

TECHNICAL MANUAL

OPERATOR'S ORGANIZATIONAL,
DIRECT SUPPORT AND GENERAL SUPPORT

MAINTENANCE MANUAL

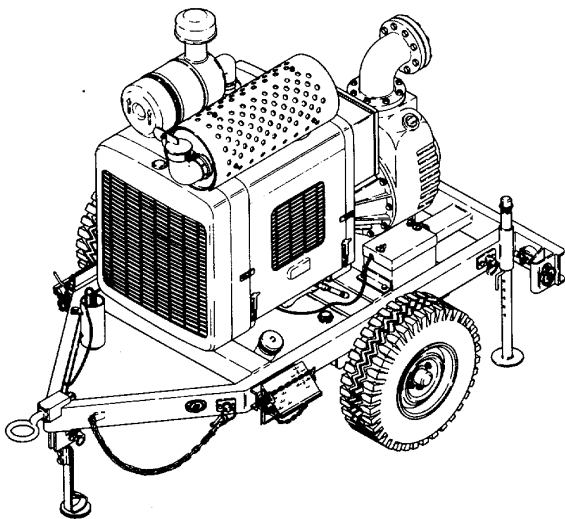
FOR

PUMP CENTRIFUGAL :

SELF-PRIMING, DIESEL-ENGINE-DRIVEN ,

WHEEL-MOUNTED

6 INCH, 1500 GPM AT 60 FOOT HEAD



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HEADQUARTERS, DEPARTMENT OF THE ARMY

15 JANUARY 1984

CHANGE

NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 10 October 1990

Operator's, Organizational,
Direct Support and General Support Maintenance Manual
for
PUMP, CENTRIFUGAL, SELF-PRIMING, DIESEL-ENGINE-DRIVEN,
WHEELMOUNTED 6 INCH, 1500 GPM AT 60 FOOT HEAD

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TM 5-4320-300-14, 15 January 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages

2-61 and 2-62
4-5 and 4-6
4-99 and 4-100

Insert pages

2-61 and 2-62
4-5 and 4-6
4-99 and 4-100

2 Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

THOMAS F. SIKORA
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:

To be distributed in accordance with DA Form 12-25E, (qty rqr block no. 1408).

WARNING**CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU**

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

- Operate engine in a ventilated area only.
- Ventilate personnel compartments when idling engine.
- While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. (Refer to FM21-11.) Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

SEVERE BURNS

illness, death, or injury may result if personnel fail to handle diesel fuel properly. Observe the following safety precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure
- Do not overfill the fuel tank.
- Work in a well-ventilated area.

Allow engine and pump to cool before performing any service or maintenance.

DEATH OR SEVERE INJURY

might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection.

HEALTH AND SAFETY HAZARD

exists when cleaning solvents are used. Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59° C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

WARNING**EXPLOSION HAZARD**

exists when welding repairs are attempted on fuel tank. Purge all fumes from tank before attempting repair involving heat or flame.

SERIOUS INJURY

may result from contact with rotating parts. Make sure battery disconnect switch is off and engine is not running during service or maintenance.

LIVE STEAM

used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

EXPLOSION HAZARD

exists when handling starting aid ether cylinder. Ether is highly flammable. Do not use near sparks or open flames. Do not inhale fumes. Do not actuate starting aid for more than 1 or 2 seconds at a time and more than twice with engine stopped. Overloading the engine air box with this highly volatile fluid could result in an explosion.

SEVERE BURNS

could result from hot coolant released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.

CAUSTIC CHEMICALS IN BATTERIES

may cause severe burns or blindness if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

WARNING**BATTERIES GENERATE FLAMMABLE GAS**

- Leave battery vent plugs installed while battery is being charged.
- Charge battery in a well-ventilated area.
- Do not smoke or use open flame or spark-producing equipment in the vicinity of charging battery.
- Disconnect negative ground on battery to prevent arcing of terminals.

SERIOUS INJURY

could result from improper use of lifting equipment. Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment. Before lifting, be sure load is balanced.

INJURY

might result if equipment is not properly secured during service or maintenance. Trailer front leg and rear stand must make solid contact with ground or block of wood. Unit could drop on leg or stand. Lower and pin the rear stands before disconnecting centrifugal pump unit from towing vehicle. Unit could drop on rear bumper and cause personal injury. Use jack stands to support trailer after jack has raised trailer to working height. Unit could drop from jack and cause personal injury.

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**Operator's, Organizational, Direct Support, and
General Support Maintenance Manual
PUMP, CENTRIFUGAL: SELF-PRIMING, DIESEL-ENGINE-DRIVEN,
WHEEL-MOUNTED, 6 INCH, 1500 GPM AT 60 FOOT HEAD**

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U. S. Army Troop Support Command, ATTN: DRSTRMPSD, 4300 Goodfellow Boulevard, St. Louis, MO 63120. A reply will be furnished directly to you.

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**CHAPTER 1
INTRODUCTION**

Section I. GENERAL INFORMATION

1-1. SCOPE

Type of Manual: Operator's, Organizational, Direct Support, and General Support Maintenance

Model Number and Equipment Name: US90CCD-1 Centrifugal Pump Unit

Purpose of Equipment: Pumps Water

1-2. MAINTENANCE FORMS, RECORDS, AND REPORTS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750, The Army Maintenance Management System (TAMMS).

1-3. DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE

Refer to TM 750-244-3 for instructions.

1-4. PREPARATION FOR STORAGE AND SHIPMENT

Instructions for preparation for storage and shipment are in Chapter 4.

1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR'S)

If your centrifugal pump needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance: Put it on an SF 368 (Quality Deficiency Report). Mail it to us at U.S. Army Troop Support Command, ATTN: DRSTR-MPSD, 4300 Goodfellow Blvd., St. Louis, MO 63120. We'll send you a reply.

1-6. NOMENCLATURE CROSS-REFERENCE

For precise identification, simplified nomenclature has been established for clarity and is shown in the nomenclature cross-reference list.

NOMENCLATURE CROSS-REFERENCE LIST

This listing includes nomenclature cross-references used in this manual.

<u>Common Name</u>	<u>Official Nomenclature</u>
Centrifugal Pump Unit	Pump, Centrifugal: Self-Priming, Diesel-Engine-Driven, Wheel-Mounted, 6 Inch, 1500 GPM at 60 Foot Head
Engine Pump	Diesel Engine Self-Priming Centrifugal Pump
Starter	Starter Motor

Section II. EQUIPMENT DESCRIPTION AND DATA

1-7.PURPOSE OF CENTRIFUGAL PUMP UNIT

General purpose water pumping applications associated with construction work.

1-8.CHARACTERISTICS

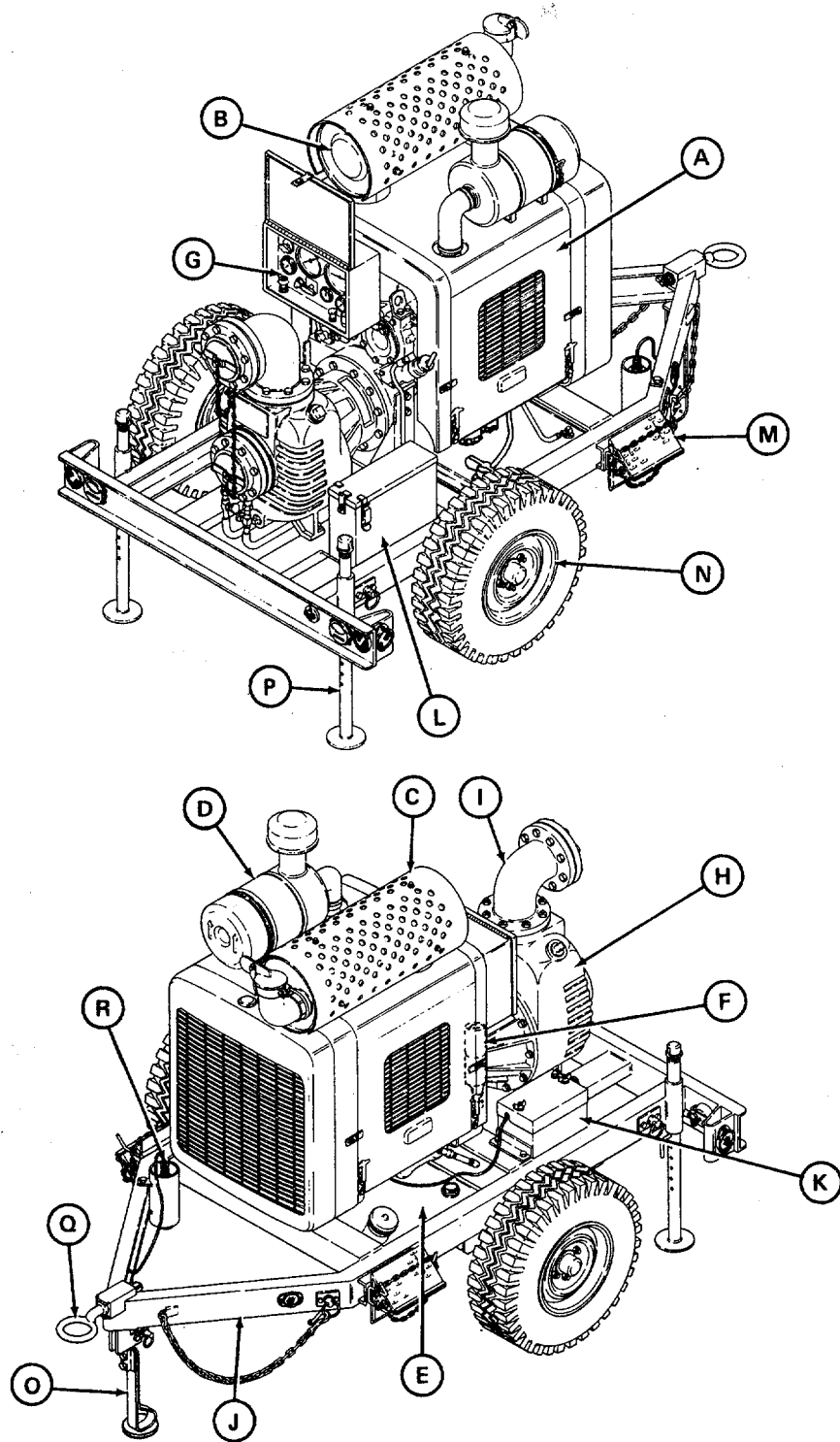
- Variable speed operation
- Wheel-mounted for mobility
- Self-priming

1-9.CAPABILITIES AND FEATURES

- Pumps at a rate of 1500 gpm
- Integral check valve retains fluid in the pump body when the pump is shut down
- Twelve-volt alternator
- Twelve-volt starter
- Twelve-volt automatic shutdown for high temperature, low oil pressure, and overspeed
- Variable speed open linkage governor
- Vernier throttle
- Horizontal top mount dry-type air cleaner
- Horizontal top mount high silencing muffler, exhaust heat shield, and weather cap.
- Engine hood and side panels
- Ether cold starting aid kit
- Enclosed and lighted control panel with tachometer, throttle control, battery disconnect switch, and gages

1-10.LOCATION AND DESCRIPTION OF EXTERNAL COMPONENTS

- (A) ENGINE. Power source.
- (B) MUFFLER. Mounts horizontally on top of engine.
- (C) EXHAUST HEAT SHIELD. Metal safety cover for muffler.
- (D) AIR CLEANER. Dry-type, mounts horizontally on top of engine.
- (E) FUEL TANK. Mounts on frame assembly.
- (F) STARTING AID ETHER CYLINDER. Mounts to engine.
- (G) CONTROL PANEL. Mounted on rear of engine hood.



- (H) PUMP BODY ASSEMBLY. Mounts to frame assembly.
- (I) DISCHARGE ELBOW. Mounts to pump body assembly.
- (J) FRAME ASSEMBLY.
- (K) BATTERY BOX ASSEMBLY. Mounts to frame assembly.
- (L) TOOL BOX WELDMENT. Mounts to frame assembly.
- (M) CHOCK BLOCK AND CHAIN ASSEMBLY. Mounts to frame assembly
- (N) WHEEL.
- (O) FRONT LEG ASSEMBLY. Front trailer support.
- (P) REAR STAND ASSEMBLY. Rear trailer support.
- (Q) COUPLING. Mounts to frame assembly.
- (R) INTERVEHICLE CONNECTOR. Connects tow vehicle and trailer assembly electrical systems for operating trailer lights.

CAUTION

Connect to 12-volt system.

1-11. IDENTIFICATION

The centrifugal pump has the following identification and instruction plates:

a. *Identification plate.* The identification plate is located on front of the pump above the suction flange. It provides the pump identification number, serial number, dimensions, weight, and shipping information.

US			
PUMP, CENTRIFUGAL, SELF PRIMING, 6-INCH, DED			
MODEL US90CCD	CONTRNR DAAK02-71-C-0342		
SER NR 39399-001	CAPACITY 1500 GPM AT 60 TDH		
REG NR	GVW 3400 LB	LG 117 IN	
FSN	DATE MFD	HGT 80 IN	
ENG SER XAX	SHIP WT XBX1972 LB	W 72 IN	
WARRANTY	MO MI	CU 390 FT	
DATE SHIPPED XBX1972	DATE INSP XBX1972	NSP STAMP	XCX
MFD BY BARNES MANUFACTURING CO. MANFIELD, OHIO, USA			

b. *Instruction plate.* The instruction plate is located in the control panel cover. It provides necessary cautions for starting the centrifugal pump, step-by-step procedures for starting engine, and shutdown procedures.

CONDENSED OPERATING INSTRUCTIONS

STARTING PROCEDURES

CAUTION:
 A. PUMP BODY FILLED
 B. ENGINE PANELS SET

- BATTERY SWITCH: ON
- THROTTLE: 1/4 OUT
- ETHER START: BUSSEL, IF NEED
- STARTER SWITCH: PUSH
- THROTTLE: FULL OUT
- ETHER START: OFF IF REQ'D

SHUT-DOWN PROCEDURES

- THROTTLE: 1/4 OUT
- PUMP: 3 MINUTES AT IDLE
- STOP SWITCH: BUSSEL

BARNES MANUFACTURING CO. OHIO
 MODEL US90CCD

c. *Suction plate.* Identifies suction port of pump.



d. *Discharge plate.* Identifies discharge port of pump.



1-12. DIFFERENCES BETWEEN MODELS

This technical manual covers only Centrifugal Pump Unit, Peabody Barnes Model US90CCD-1, part number 72121CA. No known differences exist for this model number.

1-13. EQUIPMENT DATA

a. *Pump.*

Manufacturer.....	Peabody Barnes, Inc.
Part number.....	57057SA
Type.....	Self-priming centrifugal
Service.....	Water
Duty cycle.....	Continuous
Rated output.....	1500 gpm at 60 foot head
Suction port.....	6-inch NPT
Discharge port.....	6-inch NPT
Priming port.....	2-inch NPT
Drain port.....	1-1/2-inch NPT
Rotation.....	Counterclockwise (facing pump inlet)

b. Engine.

Manufacturer General Motors Corp.
 Detroit Diesel Engine Div.
 Model 5033-7001
 Type Two-stroke-cycle diesel
 Number of cylinders 3
 Bore 3.875 in. (98.43 mm)
 Stroke 4.5 in. (114.3 mm)
 Compression ratio (nominal) 21 to 1 (2611 cu cm)
 Total displacement 159.3 cu in.
 Direction of rotation (viewing flywheel) Counterclockwise
 Firing order 1-3-2
 Number of main bearings 4

c. Engine accessories.

Starter motor
 Manufacturer Delco-Remy
 Part number 1113216
 Voltage 12

Alternator
 Manufacturer Delco-Remy
 Part number 1103131
 Voltage 12

Ether starting kit
 Manufacturer Kruber, Inc.
 Part number 20152

Air cleaner
 Manufacturer Donaldson
 Type Dry
 Element number P10-1246

d. Capacities.

Fuel tank 22.8 gal (86.30 liters)
 Oil filter 2.0 qt (1.89 liters)
 Engine crankcase 10.5 qt (9.94 liters)
 Cooling system 6 gal (22.71 liters)

e. Dimensions and weight.

Overall width 68.5 in.(1.74 meters)
 Overall length 119 in.(3.02 meters)
 Overall height 71.5 in (1.82 meters)
 Gross weight 3250 lb (1475 kg)
 Tongue weight 135 lb (61.24 kg)
 Shipping volume 270 cu ft (7.65 cu m)
 Tire size 7:00-15
 Maximum highway speed 50 mph (80.5 kilometers)
 Maximum cross country speed 15 mph (24.2 kilometers)
 Maximum tire pressure 45 psi (310.3 kPa)
 Minimum tire pressure 30 psi (207.0 kPa)

1-14.SAFETY, CARE, AND HANDLING

a. *Before operation.* Do not operate the unit in an enclosed area unless the exhaust is piped to the outside. The exhaust contains carbon monoxide, a colorless, odorless, deadly poisonous gas. Do not smoke or use an open flame in the vicinity when servicing batteries. Batteries generate hydrogen, a highly explosive gas. When filling the fuel tank, always maintain a metal-to-metal contact between the filling apparatus and the fuel tank to prevent a static spark from igniting the diesel oil fumes.

b. *During operation.* Do not fill the fuel tank while the engine is operating, nor attempt to perform maintenance on the pump unit while it is in operation.

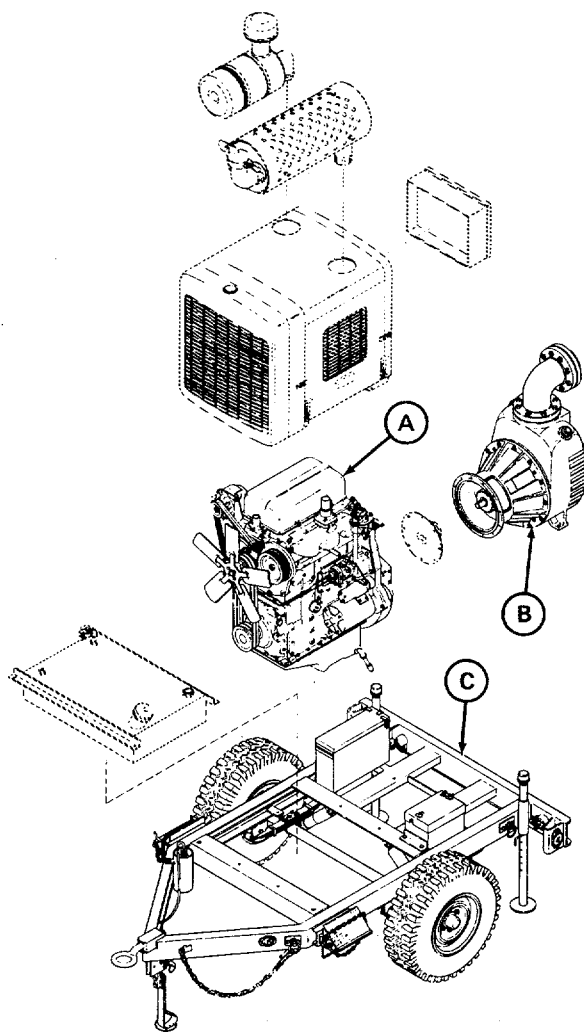
c. *After operation.* Exercise caution when removing the radiator cap while the engine is hot. Quick removal will cause steam and hot coolant to escape, and may result in serious burns to personnel. When filling the fuel tank, always maintain metal-to-metal contact between the filling apparatus and the fuel tank to prevent a static spark from igniting diesel oil fumes.

Section III. TECHNICAL PRINCIPLES OF OPERATION

1-15.CENTRIFUGAL PUMP UNIT

The centrifugal pump mounts on a two-wheel trailer in line with a 70 horsepower diesel engine. Power from the engine is transferred to the pump through a flexible coupling. The pump is self-priming (a check valve retains water in the pump body), and is capable of variable speed operation. The pump has a capacity of 1500 gallons per minute at 60 foot head. The pump is equipped with 6-inch suction and discharge ports with flanges. The continuous-duty, water-cooled diesel engine uses a 12-volt electrical system, and is equipped with electric start, spin-on oil and fuel filters, a heavy-duty dry-type air cleaner, and instrumentation.

- (A) ENGINE ASSEMBLY. Bolted to the trailer assembly. Provides the power necessary to drive the pump.
- (B) PUMP ASSEMBLY. Bolted to the trailer assembly. Uses power from the engine to forcefully move water from the suction port to the discharge port.
- (C) TRAILER ASSEMBLY. Provides a mobile mounting platform for the engine and pump assemblies



(A) ENGINE ASSEMBLY

1. ELECTRICAL SYSTEM. Major components include a battery, starter motor assembly, generator, and wiring harness. The battery provides electric power to run the starter motor and start the engine. The generator recharges the battery after the engine is started, and provides power to all electrical components through the wiring harness.
2. LUBRICATION SYSTEM. Major components include an oil pump, oil cooler, and oil filter. The oil pump pumps oil to reduce friction between moving parts, the oil cooler reduces the temperature of the oil, and the filter removes impurities from the oil.

3. **COOLING SYSTEM.** Major components include a radiator, water pump, cooling fan, and hoses. The radiator and fan cool the coolant while it is being circulated by the water pump. The hoses connect the major components.
 4. **FUEL SYSTEM.** Major components include a fuel pump, tank, strainer, filter, and lines. The fuel pump pumps fuel from the fuel tank, through the strainer and filter, to the engine. The fuel lines connect the major components.
 5. **EXHAUST SYSTEM.** Major components include a muffler and exhaust manifold. The exhaust manifold transports exhaust gases from the engine to the muffler. The muffler quiets the sound and reduces the temperature of the exhaust.
- (B) CENTRIFUGAL PUMP.** Major components include a volute, impeller, and a pump body with suction and discharge ports. The volute houses the impeller which draws water in through the suction port and forces it out of the pump through the discharge port.
- (C) TRAILER ASSEMBLY.** Major components include a frame assembly, wheels, and a coupling. The frame assembly is the mobile support for the engine and pump assemblies. The rubber-tired wheels rotate on roller bearings for ease in towing. The coupling connects the trailer assembly to the towing vehicle. The trailer assembly has a 24-volt electrical system that connects to the towing vehicle.

**CHAPTER. 2
OPERATING INSTRUCTIONS**

Section I. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS

WARNING

Personal injury may result if the engine is not turned off during service or maintenance.

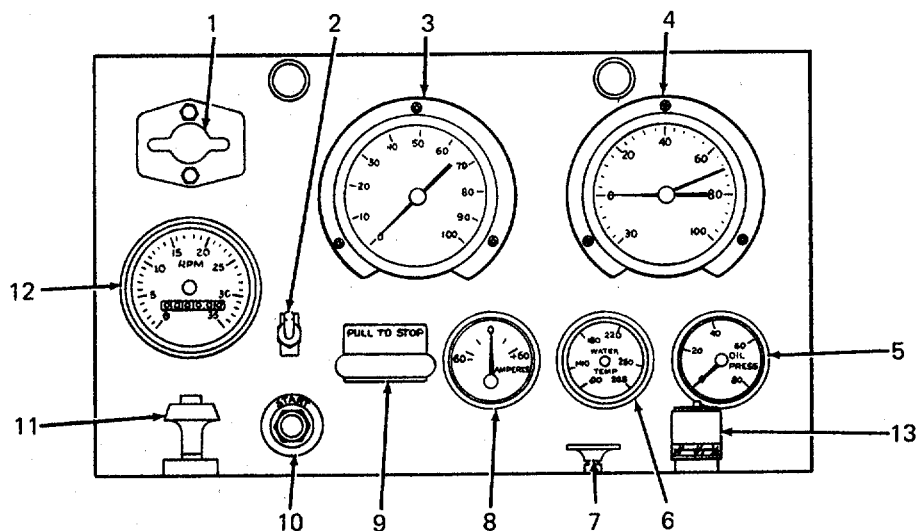


Table 2-1. Operator's Controls and Indicators

Key	Control or Indicator	Function
1	Battery disconnect switch	Disconnects battery from electrical system of engine. Operated by pulling and turning either direction.
2	Light switch	Turns control panel lights on and off. Connected between engine electrical system and light bulbs on control panel.
3	Pressure gage	Monitors pressure in pressure portion of pump. Graduated in millimeters of mercury (mm Hg), from 0 to 100.
4	Compound gage	Monitors pump discharge or suction in pressure portion of pump. Graduated in increments of 2 pounds per square inch gage (psig) from 0 to 100, and 0 to -30 millimeters of mercury (mm Hg).
5	Oil pressure gage	Indicates engine oil pressure in pounds per square inch (psi). Mechanically connected by an oil line to the lubrication system on the outlet side of the oil pump. Graduated in 10 psi increments from 0 to 80 psi.
6	Water temperature Gage	Indicates temperature of engine coolant in degrees Fahrenheit (F). Electrically connected to sending unit in engine block.

Table 2-1. Operator's Controls and Indicators - Continued

Key	Control or Indicator	Function
7	Starting aid control knob	Releases ether into engine air supply. Mechanically connected to ether cylinder by control cable. Pulling control releases ether; pushing it in shuts it off.
8	Ammeter	Indicates battery charge or discharge in amperes (A). Electrically connected in series to battery circuit. Graduated in 30 A increments from 0 to +60 A and 0 to -60 A.
9	Stop handle	Stops engine. Mechanically connected through the air shutoff control wire to the mechanical governor. Pulling handle stops engine operation through fuel starvation.
10	START pushbutton	Starts engine. Electrically connected to a relay which allows electric current to flow to the starting solenoid. The starting solenoid then allows current to flow to the starter motor.
11	Throttle	Controls engine speed. Coupled to governor through a control wire. Uses a pushbutton lock. Pulling the throttle increases engine speed; pushing it in decreases engine speed.
12	Tachometer	Indicates engine speed in revolutions per minute (rpm) and elapsed time in hours, tenths, and hundredths. Mechanically coupled to rotating cable that is connected to the governor drive gear. Graduated in 100 rpm increments from 0 to 3500 rpm. The elapsed time meter will record up to 9999.99 hours of operation.
13	Restriction indicator	Indicates blockage of air filter. A red signal appears to indicate the need for cleaning or replacement. Indicator is connected to air inlet housing by a flexible hose, and is actuated by high negative pressure. Indicator can be reset.

Section II. OPERATOR/CREW PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

2-1. GENERAL

- a. *Before you operate.* Always keep in mind the CAUTIONS and WARNINGS. Perform your before (B) PMCS.
- b. *While you operate.* Always keep in mind the CAUTIONS and WARNINGS. Perform your during (D) PMCS.
- c. *After you operate.* Be sure to perform your after (A) PMCS.
- d. *If your equipment fails to operate.* Troubleshoot with proper equipment. Report any deficiencies using the proper forms; see TM 38-750.

2-2. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

a. Table 2-2 lists the preventive maintenance checks and services which shall be performed at specified intervals by the operator/crew.

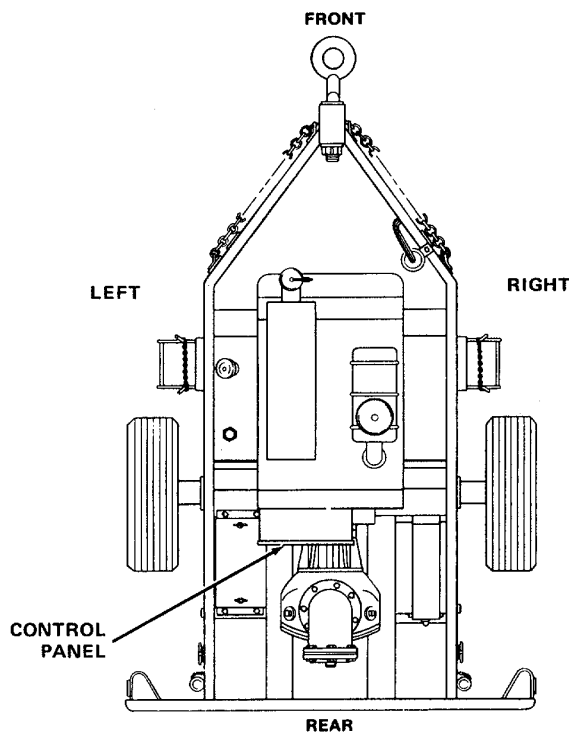
b. Item numbers are assigned to each check or service task. These numbers are to be used as a source of item numbers for the TM Number column on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.

c. The service intervals are divided into five categories; B Before Operation; D During Operation; A After Operation; W Weekly; and M Monthly. A dot (e) is placed in the Interval column for each check or service. If the same check or service is made in two or more intervals, a dot is placed in each applicable column.

d. The ITEM TO BE INSPECTED column lists the item to be checked or serviced. This column is combined with the PROCEDURE column.

e. The PROCEDURE column describes the procedure by which the check or service is to be performed. Illustrations are included to assist in locating that part of the equipment requiring the check or service. When instructions for removal of assemblies or equipment are required in order to perform PMCS, they are listed and illustrated in the PROCEDURE column.

f. The designations left, right, front, and rear as used in the preventive maintenance checks and services (PMCS) indicate the side or end of the centrifugal pump as viewed when facing the control panel.



g. The Equipment is Not Ready/Available If: column contains the basis for classifying the equipment as not ready/available because it is unable to perform its primary mission. An entry in this column will:

- (1) Identify conditions that make the equipment not ready/available for readiness reporting purposes.
- (2) Deny use of the equipment until corrective maintenance has been performed.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services

NOTE

If the equipment must be kept in continuous operation, check and service only those items that can be checked and serviced without disturbing operation. Make the complete checks and services when the equipment can be shut down.

Perform weekly as well as before operation PMCS if:

- (1) You are the assigned operator and have not operated the item since the last weekly.
- (2) You are operating the item for the first time.

Within designated interval, these checks are to be performed in the order listed.

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

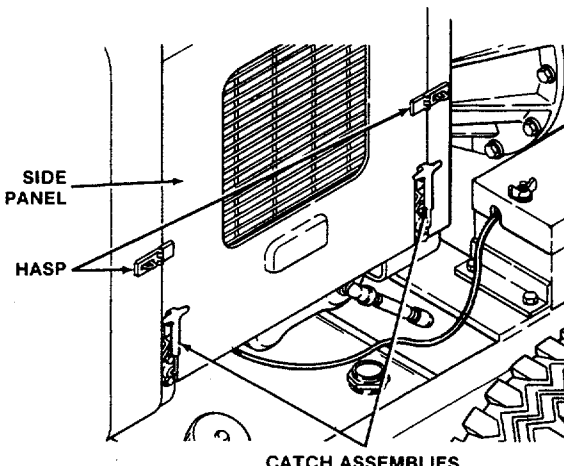
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M			
1	•	•				<p><i>Drive Belts.</i></p> <p style="text-align: center;">WARNING</p> <p>Severe injury may result from contact with the rotating cooling fan. When it is necessary to make inspections near the fan area, be aware of the fan position, or turn off engine.</p> <p>Remove engine side panels. Unfasten hasps and catch assemblies, then pull side panels up and out to remove.</p> 		

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

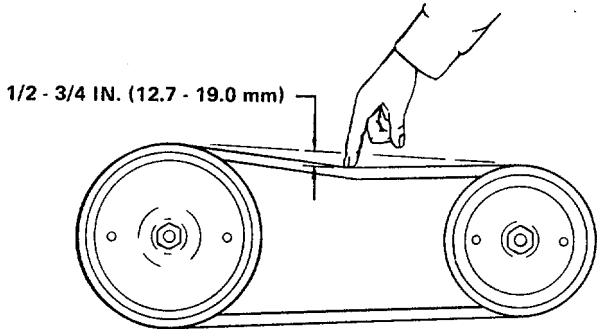
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>Check the tension of alternator drive belts and fan drive belts. Belts should be able to be deflected with forefinger pressure 1/2 to 3/4 inch (12.7 to 19.0 mm) at the midpoint between pulleys.</p>  <p>1/2 - 3/4 IN. (12.7 - 19.0 mm)</p> <p>Replace engine side panels.</p>	Belts are broken or excessively loose.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

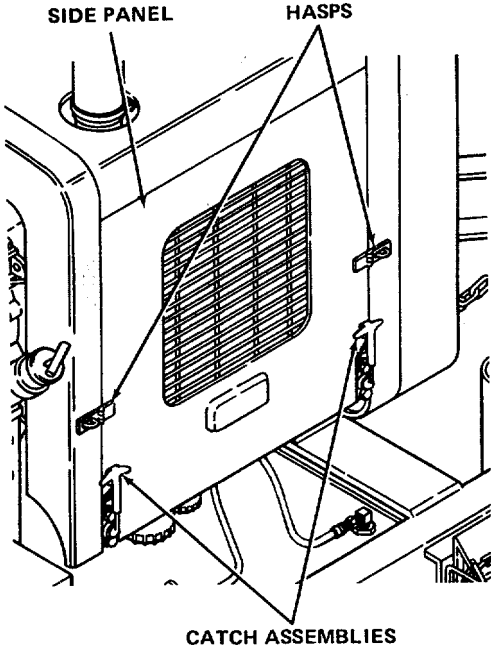
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
2	•		•			<p><i>Alternator.</i></p> <p style="text-align: center;">WARNING</p> <p>Engine should be shut down when alternator is being inspected.</p> <p style="text-align: center;">CAUTION</p> <p>Avoid grounding or shorting the alternator. Never disconnect battery while alternator is operating. Remove negative battery cable from battery before tightening connections on alternator.</p> <p>Avoid making contact across the two battery posts. This can result in severe arcing.</p> <p>Remove engine right side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> <div style="text-align: center;">  </div>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

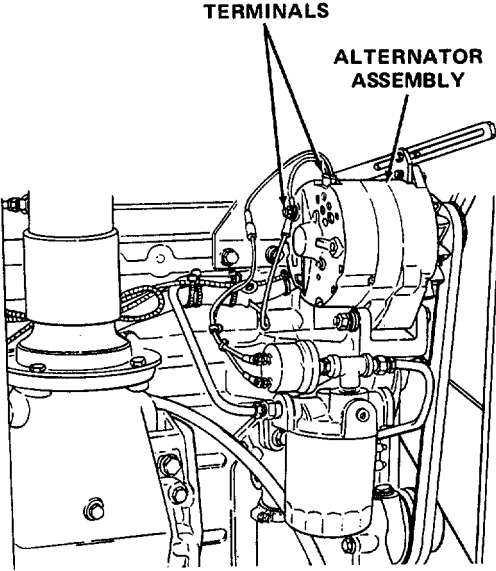
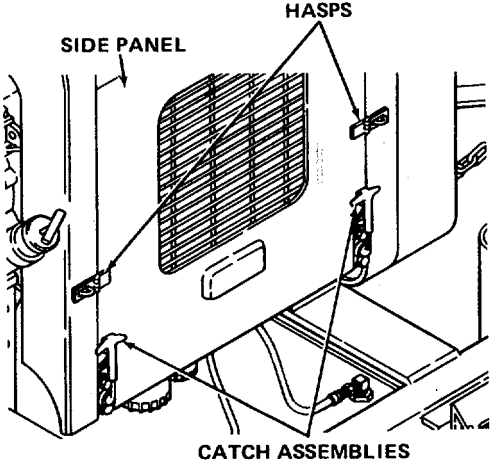
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
3	•	•	•			<p>Inspect alternator assembly terminals for corrosion or loose connections. Tighten loose connections.</p>  <p>Replace engine side panel.</p> <p><i>Water Pump.</i> Remove engine right side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> 	Water pump leaks excessively or makes unusual noise.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

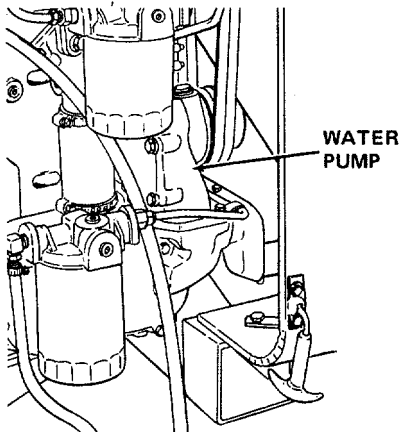
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p style="text-align: center;">WARNING</p> <p>Severe injury may result from contact with rotating cooling fan. When it is necessary to work in fan area, be aware of the fan position.</p> <p>The centrifugal-type engine fresh water pump is mounted above the oil cooler on right-hand side of engine. Check for leakage and for noises that are not normal operating sounds.</p>  <p>Replace engine side panel.</p>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

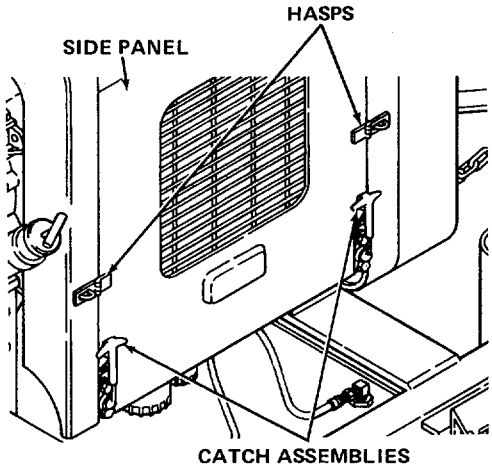
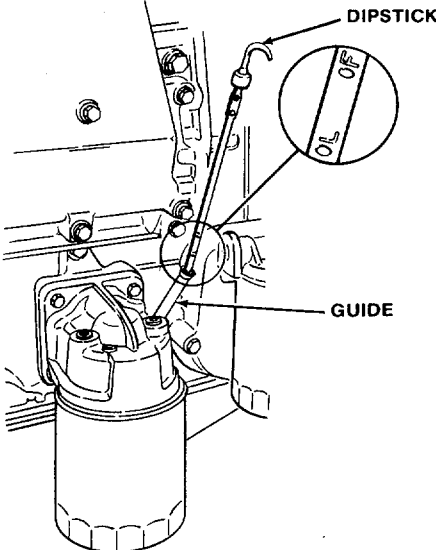
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
4	•		•			<p><i>Oil Level.</i> Remove engine right side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p>  <p>Check lubricating oil level with the engine stopped. If engine has just been stopped, wait approximately 20 minutes to allow oil to drain back to the oil pan. Engine must be level to check the oil. Remove dipstick and check oil level. Replace dipstick.</p> 	Oil level is low.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

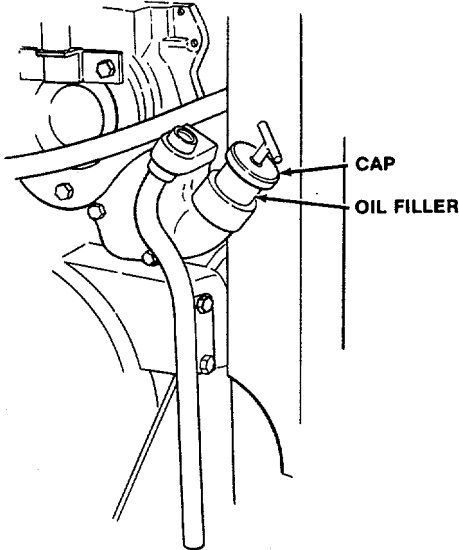
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>Remove oil filler cap and add proper grade oil as required to maintain correct oil level on the dipstick. Replace oil filler cap.</p>  <p style="text-align: center;">CAUTION</p> <p>Do not overfill. Oil may be blown out through the crankcase breather if crankcase is over-filled.</p> <p>Replace engine side panel.</p>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

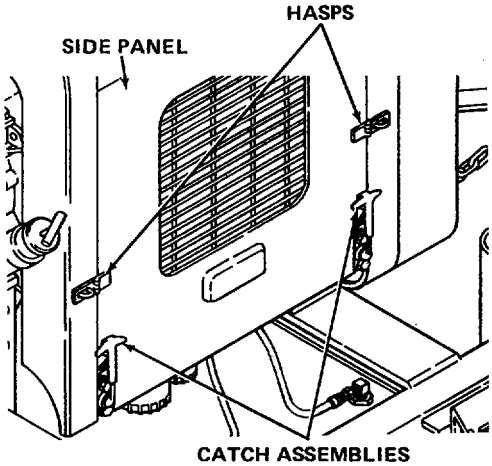
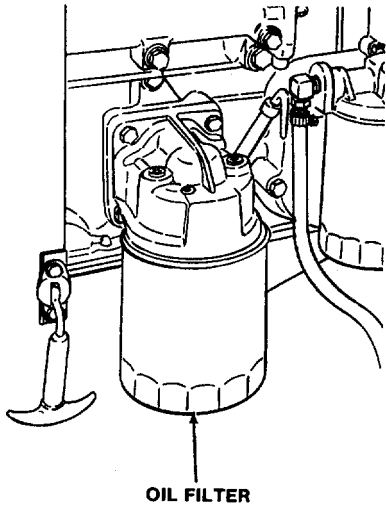
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
5	•	•	•			<p><i>Oil Filter:</i> Remove engine right side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p>  <p>Check for leaks around oil filter.</p>  <p>Replace engine side panel.</p>	Oil leakage is excessive.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

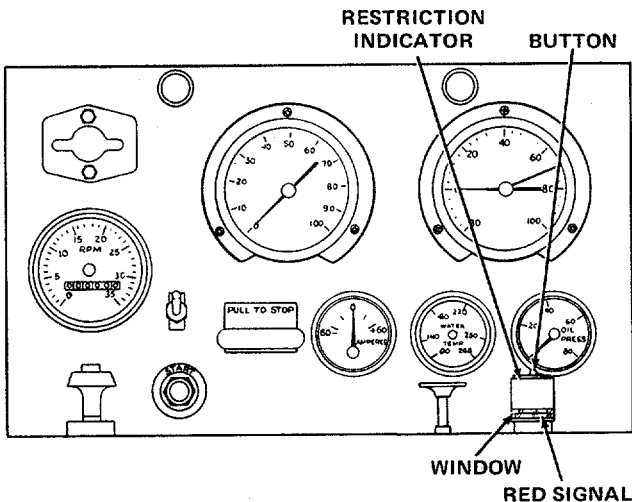
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
6	•	•				<p><i>Air Cleaner.</i> Check restriction indicator located in operator's control panel. The red signal in the window of the restriction indicator locks in view when air cleaner filter element needs servicing. A button will also pop out of the top of the indicator.</p>  <p>To clean air filter, loosen clamp assembly that secures cup assembly to body assembly. Remove baffle assembly and empty dust from the cup assembly.</p> <p>NOTE</p> <p>Do not allow dust to build up in cup assembly. Empty more frequently when operating under dusty conditions.</p>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

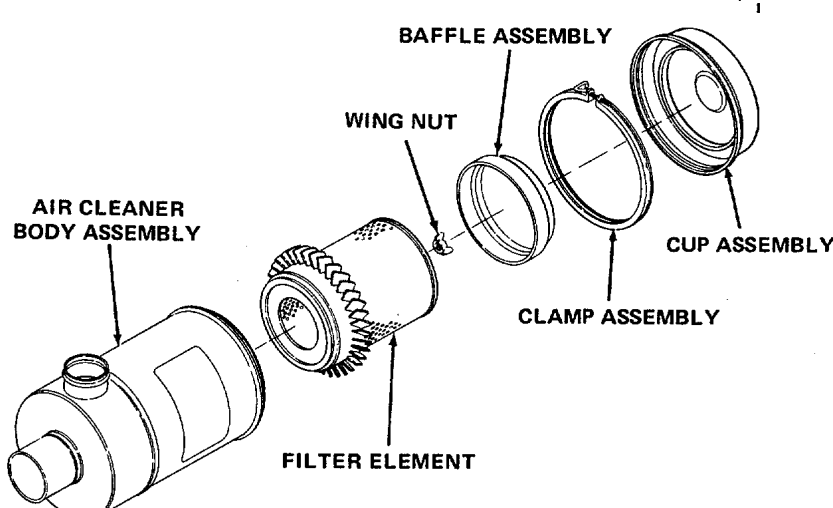
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						 <p>Wipe cup assembly and baffle assembly clean using damp cloth. To remove filter element, unscrew the wing nut and carefully remove the element from body assembly. Do not remove plastic fin assembly from the filter element. Wipe the inside of the body assembly clean with a damp cloth.</p> <p>If filter element must be reused, gently tap filter element against the palm of your hand. Install new filter element when available.</p> <p style="text-align: center;">CAUTION</p> <p>The slightest break in the air cleaner filter element will admit enough airborne dirt to cause rapid failure of piston rings.</p> <p>Inspect air filter element for breaks, holes, or damaged gasket.</p> <p style="text-align: center;">NOTE</p> <p>For temporary and quick cleaning, the pleated paper air cleaner element can be cleaned by tapping side or end of element carefully against the palm of your hand.</p>	Air cleaner filter element is torn or has breaks.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

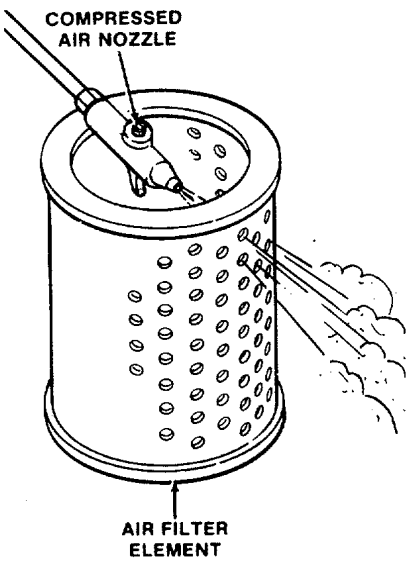
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p style="text-align: center;">WARNING</p> <p>Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct air-stream against skin.</p> <p>If a regulated compressed air supply is available, direct a stream of compressed air (100 psi (690 kPa) maximum) through the element from the inside.</p> <div style="text-align: center;">  <p>The diagram shows a cylindrical air filter element with a grid of small holes. A compressed air nozzle is inserted into the top opening. Lines radiating from the nozzle indicate air being blown through the element. Labels 'COMPRESSED AIR NOZZLE' and 'AIR FILTER ELEMENT' are present.</p> </div> <p style="text-align: center;">CAUTION</p> <p>Do not blow out body assembly with compressed air. Equipment damage could result if dust is not removed from body assembly with damp cloth.</p> <p>Reassemble air cleaner by replacing baffle assembly in cup assembly. Carefully insert filter element in body assembly and tighten wing nut securely. Reinstall cup assembly to body assembly making</p>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

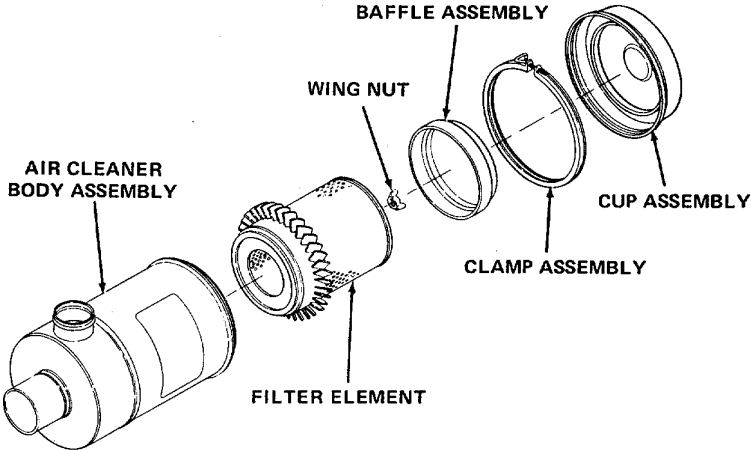
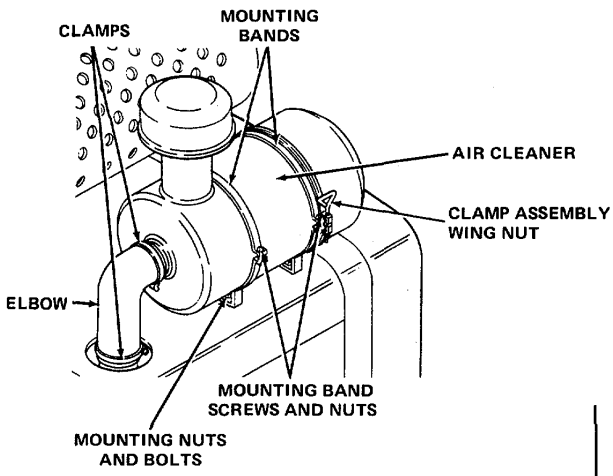
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>certain cup assembly seals completely around air cleaner body. Position clamp assembly and tighten wing nut. Reset restriction indicator by pushing down button on top of indicator.</p>  <p>Inspect the elbow between air cleaner and engine to insure all clamps are tight and there are no cracks in the elbow. Inspect air cleaner mounting band screws and nuts, mounting nuts and bolts, to insure that they are holding the air cleaner assembly securely. Check air cleaner for dents and damage.</p> 	There are cracks in elbow.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

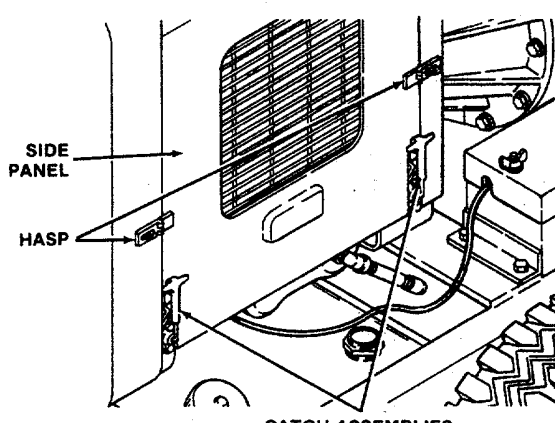
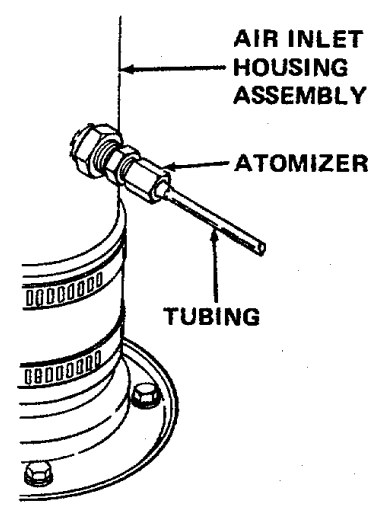
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
7	●					<p>Starting Aid Atomizer Tubing. Remove engine side panels. Unfasten hasps and catch assemblies, then pull side panels up and out to remove.</p>  <p>Inspect atomizer and atomizer tubing for visible damage.</p>  <p>Replace engine side panels.</p>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

