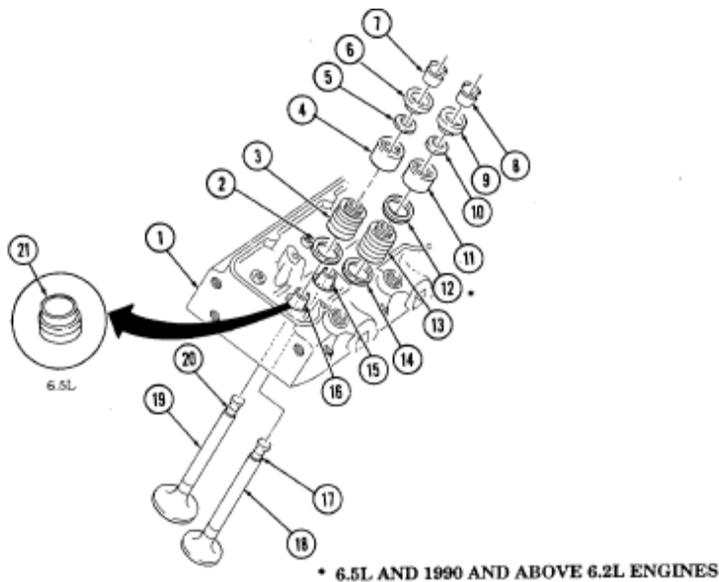
For general assembly instructions, refer to **WP 0007**.

1. Apply OE/HDO to exhaust valve (18) and install valve (18) in valve guide (15) from which it was removed.

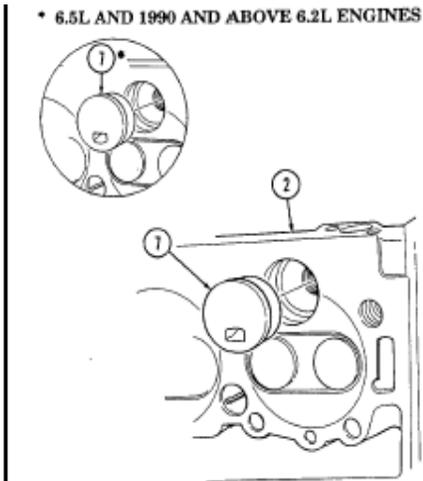
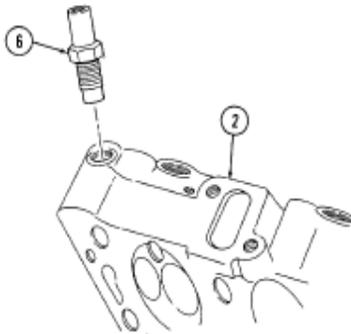
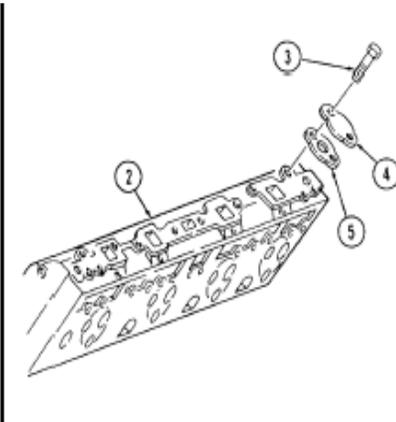
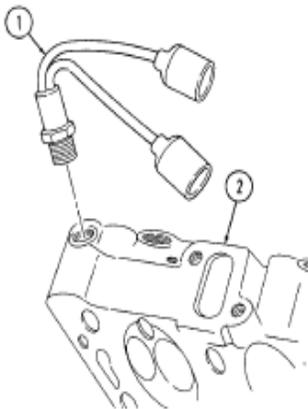
**NOTE**

Valve caps on exhaust valves are rotaters.

2. Install seal (21), valve spring shim (14), valve spring (13), valve stem seal (12), shield (11), and valve cap (9) on exhaust valve (18).
3. Using spring compressor, compress valve spring (13) and install valve seal (10) in groove (17) in exhaust valve (18) and install valve keys (8). Slowly release spring compressor.
4. Apply OE/HDO to intake valve (19) and install valve (19) in valve guide (16) from which it was removed.
5. Install valve spring shim (2), valve spring (3), shield (4), and valve cap (6) to intake valve (19).
6. Using valve spring compressor, compress valve spring (3) and install valve seal (5) in groove (20) in intake valve (19) and install valve keys (7). Slowly release spring compressor.
7. Check installed height of valve springs (3) measuring from top of valve spring shim (2) to top of shield (4).
8. Spring height must be 1-13/16 in. (46 mm). If spring height is greater, remove valve spring (3) and add spring shim(s) (2) to bring spring height within specifications.
9. Repeat steps 1 through 9 for remaining valves and opposite cylinder head.



10. Apply pipe sealing compound to cold start advance switch (1) and install in right cylinder head (2).
11. Install water jacket cover gasket (5) and water jacket cover (4) on right cylinder head (2) and secure with two capscrews (3). Tighten capscrews (3) to 25-37 lb-ft (34-50 Nm).
12. Apply pipe sealing compound to engine temperature sending unit (6) and install in left cylinder head (2).
13. Install four precombustion chambers (7) in cylinder head (2) flush to +0.002 in. (0.050 mm).
14. Repeat step 13 for opposite cylinder head.



END OF TASK

0017 00-11/12 blank



---

**VALVE TRAIN REPAIR**

**0018**

---

**THIS WORK PACKAGE (WP) COVERS:**

Disassembly, Cleaning, Inspection, Assembly

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Materials/Parts**

Four retainers:

NSN 3040-01-212-7616; PN 23500076

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

---

**DISASSEMBLY**

**NOTE**

Tag rocker arms for assembly.

1. Remove four retainers (2) and rocker arms (3) from rocker shaft (1). Discard retainers (2).
2. Repeat step 1 for remaining rocker arm and shaft assemblies.

**CLEANING**

Clean all components in accordance with **WP 0007**.

**INSPECTION****NOTE**

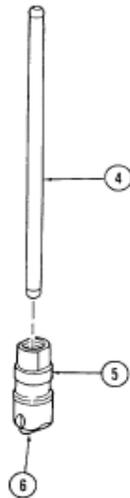
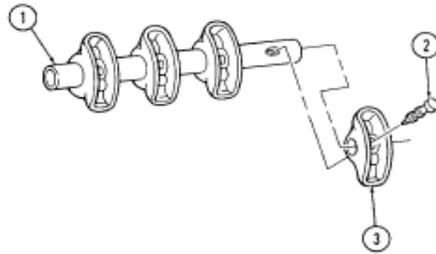
For general inspection instructions, refer to **WP 0007**.

1. Inspect rocker shaft (1) for damage. Replace if damaged.
2. Inspect rocker arms (3) for damage. Replace if damaged.
3. Inspect pushrods (4) for blocked oil passages and damage. Replace if damaged or oil passages are blocked.
4. Inspect lifters (5) for damage. Replace if damaged.
5. Inspect roller (6) on lifter (5) for scoring and binding. Replace lifter (5) if scored or binding.

**ASSEMBLY****NOTE**

For general assembly instructions, refer to **WP 0007**.

1. Install four rocker arms (3) on rocker shaft (1) with four retainers (2).
2. Repeat step 1 for remaining rocker arm and shaft assemblies.



END OF TASK



---

**TORSIONAL DAMPER REPAIR**

**0019**

---

**THIS WORK PACKAGE (WP) COVERS:**

Cleaning, Inspection

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive          NSN 5180-00-177-7033

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

---

**CLEANING**

Clean torsional damper (1) in accordance with **WP 0007**.

**INSPECTION**

**NOTE**

For general inspection instructions, refer to **WP 0007**.

1. Inspect capscrew holes (4) for thread damage. Replace torsional damper (1) if threads are damaged.
2. Inspect front cover seal mating surface (2) for damage. Replace torsional damper (1) if damaged.
3. Inspect rubber insulator (3) between inner ring and torsional damper housing for cracks or damage. Replace torsional damper (1) if cracked or damaged.

**END OF TASK**



---

**FLYWHEEL REPAIR**

**0020**

---

**THIS WORK PACKAGE (WP) COVERS:**

Cleaning, Inspection

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

---

**CLEANING**

Clean flywheel (1) in accordance with **WP 0007**.

**INSPECTION**

**NOTE**

For general inspection instructions, refer to **WP 0007**.

1. Inspect flywheel (1) for damaged teeth (2). Replace flywheel (1) if teeth (2) are damaged.
2. Inspect flywheel (1) for damage. Replace if damaged.

**END OF TASK**

0020 00-1/2 blank



---

**ROCKER ARM COVER REPAIR**

---

**0021**

---

**THIS WORKPACKAGE COVERS:**

Cleaning, Inspection

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive                      NSN 5180-00-177-7033

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

---

**CLEANING**

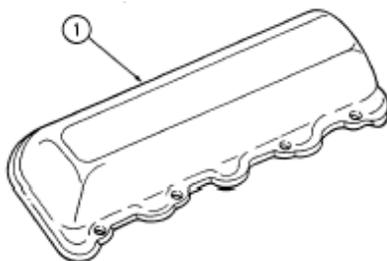
Clean rocker arm cover (1) in accordance with **WP 0007**.

**INSPECTION**

**NOTE**

For general inspection instructions, refer to **WP 0007**.

Inspect rocker arm cover (1) for cracks and sealing surface distortion. Replace if cracked, or sealing surface is distorted.



**END OF TASK**

0021 00-1/2 blank



---

**OIL PAN REPAIR**

**0022**

---

**THIS WORK PACKAGE COVERS:**

Cleaning, Inspection

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive                      NSN 5180-00-177-7033

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

---

**CLEANING**

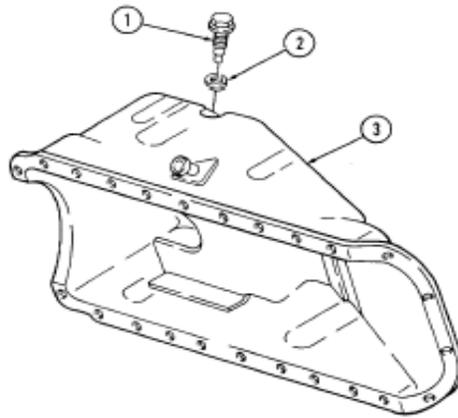
Clean oil pan (3) in accordance with **WP 0007**.

**INSPECTION**

**NOTE**

For general inspection instructions, refer to **WP 0007**.

1. Inspect oil pan (3) for cracks, damage, and sealing surface distortion. Replace if cracked, damaged, or sealing surface is distorted.
2. Inspect drainplug (1) for damage. Replace if damaged.
3. Inspect gasket (2) for damage. Replace if damaged.



END OF TASK

---

**OIL FILTER ADAPTER AND OIL PRESSURE SENDING UNIT REPAIR**

---

**0023****THIS WORK PACKAGE (WP) COVERS:**Cleaning, Inspection

---

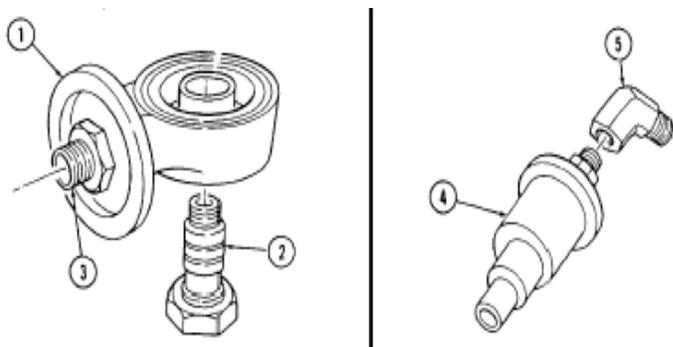
**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

**CLEANING**Clean all components in accordance with **WP 0007**.**INSPECTION****NOTE**For general inspection instructions, refer to **WP 0007**.**END OF TASK**

0023 00-1/2 blank



---

**EXHAUST MANIFOLD REPAIR**

---

**0024**

---

**THIS WORK PACKAGE (WP) COVERS:**Cleaning, Inspection

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

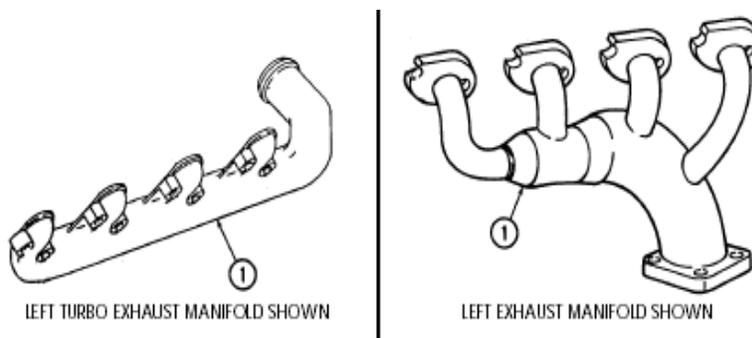
**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

---

**CLEANING**Clean all components in accordance with **WP 0007**.**INSPECTION****NOTE**For general inspection instructions, refer to **WP 0007**.

Inspect exhaust manifold (1) for damage. Replace if damaged.

**END OF TASK**



---

**INTAKE MANIFOLD REPAIR****0025**

---

**THIS WORK PACKAGE (WP) COVERS:**Cleaning, Inspection

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Materials/Parts**

Sealing compound:

NSN 8030-00-148-9833 – 10 CC Bottle

**Equipment Condition**Engine disassembled into subassemblies (WP 0011).

---

**CLEANING**

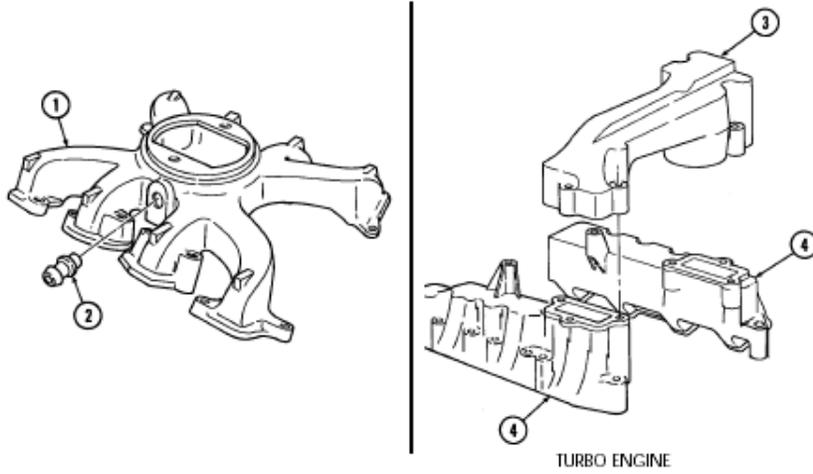
Clean intake manifold (1) or intake manifolds (4) and center manifold (3) in accordance with **WP 0007**.

**INSPECTION****NOTE**

- For general inspection instructions, refer to **WP 0007**.
- For turbocharged engines, perform step 1 only.

1. Inspect intake manifold (1) or intake manifolds (4) and center intake manifold (3) for damage. Replace if damaged.

2. Inspect nipple (2) for damage. If damaged, replace nipple (2) using sealing compound.



END OF TASK

---

**FUEL PUMP REPAIR**

**0026**

---

**THIS WORK PACKAGE (WP) COVERS:**

Cleaning, Inspection

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive                      NSN 5180-00-177-7033

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

---

**CLEANING**

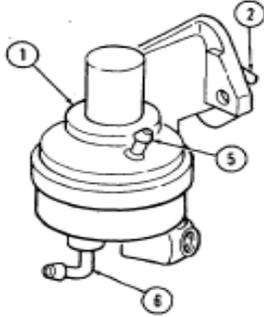
Clean intake manifold (1) or intake manifolds (4) and center manifold (3) in accordance with **WP 0007**.

**INSPECTION**

**NOTE**

For general inspection instructions, refer to **WP 0007**.

1. Inspect fuel pump (1) for damage. Replace if damaged.
2. Inspect fuel pump lever (2) for damage. Replace fuel pump (1) if damaged.
3. Inspect inlet tube (6) and vent tube (5) for damage. Replace fuel pump (1) if damaged.
4. Inspect adapter plate (3) for damage. Replace if damaged.
5. Inspect fuel pump push rod (4) for damage. Replace if damaged.



END OF TASK

---

**FUEL INJECTION PUMP REPAIR**

---

**0027**

---

**THIS WORK PACKAGE (WP) COVERS:**Disassembly, Cleaning, Inspection, Assembly

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive                      NSN 5180-00-177-7033

**Special Tools**

Hex head driver, 5/32-in.	NSN 5120-01-016-9202; PN J35171
Hex head driver, 1/8-in.	NSN 5120-00-596-8508; PN FA8A
Hex head driver, 5/16-in.	NSN 5120-00-683-8602; PN FA10B
Hex head driver, 1/4-in.	PN 67-6878
Torx drive	NSN 5120-01-078-1899; PN 22939
End cap wrench	NSN 5120-01-207-5563; PN 20548
Holding fixture	NSN 5120-01-208-7753; PN 23615
Governor weight support	NSN 5120-01-197-0236; PN 16313
Drive shaft bearing installer	NSN 5120-01-208-7771; PN 23805
Drive shaft seal installer	NSN 5120-01-208-7752; PN 22727
Roller-to-roller setting tool	NSN 5120-01-200-4526; PN 19969
Throttle and shutoff shaft bushing	NSN 5120-01-189-0448; PN 18411
Pilot tube mandrel	NSN 5120-01-208-1767; PN 16314
Delivery valve extractor	NSN 5120-00-816-7059; PN 26081

**Material/Parts**

Overhaul kit	NSN 2910-01-299-0473; PN 30405
Seven lockwashers	NSN 5310-01-213-9964; PN 11582
Two locknuts	NSN 5318-01-194-0481; PN 3029-01371-01
Adjusting plug	NSN 4930-00-459-6077; PN 15228
Valve stop	PN 26070
Cap	NSN 5340-01-415-9633; PN 26961
Calibrating fluid	NSN 4910-00-779-6851 – 5 Gal Drum
Seal lubricant	NSN n/a – (87460) 22204
Sealing compound	NSN 8030-00-148-9833 – 10 CC Bottle
Lacquer thinner	NSN 8010-00-160-5787 – 1 Gal Drum
or Acetone Technical	NSN 6810-00-223-2739 – 1 Pint Can

---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

**0027****Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

**General Safety Instructions**

- Wear eyeshields when using compressed air.
  - Do not allow solvents to get on skin or clothing.
  - Compressed air for cleaning purpose will not exceed 30 psi (207 kPa).
- 

**NOTE**

The fuel injection pump repair procedures for 1990 and above 6.5L engines are basically the same. Difference in procedures are noted. Refer to **WP 0005** to determine engine model before ordering replacement parts.

**NOTE**

- Before disassembly, fuel injection pump should be tested (**WP 0028, 0029** or **0030**, Injection Pump Check) on calibration stand to determine type of pump malfunction.
- Do not disassemble fuel injection pump if no malfunction is found after preliminary test.
- Work area should be clean, well-ventilated, and free from blowing dirt and dust.

**DISASSEMBLY****CAUTION**

Fuel pump body must be thoroughly cleaned before disconnecting any attaching components to prevent foreign particles from entering pump.

1. Clean exterior of fuel injection pump (9) in accordance with **WP 0007**.
2. Mount pump (9) in holding fixture and secure fixture in vise.
3. Remove three screws (2), lockwashers (3), and washers (4) from governor control cover (1). Discard lockwashers (3).

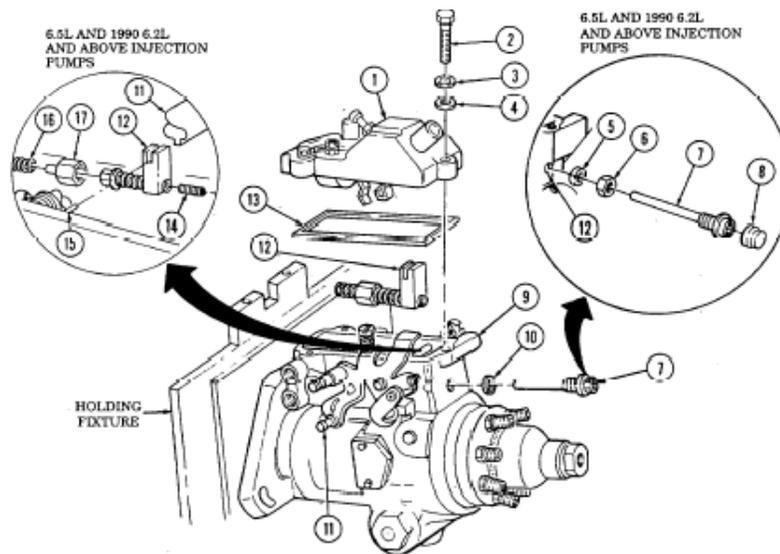
**NOTE**

If fuel is found in pump, discard fuel in an approved container.

4. Remove cover (1) and gasket (13). Discard gasket (13).
5. Remove cap (8) from guide stud (7). Using 1/4in. hex head driver, remove guide stud (7), seal (5), and nut (6) from min-max governor (12). Discard seal (5) and cap (8).
6. Turn throttle shaft (11) to low idle and remove idle spring (16).

**FUEL INJECTION PUMP REPAIR - CONTINUED****0027**

7. Turn throttle shaft (11) to wide open throttle, loosen sleeve (17) on min-max governor (12) and lift min-max governor (12) and inner governor spring (14) out of pump (9) and disengage min-max governor (12) from governor thrust spring (15).

**NOTE**

The 6.5L injection pumps are equipped with a TP sensor instead of a kick-down switch. There are four capscrews securing the TP sensor to the housing.

8. Remove two capscrews (12) and transmission kick-down switch (9) or TP sensor (23) from housing (4).

9. Remove cam pin (10) and cam (11) from throttle shaft (1).

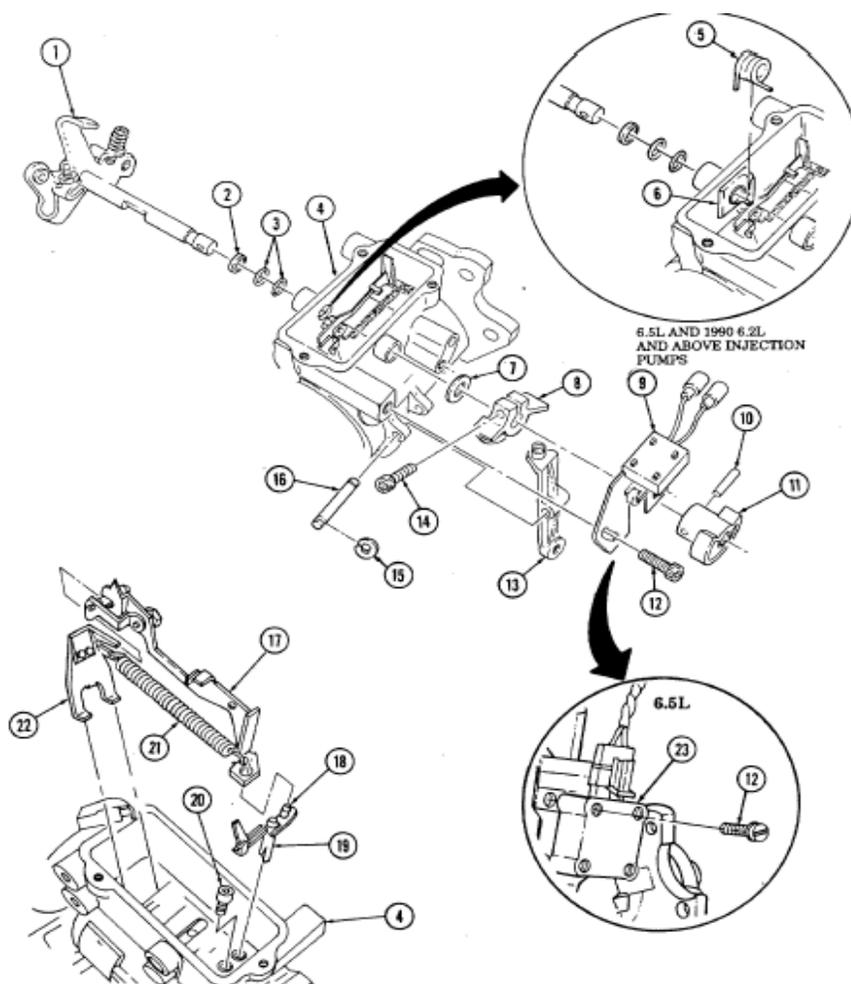
---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

**0027**

10. Remove two retaining clips (15) from rocker lever pin (16). Discard clips (15).
11. Remove rocker lever pin (16) and rocker lever (13) from housing (4).
12. Using Torx drive, remove screw (14) from face cam (8) and remove face cam (8) and washer (7) from throttle shaft (1).
13. Turn throttle shaft (1) to low idle and release the governor thrust spring (5) from housing boss (6).
14. Remove throttle shaft (1) and governor thrust spring (5) from housing (4), and remove two O-rings (3) and spacer (2) from throttle shaft (1). Discard O-rings (3).
15. Hold metering valve (19) and raise governor linkage hook (17) from valve arm pin (18).
16. Hold governor arm (22) forward and pull linkage hook (17) back and detach from governor arm (22).
17. Remove linkage hook (17), governor arm (22), and spring (21) from housing (4).
18. Remove spring (21) from linkage hook (17) and governor arm (22).
19. Remove metering valve (19) from housing (4).
20. Using 1/8-in. hex head driver, remove vent wire socket head screw (20) from housing (4).



21. Using 5/32-in. hex head driver, remove transfer pump end cap socket-head locking screw (5), plate (4), rubber washer (2), and flat washer (3) from hydraulic head (20). Discard washer (2).

22. Remove inlet tube assembly (8) from fuel pump end cap (9).

23. Using end cap wrench, remove fuel pump end cap (9) from hydraulic head (20).

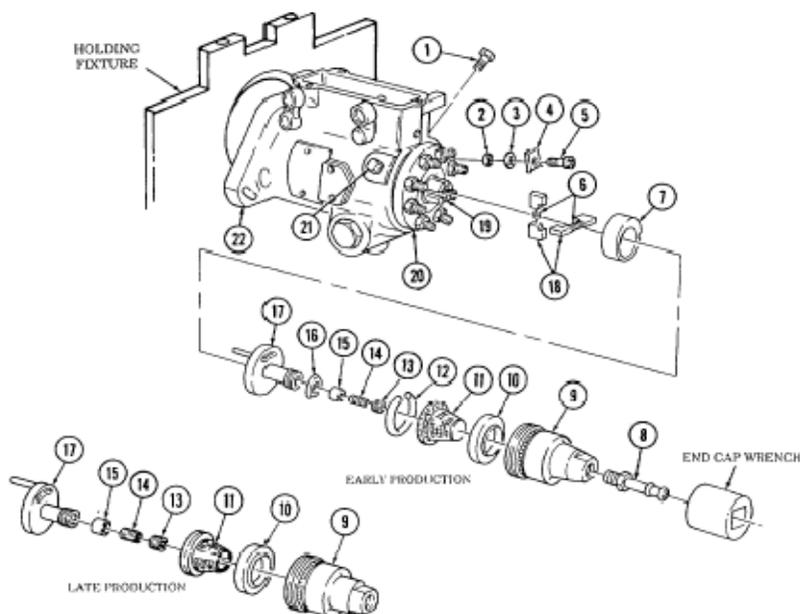
24. Remove regulator (17) from fuel pump end cap (9).

25. Remove inlet filter screen (11) and pressure plate (10) from regulator (17).

**NOTE**

Early production injection pumps have an inlet filter screen, retaining ring, and seal. Late production pumps have a different configuration screen which does not require a retaining ring and seal. When repairing early production pumps replace the screen with a late production one.

26. Remove retaining ring (12) and screen (11) from pressure plate (10).
27. Remove inlet filter screen seal (16), end plate adjusting plug (13), spring (14), and piston (15) from regulator (17). Discard adjusting plug (13) and seal (16). Tag spring (14) for assembly.
28. Remove transfer pump liner (7), four blades (18), and two springs (6).
29. Remove head-locking capscrews (1) and (21) from housing (22).



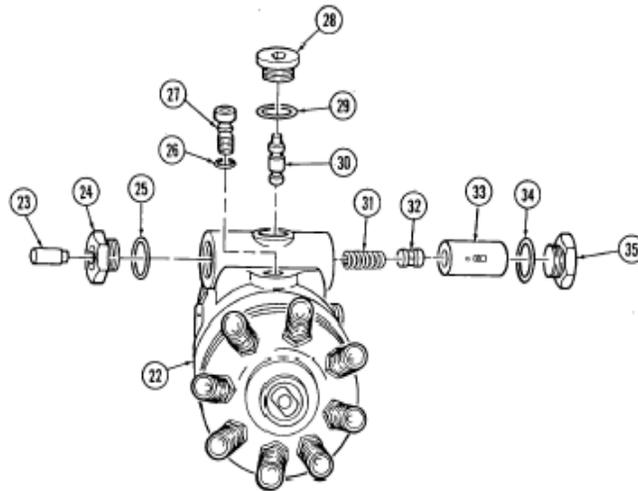
---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

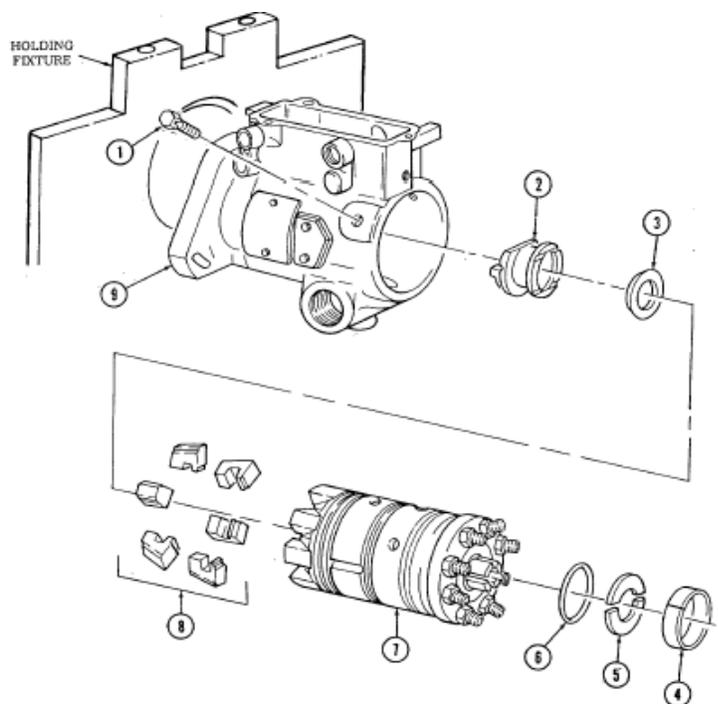
**0027**

30. Rotate housing (22) and holding fixture in vise so advance plug (28) faces upward.
31. Using 5/16-in. hex head driver, remove head locating screw (27) and O-ring (26). Discard O-ring (26).
32. Remove spring side plug assembly (24) and O-ring (25) from housing (22). Discard O-ring (25).
33. Remove servo advance plunger (23) from spring side plug (24).
34. Using 1/4-in. hex head driver, remove advance plug (28), cam advance pin (30), and O-ring (29) from housing (22). Discard O-ring (29).
35. Remove power side advance piston hole plug (35) and O-ring (34). Discard O-ring (34).
36. Remove servo advance piston assembly (33) from housing (22). Tap piston assembly (33) to remove spring (31) and valve (32). Tag spring (31) for assembly.



37. Rotate housing (9) and holding fixture right side up.
38. Remove head locking capscrew (1).
39. Remove hydraulic head assembly (7) from housing (9).
40. Remove six weights (8), washer (3), and governor thrust sleeve (2) from hydraulic head (7).
41. Remove liner locating ring (4) and two rotor retainers (5) from hydraulic head (7).

42. Remove transfer pump end cap seal (6) from hydraulic head (7). Discard seal (6).

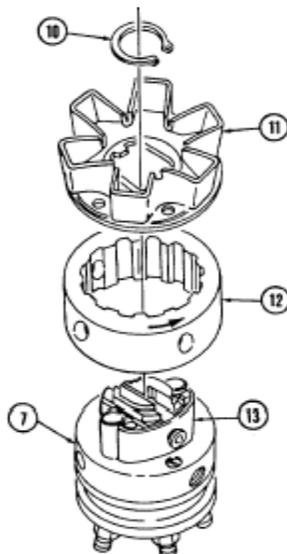


43. Remove snapping (10) and weight retainer (11) from rotor (13).

#### NOTE

Note direction of arrow on cam ring indicating rotation of pump for assembly.

44. Remove cam ring (12) from hydraulic head (7).



45. Remove two cam roller shoes (2) and two cam rollers (1) from rotor (4).
46. Remove leaf spring adjusting screw (7) and leaf spring (6) from rotor (4).
47. Remove two plungers (3) from rotor (4).
48. Install governor weight support in vise.

**CAUTION**

- Do not handle precision ground surface of rotor to avoid contamination.
- Handle all parts carefully with clean hands wet with calibrating fluid to avoid contamination.

49. Remove rotor (4) from hydraulic head (5) and place rotor (4) in governor weight support. Using 5/32-in. hex head driver, remove delivery valve stop plug (12).

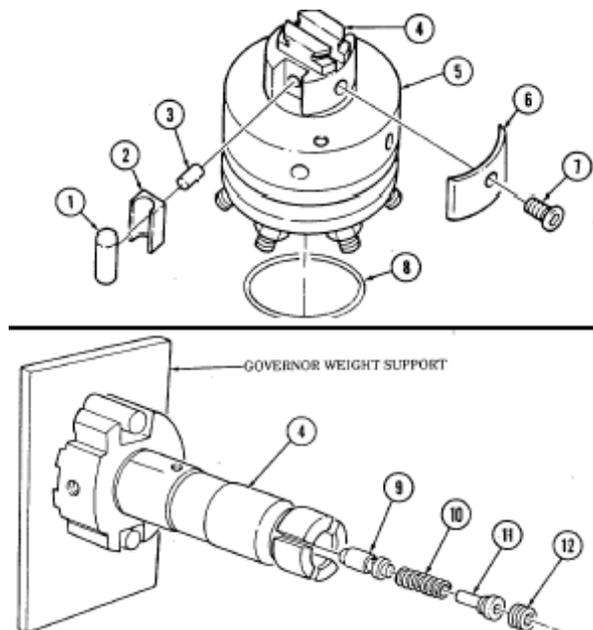
**FUEL INJECTION PUMP REPAIR - CONTINUED****0027**

50. Remove head seal (8) from hydraulic head (5). Discard head seal (2).

**NOTE**

If delivery valve cannot be removed from rotor, delivery valve extractor must be used.

51. Remove valve stop (11), spring (10), and delivery valve (9) from rotor (4). Discard valve stop (11) and tag spring (10) for assembly.



52. Remove drive shaft snapping (18) and drive shaft (15) from housing (17).

53. Remove two black seals (22) and red seal (16) from drive shaft (15). Discard seals (22) and (16).

54. Remove thrust button (13) and spring (14) from drive shaft (15) and tag spring (14) for assembly.

55. Remove two screws (20), timing cover (21), and gasket (19) from housing (17). Discard gasket (19).

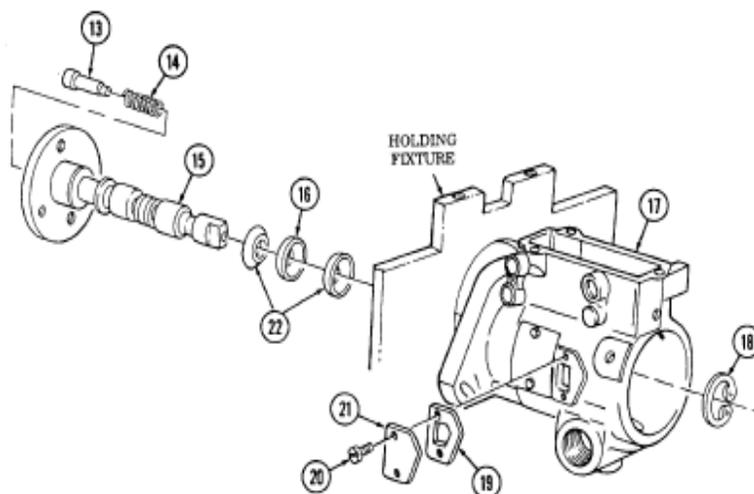
---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

**0027**

56. Remove housing (17) from holding fixture.



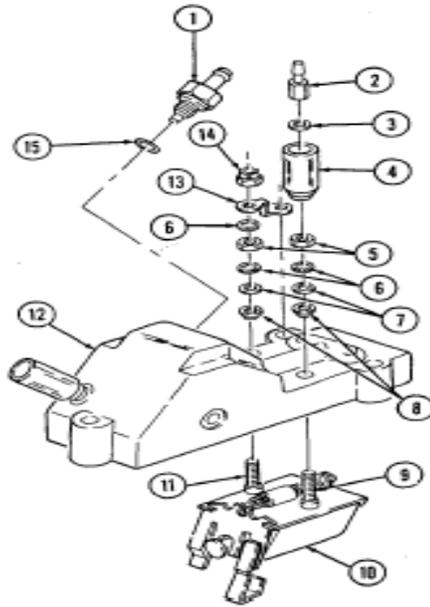
57. Remove terminal (2), washer (3), and shell (4) from stud (9).

58. Remove nut (5), lockwasher (6), washer (7), and fiber washer (8) from stud (9). Discard lockwasher (6).

59. Remove locknut (14), ground strap (13), lockwasher (6), nut (5), lockwasher (6), washer (7), and fiber washer (8) from stud (11). Discard locknut (14) and lockwashers (6).

60. Remove electrical shutoff solenoid (10) from cover (12).

61. Remove check valve (1) and O-ring (15) from cover (12). Discard O-ring (15).



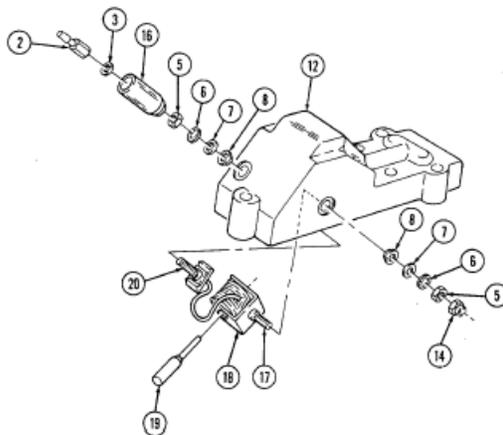
62. Remove terminal (2), washer (3), and shell (16) from stud (20).