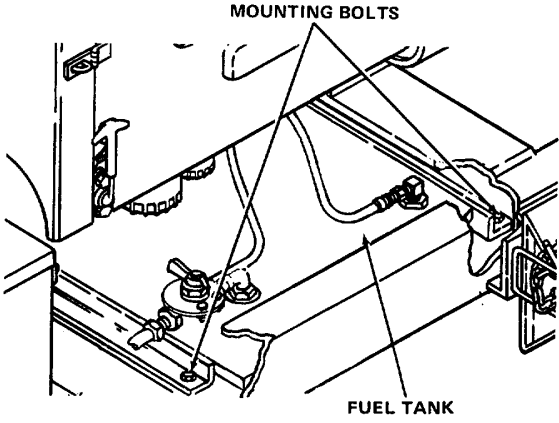
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
8	●	●	●			<p><i>Fuel Tank.</i></p> <p style="text-align: center;">WARNING</p> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not refuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Do not overfill fuel tank. • Work in a well-ventilated area. <p style="text-align: center;">CAUTION</p> <p>Condensed moisture in the fuel tank is harmful to engine operation. Keep fuel tank filled between periods of operation to reduce condensation.</p> <p>Inspect fuel tank for loose mounting bolts, dents, leaks, and other damage.</p> <div style="text-align: center;">  <p>MOUNTING BOLTS</p> <p>FUEL TANK</p> </div>	Fuel tank shows any leakage.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

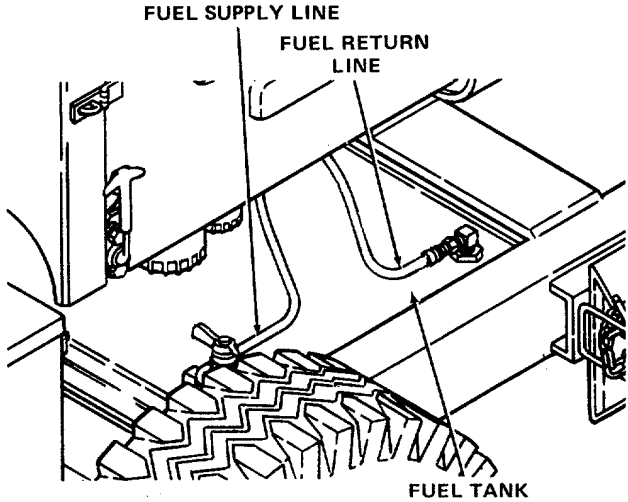
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
9	●	●	●			<p>Clean fuel tank strainer, if dirty. Check level gage operation. Refill tank at the end of each day's operation or after 8 hours of continuous service.</p> <p><i>Fuel Supply and Return Lines, Hoses, and Fittings.</i> Inspect for leaks. Leaks can best be detected by accumulation of fuel under gas tank, fuel lines, and hoses. Fuel lines and hoses are located on top of fuel tank. Check for loose fuel line and hose fittings and inspect for wear and cracks. Tighten fittings if necessary.</p> 	There is any leakage.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

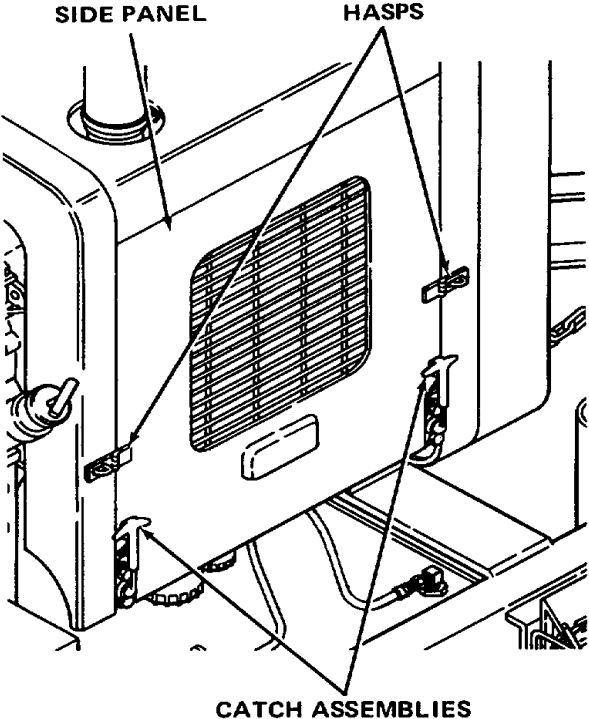
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
10	●	●	●			<p><i>Fuel Strainer Cartridge.</i></p> <p style="text-align: center;">WARNING</p> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not handle fuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Work in a well-ventilated area. <p>Remove engine right side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> <div style="text-align: center;">  </div>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

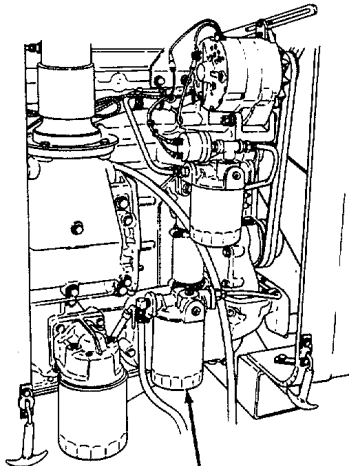
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
11	●	●	●			<p>Check fuel strainer cartridge for leakage or damage.</p>  <p>FUEL STRAINER CARTRIDGE</p> <p>Replace engine side panel.</p> <p><i>Fuel Filter Cartridge.</i></p> <p>WARNING</p> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not handle fuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Work in a well-ventilated area. 	There is any leakage.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

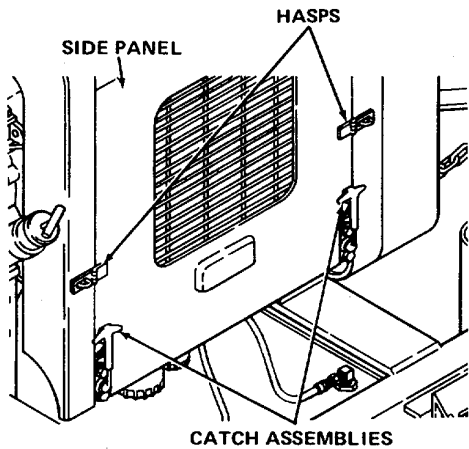
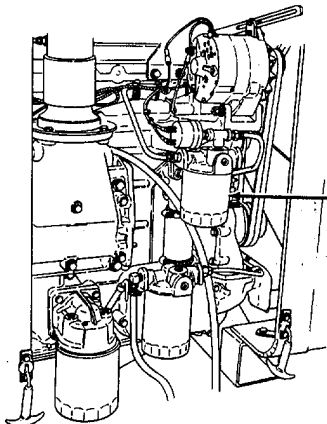
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>Remove engine right side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p>  <p>Check fuel filter cartridge for leakage or damage.</p>  <p>Replace engine side panel.</p>	There is any leakage.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

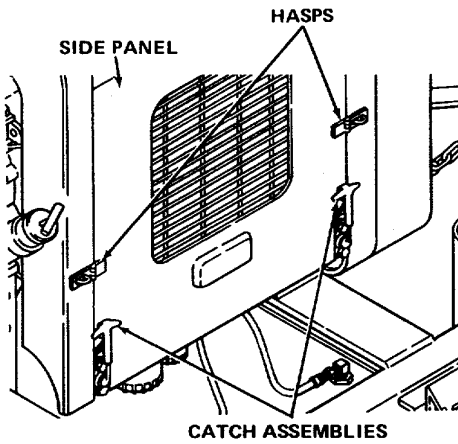
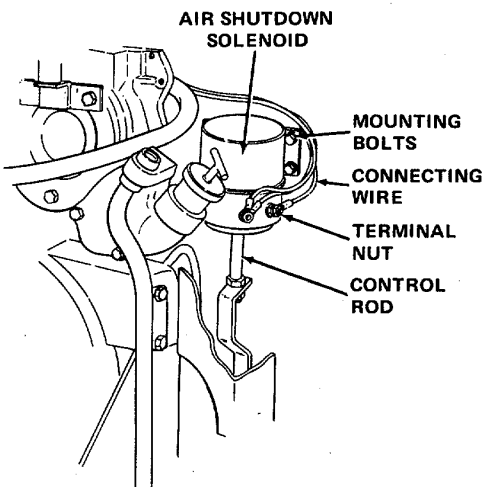
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
12	●					<p><i>Air Shutdown Solenoid.</i> Remove engine right side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p>  <p>Check solenoid electrical connections for tightness and the connecting wires for any broken insulation, kinks, or frayed ends at connectors. Check solenoid control lever and latch for binding. The air shutdown solenoid control lever and other solenoid linkage components are located at the right rear of engine, next to the blower air inlet housing.</p>  <p>Replace engine side panel.</p>	Solenoid connections are broken.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

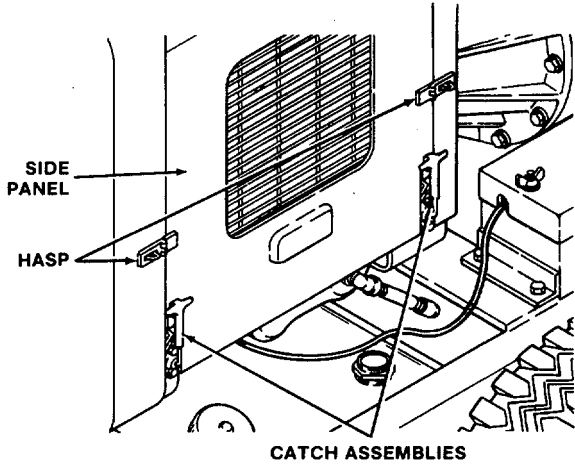
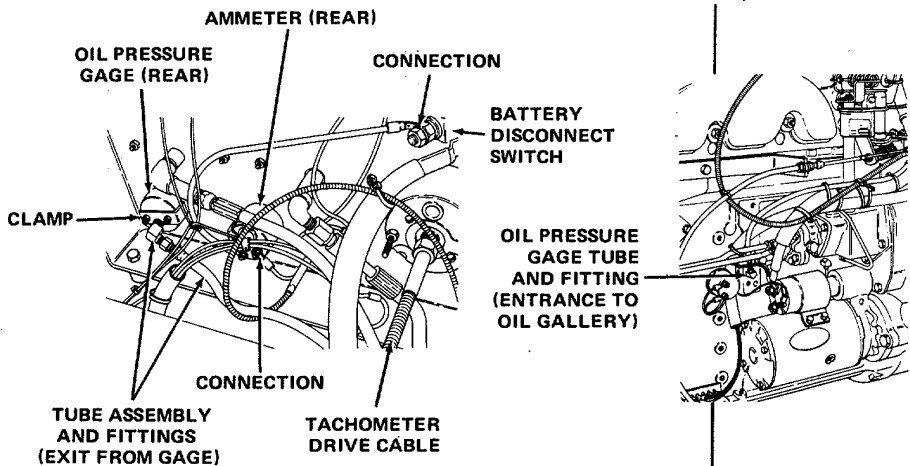
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
13	●	●	●			<p>Control Panel Assembly. Remove engine side panels. Unfasten hasps and catch assemblies, then pull side panels up and out to remove.</p>  <p>Inspect gage tube assemblies for leaks, cracks, deterioration, looseness at fittings, or other damage. If any fittings are loose, tighten them slightly. Also inspect tachometer drive cable for cracks, deterioration, other damage, or looseness at attachment points. Inspect connections to ammeter and switches for looseness, broken insulation, or frayed conductors. Inspect all gage clamps for looseness.</p>  <p>Replace engine side panels.</p>	There is any leakage.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

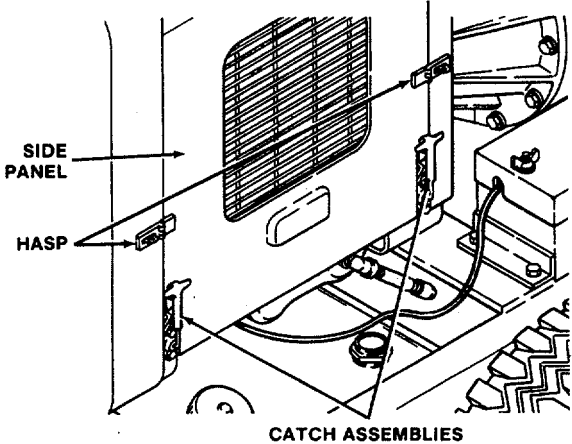
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
14	●	●	●			<p><i>Gages.</i> Inspect gages for broken glass, inoperative condition, or other damage. Clean gage faces by wiping with a damp cloth.</p>	
15	●					<p><i>Switches.</i> Inspect switches for damage or looseness in mounting. Check wires to switch for broken insulation, loose connections, or kinks. Check switch for smooth operation.</p>	Switches are loose or damaged.
16	●					<p><i>Starting Aid Control Cable.</i></p> <p style="text-align: center;">WARNING</p> <p>Handle starting aid ether cylinder carefully. Ether is highly flammable. Do not use near sparks or open flames. Do not inhale fumes.</p> <p>Do not actuate starting aid for more than 1 or 2 seconds at a time and more than twice with engine stopped. Overloading the engine air box with this highly volatile fluid could result in an explosion.</p> <p>Remove engine left side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

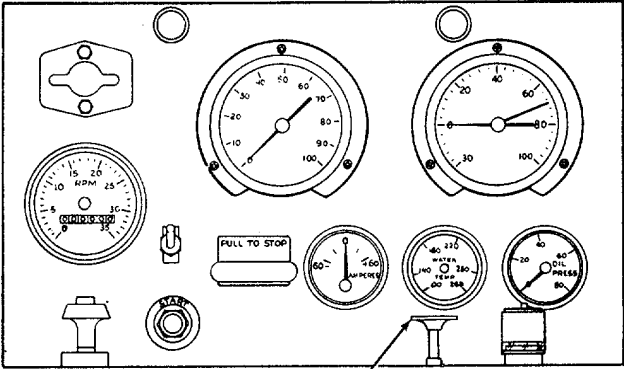
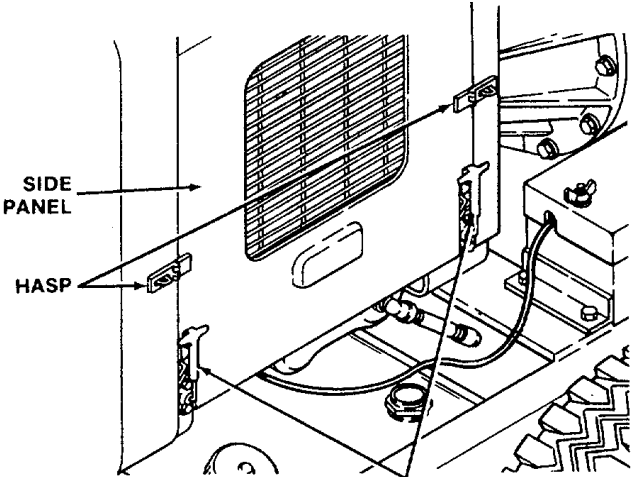
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
17						<p>Check control cable for smooth operation by actuating starting aid control knob while engine is stopped.</p>  <p>Replace engine side panel.</p> <p><i>Speed Regulating Throttle Cable.</i> Remove engine left side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

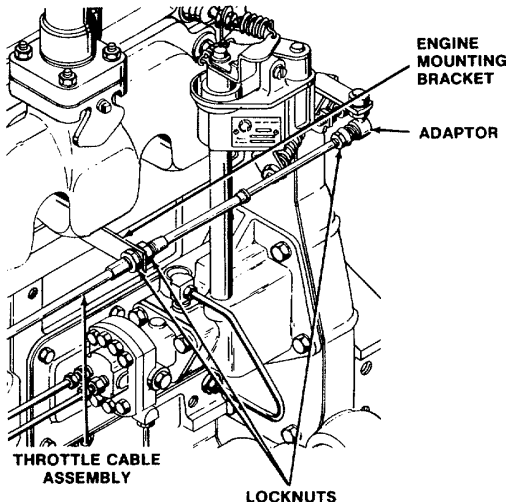
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p style="text-align: center;">WARNING</p> <p>Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure. Fumes from engines become concentrated with poor ventilation.</p> <ol style="list-style-type: none"> 1. Operate engine in a ventilated area only. 2. Ventilate personnel compartments while idling engine. 3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available. <p style="text-align: center;">GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.</p> <p>Start engine and check throttle cable assembly for smooth operation. The cable should work freely and shall hold a set position.</p> <p>Inspect the mounting and linkage; tighten if loose.</p>  <p>Re.</p>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

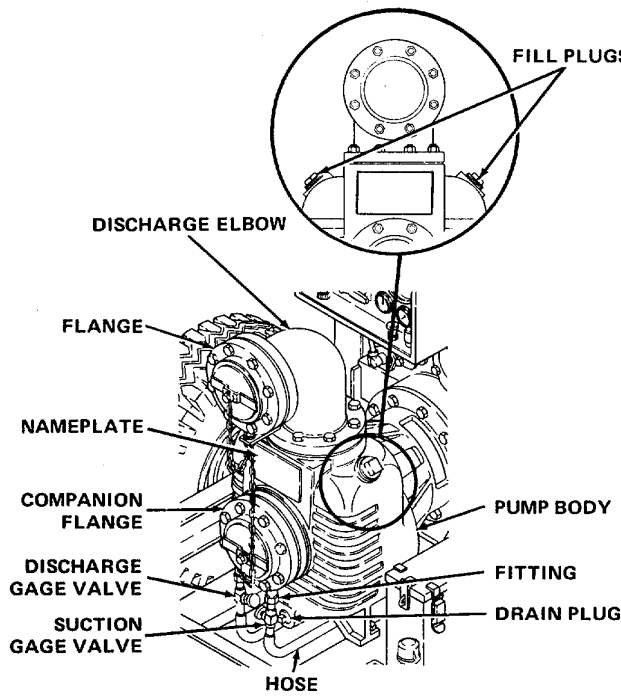
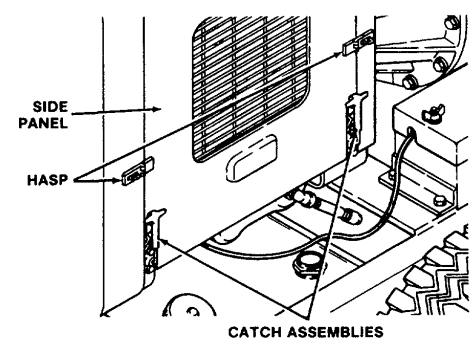
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
18	●	●	●			<p>Pump Assembly. Inspect discharge elbow, all flanges, and pump body for cracks, damaged fill and drain plugs, suction and discharge gage valves, lines, hoses, fittings, protective caps, and chains, and other damage. Inspect nameplate for damage and legibility.</p> 	
19	●					<p><i>Starting Aid Ether Cylinder.</i> Remove engine left side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

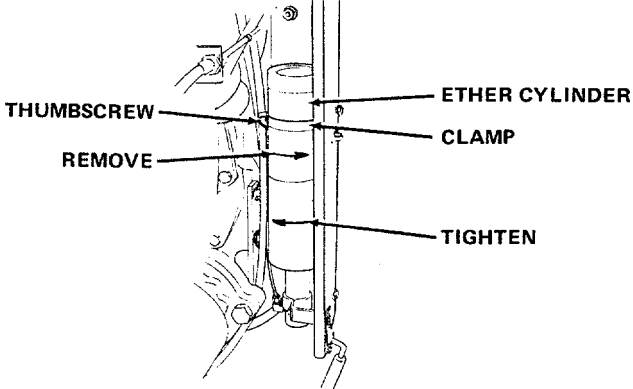
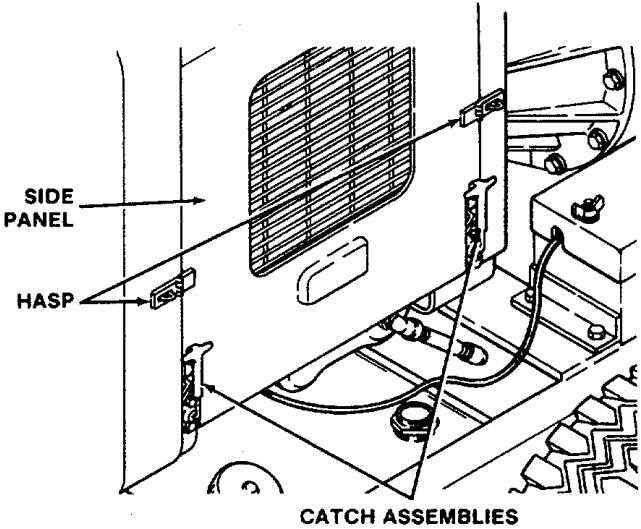
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
20	●	●	●			<p>Inspect ether cylinder to determine if it is firmly in place. Tighten if loose. Inspect for visible damage.</p>  <p>Replace engine side panel.</p> <p><i>Oil Line and Fittings.</i> Remove engine side panels. Unfasten hasps and catch assemblies, then pull side panels up and out to remove.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

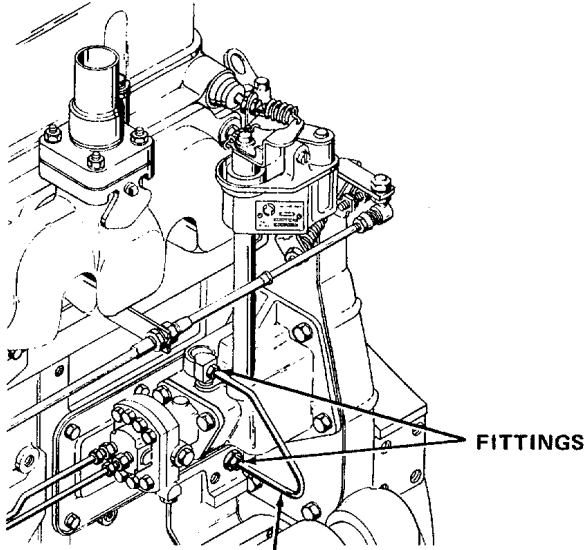
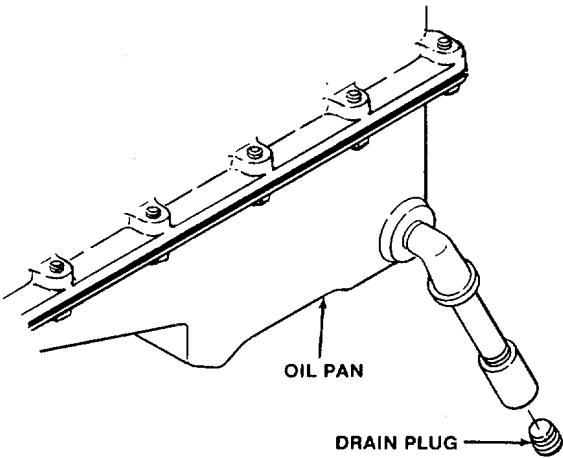
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>Check for leaks around oil line and fittings.</p>  <p>Replace (</p>	Excessive oil leakage.
21	●	●	●			<p><i>Oil Drain Plug.</i> Check for loose or missing oil pan drain plug. Tighten loose plug.</p> 	Plug is missing.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

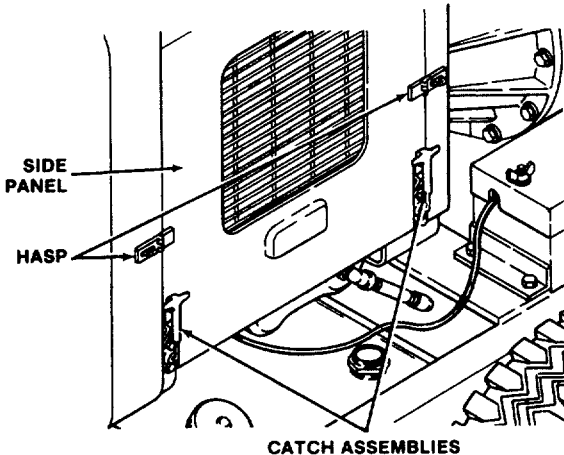
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
22	●	●	●			<p><i>Fuel Pump Assembly.</i></p> <p style="text-align: center;">WARNING</p> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not refuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Do not overfill fuel tank. • Work in a well-ventilated area. <p>Remove engine left side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation **A - After Operation** **M - Monthly**
D - During Operation **W - Weekly**

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>Inspect fuel pump assembly fittings for leakage during operation. Tighten leaking fittings. The fuel pump assembly is located at the left rear of the engine immediately above the starter solenoid.</p> <div> <p>The diagram shows a mechanical assembly with several components. A line points to a 'FUEL PUMP ASSEMBLY' at the top. Another line points to a 'FITTING' on the left side. A third line points to a 'STARTER SOLENOID' at the bottom right. The components are interconnected with pipes and electrical wires.</p> </div> <p>NOTE</p> <p>The fuel pump has two holes tapped in the underside of the pump body. These holes may or may not be fitted with drain tubes. Some fuel leakage through these holes is acceptable, but if leakage exceeds one drop per minute, the pump gaskets are worn.</p> <p>Replace engine side panel.</p>	<p>There is any leakage.</p> <p>There is excessive leakage.</p>

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

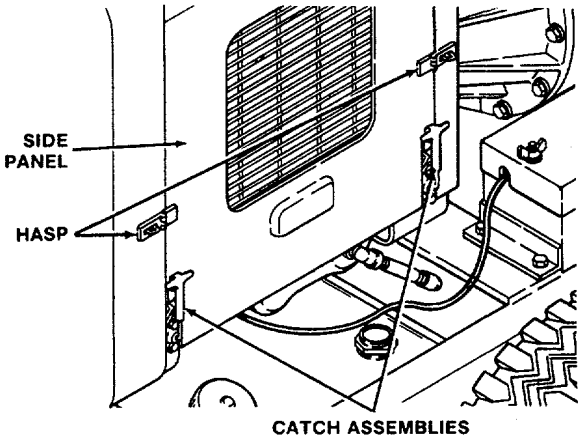
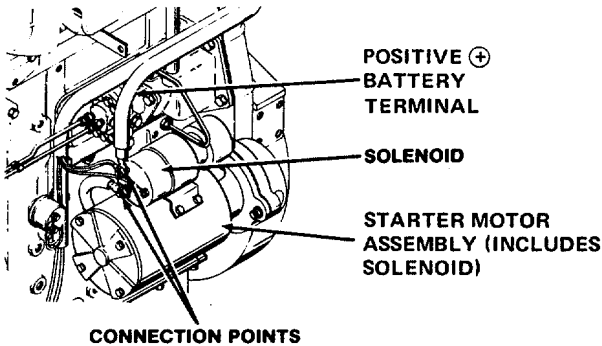
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
23	●		●			<p>Starter Motor Assembly. Remove engine left side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p>  <p>Inspect starter motor assembly, located on lower left rear of the engine, for loose electrical connections and corrosion.</p>  <p>WARNING</p> <p>Disconnect negative ground on battery to prevent arcing of terminals.</p> <p>Tighten loose connections. Check for loose starter motor assembly.</p> <p>Replace engine side panel.</p>	Starter in-operative.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

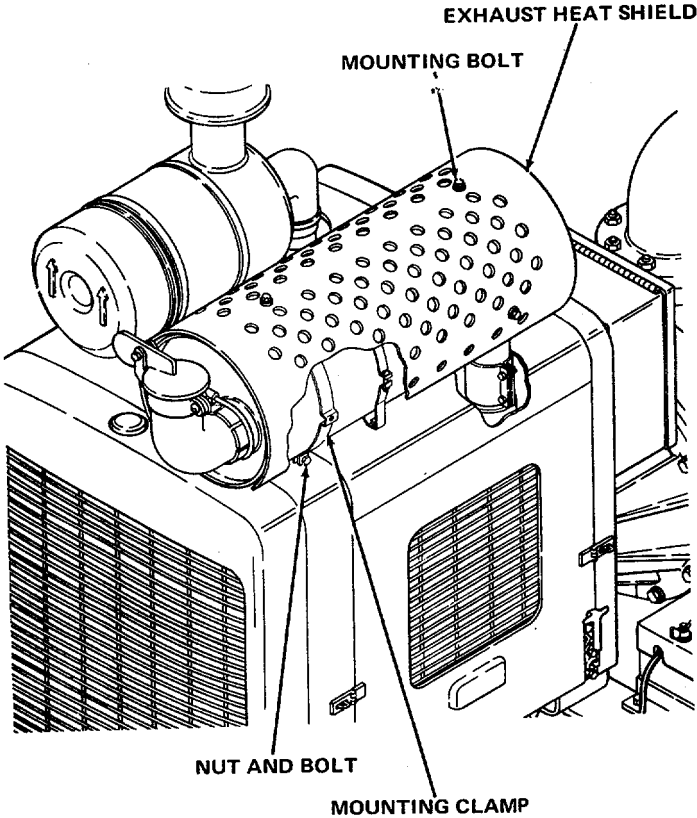
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
24	●		●			<p><i>Exhaust Heat Shield</i></p> <p style="text-align: center;">WARNING</p> <p>Handling hot exhaust shield, exhaust pipe, muffler, and weather cap can cause severe burns. Allow unit to cool before handling.</p> <p>Inspect exhaust heat shield for rust, damage, and loose nuts, bolts, and mounting clamps. Tighten loose nuts, bolts, and mounting clamps.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

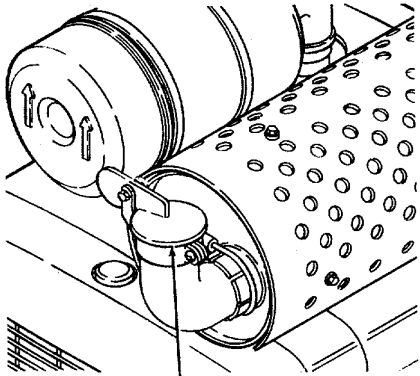
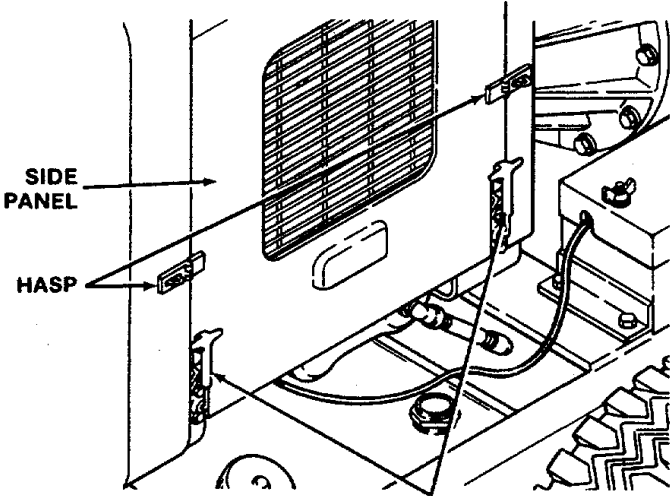
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
25	●		●			<p><i>Weather Cap.</i> Inspect weather cap for damage, rust, and loose mounting hardware. Check if it operates freely. Tighten loose hardware.</p>  <p style="text-align: center;">WEATHER CAP</p>	
26			●			<p><i>Exhaust Pipe and Exhaust Manifold Pipe.</i> Remove engine left side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p>  <p style="text-align: center;">CATCH ASSEMBLIES</p>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

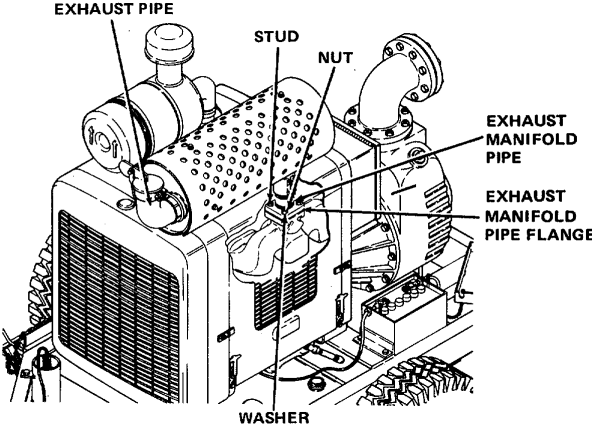
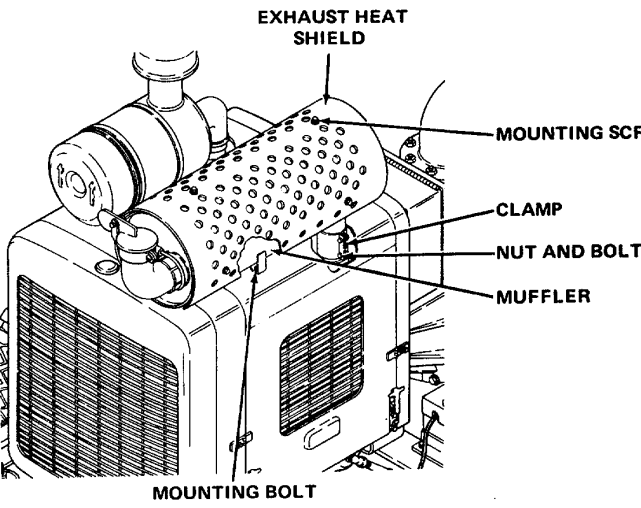
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
27	●	●				<p>Inspect both pipes for leaks, excessive rust, holes, or other damage, and for loose connections. Also inspect exhaust manifold pipe flange for loose mounting studs, nuts, or washers. Tighten loose hardware.</p>  <p>Replace engine side panel.</p> <p><i>Exhaust Muffler.</i> Inspect muffler for leaks, excessive rust, holes, or other damage, and for loose mounting or clamp nuts and bolts. Tighten loose hardware.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

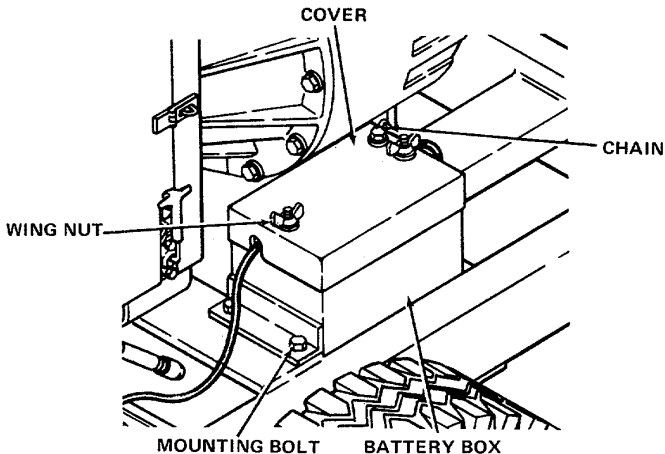
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
28	●		●			<p><i>Battery Box and Cover.</i> Check for corrosion and for loose or missing hardware. Tighten loose hardware.</p> 	
29	●		●			<p><i>Battery and Cables.</i></p> <p style="text-align: center;">WARNING</p> <p>Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.</p> <p style="text-align: center;">CAUSTIC CHEMICALS IN BATTERIES</p> <p>Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.</p> <p style="text-align: center;">CAUTION</p> <p>Avoid making contact across the two battery posts. This can result in severe arcing.</p>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

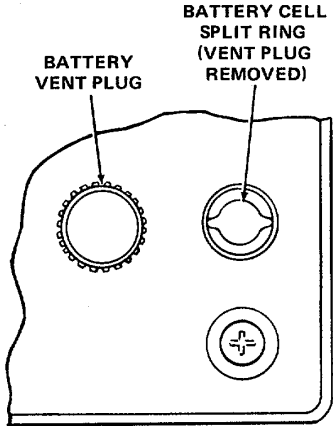
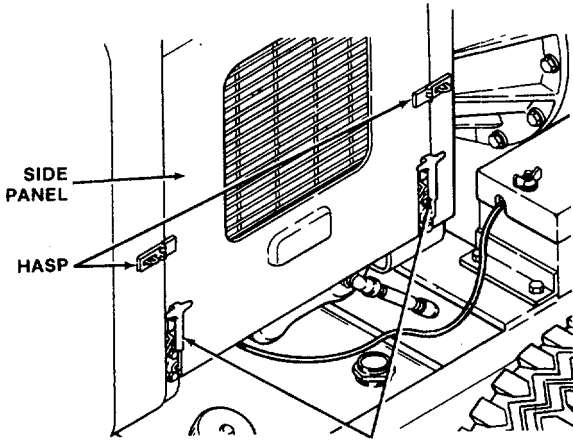
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
30						<p>Remove battery cover. Remove battery vent plugs and check electrolyte level. If low, add water up to the split rings. Replace battery vent plugs and wipe excess fluid from battery. Replace battery cover.</p>  <p><i>Time Delay Relay.</i> The time delay relay is located on the lower left front of the engine, next to the starter motor. Remove engine left side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

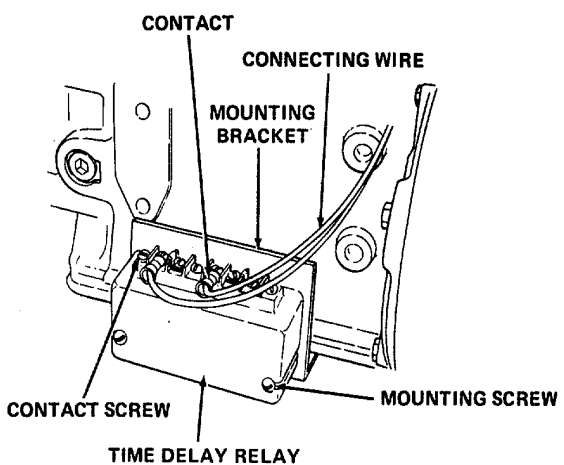
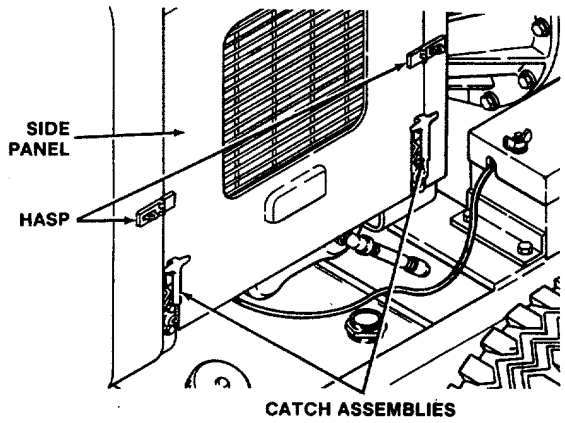
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
31	●		●			<p>Inspect relay mounting bolts and contact screws for tightness. Tighten loose screws. Inspect contacts for corrosion, and connecting wires for broken or cracked insulation, kinks, or frayed conductors.</p> <p>Replace engine side panel.</p>  <p><i>Low Oil Pressure Cutout Switch.</i> The switch is located on the left side of the engine above and to the front of the starter motor. Remove engine left side panel. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

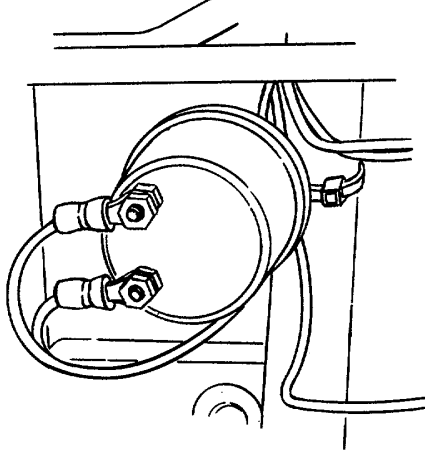
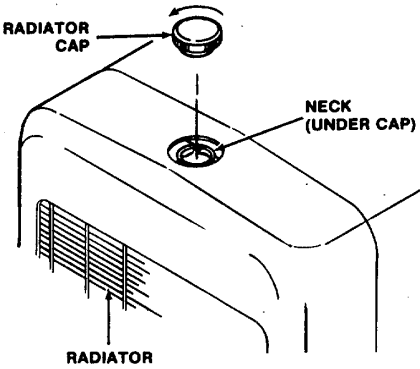
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
32	●					<p>Inspect the cut-out switch for damage. Check for oil leakage. Inspect leads for looseness, fraying, corrosion, or other deterioration.</p>  <p>Replace engine side panel.</p> <p>Radiator Coolant Level. Ethylene glycol antifreeze (Military Specification MIL-A-46153) shall be used in the cooling system.</p> <p style="text-align: center;">WARNING</p> <p>Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in coolant system is released, then remove cap.</p> 	Broken or disconnected wires.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

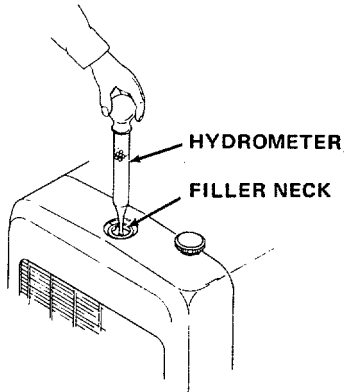
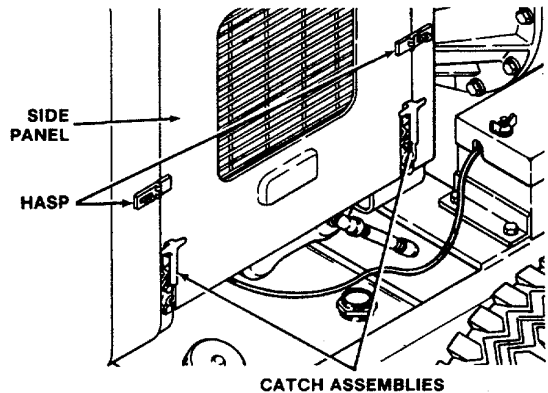
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
	B - Before Operation D - During Operation A - After Operation W - Weekly M - Monthly						
33						<p style="text-align: center;">CAUTION</p> <p>Cylinder block damage could occur if coolant freezes. Check freezing protection of coolant when engine is at operating temperature.</p> <p>Using a hydrometer, check freezing protection of coolant with engine at operating temperature.</p>  <p>Check coolant level when engine is cold. The coolant level should be about 3 inches (7.62 cm) below filler neck. Add coolant as needed. System capacity is 8 quarts (7.57 liters).</p> <p><i>Radiator Exterior.</i> Remove engine side panels. Unfasten hasps and catch assemblies, then pull side panel up and out to remove.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

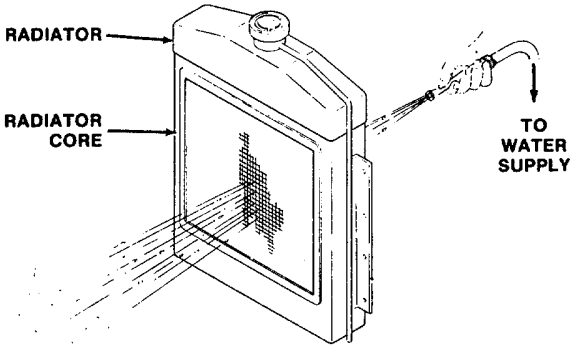
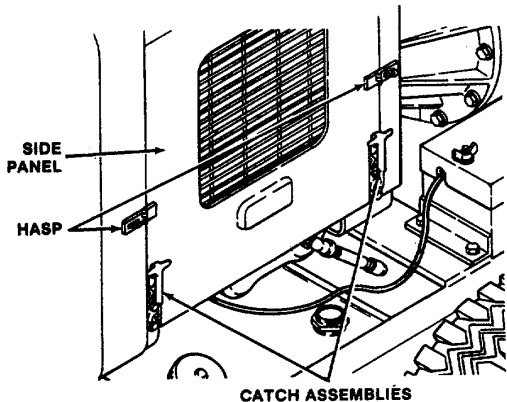
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
34	●	●	●			<p style="text-align: center;">CAUTION</p> <p style="text-align: center;">To avoid damage to radiator fins, do not use high water pressure.</p> <p>Inspect exterior of radiator. If necessary clean exterior with clean fresh water. Clean radiator core from fan side with a stream of water to remove all bugs and debris. The radiator should be cleaned whenever foreign deposits are sufficient to hinder the flow of air.</p>  <p>Replace engine side panels.</p> <p><i>Cooling System Leakage Check.</i> Remove engine side panels. Unfasten hasps and catch assemblies, then pull side panels up and out to remove.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

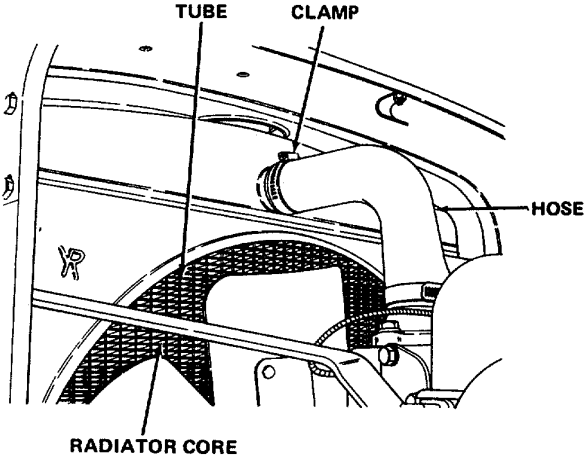
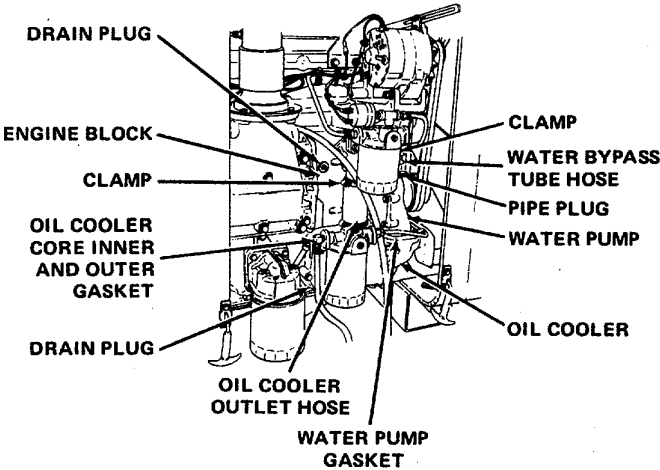
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>Inspect cooling system for leakage. Visually check radiator core for leaking tubes. Check for swollen or deteriorated radiator and oil cooler outlet hoses. Tighten loose clamps.</p>  <p>Check for water pump gasket leaks, leaks around the pipe plug and water bypass tube hose. Tighten any loose clamps.</p> 	Cooling system leaks.

Table 2-2. Insert Procedure Here! (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

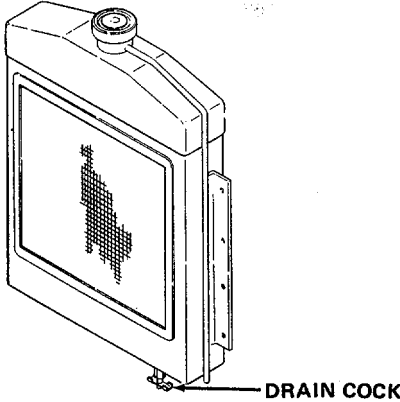
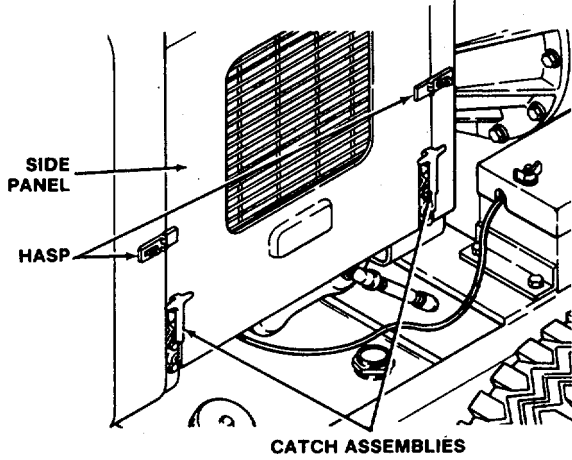
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
35						<p>Check for leaks around the engine block, drain plug, radiator and oil cooler draincocks.</p>  <p>Replace engine side panels.</p> <p>Main Wiring Harness. Remove engine side panels. Unfasten hasps and catch assemblies, then pull side panels up and out to remove.</p> 	

Table 2-2. Insert Procedure Here! (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

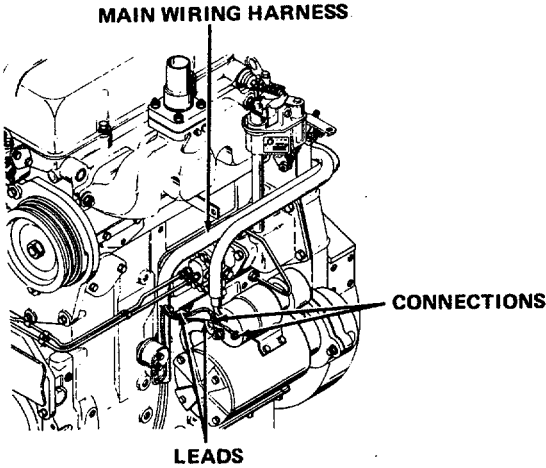
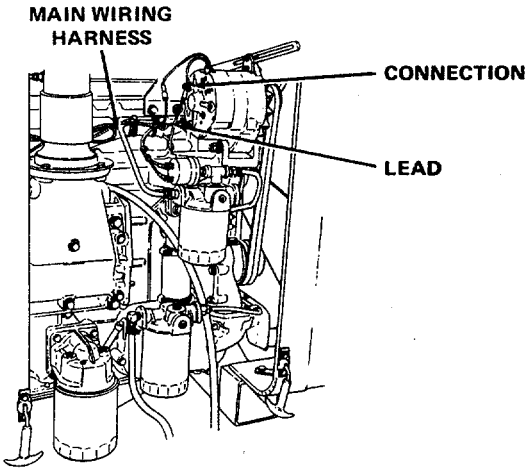
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>Inspect all main wiring harness connections and leads for secure attachment. Check for frayed insulation, broken wires, and other damage.</p>   <p>Replace engine side panels.</p>	Bare or broken wires.