63. Remove nut (5), lockwasher (6), washer (7), and fiber washer (8) from stud (20). Discard lockwasher (6).

64. Remove locknut (14), nut (5), lockwasher (6), washer (7), and fiber washer (8) from stud (17). Discard lockwasher (6) and locknut (14).

65. Remove cold advance solenoid (18) and plunger (19) from cover (12).

66. Remove plunger (19) from cold advance solenoid (18).



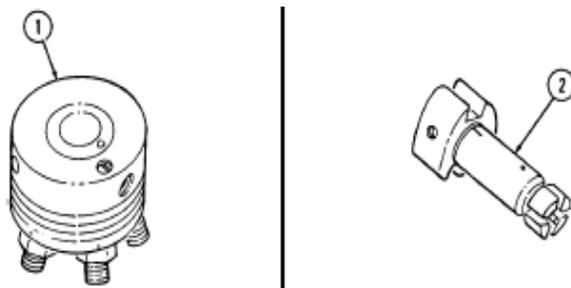
## CLEANING

### CAUTION

- Do not handle precision ground surface of rotor to avoid contamination.
- Handle all parts carefully with clean hands wet with calibrating fluid to avoid contamination.
- Do not immerse hydraulic head in solvent or sealant damage may result.

1. Clean all fuel injection pump components in accordance with instructions in **WP 0007**.

2. Rinse hydraulic head (1) and rotor (2) in calibrating fluid.

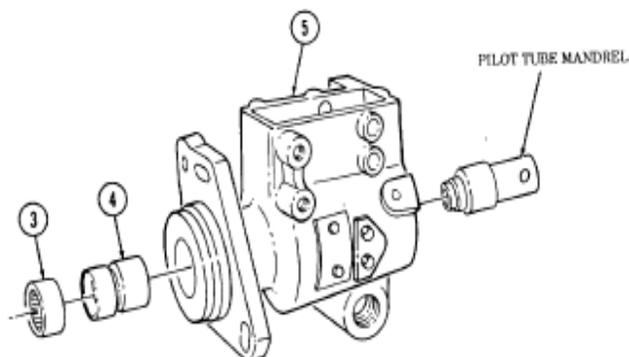


## INSPECTION

### NOTE

For general inspection instructions, refer to **WP 0007**.

1. Inspect housing (5) for damage. Replace injection pump if damaged.
2. Inspect pilot tube (4) in housing (5) for scoring or damage. If scored or damaged, perform steps 3 through 7, if not, go to step 8.
3. Remove pilot tube (4) and drive shaft bearing (3) from housing (5) using pilot tube mandrel. Discard pilot tube (4).
4. Inspect drive shaft bearing (3) for roughness or damage. Discard if rough or damaged.



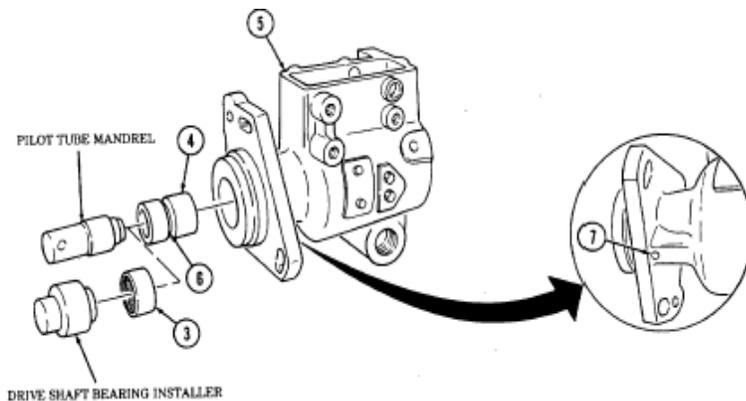
---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

**0027**

5. Apply sealing compound to outside diameter of pilot tube (4).
6. Using pilot tube mandrel, install pilot tube (4) in housing (5) until groove (6) in pilot tube (4) aligns with vent hole (7) in housing (5).
7. Using drive shaft bearing installer, install drive shaft bearing (3) in housing (5). Go to step 11.
8. Inspect drive shaft bearing (3) for roughness or damage. If rough or damaged, perform steps 9 and 10. If not, go to step 11.
9. Remove drive shaft bearing (3) from housing (5) and discard bearing (3).
10. Using drive shaft bearing installer, install driveshaft bearing (3) in housing (5).

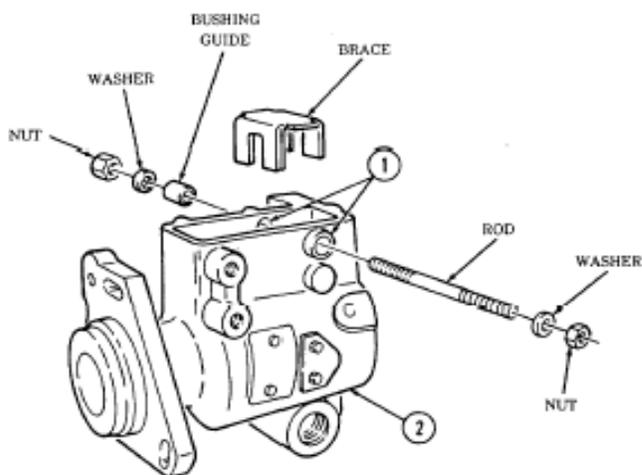


11. Inspect throttle shaft bushings (1) for damage. If damaged, perform steps 12 through 20 using throttle and shutoff shaft bushing installation kit. If not, go to step 21.
12. Install brace into housing (2) to prevent distortion of housing (2) during bushing (1) removal.
13. Install rod through bushings (1).
14. Install bushing guide, two washers, and nuts.
15. Tighten nuts until bushing (1) is removed from housing (2). Remove tools and discard bushing (1).

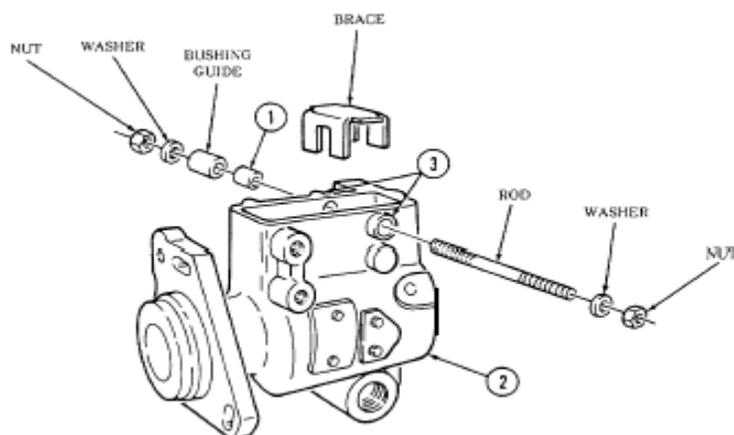
---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

**0027**

16. Install brace and rod into housing (2).
17. Apply sealing compound to outside diameter of bushing (1).
18. Install bushing (1), bushing guide, two washers, and nuts on rod.
19. Tighten nuts housing (2).
20. Repeat steps until bushing (1) is past flush with bushing boss (3) on housing (2). Remove tools from 12 through 19 for opposite bushing, if required.



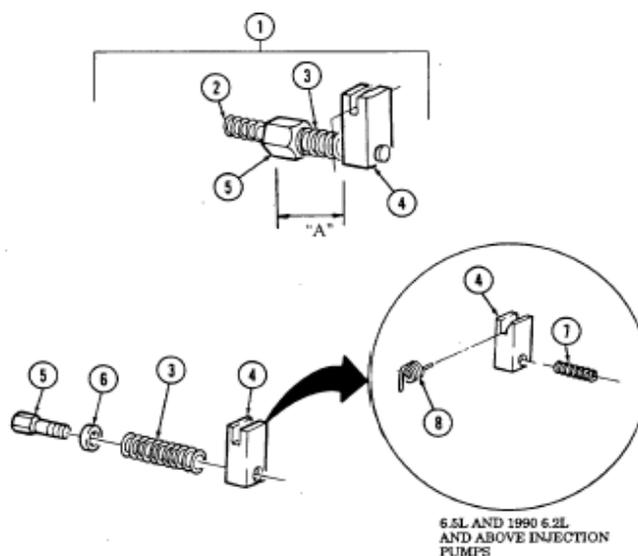
---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

**0027**

21. Inspect idle spring (2) on min-max governor (1) for corrosion or damage, Replace if corroded or damaged.
22. Inspect inner governor spring (7) for corrosion or damage. Replace if corroded or damaged.
23. Inspect governor thrust spring (8) for corrosion or damage. Replace if corroded or damaged.
24. Inspect min-max spring (3) for corrosion or damage. If corroded or damaged, perform steps 25 through 29. If not, go to step 30.
25. Remove idle spring (2) from pushrod (5).
26. Measure distance "A" from throttle block (4) to end of pushrod (5) for assembly.
27. Put throttle block (4) in vise and remove pushrod (5), spring (3), and washer (6). Discard spring (3).
28. Install washer (6) and spring (3) on pushrod (5) and install into throttle block (4).
29. Tighten pushrod (5) until measurement taken in step 26 is obtained.

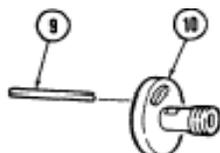


30. Inspect regulator (10) for damage. Replace if damaged.

**NOTE**

When removing roll pin, note which hole from where pin is removed, It is marked "C" or "CC".

31. Inspect roll pin (9) in regulator (10) for damage. Replace if damaged.



32. Inspect arm spring (11) for damage. Replace if damaged.

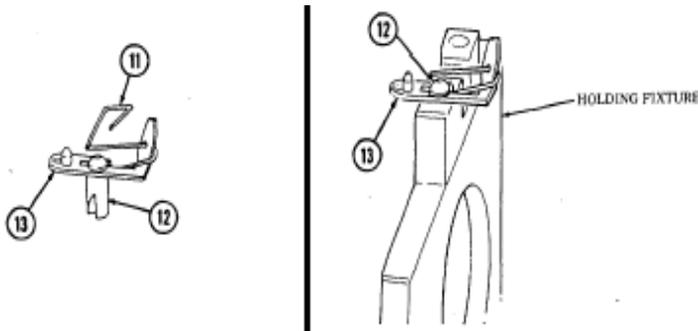
### **CAUTION**

Metering valves are available in standard and oversize. If replacing metering valve, check for number "SB-336" on top of hydraulic head. If number is present, oversize metering valve must be used or injection pump may malfunction.

33. Inspect metering valve (12) and arm (13) for damage. If damaged, perform steps 34 and 35. If not, go to step 36.

34. Place valve (12) in holding fixture hole and remove arm (13) from valve (12).

35. Install arm (13) on valve (12).



36. Using a micrometer, measure drive shaft (2) at point "A" to determine wear. Inspect drive shaft (2) seal area for nicks, burrs, scratches, or damage. Replace drive shaft (2) if measurement at point "A" is less than 0.305 in. (7.75 mm) or if any nicks, burrs, scratches, or damage is present.

37. Inspect dowel pin (1) in drive shaft (2) for damage. If damaged, replace dowel pin (1). Apply sealing compound to replacement dowel pin (1).

**CAUTION**

Hydraulic head and rotor are matched sets and must be replaced as an assembly or injection pump damage may result.

38. Inspect fittings (4) in hydraulic head (3) for damage. Replace hydraulic head (3) and rotor (13) if any fittings (4) are damaged.

**CAUTION**

Do not handle precision ground surface of rotor to prevent contamination.

39. Inspect hydraulic head (3) and rotor (13) for damage. Replace both if either is damaged.

40. Inspect charging ports (11) and discharge port (12) on rotor (13) for chipped edges. Replace hydraulic head (3) and rotor (13) if any chipped edges are apparent.

41. Inspect rotor (13) for scratches. Replace hydraulic head (3) and rotor (13) if scratches are present.

**WARNING**

Do not allow solvents to get on skin or clothing. Solvents can burn easily and give off harmful vapors. Keep away from open fire and use in a well-ventilated area. If solvent gets on skin or clothing, wash immediately. Failure to follow these instructions could cause injury or death.

**NOTE**

It maybe necessary to interchange or reverse plunger position when installing plungers into rotor.

---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

**0027**

42. While holding rotor (13) under clean calibrating fluid, insert plungers (10) into bores of rotor (13). With thumb and forefinger over roller shoe (9) slots, tilt from side to side to determine freedom of movement. If the plungers (10) are sticking, but not visibly damaged, clean both plungers (10) and bore with a soft brush and lacquer thinner or acetone. Check freedom of movement again. If plungers (10) still stick, replace them with the next smaller size ("A" is the largest, "D" is the smallest). If the smallest plungers (10) stick in rotor (13), replace hydraulic head (3) and rotor (13).
43. Inspect leaf spring contact area (14) and tang slot (7) on rotor (13) for excessive wear. Replace hydraulic head (3) and rotor (13) if leaf spring contact area (14) or tang slot (7) are excessively worn.
44. Inspect cam rollers (8) for freedom of rotation in their roller shoes (9). Inspect cam rollers (8) and roller shoes (9) for abrasive wear patterns. Replace cam rollers (8) and roller shoes (9) if cam rollers (8) do not rotate freely or if either shows signs of abrasive wear patterns.
45. Inspect top edge of each roller shoe (9) for chipping or excessive wear. Replace cam rollers (8) and roller shoes (9) if chipped or excessively worn.
46. Inspect leaf spring (6) for excessive wear. Replace leaf spring (6) if excessively worn.
47. Inspect leaf spring screw (5) for tightness in rotor (13). Replace leaf spring screw (5) if screw (5) does not thread tightly into rotor (13).

**NOTE**

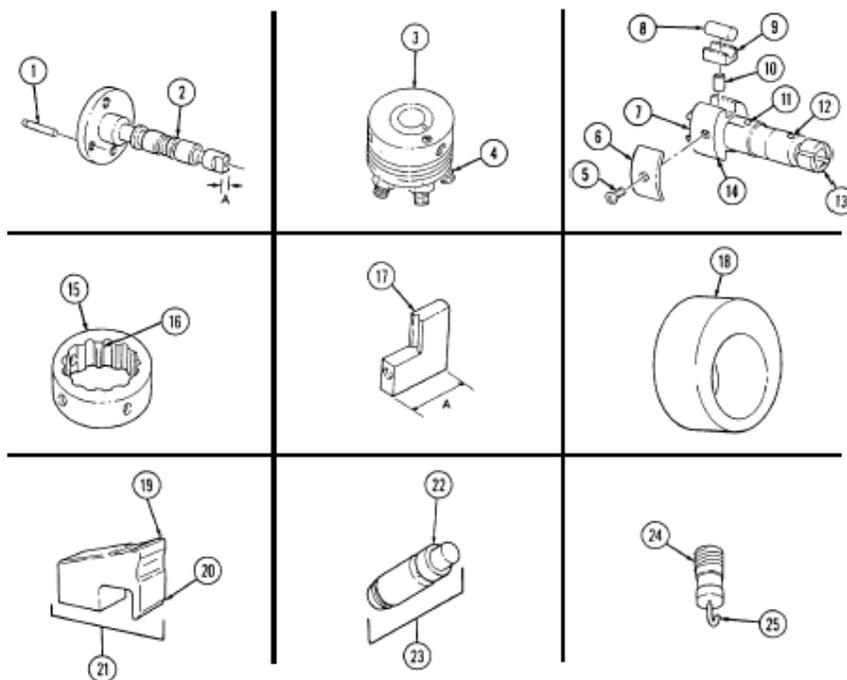
Machining marks between cam lobes should not be considered damage.

48. Inspect cam lobes (16) on cam ring (15) for spalling or flaking out. Replace cam lobes (16) if spalled or flaked. Replace cam ring (15) if cam ring (15) is damaged.
49. Inspect all transfer pump blades (17) and transfer pump liner (18) for scoring or damage. Replace all transfer pump blades (17) and transfer pump liner (18) if any are scored or damaged.
50. Using a micrometer, measure transfer pump blades (17) at point "A" to determine wear. If any transfer blade (17) is smaller than 0.538 in. (13.67 mm), replace all transfer pump blades (17) and transfer pump liner (18).
51. Inspect governor weights (21) for excessive wear at heel (19) and toe (20). Replace governor weights (21) if excessively worn.

**FUEL INJECTION PUMP REPAIR - CONTINUED****0027**

52. Inspect delivery valve reaction cuff (22) for chipping or erosion. Replace delivery valve (23) if reaction cuff (22) is chipped or eroded.

53. Inspect vent wire (25) in vent wire screw (24) for freedom of movement. If vent wire (25) is stuck, replace vent wire screw (24).



54. Inspect throttle shaft (3) for distortion or damage. Replace if distorted or damaged.

**NOTE**

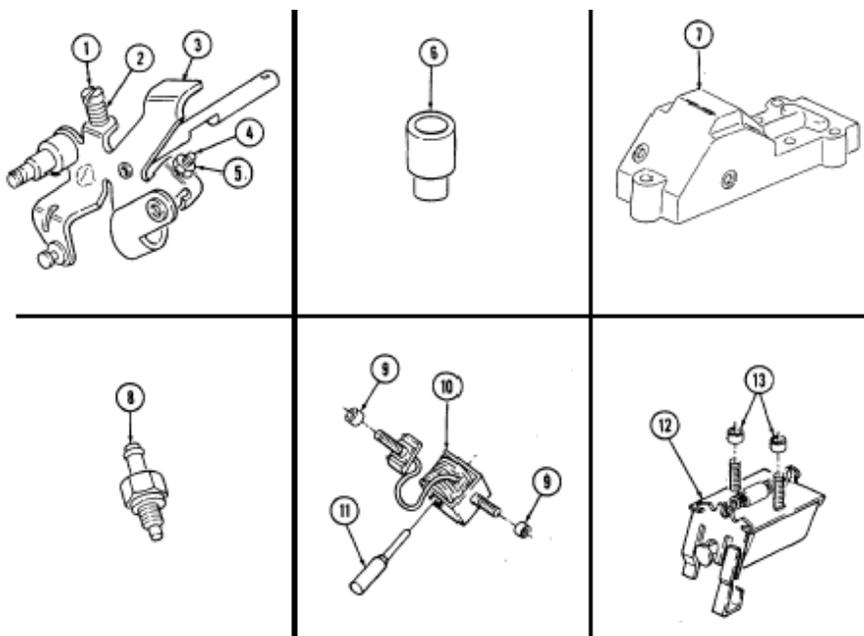
Perform step 55 only if throttle shaft was replaced.

55. Install low idle screw (1), spring (2), max travel screw (4), and nut (5) in throttle shaft (3).

56. Inspect rubber connectors (6) for deterioration, cracks, or damage. Replace if cracked, deteriorated, or damaged.

**FUEL INJECTION PUMP REPAIR - CONTINUED****0027**

57. Inspect pump cover (7) for damage. Replace if damaged.
58. Inspect check valve (8) for damage. Replace if damaged.
59. Inspect cold start advance solenoid (10) for damage. Replace if damaged.
60. Inspect insulators (9) and plunger (11) for damage, Replace if damaged,
61. Inspect insulators (13) and electrical shutoff solenoid (12) for damage. Replace if damaged.
62. Refer to WP 0007 for general inspection instructions for all other injection pump parts.



**ASSEMBLY****CAUTION**

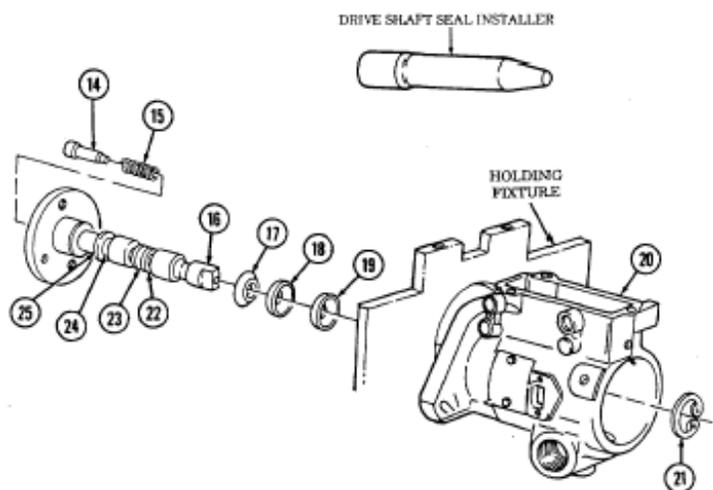
Handle all parts carefully with clean hands wet with calibrating fluid to avoid contamination.

1. Mount injection pump housing (20) in holding fixture and secure with vise.
2. Lubricate seals (17), (18), and (19) with seal lubricant and install black seal (17) in groove (25), red seal (18) in groove (24) and black seal (19) in groove (23) using drive shaft seal installer.
3. Install thrust button spring (15) and thrust button (14) in drive shaft assembly (16).

**NOTE**

Note position of timing mark on end of drive shaft tang when installing drive shaft assembly. This is necessary to align rotor to drive shaft.

4. Install drive shaft assembly (16) in housing (20).
5. Install snapping (21) in groove (22) on drive shaft assembly (16).



### **CAUTION**

- Do not handle precision ground surface of rotor to avoid contamination.
- Handle all parts carefully with clean hands wet with calibrating fluid to avoid contamination.

6. Mount governor weight support in vise and rinse rotor (1) in calibrating fluid and install in support.

### **NOTE**

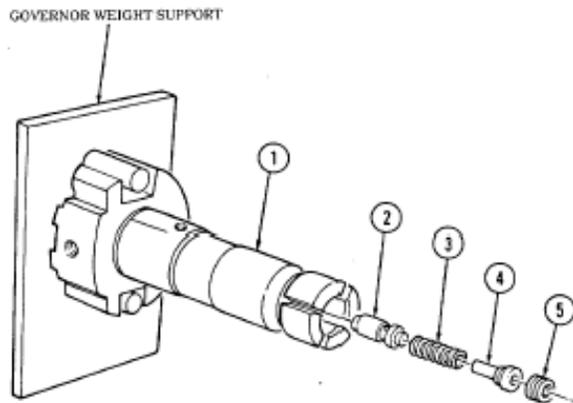
- Delivery valves are available in standard and oversize. If replacing delivery valve, check for marking "OS" on side of rotor. If "OS" marking is present, oversize delivery valve must be used.
- Oversize delivery valves have a black marking at the base of delivery valve.

7. Install delivery valve (2) in rotor (1).
8. Install valve spring (3) and valve stop (4) in rotor (1).

**CAUTION**

Excessive tightening of stop plug will cause seizure of hydraulic head and rotor.

9. Using 5/32-in. hex head driver, install stop plug (5) in rotor (1) and tighten to 85-90 lb-in. (10 N•m).



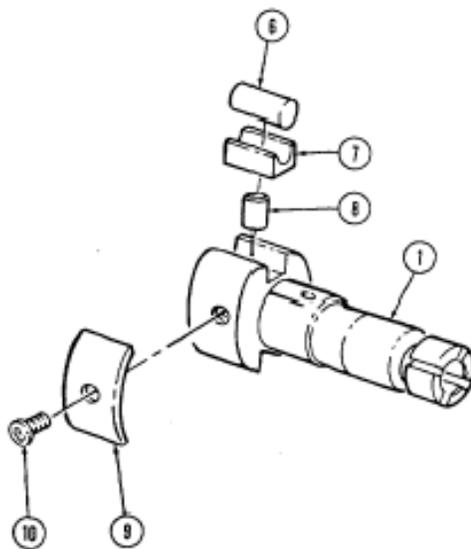
10. Install leaf spring (9) and adjusting screw (10) on rotor (1).
11. Remove rotor (1) from governor weight support and submerge in calibrating fluid.

**NOTE**

- Plungers of any given nominal diameter are graded in four select fit sizes: A, B, C, and D. The rotor is etched with the letter indicating bore size. This mark is found on the base of the rotor.
- If plunger replacement is required, check the size designation on the rotor and use the plunger of corresponding part number as indicated by letter designation on rotor.

12. Install two plungers (8) in rotor (1).

13. Assemble two cam roller shoes (7), and cam rollers (6), and install in rotor (1).



14. Install roller-to-roller setting tool in soft-jaw vise.

15. Install roller (1) in roller-broiler setting tool.

**WARNING**

Always wear eyeshields when using compressed air. Failure to wear eyeshields may result in eye injury.

16. Apply compressed air regulated to 40-100 psi (276-689 kPa) to roller-broiler setting tool.

**NOTE**

Increase roller-to-roller dimension 0.006 in. (0.152 mm) if using oversize cam ring.

17. Measure roller-to-roller dimension and compare to pump specification 1.981 in. (50.31 mm).

**NOTE**

Roller-to-roller dimension is a completely accurate maximum fuel adjustment and should not differ from pump specification.

18. Turn leaf spring adjusting screw (2) clockwise to increase or counterclockwise to decrease roller to roller dimension.

19. Rotate rotor (1) until one cam roller (3) aligns with roller-to-roller setting tool dial indicator plunger.

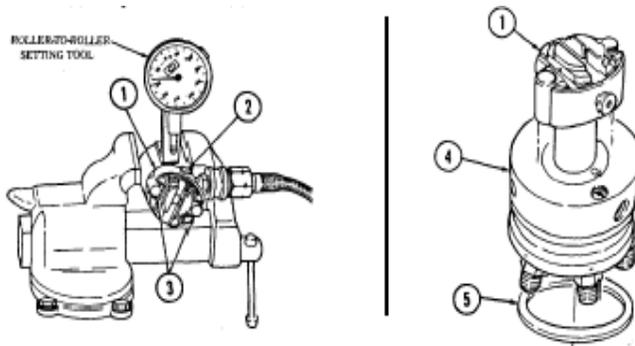
20. Loosen indicator dial retaining screw and set preload by sliding indicator down until plunger depresses on cam roller (3) 0.015 in. (0.381 mm). Tighten screw.

21. Rotate dial on indicator to "zero" indicator on high point of cam roller (3).

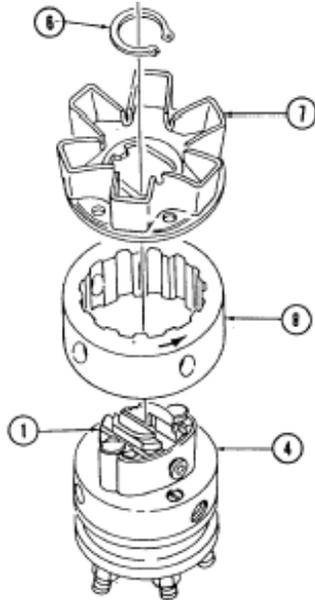
**NOTE**

If cam roller centrality is greater than 0.008 in. (0.203 mm), cam shoes can be interchanged or replaced to achieve tolerance. Centrality must be rechecked after each time components are changed.

22. Measure cam roller centrality by rotating rotor (1) in either direction until high point of other cam roller (3) depressed dial indicator plunger. Indicator reading should be 0.000 in. to 0.008 in. (0.000 to 0.203 mm).
23. Rinse hydraulic head (4) with calibrating fluid.
24. Remove rotor (1) from roller-to-roller setting tool and rinse with calibrating fluid.
25. Install rotor (1) in hydraulic head (4).



26. Install head seal (5) on rotor (4).
27. Install cam ring (8) on hydraulic head (4) with directional arrow on ring showing counterclockwise rotation of pump rotor (1).
28. Install weight retainer (7) on rotor (1), align with check ball, and secure with snapping (6).



29. Install transfer pump end cap seal (2) in hydraulic head (1).

**CAUTION**

Use care when handling rotor weight retainer and hydraulic head before retainers are installed. Rotor can fall out and cause damage to components.

30. Install two rotor retainers (3) with cut out portions meeting over roll pin hole in hydraulic head (1).

31. Install liner locating ring (4) on hydraulic head (1) with split 90° from roll pin hole.

32. Install transfer pump liner (5) so slot aligns with roll pin hole in hydraulic head (1).

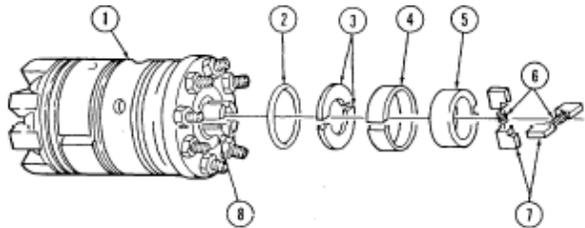
**CAUTION**

Blades must not be cocked during installation. Sharp edge of liner can score blade ends.

**NOTE**

- Transfer pump blades are available in standard and oversize. Oversize blades are marked in black and must be used whenever possible.
- Oversize and standard transfer pump blades do not have to be used as matched sets.

33. Install two springs (6) in four transfer pump blades (7) and install transfer pump blades (7) in rotor (8).

**CAUTION**

Adjusting plug must not be installed past flush with end of regulator or pump damage will result.

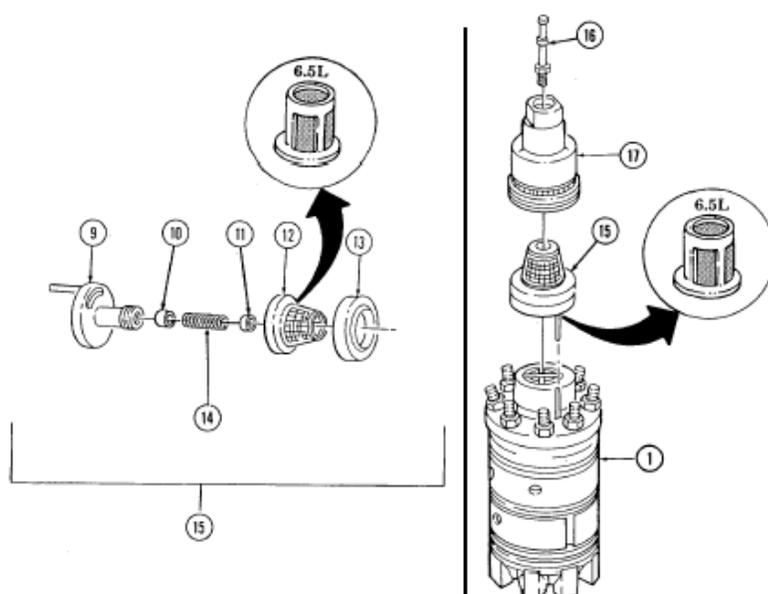
34. Install piston (10), spring (14), and adjusting plug (11) in regulator (9). Tighten adjusting plug (11) until flush with end of regulator (9).
35. Install filter screen (12) in pressure plate (13).
36. Install pressure plate (13) and filter screen (12) on regulator (9).
37. Lightly coat beveled surface of pressure plate (13) and threads of transfer end cap (17) with seal lubricant.

**FUEL INJECTION PUMP REPAIR - CONTINUED****0027**

38. Install pressure plate assembly (15) and end cap (17) on hydraulic head (1). Apply slight pressure on top of end cap (17) and rotate counterclockwise until a slight click is heard.

39. Turn end cap (17) clockwise until snug.

40. Install inlet tube assembly (16) on end cap (17).

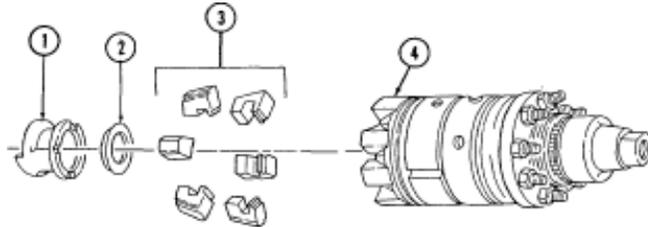


41. Install six governor weights (3) in weight retainer (4).

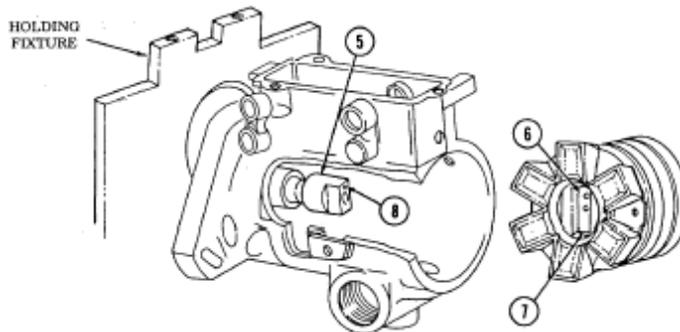
**NOTE**

Governor weights must work freely after installation.

42. Install thrust washer (2) and thrust sleeve (1) into lower slots of governor weights (3).



43. Align timing mark (11) on drive shaft (5) and timing mark (6) on rotor (7).



44. Apply light coat of seal lubricant to inside edge of housing (12).

45. Rotate cam ring (9) so index mark (11) is aligned with timing cover access hole (13).

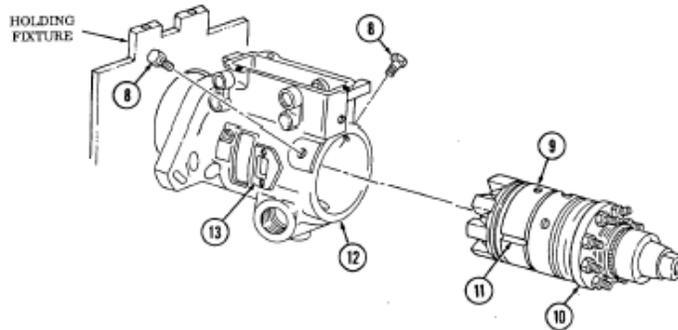
### **CAUTION**

Hydraulic head must only be installed far enough to install head locking screws, or leakage and damage to hydraulic head O-ring seal will result.

46. Install hydraulic head (10) in housing (12) with slight rotary motion.

47. Rotate head (10) and align head locking capscrew holes with holes in housing (12).

48. Install two head locking capscrews (8) finger tight.



49. Rotate housing (11) and holding fixture in vise so advance plug (8) faces up.

50. Install O-ring (6) on head locating screw (7).

51. Lightly coat head locating screw (7) with seal lubricant and install in housing (11). Tighten screw (7) to 180-220 lb-in. (20-25 N•m) using 5/16-in. hex head driver.

52. Install servo advance piston (14) in housing (11) with notch and two small holes facing head locating screw (7).

53. Install O-ring (13) and power side advance piston hole plug (12) in housing (11). Tighten plug (12) to 215-265 lb-in. (24-30 N•m).

#### **NOTE**

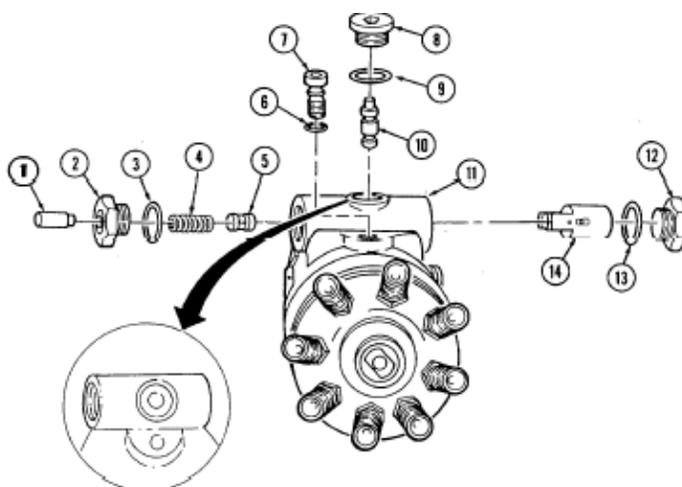
Rotate cam ring to align hole for cam advance pin in housing.

54. Install cam advance pin (10).

55. Install O-ring (9) and advance plug (8) in housing (11). Tighten advance plug (8) with 1/4-in. hex head driver to 75-100 lb-in. (9-11 N•m).

**FUEL INJECTION PUMP REPAIR - CONTINUED****0027**

56. Install servo advance valve (5) on spring (4) and install servo advance valve (5) in servo advance piston (14).
57. Install servo advance plunger (1) and O-ring (3) on spring side plug (2).
58. Install spring side plug assembly (2) in housing (11) so servo advance plunger (1) fits in spring (4). Tighten spring side plug assembly (2) to 215-265 lb-in. (24-30 N•m).



59. Rotate housing (11) and holding fixture 180°

**NOTE**

The vent wire screw is available in different sizes (identification numbers are etched on each) to adjust return oil flow. If original screw is to be replaced, use the same size. The final determination will be made during calibration.

60. Install vent wire screw (18). Tighten to 25-30 lb-in. (3 N•m) with 1/8-in. hex head driver.
61. Install metering valve assembly (17) in housing (11).
62. Connect linkage hook (15) to governor arm (20).

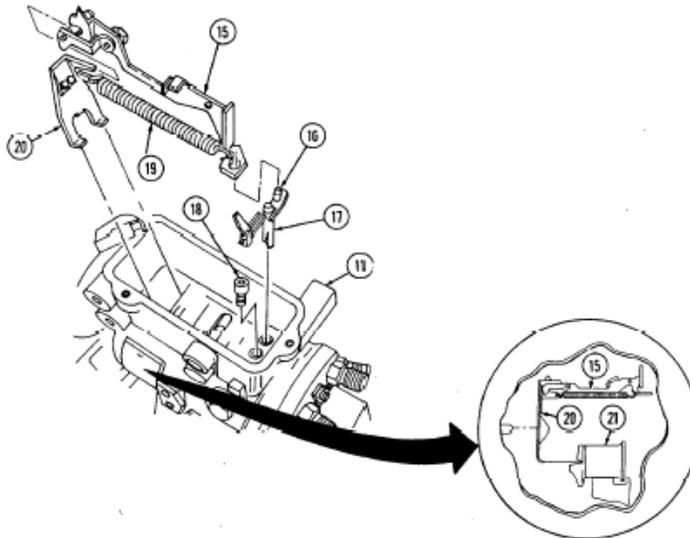
63. Install spring (19) on governor arm (20) and linkage hook (15).

**CAUTION**

Governor arm must be installed correctly or injection pump will malfunction.

64. Install governor arm (20) in housing (11) so that feet on governor arm (20) fit in slots in thrust sleeve (21).

65. Install linkage hook (15) on valve arm pin (16).



---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

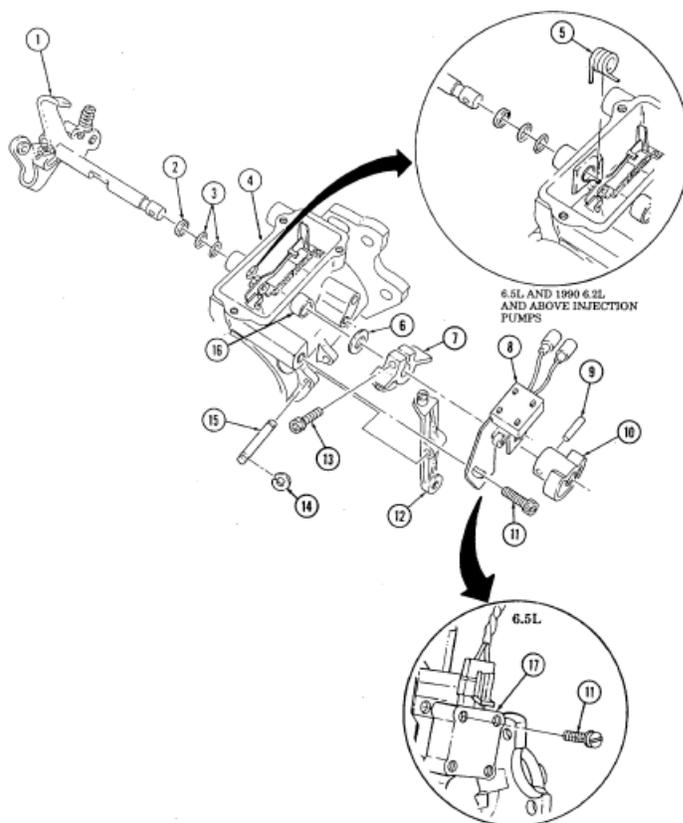
**0027**

66. Install spacer (2) and two O-rings (3) on throttle shaft (1). Position governor thrust spring (5) inside housing (4) and insert throttle shaft (1) through housing (4) and thrust spring (5).
67. Install mylar washer (6) and face cam (7) on throttle shaft (1) with screw (13). Finger tighten screw (13).
68. Install rocker lever (12) on housing (4) with rocker lever pin (15) and two retaining clips (14).
69. Put 0.005-in. (0.127 mm) feeler gauge between throttle shaft mylar washer (6) and housing boss (16).
70. Put throttle shaft (1) in idle position. Squeeze throttle shaft (1) and face cam (7) tightly toward each other and rotate face cam (7) so lower roller rests approximately in middle of low idle step. Tighten screw (13) to 30 lb-in. (3 N•m) with Torx drive and remove feeler gauge.
71. Align holes in kickdown cam (10) and throttle shaft (1).
72. Install kickdown cam (10) on throttle shaft (1) with retaining pin (9).

**NOTE**

The 6.5L (N.A. and Turbo) injection pumps are equipped with a TP sensor instead of a kickdown switch. The TP sensor is installed on the housing with four capscrews.

73. Install transmission kickdown switch (8) or TP sensor (17) on housing (4) with two capscrews (11).

**CAUTION**

Tightly wound coils on idle spring must be installed facing throttle block, or injection pump may malfunction.

74. Install idle spring (1) on pushrod (2).

---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

**0027**

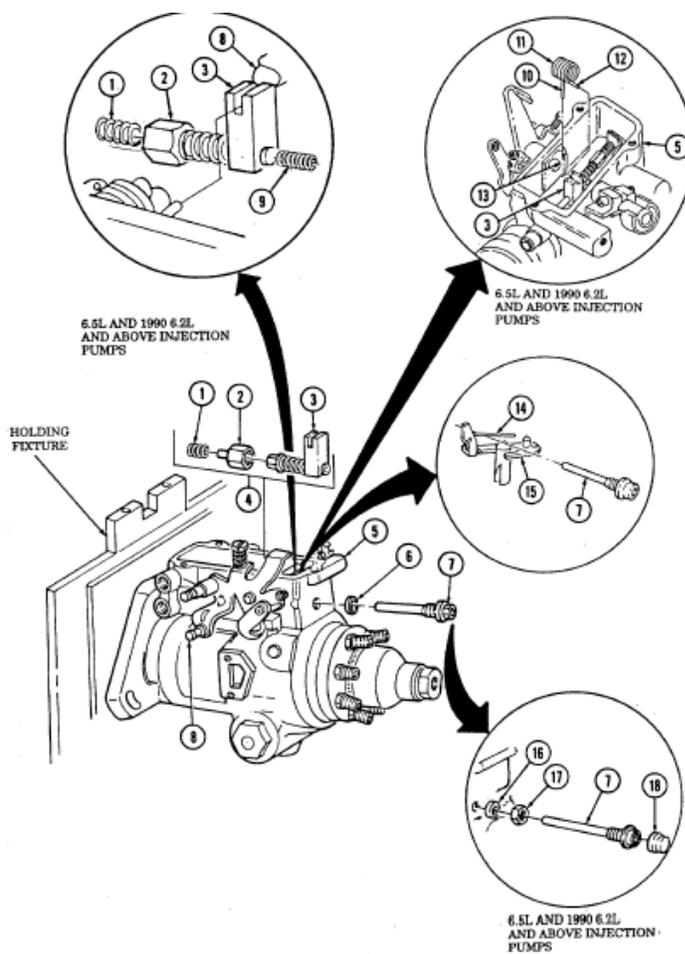
75. With throttle shaft (8) in wide open position, install min-max governor (4) on notch of throttle shaft (8). Rotate throttle shaft (8) to low idle position and lower min-max governor (4) into housing (5).
76. Insert inner governor spring (9) into pushrod (2).
77. With throttle shaft (8) in wide open position, install min-max governor (4) on notch of throttle shaft (8) and position tang (12) of thrust spring (11) in groove on throttle block (3). Rotate throttle shaft (8) to low idle position and lower min-max governor (4) into housing (5).
78. Hook tang (10) of thrust spring (11) in groove (13) of housing (5).

**CAUTION**

Guide stud must be installed between metering valve arm and spring.  
Incorrect installation may cause injection pump to malfunction.

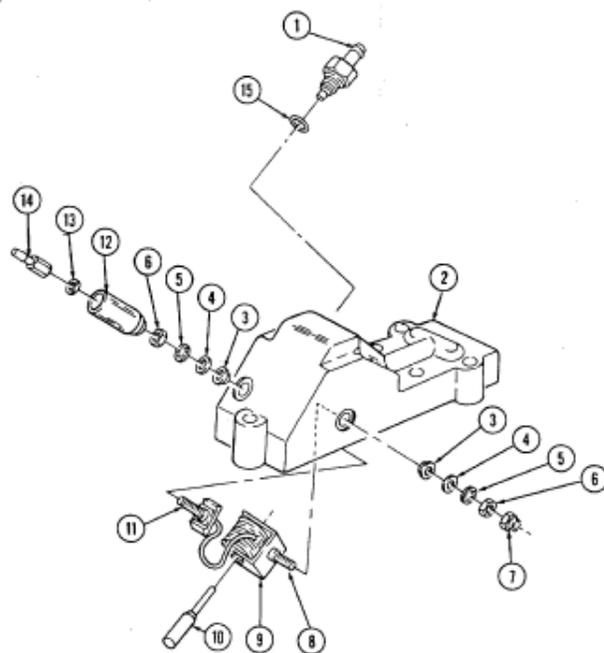
79. Install nut (17) and seal (16) on guide stud (7). Install guide stud (7) in housing (5) between metering valve arm (15) and spring (14) and into min-max governor (4). Tighten guide stud (7) to 80-90 lb-in. (9-10 N•m) using 1/4-in. hex head driver.

80. Install cap (18) on guide stud (7).



**FUEL INJECTION PUMP REPAIR - CONTINUED****0027**

81. Install O-ring (15) and check valve (1) in cover (2).
82. Install plunger (10) in cold start advance solenoid (9) and stud (11) in hole in rear of cover (2).
83. Install cold start advance solenoid (9) in cover (2) so small tip of plunger (10) fits in port of check valve (1) and stud (8) fits through hole inside of cover (2).
84. Install fiber washer (3), washer (4), lockwasher (5), nut (6), and locknut (7) on stud (8).
85. Install fiber washer (3), washer (4), lockwasher (5), and nut (6) on stud (11).
86. Install shell (12), washer (13), and terminal (14) on stud (11).



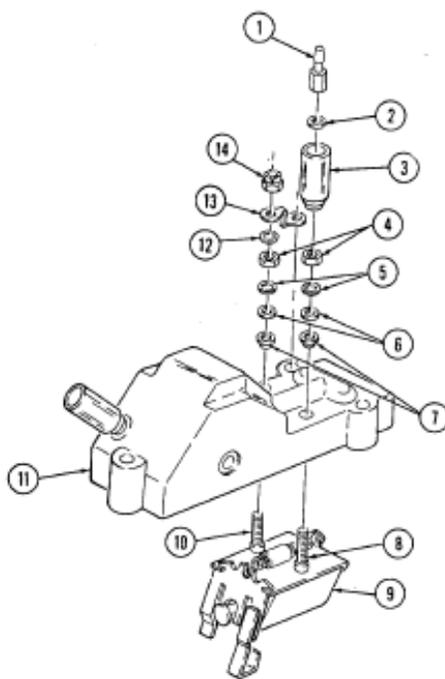
---

**FUEL INJECTION PUMP REPAIR - CONTINUED**

---

**0027**

87. Install electrical shutoff solenoid (9) in cover (11).
88. Install fiber washer (7), washer (6), lockwasher (5), nut (4), lockwasher (12), ground strap (13) and locknut (14) on stud (10).
89. Install fiber washer (7), washer (6), lockwasher (5), and nut (4) on stud (8).
90. Install shell (3), washer (2), and terminal (1) on stud (8).



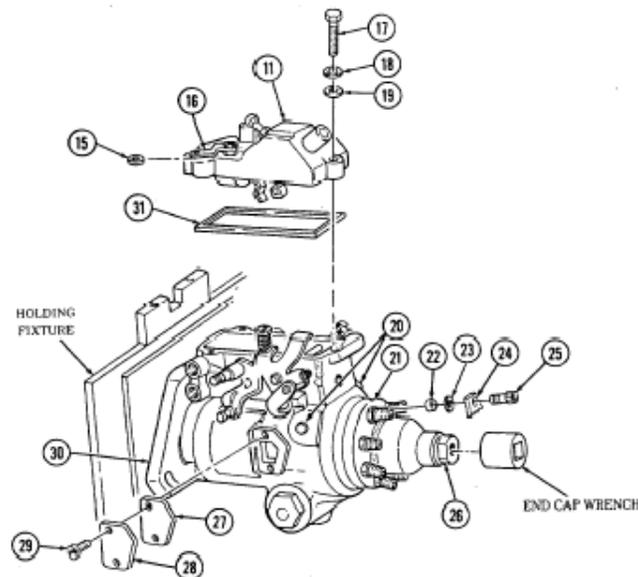
91. Install washer (15) between ground strap (16) and cover (11).

**CAUTION**

When installing cover on housing, cover must be positioned on housing ahead of threaded holes and slid rearward to align holes in cover with threaded holes in housing. Incorrect installation of cover may cause pump to malfunction.

**FUEL INJECTION PUMP REPAIR - CONTINUED****0027**

92. Install gasket (31) and cover (11) on housing (30) and secure with three screws (17), lockwashers (18), and washers (19). Tighten screws (17) to 35-45 lb-in. (4-5 N•m).
93. Install timing cover (28) and gasket (27) on housing (30) and secure with two screws (29).
94. Using end cap wrench, tighten end cap (26) to 30-37 lb-ft (41-50 N•m).
95. Install transfer pump end cap locking screw (25), plate (24), flat washer (23), and rubber washer (22) in hydraulic head (21). Tighten screw, (25) to 70-80 lb-in. (8-9 N•m) using 5/32-in. hex head driver.
96. Tighten two head locking capscrews (20) to 180-220 lb-in. (20-25 N•m).
97. Remove pump (30) from holding fixture and vise.

**END OF TASK**

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5149) CALIBRATION**

---

**0028**

**THIS WORK PACKAGE (WP) COVERS:**

Test Bench Requirements, Injection Pump Information, Injection Pump Check (Prior to Service), Injection Pump Settings (Following Pump Repair)

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive NSN 5180-00-177-7033

**Special Tools**

Roller-to-roller setting tool:	NSN 5120-01-200-4526; PN 19969
Linkage gap tool:	NSN 5120-01-249-0370; PN 23080
Automatic advance indicator:	NSN 5120-01-249-0368; PN 23745
Throttle lever gauge:	NSN 5120-01-249-0369; PN 23716
Protractor:	NSN 6675-01-247-2286; PN 22089
Air timing gauge:	NSN 5220-01-247-0361; 23715
Holding fixture:	NSN 5120-01-208-7753; 23615
Torx drive:	NSN 5120-01-078-1899; PN 22939

**Materials/Parts**

Calibrating fluid:	NSN 4910-00-779-6851 – 5 Gallon Drum
Sealing compound:	NSN 8030-00-111-2763 – 10 CC Bottle

**Test Equipment**

Digital tachometer  
 Voltage source (variable)  
 Pressure gauge (0-160 psi, 1 psi increments)  
 Pressure gauge (0-30 psi)  
 Vacuum gauge (0-30 in. Hg)  
 Flowmeter with three-way valve  
 Temperature gauge (0°-250°F)  
 Zero-backlash coupling device  
 Calibrating nozzles and lines  
 Orifice 13211  
 Calibration stand

---

**TEST BENCH REQUIREMENTS**

The fuel injection pump requires a test bench capable of at least 2,250 rpm shaft speed. The test bench must be equipped with the following items:

- (a) A zero-backlash coupling device.
- (b) A digital tachometer.
- (c) A variable voltage source.
- (d) Test gauges:

(1) 0-160 psi (0-1103 kPa) pressure gauge calibration 1 psi increments to measure transfer pump pressure. This gauge should be located as close as possible to the pump, with an in-line shutoff valve located at the pump.

(2) 0-30 psi (0-206.9 kPa) pressure gauge to measure housing pressure.

(3) 0-30 in. Hg (0-101.3 kPa) vacuum gauge to measure transfer pump lift. This gauge should be in the supply line to the pump, with a shutoff valve between the gauge and the oil source.

(4) A flowmeter for measuring return oil should be used with a three-way valve to permit the flowmeter to be in use only during the return oil check.

(5) 0°-250°F (-17.8°-121.1°C) temperature gauge, located at the pump inlet, to monitor inlet temperature.

- (e) Calibrating nozzles and injection lines:

(1) Eight 0.020-in. (0.5 mm) orifice plate nozzles set at  $1700 \pm 25$  psi ( $11,721 \pm 172$  kPa).

(2) Eight 0.098-in. (2.5 mm) inside diameter by 25 in. (63.5 cm) long injection lines.

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5149) CALIBRATION - CONTINUED**

---

**0028**

(f) Calibrating fluid conforming to SAE J967, maintaining a temperature of 110°-115°F (43°-46°C) at the pump inlet over all speed and load ranges.

(g) Orifice fitting in the inlet line between the supply pump and shutoff valve, to maintain constant fluid circulation and temperature.

**INJECTION PUMP INFORMATION****NOTE**

All speeds are in engine rpm unless otherwise noted.

1. Injection pump operating speed is half of engine speed.
2. Injection pump rotation is counterclockwise.
3. Injection pump is timed to the outlet port in the 10 o'clock position, when viewed from the transfer pump end.

**INJECTION PUMP CHECK (PRIOR TO SERVICE)**

1. Before mounting the pump on the test stand, check the drive shaft for freedom of rotation in the housing. Pump should be mounted securely in the appropriate adapter, and the intermediate coupling checked for freedom of movement.
2. Connect supply and return lines securely.
3. Install high pressure injection lines. Use copper gaskets or steel washers where required. Leave fuel line connections at the pump and nozzles loose.
4. Apply 17.6 V to electric shutoff solenoid and operate pump at 2000 rpm wide-open throttle (WOT) for 10 minutes to bring to operating temperature and clear air from system.
5. Tighten all connections securely. Check connections for leaks while operating.

**(6.5L) FUEL INJECTION PUMP (DB2831-5149) CALIBRATION - CONTINUED**

**0028**

6. Check fuel delivery at 650 rpm (low idle). Fuel delivery should be 10-18 mm<sup>3</sup>/stroke. If fuel delivery is not within the range specified, adjust low idle screw. Turn screw clockwise to decrease or counterclockwise to increase fuel delivery.
7. Check housing pressure at 650 rpm, while applying 17.6 V to housing pressure cold advance solenoid. Housing pressure should be 0-1 psi (0-7 kPa) and 8-12 psi (55-83 kPa) when de-energized.
8. Check electric shutoff solenoid for pull-in with 17.6 V maximum with throttle lever in low idle position at 400 rpm.
9. Fuel delivery measurement

(a) In order to minimize variations between readings due to residual oil in the graduates, the following timed cycle should be used:

- (1) Draw
- (2) Settle 30 seconds
- (3) Drain 30 seconds
- (4) Draw
- (5) Settle 30 seconds
- (6) Read graduates
- (7) Repeat cycle and average readings

(b) Energize electric shutoff solenoid and check delivery against the chart below.

RPM	THROTTLE POSITION	MM <sup>3</sup> /STROKE*	CAM MOVEMENT (DEGREES)	PRESSURE	
				TRANSFER PUMP	HOUSING
150	Low idle	27 min.			0-12 psi (0-83 kPa)
400	WOT	43 min.			
400	WOT**	4 max.			
700	Low idle	12-16***	0.5 min. 3.00		8-12 psi (55-83 kPa)
700	Low idle				0-1 psi (0-7 kPa)**
2000	WOT	56 max.			
3200	ADJ	21.5-23.5	3.75-16.25		
3400	WOT	48-53	3.00-5.00		
3500	WOT	43 min.			
3650	WOT	30 min.			
3900	WOT	15 max.			

\* Maximum cylinder variation should be ± 6 mm<sup>3</sup> from the average flow of all cylinders.  
 \*\* With electric shut-off solenoid de-energized.  
 \*\*\* Reset using low idle screw.  
 \*\*\*\* Minimum of 1.25 degrees more than reading.

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5149) CALIBRATION - CONTINUED**

---

**0028**

10. Disconnect pump and mount in holding fixture.
11. Using air timing gauge, check pump timing. Set to -2.0 to +0.0 degrees.
12. Total throttle travel from low idle to wide-open throttle should be 75-84 degrees.

**INJECTION PUMP SETTINGS (FOLLOWING PUMP REPAIR)**

1. Roller-to-roller dimension must be  $1.968 \pm .001$  in. ( $49.99 \pm .025$  mm). With oversize cam ring installed, roller-to-roller dimension will be  $1.976 \pm .001$  in. ( $50.19 \pm .025$  mm). Maximum eccentricity allowed is 0.008 in. (0.20 mm) TIR.
2. Linkage gap must be 0.130-0.175 in. (3.30-4.45 mm).
  - (a) Mount the pump horizontally in holding fixture and remove governor cover.
  - (b) Hold the throttle lever in the wide-open throttle (WOT) position. Rotate pump drive shaft counterclockwise until a click is heard as the rounded contact points on the governor arm engage the slots in the thrust sleeve. Continue to rotate the drive shaft until the gap between the governor arm and pump housing is minimal.
  - (c) Using linkage gap tool, check the clearance limits between the rear of the shutoff shaft and the vertical tab on the linkage hook.
  - (d) If adjustment is required, loosen governor linkage hook adjustment screw and extend the linkage hook to its maximum open length (throttle lever must be in WOT).
  - (e) Insert the appropriate step of the linkage gap tool between the vertical hook tab and the throttle shaft, with the step facing the shaft. The tool must be held vertically and parallel to the linkage hook tab.
  - (f) With the linkage hook pin seated firmly in the governor arm slot and the governor arm in the minimal gap position (step 2.(b)), shorten the linkage hook assembly until the face of the vertical tab is flush against the tool. Tighten adjusting screw to 12-15 lb-in. (1 N•m).
  - (g) Recheck linkage gap and adjust if necessary.
3. Set the throttle lever in correct low idle position prior to calibration using throttle lever gauge. The low idle screw must beat  $34 \pm 2$  degrees as measured between vertical centerline of throttle shaft bushing bore and throttle connection stud.
4. Flush the pump with calibrating oil to remove metal chips and possible contamination.

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5149) CALIBRATION - CONTINUED**

---

**0028**

5. Before mounting the pump on the test stand, check the drive shaft for freedom of rotation in the housing. Pump should be mounted securely in the appropriate adapter, and the intermediate coupling checked for freedom of movement.
6. Connect supply and return lines securely.
7. Install high pressure injection lines. Use copper gaskets or steel washers where required. Leave fuel line connections at the pump and nozzles loose.
8. Apply 17.6 V to electric shutoff solenoid and operate pump at 1000 rpm (WOT) for 10 minutes to bring to operating temperature and clear air from system.
9. Tighten all connections securely. Check connections for leaks while operating.
10. Set transfer pump pressure at 2000 rpm (WOT) for 60-62 psi (414-427 kPa); test stand boost should be set at  $5 \pm 0.5$  psi ( $34.5 \pm 3.4$  kPa).
11. Set return oil flow to 225-375 cc/minute at 2000 rpm (WOT).
12. Measure housing pressure:
  - (a) Check housing pressure at 650 rpm, with throttle shaft in low idle position, pressure should be 8-12 psi (55-83 kPa).
  - (b) Energize housing pressure cold advance solenoid with 17.6 V. Housing pressure should be 0-1 psi (0-7 kPa).
13. With governor cover removed and throttle shaft in low idle position, set min-max governor assembly for 7-9 mm<sup>3</sup>/stroke at 650 rpm (fuel reading with cover installed).

**NOTE**

If low idle screw adjustment is required, refer to step 3.  
Adjustment is  $\pm 1$  turn from the point in step 3.

14. At 650 rpm, adjust low idle screw for 13-15 mm<sup>3</sup>/stroke for the remainder of the setting and checking procedures.
15. During and at the completion of all settings, ensure face cam to throttle shaft end play measures 0.004-0.006-in. (0.10-0.15 mm) between throttle shaft spacer and housing.

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5149) CALIBRATION - CONTINUED**

---

**0028**

16. At 3400 rpm (WOT), rotate face cam to its maximum lift position in contact with the cam roller.
17. Adjust trimmer screw at 3400 rpm (WOT), for 4.0 degrees cam advance and set fuel delivery to 50-51 mm<sup>3</sup>/stroke.
18. Set guide stud for 35.5-37.5 mm<sup>3</sup>/stroke at 3650 rpm (WOT). Tighten guide stud nut to 80-90 lb-in. (9-10 N•m) and check dimension from top of nut to top of guide stud for 0.400-in. (10.2 mm) maximum.
19. Set throttle for 21.5-23.5 mm<sup>3</sup>/stroke at 3200 rpm and rotate face cam to obtain 5.10 degrees cam advance.
20. Tighten face cam screw to 28-30 lb-in. (3 N•m) and check face cam retention.
  - (a) Put 0.005-in. (0.127 mm) feeler gauge between throttle shaft mylar washer and housing boss.
  - (b) Put throttle shaft in idle position. Squeeze throttle shaft and face cam tightly toward each other and rotate face cam as lower roller rests approximately in middle at low idle step. Tighten screw to 30 lb-in. (3 N•m) with torx bit and remove feeler gauge.
21. Set total throttle travel. With throttle in low idle position, align zero degree mark on protractor with center of rib on rocker lever. Move throttle to WOT and adjust maximum travel screw to 75-84 degrees.

**NOTE**

Any changes to pump or settings after this point will require retesting of pump, starting with step 12.

**22. Fuel delivery measurement**

(a) In order to minimize variations between readings due to residual oil in the graduates, the following timed cycle should be used:

- (1) Draw
- (2) Settle 30 seconds
- (3) Drain 30 seconds
- (5) Settle 30 seconds
- (6) Read graduates
- (7) Repeat cycle and average readings

**(6.5L) FUEL INJECTION PUMP (DB2831-5149) CALIBRATION - CONTINUED**

**0028**

(b) Check points:

- (1) At 1500 rpm WOT) de-energize electric shutoff solenoid. Delivery should be 4 mm<sup>3</sup>/stroke maximum.
- (2) Re-energize electric shutoff solenoid and check delivery against the chart below.

RPM	THROTTLE POSITION	MM/ STROKE*	CAM MOVEMENT (DEGREES)	PRESSURE	
				TRANSFER PUMP	HOUSING
150	Low idle	28 min.		16 psi (110 kPa) min.	0-12 psi (0-83 kPa)
400	WOT	43 min.			
400	WOT**	4 max.			
400	Low idle***				
700	Low idle	12-16	1.0 min.		8-12 psi (55-83 kPa)
700	Low idle		1.25 min.		0-1 psi (0-7 kPa)
2000	WOT	56 max.		60-62 psi (414-427 kPa)	
2200	ADJ	21.5-23.5	4.0-6.0		
2400	WOT	49-52	3.50-4.50		
2500	WOT	45 min.			
2650	WOT	31.5 min.			
2900	WOT	15 max.		125 psi (862 kPa) max.	

\* Maximum cylinder variation should be ± 6 mm<sup>3</sup> from the average flow of all cylinders.  
 \*\* With electric shut-off solenoid de-energized.  
 \*\*\* Check electric shutoff solenoid for pull-in with 8.8 volts maximum.  
 --- Minimum of 1.25 degrees more than reading.

- 23. Disconnect pump and mount in holding fixture.
- 24. Using air timing gauge, check pump timing. Set to + 0.25 degree ± 0.50 degree.
- 25. Tighten all fasteners to specifications, refer to WP 0028, Assembly.
- 26. Apply sealing compound as follows:

(a) Apply one drop at interface of maximum travel screw and locknut.

**CAUTION**

Do not allow sealing compound to enter gap between face cam and housing. Binding of the throttle shaft may result.

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5149) CALIBRATION - CONTINUED**

---

**0028**

(b) Apply one drop to threaded end of face cam screw where it protrudes from face cam.

(c) Apply one drop to interface of servo advance adjusting screw and rocker lever, making sure sealing compound does not enter hex recess of screw.

27. Install tamper-proofing cap on guide stud.

**END OF TASK**

0028 00-9/ 10 blank



---

**(6.5L) FUEL INJECTION PUMP (DB2831-5209) CALIBRATION**

---

**0029****THIS WORK PACKAGE (WP) COVERS:**

Test Bench Requirements, Injection Pump Information, Injection Pump Check (Prior to Service), Injection Pump Settings (Following Pump Repair)

---

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive NSN 5180-00-177-7033

**Special Tools**

Roller-to-roller setting tool: NSN 5120-01-200-4526; PN 19969  
Linkage gap tool: NSN 5120-01-249-0370; PN 23080  
Automatic advance indicator: NSN 5120-01-249-0368; PN 23745  
Throttle lever gauge: NSN 5120-01-249-0369; PN 23716  
Protractor: NSN 6675-01-247-2286; PN 22089  
Air timing gauge: NSN 5220-01-247-0361; 23715  
Holding fixture: NSN 5120-01-208-7753; 23615  
Torx drive: NSN 5120-01-078-1899; PN 22939

**Materials/Parts**

Calibrating fluid: NSN 4910-00-779-6851 – 5 Gallon Drum  
Sealing compound: NSN 8030-00-111-2763 – 10 CC Bottle

**Test Equipment**

Digital tachometer  
Voltage source (variable)  
Pressure gauge (0-160 psi, 1 psi increments)  
Pressure gauge (0-30 psi)  
Vacuum gauge (0-30 in. Hg)  
Flowmeter with three-way valve  
Temperature gauge (0°-250°F)  
Zero-backlash coupling device  
Calibrating nozzles and lines  
Orifice 13211  
Calibration stand

---

**NOTE**

The following calibration procedure applies to 6.5L detuned engine fuel injection pumps. Refer to WP 0031 for calibration of 6.5L fuel injection pumps.

**TEST BENCH REQUIREMENTS**

The fuel injection pump requires a test bench capable of at least 2250 rpm shaft speed. The test bench must be equipped with the following items:

- (a) A zero-backlash coupling device.
- (b) A digital tachometer.
- (c) A variable voltage source.
- (d) Test gauges:
  - (1) 0-160 psi (0-1103 kPa) pressure gauge calibrated in 1 psi increments to measure transfer pump pressure. This gauge should be located as close as possible to the pump, with an in-line shutoff valve located at the pump.
  - (2) 0-30 psi (0-206.9 kPa) pressure gauge to measure housing pressure.
  - (3) 0-30 in. Hg (0-101.3 kPa) vacuum gauge to measure transfer pump lift. This gauge should be in the supply line to the pump, with a shutoff valve between the gauge and the oil source.
  - (4) A flowmeter for measuring return oil should be used with a three-way valve to permit the flowmeter to be in use only during the return oil check.
  - (5) 0-250°F (-17.8-121.1°C) temperature gauge, located at the pump inlet, to monitor inlet temperature.
- (e) Calibrating nozzles and injection lines:
  - (1) Eight 0.020-in. (0.5 mm) orifice plate nozzles set at  $1700 \pm 25$  psi ( $11,721 \pm 172$  kPa).
  - (2) Eight 0.098-in. (2.5 mm) inside diameter by 25 in. (63.5 cm) long injection lines.

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5209) CALIBRATION - CONTINUED**

---

**0029**

(f) Calibrating fluid conforming to SAE J967, maintaining a temperature of 110-115°F (43-46°C) at the pump inlet over all speed and load ranges.

(g) Orifice fitting in the inlet line between the supply pump and shutoff valve, to maintain constant fluid circulation and temperature.

**INJECTION PUMP INFORMATION****NOTE**

All speeds are in engine rpm unless otherwise noted.

1. Injection pump operating speed is half of engine speed.
2. Injection pump rotation is counterclockwise.
3. Injection pump is timed to the outlet port in the 10 o'clock position when viewed from the transfer pump end.

**INJECTION PUMP CHECK (PRIOR TO SERVICE)**

1. Before mounting pump on test stand, check driveshaft for freedom of rotation in the housing. Pump should be mounted securely in the appropriate adapter, and the intermediate coupling should be checked for freedom of movement.
2. Connect supply and return lines securely.
3. Install high-pressure injection lines. Use copper gaskets and/or steel washers where required. Leave fuel line connections at the pump and nozzles loose.
4. Apply 17.6 volts to electric shutoff solenoid and operate pump at 2000 rpm Wide-Open Throttle (WOT) for 10 minutes to bring to operating temperature and clear air from system.
5. Tighten all connections securely. Check connections for leaks while operating.

**(6.5L) FUEL INJECTION PUMP (DB2831-5209) CALIBRATION - CONTINUED**

**0029**

6. Check fuel delivery at 650 rpm (low idle). Fuel delivery should be 10-18 mm<sup>3</sup>/stroke. If fuel delivery is not within the range specified, adjust low-idle screw. Turn screw clockwise to decrease or counterclockwise to increase fuel delivery.

7. Check housing pressure at 650 rpm while applying 17.6 volts to housing pressure cold-advance solenoid. Housing pressure should be 0-1 psi (0-7 kPa) and 8-12 psi (55-83 kPa) when de-energized.

8. Fuel delivery:

(a) Check electric shutoff solenoid for pull-in with 17.6 volts maximum with throttle lever in low idle position at 400 rpm.

(b) Maximum fuel delivery under condition a. should be 9 mm<sup>3</sup>/stroke minimum.

9. Fuel delivery measurement:

(a) In order to minimize variations between readings due to residual oil in the graduates, the following timed cycle should be used:

- (1) Draw
- (2) Settle 30 seconds
- (3) Drain 30 seconds
- (4) Draw
- (5) Settle 30 seconds
- (6) Read graduates
- (7) Repeat cycle and average readings

(b) Energize electric shutoff solenoid and check delivery against the chart below.

RPM	THROTTLE POSITION	MM <sup>3</sup> /STROKE*	CAM MOVEMENT (DEGREES)	HOUSING PRESSURE
150	Low idle	25 min.		0-12 psi (0-83 kPa)
400	WOT	35.5 min.		
400	WOT**	4 max.		
700	Low idle	12-16***	0.5 min.	8-12 psi (55-83 kPa)
700	Low idle		****	0-1 psi (0-7 kPa)**
2000	WOT	51.5 max.		
3200	ADJ	21.5-23.5	3.75-16.25	
3500	WOT	43.5-48.5	3.25-5.25	
3600	WOT	43.5 min.		
3800	WOT	30 min.		
4050	WOT	15 max.		

\* Maximum cylinder variation should be ± 6 mm<sup>3</sup> from the average flow of all cylinders.  
 \*\* With electric shut-off solenoid de-energized.  
 \*\*\* Reset using low-idle screw.  
 \*\*\*\* Minimum of 1.25 degrees more than reading.

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5209) CALIBRATION - CONTINUED**

---

**0029**

10. Disconnect pump and mount in holding fixture.
11. Using air timing gauge, check pump timing. Set to -2.0 to +0.0 degrees.
12. Total throttle travel from low-idle to WOT should be 80-84 degrees.

**INJECTION PUMP SETTINGS (FOLLOWING PUMP REPAIR)**

1. Roller-to-roller dimension must be  $1.964 \pm .001$  in. ( $49.89 \pm .025$  mm). With oversize cam ring installed, roller-to-roller dimension will be  $1.972 \pm .001$  in. ( $50.09 \pm .026$  mm). Maximum eccentricity allowed is 0.008 in. (0.20 mm) TIR.
2. Linkage gap must be 0.130-0.1734 in. (3.30-4.40 mm).
  - (a) Mount the pump horizontally in holding fixture and remove governor cover.
  - (b) Hold the throttle lever in the WOT position. Rotate pump driveshaft counterclockwise until a click is heard as the rounded contact points on the governor arm engage the slots in the thrust sleeve. Continue to rotate driveshaft until gap between governor arm and pump housing is minimal.
  - (c) Using linkage gap tool, check clearance limits between rear of shutoff shaft and vertical tab on linkage hook.
  - (d) If adjustment is required, loosen governor linkage hook adjustment screw and extend linkage hook to its maximum open length (throttle lever must be in WOT).
  - (e) Insert appropriate step of linkage gap tool between vertical hook tab and throttle shaft, with step facing shaft. The tool must be held vertically and parallel to linkage hook tab.
  - (f) With linkage hook pin seated firmly in governor arm slot and governor arm in the minimal gap position (step 2.(b)), shorten linkage hook assembly until face of vertical tab is flush against tool. Tighten adjusting screw to 12-15 lb-in. (1 N•m).
  - (g) Recheck linkage gap and adjust if necessary.
3. Set the throttle lever in correct low-idle position prior to calibration using vacuum valve block gauge. The low-idle screw must be at  $34 \pm 2$  degrees as measured between vertical centerline of throttle shaft bushing bore and throttle connection stud.
4. Flush pump with calibrating oil to remove metal chips and possible contamination.

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5209) CALIBRATION - CONTINUED**

---

**0029**

5. Before mounting pump on test stand, check driveshaft for freedom of rotation in housing. Pump should be mounted securely in the appropriate adapter, and the intermediate coupling should be checked for freedom of movement.
6. Connect supply and return lines securely.
7. Install high-pressure injection lines. Use copper gaskets or steel washers where required. Leave fuel line connections at the pump and nozzles loose.
8. Apply 17.6 volts to electric shutoff solenoid and operate pump at 1000 rpm (WOT) for 10 minutes to bring to operating temperature and clear air from system.
9. Tighten all connections securely. Check connections for leaks while operating.
10. Set transfer pump pressure at 2000 rpm (WOT) for 60-62 psi (414-427 kPa). Test stand boost should be set at  $5 \pm 0.5$  psi ( $34.5 \pm 3.4$  kPa).
11. Set return oil flow to 225-375 cc/minute at 2000 rpm (WOT).
12. Measure housing pressure:
  - (a) Check housing pressure at 650 rpm. With throttle shaft in low idle position, pressure should be 8-12 psi (55-83 kPa).
  - (b) Energize housing pressure cold advance solenoid with 17.6 volts. Housing pressure should be 0-1 psi (0-7 kPa).
13. With governor cover removed and throttle shaft in low-idle position, set min.-max. governor assembly for 7-9 mm<sup>3</sup>/stroke at 650 rpm (fuel reading with cover installed).

**NOTE**

If low-idle screw adjustment is required, refer to step 3. Adjustment is  $\pm 1$  turn from the point in step 3.

12. At 650 rpm, adjust low-idle screw for 13-15 mm<sup>3</sup>/stroke for the remainder of the setting and checking procedures.

---

**(6.5L) FUEL INJECTION PUMP (DB2831-5209) CALIBRATION - CONTINUED**

---

**0029**

15. During and at the completion of all settings, ensure face cam-to-throttle shaft end play measures 0.004-0.006 in. (0.10-0.15 mm) between throttle shaft spacer and housing.
16. At 3500 rpm (WOT), rotate face cam to its maximum lift position in contact with the cam roller.
17. Adjust trimmer screw at 3500 rpm (WOT) for 4.25 degrees cam advance and set fuel delivery to 45.5-46.5 mm<sup>3</sup>/stroke.
18. Set guide stud for 46.5 mm<sup>3</sup>/stroke at 3800 rpm (WOT). Tighten guide stud nut to 80-90 lb-in. (9-10 N•m) and check dimension from top of nut to top of guide stud for 0.425 in. (10.80 mm) maximum.
19. Set throttle for 21.5-23.5 mm<sup>3</sup>/stroke at 3200 rpm and rotate face cam to obtain 5.00 degrees cam advance.
20. Tighten face cam screw to 28-30 lb-in. (3 N•m) and check face cam retention.
- (a) Put 0.005-in. (0.127 mm) feeler gauge between throttle shaft mylar washer and housing boss.
  - (b) Put throttle shaft in idle position. Squeeze throttle shaft and face cam tightly toward each other and rotate face cam as lower roller rests approximately in middle at lowest step. Tighten screw to 30 lb-in. (3 N•m) with torx bit and remove feeler gauge.
21. Set total throttle travel. With throttle in low-idle position, align zero degree mark on protractor with center of rib on rocker lever. Move throttle to WOT and adjust maximum travel screw to 80-84 degrees.

**NOTE**

Any changes to pump or settings after this point will require retesting of pump, starting with step 12.

22. Fuel delivery measurement:

**(6.5L) FUEL INJECTION PUMP (DB2831-5209) CALIBRATION - CONTINUED**

**0029**

(a) In order to minimize variations between readings due to residual oil in the graduates, the following timed cycle should be used:

- (1) Draw
- (2) Settle 30 seconds
- (3) Drain 30 seconds
- (4) Draw
- (5) Settle 30 seconds
- (6) Read graduates
- (7) Repeat cycle and average readings

(b) Check points:

- (1) At 1500 rpm (WOT), de-energize electric shutoff solenoid. Delivery should be 4 mm<sup>3</sup>/stroke maximum.
- (2) Re-energize electric shutoff solenoid and check delivery against the chart below.