Table 2-2. Insert Procedure Here! (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

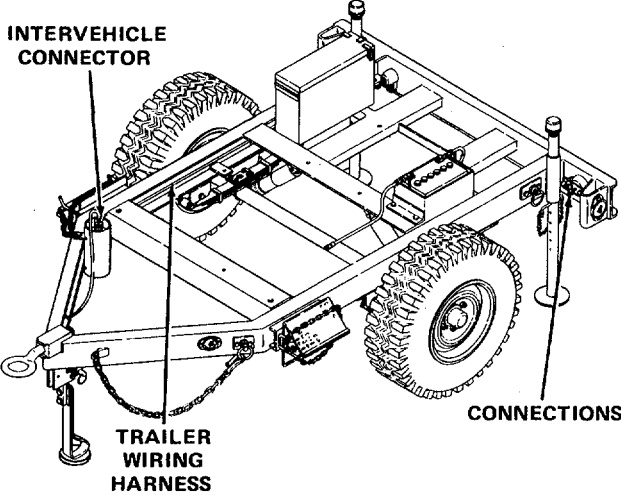
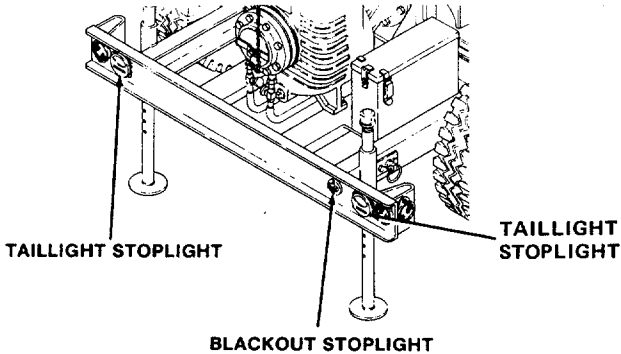
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
36	•					<p>Trailer Wiring Harness. Inspect trailer wiring harness and connections for secure attachment, and for damage of any type. Also inspect intervehicle connector for secure attachment and for damage.</p>  <p>INTERVEHICLE CONNECTOR</p> <p>TRAILER WIRING HARNESS</p> <p>CONNECTIONS</p> <p>With trailer connected to tow vehicle and trailer wiring harness connected, check that the blackout stoplight and taillight stoplights work properly.</p>  <p>TAILLIGHT STOPLIGHT</p> <p>BLACKOUT STOPLIGHT</p> <p>TAILLIGHT STOPLIGHT</p>	

Table 2-2. Insert Procedure Here! (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

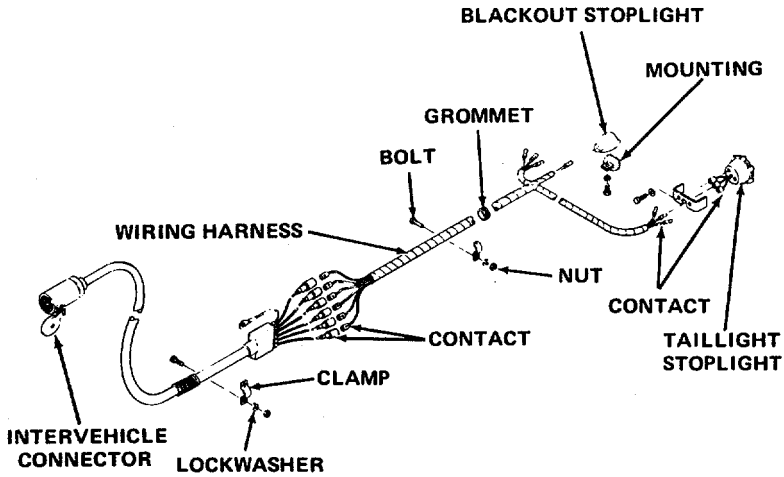
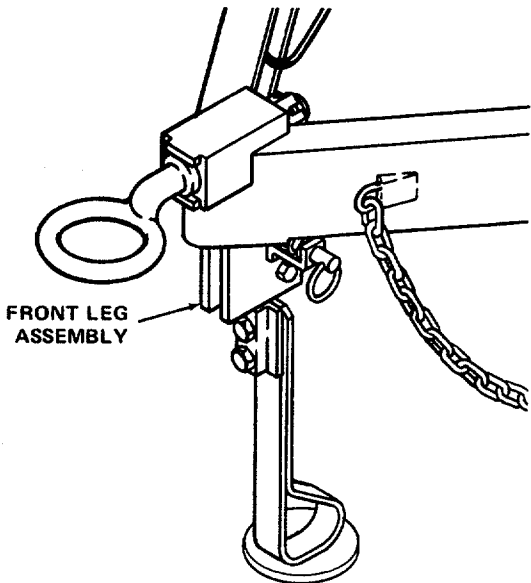
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
37						<p>Inspect trailer wiring harness and contacts for wear, breaks, loose connection, or deteriorated insulation. Inspect grommets in trailer frame to determine if they are serviceable and in place. Check that clamps, nuts, and lockwashers are secure.</p>  <p><i>Trailer Assembly.</i> Inspect front leg assembly for loose or missing parts such as nuts, cap screw, or cotter pin. Tighten loose parts. Check front leg assembly to determine if it can be lowered, raised, and locked in place freely. Tighten any loose fasteners.</p> 	

Table 2-2. Insert Procedure Here! (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

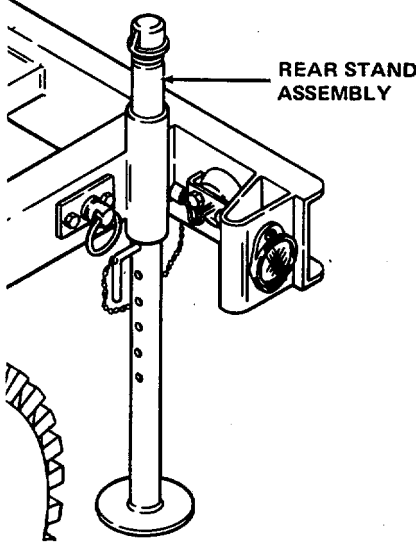
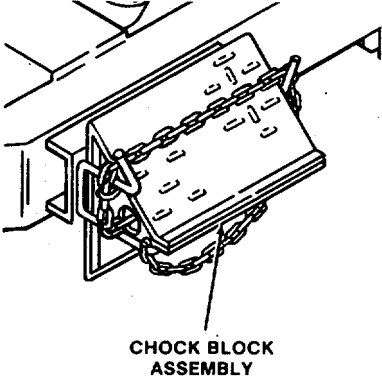
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>Inspect rear stand assemblies to insure that they are fastened securely and have no missing parts. Check for bends or other damage that would prevent stand assemblies from raising or lowering freely. Tighten loose fasteners.</p>  <p>Inspect chock block assembly for rust or other damage. Insure that the shackles and chains are fastened securely.</p> 	

Table 2-2. Insert Procedure Here! (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

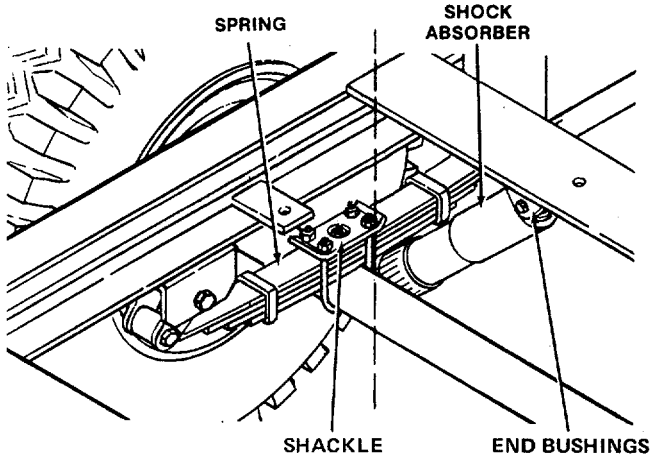
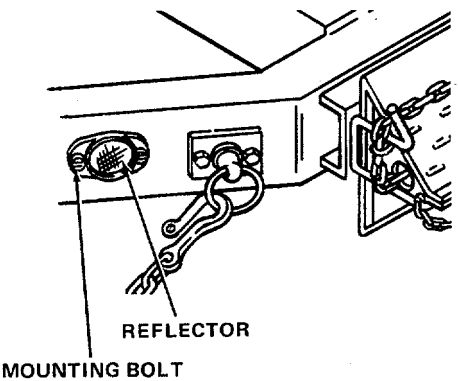
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
38	•		•			<p>Inspect springs for broken leaves and damaged or worn spring shackles. Inspect shock absorbers for leaks, worn end bushings, and other damage.</p>  <p>SHOCK ABSORBER SHOCKLE END BUSHINGS SPRING</p> <p>Frame Assembly. Inspect frame weldment for bent members, and for breaks, cracks, and rust. Inspect for loose or missing bolts and nuts. Inspect engine and pump mounting nuts and bolts for tightness. Tighten or replace hardware as needed. Inspect reflectors to determine if any are missing, broken, or loose. Tighten loose mounting bolts.</p>  <p>REFLECTOR MOUNTING BOLT</p>	

Table 2-2. Insert Procedure Here! (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

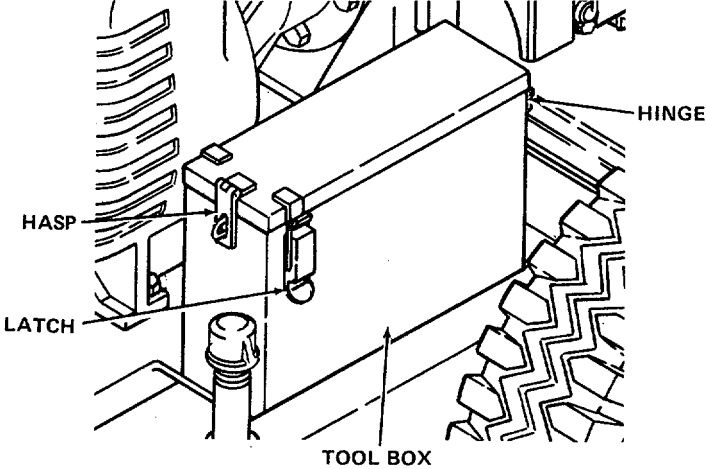
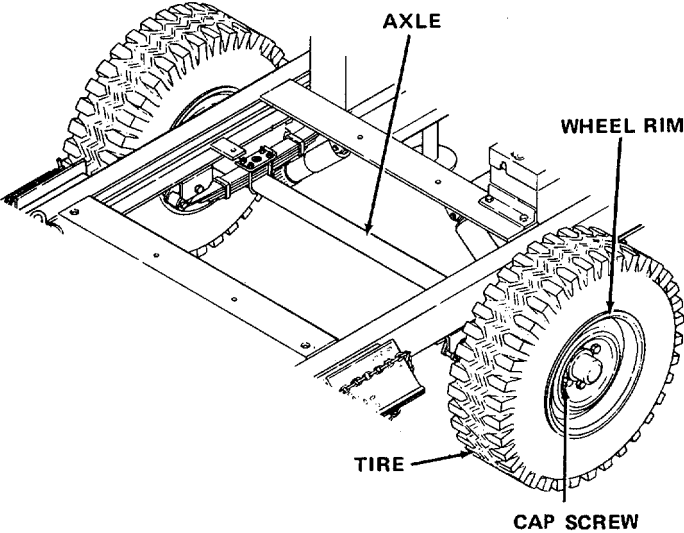
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
39						<p>Inspect tool box for broken welds, and loose or nonworking hasps, latches, or hinge. Tighten loose mounting bolts.</p>  <p><i>Axles, Wheel Rims, and Tires.</i> Inspect axle assembly for bent axle.</p> 	

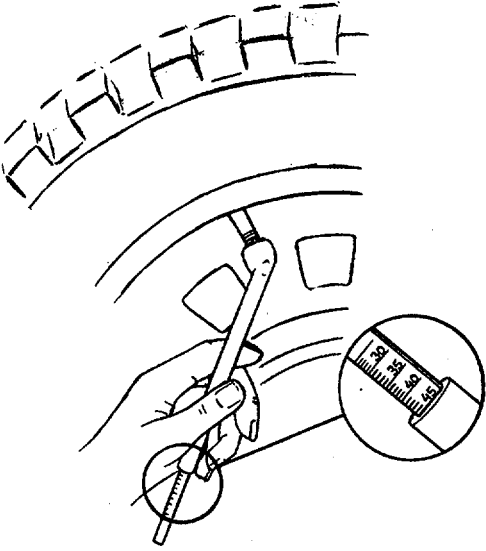
Table 2-2. Insert Procedure Here! (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						Jack up trailer so that wheel rims can be spun freely. a. Check for grease on inside of wheel, indicating worn grease seals. b. Spin wheel rims to check for binding or noise indicating frozen or Wheel rims should spin freely. c. Inspect wheel rims for cracks, dents, or other damage. d. Check for missing, loose, or broken mounting components. Inspect tires: a. Check that valve stems are in good condition and correctly positioned. b. Check that valve caps are present and installed securely. <p style="text-align: center;">CAUTION</p> <p style="text-align: center;">Do not tighten valve caps with pliers.</p> c. Examine tires for cuts, bruises, breaks, blisters, or other damage extending into the cord body. d. Check for signs of smooth wear in center of tread; irregular or one-sided wear; and flat spots, cupping, or feathered edges.	damaged bearings.

Table 2-2. Insert Procedure Here! (Continued)

B - Before Operation A - After Operation M - Monthly
 D - During Operation W - Weekly

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	IS NOT READY/ AVAILABLE IF
	B	D	A	W	M		
						<p>e. Check tire pressure. Inflate to 45 psi (310. 3 kPa) maximum.</p>  <p>f. Tighten all wheel rim cap screws securely.</p>	

Section III. OPERATION UNDER USUAL CONDITIONS

2-3. ASSEMBLY AND PREPARATION FOR USE

- a. The centrifugal pump unit comes fully assembled, ready for use after attaching appropriate suction and discharge hoses.
- b. Instructions for use are for information and guidance of personnel responsible for operation of the centrifugal pump unit.
- c. The operator must know how to perform every operation of which the unit is capable. The following paragraphs contain instructions on starting and stopping the unit, on operation of the pump assembly, and on coordinating the basic motions to perform the specific tasks for which the equipment is designed. Since nearly every job presents a different problem, the operator may have to vary given procedures to fit the individual job.

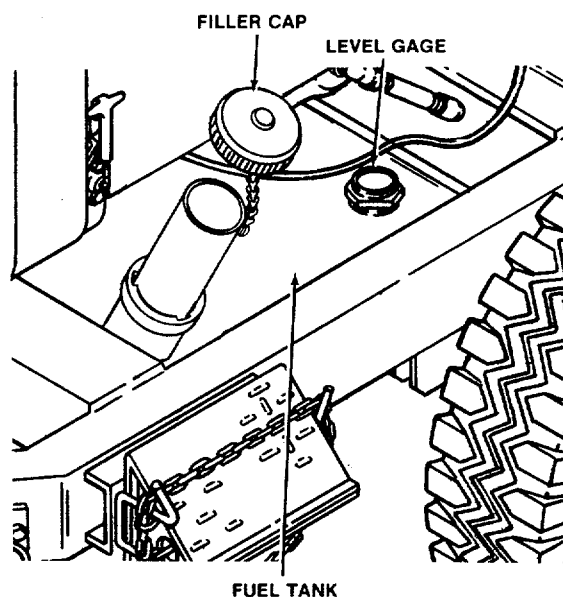
2-4. INITIAL ADJUSTMENTS

- a. Inspect pump assembly, engine, and trailer for loose or missing hardware, corrosion, or obvious damage. Report any problems to organizational maintenance.

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

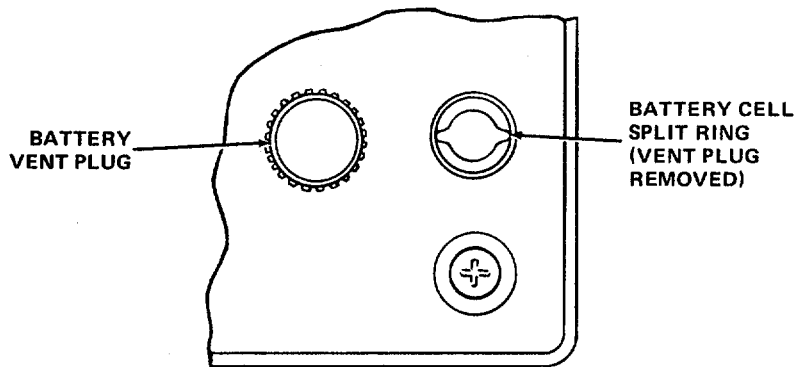
- Do not inhale vapor.
 - Do not refuel near open flame, sparks, or excessive heat.
 - Be certain fuel lines and connections are secure.
 - Do not overfill fuel tank.
 - Work in a well-ventilated area.
- b. Check fuel level. Add fuel as required.



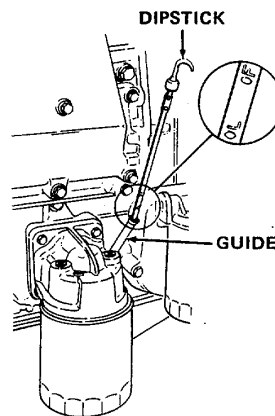
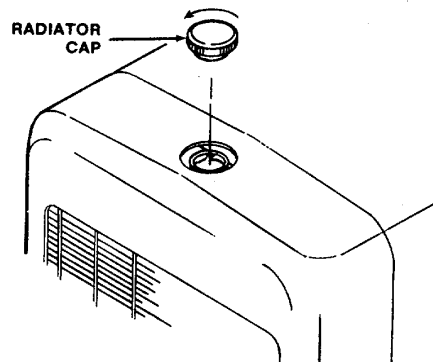
WARNING

Overfilling will cause battery electrolyte to surface. Severe burns or blindness may result if electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

- c. Remove battery vent plugs and check fluid level in battery. If low, add water up to split rings. Replace battery vent plugs and wipe excess fluid from battery.



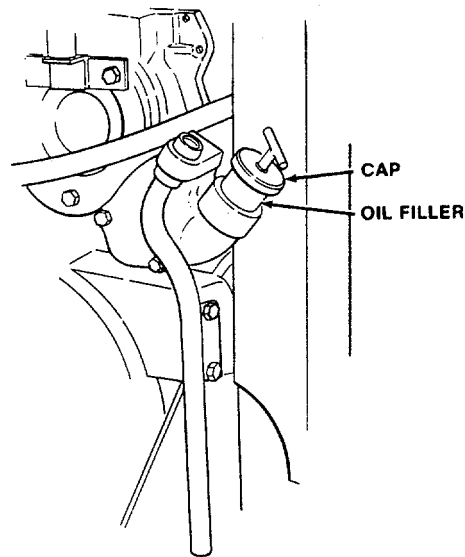
- d. Check radiator coolant level. Remove radiator cap. Coolant should be about 3 inches (7.62 cm) below filler neck. Add MIL-A-46153 coolant if needed. Replace cap.



- e. Check engine crankcase oil level and condition. Engine must be level to check the oil. Remove dipstick and check oil level. Replace dipstick.

CAUTION

Do not overfill. Oil may be blown out through the crankcase breather if crankcase is overfilled.



Remove oil filler cap and add oil as required. See LO 5-4320-300-12 (figure 4-1). Replace oil filler cap.

2-5. OPERATING PROCEDURE

a. Setup Instructions. Proper selection of an operating site is important for efficient and trouble-free pump operation. Since the pump unit is self contained, it can be moved to the most favorable operating site. Select operating site with the following characteristics:

- (1) Locate unit as close as possible to the water to be pumped. Keep the suction hose and the amount of lift as short as possible.
- (2) The operating site should be as level as possible (no more than 15 degrees slope) or the engine lubrication system may not work properly.
- (3) Keep the suction and discharge hoses as short and straight as possible.
- (4) Allow adequate space to permit support of the suction and discharge hoses where they enter the pump.

b. Securing Trailer at Site.

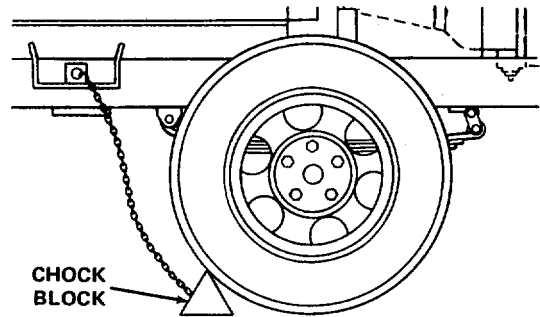
WARNING

Lower and pin the rear stands before disconnecting centrifugal pump unit from towing vehicle. Unit could drop on rear bumper and cause personal injury.

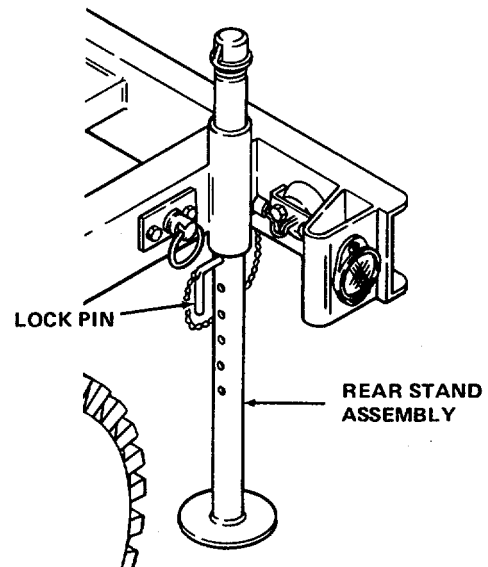
CAUTION

Remove and insert pin from rear stand assemblies with the handle end of the pin facing upward. The pin locking mechanism will stick within the rear stand if pin is inserted and removed any other way.

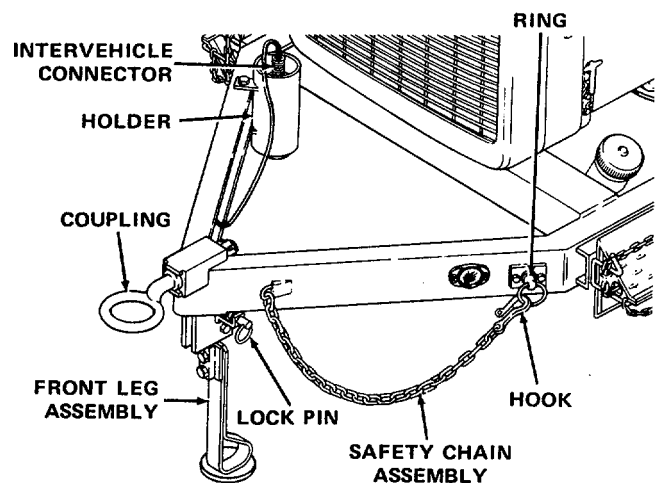
- (1) Park the trailer in position for pumping, and place chock blocks against trailer wheels on downward side of slope to keep trailer from rolling.



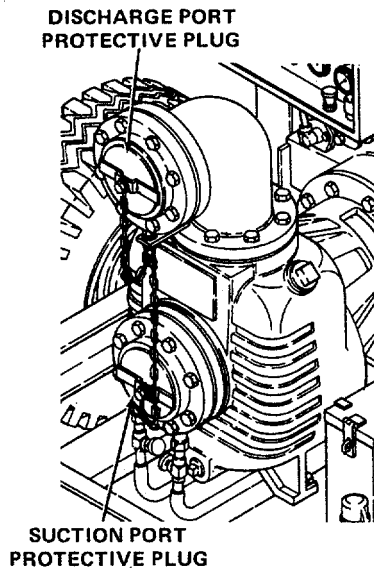
- (2) Release the rear stand assemblies by pulling lock pins with the handles upright. Install lock pins so that the lowered stand assemblies will support the trailer.



- (3) Pull out lock pin and pull down front leg assembly until it locks. Uncouple safety chain assemblies and stow chain hooks in rings. Uncouple coupling. Disconnect intervehicle connector from towing vehicle and stow in holder. Rest trailer on front leg assembly.



- c. Suction Hose Installation. Remove protective plug and connect the suction hose to the suction port.
 - (1) Highest point in the suction hose should be at the pump.
 - (2) Make sure that connections and pipe joints in the suction hose are tight.

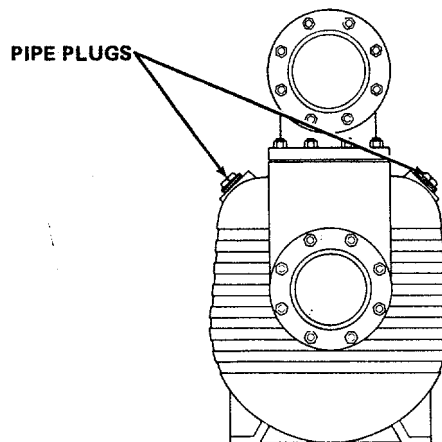


- d. Discharge Hose Installation. Remove protective plug and connect the discharge hose to the discharge port. Be certain discharge hose is tight.
- e. Preparation for Starting.

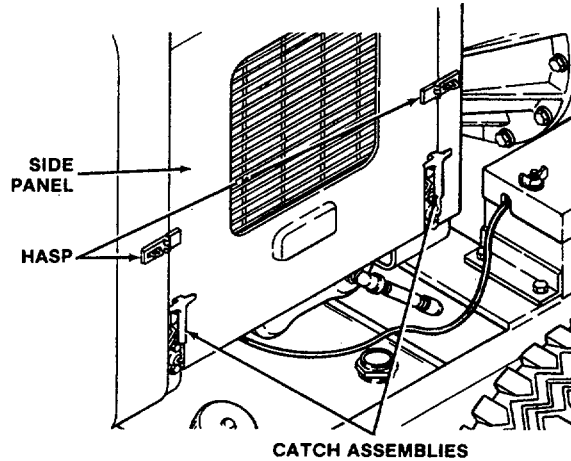
CAUTION

Always prime the pump before starting the engine. Operating the pump dry may damage the seal.

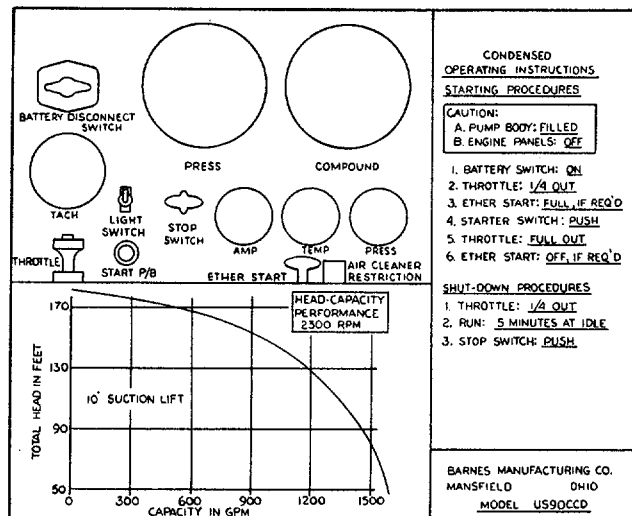
- (1) Remove either pipe plug and fill pump with water.



- (2) Remove engine side panels. Unfasten hasps and catch assemblies, then pull side panels up and out to remove.



f. *Starting.* Instructions for starting engine are located on inside of control panel cover. Follow these operating instructions.



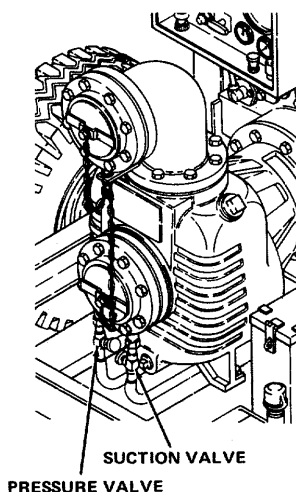
- (1) Turn battery switch on.
- (2) Pull out throttle 1/4.

WARNING

Do not actuate starting aid for more than 1 or 2 seconds at a time and more than twice with engine stopped. Overloading the engine air box with this highly volatile fluid could result in an explosion.

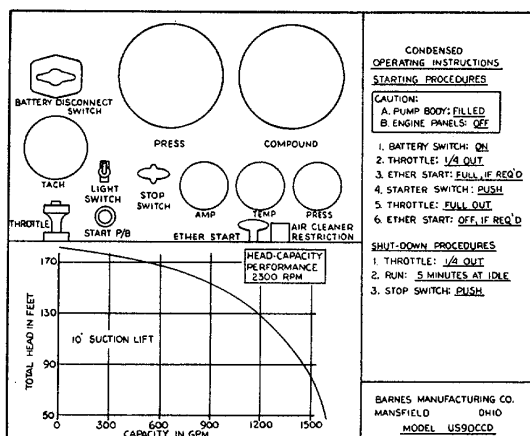
- (3) Pull ether start if required.
- (4) Push starter switch.
- (5) Pull throttle full out.

- (6) Push ether start off if required.
- (7) Open the suction gage and discharge pressure gage shutoff valves to operate gages.
- (8) Depending on pumping conditions, pump may not start pumping immediately since the suction hose must first fill with water. If the pump fails to pump after several minutes, check suction hose for leaks. A small air leak will greatly reduce pumping efficiency under any conditions, and especially when operating under a high suction lift.



- (9) After the pump starts pumping, as indicated by a reading on the discharge pressure gage, adjust the throttle control to obtain desired pumping rate.
- (10) Check the pump for any unusual or excessive vibration. If excessive vibration is noticed, stop pump immediately and correct the cause. Vibration usually results when pump or connecting lines are not properly supported, aligned, or secured.

g. *Stopping.* Instructions for stopping operation are on inside of control panel cover. Follow these shutdown procedures:



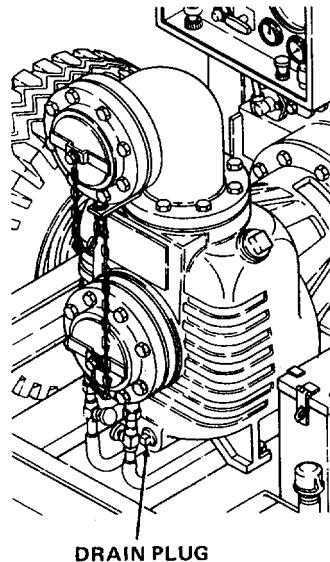
- (1) Position throttle to 1/4 out.
- (2) Run engine 5 minutes at idle.
- (3) Push stop switch.
- (4) Turn off suction gage and discharge pressure gage.

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

- (5) If pump is to be transported to a new location, remove the suction and discharge hoses. To drain the pump body, remove pump body drain plug. Remove all fluid from pump body and replace drain plug.



DRAIN PLUG

Section IV. OPERATION UNDER UNUSUAL CONDITIONS**2-6. OPERATION IN EXTREME COLD**

- a. Use proper engine oil for cold weather. See LO 5-4320-300-12 (figure 4-1).

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

- b. Keep fuel tank full to prevent condensation, which can freeze and clog lines, filters, and injectors, preventing fuel from reaching the engine.

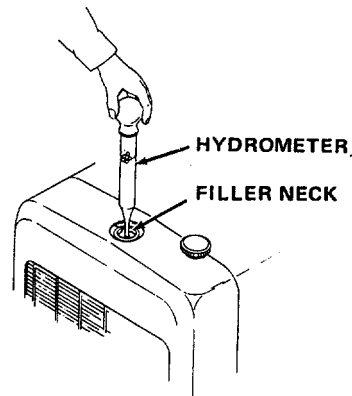
WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in coolant system is released, then remove cap.

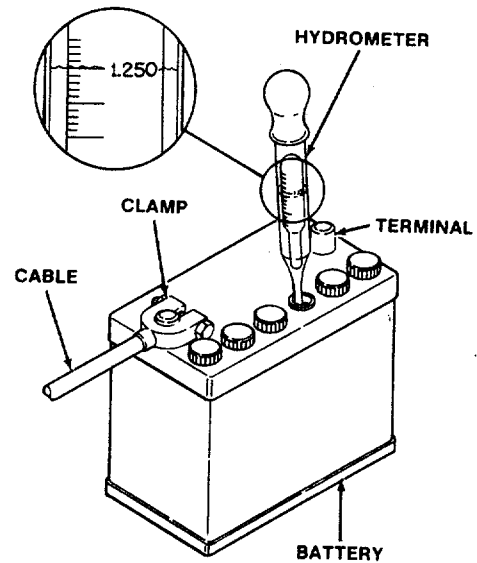
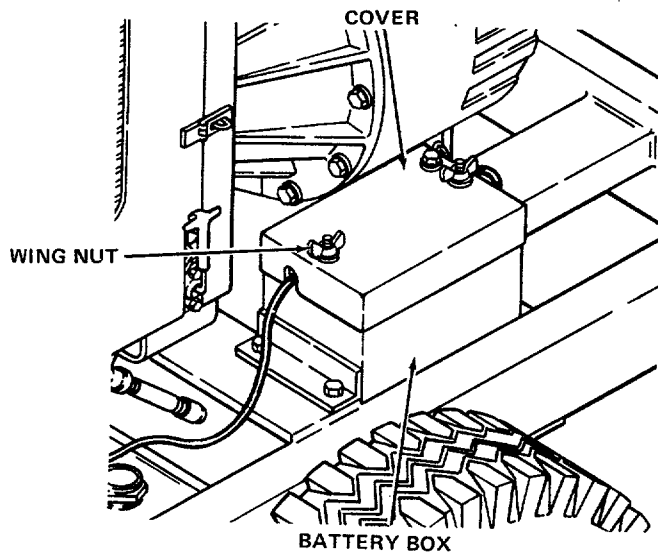
CAUTION

Cylinder block damage could occur if coolant freezes. Check freezing protection of coolant when engine is at operating temperature.

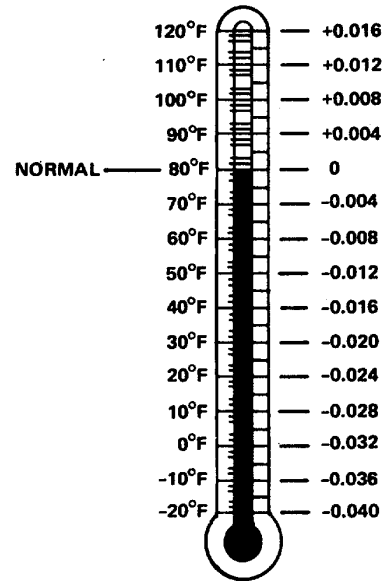
c. Using a hydrometer, check freezing protection of coolant with engine at operating temperature. Add MI L-A46153 ethylene glycol antifreeze in sufficient quantity to ensure coolant freeze point is 20°F (11°C) below lowest expected temperature.



d. Remove wing nuts and cover from battery box. Remove battery vent plugs. Using a hydrometer, check the specific gravity of the electrolyte.

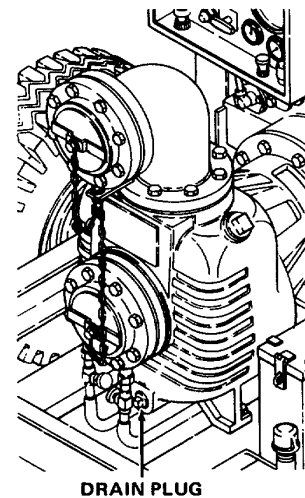


The specific gravity of a fully charged battery must be 1.250 minimum at 80°F (26.6°C). Measure the temperature of the battery electrolyte with an accurate thermometer. Compare the electrolyte temperature and the hydrometer specific gravity reading to the battery condition chart. Add or subtract (from your specific gravity reading) the decimal next to the temperature in °F that closely approximates the obtained electrolyte temperature. If the temperature corrected reading is below 1.250, charge the battery. Coat battery terminals and posts with a thin covering of MIL-G-10924 grease. Replace cover and wing nuts and tighten.



CORRECTED SPECIFIC GRAVITY	BATTERY CONDITION
1.280	FULLY CHARGED
1.250	THREE-FOURTHS CHARGED
1.220	ONE-HALF CHARGED
1.190	ONE-FOURTH CHARGED
1.160	LITTLE USEFUL CHARGE
1.130	DISCHARGE

- e. Drain pump after use to prevent water in pump from freezing. Remove pump body drain plug. Remove all fluid from pump body and replace drain plug.
- f. Cover unit when not in use.
- g. Shelter unit from weather, if possible.



2-7. OPERATION IN EXTREME HEAT

- a. Cooling. Keep engine and radiator clean to provide proper engine cooling. Keep centrifugal pump unit in open area to allow air to circulate around the radiator and engine.
- b. Battery. Increase battery PMCS. Use distilled water or a good grade drinking water (excluding mineral water) to bring electrolyte to proper levels.

2-8. OPERATION IN HIGH ALTITUDES

The operating efficiency of the engine diminishes at higher altitudes. Ensure that engine is operating at peak efficiency.

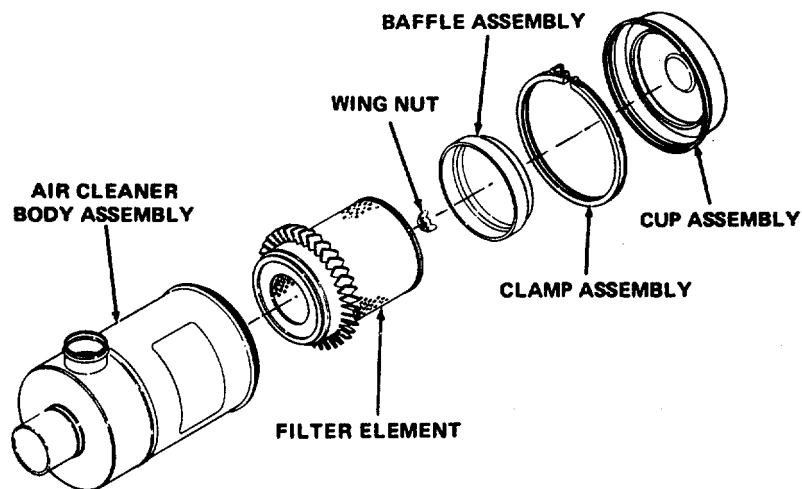
2-9. OPERATION IN SANDY OR DUSTY AREAS

a. When pump is operated under sandy or dusty conditions, check restriction indicator and service air cleaner more frequently.

- (1) To clean air filter, loosen clamp assembly that secures cup assembly to body assembly. Remove baffle assembly and empty dust from the cup assembly.

NOTE

Do not allow dust to build up in cup assembly. Empty more frequently when operating under dusty conditions.



- (2) Wipe cup assembly and baffle assembly clean using damp cloth. Unscrew the wing nut and carefully remove the element from body assembly. Wipe the inside of the body assembly clean with a damp cloth. Tap element against palm to loosen larger dirt particles. If filter element must be reused, gently tap filter element against the palm of your hand. Install new filter element when available.

CAUTION

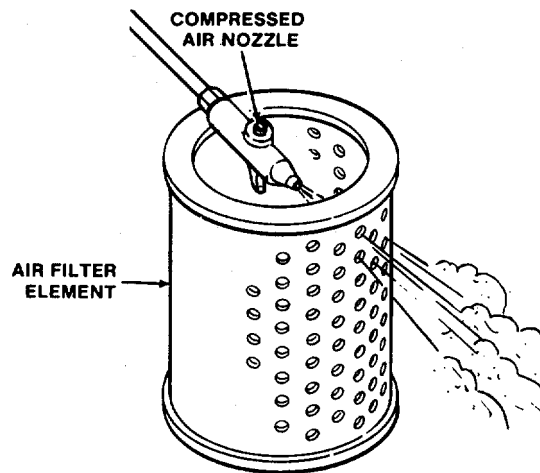
The slightest break in the air cleaner filter element will admit enough airborne dirt to cause rapid failure of piston rings.

- (3) Inspect air filter element for breaks, holes, or damaged gasket.

WARNING

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- (4) If a regulated compressed air supply is available, direct a stream of compressed air (100 psi (690 kPa) maximum) through the element from the inside.

**CAUTION**

Do not blow out body assembly with compressed air. Equipment damage could result if dust is not removed from body assembly with damp cloth.

- (5) Reassemble air cleaner by replacing baffle assembly in cup assembly. Carefully insert filter element in body assembly and tighten wing nut securely. Reinstall cup assembly to body assembly making certain cup assembly seals completely around air cleaner body. Position clamp assembly and tighten wing nut. Reset restriction indicator by pushing down button on top of indicator.

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
 - Do not refuel near open flame, sparks, or excessive heat.
 - Be certain fuel lines and connections are secure.
 - Do not overfill fuel tank.
 - Work in a well-ventilated area.
- b. While filling fuel tank, take care to prevent sand and dust from entering fuel system.

2-10. OPERATION UNDER RAINY OR HUMID CONDITIONS**WARNING**

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Do not refuel near open flame, sparks, or excessive heat.**
- **Be certain fuel lines and connections are secure.**
- **Do not overfill fuel tank.**
- **Work in a well-ventilated area.**

a. Check that gas tank filler cap is tight and gasket is not torn. Fill fuel tank immediately after every operating period to prevent condensation.

b. Take special care to prevent rust and corrosion. If surfaces become rusty or corroded, remove corrosion, then reprime and paint as necessary.

2-11. OPERATION IN SALT WATER AREAS

a. Salt water causes corrosion. Use fresh water to wash off any salt water that comes in contact with the equipment.

b. If surfaces become rusty or corroded, remove corrosion, then reprime and paint as necessary.

2-12. FORDING

The following procedures are necessary to insure the trouble-free operation of the centrifugal pump unit after crossing streams, rivers, or other bodies of water of 30 inches depth or more:

a. *Before fording.*

- (1) Close tool box cover and latch.
- (2) Close control panel cover and latch.
- (3) Insert protective plugs in suction and discharge ports.
- (4) Tighten wing nuts on top of battery box cover.
- (5) Remove fuel tank filler cap and turn valve on underside of cap to non-vent position. Replace filler cap tightly.

b. *After fording.*

- (1) Route centrifugal pump unit to organizational maintenance for wheel bearing repacking as soon as possible.
- (2) Wash unit with fresh water to remove mud or other debris.

c. *Before operation.*

- (1) Unlatch and open control panel cover.
- (2) Remove protective plugs from suction and discharge ports.
- (3) Remove fuel tank filler cap and reset valve to vent position. Replace cap.

CHAPTER 3
OPERATOR MAINTENANCE INSTRUCTIONS

Section I. LUBRICATION INSTRUCTIONS

Refer to LO 5-4320-300-12 (figure 4-1) for lubrication points, intervals, and detailed instructions.

Section II. TROUBLESHOOTING PROCEDURES

3-1. TROUBLESHOOTING

a. Table 3-1 lists common malfunctions which you may find during operation or maintenance of the centrifugal pump or its components. You should perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections or corrective actions. If a malfunction is not listed or cannot be corrected by listed corrective actions, notify your supervisor.

Table 3-1. Operator/Crew Troubleshooting

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

- ENGINE FAILS TO CRANK OR CRANKS AT LOW SPEED

WARNING

CAUSTIC CHEMICALS IN BATTERIES

Severe burns or blindness may result if battery electrolyte comes on contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

Step 1. Remove battery vent plugs and check electrolyte level.

Fill to split ring with clean water if necessary. Replace battery vent plugs.

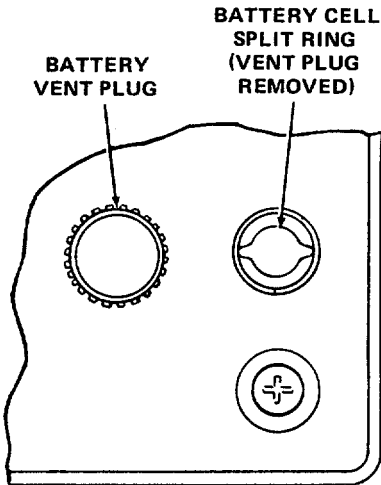


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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2. ENGINE CRANKS BUT FAILS TO START

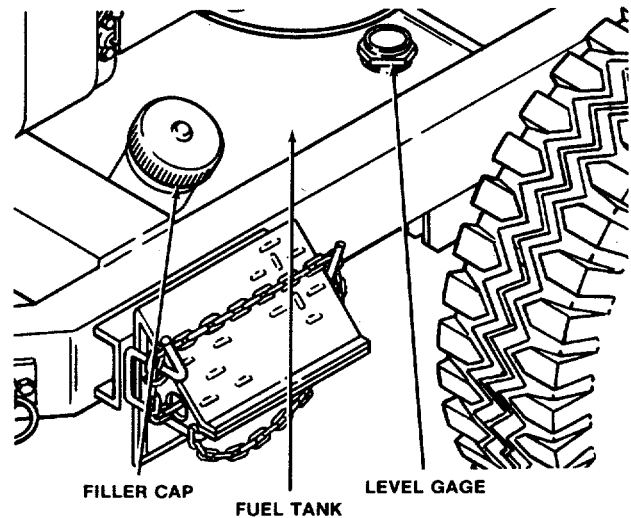
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Step 1. Check for insufficient fuel supply.

Refill low tank. If empty, notify organizational maintenance.



Step 2. Check for proper operation of starting aid.

If starting aid is not working properly, notify organizational maintenance.

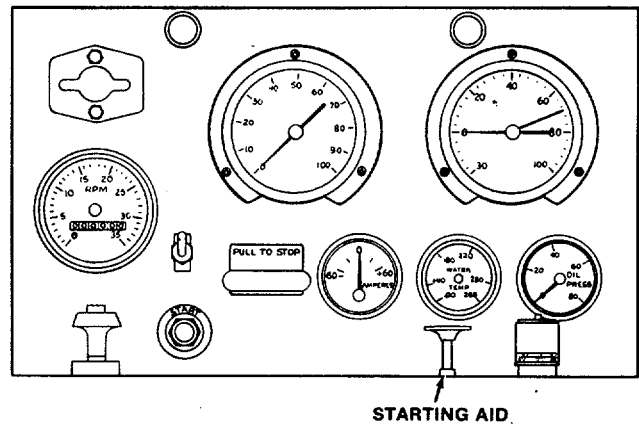


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 3. Check for tripped air shutdown solenoid.

NOTE

In the tripped (closed) position, the solenoid control lever will be pointed out and away from the side of the engine.

To reset the solenoid, push the control lever down until it locks.

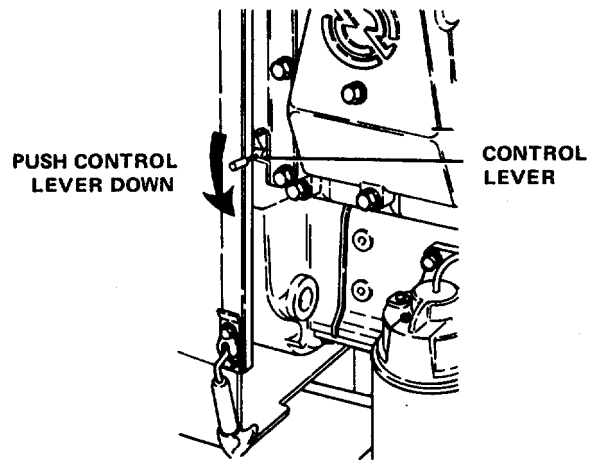


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

3. UNEVEN RUNNING OR FREQUENT STALLING

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

CAUTION

High ambient air temperature of high altitude operation will tend to make the engine run hotter. A high temperature condition may cause abnormal engine operation.

NOTE

Temperatures less than 10°F (6°C) above the pour point of fuel may cause obstruction of the fuel flow because of thickening. This situation may cause abnormal engine operation.

Step 1. Check for insufficient fuel supply.

Refill low tank. If empty, notify organizational maintenance.

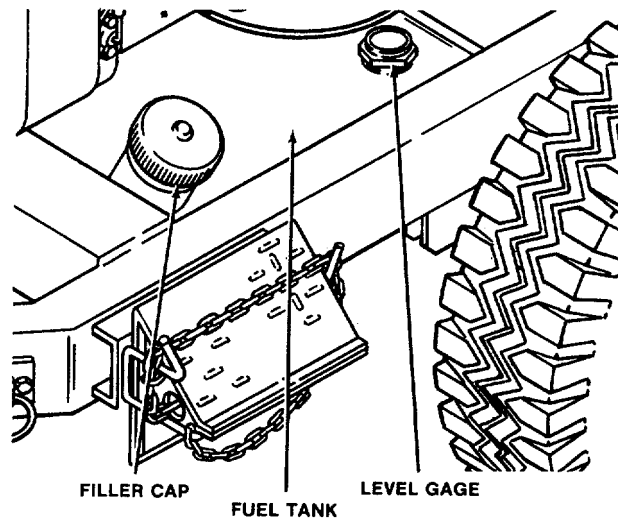
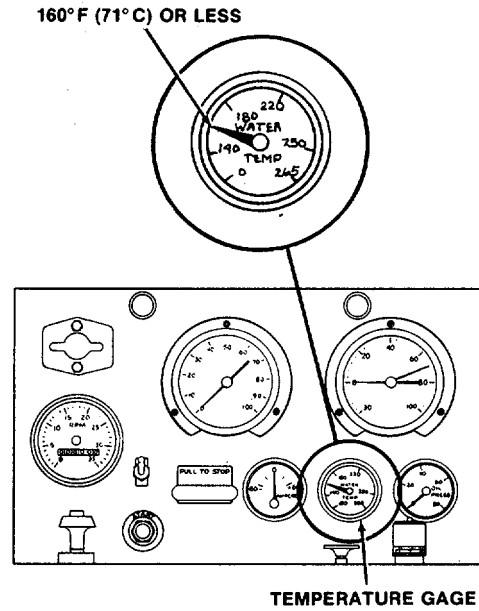


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

Step 2. Check for low operating temperature.

If operating temperature is below 160°F (71°C), after a minimum of 20 minutes of operation, notify organizational maintenance.



4. LACK OF POWER

Step 1. Check for low engine speed.

Adjust throttle to increase engine speed to 2100 rpm.

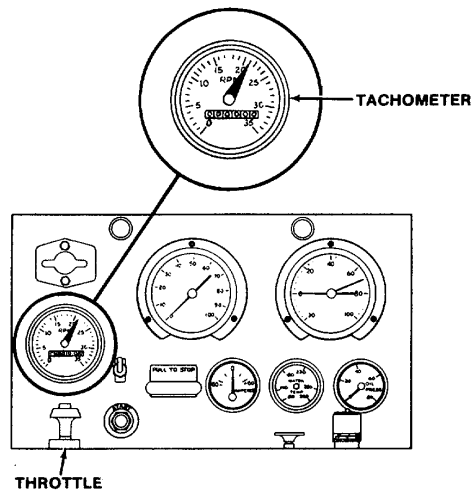


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Step 2. Check for insufficient fuel supply.

Refill low tank. If empty, notify organizational maintenance.

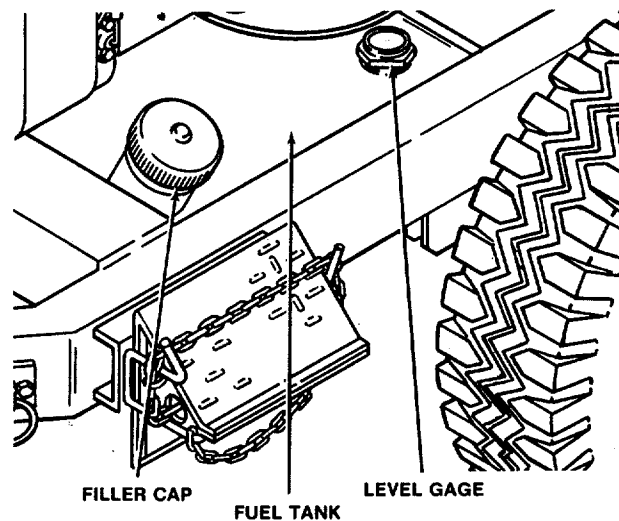
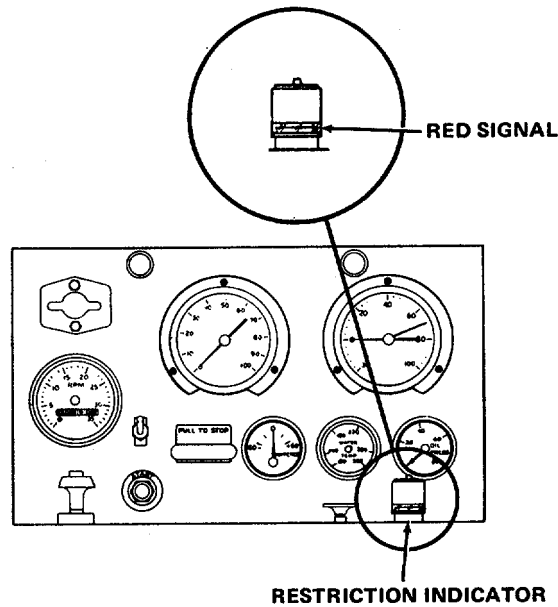


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

Step 3. Check for dirty air filter.

Inspect restriction indicator. If indicator shows red with engine shut off, check air filter element for blockage.



- a. Remove air filter element by loosening clamp assembly and sliding cup assembly off air cleaner body assembly. Remove baffle assembly and slide out filter element.

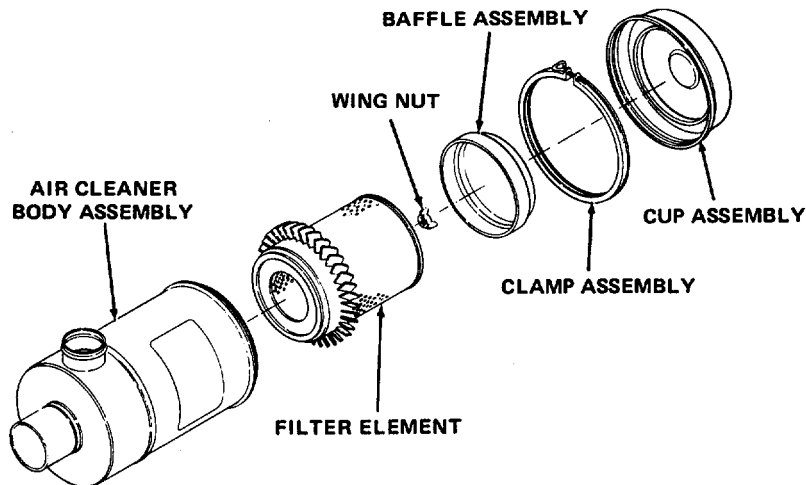


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

CAUTION

The slightest break in the air cleaner filter element will admit enough airborne dirt to cause rapid failure of piston rings.

- b. Inspect air filter element for breaks, holes, or damaged gasket. If filter element must be reused, gently tap filter element against the palm of your hand to remove dirt. Install new filter element when available.

WARNING

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- c. If a regulated compressed air supply is available, direct a stream of compressed air (100 psi (690 kPa) maximum) through the element from the inside.

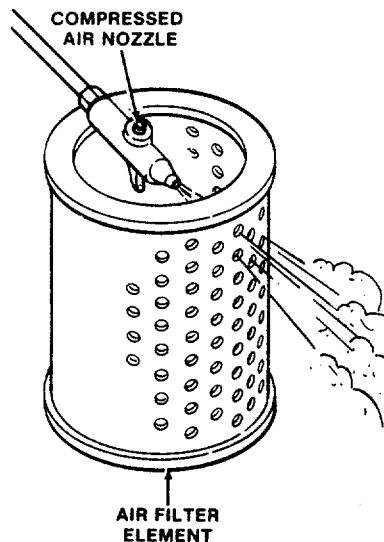


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

CAUTION

Do not blow out body assembly with compressed air. Equipment damage could result if dust is not removed from body assembly with damp cloth.

- d. Wipe body assembly, cup assembly, and baffle assembly with a damp cloth. Insert baffle assembly into cup assembly. Reinstall filter element on air cleaner body assembly. Install wing nut and tighten.
- e. Reset the restriction indicator by pushing down the button on top of indicator, then start the engine. If the restriction indicator again shows red, replace the filter element.

Step 4. Check for loose connections or a damaged line between fuel pump and tank, and between fuel pump and filter.

Tighten loose connections. Report damaged lines to organizational maintenance.

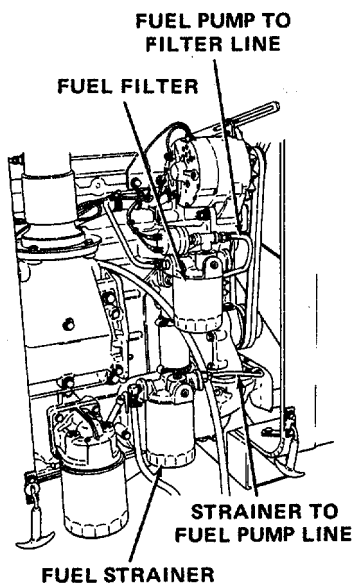
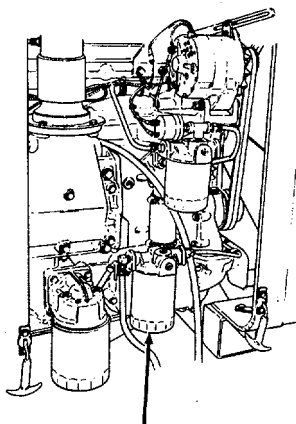


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 5. Inspect for leakage around the fuel strainer gasket.

Hand tighten leaking strainer. If strainer continues to leak, notify organizational maintenance.



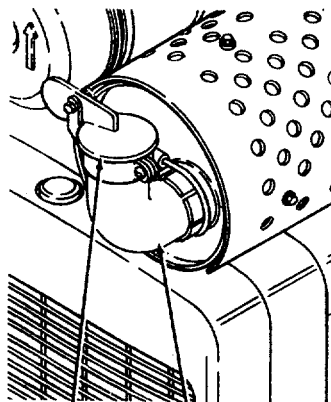
FUEL STRAINER

WARNING

Severe burns could result if weather cap is handled after engine has been running. Do not touch weather cap until engine has cooled. If burns occur get medical help immediately.

Step 6. Make sure that the weather cap on the exhaust pipe is not stuck shut or only slightly open when engine is running.

Move weather cap up and down several times to loosen it. If weather cap does not loosen, notify organizational maintenance.



EXHAUST PIPE

WEATHER CAP

Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

5. ENGINE STOPS RUNNING

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Step 1. Check for insufficient fuel supply.

Refill low tank. If empty, notify organizational maintenance.

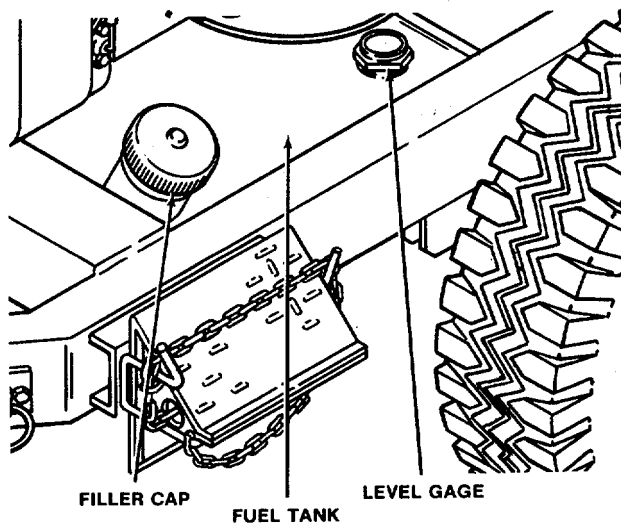
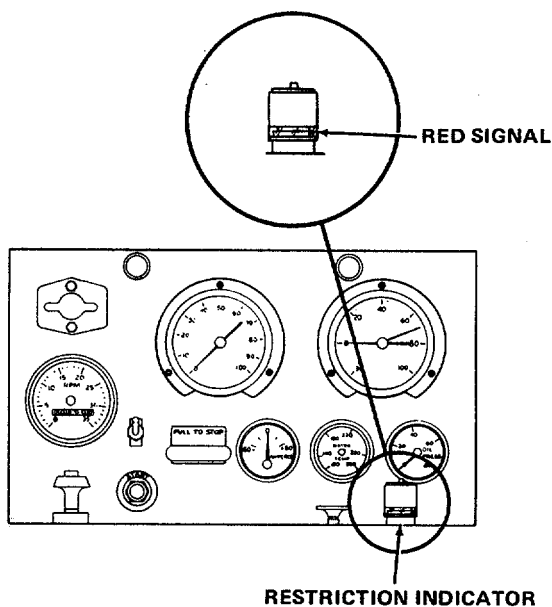


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 2. Check for dirty air filter.

Inspect restriction indicator. If indicator shows red with engine shut off, check air filter element for blockage.



- a. Remove air filter element by loosening clamp assembly and sliding cup assembly off air cleaner body assembly. Remove baffle assembly and slide out filter element.

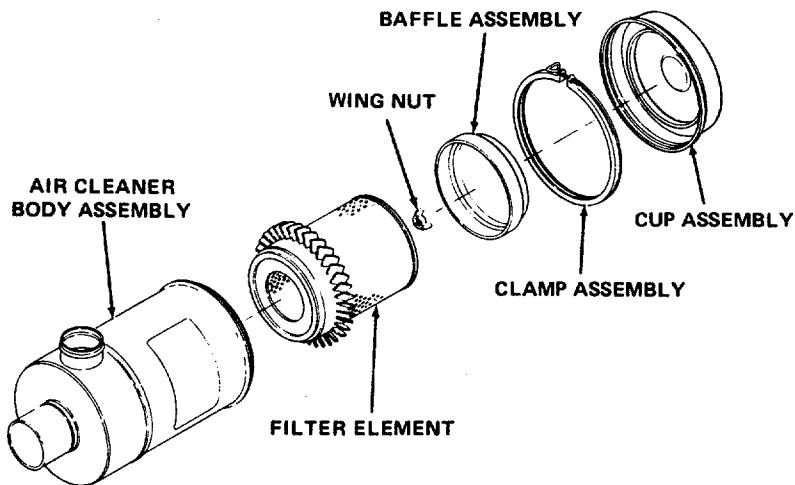


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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CAUTION

The slightest break in the air cleaner filter element will admit enough airborne dirt to cause rapid failure of piston rings.

- b. Inspect air filter element for breaks, holes, or damaged gasket. If filter element must be reused, gently tap filter element against the palm of your hand to remove dirt. Install new filter element when available.

WARNING

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- c. If a regulated compressed air supply is available, direct a stream of compressed air (100 psi (690 kPa) maximum) through the element from the inside.

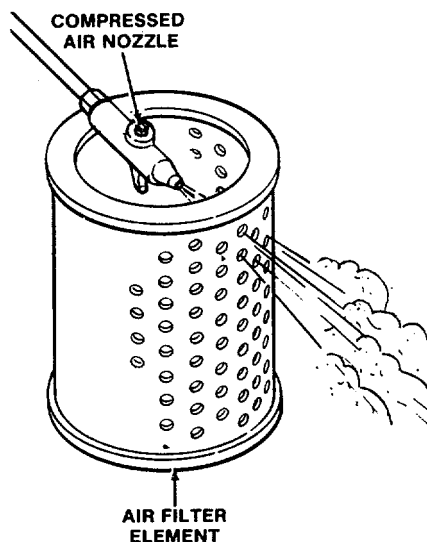


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

CAUTION

Do not blow out body assembly with compressed air. Equipment damage could result if dust is not removed from body assembly with damp cloth.

d. Wipe body assembly, cup assembly, and baffle assembly with a damp cloth. Insert baffle assembly into cup assembly. Reinstall filter element on air cleaner body assembly. Install wing nut and tighten.

e. Reset the restriction indicator by pushing down the button on top of indicator, then start the engine. If the restriction indicator again shows red, replace the filter element. Step 3. Check for tripped air shutdown solenoid.

NOTE

In the tripped (closed) position, the solenoid control lever will be pointed out and away from the side of the engine. To reset the solenoid, push the control lever down until it locks.

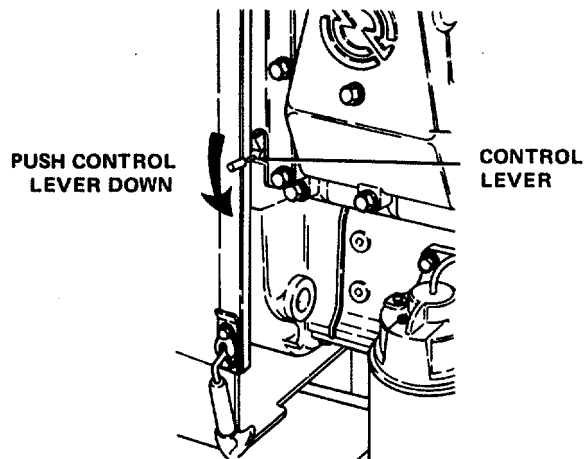
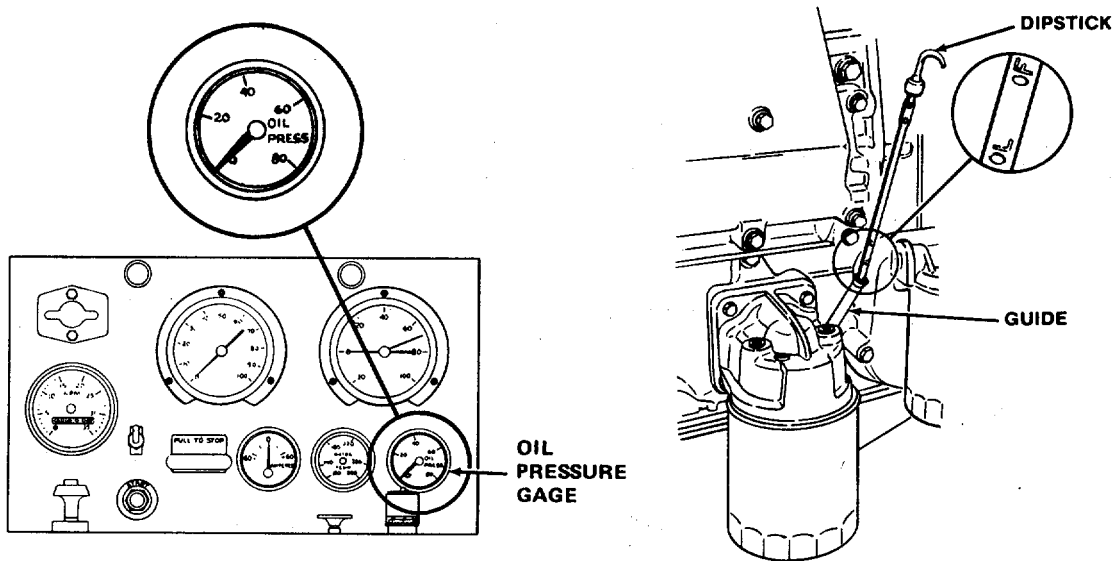


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- a. Restart engine and immediately check oil pressure gage for pressure. If no pressure shows after 15 seconds, stop engine. Allow oil to drain into crankcase for a few minutes, then check crankcase oil at dipstick level.



CAUTION

Do not overfill. Oil may be blown out through the crankcase breather if crankcase is overfilled.

If level is low, fill crankcase with the correct grade of engine oil at oil filler. If crankcase is full and no oil pressure shows on gage, notify organizational maintenance.

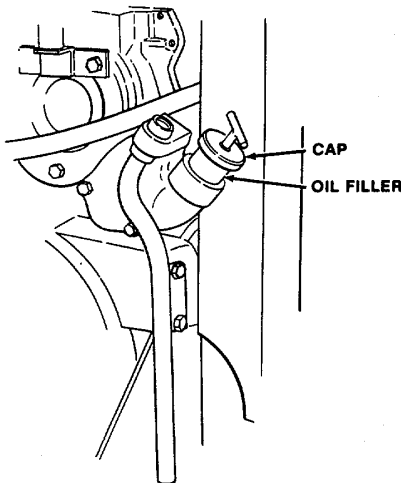
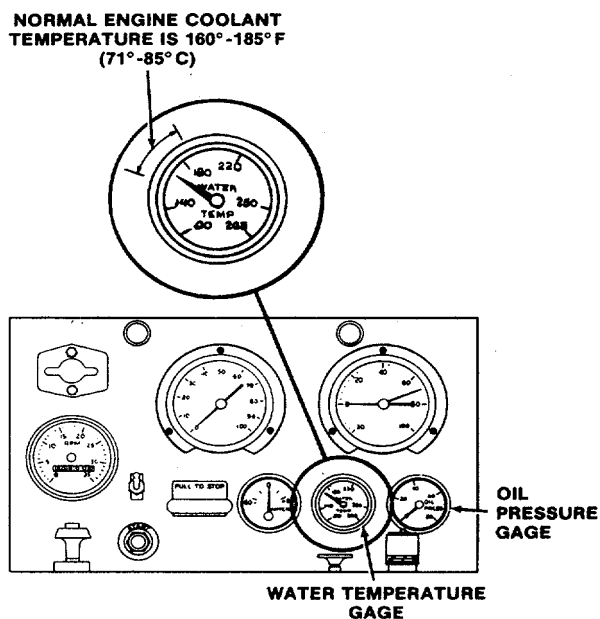


Table 3-1. Operator/Crew Troubleshooting Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- b. If oil pressure shows on gage but water temperature is out of normal range after a few minutes, stop engine.



WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in coolant system is released, then remove cap.

Remove radiator cap and check coolant level which should be about 3 inches (7.62 cm) below neck. If coolant level is below operating level, refill radiator with correct grade coolant. Restart engine.

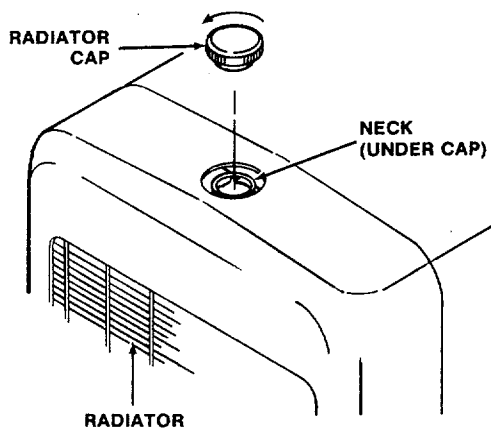
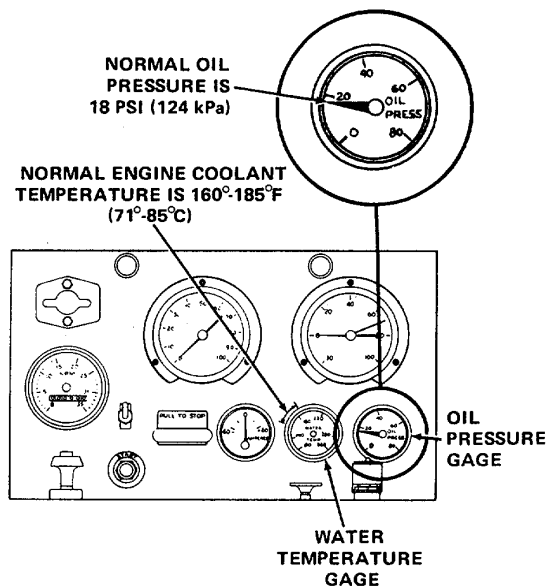


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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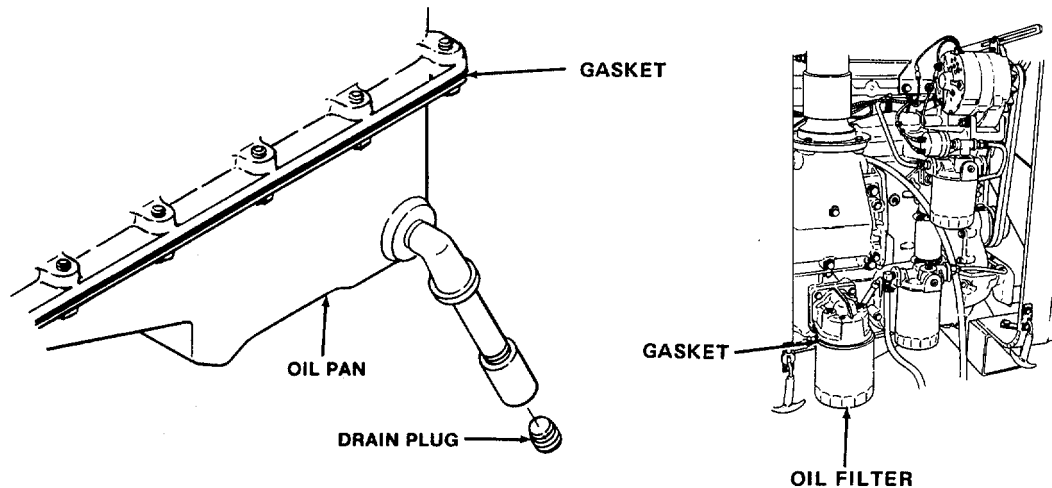
After engine is warm, check oil pressure and water temperature. Oil pressure should be 18 psi (124 kPa) at 1200 rpm. Water temperature should be between 160° to 185°F (71 to 85°C).



- c. If both oil pressure and water temperature are correct after engine warmup, but engine stops running after a few minutes, notify organizational maintenance.

6. EXCESSIVE LUBRICATING OIL CONSUMPTION

Step 1. Check for leaking oil pan gasket, drain plug, or oil filter gasket.



If filter or drain plug is leaking, try to tighten. If either continues to leak, or if oil pan gasket is leaking, notify organizational maintenance.

Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in coolant system is released, then remove cap.

Step 2. Check for oil cooler leaks by inspecting engine coolant at radiator filler cap.

If engine coolant contains oil, notify organizational maintenance.

7. LOW OIL PRESSURE

Step 1. Check that crankcase is filled to the correct level.

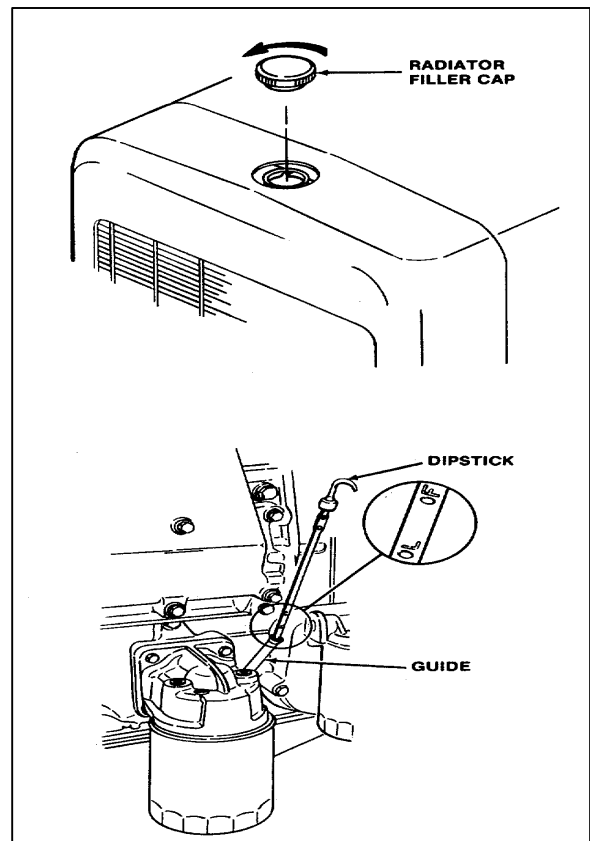
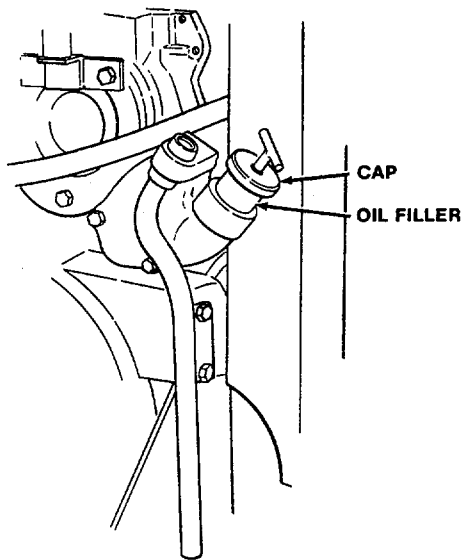


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

a. If level is low, remove oil filler cap and add proper grade oil as required to maintain correct oil level on the dipstick.



CAUTION

Do not overfill. Oil may be blow out through the crankcase breather if crankcase is over-filled.

b. Start engine and observe oil pressure. If oil pressure is below 18 psi (124 kPa), notify organizational maintenance.

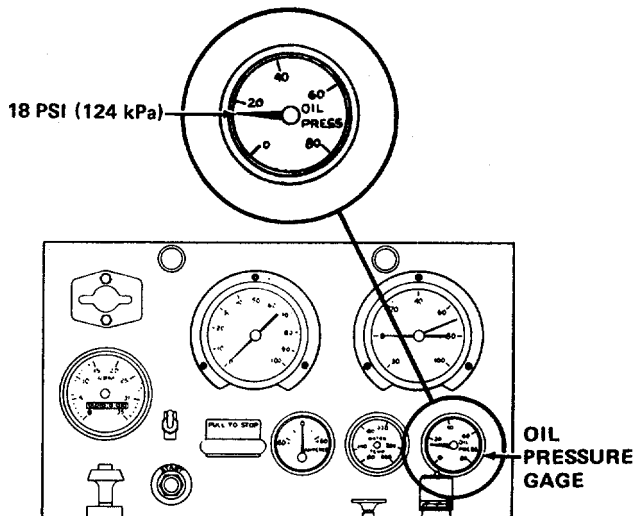
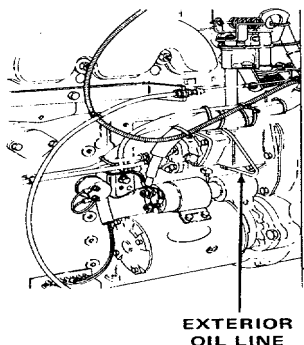


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 2. Check exterior oil line for leakage or damage at points of connection.

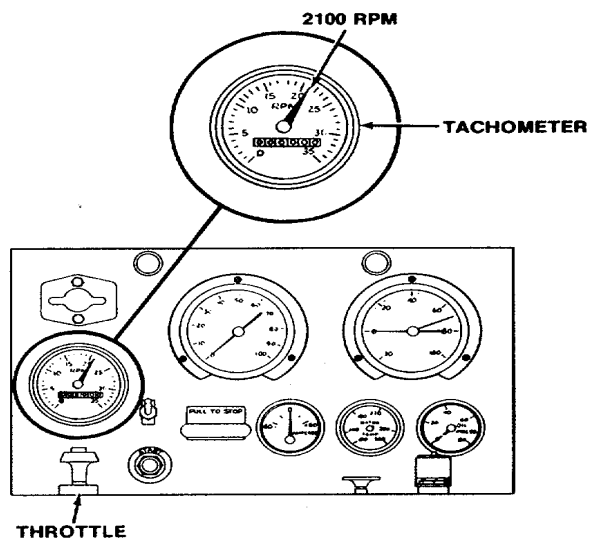
If connections are leaking or if oil line is damaged at points of connection, notify organizational maintenance.



8. PUMP FAILS TO PRIME

Step 1. Check for low engine speed.

Adjust throttle to increase engine speed to 2100 rpm.



Step 2. Check for air-locked pump.

Vent the pump body by removing either pipe plug on top of the pump body. Fill the pump body with water.

Step 3. Check for excessive suction lift.

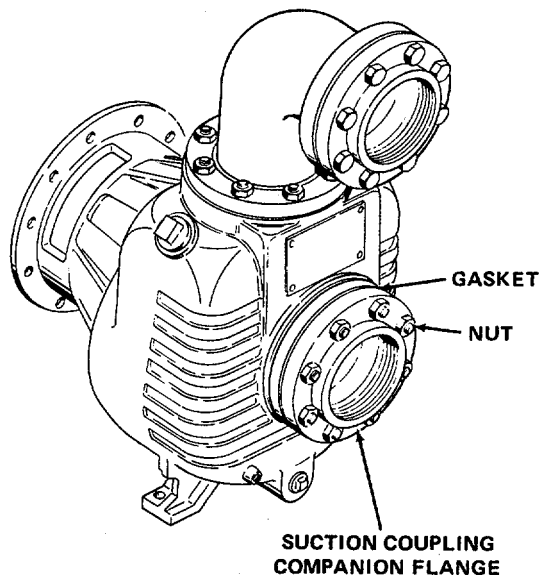
Refer to operator's instruction plate.

Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 4. Check for leaks at the suction coupling companion flange at pump body.

Tighten nuts on suction coupling companion flange at pump body flange.



9. PUMP FAILS TO DELIVER CAPACITY

Check for excessive suction lift.

Refer to operator's instruction plate.

10. NOISY PUMP OPERATION

Notify organizational maintenance.

11. LOW DISCHARGE PRESSURE

Step 1. Check for low engine speed.

Adjust throttle to increase engine speed to 2100 rpm.

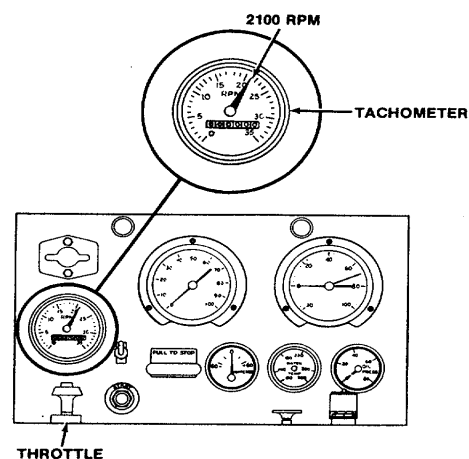


Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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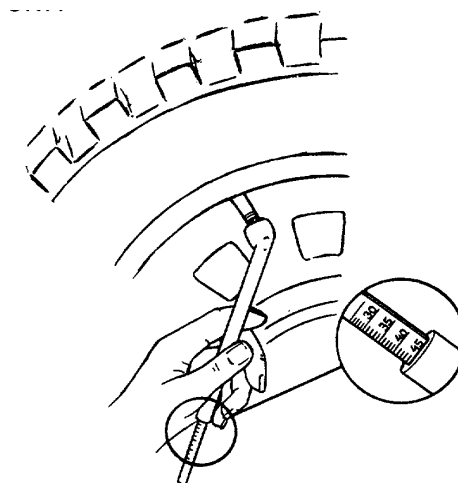
Step 2. Check suction line for loose connections.

Tighten loose connection.

12. DIFFICULTY IN TOWING WHEEL-MOUNTED PUMP UNIT

Step 1. Check for under-inflated tires.

- a. Inflate tires to 45 psi (310.3 kPa) maximum.



WARNING

Lower and pin the rear stands before disconnecting centrifugal pump unit from towing vehicle. Unit could drop on rear bumper and cause personal injury.

Use jack stands to support trailer after jack has raised trailer to working height. Unit could drop from jack and cause personal injury.

CAUTION

Remove and insert pin from rear stand assemblies with the handle end of the pin facing upward. The pin locking mechanism will stick within the rear stand if pin is inserted and removed any other way.

- b. If one or both tires are flat, carefully jack up trailer, then change tire or tires.

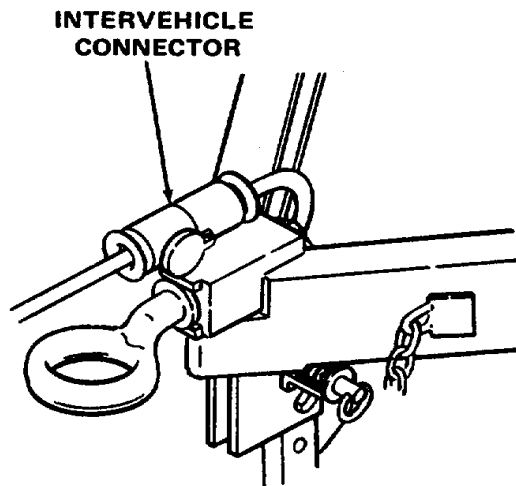
Table 3-1. Operator/Crew Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 2. Check for binding wheels by carefully jacking up each side of the trailer in turn and hand spinning the wheels.
 If wheels bind or make unusual noises, notify organizational maintenance.

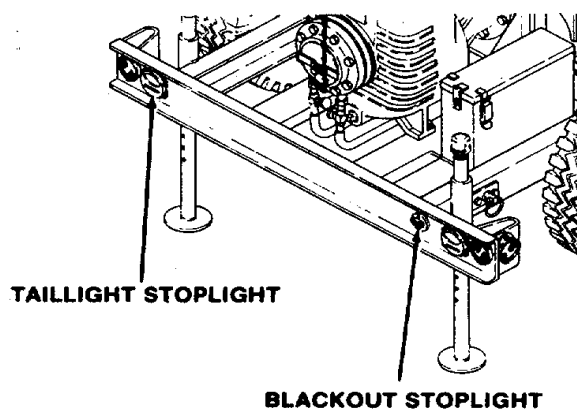
13. TAILLIGHTS DO NOT WORK

Step 1. Secure intervehicle connector.



Step 2. Check taillight bulbs.

- a. Remove taillight lenses and inspect bulbs. If bulbs are bad, replace them.
- b. If lights still do not work properly, notify organizational maintenance.



CHAPTER 4 ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

INTRODUCTION

This chapter contains the following frequently used maintenance information.

- a. Information on repair parts, special tools, test measurement diagnostic equipment (TMDE), and support equipment.
- b. Instructions for service upon receipt of equipment.
- c. Lubrication.
- d. Preventive maintenance checks and services (PMCS).
- e. Troubleshooting.
- f. Maintenance procedures.
- g. Preparation for storage or shipment.

Section I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

4-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

4-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

No special tools, TMDE, or support equipment is required for this centrifugal pump unit.

4-3. REPAIR PARTS

Repair parts are listed and illustrated in the repair parts and special tools list TM 5-4320-300-24P.

Section II. SERVICE UPON RECEIPT OF EQUIPMENT

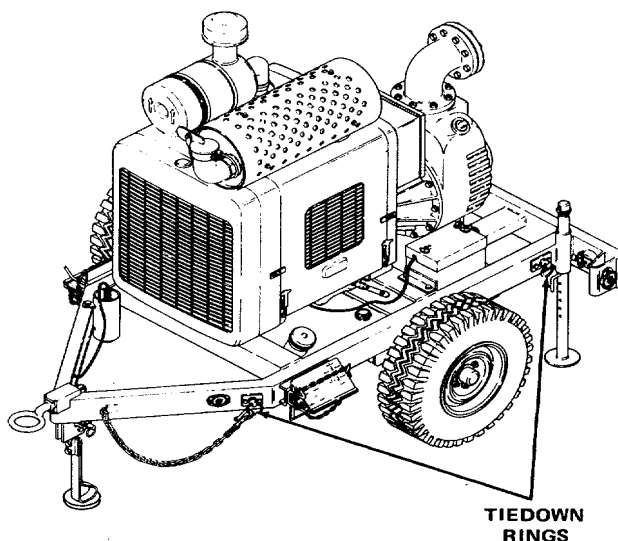
4-4. UNLOADING EQUIPMENT

- a. Before attempting to unload the Model US9OCCD-1 Centrifugal Pump, make sure that the unloading facility is capable of handling 3250 pounds (1475 kilograms).
- b. Remove the securing chains or cables from tiedown rings on the trailer.

CAUTION

Do not attempt to manually roll the pump unit down an inclined ramp. When using a crane for unloading, secure lifting sling to tiedown rings. Do not allow unit to swing while suspended. Failure to observe this warning may result in damage to the unit.

- c. Unload the centrifugal pump unit from carrier by rolling it down a suitable ramp using a mechanical restraining device, or by lifting it with a crane. If a crane is used, lift unit by securely attaching lifting sling to the tiedown rings.



4-5. INSPECTING AND SERVICING EQUIPMENT

- a. Inspect centrifugal pump unit for any damage that may have occurred during shipping.
- b. Inspect unit for loose mounting hardware.
- c. Inspect unit for missing components such as chock blocks, protective plugs, and fill plugs.
- d. Refer to LO 5-4320-300-12 (figure 4-1) for lubrication points, intervals, and detailed instructions.
- e. Refer to table 4-1 and perform preventive maintenance checks and services.

LUBRICATION ORDER

LO 5-4320-300-12

**PUMP, CENTRIFUGAL, SELF-PRIMING,
DIESEL-ENGINE-DRIVEN, WHEEL-MOUNTED
6-INCH, 1500 GPM CAPACITY AT 60 FOOT HEAD
MODEL US90CCD-1
NSN 4320-01-128-1836**

Reference: TM 5-4320-300-14 and C9100-IL

Intervals and the related man-hour times are based on normal operation. The man-hour time specified is the time required to perform all the services prescribed for a particular interval. Change the interval if lubricants are contaminated or if the equipment is operated under adverse operating conditions. The interval may be extended during periods of low level activity, commensurate with adequate preservation precautions. Clean

fittings before lubricating. Clean all parts with dry cleaning solvent (SD-2). Dry before lubricating. Dotted arrow points indicate lubrication on both sides of the equipment. The lowest level of maintenance authorized to lubricate a point is indicated by one of the following: (C) Operator/Crew or (O) Organizational Maintenance. Lubricate all chassis ports after washing or fording. Do not over-lubricate; wipe off excess.

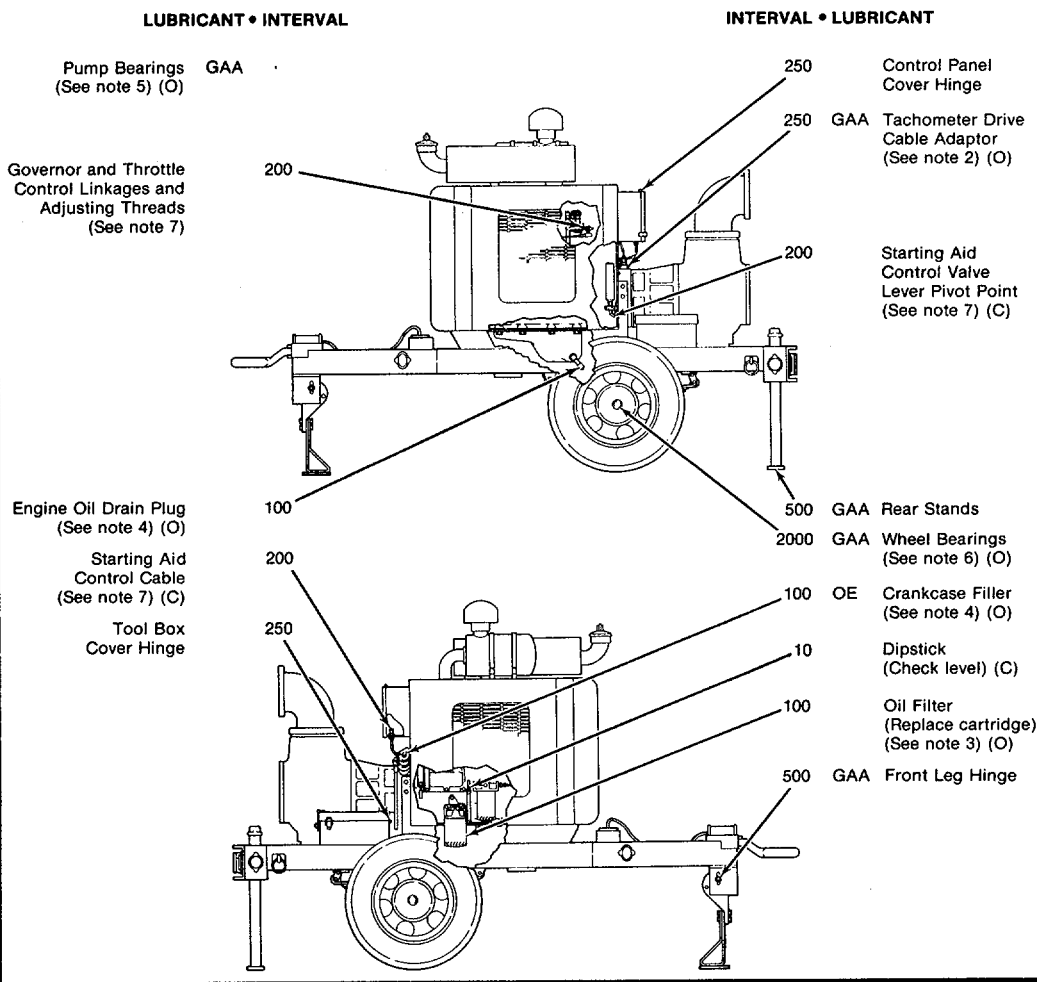


Figure 4-1. Lubrication Order (Sheet 1 of 2).

TOTAL MAN-HR		TOTAL MAN-HR	
INTERVAL	MAN-HR	INTERVAL	MAN-HR
10	0.1	250	0.1
100	0.7	500	0.3
200	0.5	2000	2.0

KEY				
LUBRICANT*	EXPECTED TEMPERATURE			INTERVALS
	Above +32° F (Above 0° C)	+42° F to -10° F (4° C to -23° C)	0° F to -65° F (-18° C to -54° C)	
OE - LUBRICATING OIL, (MIL-L-2104, internal combustion Grade 30 or 40) or OEA - LUBRICATING OIL, (MIL-L-46167)* internal combustion engine, arctic	OE Grade 40	OE Grade 30	OEA	Intervals given are in hours of normal operation For arctic operation refer to TM 9-207
GAA - GREASE, automotive (MIL-G-10924) and artillery	All temperatures			
SD-2 - SOLVENT, dry (P-D-680) cleaning				

*SAE 15W -40 may be substituted for single grade oils.

NOTES

1. FOR OPERATION OF EQUIPMENT IN PROTRACTED COLD TEMPERATURES BELOW -10° F (-23° C). Remove lubricants prescribed in the key for temperatures above -10° F (-23° C). Clean parts with dry cleaning solvent. Relubricate with lubricants specified in the key for temperatures 0° F to -65° F (-18° C to -54° C).

2. TACHOMETER DRIVE CABLE ADAPTOR. Grease tachometer drive cable adaptor with GAA every 250 hours. Remove the plug on the adaptor, which is on engine below the control panel.

3. ENGINE OIL FILTER. Replace oil filter cartridge every time oil is changed. Use hand or strap wrench to unscrew filter in counterclockwise direction. Discard filter. Install new filter hand tight after lubricating oil filter gasket with engine oil. Wipe off oil filter and immediate area of engine with rag. Refill crankcase with correct grade of engine oil as shown in the key. Capacity is 12-1/2 quarts (11.83 liters) with filter.

4. CRANKCASE FILLER. Check oil level every 10 hours. Add oil through filler if dipstick level is low. Run engine a few minutes, shut down engine, wait 20 minutes, then recheck level. Refill if necessary. Remove oil pan drain plug to drain crankcase at oil change interval. Drain oil while engine is hot. Replace drain plug after oil has drained completely, and wipe off plug and immediate area of oil pan with a rag. Tighten plug if leaks appear.

5. PUMP BEARINGS. Pump bearings are lubricated by the manufacturer at assembly and require no subsequent lubrication except at scheduled overhaul periods.

6. WHEEL BEARINGS. Remove wheels and hubs, clean and inspect bearings, and repack with grease at reassembly. Refer to TM 5-4320-300-14 for required wheel nut adjustment.

7. OIL CAN POINTS. Every 200 hours, clean and lightly coat with engine oil all pivot points, linkages, hinges, clevis pins, wing nuts, and adjusting threads.

Copy of this lubrication order will remain with the equipment at all times; instructions contained herein are mandatory.

BY ORDER OF THE SECRETARY OF THE ARMY

General, United States Army,
Chief of Staff.

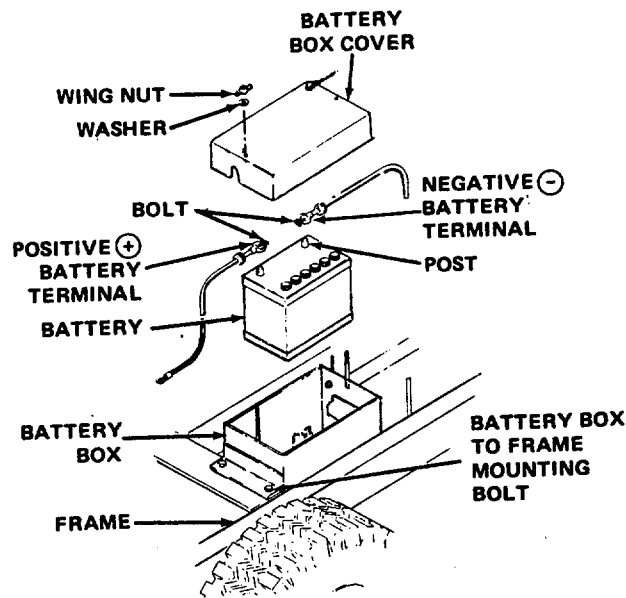
OFFICIAL

The Adjutant General.

Figure 4-1. Lubrication Order (Sheet 2 of 2)

4-6. INSTALLATION OF SEPARATELY PACKED COMPONENTS

a. The battery is shipped dry, and installed in battery box.



WARNING

CAUSTIC CHEMICALS IN BATTERIES

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

BATTERIES GENERATE FLAMMABLE GAS

- Leave battery vent plugs installed while battery is being charged.
- Charge battery in a well-ventilated area.
- Do not smoke or use open flame or spark-producing equipment in the vicinity of charging battery.

NOTE

Do not use tropical electrolyte. Tropical electrolyte has a lower specific gravity and results in a lower battery reserve capacity

b. Remove electrolyte from its shipping container.

c. Remove battery fill plugs and add electrolyte to each cell of the battery until level reaches split rings above battery plates. Install fill plugs and charge battery.

d. Connect positive (+) battery terminal first and tighten bolt securely. Then connect negative (-) battery terminal and tighten bolt securely.

e. Lightly coat battery terminals with grease (Military Specification MIL-G-10924).

4-7. SETUP INSTRUCTIONS

- a. Locate unit as level as possible.
- b. Locate unit to keep suction and discharge lines as short and straight as possible.
- c. Position trailer at site in proper position for pumping and place chock blocks under trailer wheels to prevent rolling.
- d. Pull out on lock pin and pull down the front leg assembly until it locks.
- e. Free lock pins in rear stand assemblies.

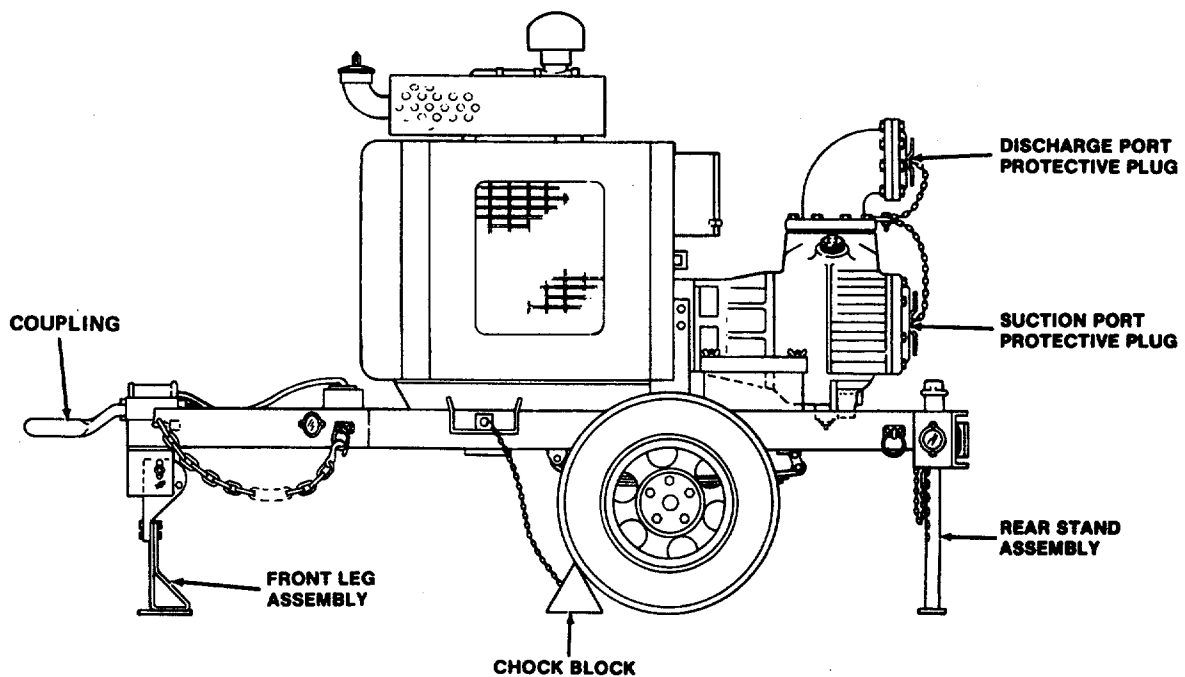
WARNING

Lower and pin the rear stands before disconnecting centrifugal pump unit from towing vehicle. Unit could drop on rear bumper and cause personal injury.

CAUTION

Remove and insert pin from rear stand assemblies with the handle end of the pin facing upward. The pin locking mechanism will stick within the rear stand if pin is inserted and removed any other way.

- f. Lower rear stand assemblies, install lock pins in holes so that the leg assemblies hold the trailer as level as possible.
- g. Disconnect safety chains and intervehicle connector. Uncouple coupling and rest centrifugal pump unit on front leg assembly.
- h. Relower rear stand assemblies to lowest point.
- i. Remove discharge port and suction port protective plugs. Connect discharge and suction lines.



Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

4-8. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

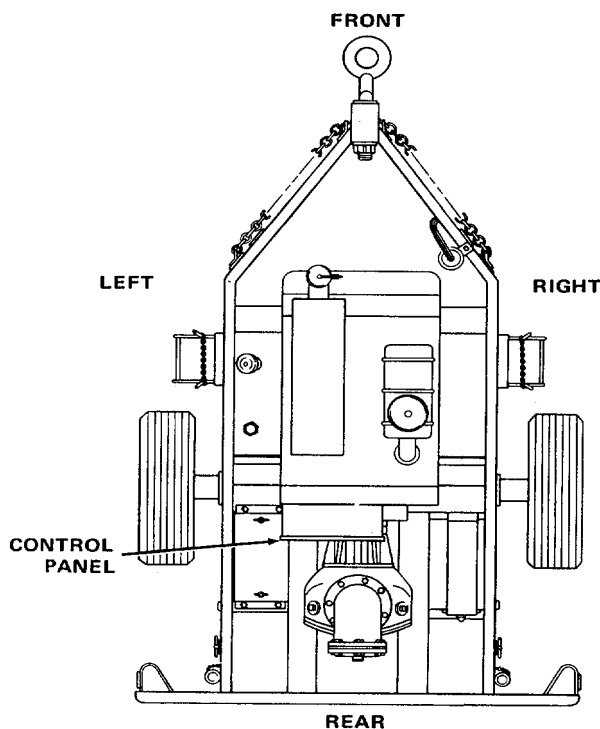
Table 4-1 lists preventive maintenance checks and services (PMCS) which shall be performed at specified intervals by organizational maintenance personnel. It includes and expands upon the preventive maintenance services performed by operator/crew maintenance and includes additional services which are allocated to organizational maintenance. The columns, codes, and location designations used in the table are as follows:

- a. Item numbers are assigned to each check or service task. These numbers are to be used as a source of item numbers for the TM Number column on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.
- b. The service intervals are divided into four categories: W Weekly; M Monthly; Q Quarterly; S Semiannually. A dot (e) is placed in the Interval column for each check or service. If the same check or service is made in two or more intervals, a dot is placed in each applicable column.
- c. The Item To Be Inspected column lists the item to be checked or serviced.
- d. The Procedures column describes the procedure by which the check or service is to be performed. Illustrations are included to assist in locating that part of the equipment requiring the check or service.