RPM	THROTTLE POSITION	MM/ STROKE*	CAM MOVEMENT (DEGREES)	PRESSURE	
				TRANSFER PUMP	HOUSING
150	Low idle	26 min.		16 psi (110 kPa) min.	0-12 psi (0-83 kPa)
400	WOT	36.5 min.			
400	WOT**	4 max.			
400	Low idle***				
700	Low idle	12-16	1.0 min.	60-62 psi (414-427 kPa)	8-12 psi (55-83 kPa) 0-1 psi (0-7 kPa)
700	Low idle		****		
2000	WOT	51.5 max.			
3200	ADJ	21.5-23.5	4.0-6.0		
3500	WOT	44.5-47.5	3.75-4.75		
3600	WOT	44 min.			
3800	WOT	31.5 min.			
4050	WOT	15 max.		125 psi (862 kPa) max.	

\* Maximum cylinder variation should be ± 6 mm<sup>3</sup> from the average flow of all cylinders.  
 \*\* With electric shut-off solenoid de-energized.  
 \*\*\* Reset using low-idle screw.  
 \*\*\*\* Minimum of 1.25 degrees more than reading.

23. Disconnect pump and mount in holding fixture.

24. Using air timing gauge, check pump timing. Set to +1.00 degree ± 0.50 degree.

25. Tighten all fasteners to specifications. Refer to WP 0028 d.

26. Apply sealing compound as follows:

(a) Apply one drop at interface of maximum travel screw and locknut.

**CAUTION**

Do not allow sealing compound to enter gap between face cam and housing. Binding of the throttle shaft may result.

(b) Apply one drop to threaded end of face cam screw where it protrudes from face cam.

(c) Apply one drop to interface of servo advance adjusting screw and rocker lever, ensuring sealing compound does not enter hex recess of screw.

27. Install tamper-proof cap on guide stud.

**END OF TASK**



---

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION**

---

**0030**

**THIS WORK PACKAGE (WP) COVERS:**

Test Bench Requirements, Injection Pump Information, Injection Pump Check (Prior to Service), Injection Pump Settings (Following Pump Repair)

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive NSN 5180-00-177-7033

**Special Tools**

Roller-to-roller setting tool:	NSN 5120-01-200-4526; PN 19969
Linkage gap tool:	NSN 5120-01-249-0370; PN 23080
Automatic advance indicator:	NSN 5120-01-249-0368; PN 23745
Throttle lever gauge:	NSN 5120-01-249-0369; PN 23716
Protractor:	NSN 6675-01-247-2286; PN 22089
Air timing gauge:	NSN 5220-01-247-0361; 23715
Holding fixture:	NSN 5120-01-208-7753; 23615
Torx drive:	NSN 5120-01-078-1899; PN 22939

**Materials/Parts**

Calibrating fluid:	NSN 4910-00-779-6851 – 5 Gallon Drum
Sealing compound:	NSN 8030-00-111-2763 – 10 CC Bottle

**Test Equipment**

Digital tachometer  
 Voltage source (variable)  
 Pressure gauge (0-160 psi, 1 psi increments)  
 Pressure gauge (0-30 psi)  
 Vacuum gauge (0-30 in. Hg)  
 Flowmeter with three-way valve  
 Temperature gauge (0°-250°F)  
 Zero-backlash coupling device  
 Calibrating nozzles and lines  
 Orifice 13211  
 Calibration stand

---

---

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION - CONTINUED**  
**0030**

---

**NOTE**

The following calibration procedure applies to 6.5L turbocharged fuel injection pumps.

**TEST BENCH REQUIREMENTS**

The fuel injection pump requires a test bench capable of at least 2250 rpm shaft speed. The test bench must be equipped with the following items:

- (a) A zero-backlash coupling device.
- (b) A digital tachometer.
- (c) A variable voltage source.
- (d) Test gauges:

(1) 0-160 psi (0-1103 kPa) pressure gauge calibrated in 1 psi increments to measure transfer pump pressure. This gauge should be located as close as possible to the pump, with an in-line shutoff valve located at the pump.

(2) 0-30 psi (0-206.9 kPa) pressure gauge to measure housing pressure.

(3) 0-30 in. Hg (0-101.3 kPa) vacuum gauge to measure transfer pump lift. This gauge should be in the supply line to the pump, with a shutoff valve between the gauge and the oil source.

(4) A flowmeter for measuring return oil should be used with a three-way valve to permit the flowmeter to be in use only during the return oil check.

(5) 0-250°F (-17.8-121.1°C) temperature gauge, located at the pump inlet, to monitor inlet temperature.

- (e) Calibrating nozzles and injection lines:

(1) Eight 0.020-in. (0.5 mm) orifice plate nozzles set at  $1700 \pm 25$  psi ( $11,721 \pm 172$  kPa).

(2) Eight 0.098-in. (2.5 mm) inside diameter by 25 in. (63.5 cm) long injection lines.

---

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION - CONTINUED**  
**0030**

---

(f) Calibrating fluid conforming to SAE J967, maintaining a temperature of 110°-115°F (43°-46°C) at the pump inlet over all speed and load ranges.

(g) Orifice fitting in the inlet line between the supply pump and shutoff valve, to maintain constant fluid circulation and temperature.

### **INJECTION PUMP INFORMATION**

#### **NOTE**

All speeds are in engine rpm unless otherwise noted.

1. Injection pump operating speed is half of engine speed.
2. Injection pump rotation is counterclockwise.
3. Injection pump is timed to the outlet port in the 10 o'clock position when viewed from the transfer pump end.

### **INJECTION PUMP CHECK (PRIOR TO SERVICE)**

1. Before mounting the pump on the test stand, check the drive shaft for freedom of rotation in the housing. Pump should be mounted securely in the appropriate adapter, and the intermediate coupling should be checked for freedom of movement.
2. Connect supply and return lines securely.
3. Install high-pressure injection lines. Use copper gaskets or steel washers where required. Leave fuel line connections at the pump and nozzles loose.
4. Apply 17.6 V to electric shutoff solenoid and operate pump at 2000 rpm wide-open throttle (WOT) for 10 minutes to bring to operating temperature and clear air from system.
6. Tighten all connections securely. Check connections for leaks while operating.

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION - CONTINUED**  
**0030**

6. Check fuel delivery at 650 rpm (low-idle). Fuel delivery should be 10-18 mm<sup>3</sup>/stroke. If fuel delivery is not within the range specified, adjust low-idle screw. Turn screw clockwise to decrease or counterclockwise to increase fuel delivery.

7. Check housing pressure at 650 rpm while applying 17.6 V to housing pressure cold-advance solenoid. Housing pressure should be 0-1 psi (0-7 kPa) and 8-12 psi (55-83 kPa) when de-energized.

8. Check electric shutoff solenoid for pull-in with 17.6 V maximum with throttle lever in low-idle position at 400 rpm.

9. Fuel delivery measurement:

(a) In order to minimize variations between readings due to residual oil in the graduates, the following timed cycle should be used:

- (1) Draw
- (2) Settle 30 seconds
- (3) Drain 30 seconds
- (4) Draw
- (5) Settle 30 seconds
- (6) Read graduates
- (7) Repeat cycle and average readings

(b) Energize electric shutoff solenoid and check delivery against the chart below:

RPM	THROTTLE POSITION	MM <sup>3</sup> /STROKE*	CAM MOVEMENT (DEGREES)	PRESSURE	
				TRANSFER PUMP	HOUSING
150	Low-idle	36 min.			0-12 psi (0-83 kPa)
400	WOT	57 min.			
400	WOT**	4 max.			8-12 psi (55-83 kPa) 0-1 psi (0-7 kPa)**
700	Low-idle	10-18***	3.0 min.		
700	Low-idle		****		
1800	WOT	65.6-70.5			
2000	WOT				
3200	WOT	58.5 min.	2.0-4.0		
3200	ADJ	21.5-23.5	5.0-7.5		
3200	Low-idle		11.0-12.0		
3650	WOT	32 min.			
3900	WOT	15 max.			

\* Maximum cylinder variation should be ± 6 mm<sup>3</sup> from the average flow of all cylinders.  
 \*\* With electric shut-off solenoid de-energized.  
 \*\*\* Reset using low-idle screw.  
 \*\*\*\* Minimum of 1.25 degrees more than reading.

---

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION - CONTINUED**  
**0030**

---

10. Disconnect pump and mount in holding fixture.

**NOTE**

Perform step 12 to check pump timing on the DB2831-5079 fuel injection pump.

11. Using air timing gauge, check pump timing. Set to 1.5 to 3.5 degrees.

12. Using air timing gauge, check pump timing. Set to 1.0 +1.0 degrees.

13. Total throttle travel from low-idle to wide-open throttle should be 75-84 degrees.

**INJECTION PUMP SETTINGS (FOLLOWING PUMP REPAIR)**

1. Roller-to-roller dimension must be  $1.975 \pm .001$  in. ( $50.19 \pm .025$  mm). With oversize cam ring installed, roller-to-roller dimension will be  $1.882 \pm .005$  in. ( $50.34 \pm .013$  mm). Maximum eccentricity allowed is 0.008 in. (0.20 mm) TIR.

2. Linkage gap must be 0.130-0.175 in. (3.30-4.45 mm).

(a) Mount the pump horizontally in holding fixture and remove governor cover.

(b) Hold the throttle lever in the wide-open throttle (WOT) position. Rotate pump driveshaft counterclockwise until a click is heard as the rounded contact points on the governor arm engage the slots in the thrust sleeve. Continue to rotate driveshaft until gap between governor arm and pump housing is minimal.

(c) Using linkage gap tool, check clearance limits between rear of shutoff shaft and vertical tab on linkage hook.

(d) If adjustment is required, loosen governor linkage hook adjustment screw and extend the linkage hook to its maximum open length (throttle lever must be in WOT).

(e) Insert appropriate step of linkage gap tool between vertical hook tab and throttle shaft, with step facing shaft. The tool must be held vertically and parallel to linkage hook tab.

---

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION - CONTINUED**  
**0030**

---

(f) With linkage hook pin seated firmly in governor arm slot and governor arm in the minimal gap position (step 2.(b)), shorten linkage hook assembly until face of vertical tab is flush against tool. Tighten adjusting screw to 12-15 lb-in. (1 N•m).

(g) Recheck linkage gap and adjust if necessary.

3. Set the throttle lever in correct low-idle position prior to calibration using vacuum valve block gauge. The low-idle screw must be at  $34 \pm 2$  degrees as measured between vertical centerline of throttle shaft bushing bore and throttle connection stud.

4. Flush the pump with calibrating oil to remove metal chips and possible contamination.

5. Before mounting the pump on the test stand, check the driveshaft for freedom of rotation in the housing. Pump should be mounted securely in the appropriate adapter, and the intermediate coupling checked for freedom of movement.

6. Connect supply and return lines securely.

7. Install high-pressure injection lines. Use copper gaskets or steel washers where required. Leave fuel line connections at the pump and nozzles loose.

8. Apply 17.6 V to electric shutoff solenoid and operate pump at 1000 rpm (WOT) for 10 minutes to bring to operating temperature and clear air from system.

9. Tighten all connections securely. Check connections for leaks while operating.

10. Set transfer pump pressure at 2000 rpm (WOT) for 60-62 psi (414-427 kPa); test stand boost should be set at  $5 \pm 0.5$  psi ( $34.5 \pm 3.4$  kPa).

11. Set return oil flow to 225-375 cc/minute at 2000 rpm (WOT).

12. Measure housing pressure:

(a) Check housing pressure at 650 rpm with throttle shaft in low-idle position. Pressure should be 8-12 psi (55-83 kPa).

(b) Energize housing pressure cold advance solenoid with 17.6 V. Housing pressure should be 0-1 psi (0-7 kPa).

13. With governor cover removed and throttle shaft in low-idle position, set min-max governor assembly for 7-9 mm<sup>3</sup>/stroke at 650 rpm (fuel reading with cover installed).

---

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION - CONTINUED**  
**0030**

---

**NOTE**

If low-idle screw adjustment is required, refer to step 3. Adjustment is  $\pm 1$  turn from the point in step 3.

14. At 650 rpm, adjust low-idle screw for 13-15 mm<sup>3</sup>/stroke for the remainder of the setting and checking procedures.
15. During and at the completion of all settings, ensure face cam to throttle shaft end play measures 0.004-0.006-in. (0.10-0.15 mm) between throttle shaft spacer and housing.
16. At 1800 rpm (WOT), rotate face cam to its maximum lift position in contact with the cam roller.
17. Adjust trimmer screw at 1800 rpm (WOT), to advance cam advance and set fuel delivery to 67.5-68.6 mm<sup>3</sup>/stroke.
18. Set guide stud for 37.0-39.0 mm<sup>3</sup>/stroke at 3650 rpm (WOT). Tighten guide stud nut to 80-90 lb-in. (9-10 N•m) and check dimension from top of nut to top of guide stud for 0.400-in. (10.2 mm) maximum.
19. Set throttle for 22.6  $\pm$ 0.3 mm<sup>3</sup>/stroke at 1800 rpm and rotate face cam to obtain 5.10 degrees cam advance.
20. Tighten face cam screw to 28-30 lb-in. (3 N•m) and check face cam retention.
  - (a) Put 0.005-in. (0.127 mm) feeler gauge between throttle shaft mylar washer and housing boss.
  - (b) Put throttle shaft in idle position. Squeeze throttle shaft and face cam tightly toward each other and rotate face cam as lower roller rests approximately in middle at low-idle step. Tighten screw to 30 lb-in. (3 N•m) with torx bit and remove feeler gauge.
21. Set total throttle travel. With throttle in low-idle position, align zero degree mark on protractor with center of rib on rocker lever. Move throttle to WOT and adjust maximum travel screw to 75-84 degrees.

---

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION - CONTINUED**  
**0030**

---

**NOTE**

Any changes to pump or settings after this point will require retesting of pump, starting with step 12.

22. Fuel delivery measurement:

(a) In order to minimize variations between readings due to residual oil in the graduates, the following timed cycle should be used:

- (1) Draw
- (2) Settle 30 seconds
- (3) Drain 30 seconds
- (4) Draw
- (5) Settle 30 seconds
- (6) Read graduates
- (7) Repeat cycle and average readings

(b) Check points:

- (1) At 1500 rpm (WOT), de-energize electric shutoff solenoid. Delivery should be 4 mm<sup>3</sup>/stroke maximum.
- (2) Re-energize electric shutoff solenoid and check delivery against the chart below.

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION - CONTINUED**  
**0030**

RPM	THROTTLE POSITION	MM <sup>3</sup> / STROKE	CAM MOVEMENT (DEGREES)	PRESSURE	
				TRANSFER PUMP	HOUSING
150	Low-idle	37 min.		16 psi (110 kPa) min.	0-12 psi (0-83 kPa)
400	WOT	58 min.			
400	WOT**	4 max.			
400	Low-idle***				
700	Low-idle	12-16	3.5 min.	80-82 psi (552-565 kPa)	8-12 psi (55-83 kPa) 0-1 psi (0-7 kPa)
700	Low-idle		1.25 min.		
1500	WOT	4 max			
1500	WOT	68.5-69.5			
2000	WOT		****		
3200	WOT	59.5 min.	2.50-3.60		
3200	ADJ	21.5-23.5	5.25-7.25		
3200	Low-idle		11-12		
3400	WOT	49-52	3.50-4.50		
3500	WOT	45 min.			
3650	WOT	31.5 min.		125 psi (862 kPa) max.	
3900	WOT	15 max.			

\* Maximum cylinder variation should be  $\pm 6 \text{ mm}^3$  from the average flow of all cylinders.  
 \*\* With electric shut-off solenoid de-energized.  
 \*\*\* Check electric shutoff solenoid for pull-in with 8.8 volts maximum.  
 \*\*\*\* Minimum of 1.25 degrees more than reading.

23. Disconnect pump and mount in holding fixture.

**NOTE**

Perform step 25 to check pump timing on the DB2831-5079.

24. Using air timing gauge, check pump timing. Set to +0.25 degree  $\pm$  0.50 degree.

25. Using air timing gauge, check pump timing. Set to 0  $\pm$ 0.50 degrees

26. Tighten all fasteners to specifications. Refer to WP 0028 d.

27. Apply sealing compound as follows:

- (a) Apply one drop at interface of maximum travel screw and locknut.

**CAUTION**

Do not allow sealing compound to enter gap between face cam and housing. Binding of the throttle shaft may result.

- (a) Apply one drop to threaded end of face cam screw where it protrudes from face cam.

---

**(6.5L) FUEL INJECTION PUMPS (DB2831-5485 OR DB2831-5079) CALIBRATION - CONTINUED**  
**0030**

---

(c) Apply one drop to interface of servo advance adjusting screw and rocker lever, ensuring sealing compound does not enter hex recess of screw.

28. Install tamper-proof cap on guide stud.

**END OF TASK**

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP  
TEST STAND (FTIS) MODEL A8022 0031**

---

**THIS WORK PACKAGE (WP) COVERS:**

Mounting Fuel Injection Pump, Test Stand Setup Procedures, Removal of Fuel Injection Pump from Test Stand

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive NSN 5180-00-177-7033

**Special Tools**

Adapter Kit 74-8033 consisting of:

Adapter plate:	NSN N/A ; PN 67-6878
Advance indicator:	NSN N/A ; 74-1094
Alignment gauge:	NSN 4910-01-397-1616; PN 67-4787
Barring tool:	NSN 4910-01-211-0879; PN 67-2840
Connector:	NSN N/A ; PN 67-5687
High-pressure lines:	NSN N/A ; PN 74-1250
Hose assembly:	NSN N/A ; PN 74-1337
Hose assembly:	NSN N/A ; PN 74-1030
Male pipe fitting:	NSN N/A ; PN 03-5253
Quick-connect plug:	NSN N/A ; PN 67-3456
Test adapter:	NSN N/A ; PN 74-1131
Test lead, black:	NSN N/A ; PN N/A
Test lead, red:	NSN N/A ; PN 77-0432
Throttle arm positioner assembly:	NSN N/A ; PN N/A
Tubing:	NSN 4720-01-206-4429; PN 03-6063

**Materials/Parts**

Three 5/16-18x1 hex-head capscrews: B1821BH031C100N	NSN 5306-00-226-4827; PN
Three 3/8-16x1 hex-head capscrews: B1821BH038C100N	NSN 5305-00-068-0510; PN
Calibrating fluid:	NSN 4910-00-779-6851 – 5 Gallon Drum

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP  
TEST STAND (FTIS) MODEL A8022 - CONTINUED** **0031**

---

**Test Equipment**

Test stand, model A8022

**Manual References**

Instruction manual 74-9225

---

**NOTE**

The following calibration procedures apply to fuel injection pump DB 2831-5149 only.

**MOUNTING FUEL INJECTION PUMP ON TEST STAND**

**NOTE**

Prior to installing fuel injection pump to drive coupling, ensure alignment gauge is installed.

1. Insert alignment gauge into test stand drive coupling.
2. Install fuel injection pump (1) on adapter plate (6) and secure with three 5/16-in. washers (3) and 5/16-18x1 hex-head capscrews (2).
3. Position fuel injection pump (1), with flange mounting bracket (5) installed, to test stand drive coupling.
4. Using barring tool, rotate driveshaft (12) until tapped holes on pump-mounted drive hub (7) are aligned with slots in test stand drive coupling.
5. Install three 3/8-in. washers (8), 3/8-in. lockwashers (9), and 3/8-16x1 hex-head capscrews (10) in slots and mounting holes on test stand drive coupling and pump-mounted drive hub (7). Remove barring tool.

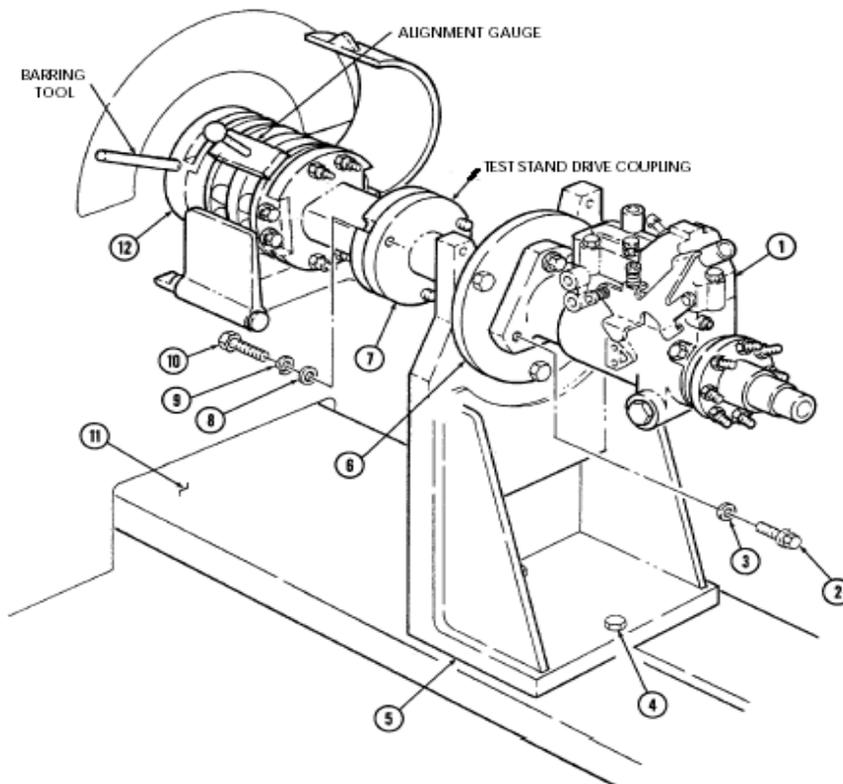
---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTION PUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED**

---

0031

6. Tighten two 3/8-16x1 hex-head capscrews (4) that secure flange mounting bracket (5) to bedplate (11). Remove alignment gauge.



7. Install test adapter and connector on fuel inlet port (2) of fuel injection pump (1).

8. Connect one end of hose assembly to connector and insert other hose end into calibration fluid supply quick-connect on front panel of test stand (3).

9. Remove screw (8), tab (7), washer (6), and O-ring (5) from fuel injection pump transfer port (4).

10. Position test adapter on fuel injection pump transfer test port (4) and secure into position with existing O-ring (5), tab (7), and washer (6) removed in step 9.

11. Install quick-connect plug into test adapter.

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP  
TEST STAND (FTIS) MODEL A8022 - CONTINUED**

---

**0031**

12. Connect one end of rubber hose assembly (9) to quick-connect plug and other hose assembly end to auxiliary pressure quick-connect on front panel of test stand (3).

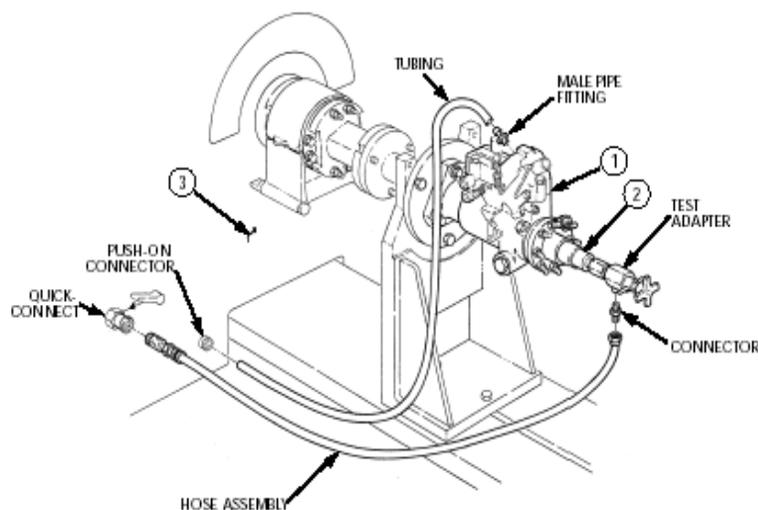
13. Install male pipefitting on fuel injection pump (1).

14. Connect one end of tubing to male pipe fitting on fuel injection pump (1) and other end to calibration fluid push-on connector on front panel of test stand (3).

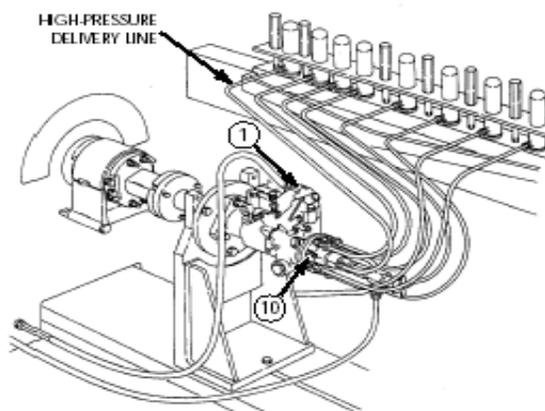
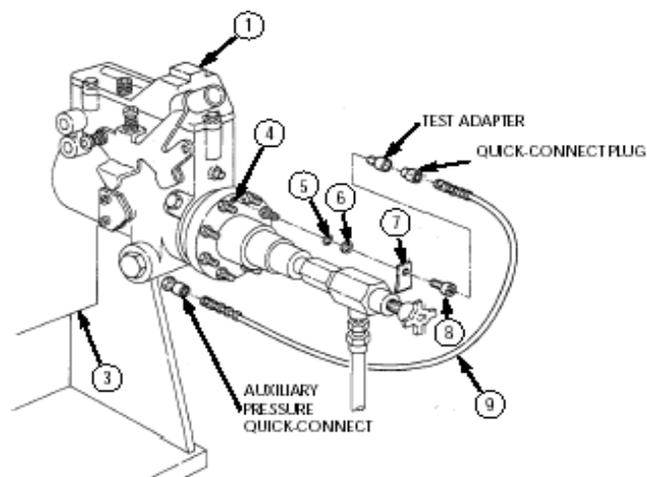
**CAUTION**

When installing high-pressure delivery lines on fuel injection pump, use two wrenches to prevent damage to discharge fittings.

15. Install eight high-pressure delivery lines on discharge fittings (10) of fuel injection pump (1).



**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTION PUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED** **0031**



16. Position throttle arm positioner assembly (3) on bedplate (7) and throttle lever (1).

**NOTE**

When installing advance indicator, ensure the flat on pointer end engages into the cam ring slot on fuel injection pump.

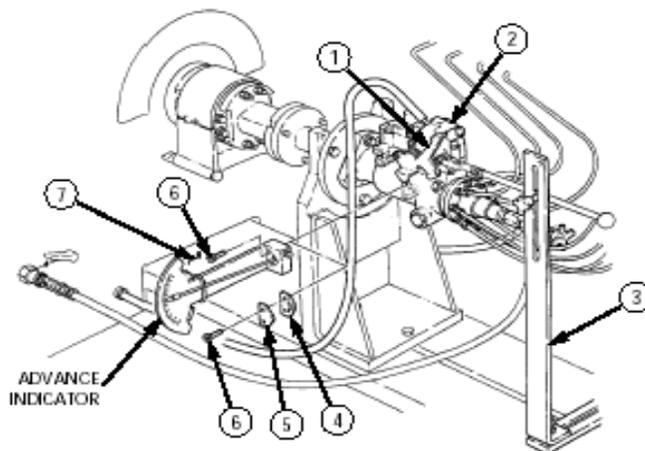
---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTION PUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED**

---

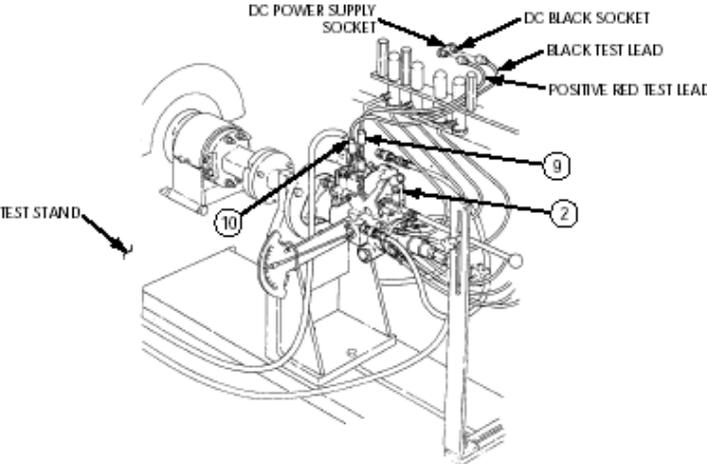
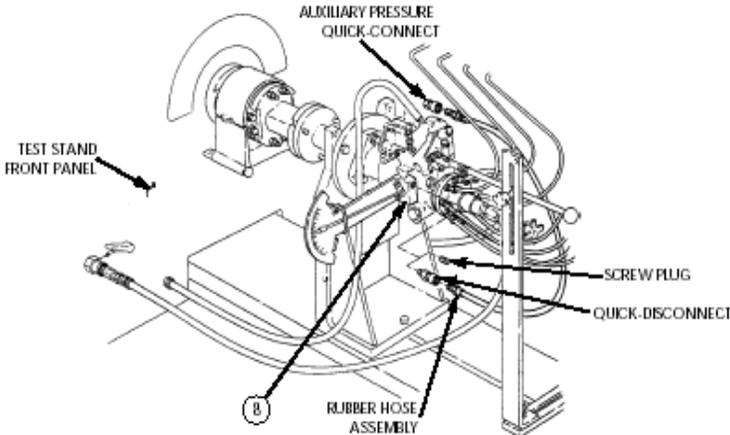
**0031**

17. Remove two screws (6), timing cover (5), and gasket (4) from fuel injection pump (2) and install advance indicator with two screws (6).
18. Remove screw plug from advance indicator block and install quick-connect on advance indicator block (8).
19. Attach one end of rubber hose assembly to quick-connect and the other hose assembly end to auxiliary pressure quick-connect plug on front panel of test stand.
20. Connect positive red test lead to DC power supply socket marked (+) on test stand, and attach the alligator clip end of red test lead to the electric shutoff solenoid terminal (9) on fuel injection pump (2).
21. Connect black lead to DC black socket marked "P" on test stand and connect alligator clip end of black lead to ground terminal (10) on fuel injection pump (2).
22. After installation and hookup of the fuel injection pump has been completed, inspect pump, all hoses, and related hardware connections before beginning pump calibration. Review operation test procedures for the FTIS prior to calibrating the fuel injection pump.



**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED**

0031

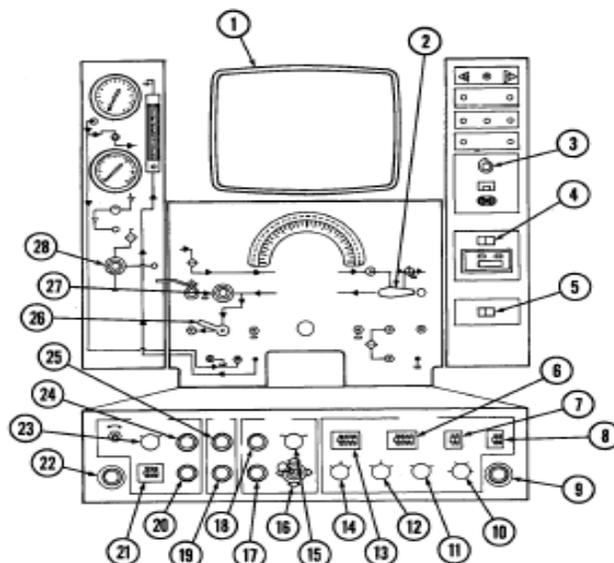


---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED** **0031**

---

**TEST STAND SETUP PROCEDURES**



- |                                      |                                             |
|--------------------------------------|---------------------------------------------|
| 1. Cathode Ray Tube (CRT) Monitor    | 16. Speed Select Control                    |
| 2. Injection Pump/Auxiliary Selector | 17. Main Drive Off                          |
| 3. DC Supply Selector                | 18. Main Drive On                           |
| 4. Printer Switch                    | 19. Lube Oil System Off                     |
| 5. Accumulator Switch                | 20. Calibration Fluid System Off Pushbutton |
| 6. Low-Limit Thumbwheel              | 21. Nominal Temperature Thumbwheel          |
| 7. Outlet Number                     | 22. Stop                                    |
| 8. Number of Outlets                 | 23. Reservoir Bulkhead Selector             |
| 9. Stop                              | 24. Calibration Fluid System On Pushbutton  |
| 10. Mode Selector                    | 25. Lube Oil System On                      |
| 11. Ratio Switch                     | 26. Calibration Fluid System                |
| 12. Units Switch                     | 27. Calibration Fluid Pressure              |
| 13. Hi-Limit Thumbwheel              | 28. Lube Pressure                           |
| 14. Stroke                           |                                             |
| 15. Pump Rotation Selector           |                                             |

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP  
TEST STAND (FTIS) MODEL A8022 - CONTINUED 0031**

---

1. Set test stand in accordance with the following checklist and instructions in steps 2 through 25.

ITEM	SETTING
Bypass Valve	Open Position
Calibration Fluid System	On
Fluid Selector Valve	Injection Pump
Accumulator Switch	Right
Fluid Shutoff Valve	On
Mode Selector	Auto
Ratio Switch	1:2
Units Switch	mm <sup>3</sup> /stroke
Stroke	50
Throttle	WOT
Number of Outlets	8
Outlet Number	Between 1 and 8
Low-Limit Thumbwheel	10.0
Hi-Limit Thumbwheel	Limit Thumbwheel 40.0
Pump Rotation Selector	Counterclockwise
Temperature Select	Bulkhead
Nominal Temperature Thumbwheel	44.7
Master Power Switch	On
DC Supply Selector	17.6 Volts Energize Electric Shutoff
Lube Pressure	Solenoid (ESO)
Lube Oil System	4.5 to 5.5 psi
Main Drive	Pushbutton On
Printer Switch	Pushbutton On
Speed Select Control	On Increase/Decrease Control

2. Set fuel injection pump per calibration chart specifications and settings in WP 0029, 0030, or 0031.

3. Secure throttle positioner arm in Wide Open Throttle (WOT) position.

4. Turn calibration fluid pressure regulator fully counterclockwise.

5. Press calibration fluid system on pushbutton.

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTION PUMP  
TEST STAND (FTIS) MODEL A8022 - CONTINUED**

---

**0031**

---

6. Adjust calibration fluid pressure regulator knob clockwise until 4.5-5.5 psi (31-38 kPa) is indicated on the Cathode Ray Tube (CRT) monitor. Apply 17.6 volts by adjusting the variable DC voltage supply knob to energize the electric shutoff solenoid.

**CAUTION**

Be aware that under no circumstances should the transfer pump pressure exceed 130 psi (896 kPa). Excess pressure will damage pump.

7. Turn on main drive system by pressing main drive on pushbutton and holding button depressed for a minimum of three seconds. Increase pump speed to approximately 150 rpm to prime transfer pump and bleed air from the high-pressure fuel line nuts at each test nozzle.

8. Increase pump speed to 1000 rpm. Ensure throttle lever is secured in WOT position. Run pump approximately 10 minutes to warm the calibration fluid to 110°-115°F (43.3°-46.1°C) and bleed all air from test stand and fuel pump. Observe transfer pump pressure reading on CRT monitor. It should be 70-76 psi (483-524 kPa).

9. If transfer pump pressure does not read 70-76 psi (483-524 kPa), decrease pump speed to 0 rpm and turn off main drive and calibration fluid systems. Disconnect hose at hydraulic head fuel inlet port.

10. Adjust transfer pump pressure with 74-1137 5/32-in. Allen screw-driver (74-8032 adapter kit, slot 3, or equivalent) and reconnect hose. This pressure setting is critical. Repeat test and adjust until transfer pump pressure is within limits.

11. Check pump return flow. With pump speed at 1000 rpm WOT, pump return flow meter should read 225-375 cc/minute. Perform adjustment if necessary.

12. Reduce pump speed to 325 rpm. Move throttle lever to LOW IDLE position and secure. The average flow reading on CRT monitor should be 10-18 mm<sup>3</sup>/stroke. If flow is not correct, adjust low-idle screw or MIN-MAX governor setting to obtain proper flow.

13. With pump speed still at 325 rpm, and throttle lever secured in low-idle position, check/adjust variable DC voltage to 17.6 volts as follows:

- (a) Connect positive red test lead to cold-advance solenoid terminal. Housing pressure reading on CRT monitor should be 0-1 psi (0-7 kPa).

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTION PUMP  
TEST STAND (FTIS) MODEL A8022 - CONTINUED**

---

**0031**

---

(b) Disconnect positive red test lead from cold-advance solenoid terminal. Reduce variable DC voltage to 0 volts. Reconnect red test lead to shutoff solenoid terminal. Reduce pump speed to 200 rpm.

(c) Slowly increase variable DC voltage and note voltage at which time the solenoid pulls in by listening for a clicking sound from the shutoff solenoid. (That indicates proper operation.) The shutoff solenoid should pull in with a maximum of 17.6 volts applied.

14. Reduce pump speed to 75 rpm. Move throttle lever to WOT position and secure. Average flow reading on CRT monitor must be a minimum of 28 mm<sup>3</sup>/stroke.

15. Increase pump speed to 200 rpm with throttle lever secured in WOT position. Average flow reading on CRT monitor must be a minimum of 47 mm<sup>3</sup>/stroke. Disconnect positive red test lead from solenoid shutoff terminal. The average flow reading on CRT monitor must be 4 mm<sup>3</sup>/stroke maximum. Reconnect positive red test lead to shutoff solenoid terminal.

16. Increase pump speed to 325 rpm. Move throttle lever to LOW IDLE position and secure. Average flow reading on CRT monitor should be 10-18 mm<sup>3</sup>/stroke with a minimum of 1.5 degree cam movement on advance indicator. Connect positive red test lead to cold-advance solenoid terminal. Housing pressure reading on CRT monitor should be 0-1 psi (0-7 kPa) with a minimum of 2.75 degree cam movement on advance indicator. Reconnect positive red test lead to shutoff solenoid terminal.

17. Increase pump speed to 750 rpm. Adjust throttle lever to obtain average flow reading on CRT monitor of 21.5-23.5 mm<sup>3</sup>/stroke and secure throttle lever. Advance indicator should have 2.25-4.75 degree cam movement.

18. Increase pump speed to 1000 rpm. Move and secure throttle lever in WOT position. Average flow reading on CRT monitor should be 51.0-55.0 mm<sup>3</sup>/stroke with 0.5-2.5 degree cam movement on advance indicator.