NOTE

All procedural instructions assume that engine right and/or left

- e. The designations left, right, front, and rear as used in PMCS indicate side or end of centrifugal pump as viewed when facing control panel.



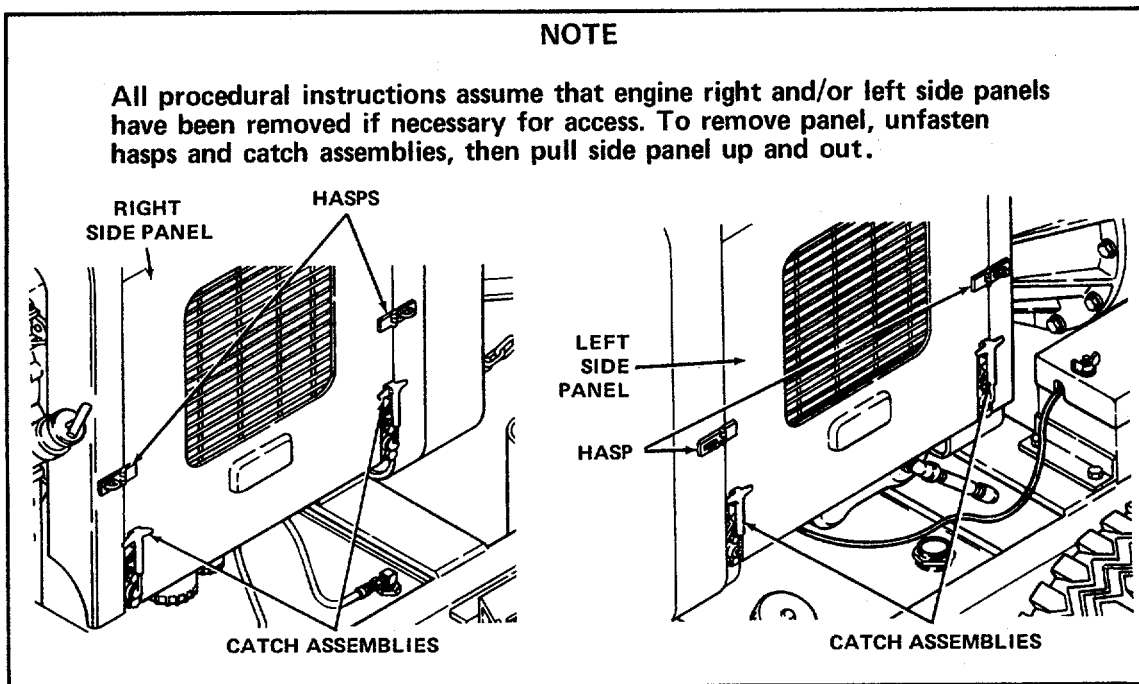


Table 4-1. Organizational Preventive Maintenance Checks and Services

W - Weekly

Q - Quarterly

M - Monthly

S - Semiannually

Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
1	•				Drive Belts.	<p style="text-align: center;">WARNING</p> <p>Severe injury may result from contact with the rotating cooling fan. When it is necessary to make inspections and adjustments near the fan area, turn off engine.</p> <p>Check for wear, fraying, cuts, or glazing. If either alternator or fan drive belts are defective, replace as a matched set as described in paragraph 4-23.</p>

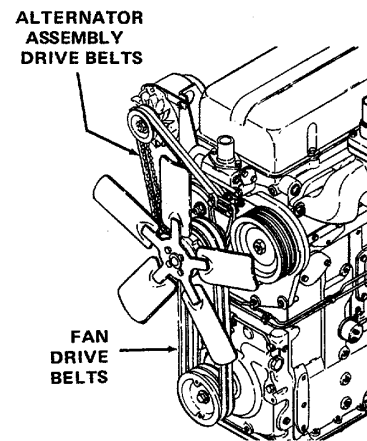


Table 4-1. Organizational Preventive Maintenance Checks and Services - Continued

W - Weekly
M - Monthly

Q- Quarterly
S- Semiannually

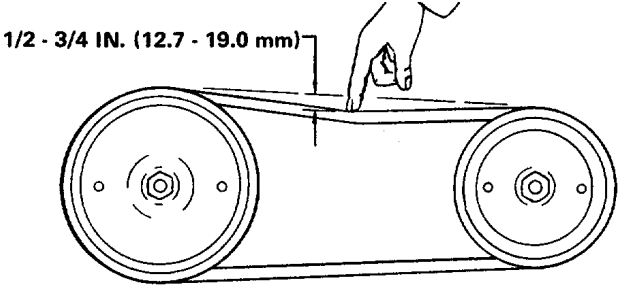
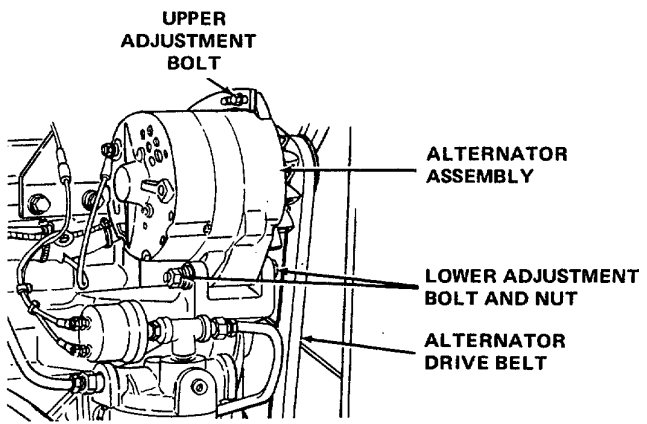
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
						<p>Check drive belt tension.</p>  <p>1/2 - 3/4 IN. (12.7 - 19.0 mm)</p> <p>Tension is correct when belts can be deflected with forefinger pressure 1/2 to 3/4 inch (12.7 to 19.0 mm) at the midpoint between pulleys.</p> <p style="text-align: center;">CAUTION</p> <p style="text-align: center;">Do not tighten drive belts beyond recommended tension. Premature belt failure may result. If belts are overtightened during adjustment, readjust belt tension immediately.</p> <p>Adjust alternator assembly drive belts by loosening alternator lower adjustment bolt. Then loosen upper adjustment bolt. Pull alternator away from engine until belt is adjusted. Tighten</p>  <p style="text-align: center;">UPPER ADJUSTMENT BOLT</p> <p style="text-align: right;">ALTERNATOR ASSEMBLY</p> <p style="text-align: right;">LOWER ADJUSTMENT BOLT AND NUT</p> <p style="text-align: right;">ALTERNATOR DRIVE BELT</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services - Continued
 W - Weekly
 M - Monthly
 Q- Quarterly
 S- Semiannually

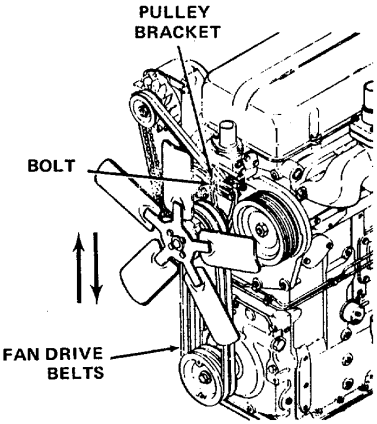
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
2					<ul style="list-style-type: none"> Alternator Assembly 	<p>Adjust fan drive belts by loosening four bolts on the pulley bracket. Slide pulley bracket up to tighten drive belts. Tighten the four bolts after adjusting drive belts.</p>  <p>Recheck drive belt tension.</p> <p>WARNING</p> <p>Severe injury may result from contact with rotating engine cooling or alternator fan. Shut off the engine when it is necessary to inspect alternator.</p> <p>CAUTION</p> <p>Never disconnect battery while alternator is operating.</p> <p>Disconnect battery cable from negative (-) battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage alternator, voltage regulator, or other parts.</p> <p>Do not reverse the battery connections. Reversing connections will damage the alternator.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services - Continued
W - Weekly **Q- Quarterly**
M - Monthly **S- Semiannually**

Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
						<p style="text-align: center;">CAUTION</p> <p style="text-align: center;">Do not disconnect alternator output lead or voltage regulator while alternator is operating.</p> <p>Inspect alternator assembly for damaged or loose terminals or adjustment bolts, bent or damaged cooling fan and pulley, or other exterior damage. Disconnect battery cable from negative (-) battery post before tightening loose terminals. Tighten loose terminals and adjustment bolts. If cooling fan, pulley, or terminals are damaged, replace alternator as described in paragraph 4-20. Connect battery lead.</p> <div style="text-align: center;"> </div>

Table 4-1. Organizational Preventive Maintenance Checks and Services - Continued

W - Weekly
M - Monthly

Q- Quarterly
S- Semiannually

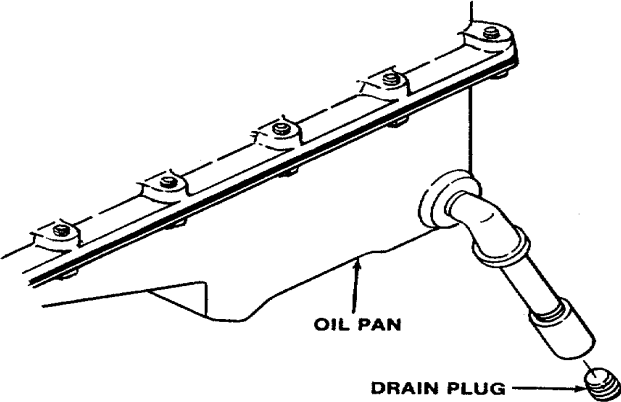
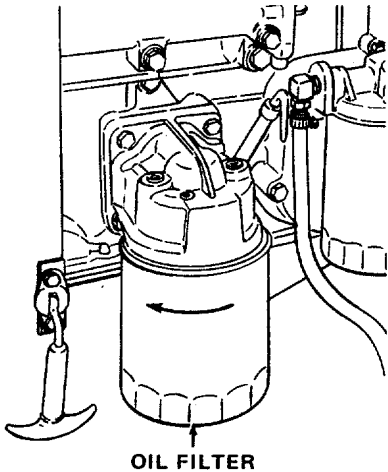
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
3		•			Engine Oil and Oil Filter Cartridge	<p>Check that engine oil has been changed at the correct maintenance intervals. See LO 5-4320-300-12 (figure 4-1). Change oil if necessary.</p>  <p>Place a suitable container under oil pan, beneath engine, and drain warm oil by removing drain plug. Clean and replace drain plug. Wipe off plug and oil pan with a rag. Refill with correct grade of oil. Capacity is 10-1/2 quarts (9.94 liters), 12-1/2 quarts (11.83 liters) with filter.</p> <p>Change oil filter</p> 

Table 4-1. Organizational Preventive Maintenance Checks and Services - Continued

W - Weekly

Q- Quarterly

M - Monthly

S- Semiannually

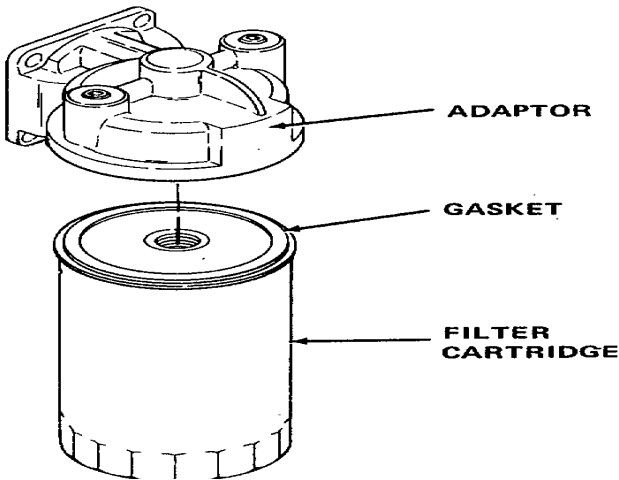
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
						<p>Remove and discard filter cartridge and gasket. The filter is located on the left lower side of engine. Inspect filter adaptor on the engine for nicks, burrs, or other damage. Before installing new filter cartridge, coat filter gasket with oil and wipe off filter adaptor before screwing the filter cartridge on hand tight. Run engine for a few minutes and check for filter leaks. Retighten by hand if necessary.</p> 

Table 4-1. Organizational Preventive Maintenance Checks and Services - Continued

W - Weekly
M - Monthly

Q- Quarterly
S- Semiannually

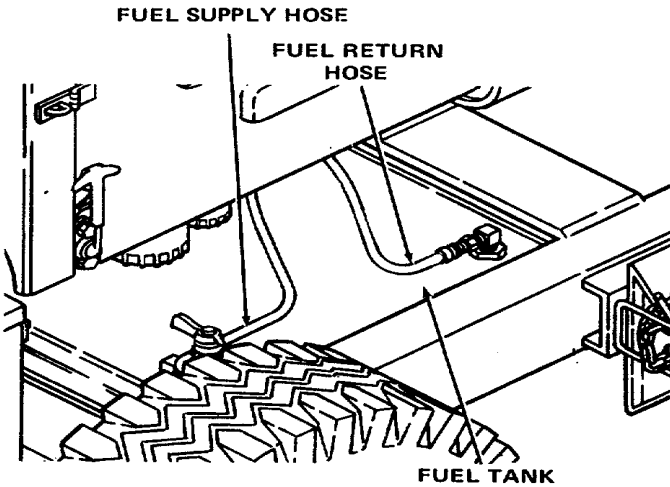
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
4					<ul style="list-style-type: none"> Fuel Supply and Return Hoses, and Fittings 	<p style="text-align: center;">WARNING</p> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> Do not inhale vapor. Do not refuel near open flame, sparks, or excessive heat. Be certain fuel lines and connections are secure. Do not overfill fuel tank. Work in a well-ventilated area. <div style="text-align: center;">  <p>The diagram shows a cross-section of a vehicle's fuel system. A 'FUEL SUPPLY HOSE' is connected to a fuel source on the left. A 'FUEL RETURN HOSE' is connected to a 'FUEL TANK' at the bottom right. The hoses are routed through the vehicle's chassis. The fuel tank is shown with a textured surface, possibly representing a filter or a specific material.</p> </div> <p>Replace damaged or leaking hoses (paragraph 4-27).</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services - (Continued)

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

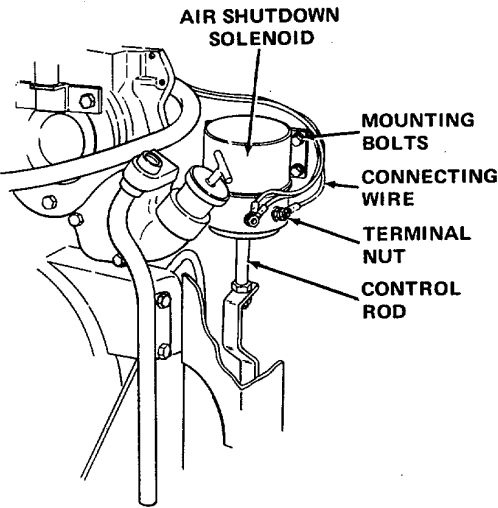
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
5			•	•	Air Shutdown Solenoid	<p>Inspect solenoid for proper operation and for exterior damage, broken or loose connecting wires, loose terminal nuts, or broken insulation.</p>  <p>Inspect control rod for bends or other damage. Also inspect other solenoid linkage components for exterior damage. Check operation of air shutdown solenoid as follows:</p> <p style="text-align: center;">WARNING</p> <p>Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure. Fumes from engines become concentrated with poor ventilation.</p> <ol style="list-style-type: none"> 1. Operate engine in a ventilated area only. 2. Ventilate personnel compartments when idling engine. 3. While running vehicles, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available. <p>GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.</p> <ol style="list-style-type: none"> a. Start engine. Allow it to warm up for 1 minute. <p style="text-align: center;">4-15</p>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W - Weekly
M - Monthly

Q- Quarterly
S- Semiannually

Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
6			•		Overspeed Governor	<p>b. Carefully detach one connecting wire from the back of the low oil pressure cutout switch. Air shutoff solenoid should energize 5 to 10 seconds after low oil pressure cutout switch is disconnected. If solenoid does not shut off engine, replace solenoid (paragraph 4-25).</p> <p>c. Reconnect low oil pressure cutout switch.</p> <p>d. Reset air shutdown solenoid by pulling down on solenoid control lever until it holds in the set position.</p> <p style="text-align: center;">CAUTION</p> <p>Do not run overspeed governor test without the pump connected to a large water source. Damage to internal pump seals could result.</p> <p>Inspect exterior of overspeed governor for rust or other damage. Inspect terminals and mounting bolts for tightness.</p> <div style="text-align: center;"> </div> <p>Inspect connecting wires for broken conductors or damaged insulation. If governor is rusty or damaged, notify direct support maintenance. Tighten loose terminals and mounting bolts, and repair or replace any damaged governor connecting wires before performing overspeed governor test.</p>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

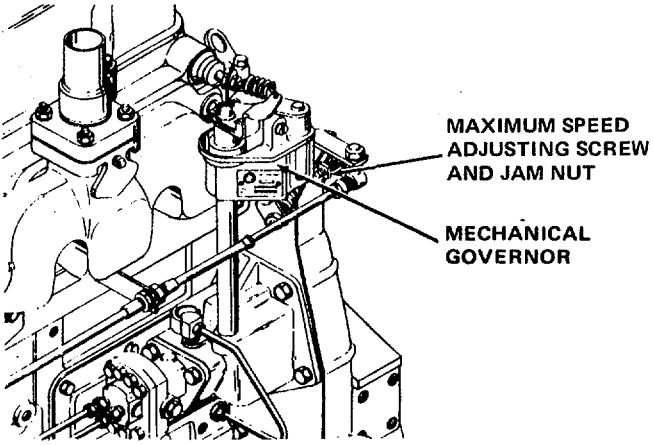
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
						<p>Start engine and allow it to warm up. While engine is warming up, make an alinement mark on the governor body and cap. Loosen the adjusting lock screws on the governor cap just enough to allow the cap to be rotated either direction. Raise the engine speed with the throttle control to the maximum rpm allowed by the mechanical governor. Carefully and slowly rotate clockwise the cap of the overspeed governor. When the lowering trip speed of the governor matches the actual engine speed, the overspeed governor will shut down the engine.</p> <p>If the overspeed governor does not shut down the engine when it is rotated fully clockwise, the mechanical governor will have to be adjusted in order to increase the engine speed.</p> <p>Release the jam nut, mark the position of the maximum speed adjusting screw, and turn the adjusting screw to increase the engine speed. If the overspeed governor does not trip after raising engine speed with maximum speed adjusting screw, notify direct support maintenance.</p>  <p>Return the maximum speed adjusting screw to its original position and tighten jam nut. Return overspeed governor cap to original marked position and tighten the adjusting lock screws.</p>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

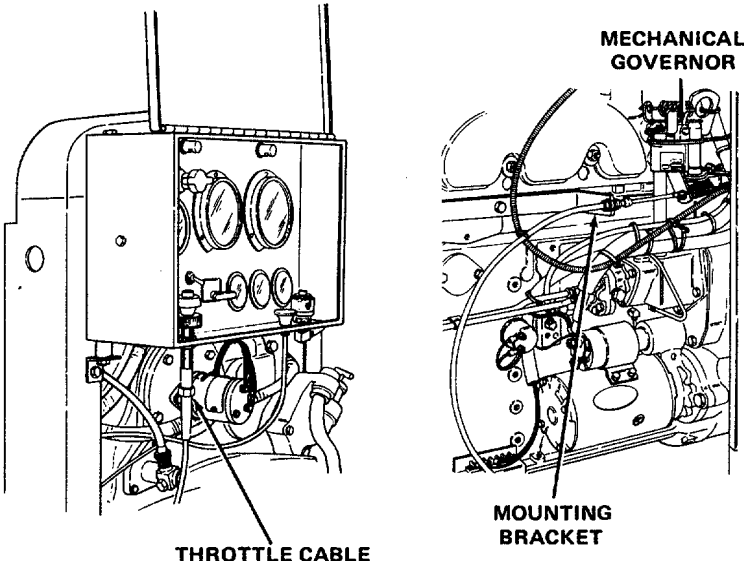
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
7			•		Speed Regulating Throttle Cable	 <p>Inspect throttle cable for surface damage and kinks. Check mounting of throttle cable at control panel and at engine mounting bracket for tightness. Check that throttle moves freely within its range and that the pushbutton holds throttle at desired position. If throttle cable is kinked or damaged, does not hold a set position, or does not work freely after throttle parts and the mechanical governor have been lubricated, replace cable as described in paragraph 4-24.</p>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

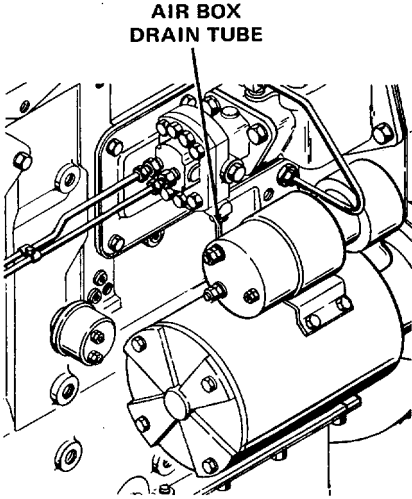
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
8		•			Air Box Drain Tube	<p style="text-align: center;">WARNING</p> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not refuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Do not overfill fuel tank. • Work in a well-ventilated area. <p>With the engine running, check to see that air is flowing out of drain tube. If no air is flowing out of tube, remove and clean tube with clean fuel oil and replace on engine.</p> <div style="text-align: center;">  <p>AIR BOX DRAIN TUBE</p> </div>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

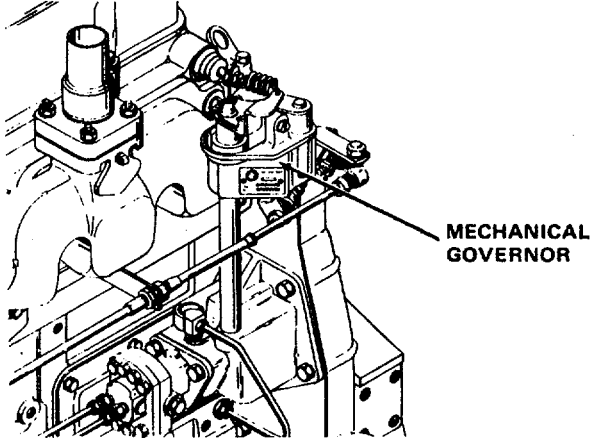
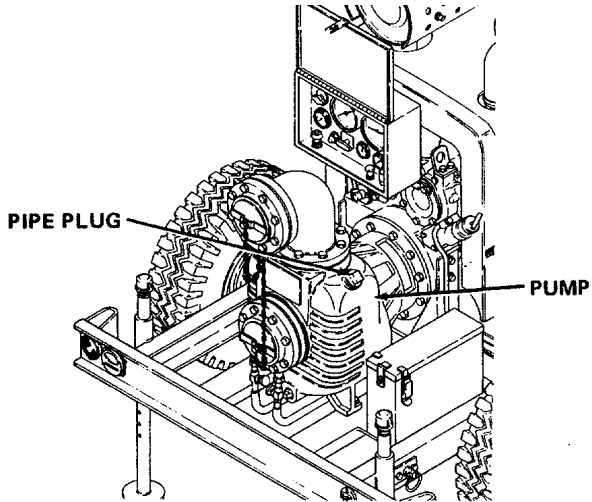
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
9			•		Mechanical Governor	<p>Inspect exterior of mechanical governor for rust or other damage. Check linkages for damage. If governor or linkages are rusty or damaged, notify direct support maintenance.</p>  <p>CAUTION</p> <p>Do not run mechanical governor test without the pump connected to a large water source. Damage to internal pump seals could result.</p> <p>Put suction and discharge hoses into a suitable water supply of sufficient volume for test purposes and remove one of the pipe plugs and prime the pump.</p> 

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

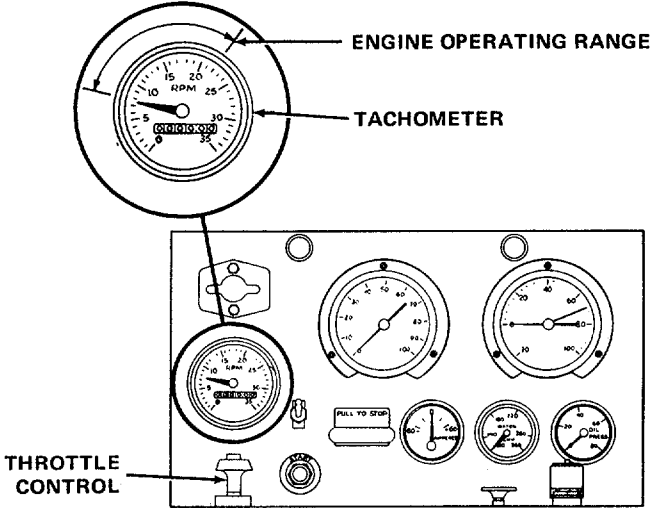
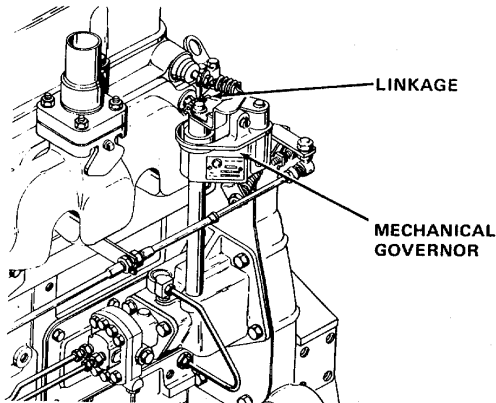
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
						<p>Start engine and allow it to warm up. Adjust engine idle speed to 550 rpm with throttle control.</p>  <p>Adjust throttle control to raise engine rpm to operating speed (2200 rpm). Note any binding governor linkage or hangup DURING operation. If governor linkage binds and prevents a smooth increase from 550 to 2200 rpm, notify direct support maintenance.</p> 

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

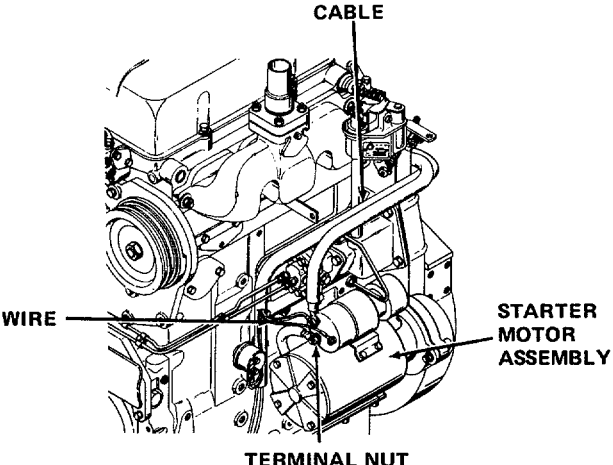
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
10			•		Starter Motor Assembly	<p>With engine warmed up and at operating speed, alternately restrict and clear the end of the suction line (while it is under water). This activity will produce a changing load condition. As the load changes, the engine speed will also change. The governor should prevent wild swings in engine speed as the load on the pump varies. If wild swings of engine speed occur as the suction line is partially restricted and then cleared, notify direct support maintenance.</p> <p style="text-align: center;">CAUTION</p> <p>Disconnect battery cable from negative (-) battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage alternator, voltage regulator, or other parts.</p> <p>Inspect starter motor assembly for exterior damage. Inspect terminal nuts and mounting bolts. Also check for frayed wires or cables connected to starter motor that may cause faulty operation. Replace any frayed or damaged wires and cables described in paragraph 4-21. If starter motor does not work after correcting above problems, replace starter motor assembly as described in paragraph 4-21. Replace battery cable.</p> <div style="text-align: center;">  <p>The diagram shows a detailed view of an engine's front end. A cable is connected to the top of the engine. A wire is connected to the side. A terminal nut is located at the bottom. The starter motor assembly is shown on the right side of the engine.</p> </div>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

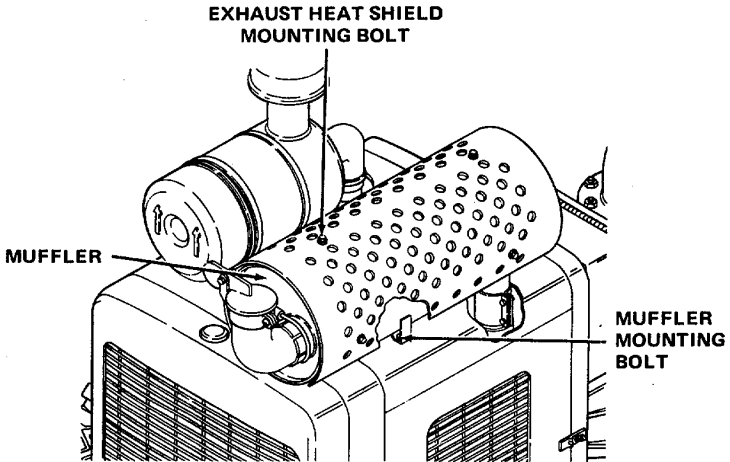
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
11			•		Muffler	<p style="text-align: center;">WARNING</p> <p>Handling hot exhaust shield, exhaust pipe, muffler, and weather cap can cause severe burns. Allow unit to cool before handling .</p> <p>Inspect muffler and exhaust heat shield for leaks, excessive rust, holes, other damage, and loose mounting bolts. Tighten loose mounting bolts. If muffler or exhaust heat shield is damaged or excessively rusty, replace as described in paragraph 4-17 or 4-14.</p> <div style="text-align: center;">  </div>
12			•		Battery Box and Cover	<p style="text-align: center;">WARNING</p> <p>CAUSTIC CHEMICALS IN BATTERIES Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.</p>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

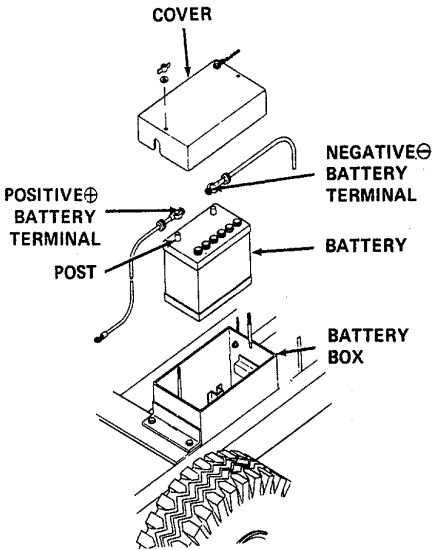
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
						<p style="text-align: center;">CAUTION</p> <p>When using baking soda solution to clean battery box, insure that solution does not enter the battery cells; it will destroy the electrolyte.</p> <p>When removing battery, disconnect negative (-) terminal first. This will prevent short circuits which may damage other electrical components.</p> <p>Avoid making contact across the two battery posts. This can result in severe arcing.</p> <p>When removing battery cables, use battery terminal puller to remove loosened terminals. Forcing battery terminals off without using a puller may damage the battery terminals.</p>  <p>Remove battery box cover. To remove battery from battery box, disconnect the negative (-) battery terminal first and then the positive (+) terminal. To remove cables, loosen terminals, then use a battery terminal puller to remove terminals. Clean box and cover with a solution of baking soda (Federal Specification EE-B-86) and water to remove acid or corrosion caused by battery electrolyte. Inspect for cracks, dents, and other damage.</p> <p>If battery box or cover is defective, replace as described in paragraph 4-19.</p> <p>Install cables.</p> <p>Install battery box cover.</p>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
13			•		Battery and Cables	<p style="text-align: center;">WARNING</p> <p>Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.</p> <p style="text-align: center;">CAUTION</p> <p>Disconnect battery cable from negative (-) battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage the alternator, voltage regulator, or other parts.</p> <p>Inspect battery terminals, cables, and posts for corrosion. If corroded, clean with a solution of baking soda (Federal Specification EE-B-86) and water. Take care not to get baking soda solution in the battery cells.</p> <p>Inspect battery for cracks, loose posts, leakage, and other damage.</p> <p>Using a hydrometer, check the specific gravity of the electrolyte. The specific gravity of a fully charged battery must be 1.250 minimum at 80° F (26.60C). Measure the temperature of the battery electrolyte with an accurate thermometer. Compare the electrolyte temperature and the hydrometer specific gravity reading to the battery condition chart. Add or subtract (from your specific gravity reading) the decimal next to the temperature in 0 F that closely approximates</p>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
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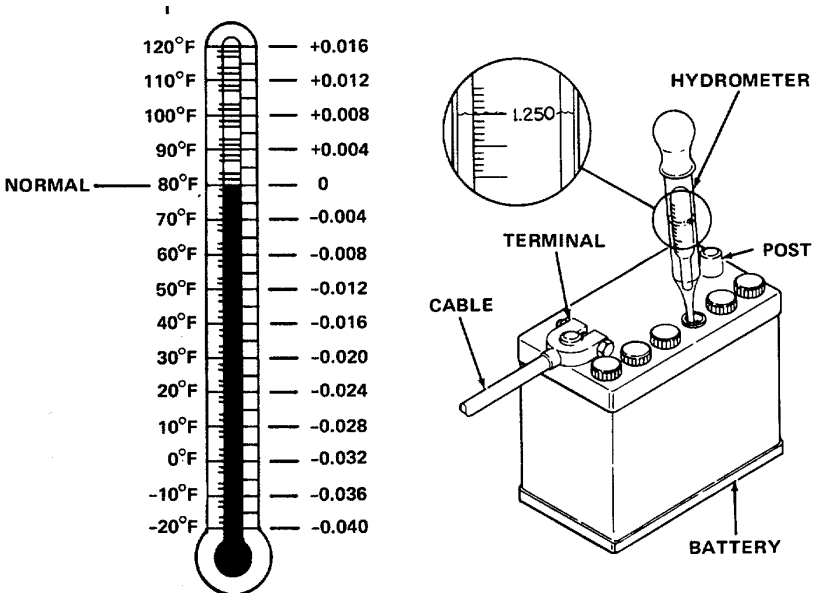
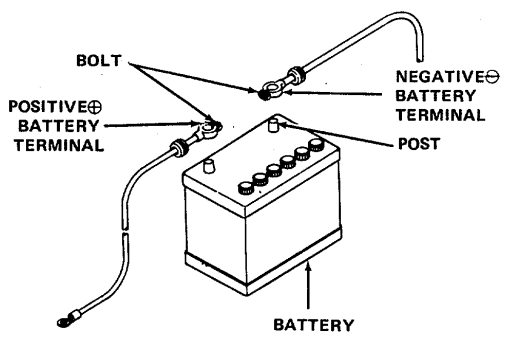
Item No.	Interval				Item To Be Inspected	Procedures														
	W	M	Q	S																
						<p>the obtained electrolyte temperature. If the temperature corrected reading is below 1.250, charge the battery.</p>  <table border="1"> <thead> <tr> <th>CORRECTED SPECIFIC GRAVITY</th> <th>BATTERY CONDITION</th> </tr> </thead> <tbody> <tr> <td>1.280</td> <td>FULLY CHARGED</td> </tr> <tr> <td>1.250</td> <td>THREE-FOURTHS CHARGED</td> </tr> <tr> <td>1.220</td> <td>ONE-HALF CHARGED</td> </tr> <tr> <td>1.190</td> <td>ONE-FOURTH CHARGED</td> </tr> <tr> <td>1.160</td> <td>LITTLE USEFUL CHARGE</td> </tr> <tr> <td>1.130</td> <td>DISCHARGED</td> </tr> </tbody> </table> <p>Coat battery terminals and posts with a thin covering of MIL-G-10924 grease.</p> 	CORRECTED SPECIFIC GRAVITY	BATTERY CONDITION	1.280	FULLY CHARGED	1.250	THREE-FOURTHS CHARGED	1.220	ONE-HALF CHARGED	1.190	ONE-FOURTH CHARGED	1.160	LITTLE USEFUL CHARGE	1.130	DISCHARGED
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1.220	ONE-HALF CHARGED																			
1.190	ONE-FOURTH CHARGED																			
1.160	LITTLE USEFUL CHARGE																			
1.130	DISCHARGED																			

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
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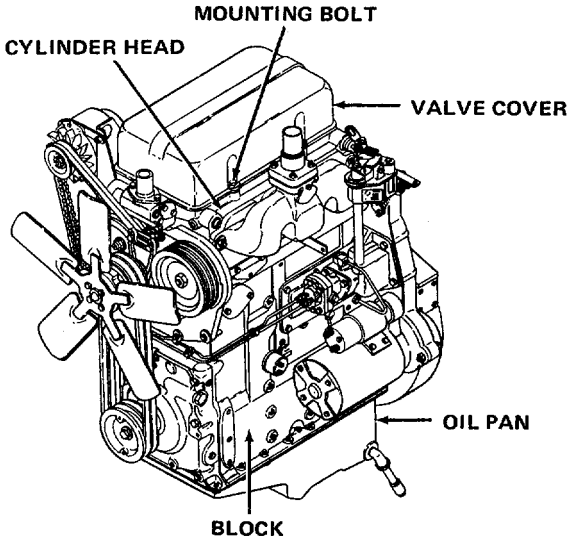
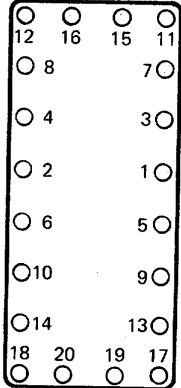
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
14		•			Crankcase, Block, Cylinder Head, and Valve Cover	<p>Inspect crankcase, block, cylinder head, and valve cover for oil or water leaks or other damage. Oil or water leaks indicate cracks.</p>  <p>Inspect and tighten any loose fittings securing components mounted on crankcase, block or cylinder head. Tighten any loose valve cover mounting bolts. Tighten oil pan bolts as follows:</p> <p>a. Tighten oil pan mounting bolts to 20 ft-lb (27 N.m) in the sequence shown.</p> 

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

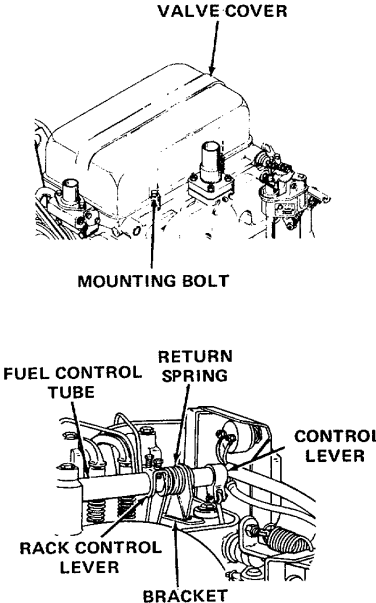
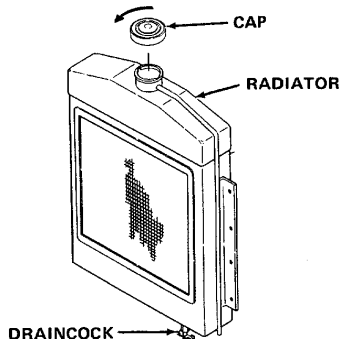
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
15					<ul style="list-style-type: none"> Fuel Control Tube 	<p>Remove valve cover mounting bolts and valve cover. Examine the fuel control tube, control lever, rack control lever, and brackets for excessive wear, cracks, or other damage. Examine the return springs for wear or fracture. If the components are worn, fractured, cracked, or otherwise damaged, notify direct support maintenance. Replace valve cover and mounting bolts. Tighten securely.</p> 
16					<ul style="list-style-type: none"> Cooling System 	<p>To flush the system proceed as follows:</p> <p>WARNING</p> <p>Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.</p> <p>a. Drain solution from radiator by removing the radiator cap and opening the radiator draincock. Then drain the cylinder block by opening the draincock on the bottom of the oil cooler (behind fuel strainer).</p> 

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W -Weekly
M -Monthly

Q- Quarterly
S- Semiannually

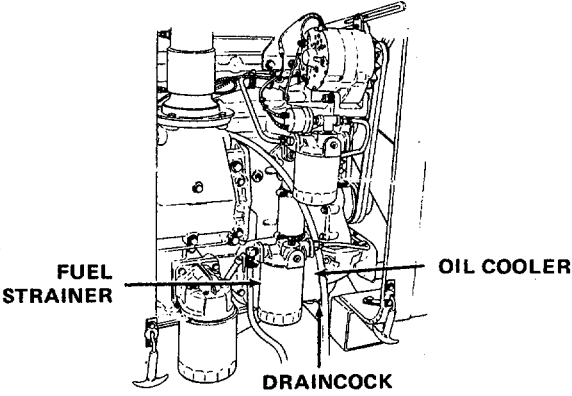
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
					cap off. evidence	<p style="text-align: center;">NOTE</p> <p>The cylinder block will drain faster if radiator cap is left open.</p>  <p>b. Close the radiator and oil cooler draincocks.</p> <p style="text-align: center;">CAUTION</p> <p style="text-align: center;">Ensure that engine temperature does not exceed 1850F (850C).</p> <p>c. Refill cooling system with clean water. Leave radiator</p> <p>d. Start engine and observe water level of radiator for of thermostat opening.</p> <p style="text-align: center;">CAUTION</p> <p style="text-align: center;">Engine damage may occur if engine is allowed to run without water in cooling system.</p> <p>e. With engine running open the draincocks on the radiator and oil cooler. Flush the cooling system with clean water. Replace water being drained by adding an equivalent amount to radiator.</p> <p>f. Stop the engine and drain the cooling system completely.</p>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W - Weekly
M - Monthly

Q- Quarterly
S- Semiannually

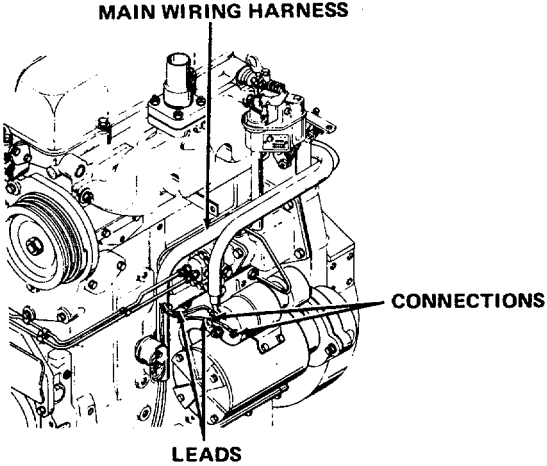
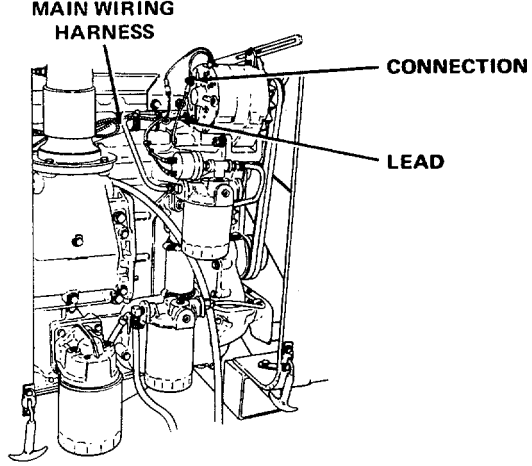
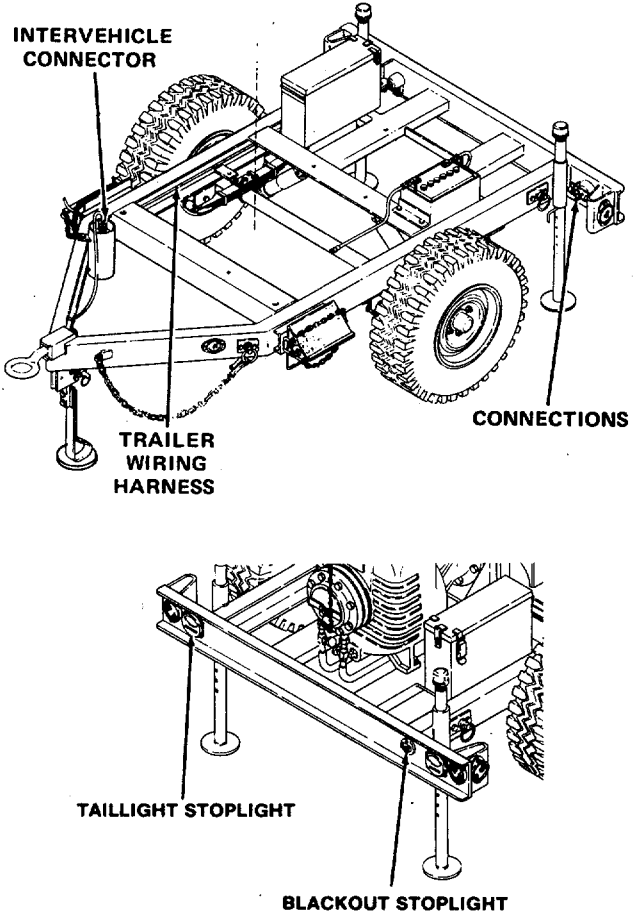
Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
17					Main Wiring Harness	<p style="text-align: center;">CAUTION</p> <p>When refilling hot engine with coolant, fill slowly to prevent rapid cooling and distortion of engine castings.</p> <p>g. Refill the cooling system with a fresh solution of 50% water and 50% antifreeze conforming to MI L-A-46153.</p> <p style="text-align: center;">CAUTION</p> <p>Disconnect battery cable from negative (-) battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage alternator, voltage regulator, or other parts.</p> <p>Inspect main wiring harness for broken or burned insulation, frayed connecting wires, and loose or broken contacts.</p> <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>MAIN WIRING HARNESS</p> <p>LEADS</p> <p>CONNECTIONS</p> </div> <div style="text-align: center;">  <p>MAIN WIRING HARNESS</p> <p>CONNECTION</p> <p>LEAD</p> </div> </div>

Table 4-1 Organizational Preventive Maintenance Checks and Services - Continued

W - Weekly
M - Monthly

Q- Quarterly
S- Semiannually

Item No.	Interval				Item To Be Inspected	Procedures
	W	M	Q	S		
18					<ul style="list-style-type: none"> Trailer Wiring Harness 	<p>Inspect trailer wiring harness assembly, intervehicle connector, taillight stoplights, and blackout stoplight.</p>  <p>The diagram consists of two parts. The upper part is a perspective view of the rear trailer chassis, showing the axle, wheels, and various electrical components. Labels include 'INTERVEHICLE CONNECTOR' pointing to a component on the left, 'TRAILER WIRING HARNESS' pointing to a bundle of wires, and 'CONNECTIONS' pointing to electrical terminals on the right. The lower part is a side view of the rear of the trailer, showing the 'TAILLIGHT STOPLIGHT' and 'BLACKOUT STOPLIGHT' mounted on the frame.</p> <p>Tighten loose connectors. Replace damaged wires as described in paragraph 4-45.</p>

Section IV. TROUBLESHOOTING:

4-9. TROUBLESHOOTING

a. Table 4-2 contains troubleshooting information for locating and correcting most of the operating troubles which are the responsibility of organizational maintenance. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. Perform the tests/inspections and corrective actions in the order listed.

NOTE
All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

c. Only those functions within the scope of organizational maintenance are listed. For troubleshooting procedures within the scope of operator/crew maintenance, refer to table 3-1.

4-10. SYMPTOM INDEX

Refer to the Symptom Index below. Locate the malfunction which is the same, or most nearly the same, as the trouble you are having with the pump. The Symptom Index lists the first page of troubleshooting information for that malfunction. Follow the steps one by one, and perform the corrective actions listed.

Malfunction Number	Description	Page
1	Engine fails to crank or cranks at low speed	4-33
2	Engine cranks but fails to start	4-36
3	Engine starts but runs unevenly or stalls	4-40
4	Engine lacks power	4-45
5	Engine stops running	4-47
6	Engine consumes excessive lubricating oil or produces black or grey smoke	4-53
7	Low oil pressure	4-59
8	Engine coolant temperature is excessively high or low	4-63
9	Unusual exhaust noise	4-71
10	Pump makes excessive noise	4-72
11	Trailer-mounted pump is hard to tow	4-72
12	Lights do not work	4-76

Table 4-2. Organizational Maintenance Troubleshooting

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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NOTE

All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.

1. ENGINE FAILS TO CRANK OR CRANKS AT LOW SPEED

WARNING

CAUSTIC CHEMICALS IN BATTERIES
 Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

BATTERIES GENERATE FLAMMABLE GAS

- Leave battery vent plugs installed while battery is being charged.
- Charge battery in a well-ventilated area.
- Do not smoke or use open flame or spark-producing equipment in the vicinity of charging battery.

Step 1. Check for weak battery.

Recharge or replace battery if necessary.

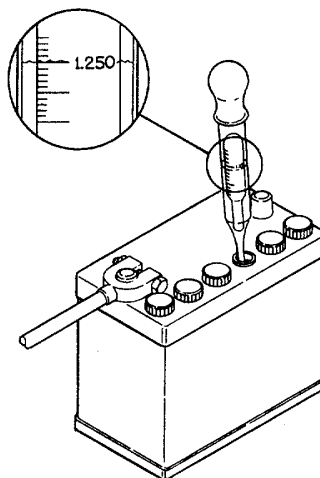
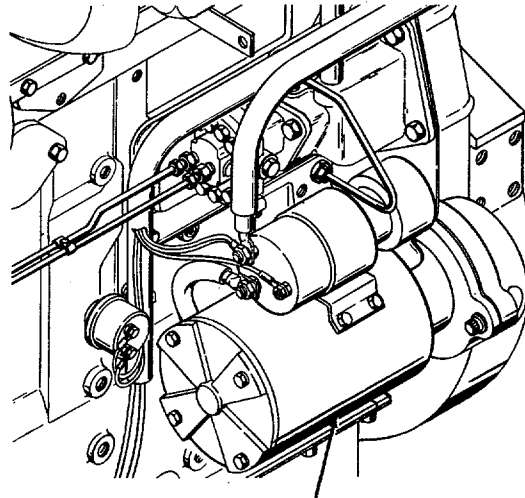


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 2 .Check for dirty, corroded, or loose starter and battery connections.

Clean and tighten starter and battery connections if necessary.



STARTER MOTOR

Step 3. Check for wrong grade of lubricating oil.

If oil is wrong grade (dependent on temperature), remove oil pan drain plug and drain oil into suitable pan. Replace drain plug, and refill crank- case with correct grade of engine oil. Capacity is 12-1/2 quarts (11.83 liters) with oil filter change.