19. Increase pump speed to 1600 rpm and ensure throttle lever is secured in WOT position. There should be 4.25-7.25 degree cam movement on advance indicator. Move throttle lever to LOW IDLE position. There must be a maximum of 10.0 degree cam movement on advance indicator. Move and secure throttle lever in WOT position.

20. Increase pump speed to 1800 rpm and ensure throttle lever is secured in WOT position. Average flow reading on CRT monitor must be a minimum of 44.5 mm<sup>3</sup>/stroke.

21. Increase pump speed to 1950 rpm and ensure throttle lever is secured in WOT position. Average flow reading on CRT monitor must be a minimum of 42.5 mm<sup>3</sup>/stroke.

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP  
TEST STAND (FTIS) MODEL A8022 - CONTINUED**

---

**0031**

22. Increase pump speed to 2100 rpm and ensure throttle lever is secured in WOT position. Average flow reading on CRT monitor must be a maximum of 8 mm<sup>3</sup>/stroke. Transfer pump pressure reading on CRT monitor must be a maximum of 135 psi (931 kPa).
23. Reduce pump speed to 0 rpm and secure test stand. If pump met specifications, remove from test stand and mount in holding fixture. If pump did not meet specifications, repair as necessary and proceed to calibration instructions.
24. Using air timing gauge, check pump timing. Set timing to -0.75 to +1.25 degree.
25. Shut down test stand as follows:
- (a) Main drive pushbutton OFF.
  - (b) Lube pushbutton OFF.
  - (c) Calibration fluid pushbutton OFF.
  - (d) DC selector OFF.
  - (e) Master power switch OFF.

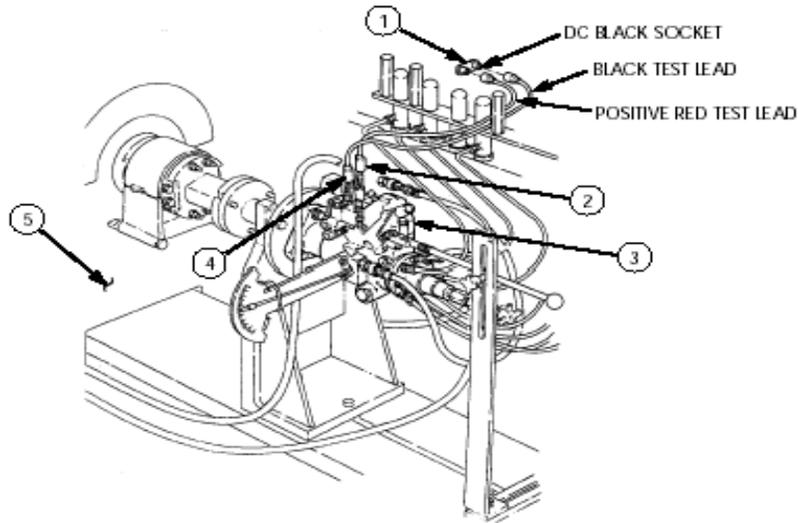
**REMOVAL OF FUEL INJECTION PUMP FROM TEST STAND**

1. Disconnect black test lead from DC black socket marked "P" on test stand (5), and remove alligator clip end of black test lead from ground terminal (4) on fuel injection pump (3).
2. Disconnect positive red test lead from DC power supply socket (1) marked (+) on test stand (5), and remove alligator clip end of red test lead from electric shutoff solenoid terminal (2) on fuel injection pump (3).

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED** **0031**

---



3. Remove rubber hose assembly from quick-connect on advance indicator block and auxiliary pressure quick-connect on front panel of test stand (2).
4. Remove quick-connect from advance indicator block and install screw plug (1) into advance indicator block.
5. Remove two screws (7) and advance indicator from fuel injection pump (4), and install gasket (5) and timing cover (6) on fuel injection pump (4) with two screws (7).
6. Remove throttle arm positioner assembly from bedplate (8) and disconnect from throttle lever (3) on fuel injection pump (4).

**CAUTION**

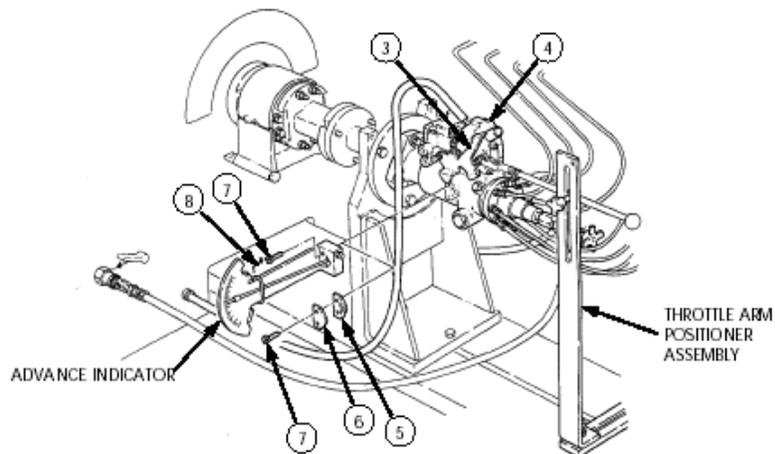
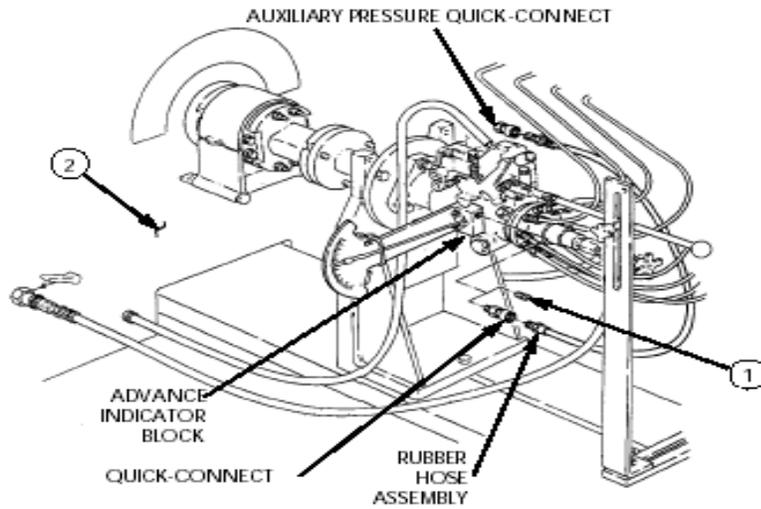
When removing high-pressure delivery lines from fuel injection pump, use two wrenches to protect discharge fittings.

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED** **0031**

---

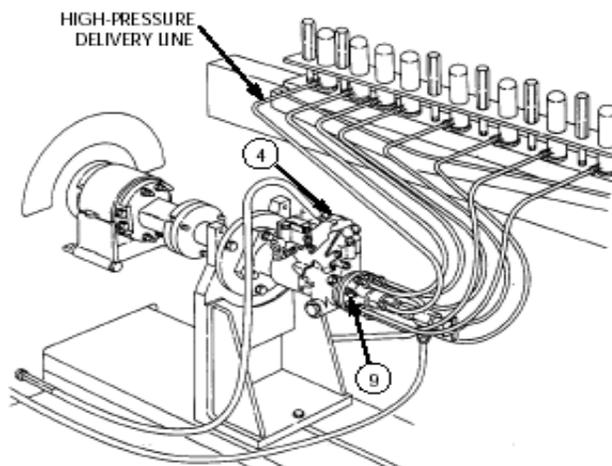
7. Remove eight high-pressure delivery lines from discharge fittings (9) on fuel injection pump (4).



---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTION PUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED** **0031**

---



8. Disconnect tubing from male pipe fitting on fuel injection pump (1) and from calibration fluid pushon connector (3) on front panel of test stand (5).

9. Remove male pipe fitting from fuel injection pump (1).

10. Disconnect rubber hose assembly from quick-connect plug on test adapter and from auxiliary pressure quick-connect (11) on front panel of test stand (5).

11. Remove quick-connect plug from test adapter.

12. Remove test adapter, tab (9), washer (8), and O-ring (7) from transfer test port (6) of fuel injection pump (1).

13. Install O-ring (7), washer (8), tab (9), and screw (10) in transfer test port (6) of fuel injection pump (1).

14. Disconnect hose assembly from connector and calibration fluid supply quick-connect (4) on front panel of test stand (5).

14. Remove test adapter and connector from fuel inlet port (2) of fuel injection pump (1).

---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTIONPUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED** **0031**

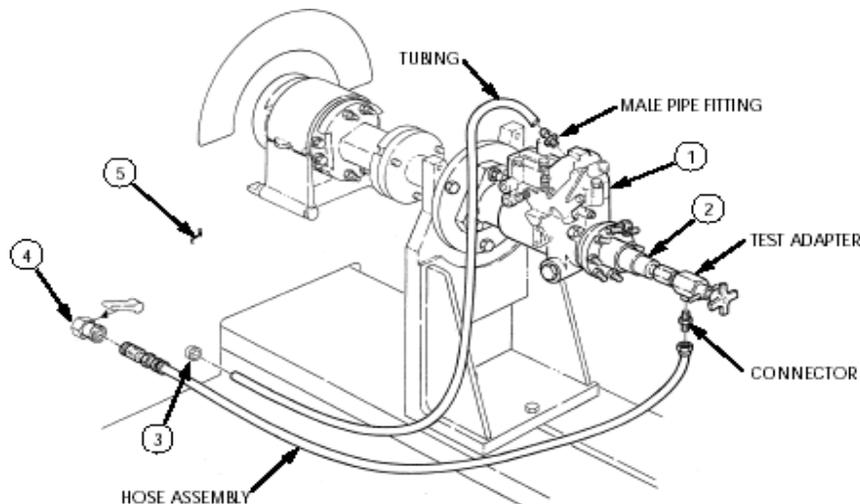
---

16. Remove three 3/8-16x1 hex-head capscrews (20), 3/8-in. lockwashers (19), and 3/8-in. washers (18) from slots and mounting holes on test stand drive coupling (12) and pump-mounted drive hub (17).

17. Loosen two 3/8-16x1 hex-head capscrews (15) from flange mounting bracket (16) and bedplate (21).

18. Remove flange mounting bracket (16) and fuel injection pump (1) from test stand drive coupling (12) and remove alignment gauge and barring tool.

19. Remove three 5/16-18x1 hex-head capscrews (13), 5/16-in. washers (14), and fuel injection pump (1) from adapter plate.

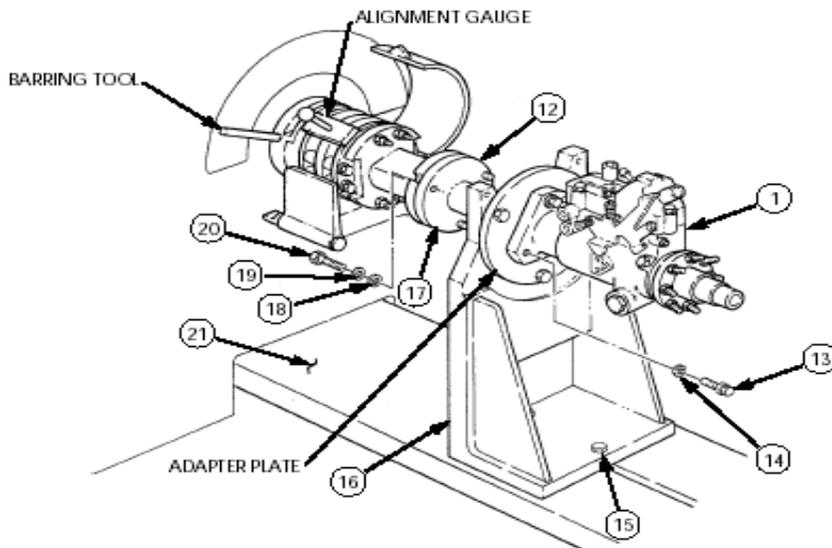
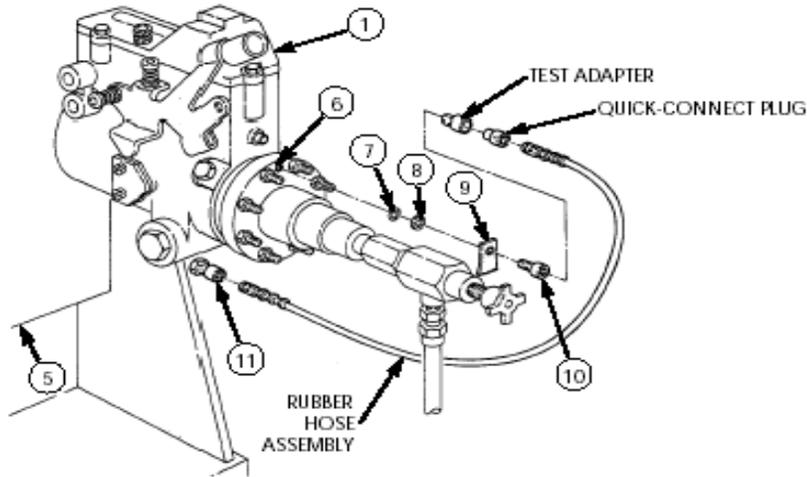


---

**6.5L FUEL INJECTION PUMP (DB2831-5149) CALIBRATION USING FUEL INJECTION PUMP TEST STAND (FTIS) MODEL A8022 - CONTINUED**

---

0031



**END OF TASK**



---

**FUEL INJECTION NOZZLE REPAIR**

**0032**

---

**THIS WORK PACKAGE (WP) COVERS:**

Cleaning, Inspection, Testing

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Test Equipment**

Nozzle tester:

NSN 4910-00-255-8641

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

**General Safety Instructions**

- Do not place hands or arms near nozzle during testing.
  - Compressed air for cleaning purposes will not exceed 30 psi (207 kPa).
  - Wear eyeshields when using compressed air.
- 

**CLEANING**

Clean fuel injection nozzle (2) in accordance with **WP 0007**.

**INSPECTION**

**NOTE**

For general inspection instructions, refer to **WP 0007**.

---

**FUEL INJECTION NOZZLE REPAIR - CONTINUED**

---

**0032**

1. Inspect fuel injection nozzle (2) for thread damage. Replace if damaged.
2. Inspect fuel injection nozzle return nipples (1) for damage. Replace fuel injection nozzle (2) if damaged.
3. Inspect fuel injection nozzle (2) for cracks and evidence of heat damage. Replace if cracked or damaged.

**TESTING**

1. Preparation.
  - (a) Connect fuel injection nozzle (2) to tester.
  - (b) Connect lines to return line nipples (1).

---

**WARNING**

Do not place hands or arms near nozzle during testing.  
Penetrating force of oil may cause serious injury or death.

- (c) Close shutoff valve to pressure gauge on tester.
    - (d) Operate tester to prime nozzle (2).
2. Obtaining pressure check.
  - (a) Open shutoff valve to pressure gauge 1/4 turn.
  - (b) Depress lever on tester slowly. Note at what pressure the needle on pressure gauge stops. Opening pressure must be between 1,500 psi (10,343 kPa) and 1,960 psi (13,514 kPa). Replace nozzle (2) if opening pressure does not meet specifications.
1. Leakage test.
  - (a) Open shutoff valve to pressure gauge one additional turn.

---

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

(b) Blow-dry end of nozzle (2).

**NOTE**

A pressure of 1,400 psi (9,653 kPa) must be maintained for 10 seconds while checking for nozzle leakage.

(c) Depress lever on tester until pressure gauge reads 1,400 psi (9,653 kPa) and observe tip of nozzle (2). If a droplet forms and drops off the nozzle (2) in 10 seconds or less, replace nozzle (2).

**4. Chatter test.**

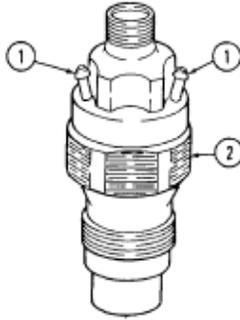
(a) Close shutoff valve to pressure gauge.

(b) Depress lever on tester slowly, noting whether a chattering noise can be heard.

**NOTE**

Faster lever movement may cause nozzle to hiss or squeal rather than chatter; this is acceptable.

(c) If no chatter is heard, increase speed of lever movement on tester until nozzle (2) chatters. If no chatter is heard, replace nozzle (2).



END OF TASK

---

**WATER PUMP REPAIR**

**0033**

---

**THIS WORK PACKAGE (WP) COVERS:**

Disassembly, Cleaning, Inspection, Assembly

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Materials/Parts**

Pipe sealing compound:

NSN 8030-01-054-0740 – 10 CC Bottle

Sealing compound:

NSN 8030-00-148-9833 – 10 CC Bottle

**Test Equipment**

Nozzle tester:

NSN 4910-00-255-8641

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

---

**DISASSEMBLY**

**NOTE**

Perform steps 1 through 3 if replacing water pump or damaged parts.

1. Loosen hose clamp (3) and remove bypass hose (4) from bypass hose adapter (5).
2. Remove 45 degree adapter (1) and heater hose nipple (2) from water pump (6).
3. Remove bypass hose adapter (5) from water pump (6).

---

**WATER PUMP REPAIR - CONTINUED**

---

**0033****CLEANING**

Clean all components in accordance with **WP 0007**.

**INSPECTION****NOTE**

For general inspection instructions, refer to **WP 0007**.

1. Inspect heater hose nipple (2), 45° adapter (1), and bypass hose adapter (5) for thread damage. Replace if threads are damaged.
2. Inspect water pump (6) for cracks and wear. Replace if cracked or worn.
3. Inspect threaded holes in water pump (6) for damage. Replace water pump (6) if threads are damaged.
4. Inspect bypass hose (4) for damage. Replace if damaged.
5. Inspect water pump rivet (7) for damage or looseness. Replace if damaged or loose. Apply sealing compound to replacement rivet prior to installation.

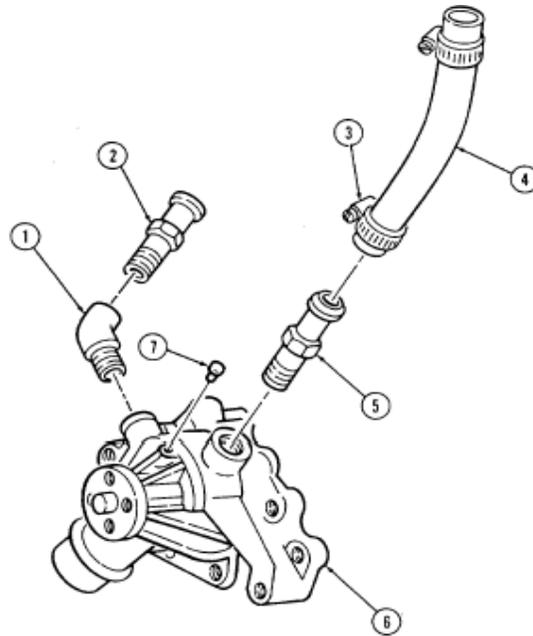
**ASSEMBLY**

1. Coat threads on 45° adapter (1) and heater hose nipple (2) with pipe sealing compound and install in pump (6).
2. Coat threads on bypass hose adapter (5) with pipe sealing compound and install in water pump (6).
3. Install bypass hose (4) on bypass hose adapter (5) and secure with hose clamp (3).

**NOTE**

Perform step 4 if water pump was replaced.

4. Apply sealing compound to water pump rivet (7) and install in water pump (6).



**END OF TASK**



---

**WATER CROSSOVER REPAIR**

**0034**

---

**THIS WORK PACKAGE (WP) COVERS:**

Disassembly, Cleaning, Inspection, Assembly

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Materials/Parts**

Water crossover gasket:

NSN 5330-01-149-0874; PN 10137488

Pipe sealing compound:

NSN 8030-01-054-0740 – 10 CC Bottle

**Equipment Condition**

Engine disassembled into subassemblies (WP 0011).

---

**NOTE**

In some cases, flanged head fasteners may be present instead of standard fasteners and washers. In all cases, washers should be used when replacing a flanged head fastener with a standard fastener.

**DISASSEMBLY**

1. Remove capscrew (6), stud (5), two washers (4), water outlet (7), thermostat (9), and gasket (8) from water crossover (11). Discard gasket (8).

**NOTE**

Only perform steps 2 through 4 if replacing water crossover or damaged parts.

---

**WATER CROSSOVER REPAIR - CONTINUED**

---

**0034**

2. Remove glow plug controller (1).
3. Remove temperature switch (3).
4. Remove de-airation nipple (2), bypass hose nipple (10), and heater hose nipple (12) from water crossover (11).

**CLEANING**

Clean all components in accordance with **WP 0007**.

**INSPECTION****NOTE**

For general inspection instructions, refer to **WP 0007**.

1. Inspect water crossover (11) and water outlet (7) for damage. Replace if damaged.
2. Inspect all threaded holes in water crossover (11) for thread damage. Replace if threads are damaged.
3. Inspect heater hose nipple (12), de-airation nipple (2), and bypass hose nipple (10) for damage. Replace if damaged.
4. Inspect glow plug controller (1), thermostat (9), and temperature switch (3) for damage. Replace if damaged.

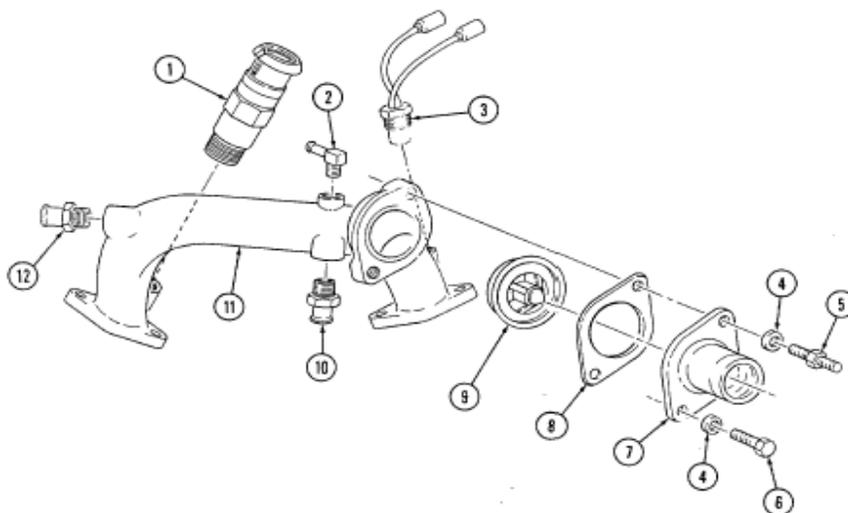
**ASSEMBLY****CAUTION**

Thermostat must be installed correctly or engine damage may result.

**NOTE**

For general assembly instructions, refer to **WP 0007**.

1. Install thermostat (9), gasket (8), and water outlet (7) on water crossover (11) with two washers (4), capscrew (6), and stud (5). Tighten capscrew (6) and stud (5) to 25 lb-ft (34 N•m).
2. Coat threads on heater hose nipple (12), bypass hose nipple (10), and de-airation nipple (2) with pipe sealing compound and install in water crossover (11).
3. Coat threads on glow plug controller (1) and temperature switch (3) with pipe sealing compound and install in water crossover (11).

**END OF TASK**



---

**FAN DRIVE REPAIR**

**0035**

---

**THIS WORK PACKAGE (WP) COVERS:**

Disassembly, Cleaning, Inspection, Assembly

---

**INITIAL SETUP**

**Tools**

General mechanics tool kit: Automotive

NSN 5180-00-177-7033

**Materials/Parts**

Locknut:

NSN 5318-01-194-0481; PN 3029-01371-01

Spring:

NSN 5360-01-190-6214; PN 4088-35869-01

Two shaft O-rings:

NSN 5330-01-194-8966; PN 9002-00181-48

or

NSN 5330-01-195-1500; PN 9002-00741-58

Friction lining:

NSN 2930-01-189-8643; PN 4026-38368-01

Cylinder O-ring:

NSN 5330-01-192-8892; PN 3018-01265-01

Dust seal:

NSN 5330-01-247-8438; PN 3018-01339-01

Grease Seal:

NSN 5330-01-252-0461; PN 3018-01425-01

Lithium grease:

NSN 9150-01-015-1542 – 14.5 Ounce

Cartridge

**Personnel Required**

One mechanic

One assistant

**Equipment Condition**

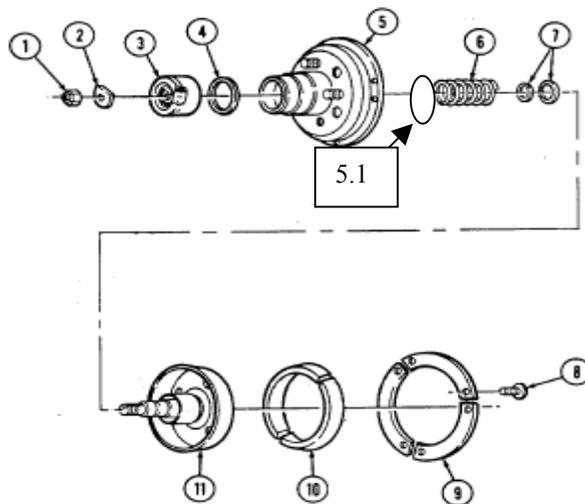
Engine disassembled into subassemblies (WP 0011).

**General Safety Instructions**

- Use eyeshields when cleaning with compressed air.
  - Do not use compressed air to spin bearings.
-

**DISASSEMBLY**

1. Remove six screws (8) and three retaining plates (9) from housing (5).
2. Remove grease seal (5.1) from housing (5). Discard Grease Seal (5.1).
3. Remove friction lining (10) from housing (5). Discard friction lining (10).
4. Remove locknut (1) and tabwasher (2) securing shaft assembly (11) and cylinder assembly (3) to housing (5). Discard locknut (1).
5. Remove cylinder assembly (3) from front of housing (5).
6. Remove O-ring (4) from inside cylinder assembly (3). Discard O-ring (4).
7. Remove shaft assembly (11) and spring (6) from housing (5). Discard spring (6).
8. Remove two O-rings (7) from shaft assembly (11). Discard O-rings (7).



**CLEANING****WARNING**

- Compressed air used for cleaning purposes will not exceed 30 psi (07 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).
- Do not use compressed air to spin bearings. Spinning a dry bearing with compressed air may cause injury to personnel or damage to equipment.

1. Clean shaft assembly (7) and housing (2) with compressed air and wipe with clean cloth.
2. Clean all other parts in accordance with **WP 0007**.

**INSPECTION****NOTE**

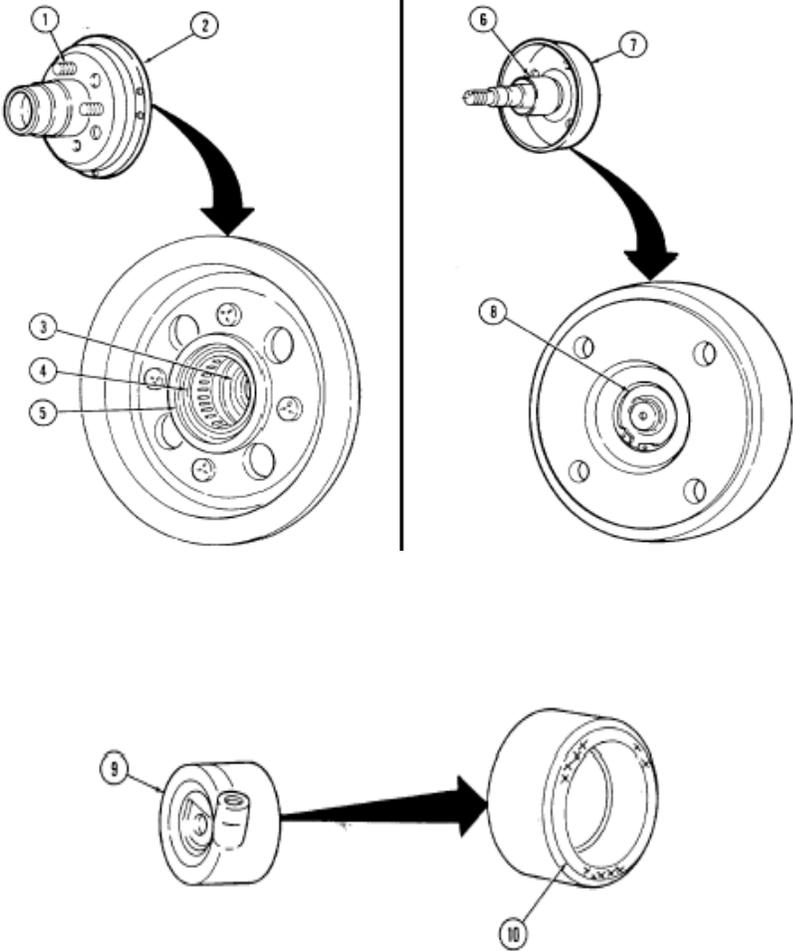
For general inspection instructions, refer to **WP 0007**.

1. Inspect cylinder assembly (9) for damage. Replace if damaged.
2. Inspect roller bearings (3) and (4) in housing assembly (2) for damage. Replace fan drive assembly if damaged.
3. Inspect studs (1) on housing assembly (2) for stripped threads. Replace if damaged.
4. 5. Inspect seal surface (6) on shaft assembly (7) for damage. Replace fan drive assembly if damaged.

FAN DRIVE REPAIR - CONTINUED

0035

5. Inspect bearing (8) on shaft assembly (7) for damage. Replace fan drive assembly if damaged.

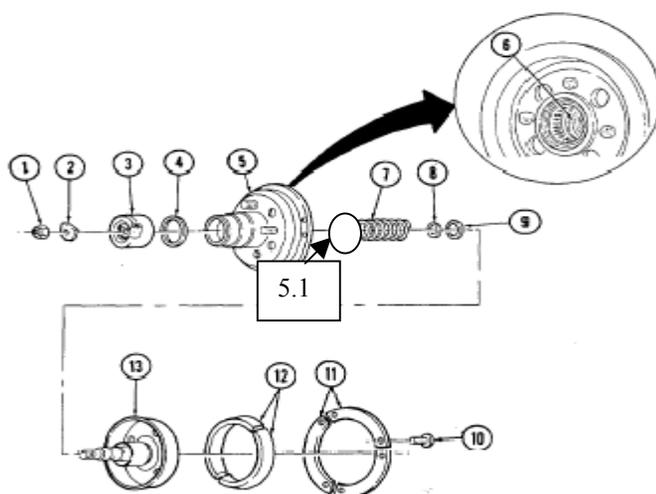


## ASSEMBLY

## NOTE

For general assembly instructions, refer to **WP 0007**.

1. Install O-ring (4) in groove inside cylinder assembly (3).
2. Install grease seal (5.1) into housing (5) with seal lip toward bearing.
2. Install cylinder assembly (3) on housing (5).
3. Install large O-ring (9) and small O-ring (8) on shaft assembly (13).
4. Lubricate roller bearing (6) with lithium grease,
5. Install shaft assembly (13) and spring (7) in housing (5).
6. Install shaft assembly (13) on cylinder assembly (3) with tabwasher (2) and locknut (1). Tighten locknut (1) to 96 lb-in. (11 N•m).
7. Install friction lining (12) in housing (5).
8. Install three retaining plates (11) on housing (5) with six screws (10). Tighten screws (10) to 22 lb-in. (3 N•m),



END OF TASK

0035 00-5/6 blank



**ENGINE ASSEMBLY FROM SUBASSEMBLIES****0036****THIS WORK PACKAGE (WP) COVERS:**

(a) Crankshaft and Main Bearings, (b) Installation of Drain Tube, (c) Flywheel, (d) Pistons and Connecting Rods, (e) Oil Pump, (f) Camshaft, (g) Timing Chain and Drive Sprockets, (h) Timing Gear Cover, (i) Oil Pan, (j) Oil Filter and Adapter, (k) Fuel Pump, (l) Oil Pump Drive, (m) Fuel Injection Pump, (n) Water Pump and Adapter Plate, (o) Valve Lifters, (p) Cylinder Heads, (q) Glow Plugs, (r) Fuel Injection Nozzles, (s) Rocker Arm Shafts and Pushrods, (t) Rocker Arm Covers, (u) Fuel Supply and Return Lines, (v) Fuel Injection Lines, (w) Water Crossover, (x) Intake Manifold, (y) Exhaust Manifold, (y.1.) Turbocharger, (y.2.) Manifold-to-Turbocharger Exhaust Pipe, (y.3.) Wastgate Housing, (y.4.) Wastgate Actuator, (z) Torsional Damper, (aa) Crankshaft Pulley, (bb) Fan Drive and Water Pump Pulley

**INITIAL SETUP****Tools**

General mechanics tool kit: Automotive	NSN 5180-00-177-7033
Feeler gauge:	NSN 5210-01-045-3526
Piston ring compressor:	NSN 5120-00-250-6055

**Special Tools**

Rear main seal installer ( <b>6.5L</b> )	NSN 5120-01-422-0334; PN J39084
Injector nozzle socket:	NSN 5120-01-171-5233; PN J29873
Glow plug socket:	NSN 5120-00-277-1473; PN FUS121
Hex-head driver, 6 mm:	NSN 5120-01-055-1308; PN FAM6
Hex-head driver, 8 mm:	NSN 5120-01-053-4159; PN FAM8
Hex-head driver, 5/16-in.:	NSN 5120-00-683-8602; FA10B
Crowfoot, 16 mm:	NSN 5120-01-242-8165; PN J35159
Crowfoot, 19 mm:	NSN 5120-01-230-9421; PN J35160

**Materials/Parts**

Turbocharger oil gasket:	NSN N/A; PN 10218787
Intake manifold gasket kit:	NSN 5330-01-157-0856; PN 15633464
Two center intake manifold gaskets, turbo engine:	NSN 5330-01-437-0547; PN 10211661
Two O-rings:	NSN 5330-00-585-7723; PN MS28775-020
Fuel pump gasket:	NSN 5330-01-112-1533; PN 10114141
Adapter plate gasket:	NSN 5330-00-830-1745; PN 10108438
Oil pump drive gasket:	NSN 5330-01-156-5147; PN 14022649
Water pump gasket:	NSN 5330-01-147-9808; PN 10137492
Injection pump gasket:	NSN 5330-01-150-5944; PN 10137486
Two cylinder head gaskets:	NSN 5330-01-367-2308; PN 10149600

**ENGINE ASSEMBLY FROM SUBASSEMBLIES - CONTINUED****0036**

Two water crossover gaskets:	NSN 5330-01-149- 0874; 10137488
Eight injector nozzle gaskets:	NSN 5330-01-150-1215; PN 14025557
Two exhaust manifold gaskets:	NSN 5330-01-194-0472; PN 5574856
Front cover oil seal:	NSN 5330-00-110-8437; 3860095
Rear oil pan seal:	NSN 5330-01-150-7744; PN 14022683
Oil filter:	NSN 2940-00-082-6034; PN 6438148
Eight rod bearings:	NSN 3120-01-155-3317; PN 18009094
Oil filter adapter bolt gasket:	NSN 5330-01-184-6500; PN 5577933
Three woodruff keys:	NSN 5315-00-012-4548; PN 106751
Oil pan gasket set:	NSN 5330-01-310-6780; PN OS30442A
Two rocker arm cover gaskets:	NSN 5330-01-372-0636; PN 91599
Rear main oil seal ( <b>6.5L</b> ):	NSN5330-01-378-8577; PN 23503969
O-ring:	NSN 5330-01-184-6500; PN 5577933
Adhesive:	NSN 8040-00-826-3535 – 16 Ounce Bottle NSN 8040-01-043-7537 – 1 Pound Container
Bearing clearance gauge:	NSN 5210-00-640-6177 -- Box
Sealer, anaerobic gasket:	NSN 8030-01-374-3504 – 50 Milliliter Tube NSN 8030-01-374-2338 – 300 Milliliter
Lubricating oil OE/HDO:	NSN 9150-00-189-6727 – 1 Quart Can NSN 9150-00-186-6618 – 5 Gallon Drum NSN 9150-00-191-2772 – 55 Gallon Drum
Silicone sealant:	NSN 8030-01-159-4844 – 50 Milliliter
Pipe sealing compound:	NSN 8030-01-054-0740 – 10 CC Bottle
Sealing compound:	NSN 8030-00-148-9833 – 10 CC Bottle

**General Safety Instructions**

- Crankshaft must be supported during removal and installation.
- Do not perform this procedure near fire, flame, or sparks .

**NOTE**

- During assembly operations, it is important to closely inspect each unit to make sure nothing has been overlooked during inspection and repair. Plugs should be checked for tightness, parts kept clean, openings covered, and machined surfaces protected. Application of lubricant should be performed from covered containers.
- Work area should be clean, well-ventilated, and free of blowing dirt and dust.
- In some cases, flanged head fasteners may be present instead of standard fasteners and washers. In all cases, washers should be used when replacing a flanged head fastener with a standard fastener.
- For general assembly instructions, refer to **WP 0007**.

**a. CRANKSHAFT AND MAIN BEARINGS****NOTE**

- Measure outside diameter of crankshaft main bearing journals to determine what thickness main bearings to install.
- Main bearings are of the precision insert type and do not utilize shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and undersize.
- Selective fitting of both rod and main bearing inserts is necessary in production in order to obtain close tolerances. For this reason you may find one-half of a standard insert with one half of a 0.001 in. (0.025 mm) undersize insert, which will decrease the clearance 0.0005 in. (0.013 mm) from using a full standard bearing.

---

**ENGINE ASSEMBLY FROM SUBASSEMBLIES - CONTINUED**

---

**0036**

1. Remove all capscrews (1) and (2) and bearing caps (3) and install upper halves of main bearings (7) in cylinder block (6).
2. Install lower halves of main bearings (4) in bearing caps (3).

---

**WARNING**

---

Crankshaft must be supported during removal and installation. Failure to support crankshaft may cause injury to personnel or damage to equipment.

3. Install crankshaft (8) in cylinder block (6).

**NOTE**

The gaging plastic shall be positioned the full width of the bearing and centered on the bearing journal when the bearing cap is installed.

4. Position gauging plastic on bearing journal (5) the full width of the bearing (4) and parallel to the center line of the crankshaft (8).

**CAUTION**

Bearing caps are numbered 1 through 5 and must be installed in correct order, starting with number 1 at front of cylinder block. Arrow on bearing cap must point forward or engine damage will result.

5. Install bearing cap (3) on cylinder block (6) with two long capscrews (1) and short capscrews (2). Tighten capscrews (1) and (2) finger tight.
6. Tighten all long capscrews (1) to 110 lb-ft (149 N•m). Tighten all short capscrews (2) to 100 lb-ft (136 N•m).