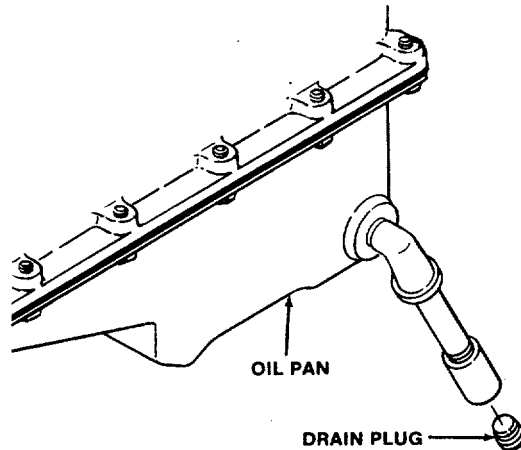
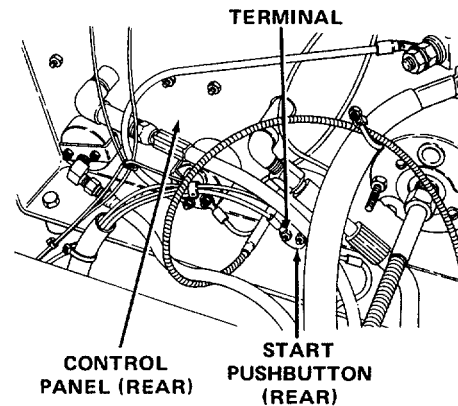
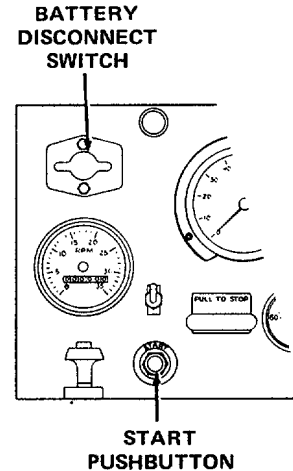


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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	<p>Step 4. Check START pushbutton continuity. Disconnect battery by pulling and turning battery disconnect switch. Use multimeter type TS-352 B/U to check the START pushbutton. Connect the multimeter to the two terminals on the rear of the START pushbutton. Set the multimeter to 10 megohms and press the START pushbutton. The multimeter should indicate zero resistance if the button is functioning properly.</p>	
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		<p>If switch is faulty, replace in accordance with paragraph 4-41.</p>
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	<p>Step 5. Check for internal engine seizure. Try to start engine with starter motor.</p>	
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		<p>If the starter motor engages but cannot be rotated a complete revolution, there is internal damage. Notify direct support maintenance.</p>
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Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

NOTE

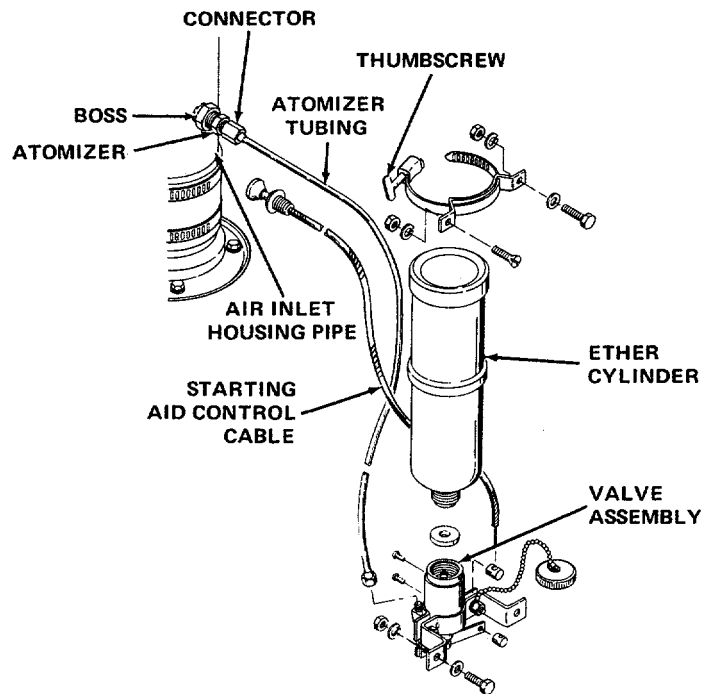
All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.

2. ENGINE CRANKS BUT FAILS TO START

Step 1. Check starting aid system.

- a. Check starting aid control cable for binding or restricted movement.

Replace defective cable as described in paragraph 4-30.



- b. Check for restricted atomizer. Disconnect atomizer tubing from atomizer at connector. Remove atomizer from bushing on air inlet housing pipe by unscrewing it counterclockwise.

Install cleaned or replacement atomizer into boss and tighten securely. Connect atomizer tubing to atomizer at connector. Tighten securely.

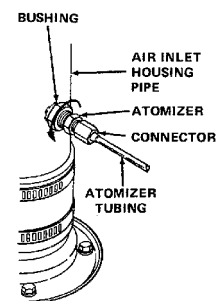


Table 4-2. Organizational Maintenance Troubleshooting - Continued

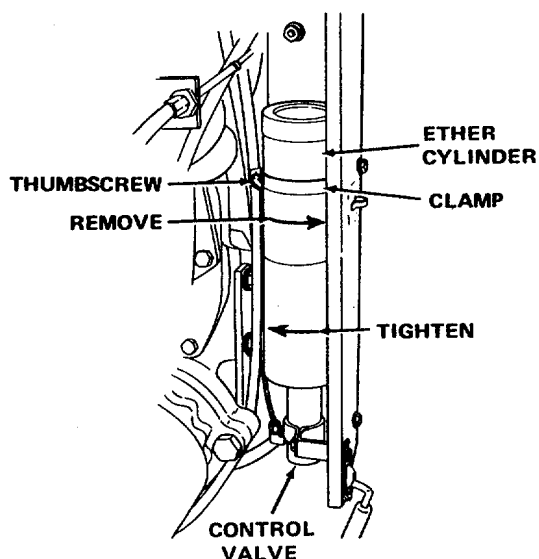
MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

WARNING

Handle starting aid ether cylinder carefully. Ether is highly flammable. Do not use near sparks or open flames. Do not inhale fumes.

Do not actuate starting aid for more than 1 or 2 seconds at a time and more than twice with engine stopped. Overloading the engine air box with this highly volatile fluid could result in an explosion.

- c. Check for sufficient fluid in ether cylinder. Remove cylinder from valve assembly by loosening thumb screw and turning cylinder counterclockwise. Weigh the cylinder and consult the chart below.



ETHER CYLINDER VOLUME

Fraction of starting fluid remaining	Weight of ether cylinder
Full cylinder	33 oz. (935.6 grams)
3/4 full cylinder	28.5 oz. (808 grams)
1/2 full cylinder	24 oz. (680.4 grams)
1/4 full cylinder	19.5 oz. (552.8 grams)
Empty cylinder	15 oz. (425.3 grams)

If ether cylinder is much below 1/4 full, replace it. Slip replacement cylinder through clamp and into control valve assembly. Tighten snugly. Tighten thumb screw or clamp. If cylinder leaks at control valve, tighten cylinder slightly.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 2. Check for fuel filter and strainer blockage.

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

CAUTION

Do not crank the engine more than 30 seconds at a time. Always allow one-minute intervals between cranking attempts to allow the starter motor to cool.

- a. Disconnect fuel return line at fuel tank and crank engine.

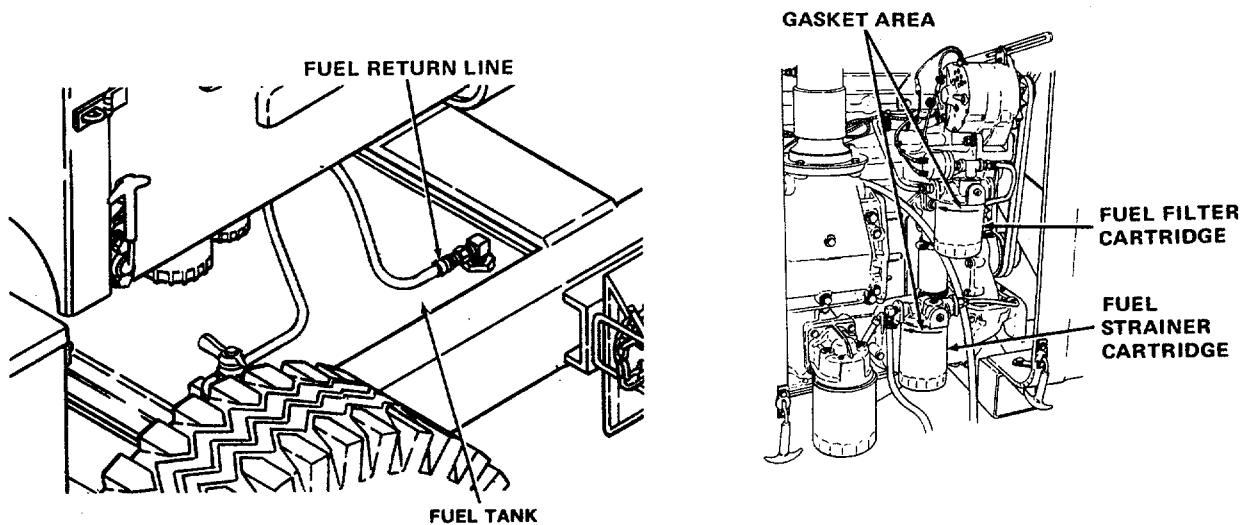
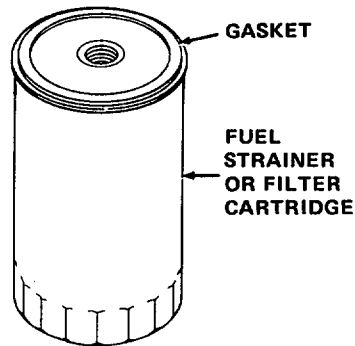


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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If fuel does not flow from return line, re- place strainer. Unscrew strainer counter- clockwise; remove and discard. Fill replacement strainer cartridge about two- thirds full of clean diesel fuel. Install the strainer hand tight.



- b. Crank engine again.

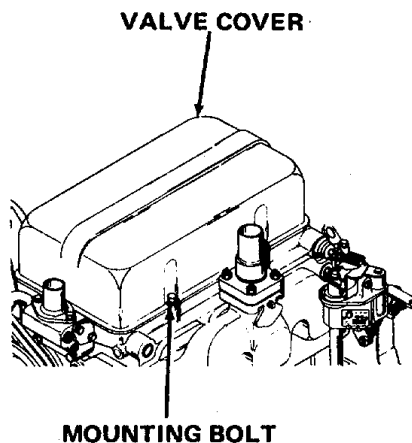
If fuel still does not flow from fuel return line, replace fuel filter. Unscrew filter counterclockwise; remove and discard. Fill replacement filter about two-thirds full of clean diesel fuel. Coat gasket lightly with clean diesel fuel. Install the filter hand tight.

- c. Crank engine again.

If fuel still does not flow from return line, replace fuel lines as described in paragraph 4-27. If replacing fuel lines does not solve problem, notify direct support maintenance.

Step 3. Check that injector control tube is in full fuel position.

- a. Remove valve cover by removing mounting bolts.

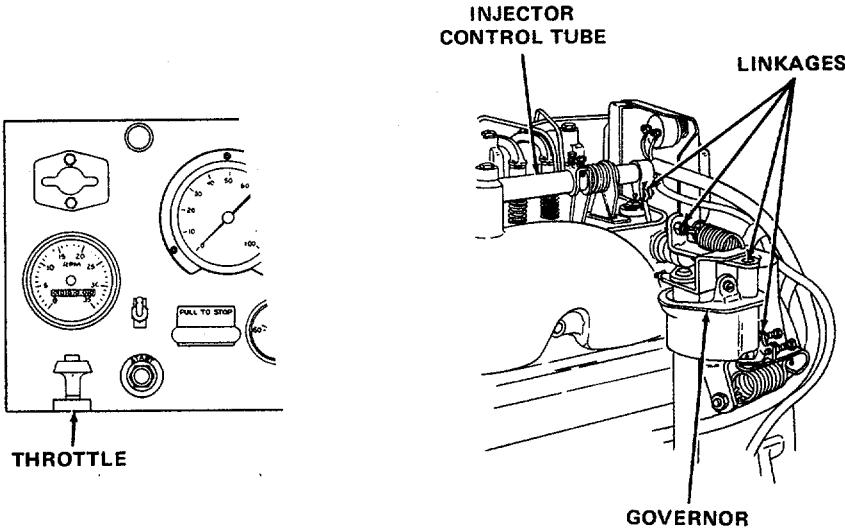


- b. Start engine.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

- c. Check for bind in the governor linkage and governor-to-injector control tube linkages while varying engine speed with throttle.



If linkages are binding, notify direct support maintenance.

NOTE
All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.

3. ENGINE STARTS BUT RUNS UNEVENLY OR STALLS

Step 1. Check for low coolant temperature, below 160°F (71°C). If coolant temperature remains low during running, check the following.

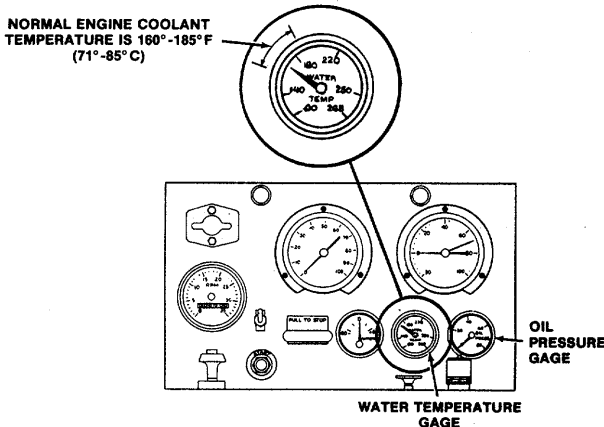


Table 4-2. Organizational Maintenance Troubleshooting - Continued

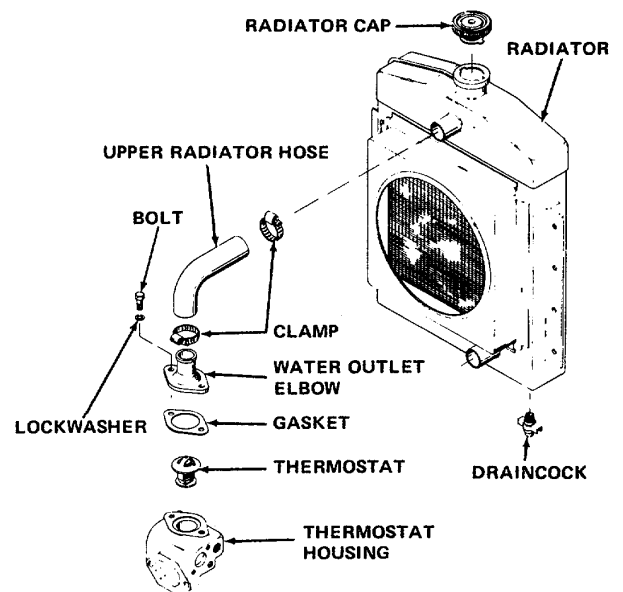
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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WARNING

Do not remove thermostat when engine is at operating temperature unless it is absolutely necessary. Hot coolant escaping from the cooling system can cause severe scalding. If thermostat must be removed, open the radiator cap part way and wait until escaping air stops. Then drain cooling system to a level below the thermostat.

a. Remove and test the thermostat. Remove radiator cap and open draincock at bottom right of radiator. Drain the cooling system to a level where the coolant is below the thermostat. Disconnect the radiator hose at water outlet elbow after loosening clamp. Remove bolts, lockwashers, water outlet elbow, gasket, and thermostat. Check the operation of the thermostat by immersing it in a container of hot water. Place a thermometer in the container, but do not allow it to touch the bottom. Agitate the water to maintain an even temperature throughout the container. As the water is heated, the thermostat should begin to open when the temperature reaches 167-172°F (75-78°C). The opening temperature is stamped on the thermostat. The thermostat should be fully open at approximately 190-192°F (88-89° C).

If thermostat is faulty, re- place it. Remove any old gasket from gasket surface of thermostat housing and the water outlet elbow. Install new gasket and position water outlet elbow. Install mounting bolts and lockwashers. Tighten bolts to 23-26 ft-lbs (31-35 N.m). Position upper radiator hose



4-41

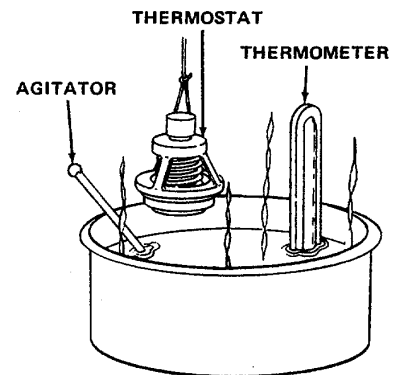


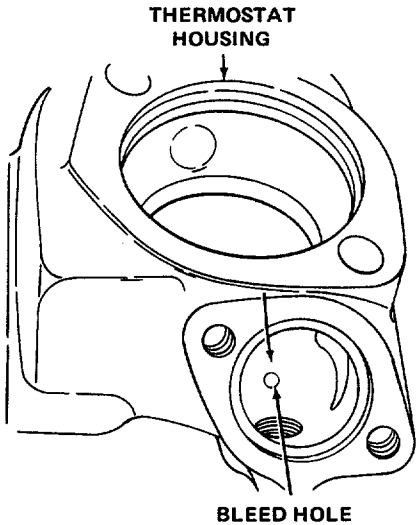
Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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on water outlet elbow and tighten hose clamp snugly. Pour collected coolant back into radiator and install radiator cap. Start engine and check for leaks. If leaks appear, tighten hose clamp on water outlet elbow.

- b. Check the bleed hole in the thermostat housing.

Clean bleed hole.



Step 2. Check for empty fuel tank.

If tank is empty, air must be bled from system after tank is filled.

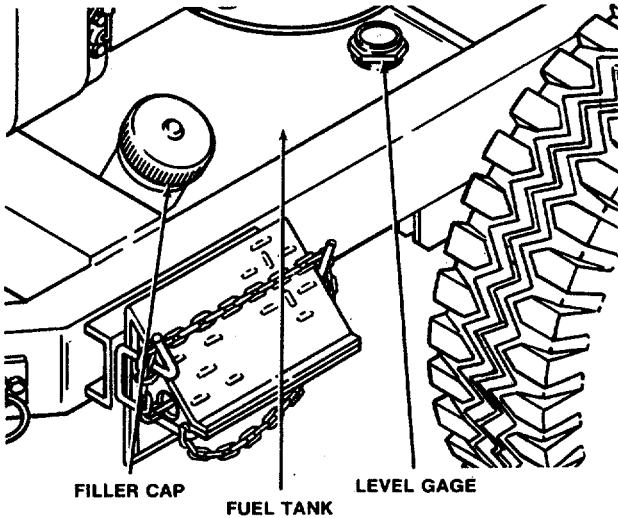


Table 4-2. Organizational Maintenance Troubleshooting - Continued

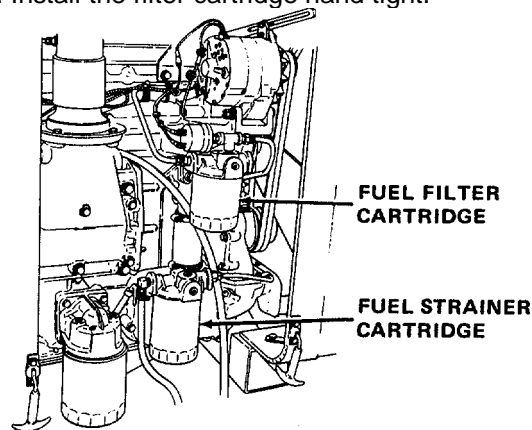
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- .. Do not inhale vapor.
- .. Do not refuel near open flame, sparks, or excessive heat.
- .. Be certain fuel lines and connections are secure.
- .. Do not overfill fuel tank.
- .. Work in a well-ventilated area.

- a. Fill the fuel tank with diesel fuel.
- b. Remove the fuel strainer cartridge by unscrewing counterclockwise. If necessary, replace defective cartridge. Fill the cartridge with diesel fuel. Install the strainer cartridge hand tight.
- c. Remove the fuel filter cartridge by unscrewing counterclockwise. If necessary, replace defective cartridge. Fill the cartridge with diesel fuel. Install the filter cartridge hand tight.



- d. Remove the mounting bolts that secure the valve cover. Remove the valve cover, and loosen a fuel pipe (inlet) nut.

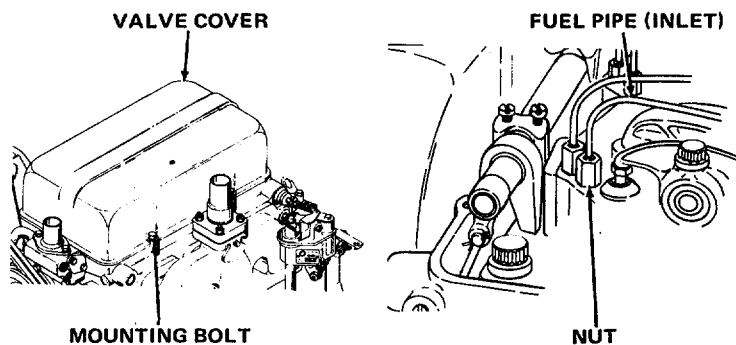


Table 4-2. Organizational Maintenance Troubleshooting - Continued

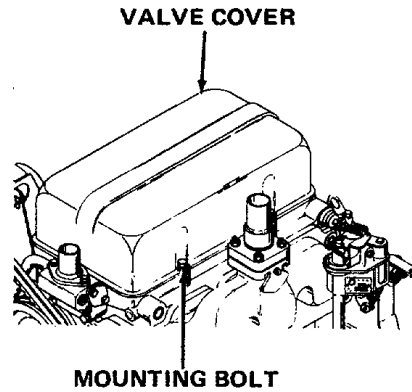
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- e. Start the engine. Check the fuel strainer and fuel filter for leaks.
- f. Retighten the fuel pipe (inlet) nut and replace the valve cover.
- g. Start engine. If engine continues to stall or run unevenly after several minutes, notify direct support maintenance.

Step 3. Check for faulty fuel injectors as described in paragraph 4-29. If injectors are faulty, report to direct support maintenance.

Step 4. Check for malfunctioning mechanical governor.

- a. Start engine and allow it to warm up.
- b. Remove mounting bolts that secure the valve cover; remove valve cover.



- c. Slowly adjust the throttle to increase the engine speed while inspecting governor and governor-to-injector control tube linkages for any binding or toughness of operation. The governor should prevent the engine from speeding beyond 2200 rpm while the engine is under load. If the governor linkages bind or operate roughly, or if the governor does not prevent the engine from speeding over 2200 rpm (approximately), notify direct support maintenance.

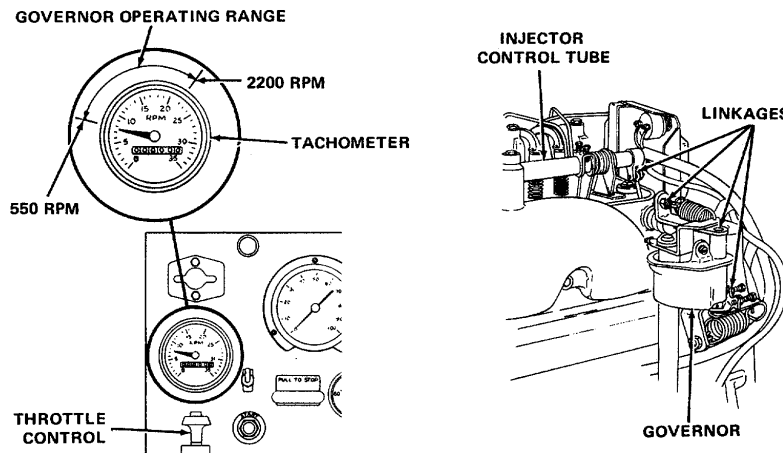


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- d. If the governor functions properly in step c, proceed to step e.
- e. Slowly adjust the throttle to decrease the engine speed while inspecting the governor linkages for binding or rough operation. The governor should prevent the engine from reducing speed below 550 rpm while the engine is under load.

If the governor linkages bind, operate roughly, or the governor does not prevent the engine speed from dropping below 550 rpm (approximately), notify direct support maintenance.

NOTE
All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.

4. ENGINE LACKS POWER

Step 1. Check for damaged fuel lines.

Replace damaged lines as described in paragraph 4-27.

Step 2. Check for high coolant temperature, above 192°F (89°C). If coolant temperature remains high during running, check the following.

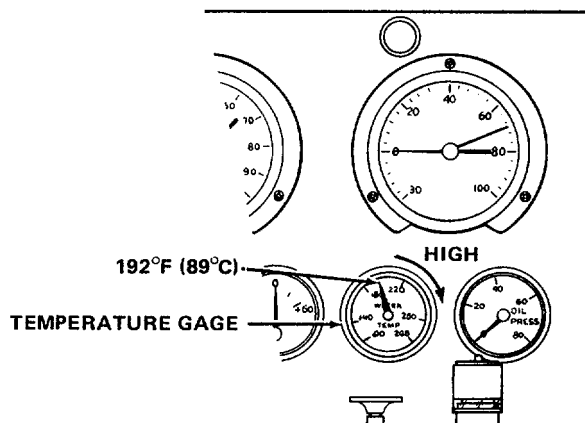


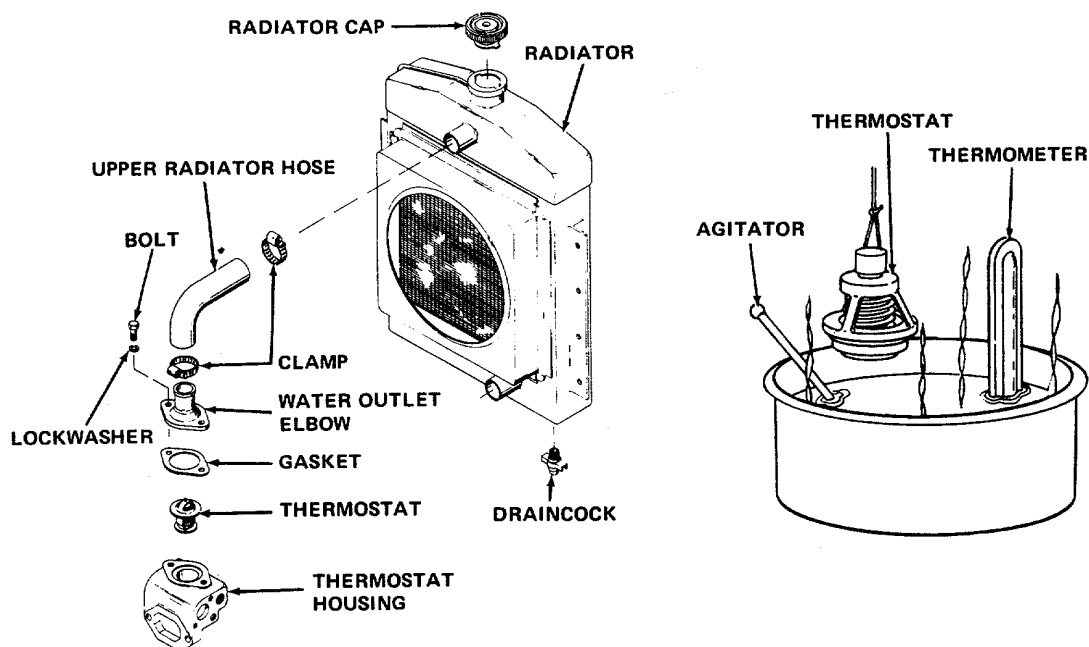
Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.

- Remove and test the thermostat. Remove radiator cap and open draincock at bottom right of radiator. Drain the cooling system to a level where the coolant is below the thermostat. Disconnect the radiator hose at water outlet elbow after loosening clamp. Remove bolts, lockwashers, water outlet elbow, gasket, and thermostat. Check the operation of the thermostat by immersing it in a container of hot water. Place a thermometer in the container, but do not allow it to touch the bottom. Agitate the water to maintain an even temperature throughout the container. As the water is heated, the thermostat should begin to open when the temperature reaches 167-172°F (75-78°C). The opening temperature is stamped on the thermostat.-The thermostat should be fully open at approximately 190-192°F (88-89°C).



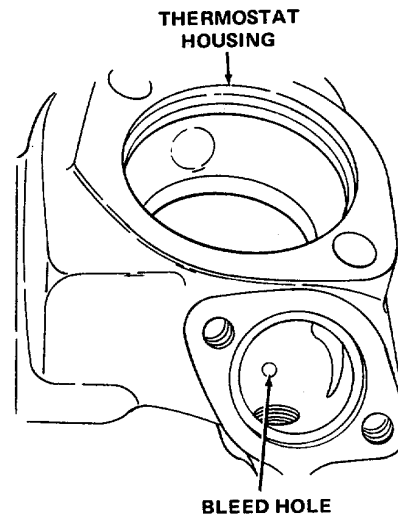
If thermostat is faulty, replace it. Remove any old gasket from gasket surface of thermostat housing and the water outlet elbow. Install new gasket and position water outlet elbow. Install mounting bolts and lockwashers. Tighten bolts to 23-26 ft-lbs (31-35 N•m). Position upper radiator hose on water outlet elbow and tighten hose clamp snugly. Pour collected coolant back into radiator and install radiator cap. Start engine and check for leaks. If leaks appear, tighten hose clamp on water outlet elbow.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

b. Check the bleed hole in the thermostat housing.

Clean bleed hole.



NOTE
 All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.

5. ENGINE STOPS RUNNING

Step 1. Check for empty fuel tank.

If tank is empty, air must be bled from system after tank is filled.

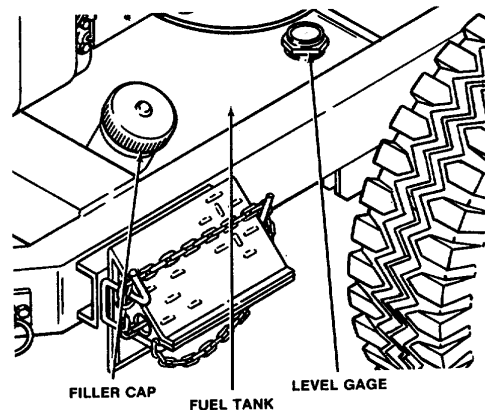


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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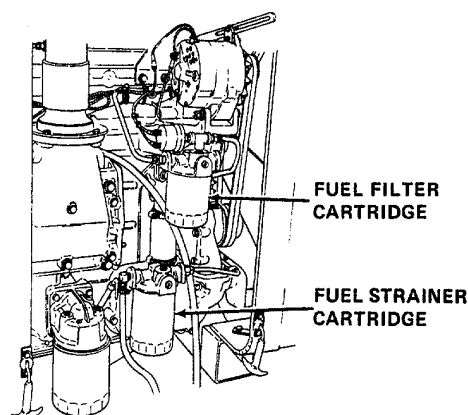
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly.

Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

- a. Fill the fuel tank with diesel fuel.
- b. Remove the fuel strainer cartridge by unscrewing counterclockwise. If necessary, replace defective cartridge. Fill the cartridge with diesel fuel. Install the strainer cartridge hand tight.
- c. Remove the fuel filter cartridge by unscrewing counterclockwise. If necessary, replace defective cartridge. Fill the cartridge with diesel fuel. Install the filter cartridge hand tight.



- d. Remove the mounting bolts that secure the valve cover. Remove the valve cover, and loosen a fuel pipe (inlet) nut.

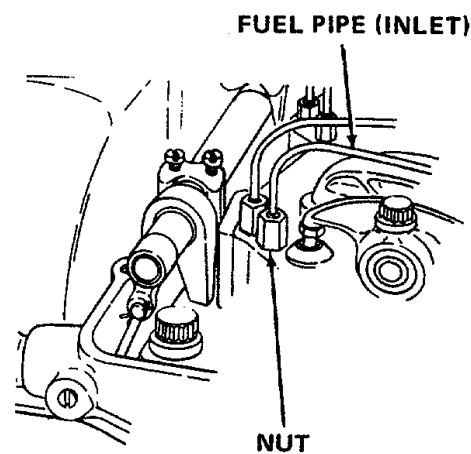
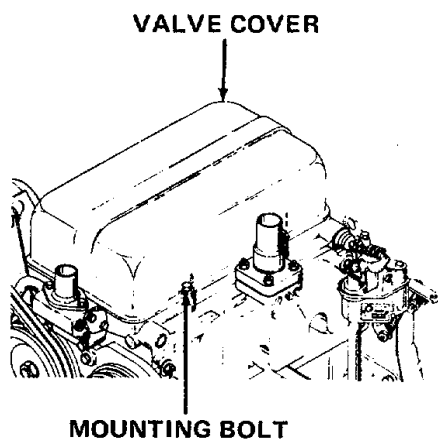


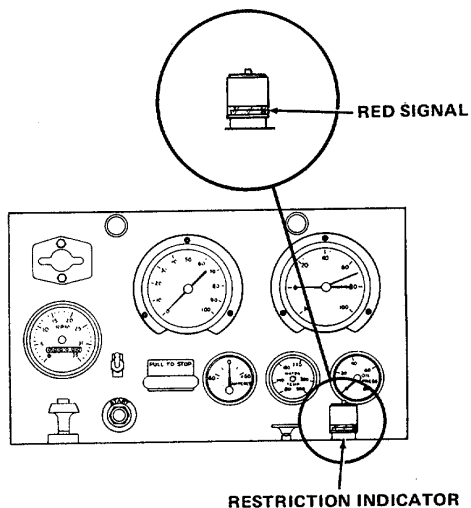
Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- e. Start the engine. Check the fuel strainer and fuel filter for leaks.
- f. Retighten the fuel pipe (inlet) nut and replace the valve cover.
- g. Start engine. If engine continues to stall or run unevenly after several minutes, notify direct support maintenance.

Step 2. Check for clogged air filter.

Inspect restriction indicator.
If indicator shows red with engine shut off, check air filter element for blockage.



- a. Remove air filter element by loosening clamp assembly and sliding cup assembly off air cleaner body assembly. Remove baffle assembly and slide out filter element.

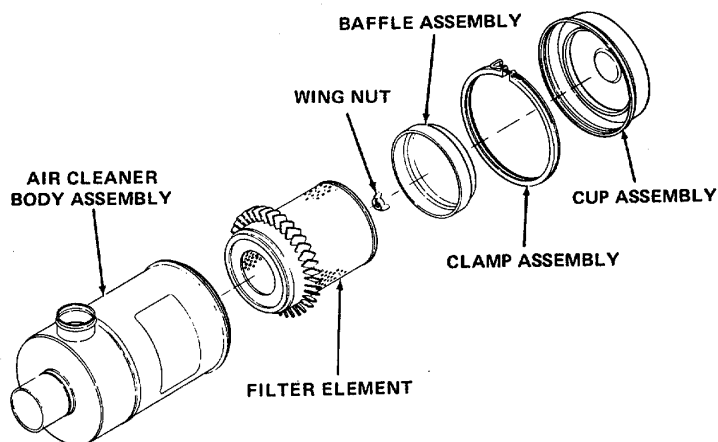


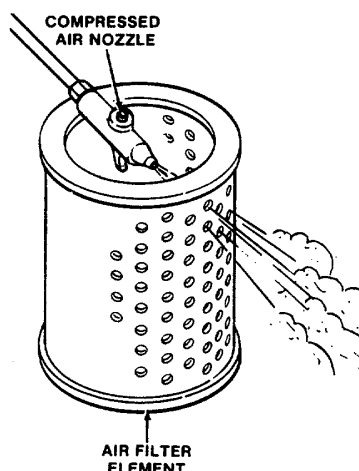
Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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WARNING

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- b. If a regulated compressed air supply is available, direct a stream of compressed air (100 psi (690 kPa) maximum) through the element from the inside.



- c. Reinstall the clean filter element and the baffle and cup assembly. Reinstall and securely tighten the clamp assembly wing nut.
- d. Reset the restriction indicator by pushing down the button on top of indicator, then start the engine. If the restriction indicator again shows red, replace the filter element. Step 3. Check for high coolant temperature, above 192°F (89°C). If coolant temperature remains high during running, check the following.

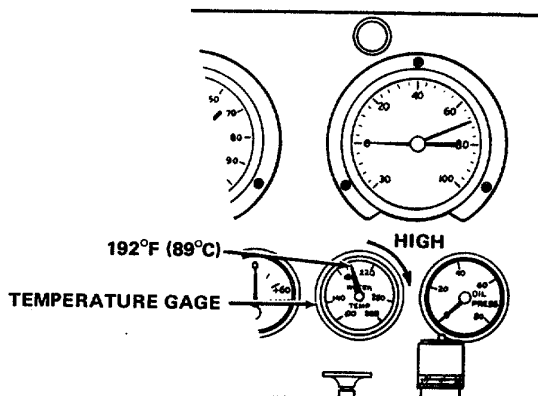
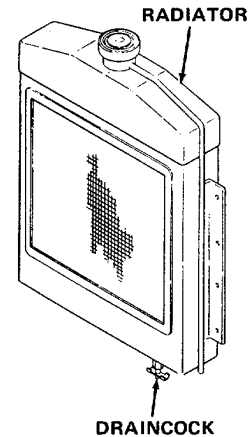


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- a. Inspect the radiator for leaks and tighten draincock if necessary. Notify direct support maintenance if radiator is leaking.



WARNING

Do not remove thermostat when engine is at operating temperature unless it is absolutely necessary. Hot coolant escaping from the cooling system can cause severe scalding. If thermostat must be removed, open the radiator cap part way and wait until any escaping air stops. Then drain cooling system to a level below the thermostat .

- b. Remove and test the thermostat. Remove radiator cap and open draincock at bottom right of radiator. Drain the cooling system to a level where the coolant is below the thermostat. Disconnect the radiator hose at water outlet elbow after loosening clamp. Remove bolts, lockwashers, water outlet elbow, gasket, and thermostat. Check the operation of the thermostat by immersing it in a container of hot water. Place a thermometer in the container, but do not

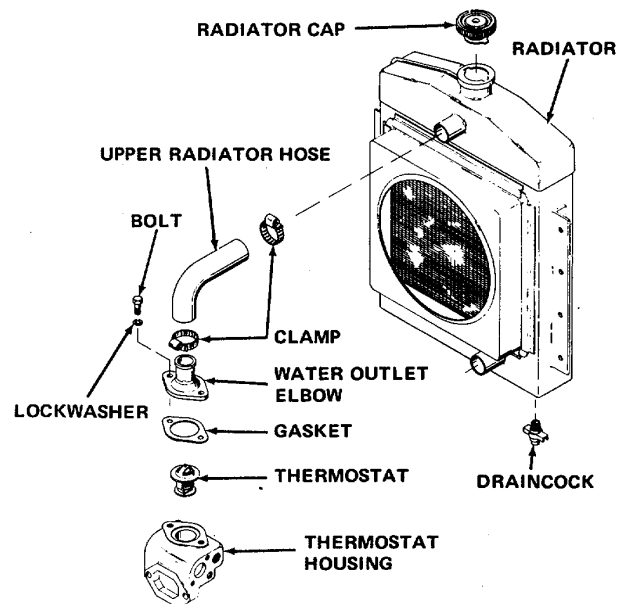
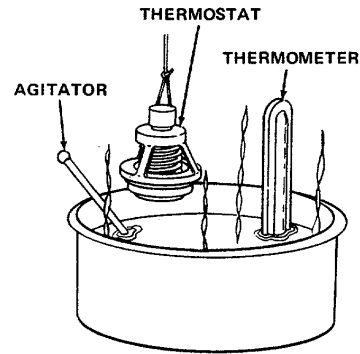


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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allow it to touch the bottom. Agitate the water to maintain an even temperature throughout the container. As the water is heated, the thermostat should begin to open when the temperature reaches 167-172°F (75-78°C). The opening temperature is stamped on the thermostat. The thermostat should be fully open at approximately 190-192° F (88-89° C).



If thermostat is faulty, replace it. Remove any old gasket material from gasket surface of thermostat housing and the water outlet elbow. Install new gasket and position water outlet elbow. Install mounting bolts and lockwashers. Tighten bolts 23-26 ft-lbs (31-35 N•m). Position upper radiator hose on water outlet elbow and tighten hose clamp snugly. Pour collected coolant back into radiator and install radiator cap. Start engine and check for leaks. If leaks appear, tighten hose clamp on water outlet elbow.

c. Check the bleed hole in the thermostat housing.

Clean bleed hole.

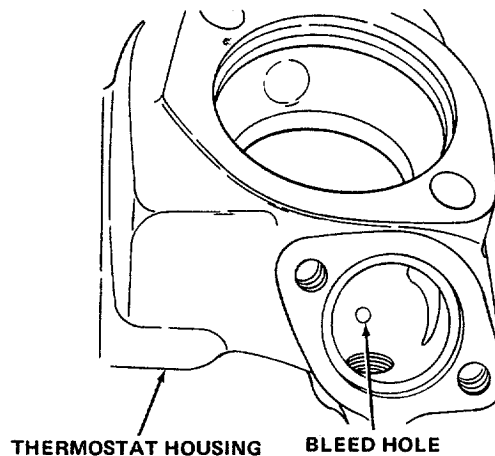


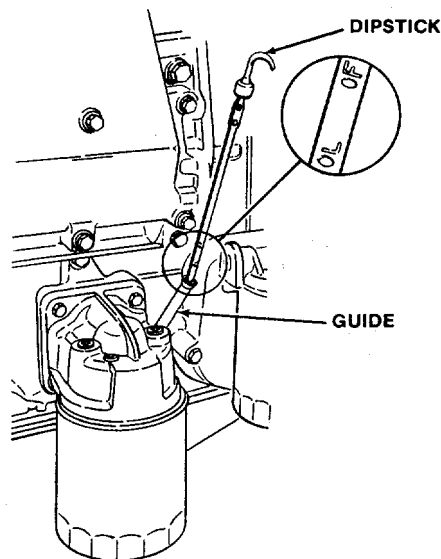
Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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<p>NOTE All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.</p>

6. ENGINE CONSUMES EXCESSIVE LUBRICATING OIL OR PRODUCES BLACK OR GREY SMOKE

Step 1. Check for excessive oil in crankcase. Check lubricating oil level with the engine stopped. If engine has just been stopped, wait approximately 20 minutes to allow oil to drain back to the oil pan. Engine must be level to check the oil.



If oil level is above F on dipstick, remove oil pan drain plug and drain oil into metal container. Replace drain plug.

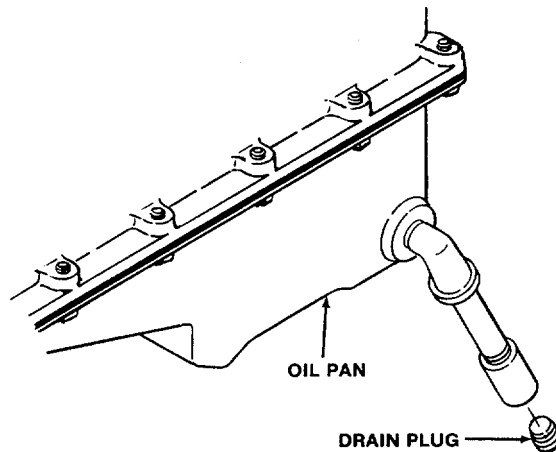
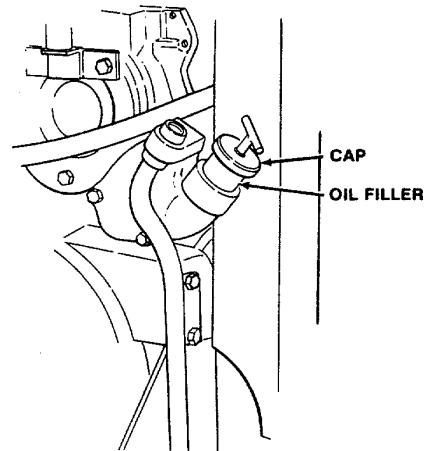


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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If oil is to be reused, remove oil filler cap and pour approximately 50%, or less, of the collected oil into the oil filler. Wait several minutes and check oil level.

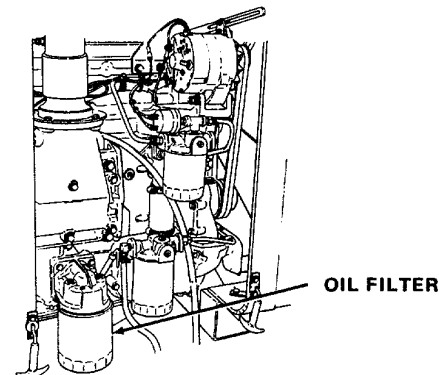
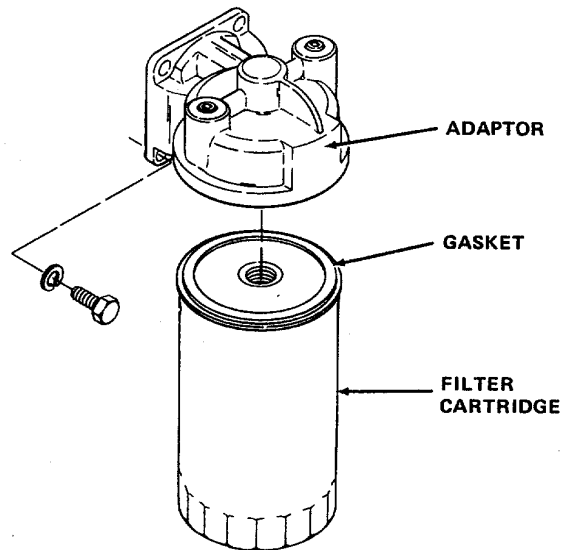
Pour enough of the remaining oil into the oil filler to bring the crankcase oil level to F on the dipstick.



CAUTION

Do not overfill. Oil may be blown out through the crankcase breather if crankcase is overfilled.

If crankcase is to be refilled with fresh oil, discard old oil. Remove and discard filter cartridge. Inspect filter adaptor on the engine for nicks, burrs, or other damage. Before installing new filter cartridge, coat filter gasket with oil and wipe off filter adaptor before screwing the filter cartridge on hand tight. Run engine for a few minutes and check for filter leaks. Retighten if necessary.

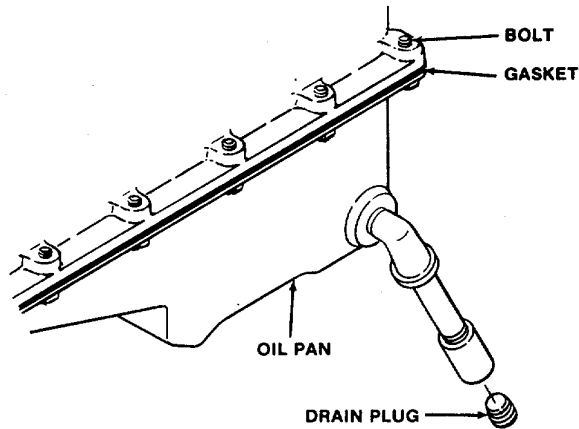


Fill crankcase through oil filter with oil to F on dipstick.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

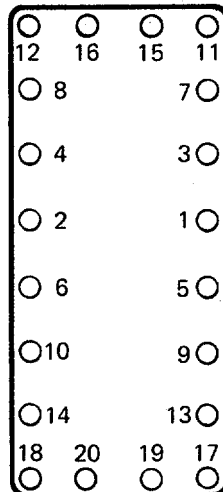
MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

Step 2. Check for leaking oil pan drain plug or oil pan gasket.



If drain plug is leaking, tighten plug. If leakage continues, replace plug.

If oil pan gasket is leaking, tighten bolts to 10-20 ft lb (14-27 N•m) torque, in the sequence shown.



If leakage continues, notify direct support maintenance.

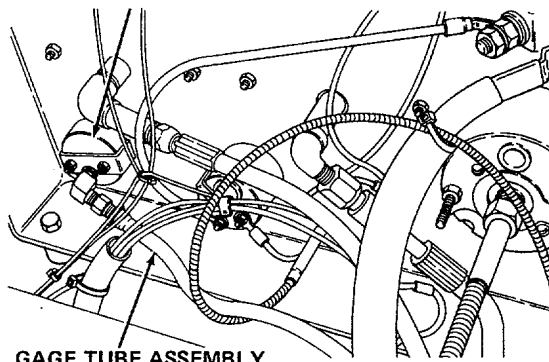
Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 3. Check for leaking exterior oil line, fittings, oil filter, or oil pressure gage tube assembly.

- a. If oil line or gage tube assembly is damaged or leaking, replace line or tube assembly as described in paragraph 4-35.

OIL PRESSURE GAGE (REAR)



- b. If oil line or oil filter is leaking at connection point, try tightening oil line fitting slightly, and oil filter hand tight.

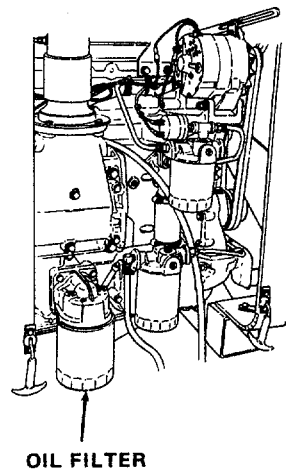
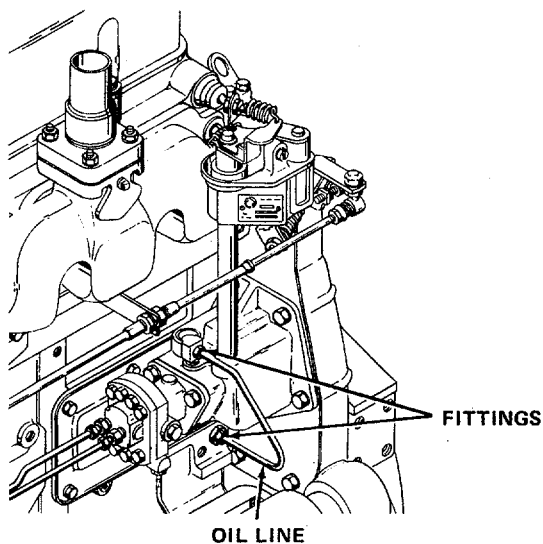
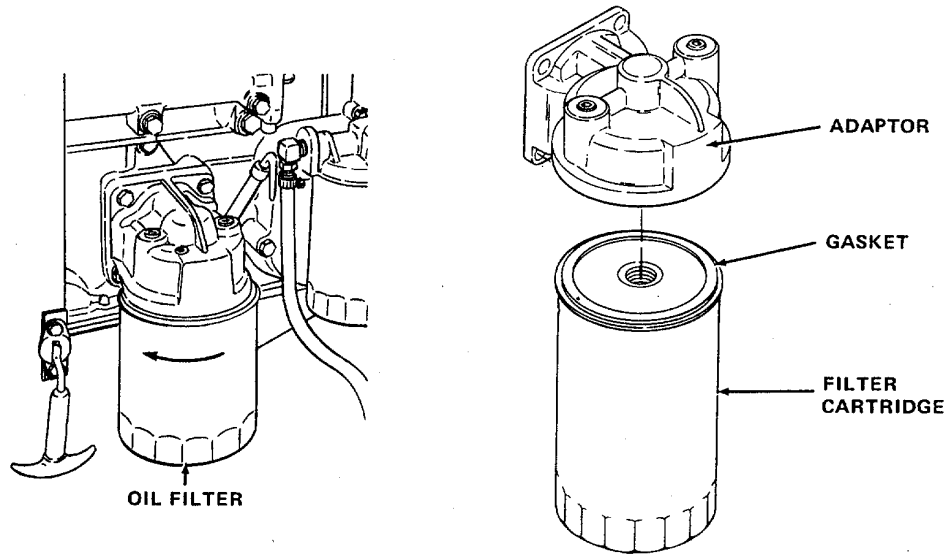


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- c. If oil line or filter continues to leak after tightening, replace oil line and fittings as described in paragraph 4-35, or replace the oil filter. Unscrew oil filter cartridge counterclockwise; remove and discard. Coat the filter gasket with clean lubricating oil and wipe off the filter adaptor before screwing on the replacement cartridge. Tighten hand tight.



Step 4. Check for blocked breather element.

CAUTION

Remove breather pipe assembly from engine slowly and ca

- a. Remove breather assembly bolts and lockwashers, then remove breather from engine. Remove element from breather.

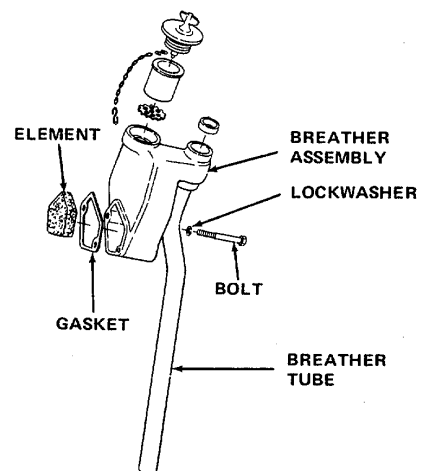


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly.

Observe the following precautions:

- Do not inhale vapor.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Do not direct compressed air against skin.

- b. Inspect breather tube for blockage and clean with diesel fuel. Dry with compressed air.
- c. Wash element in diesel fuel and dry with compressed air. If cleaning does not remove clogged or caked material from element, discard it and install a new element in breather assembly.

NOTE

If gasket was destroyed during removal of the breather assembly from the engine, a new gasket should be installed after the gasket surfaces on the breather and engine have been cleaned.

- d. Insert bolts and lockwashers in breather, position gasket, and install breather assembly on engine. Tighten bolts securely.

Step 5. Check for obstructed muffler exhaust pipe.

WARNING

Handling hot exhaust shield, exhaust pipe, muffler, and weather cap can cause severe burns. Allow unit to cool before handling.

Open weather cap and remove obstruction from exhaust pipe.

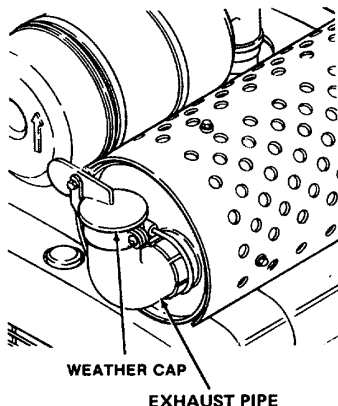


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

If obstruction cannot be removed, or if muffler is damaged when obstruction is removed, replace muffler as described in paragraph 4-17.

NOTE
All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.

7. LOW OIL PRESSURE

Step 1. Check for lubricating oil level. Check oil level with the engine stopped. If engine has just been stopped, wait approximately 20 minutes to allow oil to drain back to the oil pan. Engine must be level to check the oil.

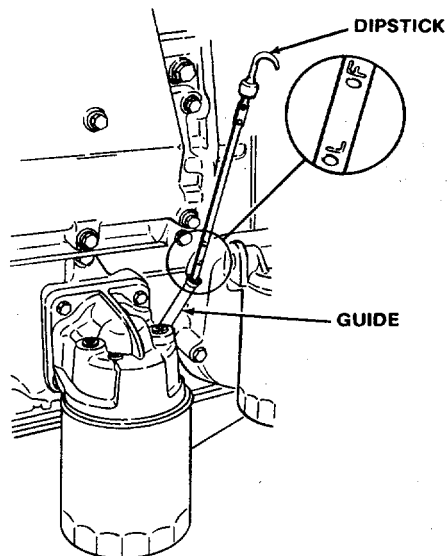


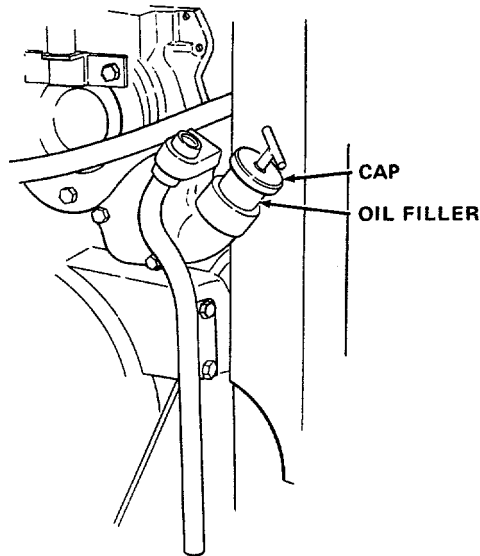
Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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CAUTION

Do not overfill. Oil may be blown out through the crankcase breather if crankcase is overfilled.

If oil level is below F on dipstick, remove oil filler cap and add enough oil to bring crankcase oil level to F on the dipstick. Replace oil filler cap.



Step 2. Check for wrong grade of lubricating oil.

See LO 5-4320-300-12, figure 4-1. If oil is wrong grade, remove oil pan drain plug and drain oil into metal container. Replace drain plug. Wipe off plug and oil pan with a rag. Unscrew oil filter cartridge counterclockwise; remove and discard. Inspect filter adaptor on the engine for nicks, burrs, or other damage.

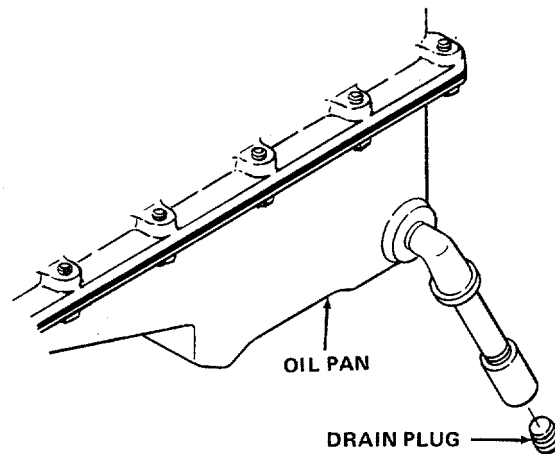
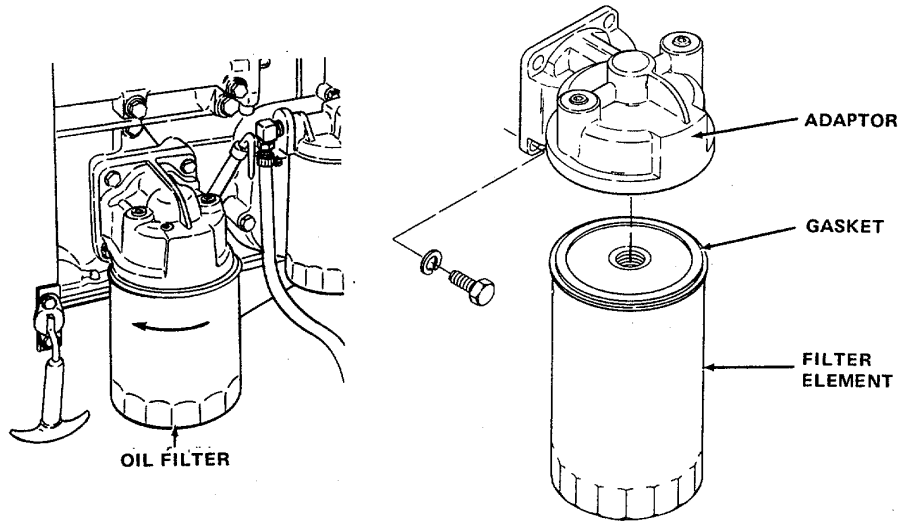


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Coat the filter gasket with clean lubricating oil and wipe off the filter adaptor before screwing on the replacement cartridge. Tighten hand tight. Refill crankcase with correct grade of oil. Capacity is 10-1/2 quarts (9.94 liters), 12-1/2 quarts (11.83 liters) with filter. Run engine for a few minutes and check for filter leaks. Retighten if necessary.



Step 3. Check for obstructed oil pressure gage tube assembly or fittings.

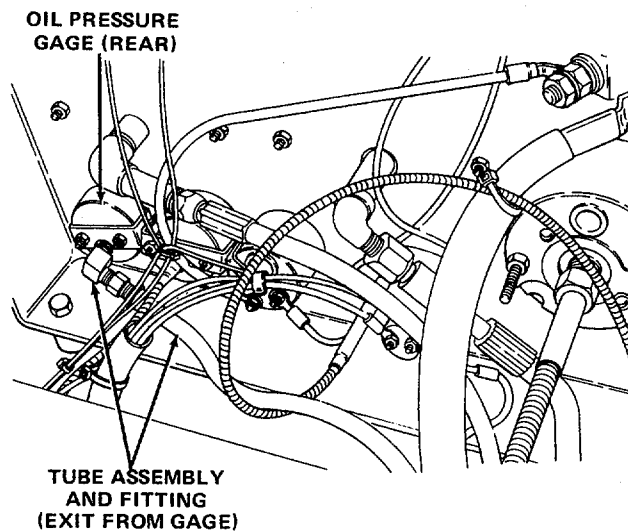
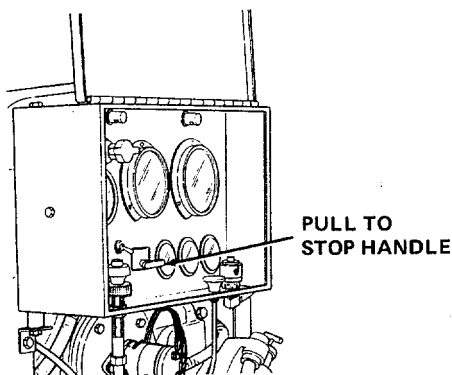


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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If engine is running, shut it down. Leave the PULL TO STOP handle pulled out.



Disconnect tube assembly and fitting at exit from gage.

CAUTION

Do not crank engine more than 30 seconds at a time. Always allow one-minute intervals between cranking attempts to allow the starter motor to cool.

Hold end of tube over a small metal container and crank the engine. Oil should flow from tube within 5 seconds.

If no oil flows from tube within 5 seconds, disconnect tube assembly at entrance to oil gallery. Remove tube assembly and fittings from engine and remove any obstructions. If tube or fittings cannot be cleared of blockage, replace tube assembly or fittings as described in paragraph 4-35.

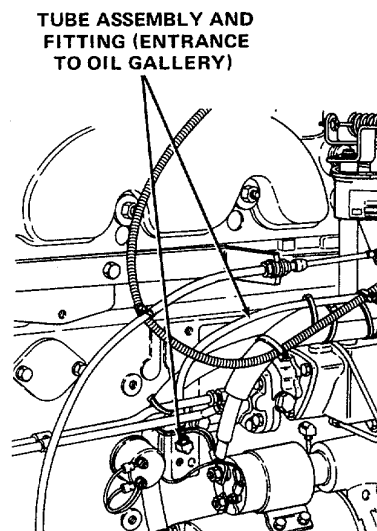


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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If oil flows from tube assembly, replace gage as described in paragraph 4-41.

<p>NOTE All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.</p>
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8. ENGINE COOLANT TEMPERATURE IS EXCESSIVELY HIGH OR LOW

Step 1. Check for low coolant level.

WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.

Remove radiator cap. Coolant level should be about 3 inches (7.62 cm) below filler neck.

If coolant level is below operating level, refill radiator with MIL-A-46153 coolant. Restart engine. After engine is warm, check oil pressure and water temperature. Oil pressure should be 18 psi (124 kPa) at 1200 rpm. Water temperature should be between 160-185°F (71-85°C).

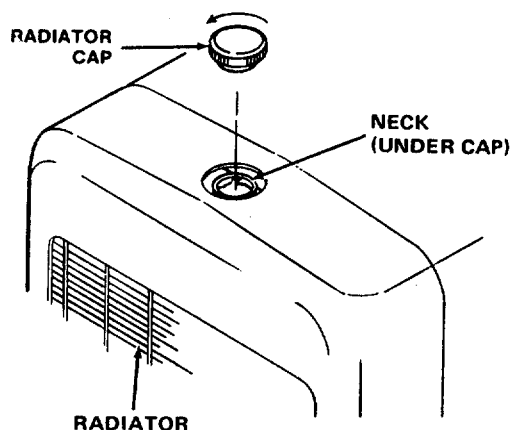


Table 4-2. Organizational Maintenance Troubleshooting - Continued

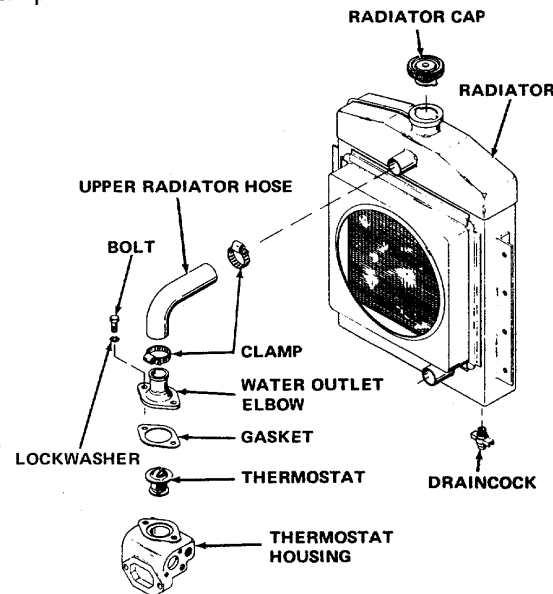
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 2. Check for malfunctioning thermostat.

WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.

Remove radiator cap and open draincock at bottom of radiator. Drain cooling system to a level where coolant is below the thermostat. Disconnect radiator hose at water outlet elbow after loosening clamp.



CAUTION

Remove water outlet elbow slowly to avoid damaging gasket.

Remove bolts, lockwashers, water outlet elbow, gasket, and thermostat. Check operation of the thermostat by immersing it in a container of hot water. Place a thermometer in the container, but do not allow it to touch the bottom. Agitate the water to maintain an even temperature throughout the container. As water is heated, the thermostat should begin to open when temperature reaches 167-172°F (75-78°C). The opening temperature is stamped on the thermostat. Thermostat should be fully open at approximately 190-192°F (88-89°C).

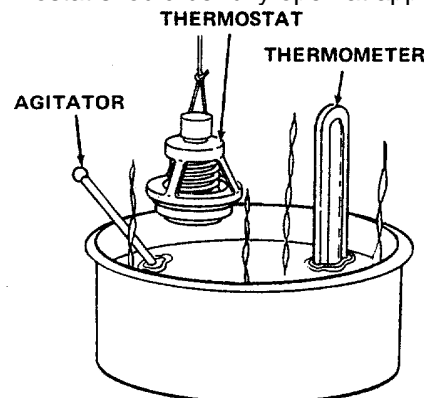
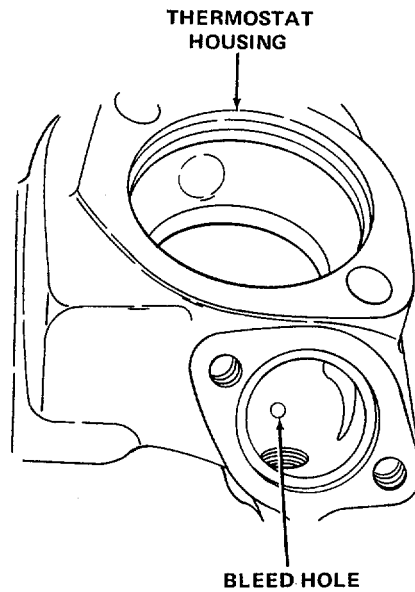


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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If thermostat is faulty, replace it. Remove any old gasket from gasket surface of thermostat housing and water outlet elbow. Install new gasket and position water outlet elbow. Install mounting bolts and lockwashers. Tighten bolts 23-26 ft lbs (31-35 N•m). Position upper radiator hose on water outlet elbow and tighten hose clamp snugly. Check and clean bleed hole in thermostat housing. Pour collected coolant back into radiator and install radiator cap. Start engine and check for leaks. If leaks appear, tighten hose clamp on water outlet elbow.



Step 3. Check fan belt tension. Belt tension is correct when belts can be deflected with forefinger pressure 1/2-3/4 inch (12.7-19.0 mm) at the midpoint between pulleys.

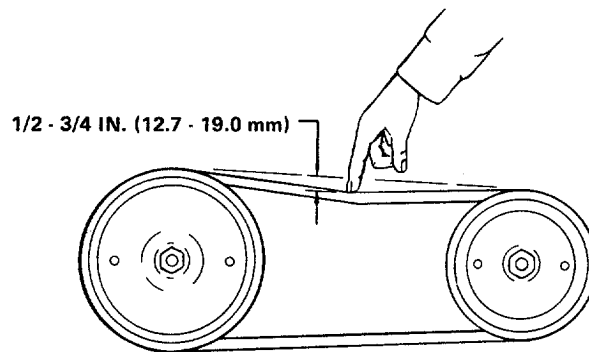
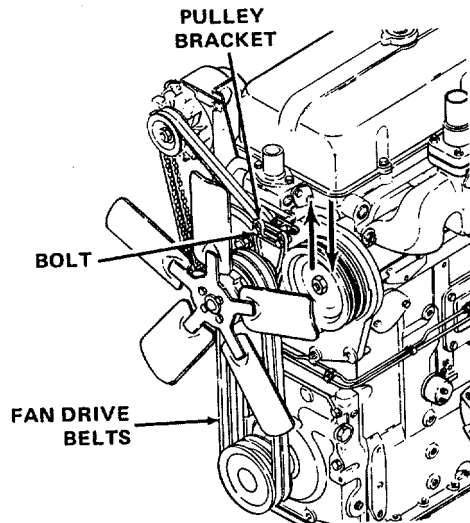


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Adjust fan drive belts by loosening four bolts on the pulley bracket. Slide pulley bracket up to tighten drive belts. Tighten the four bolts after adjusting drive belts. If fan drive belts are frayed or worn, replace as a matched set as described in paragraph 4-23.



Step 4. Check for scale deposits in cooling system.

WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.

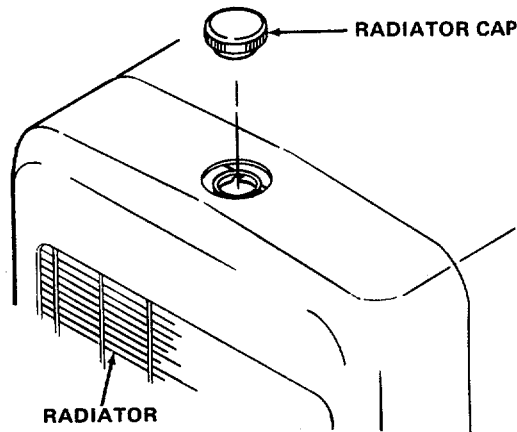
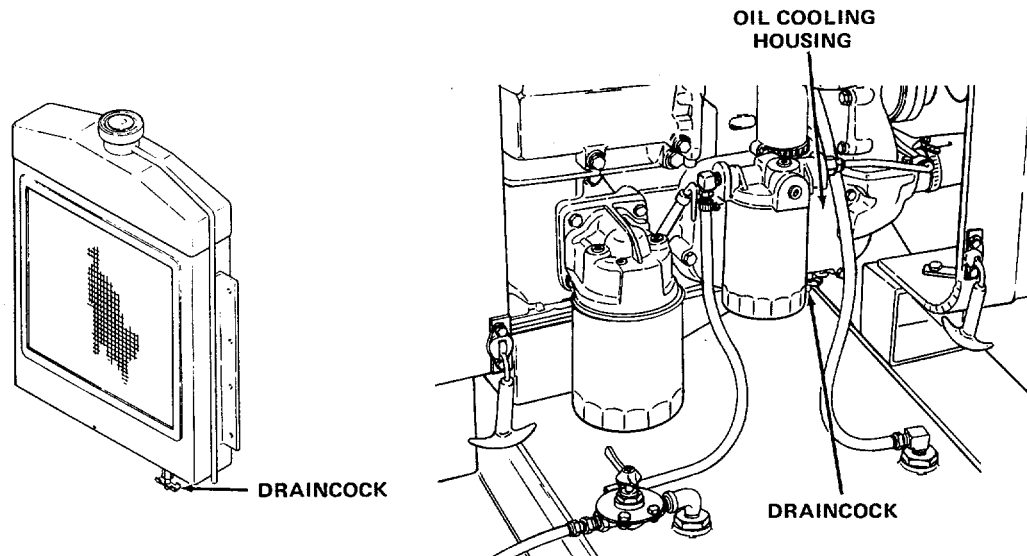


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- a. Remove radiator cap and cylinder block drain plug, and loosen oil cooler housing and radiator draincocks. Drain coolant into a large metal container.



- b. Install cylinder block drain plug and tighten radiator and oil cooler housing draincocks.

CAUTION

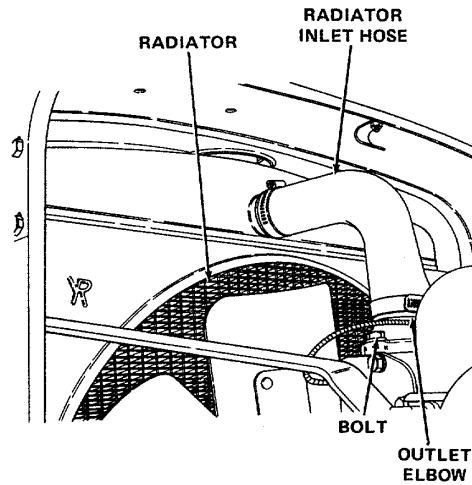
If the engine is hot, fill SLOWLY to prevent rapid cooling and distortion of engine castings.

- c. Refill cooling system with clean, soft water. Start engine and operate it for 15 minutes to thoroughly circulate the water. Drain solution completely.
- d. Refill with descaling solution and perform the descaling procedure.
- e. Reverse-flush the cooling system as follows:
- (1) Remove water pump as described in paragraph 4-37.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- (2) Remove radiator inlet and outlet hoses and replace radiator cap.



- (3) Attach a hose at top of radiator to lead water away from engine. Attach a hose to bottom of radiator and insert a flushing gun in hose.

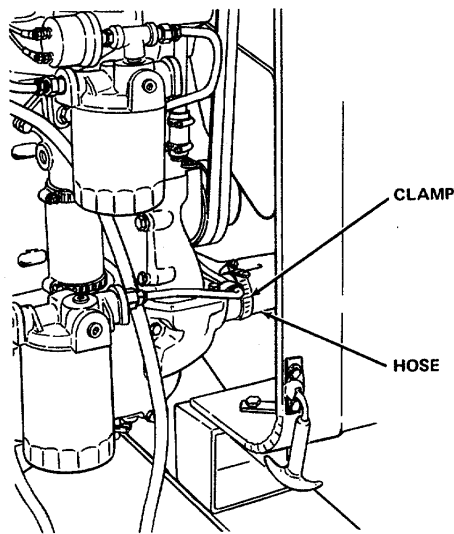


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- Connect the water hose of the gun to water outlet and the air hose to compressed air outlet.

CAUTION

Apply air gradually. Do not exert more than 30psi (207 kPa) air pressure. Too great a pressure may rupture a radiator tube.

- Turn on water and, when radiator is full, turn on the air in short blasts, allowing radiator to fill between air blasts. Continue flushing until only clean water is expelled from the radiator.
- Remove the thermostat after removing the bolts that secure outlet elbow to thermostat housing.

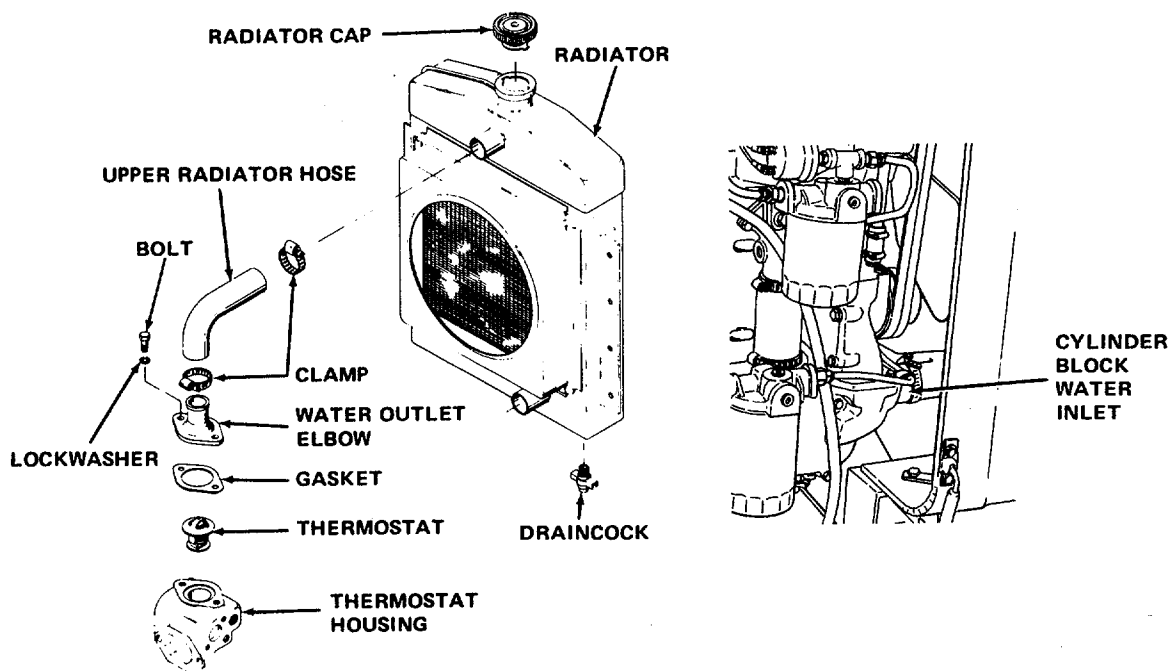


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
		(7) Attach a hose to water inlet of cylinder block to drain water away from engine. Attach a hose to water outlet at top of cylinder block and insert flushing gun in the hose.
		CAUTION
		Apply air gradually. Do not exert more than 30 psi (207 kPa) air pressure. Too great a pressure may rupture a radiator tube.
		(8) Turn on the water and, when water jackets are filled, turn on the air in short blasts, allowing engine to fill with water between air blasts. Continue flushing until water from engine runs clean.
		(9) Install engine block drain plugs, and thermostat and outlet elbow. Tighten oil cooler and radiator draincocks. Refill cooling system with a fresh solution of 50% water and 50% MIL-A-46153 antifreeze.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

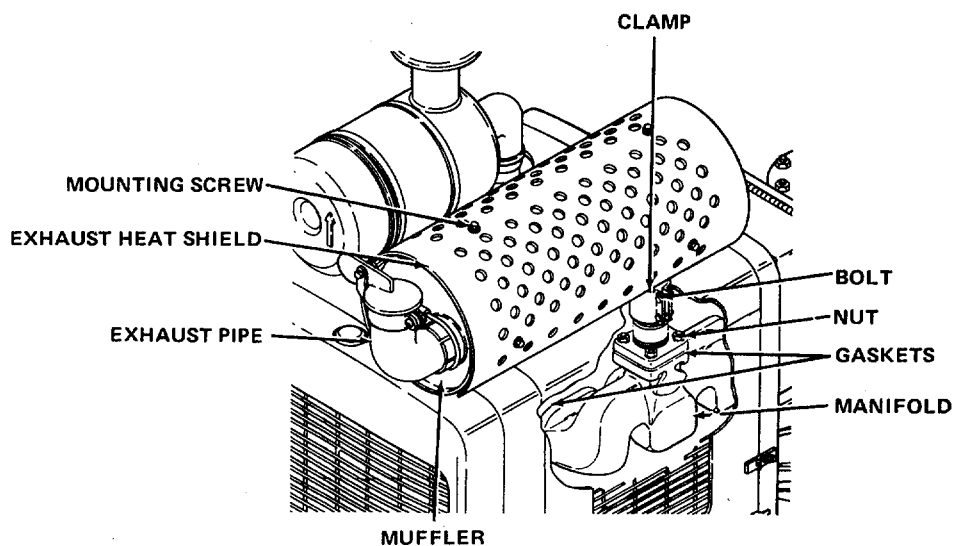
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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9. UNUSUAL EXHAUST NOISE

WARNING

Handling hot exhaust shield, exhaust pipe, muffler, and weather cap can cause severe burns. Permit unit to cool before handling.

Step 1. Check exhaust system for loose or damaged parts.



- a. Remove exhaust heat shield mounting screws and exhaust heat shield.
- b. Inspect muffler for holes or other damage.

If muffler has holes or is damaged seriously in other ways, replace as described in paragraph 4-17.

- c. Inspect manifold, clamp, and exhaust manifold pipe for cracks, breaks, or other damage.

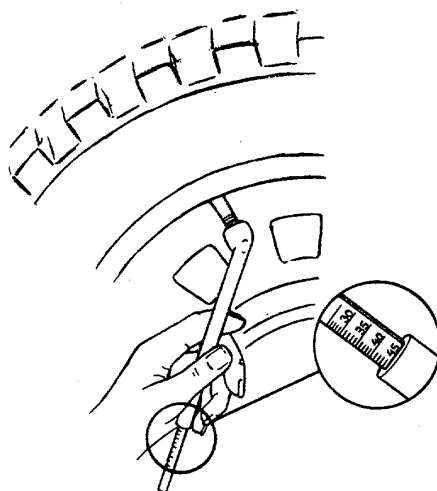
If clamp or exhaust manifold pipe is damaged, replace as described in paragraph 4-18.
If manifold is damaged, notify direct support maintenance.

- d. Inspect exhaust system connections and mounting nuts and bolts for tightness. Make sure that gasket material is in place.

Tighten any loose nuts and bolts.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
10. PUMP MAKES EXCESSIVE NOISE		Step 1. Notify direct support maintenance.
11. TRAILER-MOUNTED PUMP IS HARD TO TOW		Step 1. Check for under-inflated tires. a. Inflate tires if pressure is low. b. If one or both tires are flat, carefully jack up trailer, then replace tire or tires as described in paragraph 4-44.

**WARNING**

Lower and pin the rear stands before disconnecting centrifugal pump unit from towing vehicle. Unit could drop on rear bumper and cause personal injury.

Use jack stands to support trailer after jack has raised trailer to working height. Unit could drop from jack and cause personal injury.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

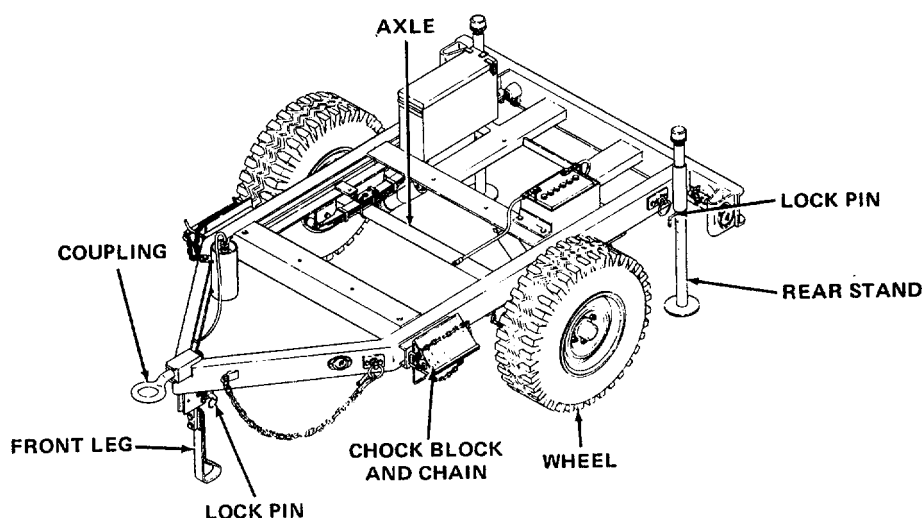
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

CAUTION

Remove and insert pin from rear stand assemblies with the handle end of the pin facing upward. The pin locking mechanism will stick within the rear stand if pin is inserted and removed any other way.

Step 2. Check for binding wheels. On flat ground, carefully jack up the trailer as follows:

- a. Lower and pin rear stands and uncouple unit from towing vehicle. Lower front leg and insert lock pin.



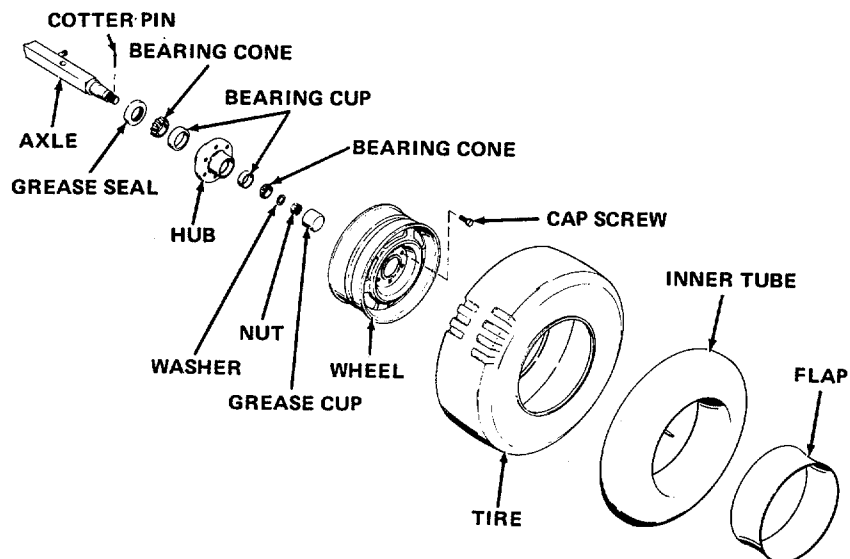
- b. Position jack under frame assembly between wheel to be raised and wheel chock. Raise wheel off ground and lower rear stand on same side and/or put block of wood under front leg. Install lock pin (jack may have to be raised slightly to allow stand to be pinned). Both front leg and rear stand should make solid contact with wood block or ground.
- c. Position a jack stand under axle near raised wheel. Leave jack, front leg, and rear stand positioned to supply support during work. Hand-spin the wheel. If wheel binds or makes unusual noises, tap off the grease cup and check whether grease is present.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

TEST OR INSPECTION
CORRECTIVE ACTION

If no grease is present, replace the grease seals, bearing cones, cups, hubs, and axle, if necessary, as described in paragraph 4-44.



- d. If grease is present, check for excessive bearing preload. Back off axle nut about 1/4 turn. Move the wheel several times.

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100-138°F (38-59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

If the wheel loosens up and spins freely, remove wheel and hub, any old grease, and bearing cones and cups. Clean bearing cones and cups by placing them in a wire basket and agitating them in a container of P-D-680 dry cleaning solvent. Pack bearings about 1/3 full of MIL-G-10924 grease, and install them in the hubs. Take care to avoid damaging lips of grease seal when installing hub on axle.

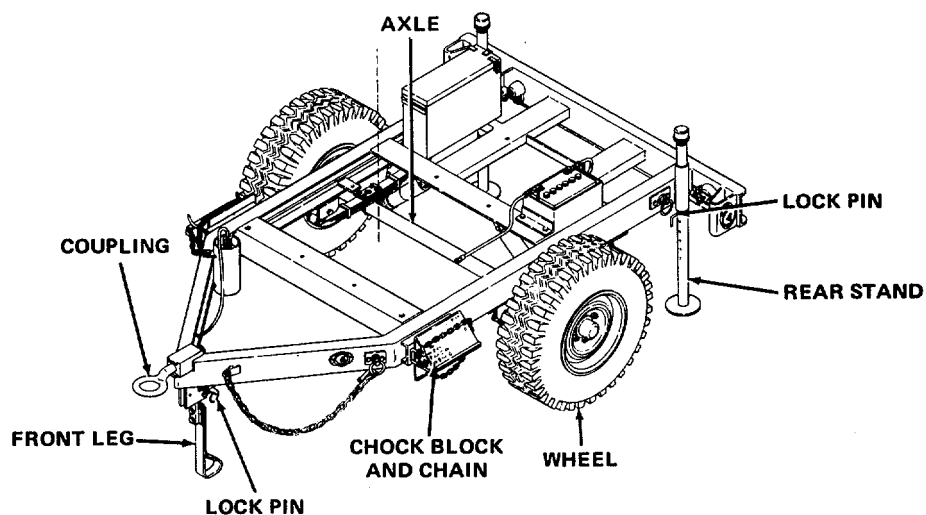
Install axle nut and washer, and tighten nut slightly to seat the bearing. Back off axle nut and retighten it hand tight.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

Mount wheel on hub, and tighten cap screws hand tight if hub was replaced. Spin the wheel and hand adjust axle nut until wheel spins freely but without looseness on the shaft. Install cotter pin and bend it over to lock nut into position. Drive the grease hub onto the hub.

Carefully lower the trailer according to the following procedures.



- (1) Remove jack stand from under the axle.

CAUTION

Remove and insert pin from rear stand assemblies with the handle end of the pin facing upward. The pin locking mechanism will stick within the rear stand if pin is inserted and removed any other way.

- (2) Remove lock pin from rear stand on jacked up side of trailer (jack may have to be raised slightly to allow pin to be removed).
- (3) Lower jack until tire makes firm contact with ground. Tighten cap screws securely if hub was replaced.
- (4) Install lock pin in rear stand and remove wood block.
- (5) Attach coupling to towing vehicle and put front leg and rear stands in storage position.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

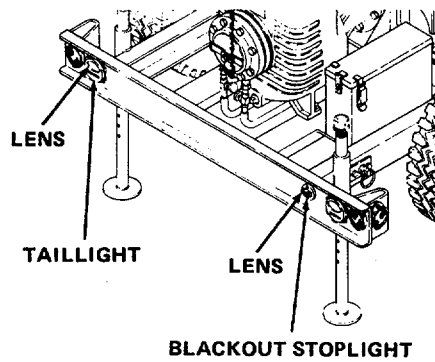
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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12. LIGHTS DO NOT WORK

Step 1. Check taillight and blackout stoplight bulbs.

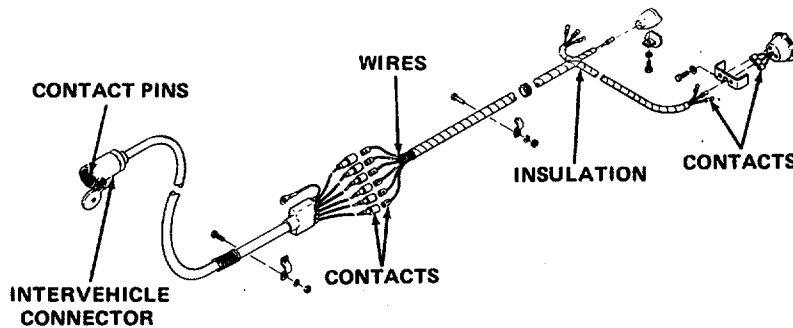
a. Disconnect intervehicle connector and place in holder.

b. Remove lens by removing mounting screws. Remove bulb and check for broken filament. Replace defective bulb.



Step 2. Inspect trailer wiring harness for broken wires, deteriorating insulation, or broken contacts. Inspect intervehicle connector for missing contact pins.

If necessary, repair or replace harness as described in paragraph 4-45.



Section V. MAINTENANCE PROCEDURES

INDEX

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4-11. GENERAL INSTRUCTIONS

Maintenance instructions in this section will list resources required, personnel required, and equipment condition for the start of the procedure. Note the following:

- Resources required are not listed unless they apply to the procedure.
- Personnel required are listed only if the task requires more than one. If PERSONNEL is not listed, it means one person can do the task.
- The normal standard equipment condition to start a maintenance task is engine stopped and battery disconnect switch off. EQUIPMENT CONDITION is not listed unless some other condition is required besides the power being off.
- Refer to Appendix F to determine torque requirements when tightening threaded fasteners, unless a specific torque value is given in procedure. Standard torque values given in Appendix F are determined by thread size.

4-12. CENTRIFUGAL PUMP UNIT INSPECTION

Component	Acceptable	Repairable	Not Repairable
Air cleaner assembly	Clean. Air flow not restricted. No leaks, no damage. Clamps tight. Mounting bands tight. Fasteners not stripped.	Dirty. Loose. Replace components.	
Exhaust heat / shield	Clean. Heat discoloration. Tight. Fasteners not stripped.	Dirty. Loose. Replace.	
Weather cap	Clean. Heat discoloration. Fasteners tight, not stripped.	Dirty. Loose. Bound pivot point. Replace.	
Exhaust pipe and exhaust manifold pipe	Heat discoloration. No leaks. No holes. Tight. Fasteners tight, not stripped.	Loose. Replace.	
Muffler	Heat discoloration. No leaks. No holes. Fasteners tight, not stripped.	Loose. Replace.	
Battery, cables, battery box, and cover	Clean. No corrosion. Cable ends tight. No leaks. No physical damage. Fasteners tight, not stripped.	Dirty. Loose. Replace components.	
Alternator assembly	Clean. Connections tight. No corrosion. Belts tight; not frayed, cut, or damaged. No physical damage. Mounting hardware tight, not stripped.	Dirty. Loose. Replace.	
Starter motor assembly	Clean. Connections tight. No corrosion. Mounting hardware tight, not stripped. No physical damage.	Dirty. Loose. Replace.	
Main wiring harness	Clean. Slight abrading of sheath material. Terminals tight. No corrosion. Tie wraps tight.	Dirty. Loose. Tape abrasions. Splice damaged individual wires and tape. Replace tie wraps.	Harness severed.
Alternator and fan drive belts	Tight. Not frayed, glazed, or cut. Mounting hardware tight, not stripped.	Loose. Replace.	
Speed regulating throttle cable	Clean. Moves freely through range. Mounting hardware tight.	Dirty. Loose. Replace.	
Air shutdown solenoid	Clean. Connections tight. No corrosion. Mounting hardware tight, not stripped.	Dirty. Loose. Replace.	

Component	Acceptable	Repairable	Not Repairable
Fuel tank	Clean. No sediment. No leaks. Gage works. Valve moves freely. Mounting hardware tight, not stripped.	Dirty. Loose. Drain sediment and flush. Replace gage. Replace valve. Replace tank.	
Fuel lines, hoses, and fittings	Clean. Tight. No leaks. Mounting hardware tight, not stripped. Fittings tight, not stripped.	Dirty. Loose. Replace.	
Fuel strainer	Clean. Tight. No leaks. Fittings not stripped. Mounting hardware tight, not stripped.	Dirty. Loose. Replace strainer element.	
Fuel pump Assembly	Clean. No leaks. Tight.	Dirty. Loose.	
Fuel filter	Clean. Tight. No leaks. Mounting hardware tight, not stripped. Fittings not stripped.	Dirty. Loose. Replace filter element.	
Starting aid control cable	Clean. No kinks. Mounting hardware tight, not stripped.	Dirty. Loose. Replace cable.	
Ether cylinder	Clean. Tight. No leaks. Mounting hardware tight, not stripped.	Dirty. Loose. Replace cylinder.	
Atomizer	Clean. Tight. No leaks. Tubing not blocked. No holes.	Dirty. Loose. Replace.	
Overspeed governor	Clean. Mounting hardware tight, not stripped. Connections tight. No corrosion.	Dirty. Loose.	
Mechanical governor	Clean. No physical damage. Linkage free. Mounting hardware tight, not stripped.	Dirty. Loose.	
Oil filter	Clean. Tight. No leaks. Fittings not stripped. Mounting hardware tight, not stripped.	Dirty. Loose. Replace filter element.	
Low oil pressure cutout switch	Clean. Tight. Fitting not stripped. No leaks. Connections tight.	Dirty. Loose. Replace.	
Oil cooler	No corrosion. Clean. Tight. Fasteners tight, not stripped. No leaks at parting surfaces.	Dirty. Loose.	
Oil lines and fittings	Clean. Tight. Fittings not stripped. No leaks.	Dirty. Loose. Replace.	
Cooling fan	Clean. Tight. Belts tight, not frayed, cut, or damaged. Mounting hardware not stripped.	Dirty. Loose. Replace.	

Component	Acceptable	Repairable	Not Repairable
Crankcase, valve cover, block, and cylinder head	Clean. Tight. No leaks at parting surfaces. Threads not stripped.	Dirty. Loose.	
Water pump	Clean. Belts tight, not frayed, cut, or damaged. Hoses, clamps, and parting surfaces tight, no leaks.	Dirty. Loose. Replace.	
Radiator	Clean. Cooling fins straight, not bent. Hose clamps tight. No leaks. Mounting hardware tight, not stripped.	Dirty. Loose. Replace.	
Pump assembly	Clean. Mounting hardware tight, not stripped. Housing not cracked. No leaks at parting surfaces. Plugs tight, not stripped.	Dirty. Loose.	
Control panel assembly	Clean. Tight. Mounting hardware, not stripped. Lenses tight, not cracked. Cover tight, in place. Electrical connections tight, no corrosion. Fittings tight, not stripped, no leaks.	Dirty. Loose. Replace defective component.	
Trailer assembly	Clean. Components present. No corrosion. Reflectors not broken. Mounting hardware tight, not stripped. No distortion. No cracks. Tires inflated, tread good. Shock absorbers not leaking, rubber grommets in place and complete.	Dirty. Loose. Paint. Replace defective component.	
Trailer wiring harness	Clean. Slight abrading of sheath material. Intervehicular connector clean, pins not distorted. Terminals tight. No corrosion. Tie wraps tight. Lights work.	Dirty. Loose. Tape abrasions. Splice damaged individual wires and tape. Replace tie wraps.	Harness severed.
Springs	Clean. Mounting hardware tight, not stripped. Individual leaves not cracked. Rubber grommets in place and complete. Rubber spring bumpers in place and complete.	Replace tie wraps.	

4-13. AIR CLEANER ASSEMBLY

This task covers:

- a. Removal
- b. Installation/Replacement
- c. covers:

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

- Elbows (2)
- Nipple
- Washers (2)
- Hose (restriction indicator)
- Mounting bands (2)
- Screws (4)

Materials/Parts

Antiseize (Teflon) tape, 1/2 inch
(Item 18, Appendix E)

- Rags
- Clamps (2)
- Restriction indicator
- Reducer bushing

Troubleshooting References

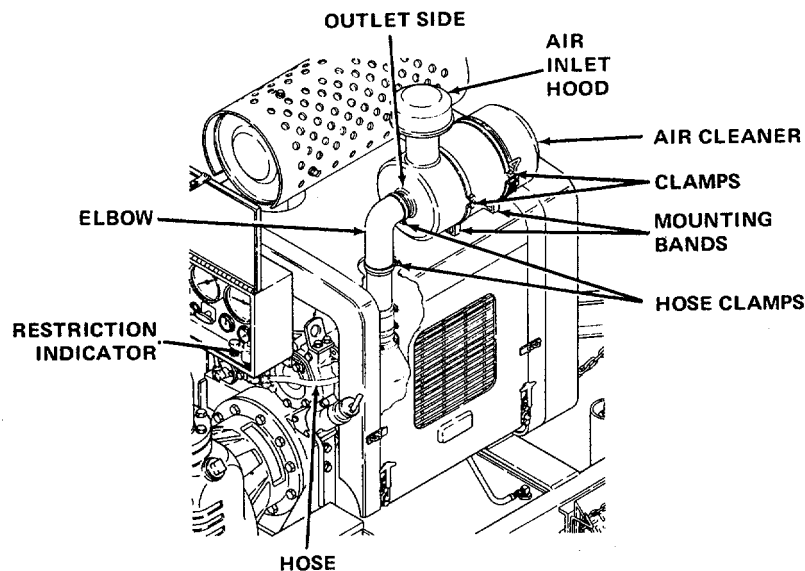
Malfunction 5, step 2

Special Environmental Conditions

Adequate ventilation required during cleaning and test.

Location/Item	Action	Remarks
---------------	--------	---------

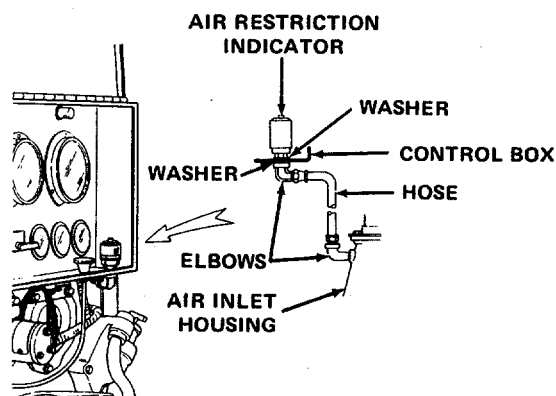
REMOVAL



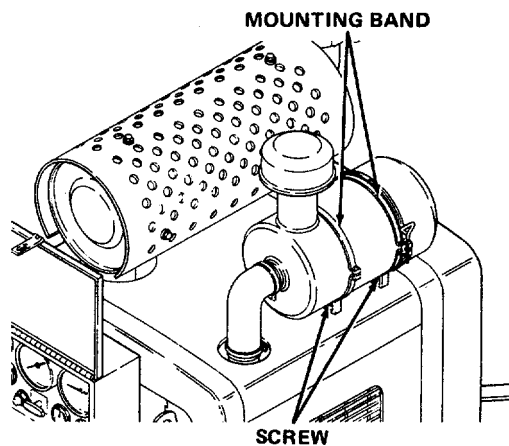
1. Air cleaner assembly
Loosen hose clamp on outlet side of cleaner. Remove mounting band clamp screws and nuts. Remove air cleaner with air inlet hood.

4-13. AIR CLEANER ASSEMBLY (CONT)

Location/Item	Action	Remarks
2. Elbow	Loosen lower clamp. Remove elbow.	
3. Restriction indicator	Remove hose from elbow below panel and from elbow in air inlet housing. Remove elbow from nipple extending through panel bottom. Remove washer, restriction indicator with assembled nipple, and washer. Remove nipple and washer from base of indicator. Remove elbow from air inlet housing.	