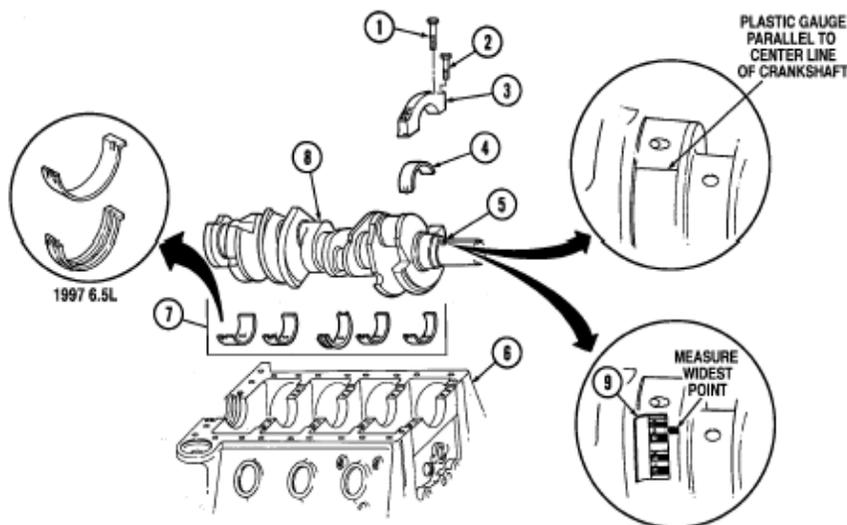
7. Remove two long capscrews (1), short capscrews (2), and bearing cap (3) from cylinder block (6).
8. On edge of envelope (9) there is a scale which is graduated in thousandths of an inch. Without removing gauging plastic, measure its thickness at the widest point with scale on envelope (9).
9. If gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot, or irregularity of bearing or crankshaft journal. If gauging plastic indicates more than 0.001 in. (0.025 mm) taper, measure crankshaft journal with micrometer (**WP 0013**).

### NOTE

If unable to obtain the proper crankshaft journal clearance, it is acceptable to use a standard bearing with a 0.0005 in. (0.013 mm) or 0.001 in. (0.025 mm) undersize bearing to produce clearance. If unable to produce proper clearance, replace crankshaft.

10. If the measurement is within the specifications of 0.002-0.004 in. (0.051-0.102 mm), go to step 11. If measurement is not within specifications, a 0.0005 in. (0.013 mm) or 0.001 in. (0.025 mm) undersize bearing may produce proper bearing clearance. Replace bearings and repeat steps 4 through 10.

11. Repeat steps 4 through 10 for remaining main bearings.



---

**WARNING**

---

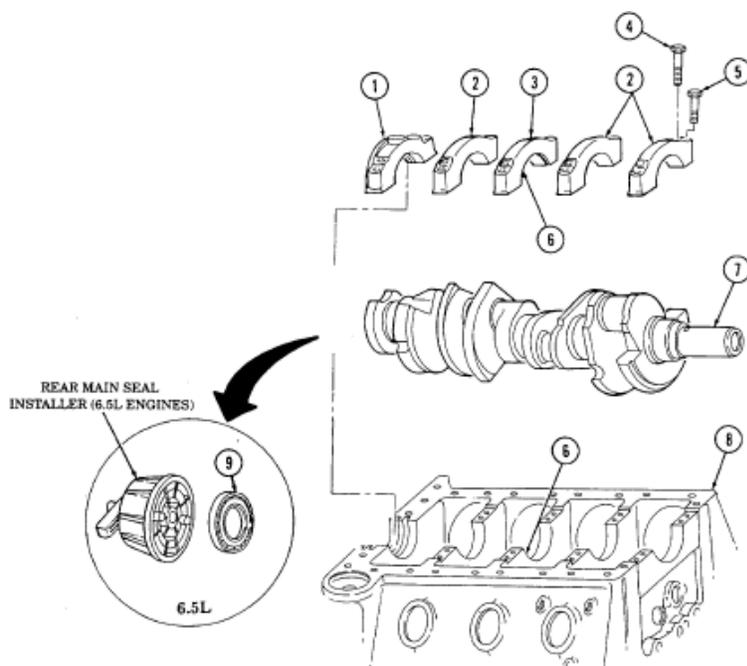
Crankshaft must be supported during removal and installation. Failure to support crankshaft may cause injury to personnel or damage to equipment.

**CAUTION**

Bearing caps are numbered one through five and must be installed in correct order, starting with number one at front of cylinder block. Arrow on bearing cap must point forward or engine damage will result.

12. After all main bearing clearances have been set, remove crankshaft (7) and gauging plastic and apply OE/HDO to all main bearings. Install crankshaft (7), all bearing caps (1), (2), and (3), long capscrews (4) and short capscrews (5). Tighten long capscrews (4) and short capscrews (5) to 12 lb-ft (16 N•m).
13. Tap crankshaft (7) rearward, then forward; this will align main bearing thrust surfaces (6).
14. Tighten long capscrews (4) and short capscrews (5) to 40 lb-ft (54 N•m). Tighten all long capscrews (4) to 110 lb-ft (149 N•m). Tighten all short capscrews (5) to 100 lb-ft (136 N•m).
15. Rotate crankshaft (7) to ensure crankshaft (7) rotates freely.
16. Force the crankshaft (7) to the extreme front position and hold in place. Measure end play at the front end of the number three bearing with a feeler gauge. End play should be 0,004-0.010 in. (0.101-0.250 mm).
17. Apply thin film of sealer to rear main bearing cap (1) mating surface. Keep sealer off bearing and oil seal (9) (installed on 6.2L engines).
18. Install rear main bearing cap (1) on cylinder block (8) with long capscrews (4), and short capscrews (5). Tighten capscrews (4) and (5) to 40 lb-ft (54 N•m).
19. Install remaining bearing caps (2) on cylinder block (8) with long capscrews (4) and short capscrews (5). Tighten capscrews (4) and (5) to 40 lb-ft (54 N•m).

20. Evenly tighten all long capscrews (4) to 110 lb-ft (149 N•m).
21. Evenly tighten all short capscrews (5) to 100 lb-ft (136 N•m).
22. Coat rear crankshaft (7) surface with engine oil, and lightly coat lip of rear main oil seal (9) with engine oil.
23. Install rear main oil seal (9), with spring Cavity towards cylinder block (8), on crankshaft (7).
24. Using seal installer, drive rear main oil seal (9) in until tool bottoms against cylinder block (8) and rear main bearing cap (1).

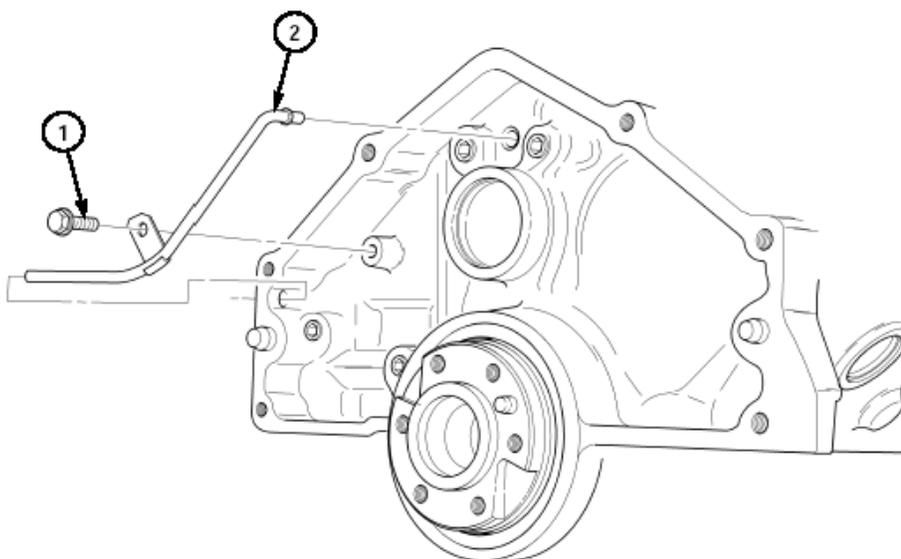


**b. INSTALLATION OF DRAIN TUBE:**

Install tube (14066252) (2) into left hand side of engine block. Apply sealer (9985530) to flanged end of tube and insert into existing hole in top center of engine block. Secure tube to engine block with bolt (14002104) (1) . Tighten bolt to 25 lb-ft. 34N-m.

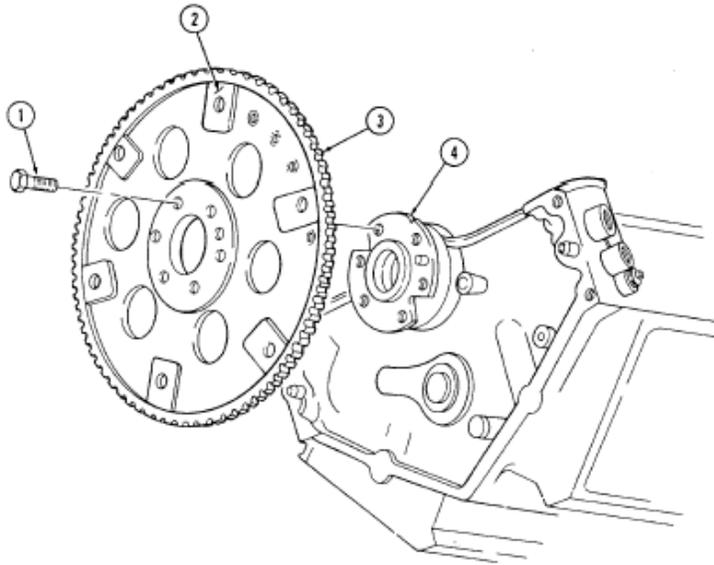
*Rear Engine Drain Tube.*

(1) ITEM NO	(2) SMR CODE	(3) NSN	(4) CAGEC	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
1	PAOZZ		1RGD4	14002104	BOLT .....	1
2	PAOZZ		1RGD4	14066252	TUBE ASSEMBLY, METAL .....	1



**c. FLYWHEEL**

1. Install flywheel (3) on crankshaft (4) so that converter mounting surface (2) faces outward.
2. Secure flywheel (3) to crankshaft (4) with six capscrews (1). Tighten capscrews (1) to 65 lb-ft (88 N•m).

**d. PISTONS AND CONNECTING RODS**

1. Rotate cylinder block (6) approximately 90°.

**NOTE**

Measure outside diameter of crankshaft rod bearing journals to determine what thickness connecting rod bearings to install.

2. Check identification number on side of connecting rod (9) and install upper rod bearing half (7) in connecting rod (9) and lower rod bearing half (12) in corresponding rod cap (5).
3. Rotate crankshaft (4) so rod journal (13) faces outward.
4. Cover connecting rod bolts (8) with 3/8-in. inside diameter rubber hose.

5. Apply OE/HDO to piston rings (11) and piston (10).

**NOTE**

Make sure all ring gaps are staggered so they are not in line with each other or piston pin.

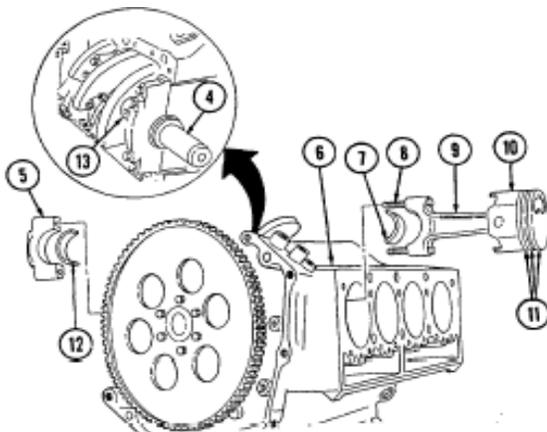
6. Compress piston rings (11) with ring compressor.

**NOTE**

- Depression on top of piston must be assembled toward outside of engine.
- Starting from front of cylinder block, cylinders 1, 3, 5, and 7 are on left side and cylinders 2, 4, 6, and 8 are on right side.
- For remaining pistons, rotate crankshaft so rod journal faces outward.

7. Check identification number on side of connecting rod (9) and install piston (10) and connecting rod (9) into corresponding cylinder.

8. Tap piston (10) into cylinder until connecting rod (9) seats on crankshaft (4) and remove rubber hoses.



**NOTE**

The gauging plastic shall be positioned the full width of the bearing and centered on the bearing journal when the bearing cap is installed.

9. Position gauging plastic on bearing journal (3) the full width of the bearing (4) and parallel to the center line of the crankshaft.

**NOTE**

Identification numbers on connecting rods and rod caps must be installed on the same side.

10. Check identification number on side of connecting rod (6) and install corresponding rod cap (2).

11. Secure rod cap (2) to connecting rod (6) with two nuts (1) and tighten to 44-52 lb-ft (60-71 N•m).

12. Remove two nuts (1) and rod cap (2) from connecting rod (6).

13. Measure gauging plastic at its widest point.

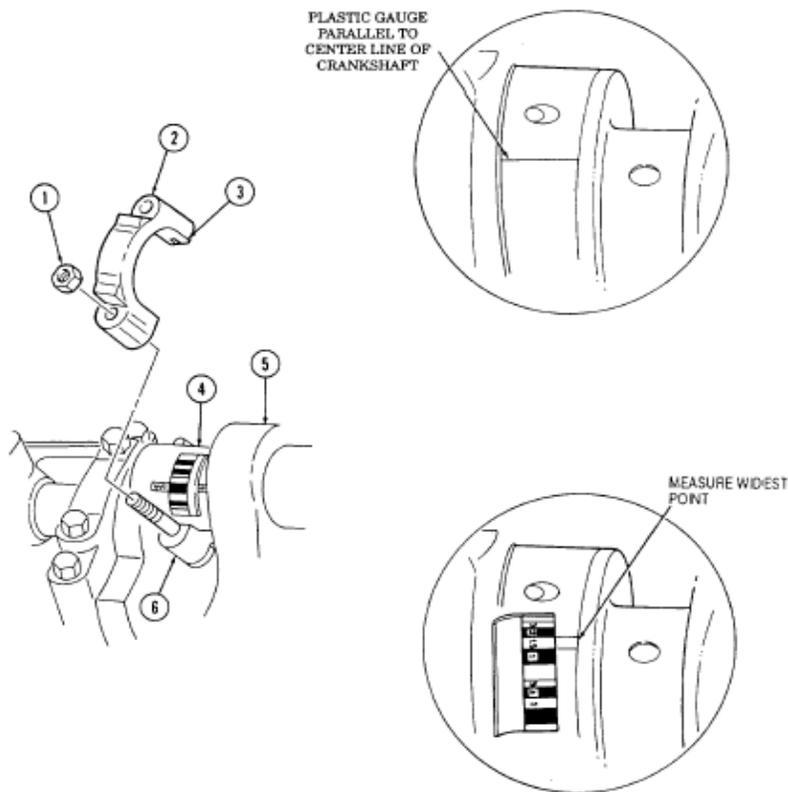
14. If the gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot, or irregularity of bearing or crankshaft journal. If gauging plastic indicates more than 0.001 in. (0.025 mm) taper, measure crankshaft journal with micrometer (WP 0013).

**NOTE**

It is acceptable to use a standard bearing with a 0.001 in. (0.025 mm) undersize bearing to obtain the proper rod bearing clearance. If unable to produce proper clearance, replace crankshaft.

15. If the measurement is within specification, 0.002-0.004 in. (0.051-0.102 mm) bearing is satisfactory.

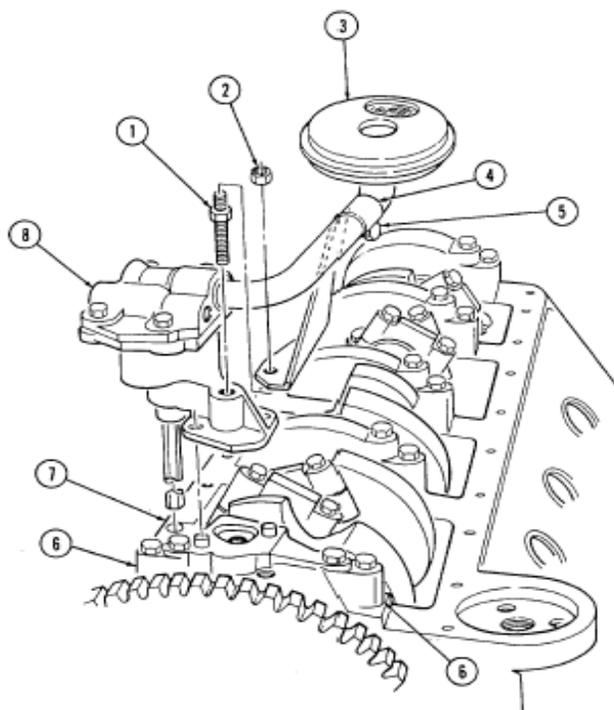
16. If measurement is not within specifications, a 0.001 in. (0.025 mm) undersize bearing may produce proper bearing clearance. Replace bearings and repeat steps 9 through 15. Remove gauging plastic.
17. Apply OE/HDO to rod bearings. Check identification number on side of connecting rod (6) and install corresponding rod cap (2).
18. Secure rod cap (2) to connecting rod (6) with two nuts (1) and tighten to 44-52 lb-ft (60-71 N•m).
19. Rotate crankshaft (5) to ensure crankshaft (5) rotates.
20. Repeat steps 2 through 19 for remaining pistons and connecting rods.



#### e. OIL PUMP

1. Rotate cylinder block (7) so crankshaft faces upward.
2. Install oil pump (8) on rear main bearing cap (6).

3. Install stud (1) and oil pump (8) on rear main bearing cap (6) and tighten stud (1) to 59-74 lb-ft (80-100 N•m).
4. Install pickup tube bracket (4) on stud (1) with nut (2). Tighten nut (2) to 35 lb-ft (48 N•m).
5. Tighten capscrew (5) securing pickup tube bracket (4) to pickup tube (3) to 12 lb-ft (16 N•m).

**f. CAMSHAFT**

1. Rotate cylinder block (7) 180°.
2. Apply OE/HDO to all bearing journals (12) and cam lobes (11) on camshaft (13).

**CAUTION**

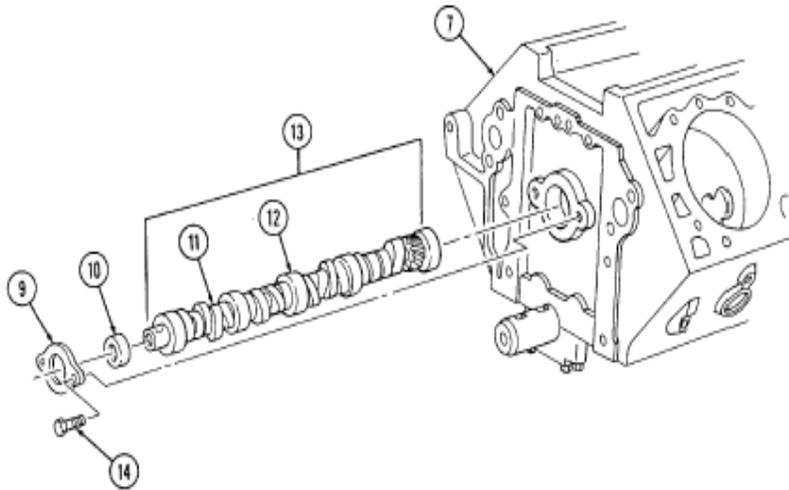
Support camshaft during installation to prevent damage to camshaft bearings.

3. Install camshaft (13) into cylinder block (7).

### NOTE

Beveled edge of spacer must seat against front bearing journal on camshaft.

4. Install spacer (10) and camshaft thrust plate (9) with two capscrews (14). Tighten capscrews (14) to 18 lb-ft (24 N•m).



### g. TIMING CHAIN AND DRIVE SPROCKETS

1. Install woodruff key (7) in camshaft (6) and woodruff key (8) in crankshaft (9).

2. Install crankshaft sprocket (10) and camshaft sprocket (4) in timing chain (5) and align timing marks (11).

3. Rotate crankshaft (9) and camshaft (6) so woodruff keys (7) and (8) align with keyway slots in crankshaft sprocket (10) and camshaft sprocket (4).

**CAUTION**

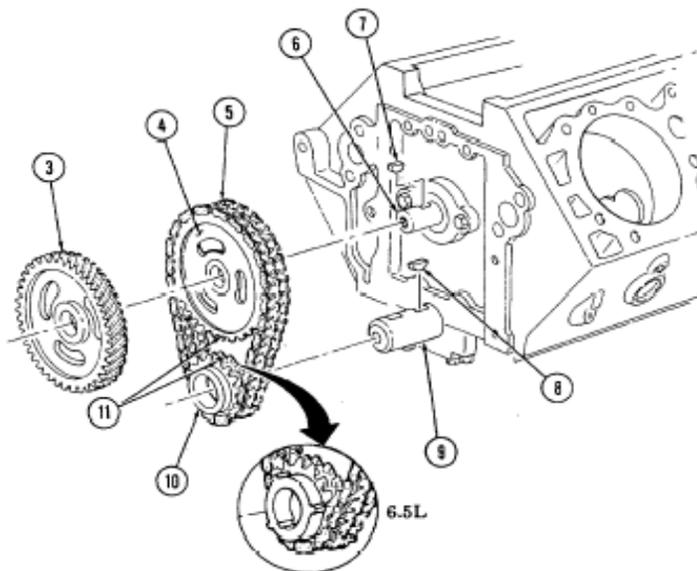
Timing marks on crankshaft sprocket and camshaft sprocket must remain aligned after installation or engine damage may result.

4. Install crankshaft sprocket (10), camshaft sprocket (4), and timing chain (5) as an assembly onto camshaft (6) and crankshaft (9).
5. Install pump drive gear (3) on camshaft (6) with washer (2) and capscrew (1). Tighten capscrew (1) to 55-66 lb-ft (75-90 N•m).
6. Apply OE/HDO to timing chain (5).

**NOTE**

Ensure timing chain deflection is correct.

7. Check timing chain deflection midway between camshaft sprocket (4) and crankshaft sprocket (10). Total deflection must not exceed 0.5 in. (12.7 mm). If deflection exceeds specification, inspect camshaft sprocket (4) and crankshaft sprocket (10) for damage. Replace either if damaged and recheck deflection.



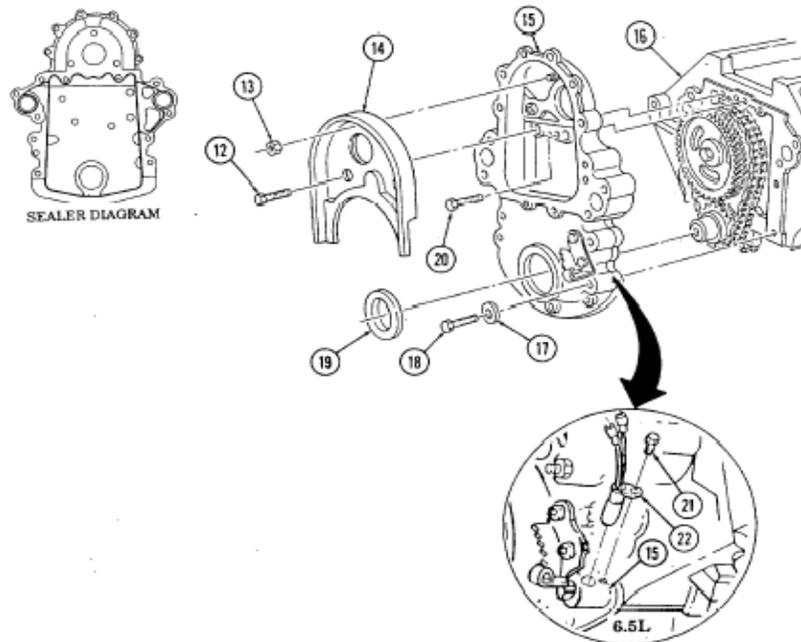
**h. TIMING GEAR COVER**

1. Install front cover seal (19) in timing gear cover (15), ensuring lip of seal (19) faces inward.
2. Apply a 3/32 in. (2 mm) bead of sealer to sealing surface on timing gear cover (15), following diagram shown.
3. Install timing gear cover (15) on cylinder block (16) with four washers (17), capscrews (18), and short capscrews (20). Tighten four capscrews (18) and short capscrews (20) to 33 lb-ft (45 N•m).

**CAUTION**

Maintain 0.040 in. (1.02 mm) minimum clearance between baffle plate and pump drive gear to avoid noise.

4. Install baffle plate (14) in timing gear cover (15) with two capscrews (12) and nut (13). Tighten capscrews (12) and nut (13) to 33 lb-ft (45 N•m).
5. Install rpm sensor (22) in timing gear cover (15) with capscrew (21).



### i. OIL PAN

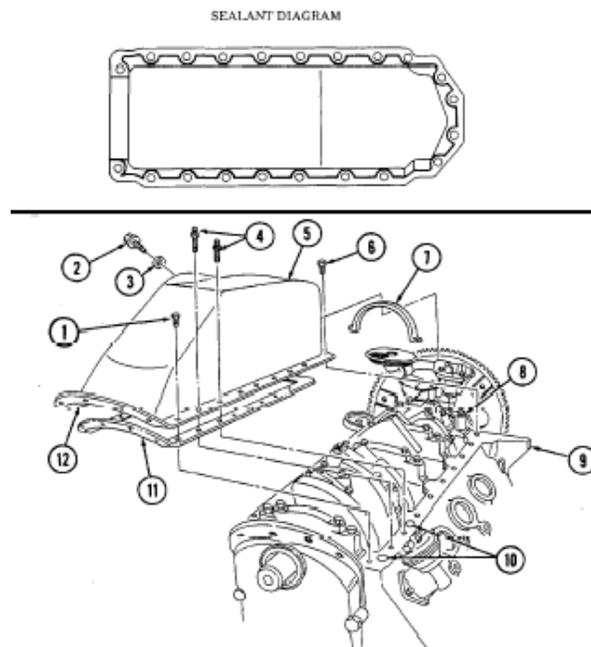
1. Rotate cylinder block (9) 180°.
2. Install oil pan rear seal (7) in rear main cap (8) and apply a drop of silicone sealant at each end of seal (7).

### NOTE

Install oil pan immediately after application of sealant.

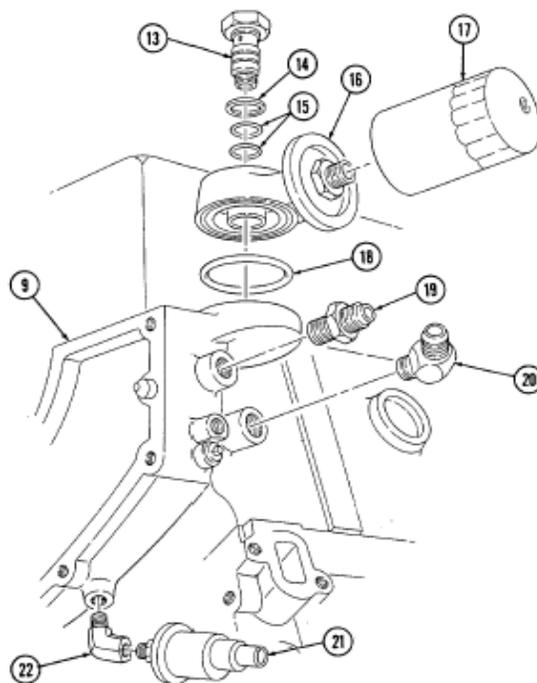
**ENGINE ASSEMBLY FROM SUBASSEMBLIES - CONTINUED****0036**

3. Apply a 3/16 in. (5 mm) bead of silicone sealant around two large holes (10) on cylinder block (9). Apply a 3/16 in. (5 mm) bead of silicone sealant around oil pan sealing surface (12), following diagram shown.
4. Install oil pan (5) on cylinder block (9) with twenty capscrews (1), two studs (4), and two large capscrews (6). Tighten studs (4) and capscrews (1) to 48-120 lb-in. (5-14 N•m) and capscrews (6) to 156-240 lb-in. (18-27 N•m).
5. Install drainplug (2) and washer (3) in oil pan (5). Tighten drainplug (2) to 20 lb-ft (27 N•m).

**j. OIL FILTER AND ADAPTER**

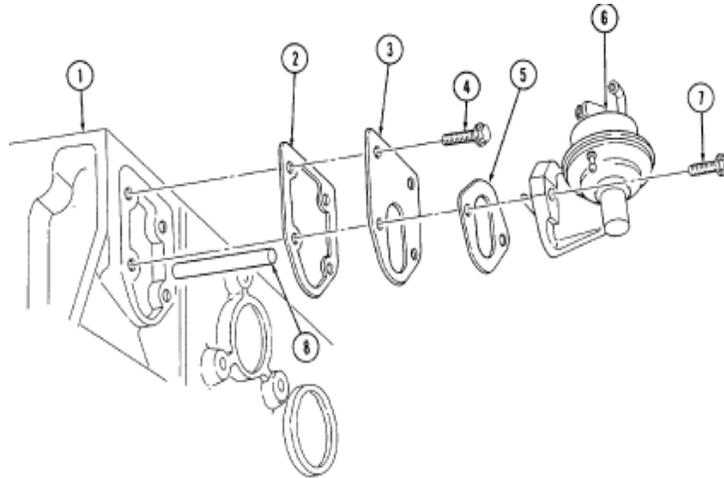
1. Install two O-rings (15) on adapter bolt (13).
2. Install O-ring (18) on adapter (16).
3. Install adapter (16) on cylinder block (9) with adapter bolt (13) and gasket (14). Tighten adapter bolt (13) to 40 lb-ft (54 N•m).

4. Install oil filter (17) on adapter (16). Tighten oil filter (17) until gasket contacts adapter (16) and tighten an additional 1/2 to 3/4 turn.
5. Coat threads on fitting (22) with pipe sealing compound and install in cylinder block (9).
6. Coat threads on oil pressure sending unit (21) with pipe sealing compound and install in fitting (22).
7. Coat threads on cooler line adapters (19) and (20) with pipe sealing compound and install in cylinder block (9).



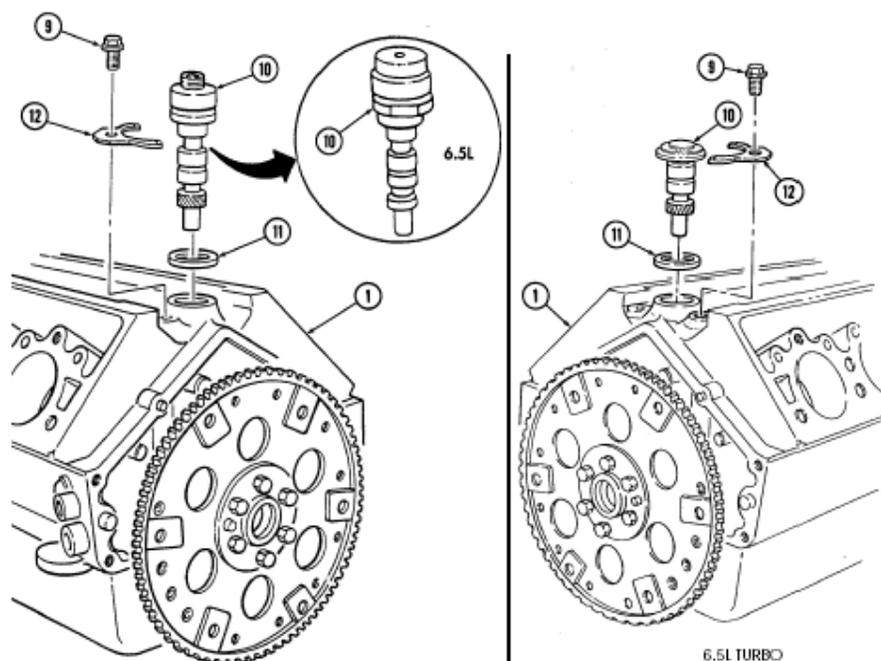
#### k. FUEL PUMP

1. Apply OE/HDO to pushrod (8) and install into cylinder block (1).
2. Install gasket (2) and adapter plate (3) on cylinder block (1) with two cap screws (4). Tighten cap screws (4) to 48-84 lb-in. (5-10 N•m).
3. Install gasket (5) and fuel pump (6) on adapter plate (3) with two cap screws (7). Tighten cap screws (7) to 20-30 lb-ft (27-41 N•m).



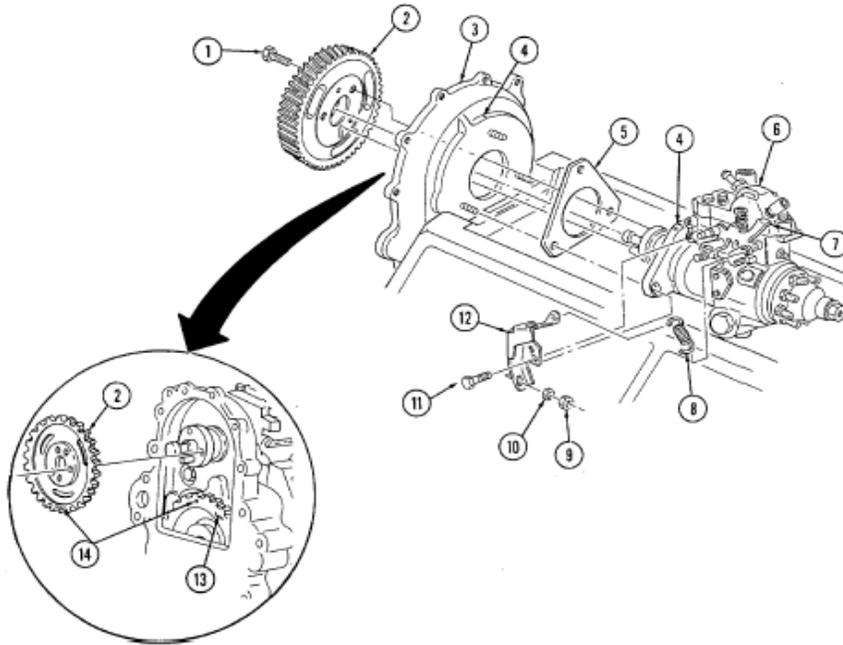
## I. OIL PUMP DRIVE

1. Rotate cylinder block (1) 180 degrees.
2. Install gasket (11) and oil pump drive (10) into cylinder block (1).
3. Secure oil pump drive (10) with clamp (12) and capscrew (9). Tighten capscrew (9) to 25-37 lb-ft (34-50 N•m).



### m. FUEL INJECTION PUMP

1. Install gasket (5) and injection pump (6) on timing gear cover (3).
2. Install accelerator cable bracket (12) on fuel injection pump (6) with two capscrews (11). Tighten capscrews (11) to 13 lb-ft (18 N•m).
3. Install idle return spring (8) on throttle lever (7) and accelerator cable bracket (12).
4. Align timing marks (4) on injection pump (6) and timing gear cover (3).
5. Install injection pump (6) to timing gear cover (3) with three washers (10) and washer nuts (9).
6. Rotate crankshaft until timing mark (14) on pump drive gear (13) is straight up.
7. Align timing marks (14) on pump drive gear (13) and pump driven gear (2) and install driven gear (2) into timing gear cover (3).
8. Install three capscrews (1) on driven gear (2) and tighten capscrews (1) to 13-20 lb-ft (18-27 N•m).



#### n. WATER PUMP AND ADAPTER PLATE

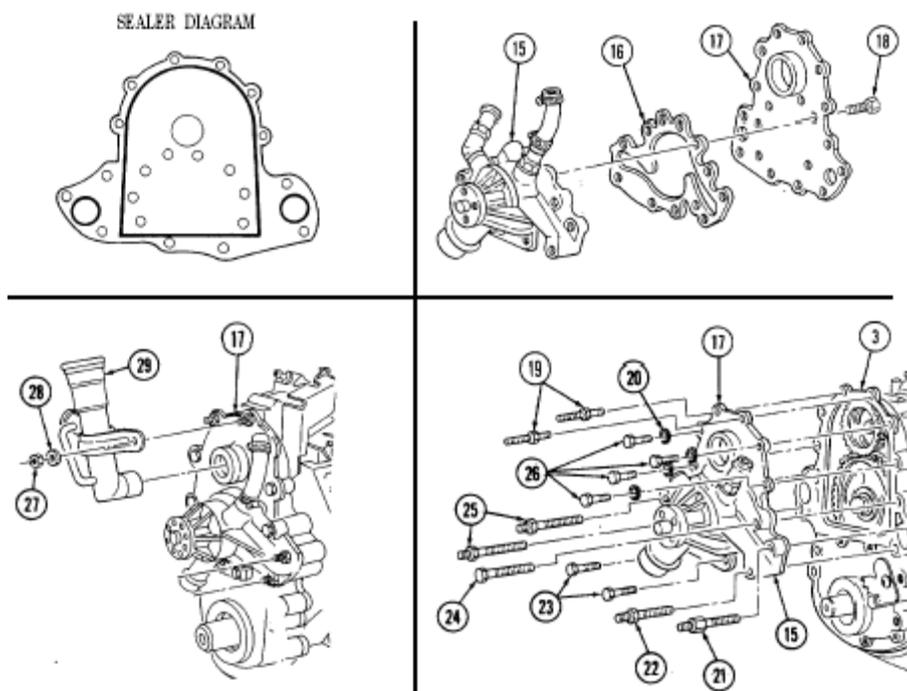
#### **CAUTION**

Ensure water pump P/N 23500085 is used on 6.5 L engines or damage to equipment will result.

1. Install gasket (16) and water pump (15) on adapter plate (17) with seven capscrews (18). Tighten capscrews (18) to 13-20 lb-ft (18-27 N•m).
2. Apply sealer to sealing surfaces on adapter plate (17), following diagram shown.
3. Apply pipe sealing compound to capscrews (24) and (23).
4. Install adapter plate (17) and water pump (15) on timing gear cover (3) with two long studs (25), short stud with thick hex (21), stud (22), and capscrew (24).
5. Install two long capscrews (23), studs (19), four washers (20), and capscrews (26). Tighten studs (19) and capscrews (26) and (23) to 13-20 lb-ft (18-27 N•m). Tighten studs (21), (22), and (25), and capscrew (24) to 24-37 lb-ft (34-50 N•m).

**ENGINE ASSEMBLY FROM SUBASSEMBLIES - CONTINUED****0036**

6. Install oil fill tube (29) on adapter plate (17) with two washers (28) and nuts (27). Tighten nuts (27) to 13-20 lb-ft (18-27 N•m).

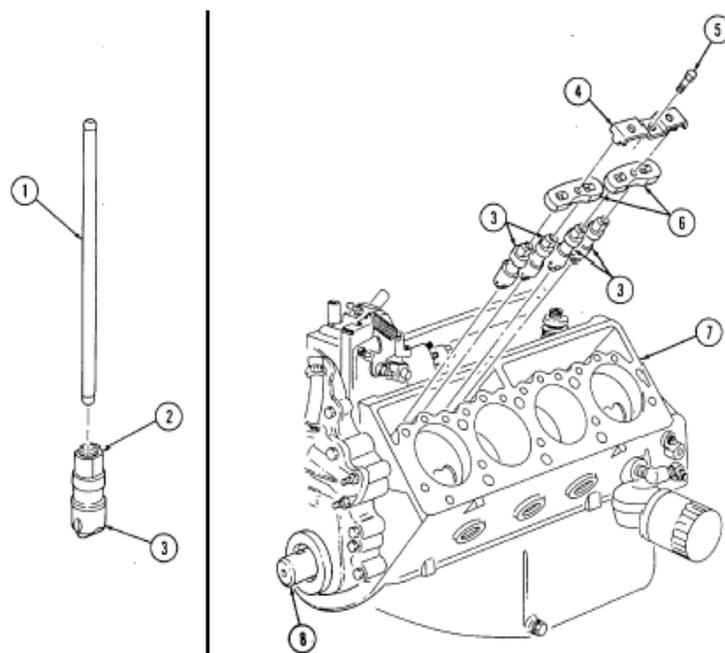
**o. VALVE LIFTERS****WARNING**

Diesel fuel is highly flammable. Do not perform this procedure near fire, flame, or sparks. Severe injury or death may result.

1. Submerge eight lifters (3) in clean diesel fuel or kerosene and work plunger (2) up and down with pushrod (1) to prime lifters (3).
2. Apply OE/HDO to lifters (3).
3. Install lifters (3) into cylinder block (7).
4. Install four guide plates (6) on lifters (3).

**ENGINE ASSEMBLY FROM SUBASSEMBLIES - CONTINUED****0036**

5. Install two guide plate clamps (4) with two capscrews (5). Tighten capscrews (5) to 15-20 lb-ft (20-27 N•m).
6. Repeat steps 1 through 5 for opposite side.
7. Manually rotate crankshaft (8) two complete revolutions to ensure free movement of lifters (3).

**p. CYLINDER HEADS****CAUTION**

Head gasket must be used without sealer. Additional sealant may cause leaks or damage to engine.

1. Install head gasket (11) over dowel pins (12) on cylinder block (7).
2. Clean threads of capscrews (10) with a wire brush to remove old pipe sealing compound. Apply pipe sealing compound to threads of capscrews (10).

**CAUTION**

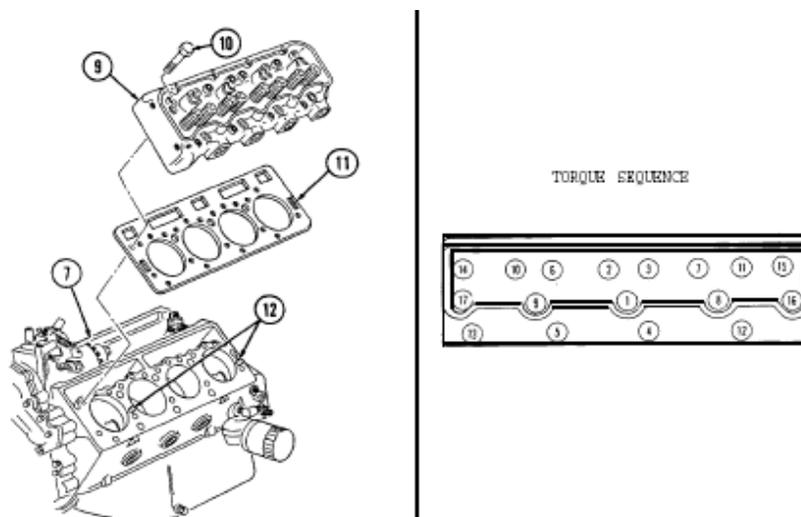
Failure to tighten cylinder head capscrews in proper sequence may result in leaks or damage to cylinder head.

3. Install cylinder head (9) on cylinder block (7) with seventeen capscrews (10). Tighten capscrews (10) to 20 lb-ft (27 N•m), following torque sequence shown.
4. Tighten seventeen capscrews (10) to 50 lb-ft (68 N•m), following torque sequence shown.

**NOTE**

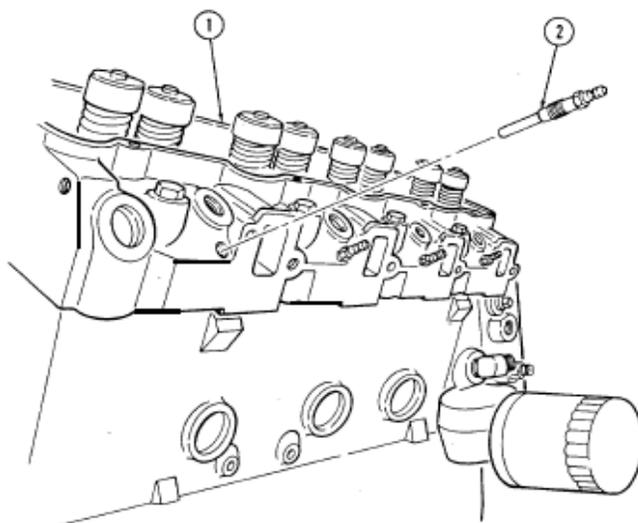
Mark capscrews after torque turn to prevent retightening.

5. Tighten seventeen capscrews (10) an additional 90°, following torque sequence shown and mark capscrews (10).
6. Repeat steps 1 through 5 for opposite side.

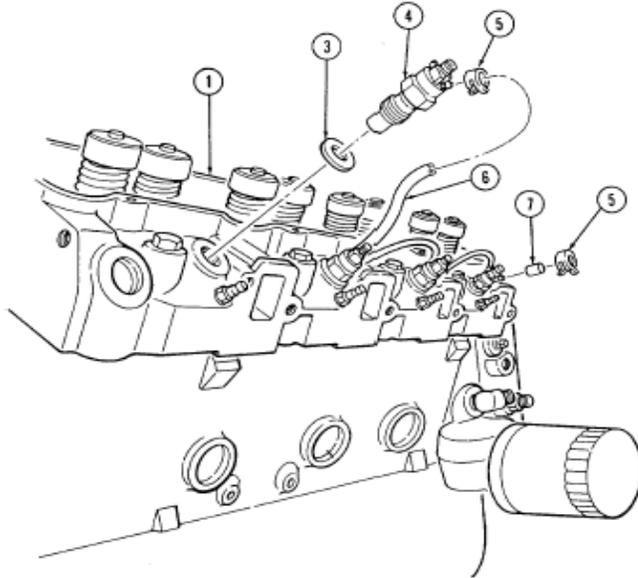


**q. GLOW PLUGS**

1. Install four glow plugs (2) into cylinder head (1). Using glow plug socket, tighten glow plugs (2) to 8-12 lb-ft (11-16 N•m).
2. Repeat step 1 for opposite side.

**r. FUEL INJECTION NOZZLES**

1. Install four gaskets (3) and fuel injection nozzles (4) into cylinder head (1). Using injector nozzle socket, tighten fuel injection nozzles (4) to 44-60 lb-ft (60-81 N•m).
2. Install three hoses (6) on fuel injection nozzles (4) with six clamps (5).
3. Install cap (7) on rear fuel injection nozzle (4) with clamp (5).
4. Repeat steps 1 through 3 for opposite side.

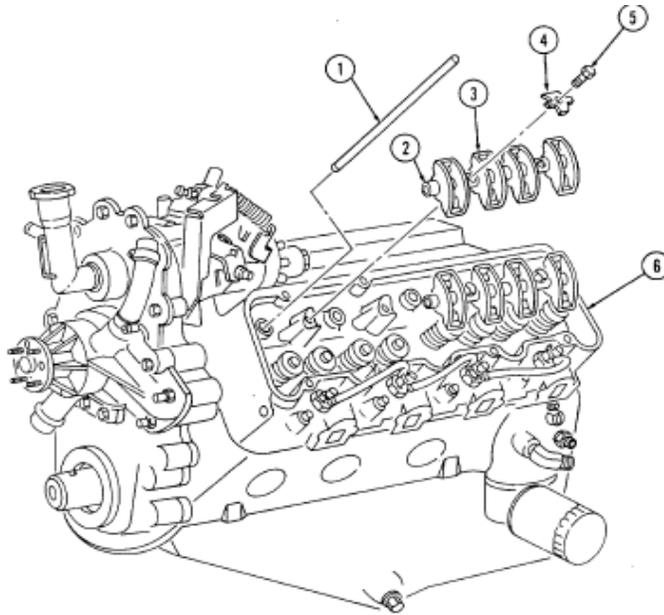


### s. ROCKER ARM SHAFT AND PUSHRODS

#### **CAUTION**

Marked ends of pushrods must point up when installed or engine damage may result.

1. Install eight pushrods (1) in proper location with marked end of pushrods (1) up. Make sure pushrods (1) are properly seated.
2. Install two rocker arm and shaft assemblies (2) on cylinder head (6). Make sure pushrods (1) properly seat in rocker arms (3).
3. Secure rocker arm and shaft assemblies (2) with four retainers (4) and capscrews (5). Tighten capscrews (5) to 41 lb-ft (56 N•m).
4. Repeat steps 1 through 3 for opposite side.



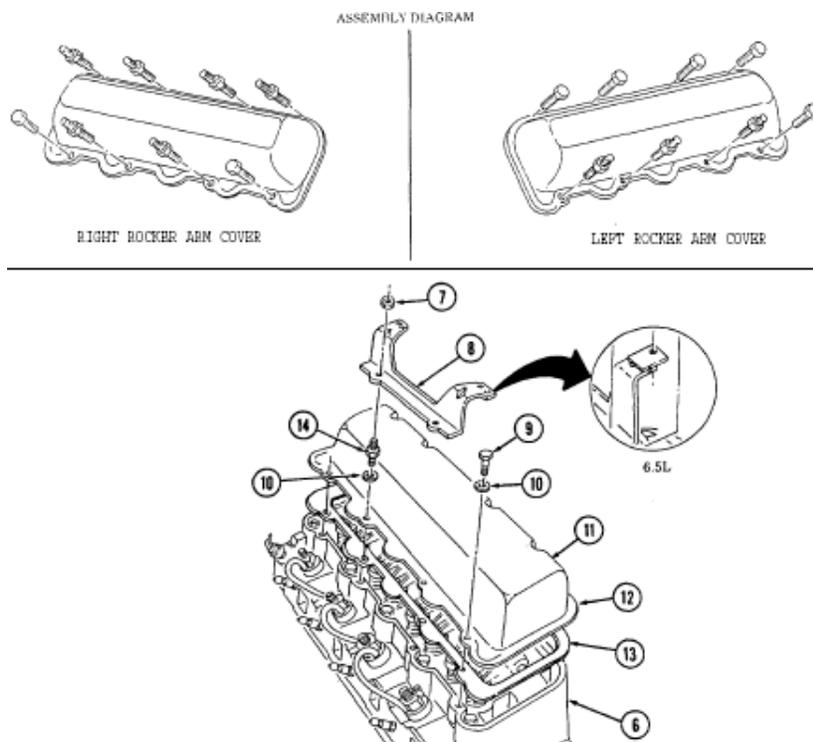
#### t. ROCKER ARM COVERS

##### NOTE

- If applying sealant, perform step 2. Keep sealant out of capscrew holes.
- If installing new rocker arm cover gaskets, perform step 1, then step 3.
- Silicone sealant can be used with the gasket, but is not required.

1. Install rocker arm cover gasket (13) on lip of cover (12) and align with capscrew holes.
2. Apply a 1/16-in. (4 mm) bead of silicone sealant around sealing surface of rocker arm covers (11).
3. Install rocker arm covers (11) on cylinder head (6) with sixteen washers (10), seven capscrews (9), and nine studs (14), following assembly diagram.
4. Tighten capscrews (9) and studs (14) to 13-25 lb-ft (18-34 N•m).

5. Install two injection line support brackets (8) on studs (12) with four nuts (7). Tighten nuts (7) to 13-20 lb-ft (18-27 N•m).

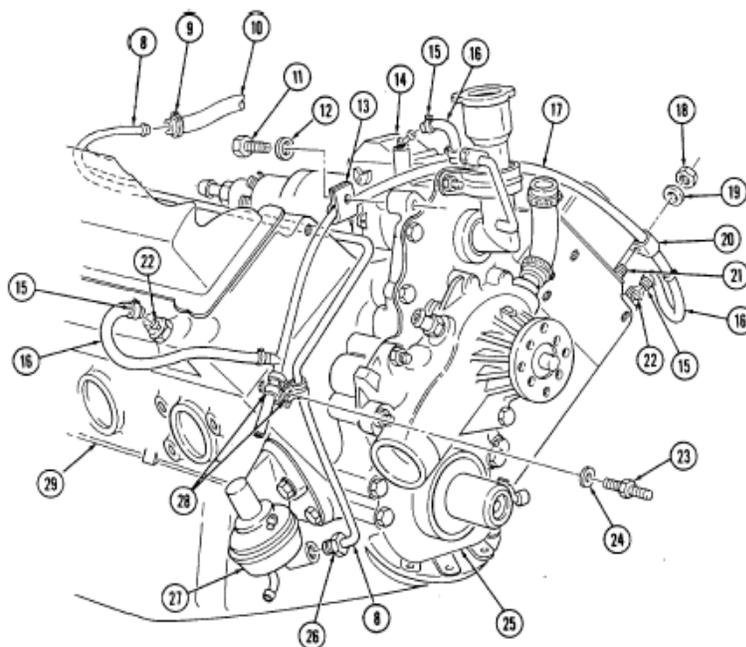


#### u. FUEL SUPPLY AND RETURN LINES

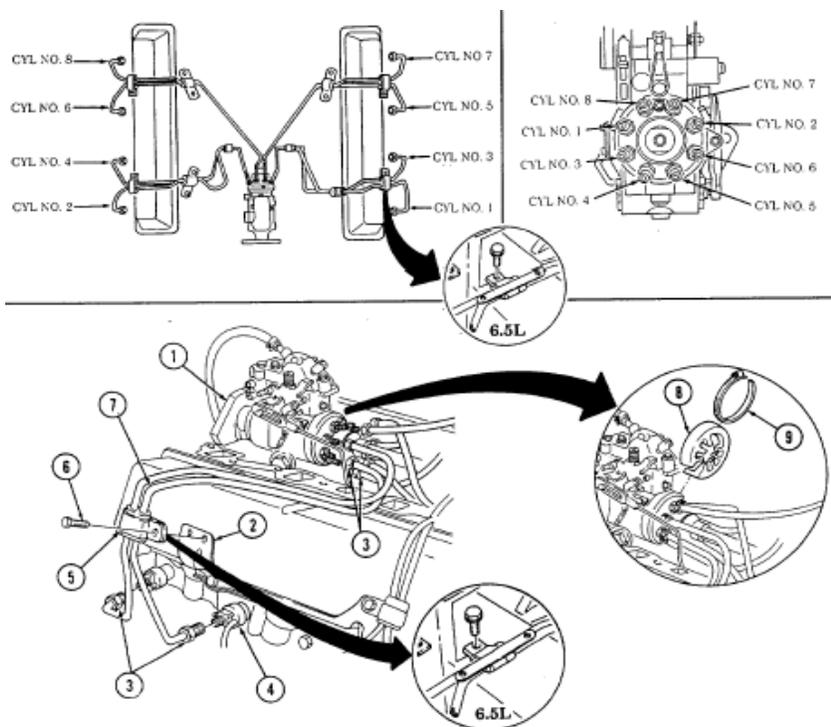
1. Install fuel supply line (8) on fuel pump (27) and finger tighten tube nut (26).
2. Install fuel return line (17) on timing gear cover (25) with clamp (13), washer (12), and capscrew (11). Finger tighten capscrew (11).
3. Install return line (17) to valve cover stud (21) with clamp (20), washer (19), and nut (18). Tighten nut (18) to 13-20 lb-ft (18-27 N•m).
4. Install supply line (8) and return line (17) to cylinder block (29) with two clamps (28), washer (24), and stud (23). Tighten stud (23) and capscrew (11) to 25 lb-ft (34 N•m).
5. Tighten tube nut (26).

**ENGINE ASSEMBLY FROM SUBASSEMBLIES - CONTINUED****0036**

6. Connect three rubber hoses (16) to front fuel injection nozzles (22) and fuel injection pump (14) with, three clamps (15).
7. Connect fuel filter inlet hose (10) to fuel supply line (8) with hose clamp (9).

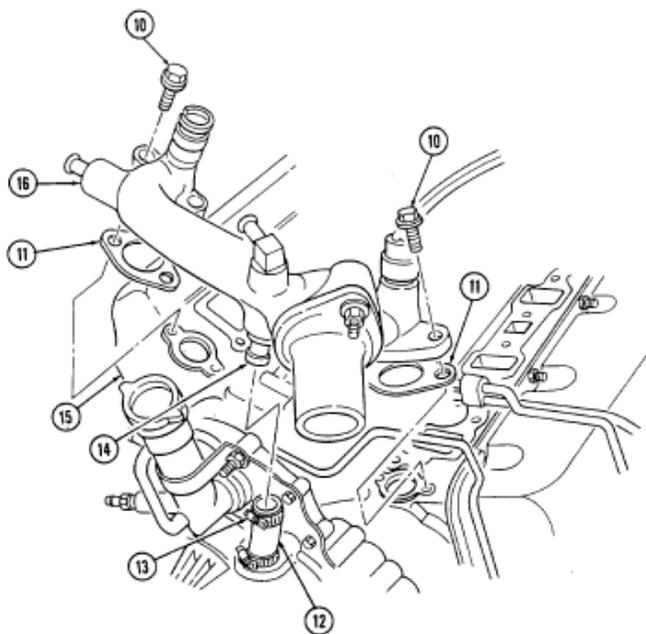
**v. FUEL INJECTION LINES**

1. Install number 1 and 3 injection lines (7) and connect to fuel injection pump (1) and fuel injection nozzles (4).
2. Using crowfoot wrenches, tighten four nuts (3) and fuel injection lines (7) on fuel injection nozzles (4) and fuel injection pump (1) to 20 lb-ft (27 N•m).
3. Repeat steps 1 and 2 for each set of remaining fuel injection lines (7), number 5 and 7, number 6 and 8, and number 2 and 4.
4. Install four clamps (5) securing fuel injection lines (7) to support brackets (2) with four screw assembled washers (6).
5. Install boot (8) onto fuel injection pump (1) and tighten clamp (9).



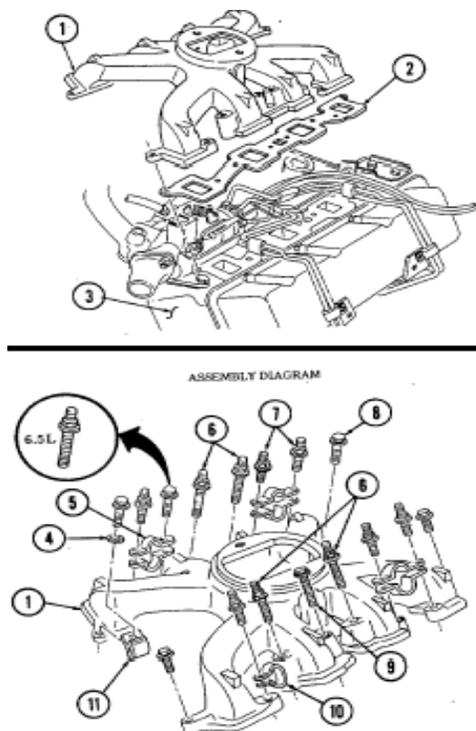
### w. WATER CROSSOVER

1. Install two gaskets (11) and water crossover (16) on cylinder heads (15).
2. Install four capscrews (10) on water crossover (16) and cylinder heads (15). Tighten capscrews (10) to 25-37 lb-ft (34-50 N•m).
3. Connect thermostat bypass hose (12) to nipple (14) and tighten hose clamp (13).



#### x. INTAKE MANIFOLD

1. Install two gaskets (2) and intake manifold (1) on cylinder heads (3).
2. Install injection line clip (10), three injection line clips (5), and fuel supply line clamp (11) on intake manifold (1), following assembly diagram shown.
3. Install four long studs (6), long cap screw (9), seven studs (7), four cap screws (8), and sixteen washers (4), following assembly diagram.



4. Tighten all studs (6) and (7) and capscrews (8) and (9) to 30 lb-ft (41 N•m), following torque sequence shown.

#### NOTE

Perform steps 5 through 8 for turbo charged engines.

5. Install gasket (17) and intake manifold (16) on cylinder head (18) with eight studs (15).

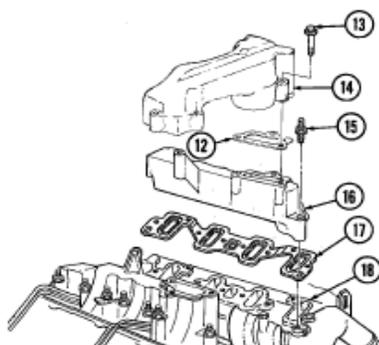
6. Beginning at center of intake manifold (16) and working toward ends, tighten studs (15) to 30 lb-ft (41 N•m).

7. Repeat steps 5 and 6 for opposite side.

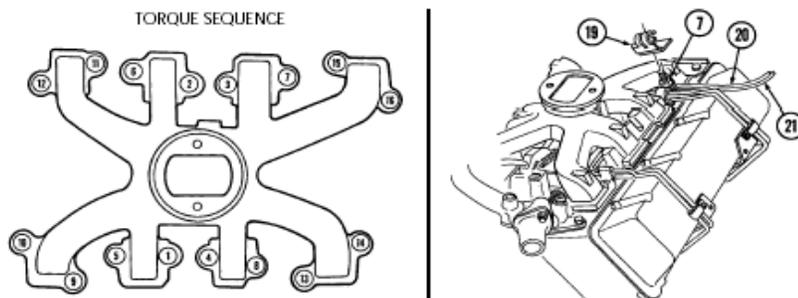
#### NOTE

Install turbocharger before installing center intake manifold.

8. Install two gaskets (12) and center intake manifold (14) on intake manifolds (16) with six capscrews (13). Tighten capscrews (13) to 17 lb-ft (23 N•m).
9. Secure fuel supply line (21) and hose (20) to stud (7) with clamp (19).



TURBOCHARGED ENGINE



## y. EXHAUST MANIFOLDS

### NOTE

Early production vehicles may have a socket-head screw in place of stud.

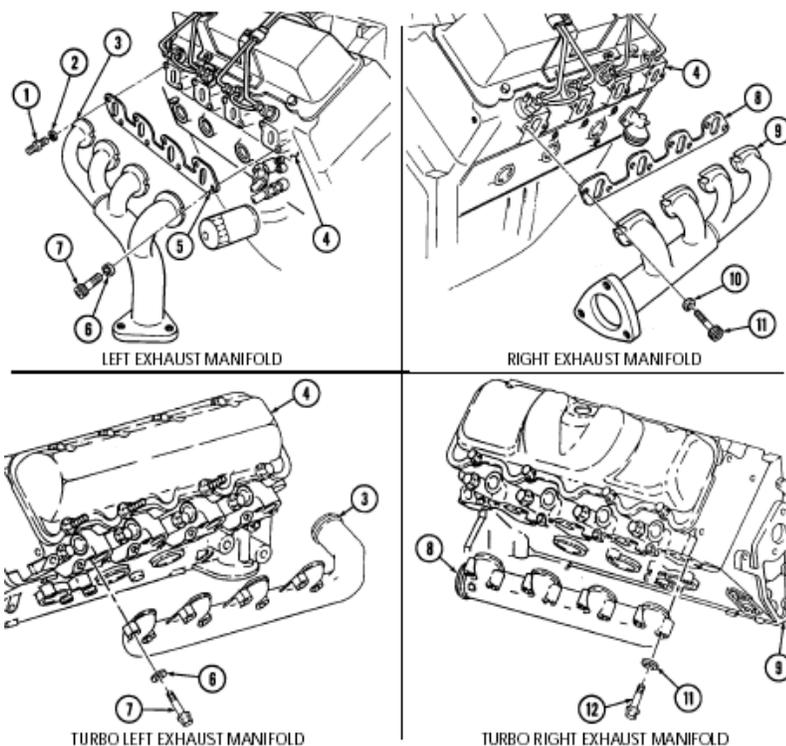
Turbo exhaust manifolds use hex-head capscrews and do not have gaskets or stud as indicated in steps 1 through 3.

1. Install gasket (5) and left exhaust manifold (3) on cylinder head (4) with seven washers (6) and socket-head screws (7). Using 8-mm hex-head driver, tighten socket-head screws (7) to 18-25 lb-ft (24-34 N•m) .

**ENGINE ASSEMBLY FROM SUBASSEMBLIES - CONTINUED****0036**

2. Install washer (2) and stud (1) on left exhaust manifold (3) and cylinder head (4). Tighten stud (1) to 18-25 lb-ft (24-34 N•m).

3. Install gasket (8) and right exhaust manifold (9) on cylinder head (4) with eight washers (10) and sockethead screws (11). Using 8-mm hex-head driver, tighten socket-head screws (11) to 18-25 lb-ft (24-34 N•m) .

**NOTE**

Perform tasks y.1 through y.4 for 6.5L turbo engines only.

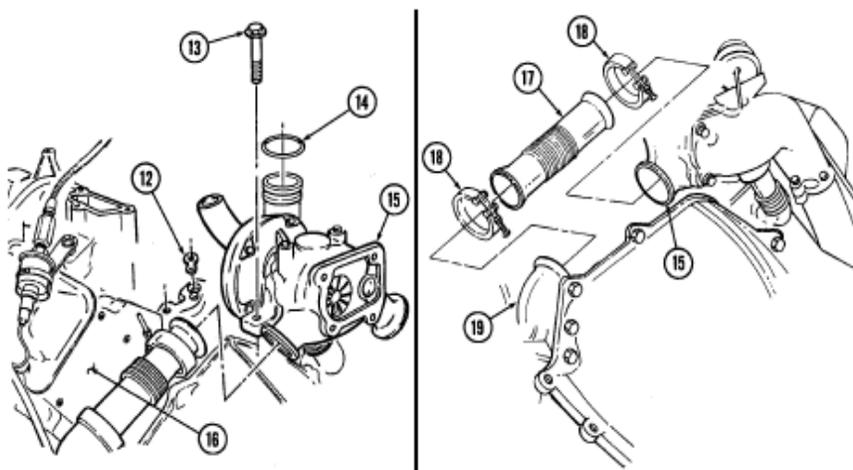
**y.1. TURBOCHARGER**

1. Install turbocharger oil gasket (12) and turbocharger (15) on engine block (16) with two capscrews (13).

2. Install O-ring (14) on turbocharger (15) outlet.

**y.2. MANIFOLD-TO-TURBOCHARGER EXHAUST PIPE**

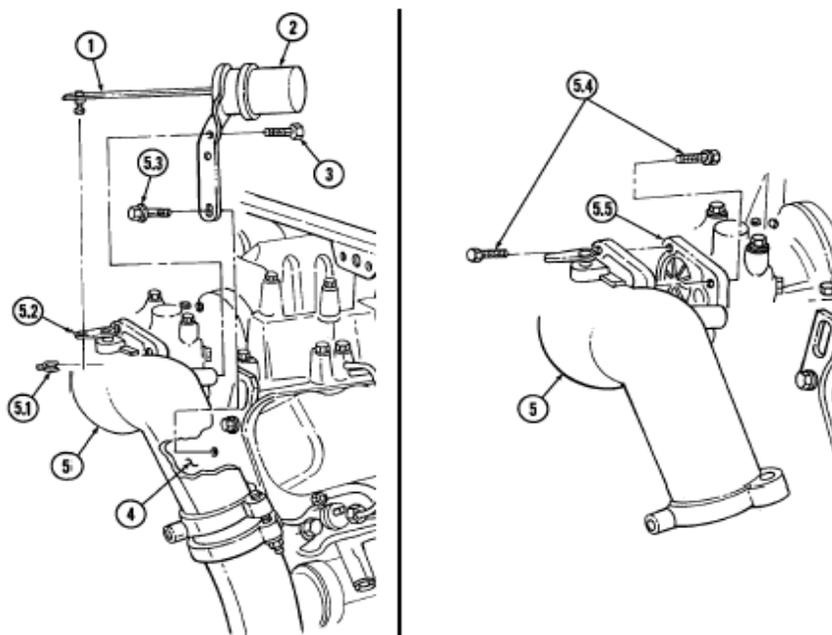
1. Install two clamps (18) on exhaust pipe (17).
2. Install exhaust pipe (17) on turbocharger (15) and tighten clamp (18).
3. Install exhaust pipe (17) on exhaust manifold (19) and tighten clamp (18).
4. Repeat steps 1 through 3 for opposite side.

**y.3. WASTEGATE HOUSING**

Install wastegate housing (5) on turbocharger (5.5) with four capscrews (5.4).

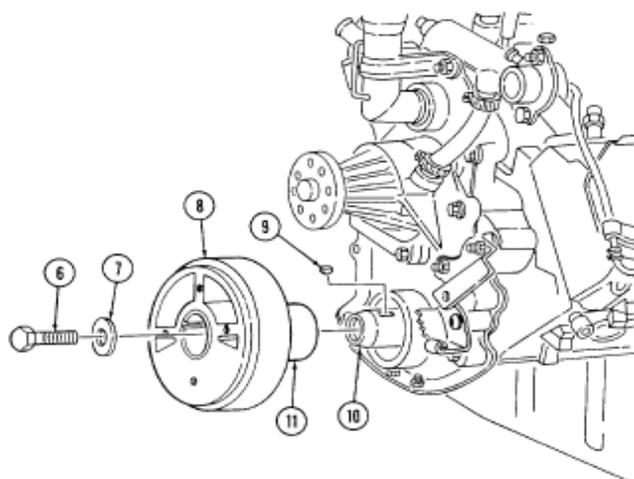
**y.4. WASTEGATE ACTUATOR**

1. Install wastegate actuator (2) on cylinder head (4) with capscrew (5.3).
2. Install wastegate actuator (2) on wastegate housing (5) with two capscrews (3).
3. Install actuator rod (1) on wastegate bellcrank (5.2) with clip (5.1).

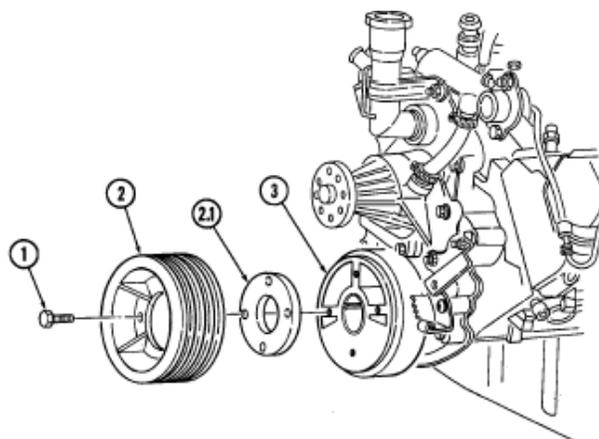


#### **z. TORSIONAL DAMPER**

1. Install woodruff key (9) in crankshaft (10).
2. Apply lubricating oil to seal surface (11) on torsional damper (8).
3. Install torsional damper (8) on crankshaft (10) far enough to install washer (7) and capscrew (6).
4. Hold flywheel stationary with pry bar and tighten capscrew (6) to 140-162 lb-ft (190-220 N•m).

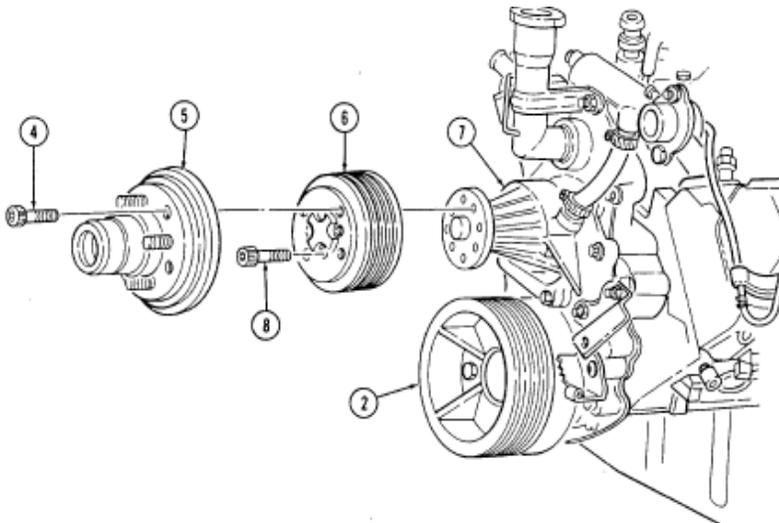
**aa. CRANKSHAFT PULLEY**

1. Apply sealing compound to four capscrews (1).
2. Install crankshaft pulley (2) and spacer (2.1) (if removed) on torsional damper (3) with four capscrews (1).
3. Hold flywheel stationary with pry bar and tighten capscrews (1) to 48 lb-ft (65 N•m).



**bb. FAN DRIVE AND WATER PUMP PULLEY**

1. Apply sealing compound to four socket head screws (8).
2. Install water pump pulley (6) on water pump (7) with four socket head screws (8).
3. Position pry bar between water pump pulley (6) and crankshaft pulley (2) and apply pressure to prevent rotation. Using 6 mm hex head driver, tighten socket head screws (8) to 20 lb-ft (27 N•m).
4. Apply sealing compound to four socket head screws (4).
5. Install fan drive (5) on water pump pulley (6) with four socket head screws (4). Repeat step 3. Using 5/16-in. hex head driver, tighten socket head screws (4) to 45 lb-ft (61 N•m).

**FOLLOW-ON TASKS**

- Remove engine from repair stand (.).

Perform engine run-in (WP 0038).

**END OF TASK**



---

**GENERAL**

**0037**

---

**THIS WORK PACKAGE (WP) COVERS:**

Engine Run-In

---

**ENGINE RUN-IN**

Following any major repair to the engine, the engine must be run-in, and tests made prior to release for issue to user. **Work Package 0038** contains instructions for engine run-in.

**END OF TASK**



---

**ENGINE RUN-IN**

---

0038

**THIS WORK PACKAGE (WP) COVERS:**Out of Chassis Run-In

---

**INITIAL SETUP****Test Equipment**

Dynamometer

**NOTE**

- This procedure should be performed in a well-ventilated work area.
- Follow dynamometer manufacturer's instructions for its use.

1. Connect engine to dynamometer.
2. Fill the crankcase with 8 quarts of 15W40 conforming to MIL-L-21260.

**NOTE**

If AOAP is being conducted it is recommended that oil used in initial run-in test phases be drained and refilled with filter changed prior to the sample being drawn. If this is not done you would experience high wearmetal contents due to new parts/components after repair. (Preservative oil can be used in the DYNO tests.)

3. Use a 50/50 mixture of MIL-A-46153 or equivalent coolant and water when running the test. If 50/50 mixture cannot be used in DYNO test the Repair Facility must warranty any needed repairs due to anti-freeze found in oil after initial AOAP analysis.

**CAUTION**

- Operating an engine without sufficient lubricating oil will cause damage to engine.
- If any leaks or abnormal noise is noted, stop engine immediately and correct as necessary. Any abnormalities must be corrected before proceeding to the next test interval.
- Oil pressure should be 40-50 psi (276-345 kPa) under load and 10 psi (69 kPa) minimum at idle. If oil pressure does not meet specifications, stop engine immediately and correct as necessary.
- Oil temperature must not exceed 260°F ( 127°C) and coolant temperature must not exceed 230°F (110°C). If coolant temperature or oil temperature exceed limits, stop engine immediately and correct as necessary.

4. Start engine and run-in according to schedule in table 1 (for 6.5L De-tuned), table 2 (6.5L NA), table 3 (6.5T).

**Table 2-1. 6.5L De-tuned Engine**

**Run-In Schedule**

Engine Speed (ERPM)	Time (Minutes)	Torque (ft-lb)		THROTTLE
		Ft-lb	Nm	
650	5	0	0	0%
1200	30	80	108	PART
2000	30	94	128	PART
3000	30	140	190	PART
* 3600	5	219	297	100%

- After the engine has run for 5 minutes at 3600 ERPM, WOT, check torque. The engine must produce at least 219 Ft-Lbs of torque (297 Nm).

**NOTE**

Power output should be 197 Ft-Lbs torque (267 Nm) at 3600 ERPM WOT, when using JP-8 fuel. The degree and type of adjustments needed when using JP-8 varies from engine to engine. Some engines do not require any modification at all when running in JP-8 as they can meet performance requirements. Others require adjustment of the fuel volumetric flow to compensate for the fuels lower energy (~5%).

Test for blow-by – not to exceed 4” of water.

If AOAP is being conducted it is recommended that oil used in initial run-in test phases be drained and refilled with filter changed prior to the sample being drawn. If this were not done you would experience high wearmetal contents due to new parts/components after repair. (Preservative oil can be used in the DYNO tests.)

1. Remove engine load and idle until temperatures drop.
2. Test governor speed with a WOT no-load test. Governor no load speed must be within the 3600-3800 ERPM. (Time at governor speed not to exceed 15 seconds.)
3. Stop engine and inspect for and correct any leaks.
3. Disconnect engine from dynamometer.

**Table 2-1.1 - 6.5 L (NA) Engine**

**Run-in Schedule**

Engine Speed (ERPM)	Time (Minutes)	Torque (ft-lb)		THROTTLE
		Ft-lb	Nm	
725	5	0	0	0%
2000	30	103	140	PART
3000	30	133	180	PART
3400	30	146	198	PART
3400 *	5	247	335	100%

\* After the engine has run for 5 minutes at 3400 RPM, WOT, check torque. The engine must produce at least 247 Ft-Lbs (335 Nm) of torque.

**NOTE**

Power output should be 222 Ft-Lbs torque (301 Nm) at 3400 ERPM WOT, when using JP-8 fuel. The degree and type of adjustments needed when using JP-8 varies from engine to engine. Some engines do not require any modification at all when running in JP-8 as they can meet performance requirements. Others require adjustment of the fuel volumetric flow to compensate for the fuels lower energy (~5%).

Test for blow-by – not to exceed 4” of water.

If AOAP is being conducted it is recommended that oil used in initial run-in test phases be drained and refilled with filter changed prior to the sample being drawn. If this were not done you would experience high wearmetal contents due to new parts/components after repair. (Preservative oil can be used in the DYNO tests.)

1. Remove engine load and idle until temperatures drop.
2. Test governor speed with a WOT no-load test. Governor no load speed must be within the 3900-4100 ERPM. (Time at governor speed not to exceed 15 seconds.)
3. Stop engine and inspect for and correct any leaks.
4. Disconnect engine from dynamometer.

**Table 2-1.1.1 - 6.5 L Turbo**

**Run-in Schedule**

Engine Speed (ERPM)	Time (Minutes)	Torque (ft-lb)		THROTTLE
		Ft-lb	Nm	
725	5	0	0	0%
2000	30	103	140	PART
3000	30	133	180	PART
3400	30	146	198	PART
3400 *	5	294	399	100%

\* After the engine has run for 5 minutes at 3400 RPM, WOT, check torque. The engine must produce at least 294 Ft-Lbs (399 Nm) of torque.

**NOTE**

Power output should be 265 Ft-Lbs torque (359 Nm) at 3400 ERPM WOT, when using JP-8 fuel. The degree and type of adjustments needed when using JP-8 varies from engine to engine. Some engines do not require any modification at all when running in JP-8 as they can meet performance requirements. Others require adjustment of the fuel volumetric flow to compensate for the fuels lower energy (~5%).

Test for blow-by – not to exceed 4” of water.

If AOAP is being conducted it is recommended that oil used in initial run-in test phases be drained and refilled with filter changed prior to the sample being drawn. If this were not done you would experience high wearmetal contents due to new parts/components after repair. (Preservative oil can be used in the DYNO tests.)

1. Remove engine load and idle until temperatures drop.
2. Test governor speed with a WOT no-load test. Governor no load speed must be within the 3900-4100 ERPM. (Time at governor speed not to exceed 15 seconds.)
3. Stop engine and inspect for and correct any leaks.
4. Disconnect engine from dynamometer.

**END OF TASK**



---

**GENERAL**

**0039**

---

**THIS WORK PACKAGE (WP) COVERS:**

Repair Standards

---

**REPAIR STANDARDS**

All parts, components or assemblies which do not meet the standards specified in **WP 0044** will be replaced with new material. Parts must be closely inspected to ensure there is no damage in areas not listed, which would make them unfit for further use.

**NOTE**

Engine component repair parts on Mandatory Replacement List need not be inspected.

**END OF TASK**



**REPAIR AND REPLACEMENT STANDARDS**

**0040**

**THIS WORK PACKAGE (WP) COVERS:**

Repair Standards

**Table 1 General Repair Standards (6.5L)**

	<b>STANDARD</b>	<b>METRIC</b>
Cylinder Bore Diameter	3.978-3.981 in.	101.041-101.12 mm
Out of Round	0.0008 in.	0.0203 mm max.
Taper - Thrust Side	0.0008 in.	0.0203 mm max.
Piston		
Piston Clearance - # 1,2,3,4, 5,6	0.0035-0.0045 in.	0.0889-0.1143 mm
Piston Clearance - # 7,8	0.004-0.005 in.	0.102-0.127 mm
Compression Rings		
Groove Clearance:		
Top	0.003-0.007 in.	0.076-0.178 mm
Second	0.002-0.003 in.	0.051-0.076 mm
Gap:		
Top	0.012-0.022 in.	0.30-0.55 mm
Second	0.030-0.039 in.	0.76-1.0 mm
Oil Ring		
Groove Clearance	0.002-0.004 in.	0.051-0.102 mm
Gap	0.010-0.020 in.	0.25-0.51 mm
Piston Pin		
Diameter	1.2203-1.2206 in.	30.9956-31.0032 mm
Clearance	0.0003-0.0006 in.	0.0076-0.0153 mm
Fit in Rod	0.0003-0.0010 in.	0.0076-0.025 mm
Camshaft		
Lift:		
Intake	0.281±0.002 in.	7.137±0.05 mm
Exhaust	0.281±0.002 in.	7.137±0.05 mm
Journal Diameter - # 1,2,3,4	2.164-2.166 in.	54.965-55.016 mm
Journal Diameter - # 5	2.007-2.009 in.	50.978-51.029 mm
Journal Clearance	0.001-0.004 in.	0.025-0.102 mm
Crankshaft		
Main Journal Diameter - # 1,2, 3,4	2.949-2.950 in.	74.905-74.930 mm
Main Journal Diameter - # 5	2.949-2.950 in.	74.905-74.930 mm
Taper	0.0002 in. max.	0.0051 mm max.
Out of Round	0.0002 in. max.	0.0051 mm max.
Main Bearing Clearance - # 1,2,3,4,5	0.002-0.004 in.	0.051-0.102 mm
End Play	0.004-0.010 in.	0.102-0.254 mm

**REPAIR AND REPLACEMENT STANDARDS - CONTINUED**

**0040**

***Table 1 General Repair Standards (6.5L) Continued***

	<b>STANDARD</b>	<b>METRIC</b>
<b>Crankpin:</b>		
Diameter	2.398-2.399 in.	60.909-60.935 mm
Taper	0.0002 in. max.	0.0051 mm max.
Out of Round	0.0002 in. max.	0.0051 mm max.
Rod Bearing Clearance	0.002-0.004 in.	0.051-0.102 mm
Rod Side Clearance	0.007-0.025 in.	0.178-0.635 mm
<b>Valve Train</b>		
Rocker Arm Ratio	1.5:1	1.5:1
Face Angle	45°	45°
Seat Angle	46°	46°
Seat Runout	0.002 in.	0.05 mm
<b>Seat Width:</b>		
Intake	0.035-0.060 in.	0.89-1.52 mm
Exhaust	0.062-0.093 in.	1.57-2.36 mm
<b>Stem Clearance:</b>		
Intake	0.001-0.003 in.	0.025-0.076 mm
Exhaust	0.001-0.003 in.	0.025-0.076 mm
<b>Valve Spring Force</b>		
Closed	80 lb @ 1.8 in.	356 N @ 46.0 mm
Open	230 lb @ 1.39 in.	1023 N @ 35.3 mm
Installed Height	1.8 in.	46.0 mm
<b>Timing Chain Deflection</b>		
New Chain	0.5 in. max.	12.7 mm max.
Old Chain	0.81 in. max.	20.6 mm max.

**Table 2 6.5L Diesel Engine Piston-Cylinder Specification**

<b>PISTON</b>	<b>PISTON SIZE</b>	<b>CYLINDER SIZE</b>
Standard (11862) 12550059	4.0529 in. to 4.0534 in. (102.944-102.956 mm)	4.0571 in. to 4.0576 in. (103.050-103.063 mm)
0.50 mm Oversized (11862) 12550062	4.0739 in. to 4.0745 in. (103.477-103.492 mm)	4.0782 in. to 4.0787 in. (103.586-103.599 mm)
Piston ring set part numbers are:  Standard – (11862) 12369198 0.50 mm Oversized – (11862) 12510753  The 6.5L engine does not have a standard Hi-Limit piston.		

**END OF TASK**



---

**SUPPORTING INFORMATION**

---

**0041****THIS WORK PACKAGE (WP) COVERS:**Engine and Container, Container, and Quality Assurance

---

**ENGINE AND CONTAINER**

You'll perform packing, packaging, preservation and marking requirements in accordance with Special Packaging Instructions (SPI) (**Appendix B**). The level of protection shall be A/A. You will inspect and recondition the containers IAW TB 9-289, Reconditioning of Type I and Type II Reusable Metal Containers, and drawing package P/N 12338064, with the current Notice of Revision/Engineering Change Proposal documents. This reconditioning effort includes mandatory replacement of breather valves, humidity indicators, data plates, sealing gaskets, desiccant and all shear mounts five years or older. It also includes a leak test after reconditioning, inspection and replacement of unserviceable wood skids, and touch up or total stripping and refinishing of the container surfaces with CARC paint. Any replacement shear mounts shall meet the requirements of drawing P/N 12338070, including CID A-A-52486 (replaced MIL-M-45907).

**CONTAINER**

When you repair a container and return it to us without an engine, you will pack and mark the container in accordance with Special Packaging Instructions AK12313747.

**QUALITY ASSURANCE**

The repair activity will implement and maintain a Quality Assurance program that complies with ISO 9002 (dated 1994), "Quality System – Model for Quality Assurance in Production, Installation and Servicing."

**END OF TASK**



**AFTER REPAIR PERFORMANCE TEST REPORT****0042****THIS WORK PACKAGE (WP) COVERS:**

De-tuned Engine, Naturally Aspirated Engine, Turbo Engine

**Table 1 6.5L De-tuned Engine****After Repair Performance Test Report**

Test Period Number	Required Time in Minutes	Engine RPM	Oil Pressure	Oil Temp.	Coolant Temp.	HP
1	5	650				NA
2	30	1200				NA
3	30	2000				
4	30	3000				NA
5	5	3600				

**NOTE**

You will do a performance test on each engine repaired. The Repair Facility Quality Representative and/or the Dynamometer Operator must witness the testing. As part of the performance test a Test Report should be kept at the Repair Facility for a minimum of two (2) years. You will also attach a Repair Facility Data Plate of your design to the engine – to include NSN or NIIN.

AOAP Report:

**NOTE**

It is recommended that oil used in initial run-in test phases be drained and refilled with filter changed prior to the sample being drawn. If this is not done you would experience high wearmetal contents due to new parts/components after repair.

**AFTER REPAIR PERFORMANCE TEST REPORT - CONTINUED****0042**

A copy of the Repair Facility's monthly Production Report will be provided to:  
[HarriRob@tacom.army.mil](mailto:HarriRob@tacom.army.mil). (Electronic copy preferred.)

Commander  
 USA TACOM  
 ATTN: AMSTA-LC-CHLC  
[HarriRob@tacom.army.mil](mailto:HarriRob@tacom.army.mil)  
 Warren, MI 48397-5000

**Table 2 6.5L Naturally Aspirated Engine**  
**After Repair Performance Test Report**

Test Period Number	Required Time in Minutes	Engine RPM	Oil Pressure	Oil Temp.	Coolant Temp.	HP
1	5	725				NA
2	30	2000				NA
3	30	3000				
4	30	3400				NA
5	5	3400*				

**NOTE**

You will do a performance test on each engine repaired. The Repair Facility Quality Representative and/or the Dynamometer Operator must witness the testing. As part of the performance test a Test Report should be kept at the Repair Facility for a minimum of two (2) years. You will also attach a Repair Facility Data Plate of your design to the engine – to include NSN or NIIN.

AOAP Report:

**NOTE**

It is recommended that oil used in initial run-in test phases be drained and refilled with filter changed prior to the sample being drawn. If this is not done you would experience high wearmetal contents due to new parts/components after repair.

A copy of the Repair Facility's monthly Production Report will be provided to: [HarriRob@tacom.army.mil](mailto:HarriRob@tacom.army.mil). (Electronic copy preferred.)

Commander  
 USA TACOM  
 ATTN: AMSTA-LC-CHLC  
[HarriRob@tacom.army.mil](mailto:HarriRob@tacom.army.mil)  
 Warren, MI 48397-5000

**Table 3 6.5L – Turbo Engine**

**After Repair Performance Test Report**

Test Period Number	Required Time in Minutes	Engine RPM	Oil Pressure	Oil Temp.	Coolant Temp.	HP
1	5	725				NA
2	30	2000				NA
3	30	3000				
4	30	3400				NA
5	5	3400*				

**NOTE**

You will do a performance test on each engine repaired. The Repair Facility Quality Representative and/or the Dynamometer Operator must witness the testing. As part of the performance test a Test Report should be kept at the Repair Facility for a minimum of two (2) years. You will also attach a Repair Facility Data Plate of your design to the engine – to include NSN or NIIN.

AOAP Report:

**NOTE**

It is recommended that oil used in initial run-in test phases be drained and refilled with filter changed prior to the sample being drawn. If this is not done you would experience high wearmetal contents due to new parts/components after repair.

A copy of the Repair Facility's monthly Production Report will be provided to:  
[HarriRob@tacom.army.mil](mailto:HarriRob@tacom.army.mil). (Electronic copy preferred.)

Commander  
USA TACOM  
ATTN: AMSTA-LC-CHLC  
[HarriRob@tacom.army.mil](mailto:HarriRob@tacom.army.mil)  
Warren, MI 48397-5000

**REPAIR OF THE 6.5L ENGINE**

**POINTS OF CONTACT**

- |                            |                  |                                                                      |
|----------------------------|------------------|----------------------------------------------------------------------|
| 1. ITEM MANAGER            | (AMSTA-LC-CHL)   | <a href="mailto:HarriRob@tacom.army.mil">HarriRob@tacom.army.mil</a> |
| 2. Quality Representative  | (AMSTA-TR-E/LTV) | <a href="mailto:whitney@tacom.army.mil">whitney@tacom.army.mil</a>   |
| 3. Engineering             | (AMSTA-TR-E/LTV) | <a href="mailto:kachaduB@tacom.army.mil">kachaduB@tacom.army.mil</a> |
| 4. Maintenance Log Manager | (AMSTA-LC-CHL)   | <a href="mailto:mcinernj@tacom.army.mil">mcinernj@tacom.army.mil</a> |

**END OF TASK**



**THIS WORK PACKAGE (WP) COVERS:**Model, Subject, Comments, Procedure

---

**APPENDIX A****NMWR****CRANKSHAFT BEARING  
TORQUE SPECIFICATIONS****FOR  
6.5L ENGINE****MODEL** HMMWV FOV with 6.5L Engines**SUBJECT** Crankshaft Bearing Cap Torque Change

**COMMENTS** During March 1997 production of 6.5L engines, crankshaft bearing cap retaining capscrew sizes were changed. At outer positions on bearing caps 2, 3, and 4, the size of the capscrews went from 12 mm to 10 mm. All other bearing cap retaining capscrews remain at 12 mm. This requires a revision of the torque value and sequence. Prior to installing the crankshaft, verify the size of capscrews used for the bearing caps. For 6.5L engines built before March 1997, 12 mm capscrews are used on inner and outer bearing caps and the current TM procedure has the correct torque value and sequence. The following procedure is provided for interim field use until publications can be updated to reflect the new procedure.

**PROCEDURE****NOTE**

There is no change in removal procedure.  
This procedure covers installation only.

Crankshaft Main Bearing Installation:

**NOTES**

- Measure outside diameter of crankshaft main bearing journals to determine which thickness main bearing to install.
  - Main bearings are of the precision insert type and do not utilize shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearing are available in standard size and undersize.
  - Selective fittings of both rod and main bearing inserts is necessary in production in order to obtain close tolerances. For this reason, you may find one-half of a standard insert with one-half of a 0.001 in. (0.25 mm) undersize insert, which will decrease the clearance 0.0005 in. (0.013 mm) from using a full standard bearing.
1. Remove all capscrews (1) and (2), bearing caps (3), if installed, and install upper halves of main bearings (5) in cylinder block (6) as shown in figure 1.
  2. Install lower halves of main bearings (7) in bearing caps one through five (1), (3), (4), (5), and (6) as shown in figure 2.

**WARNING**

Crankshaft must be supported during removal and installation. Failure to support crankshaft may cause injury to personnel or damage to equipment.

3. Install crankshaft (4) in cylinder block (6) as shown in figure 1.

**CAUTION**

Bearing caps are numbered 1 through 5 and must be installed in correct order, starting with number 1 at front of cylinder block. Arrow on bearing cap must point forward or engine damage will result.

4. Install bearing caps one (1), two (3), four (5), and five (6) on cylinder block (8) as shown in figure 2.
5. Apply OE/HDO to threads of eight 12 mm capscrews (2) and install 12 mm capscrews (2) at inner positions on bearing caps one (1), two (3), four (5), and five (6) as shown in figure 2. Tighten eight 12 mm capscrews (2) to 55 lb-ft (75 N•m).
6. Install bearing cap three (4) on cylinder block (8) with two 12 mm capscrews (2) at inner position as shown in figure 2. Tighten 12 mm capscrews (2) to 10 lb-ft (14 N•m).

APPENDIX A - CONTINUED

CRANKSHAFT MAIN JOURNAL DIAMETER	BLOCK ASSEMBLY MAIN BEARING BORE DIAMETER (INSTALL UPPER AND LOWER BEARING SHELLS PER THE FOLLOWING CHART)			
	STANDARD	METRIC	STANDARD	METRIC
Front, Front Intermediate Center & Rear Intermediate Main Bearings	2.9494 in.	74.917 mm	3.1433 in.	79.842 mm
	2.9497 in. <b>BLUE</b>	74.925 mm	3.1430 in.	79.834 mm
	2.9497 in.	74.925 mm	STAMP 2	
	2.9501 in. <b>ORANGE</b>	74.933 mm	STAMP 1	
	2.9501 in.	74.933 mm	1-0.0005 in.	0.013 mm
	3.9504 in. <b>WHITE</b>	74.942 mm	undersize in case	
	2.9492 in.	74.912 mm	1-0.010 in.	0.026 mm
	2.9496 in. <b>BLUE</b>	74.920 mm	undersize in case	
	2.9496 in.	74.920 mm	undersize in case	
	2.9499 in. <b>ORANGE</b>	74.928 mm	undersize in case	
Rear Main Bearing	2.9499 in.	74.928 mm	1-0.0005 in.	0.013 mm
	2.9502 in. <b>WHITE</b>	74.936 mm	undersize in case	

7. Tap crankshaft (1) rearward, then forward; this will align crankshaft bearing and crankshaft thrust surface as shown in figure 3. Tighten ten inner 12 mm capscrews (2) to 55 lb-ft (75 N•m).
8. With crankshaft (1) forced forward and held in place, measure end play at front end of the number three bearing (3) with a feeler gauge. End play should be 0.004-0.010 in. (0.102-0.250 mm) as shown in figure 3.
9. Apply OE/HDO to threads of four 12 mm capscrews (1) and install at outer positions on bearing cap one (7) and five (3) as shown in figure 4.
10. Apply OE/HDO to threads of six 10 mm capscrews (2) and install at outer positions on bearing caps two (6), three (5), and four (4) as shown in figure 4.
11. Retighten ten 12 mm capscrews (8) at inner positions on bearing caps one (7), two (6), three (5), four (4), and five (3) to 55 lb-ft (75 N•m) as shown in figure 4.
12. Tighten ten 12 mm capscrews (8) at inner positions an additional 90° as shown in figure 4.
13. Tighten four 12 mm capscrews (1) at outer positions on bearing caps one (7) and five (3) to 48 lb-ft (65 N•m) as shown in figure 4.
14. Retighten four 12 mm capscrews (1) at outer positions on bearing caps one (7) and five (3) to 48 lb-ft (65 N•m) as shown in figure 4.
15. Tighten four 12 mm capscrews (1) at outer positions on bearing caps one (7) and five (3) an additional 90° as shown in figure 4.
16. Tighten six 10 mm capscrews (2) at outer positions on bearing caps two (6), three (5), and four (4) to 30 lb-ft (40 N•m) as shown in figure 4.

**CAUTION**

Do not tighten 10 mm outer bearing capscrews an additional 90°.

17. Rotate crankshaft to ensure crankshaft rotates freely.
18. Coat rear crankshaft (1) surface with engine oil, and lightly coat lip of rear main oil seal (2) with engine oil as shown in figure 5.
19. Install rear main oil seal (2) with spring cavity towards cylinder block (3) on crankshaft (1) as shown in figure 5.
20. Using seal installer, drive rear main oil seal (2) in until tool bottoms against cylinder block (3) and rear main bearing cap (4) as shown in figure 5.

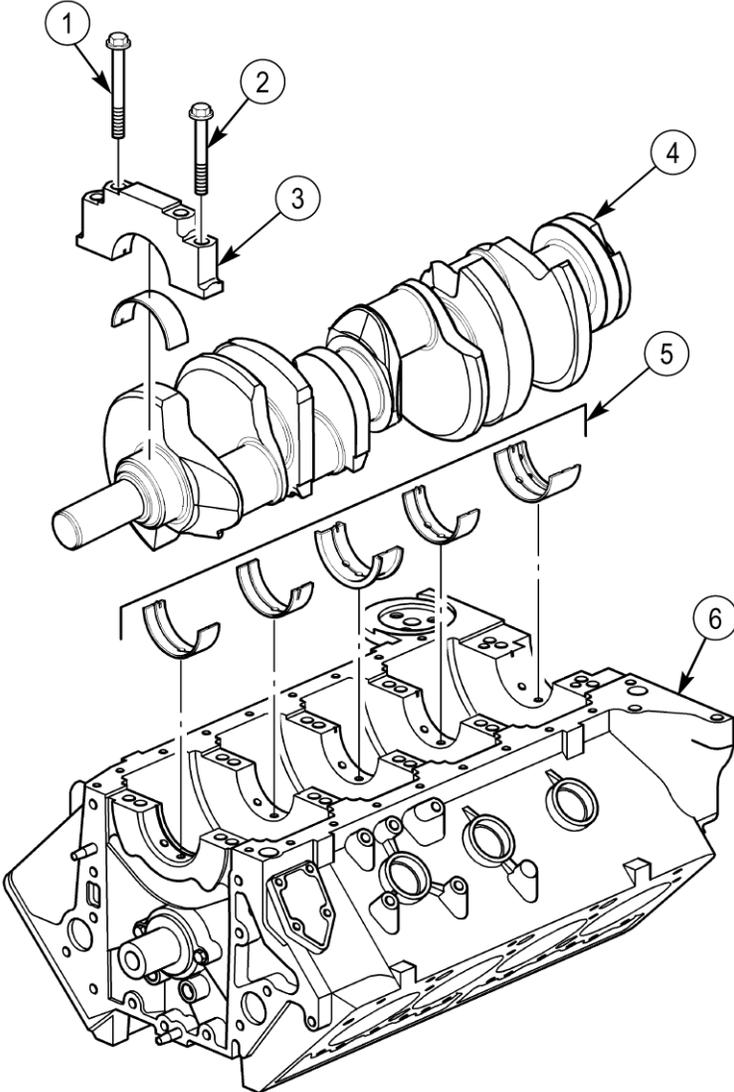


Figure 1

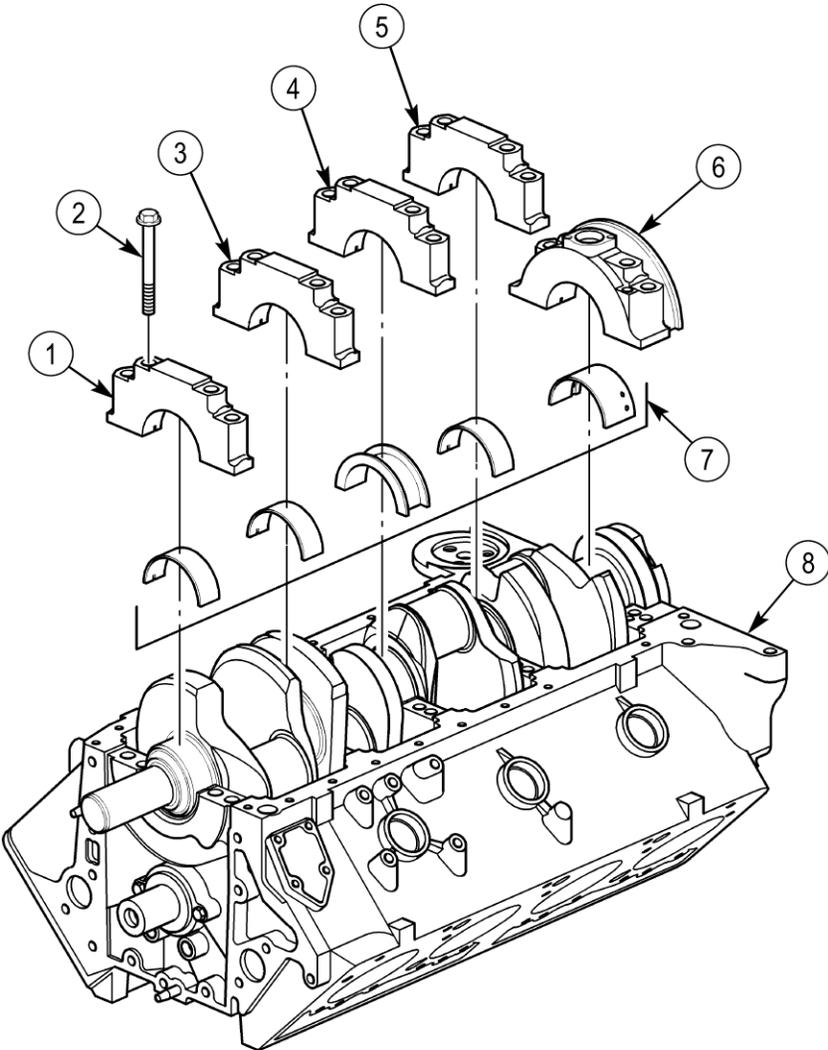


Figure 2

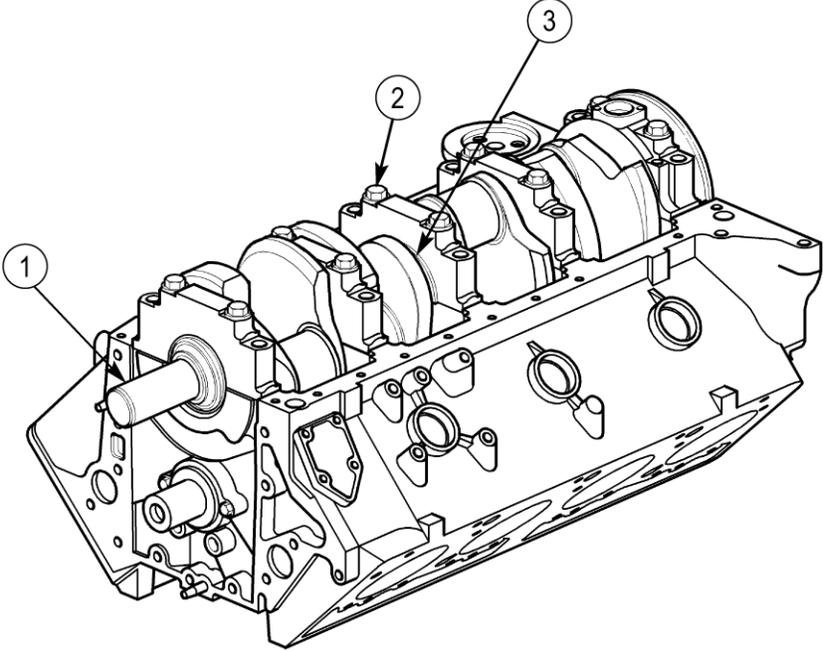


Figure 3

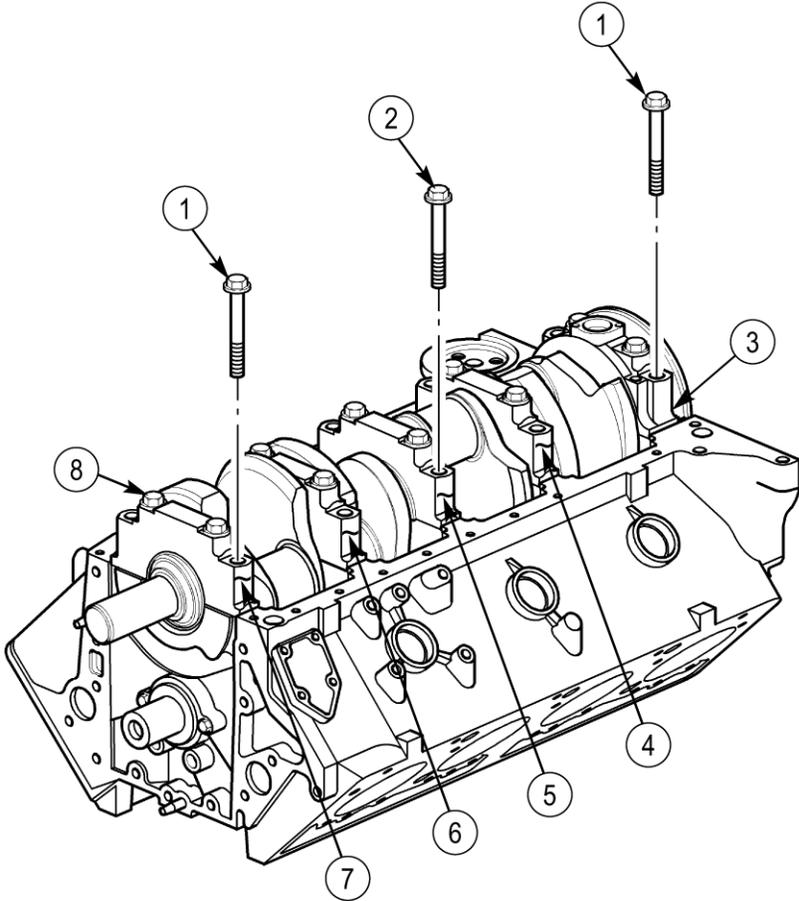


Figure 4

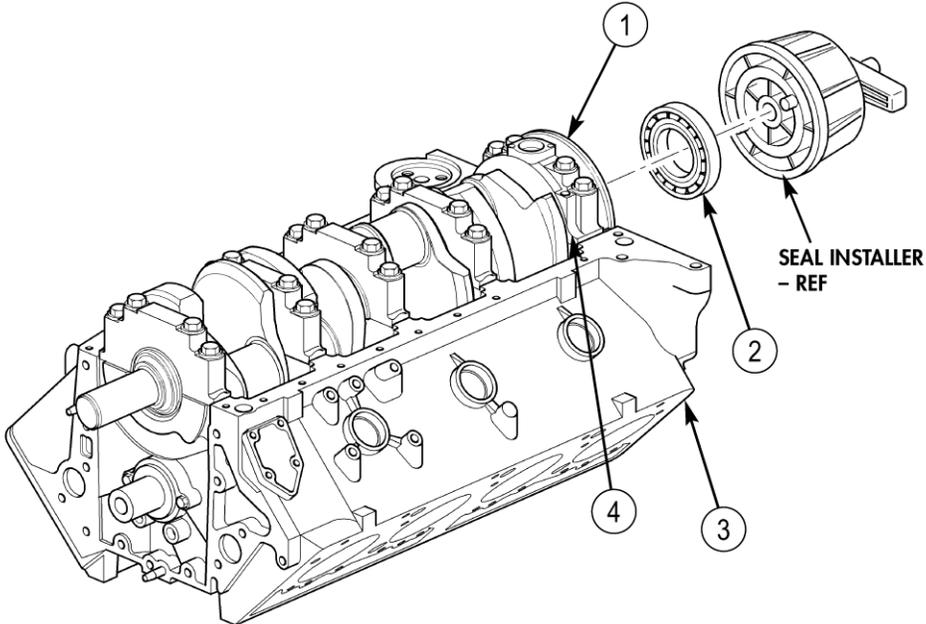


Figure 5

END OF TASK

---

**APPENDIX B**

**0044**

---

**THIS WORK PACKAGE (WP) COVERS:**  
Special Packaging Instructions

---

**APPENDIX C**

**Special Packaging Instructions**

**FOR 6.5L ENGINE**

Additional packaging information can be found in this Web site. You must enter the engine Part Number at the Query screen. You will need to have the Image Reviewer to view the images. You can down load the viewer from the Web Site by going to Help and following the directions.

<https://www.tdps.tacom.army.mil/PackagingHome.htm>

**END OFTASK**

0044 00-1/2 blank



**MANDATORY REPLACEMENT LIST****0045****THIS WORK PACKAGE (WP) COVERS:**

Item Description, Part Number, NSN, and Quantity

**MANDATORY REPLACEMENT LIST****6.5 Liter Detuned Engines****NSN 2815-01-406-6675 (1996)****NSN 2815-01-453-7404 (1998)****NSN 2815-01-439-6664 (2000)****6.5 Liter NA Engines****NSN 2815-01-410-9710 (1995, 1996)****NSN 2815-01-439-6665 (1997)****NSN 2815-01-453-7403 (1998)****NSN 2815-01-461-7078 (1999, 2001)****NSN 2815-01-461-7978 (2000)****6.5L Turbo Engines****NSN 2815-01-420-4180 (1996)****NSN 2815-01-453-7402 (1998)****NSN 2815-01-439-8164 (2000)**

Mandatory replacement parts listed are those parts considered unserviceable after removal during disassembly procedures. All gaskets, seals, cotter pins, and standard stock of this type will be replaced. To eliminate the necessity of more costly inspections all other items of negligible cost are also to be replaced.

<b>Item Description</b>	<b>Part Number</b>	<b>NSN</b>	<b>QTY</b>
Seal , Plain Rear Main 6.5	12532530	5330-01-378-8577	1
Gasket Set, Intake Manifold	12531704	5330-01-437-9216	1
Gasket Set, 6.5 L Overhaul	12514591	5330-01-378-8646	1
Parts Kit, Cyl Head 6.5L	12456409	5330-01-398-3727	1
Parts Kit, Bearing Camshaft	1496M	3120-01-417-8084	1
Ring Set, Piston Standard	12369198	2815-01-399-1020	8
Ring Set, Piston .50mm Oversized (as/if required)	12510753	2815-01-412-6760	8 (as/if required)
Ring, Piston Pin (As required 2 per piston)	14025531	5325-01-234-0447	2
Rod Bearing Half, Sleeve (Std)	12517006	<b>*3120-01-155-3517*</b>	8 pr
.025 MM (undersize)	CB1286P.25MM	3120-01-423-3698	8 Pr
.026 MM (Undersize)	57K3224	2815-01-414-9135	8 Pr
Plug, Expansion, Camshaft	3999200	5340-01-149-7977	1

**MANDATORY REPLACEMENT LIST - CONTINUED****0045**

<b>Item Description</b>	<b>Part Number</b>	<b>NSN</b>	<b>QTY</b>
Plug, Pipe, Magnetic	12554844	4730-01-436-5769	2
Cap, Production, Dust Cylinder Block	10000462	5340-00-449-6408	6
Bearing, Sleeve Crankshaft, Nos 1,2,4 Standard	18009096 12531692 (1997)	3120-01-152-4239 3120-01-459-3844	3
Bearing, Sleeve Crankshaft Nos 1,2, 4 .013mm Undersized (if required)	12531702 (1996) 12531693 (1997)	3120-01-152-8201 Not assigned	3
Bearing, Sleeve Crankshaft, Nos 1, 2, 4 .026 mm Undersized (if required)	18009098 12531694 (1997)	3120-01-153-7545 Not assigned	3
Bearing, Sleeve Crankshaft No. 3 Standard	5740201 12531695 (1997)	3120-01-152-2039 Not assigned	1
Bearing Sleeve Crankshaft, No. 3, .013mm Undersized (if required)	14053400 12531696 (1997)	3120-01-173-3728 Not assigned	1
Bearing, Sleeve Crankshaft, No. 3 .026mm Undersized (if required)	23500111 12531697 (1997)	3120-01-175-3813 Not Assigned	1
Bearing, Sleeve, Crankshaft No. 5, Standard	14055002 12531698 (1997)	3120-01-152-1989 Not assigned	1
Bearing , Sleeve, Crankshaft No. 5 .013 mm Undersized (if required)	14055003 12531699 (1997)	3120-01-177-3064 Not Assigned	1
Bearing, Sleeve, Crankshaft, No. 5 .026 mm Undersized (if required)	14055004 (1996) 12531700 (1997)	3120-01-181-7938 Not Assigned	1
Glow Plugs	5614017(70040)	2920-01-188-3863	8
Hardware Kit, Elect. Fuel Injection Pump Cover	26431	5340-01-334-1422	1
Parts Kit, Metering Fuel Injection Pump	30405	2910-01-299-0473	1

**MANDATORY REPLACEMENT LIST - CONTINUED****0045**

<b>Item Description</b>	<b>Part Number</b>	<b>NSN</b>	<b>QTY</b>
Lockwasher (Fuel Injection Pump)	11582	5310-01-213-9964	3
Adjusting Plug	15228	4930-00-459-6077	1
Valve Stop (Fuel Injection Pump)	26070	2910-01-191-8464	1
Cap (Fuel Injection Pump)	26961	5340-01-415-9633	1
Bolt, Externally Relieved Body (Head Bolts)	14077194	5306-01-410-8159	34
Bolt, Shoulder Outboard (12mm) (Main Bearing Bolts)	14077192	5306-01-149-9668	4
Bolt, Shoulder Outboard (10mm) (Main Bearing Bolts)	12552171	5306-01-486-2891	6
Bolt, Externally Inboard (Main Bearing Bolts)	14077195	5306-01-198-5515	10
Retainer	23500076	3040-01-212-7616	16
Mount, Resilient***	5568310	5342-01-189-9982	2
Thermostat	12551497	6685-01-444-9478	1
Control Unit	12338772	2920-01-175-7214	1
Chain, Roller	14022647	3020-01-155-5779	1
Oil Pump (1996	(72582) 23502073	2815-01-168-7871	1
Oil Pump (1997-2001)	(7X677) 12559797	2815-01-493-3933	1
Locknut (Fan Drive)	3029-01371-01	5318-01-194-0481	1
Spring (Fan Drive)	4088-35869-01	5360-01-190-6214	1
Shaft Oring (Fan Drive)	9002-00181-48	5330-01-194-8966	1
Shaft Oring (Fan Drive)	9002-00741-58	5330-01-195-1500	1
Friction Lining (Fan Drive)	4026-38368-01	2930-01-189-8463	2
Cylinder O-ring (Fan Drive)	3018-01265-01	5330-01-192-8892	1
Dust Seal (Fan Drive)	3018-01339-01	5330-01-247-8438	1
Grease Seal (Fan Drive)	3018-01425-01	5330-01-252-0461	1
Water Jacket Cover Gasket	10137488	5330-01-149-0874	
Filter, Element	PF1218	4330-01-398-8484	1
Valve Spring Locks	3947770	2805-00-155-7266	32

---

**MANDATORY REPLACEMENT LIST - CONTINUED**

---

**0045**

Note: Drain Tube will be installed on all rebuilt engines.

**NOTE**

Crankshaft bearing Part Numbers for 1997 engines are General Motors part numbers. If necessary you can go direct to AM General with these part numbers. AM General will be able to cross reference to their own part numbers. This will be the case until NSNs are assigned to these items.

**NOTE**

\*\*\* Mount, Resilient -- applies to engines involved as part of the Recap program.

**END OF TASK**