4. Mounting bands Remove screws. Remove bands.

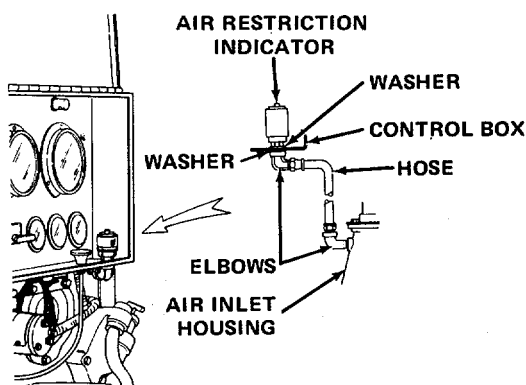


INSTALLATION/REPLACEMENT

5. Mounting bands Place bands in position, with clamps towards air inlet side of engine. Install screws and tighten securely.

4-13. AIR CLEANER ASSEMBLY (CONT)

Location/Item	Action	Remarks
6. Air cleaner assembly	Place air cleaner under straps of mounting band. Install clamp screws and nuts. Position cleaner inlet straight up. Tighten clamps securely.	
7. Air inlet hood	Fit hood outlet over cleaner inlet. Press down on hood to mate tapers.	
8. Elbow	Place clamps over elbow. Place ends over cleaner outlet and inlet pipe. Slide clamps to ends of hose. Position clamps for easy access. Tighten clamps securely.	
9. Restriction indicator	Apply 1/2-inch (5.08 cm) Teflon tape (MIL-T-27730) to male pipe threads prior to assembly. Install elbow into air inlet housing, tighten, and position for easy installation of hose. Install hose into elbow and tighten. Install elbow on free end of hose and tighten; position elbow to line up with hole in bottom of control panel. Install washers on either side of panel bottom. Install nipple, through washers and panel bottom, into elbow and tighten. Install indicator onto nipple and tighten. Reset indicator by pushing down button on its top.	



4-13. AIR CLEANER ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

TEST

WARNING

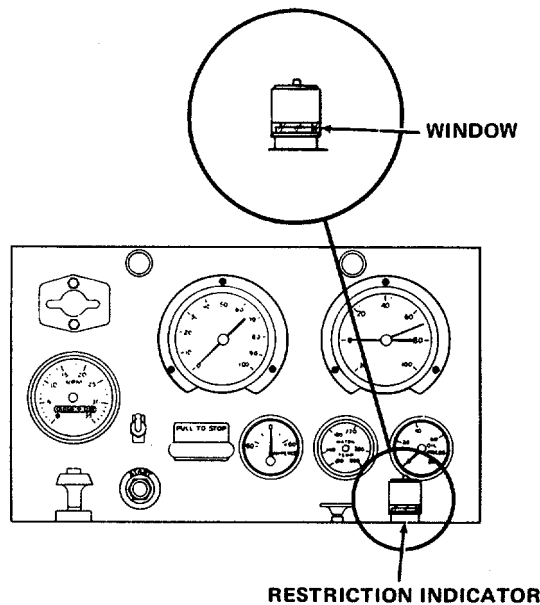
Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

1. Operate engine in a ventilated area only.
2. Ventilate personnel compartments when idling engine.
3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

- | | |
|--------------------------|--|
| 10. Air cleaner assembly | Start engine and observe installed components for leaks. Tighten as required. Observe operation of restriction indicator. If red is visible in window, shut down engine, and reset indicator. Start engine; recheck indicator. If red is still visible, replace indicator. |
|--------------------------|--|



4-14. EXHAUST HEAT SHIELD

This task covers:

- a. Removal
- b. Inspection
- c. Cleaning
- d. Installation/Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop equipment, automotive maintenance
and repair, common no. 1
NSN 4910-00-754-0654

Materials/Parts

Diesel fuel oil (Item 6, Appendix E)
Soft-bristle brush

Exhaust heat shield

Troubleshooting References

Malfunction 9

Special Environmental Conditions

Adequate ventilation required during cleaning.

General Safety Instructions

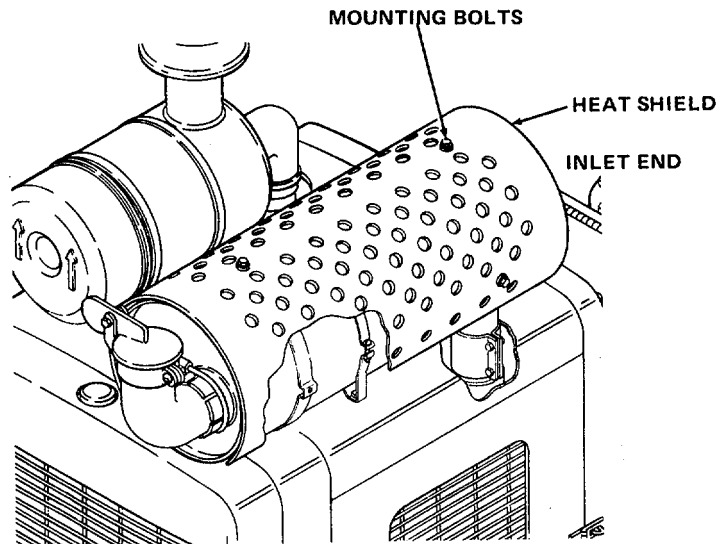
WARNING

Handling hot exhaust shield can cause severe burns. Allow unit to cool before handling.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | | |
|-------------------|--------------------------------------|---------------|
| 1. Mounting bolts | Remove from heat shield. | Self-tapping. |
| 2. Heat shield | Slide off over inlet end of muffler. | Discard. |



INSERT SUBTITLE HERE!

Location/Item	Action	Remarks
3. Mounting bands	Mark muffler to indicate proper relationship of bands to each other and to heat shield. Remove screw and nut from clamp portion of each band. Remove bands. Discard if damaged.	

INSPECTION

- | | | |
|---------------------------------|--|--|
| 4. Mounting bands and fasteners | Inspect for damage and distortion that would prevent use. Discard if not usable. | |
|---------------------------------|--|--|

CLEANING

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Work in a well-ventilated area.**
- **Do not use near open flame, sparks, or excessive heat.**

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | | |
|---------------------------------|---|--|
| 5. Mounting bands and fasteners | Using fuel oil and a soft-bristle brush, clean ports by scrubbing with fuel oil and drying with compressed air. | |
|---------------------------------|---|--|

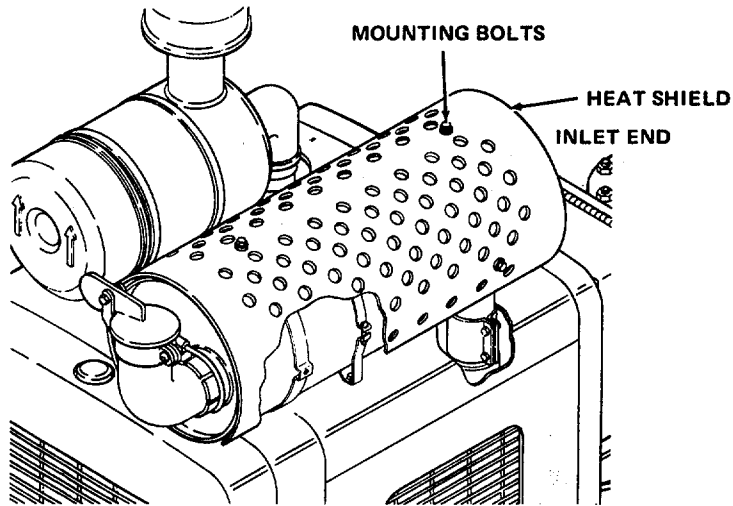
INSTALLATION/REPLACEMENT

- | | | |
|-------------------|---|--|
| 6. Mounting bands | Install over muffler. Place screw through clamp portion of band, and thread nut onto screw. Aline bands with marks made on muffler during band removal. Tighten clamps securely onto muffler. | |
| 7. Heat shield | Slide on over inlet end of muffler. Aline threaded holes in mounting band. | |

4-14. EXHAUST HEAT SHIELD (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-------------------|---|--|
| 8. Mounting bolts | Install through heat shield and into mounting band. Tighten bolts securely. | |
|-------------------|---|--|



4-15. WEATHER CAP

This task covers:

- a. Repair
- b. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Troubleshooting References

Malfunction 9

General Safety Instructions

Materials/Parts

Weather cap

Lubricating oil (Item 10, Appendix E)

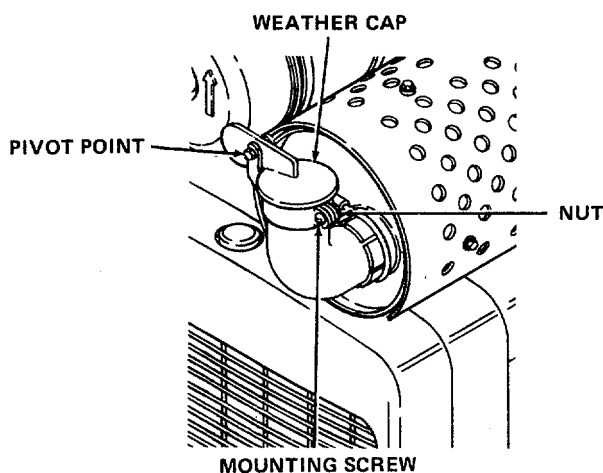
WARNING

Handling a hot weather cap can cause severe burns. Allow unit to cool before handling.

Location/Item	Action	Remarks
---------------	--------	---------

REPAIR

1. Weather cap pivot point
Lubricate with oil (MIL-L-2104). Raise and lower weather cap till pivot frees up. Replace pivot cap screw and nut, if necessary.
2. Weather cap
Tighten or replace screw and nut.
clamp



REPLACEMENT

3. Weather cap
Loosen screw and nut in clamp. Remove and discard cap. Install new cap over exhaust pipe. Tighten screw and nut on clamp. Lubricate pivot with MIL-L-2104 oil. Make sure cap pivots freely.

4-16. EXHAUST PIPE

This task covers:

- a. Removal
- b. Inspection
- c. Installation/Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033
 Shop equipment, automotive maintenance
 and repair, common no. 1
 NSN 4910-00-754-0654

**Equipment
 Condition**

Para

Condition Description

4-15

Weather cap removed.

General Safety Instructions

Materials/Parts

Exhaust pipe

WARNING

Troubleshooting References

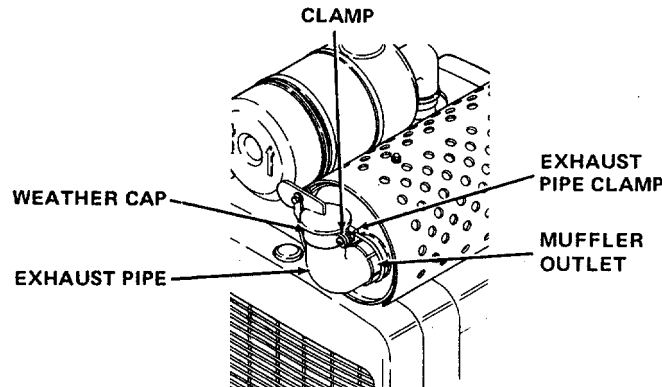
Malfunction 6, step 5
 Malfunction 9

Handling a hot exhaust pipe can cause severe
 burns. Allow unit to cool before handling.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

1. Exhaust pipe Clamp Loosen nuts.
2. Exhaust pipe Remove. Discard.



4-89

4-16. EXHAUST PIPE (CONT)

Location/Item	Action	Remarks
INSPECTION		
3. Exhaust pipe clamp	Inspect for stripped threads or distortion. Distortion. Discard if not usable.	
4. Muffler outlet	Inspect for: Distortion that might interfere with installation of exhaust pipe. Holes.	
	If damaged, replace as described in paragraph 4-17.	
INSTALLATION/REPLACEMENT		
5. Exhaust pipe Clamp	Place over muffler outlet. Do not tighten.	
6. Exhaust pipe	Install into muffler outlet. Position. Tighten clamp evenly and securely.	Cap end at 12 o'clock.

4-17. MUFFLER

This task covers:

- a. Removal
- b. Inspection
- c. Installation/Replacement
- d. Test**

INITIAL

Tools

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033
 Shop equipment, automotive maintenance
 and repair, common no. 1
 NSN 4910-00-754-0654

Equipment Condition

Para	Condition Description
4-14	Exhaust heat shield removed.
4-16	Exhaust pipe removed (weather cap need not be removed).

Materials/Parts

Seal clamp
 Muffler

General Safety Instructions

WARNING

Handling a hot muffler can cause severe burns. Allow unit to cool before handling .

Troubleshooting reference

Malfunction 6, step 5
 Malfunction 9

Location/Item	Action	Remarks
---------------	--------	---------

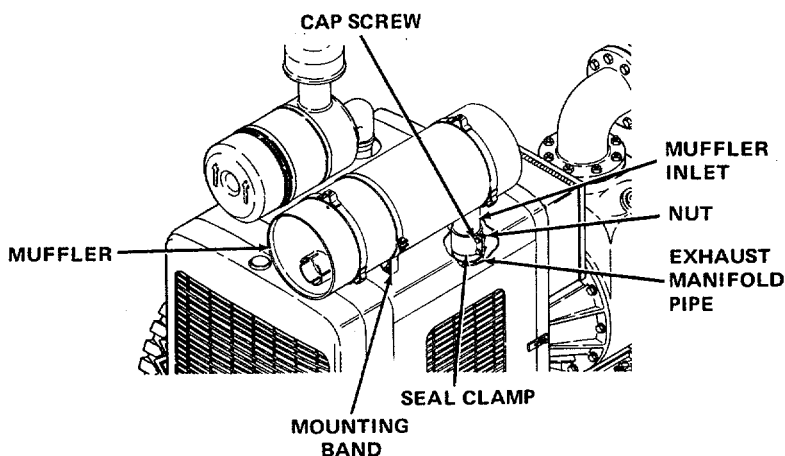
REMOVAL

1. Muffler mounting band Remove bolt and nut from clamp.
2. Seal clamp Remove cap screws and nuts. Loosen clamp and slide down exhaust manifold pipe.
3. Muffler Remove and set aside.

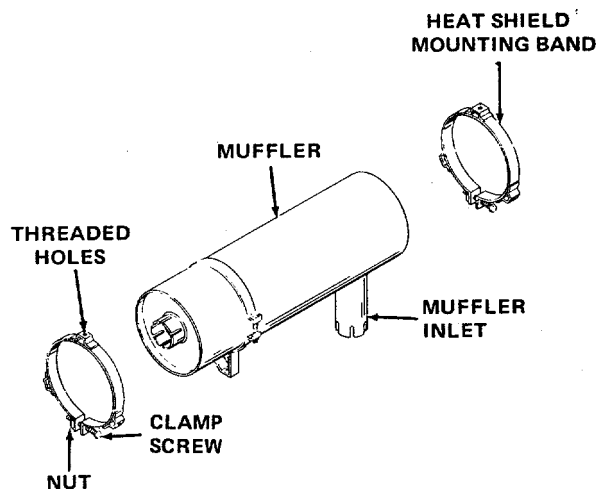
4-17. MUFFLER (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

4. Seal clamp Remove and discard.



5. Heat shield mounting bands Place muffler on flat surface and note relative position of bands to muffler inlet. Measure distance between bands and record. Loosen clamp screw and nut. Slide bands off muffler. Discard muffler.



INSPECTION

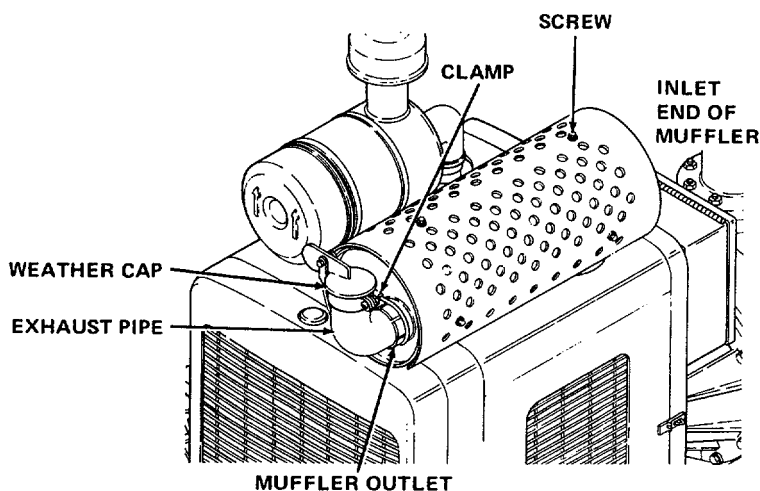
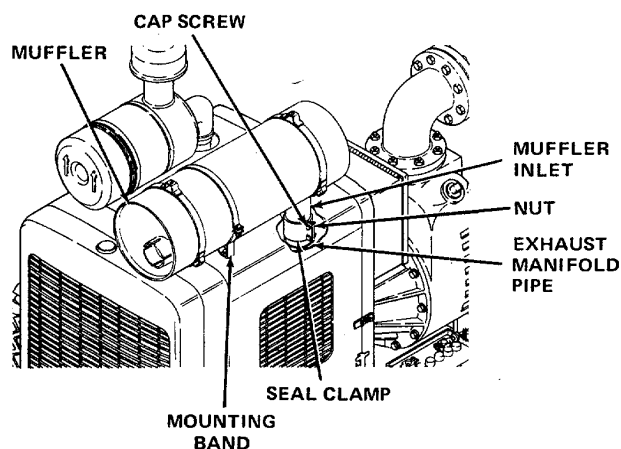
6. Muffler mounting bands If loose on engine cover, tighten. If damaged, remove and replace. Tighten mounting bolts securely.
7. Heat shield mounting bands Inspect for damage to bands, clamp screws and nuts, and threaded holes. Replace if damaged.

INSTALLATION/REPLACEMENT

8. Heat shield mounting bands Install onto new muffler. Position bands as noted in 5, above. Tighten clamp screw and nut.

4-17. MUFFLER (CONT)

Location/Item	Action	Remarks
9. Seal clamp	Install over exhaust manifold pipe. Slide clamp down pipe to clear muffler inlet.	
10. Muffler	Place muffler into mounting band attached to engine cover. Install clamp screw and nut. Do not tighten clamp. Aline muffler inlet with exhaust manifold pipe.	
11. Seal clamp	Slide up onto muffler inlet. Position across gap between muffler and exhaust manifold. Tighten seal clamp cap screws and nuts.	
12. Muffler	Tighten mounting bolt and nut. mounting band	
13. Exhaust pipe	Slide clamp over muffler outlet. Insert pipe into muffler outlet. Tighten clamp.	Weather cap installed and at 12 o'clock.
14. Heat shield	Slide on over inlet end of muffler. Install screws, through shield, into mounting band threaded holes. Tighten screws.	



4-17. MUFFLER (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

TEST

WARNING

Touching exhaust system during test can cause severe burns.

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

1. Operate engine in a ventilated area only.
2. Ventilate personnel compartments when idling engine.
3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

15. Muffler	Start engine and observe installed components for leaks and/or loose, rattling components. Tighten fasteners as necessary to close leaks and prevent rattles.	
-------------	---	--

4-18. EXHAUST MANIFOLD PIPE

This task covers:

- a. Removal
- b. Inspection
- c. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033
 NSN 5180-00-177-7033
 Shop equipment, automotive maintenance
 and repair, common no. 1
 NSN 491Q-00-754-0654

**Equipment
 Condition**

Para	Condition Description
4-17.4	Seal clamp removed.

General Safety Instructions

Materials/Parts

Gasket

Troubleshooting Reference

Malfunction 9

References

Para 4-17 Muffler

WARNING

Handling a hot exhaust manifold pipe can cause severe burns. Allow unit to cool before handling.

Location/Item

Action

Remarks

REMOVAL

NOTE

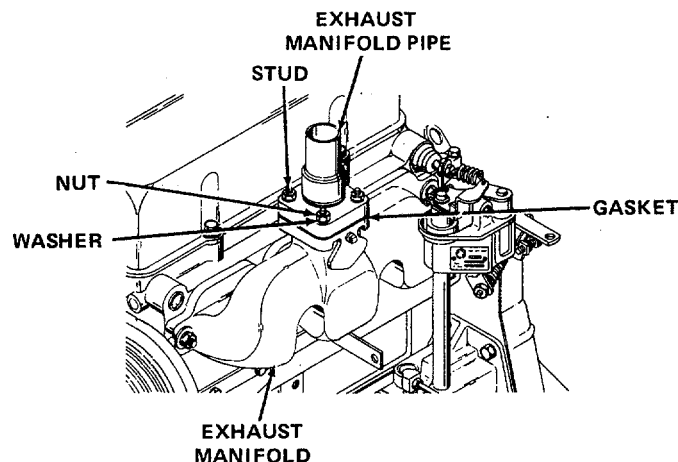
Exhaust system components removed as described in paragraph 4-17.

- | | |
|--------------------------|-------------------------|
| 1. Nuts and Washers | Remove from four studs. |
| 2. Exhaust manifold pipe | Remove. |

4-18. EXHAUST MANIFOLD PIPE (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-----------|---------------------|--|
| 3. Gasket | Remove and discard. | |
|-----------|---------------------|--|

**INSPECTION**

- | | |
|--------------------------|--|
| 4. Nuts | Inspect for damaged threads. Discard if not usable. |
| 5. Studs | Inspect for damaged threads. Replace damaged studs. Inspect for looseness, Tighten securely. |
| 6. Exhaust manifold pipe | Inspect for holes. Inspect for damage to gasket mating surface. Replace if not usable. |

REPLACEMENT

- | | |
|--------------------------|--|
| 7. Gasket | Place over studs onto exhaust manifold mating surface. |
| 8. Exhaust manifold pipe | Place over studs onto gasket. |
| 9. Washers | Place one on each stud. |
| 10. Nuts | Place one on each stud. Tighten evenly in an alternating pattern. Torque to 53-56 inch-pounds (72-76 N•m). |

NOTE

Install remaining exhaust system components and test as described in paragraph 4-17.

4-19. BATTERY BOX AND COVER ASSEMBLY, BATTERY, AND CABLES

This task covers:

- a. Removal
- b. Installation/Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033
 Shop equipment, automotive maintenance
 and repair, common no. 1
 NSN 4910-00-754-0654

Materials/Parts

Grease (Item 7, Appendix E)

 Battery box and cover assembly
 Battery

 Battery cables

Troubleshooting References

Malfunction 1, steps 1 and 2

General Safety Instructions

WARNING

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte. Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.

Location/Item

Action

Remarks

REMOVAL

WARNING

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

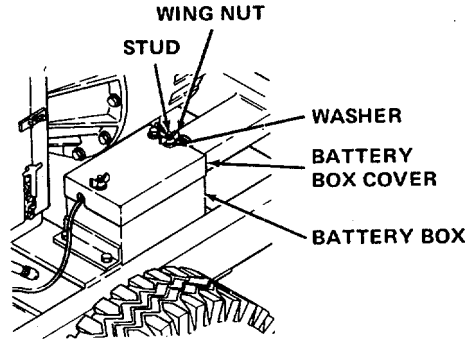
Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.

- 1. Wing nut Remove from threaded studs.
- 2. Washer Remove from studs.

4-19. BATTERY BOX AND COVER ASSEMBLY, BATTERY, AND CABLES (CONT)

Remarks

- | | | |
|----------------|-----------------------|-----------------------------|
| 3. Battery box | Remove and set aside. | Cover still chained to box. |
|----------------|-----------------------|-----------------------------|



CAUTION

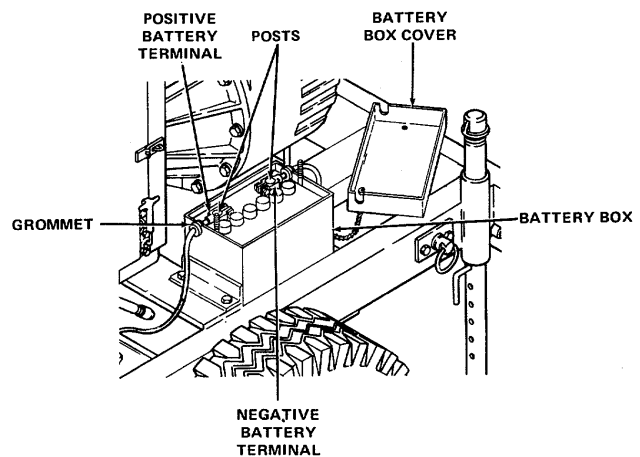
Avoid making contact across the two battery posts. This can result in severe arcing.

Disconnect battery cable from negative battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage the alternator, voltage regulator, or other electrical components.

When removing battery cable, use battery terminal puller to remove loosened terminals. Forcing battery terminals off without using puller may damage the battery posts.

Never disconnect battery while alternator is operating. Never attempt to polarize the alternator.

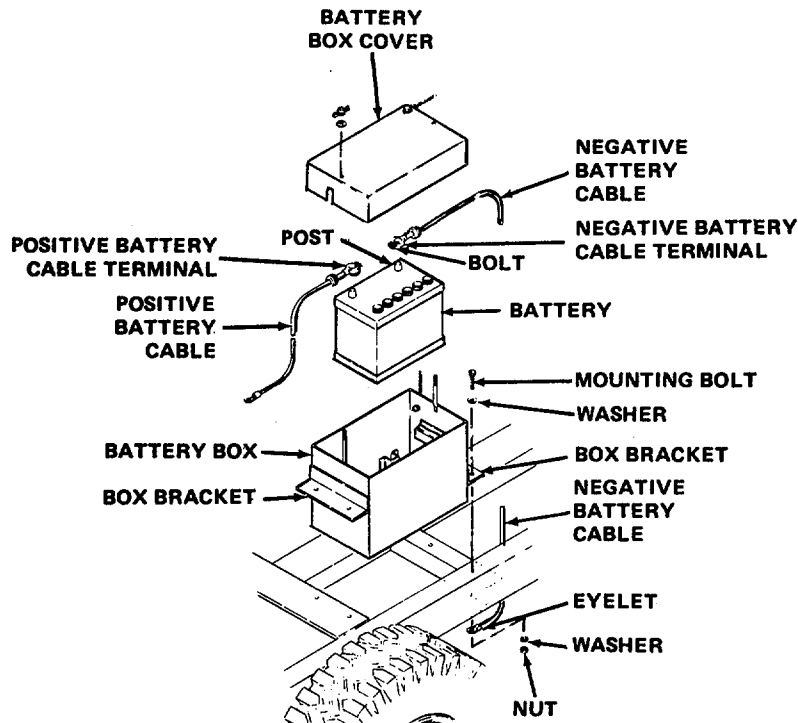
- | | |
|-------------------|--|
| 4. Battery cables | Loosen bolt securing negative battery terminal to post and remove terminal from post using a battery terminal puller. Using same method, remove positive battery terminal from post. |
|-------------------|--|



4-19. BATTERY BOX AND COVER ASSEMBLY, BATTERY, AND CABLES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- 5. Battery Lift from battery box.
- 6. Mounting bolts, nuts, and washers Remove battery box-to-frame mounting bolts, nuts, and washers.

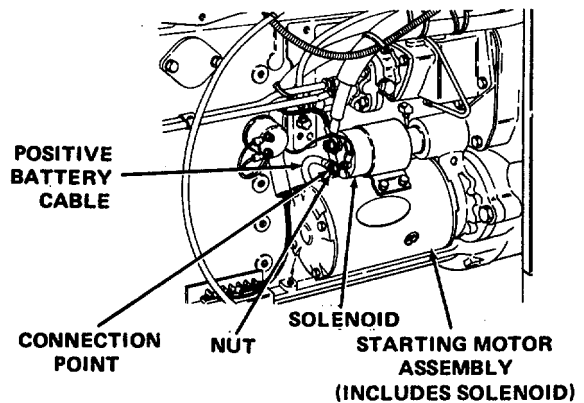


- 7. Negative battery cable Remove.

Battery box mounting hardware attaches negative cable to frame.

- 8. Positive battery cable Remove nut at positive battery cable-to-solenoid connection point on starter motor assembly and remove cable.

- 9. Battery box and cover assembly Remove from frame.



4-13. BATTERY BOX AND COVER ASSEMBLY, BATTERY, AND CABLES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

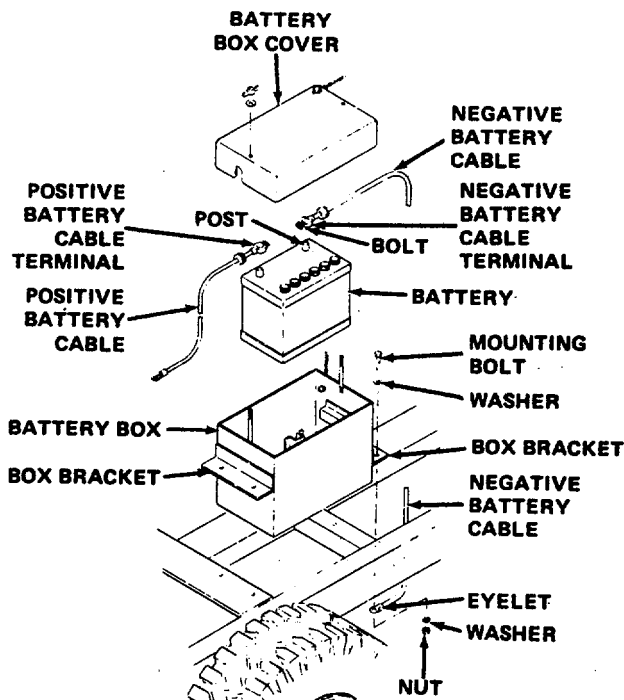
INSTALLATION/REPLACEMENT

- | | | |
|---|---|--|
| 10. Battery box and cover | Position on frame. | |
| 11. Mounting bolts, nuts, and washers; negative battery cable | Insert bolts, with washers, through mounting holes on box brackets and frame. Place eyelet of negative battery cable on bolt. Install washers and nuts. Tighten securely. | |
| 12. Positive battery cable | Attach a positive battery cable to the connection point at the solenoid. Tighten nut securely | |

NOTE

Do not use a tropical electrolyte. Tropical electrolyte has a lower specific gravity and results in a lower battery reserve capacity.

- | | | |
|-------------|--|--|
| 13. Battery | Fill replacement battery to split rings and charge battery before installing it. Place in battery box, posts toward centerline of trailer. | |
|-------------|--|--|



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PIN: 054695-001

4-19. BATTERY BOX AND COVER ASSEMBLY, BATTERY, AND CABLES (CONT)

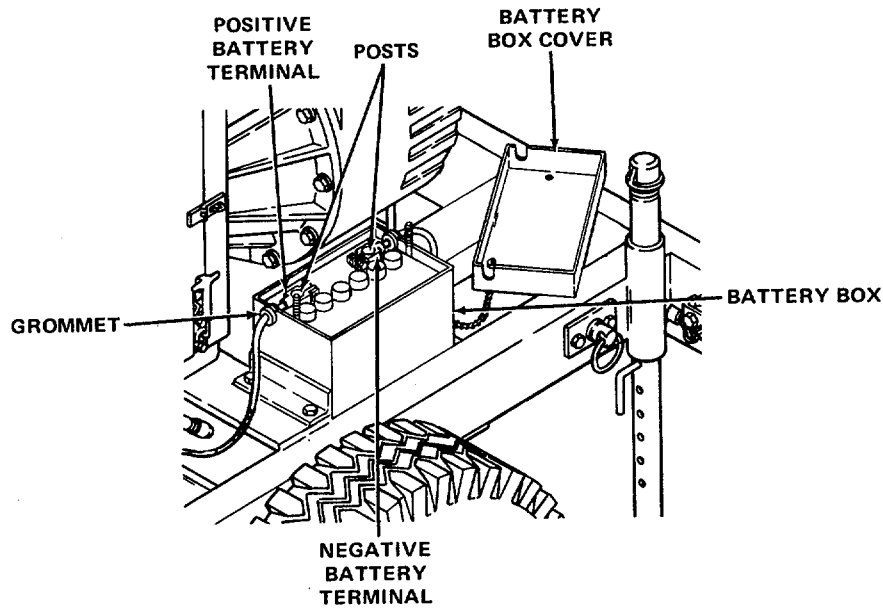
Location/Item	Action	Remarks
---------------	--------	---------

CAUTION

Connect the positive battery cable first when installing replacement cables. This precaution will prevent a short circuit which could damage alternator, voltage regulator, or other electrical components.

14. Battery cable

Make sure posts and terminals are clean. Install positive battery terminal onto positive post and tighten securely. Place negative battery terminal onto negative post and tighten securely. Cover terminals and posts with MIL-G-10924 grease.



15. Battery box cover

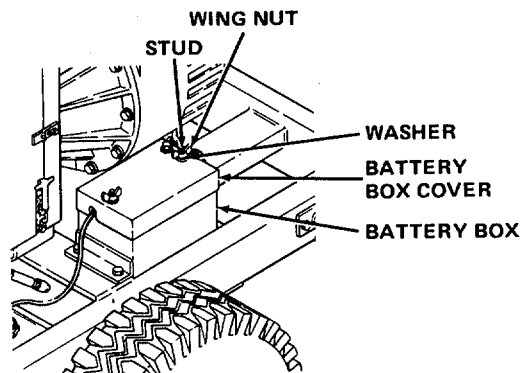
Position grommet on positive cable. Place cover over cables, aligning grommet with cutout in cover. Slide cover down onto studs.

16. Washers

Place washers over studs.

17. Wing nuts

Thread onto studs; tighten securely.



4-20. ALTERNATOR ASSEMBLY

This task covers:

- a. Removal
- b. Installation/Replacement
- c. Test

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033
 Shop equipment, automotive maintenance
 and repair, common no. 1
 NSN 4910-00-754-0654

Materials/Parts

Alternator assembly

Equipment Condition

Engine right side panel removed.

Special Environmental Conditions

Adequate ventilation necessary during test.

General Safety Instructions

WARNING

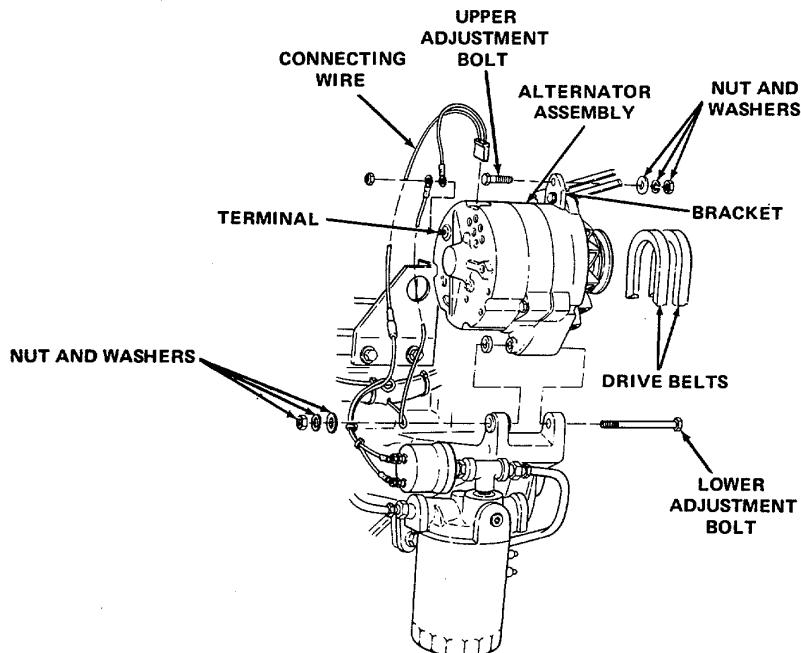
Severe injury may result from contact with rotating alternator. Make sure engine is off and battery disconnect switch is off.

Operate engine only in a well-ventilated area.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | | |
|--|---------------------------------------|--|
| 1. Alternator connecting wires | Disconnect from alternator terminals. | |
| 2. Upper and lower alternator adjustment bolts | Loosen. | |



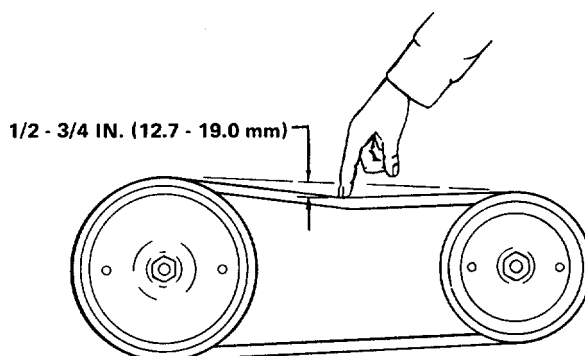
- | | | |
|----------------|---------|--|
| 3. Drive belts | Remove. | |
|----------------|---------|--|

4-20. ALTERNATOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
4. Alternator	Support alternator and remove upper and lower alternator adjustment bolts, nuts, and washers. Remove alternator and set hardware aside. If replacement alternator is supplied with mounting hardware; discard old hardware. Remove bracket from alternator and set hardware aside.	Notify direct support maintenance.

INSTALLATION/REPLACEMENT

- 5. Alternator bracket Install onto replacement alternator and tighten securely.
- 6. Alternator Support alternator and install upper and lower mounting bolts, nuts, and washers. Tighten hand tight. Swing alternator upward and install drive belts.
- 7. Drive belts Pull alternator away from engine just enough to permit belt adjustment, then tighten upper and lower alternator adjustment bolts securely.
- 8. Drive belt tension Depress each belt in turn midpoint between pulleys. Belts should deflect 1/2-3/4 inch (12.7-19 mm). If belt tension is incorrect, loosen adjustment belts slightly and pull alternator away from engine to tighten belts, or push it toward engine slightly to loosen. Retighten bolts.



- 9. Alternator Reconnect connecting wires

4-20. ALTERNATOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

TEST

WARNING

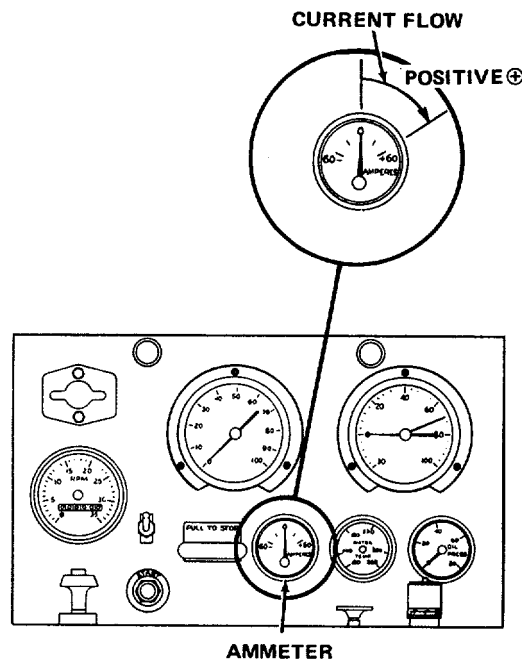
Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

1. Operate engine in a ventilated area only.
2. Ventilate personnel compartments when idling engine.
3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

- | | |
|-------------|---|
| 10. Engine | Start. |
| 11. Ammeter | Check current reading. Ammeter needle should indicate zero on a positive current flow. If ammeter shows a negative current flow, replace alternator after checking battery and electrical system. |



4-21. STARTER MOTOR ASSEMBLY

This task covers:

- a. Removal
- b. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033
 Shop equipment, automotive maintenance
 and repair, common no. 1
 NSN 4910-00-754-0654

Materials/Parts

Starter motor assembly

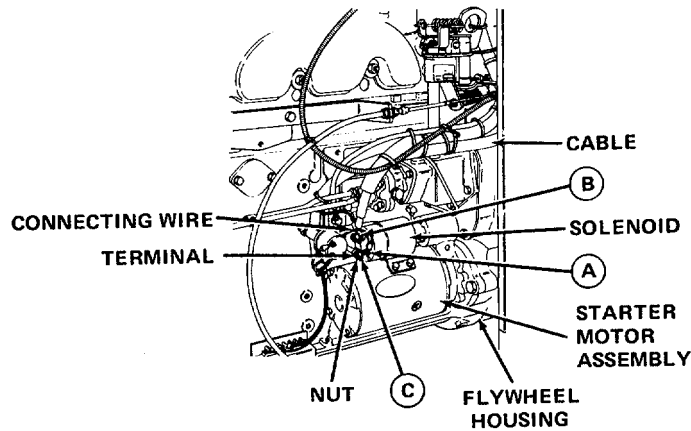
Equipment Condition

Engine left side panel removed.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|--------------------------------|------------------------------|
| 1. Connecting wires and cables | Tag and disconnect solenoid. |
|--------------------------------|------------------------------|



- | | | |
|---------------------------|--|------------------------------------|
| 2. Starter motor assembly | Support starter motor assembly and remove mounting bolts. Remove starter motor assembly from flywheel housing. | Notify direct support maintenance. |
|---------------------------|--|------------------------------------|

4-21. STARTER MOTOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
REPLACEMENT		
3. Starter motor assembly	Support and position starter motor assembly against mounting hole in flywheel housing. Install mounting bolts. Tighten to 137-147 ft lb (186-199 N.m) torque.	
4. Connecting wires and cables	Attach cables and connecting wires to the correct terminals and tighten connection (A) to 16-30 in. lb (1.81-3.39 N-m) torque and connections (B and C) to 20-25 ft lb (27-34 N.m) torque.	

4-22. MAIN WIRING HARNESS

This task covers:

- a. Repair

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop equipment, automotive maintenance
and repair, common no. 1
NSN 4910-00-754-0654

Equipment Condition

Engine side panels removed.

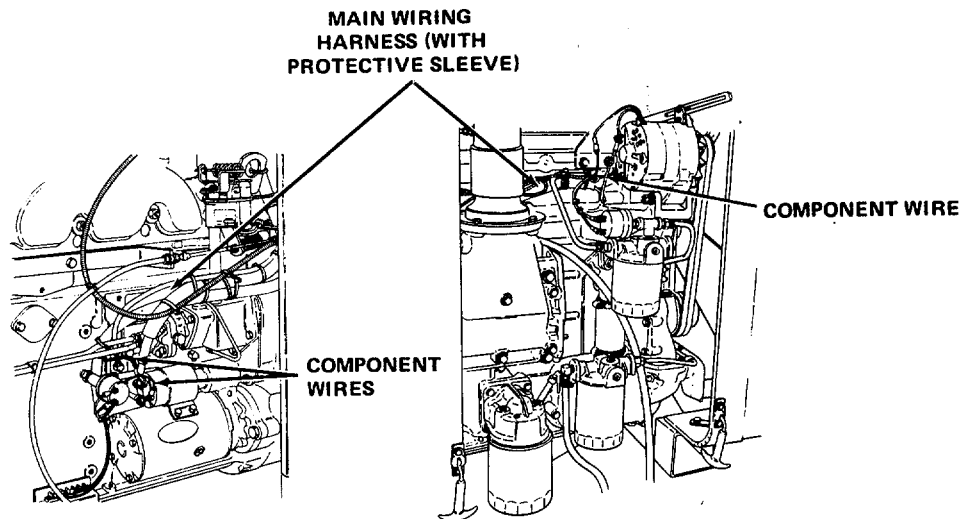
Location/Item	Action	Remarks
---------------	--------	---------

REPAIR

NOTE

Remove positive and negative terminals from battery posts prior to attempting repair.

1. Main wiring harness
Repair any damaged component wires. If damage is excessive, notify direct support maintenance. Tag or mark all wires that will be removed to ease reconnection. Re-route and tie-wrap any repaired wires as removed.



2. Main wiring harness protective sleeving
Inspect and, if necessary, repair any defective sections of protective sleeving when reinstalling sections of repaired main wiring harness.

4-23. ALTERNATOR AND FAN DRIVE BELTS

This task covers:

- a. Removal
- b. Replacement
- c. Test

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Materials/Parts

Alternator drive belt
Fan drive belt

Troubleshooting Reference

Malfunction 8, step 3

Equipment Condition

Engine side panels removed.

Special Environmental Conditions

Well-ventilated area required during test.

General Safety Instructions

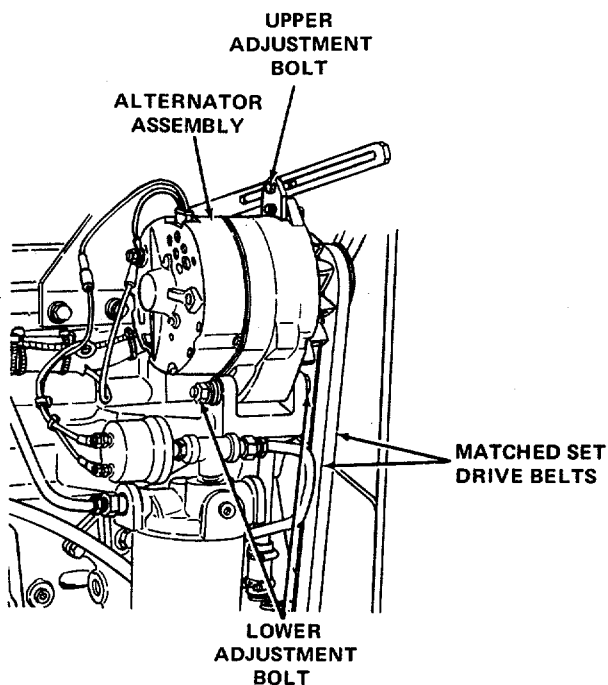
WARNING

Severe injury may result from contact with rotating engine accessories. Make sure engine is off, and battery disconnect switch is off.

Location/Item	Action	Remarks
---------------	--------	---------

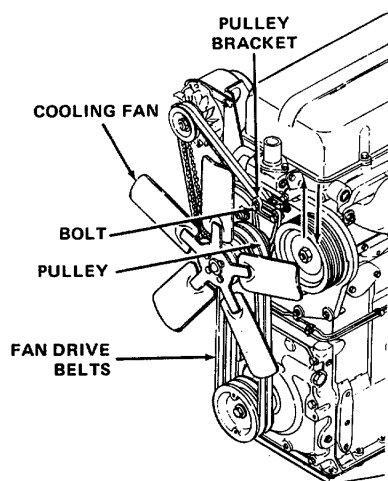
REMOVAL

- | | | |
|--|---------|--|
| 1. Upper and lower alternator adjustment bolts | Loosen. | |
|--|---------|--|



4-23. ALTERNATOR AND FAN DRIVE BELTS (CONT)

Location/Item	Action	Remarks
2. Alternator drive belts	Remove.	
3. Cooling fan assembly	Loosen pulley bracket bolts and jostle pulley to loosen bracket.	



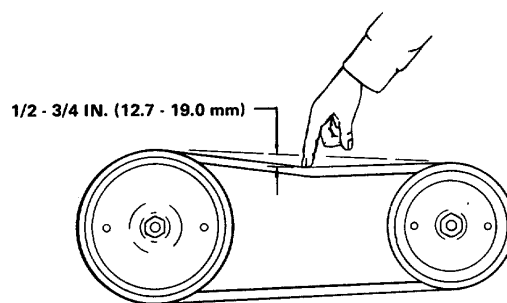
4. Fan drive belt	Remove.	
-------------------	---------	--

REPLACEMENT

NOTE

Replace belts as a matched set. They are matched to 0.032 inch (0.013 cm) of their specified center distances.

5. Alternator drive belts	Install matched replacement belts. Tighten in position by pulling alternator away from engine.
6. Upper and lower alternator adjustment bolts	Tighten.
7. Alternator drive belt tension	Depress each belt in turn midpoint between pulleys. Belts should deflect 1/2-3/4 inch (12.7-19 mm). If belt tension is incorrect, loosen adjustment bolts slightly and pull alternator away from engine to tighten belts, or push it toward engine slightly to loosen. Retighten bolts.



4-23. ALTERNATOR AND FAN DRIVE BELTS (CONT)

Location/Item	Action	Remarks
8. Fan drive belts	Install matched replacement belts. Push pulley upward and tighten the two uppermost pulley bracket bolts. Then tighten remaining bolts.	
9. Fan drive belt tension	Check belt tension the same way that the alternator belt tension was checked.	

TEST**WARNING**

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

1. Operate engine in a ventilated area only.

2. Ventilate personnel compartments when idling engine.

3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

- | | | |
|------------|---|--|
| 10. Engine | Start engine and run for a few minutes to seat belts. Then recheck tension and readjust if necessary. If necessary, check and readjust tension after 1/2 hour and 8 hours of operation. Shut down engine. | |
|------------|---|--|
-

4-24. SPEED REGULATING THROTTLE CABLE

This task covers:

- a. Removal
- b. Replacement

INITIAL SETUP:

Tools Materials/Parts

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Speed regulating throttle cable assembly

Shop equipment automotive maintenance
and repair, common no. 1
NSN 4910-00-754-0654

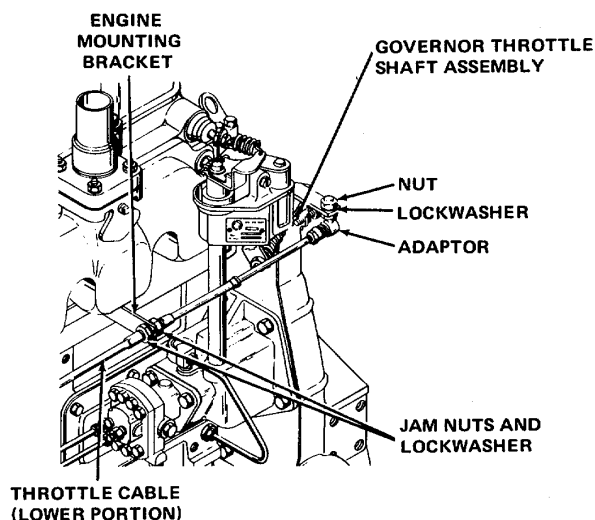
Equipment Condition

Engine left side panel removed.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

1. Throttle cable adaptor
Remove from governor throttle shaft assembly by removing nut and lockwasher.

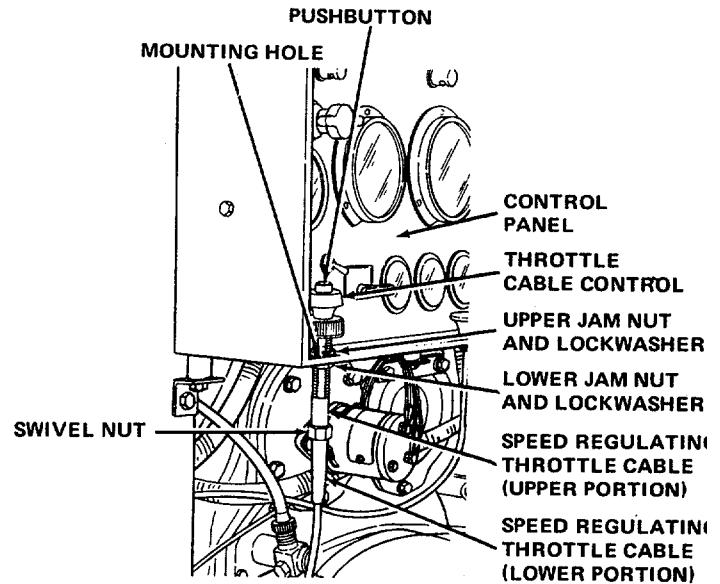


2. Throttle cable (lower portion)
Loosen jam nuts attaching lower portion of throttle cable-to-engine mounting bracket. Slide cable out of engine mounting bracket slot.

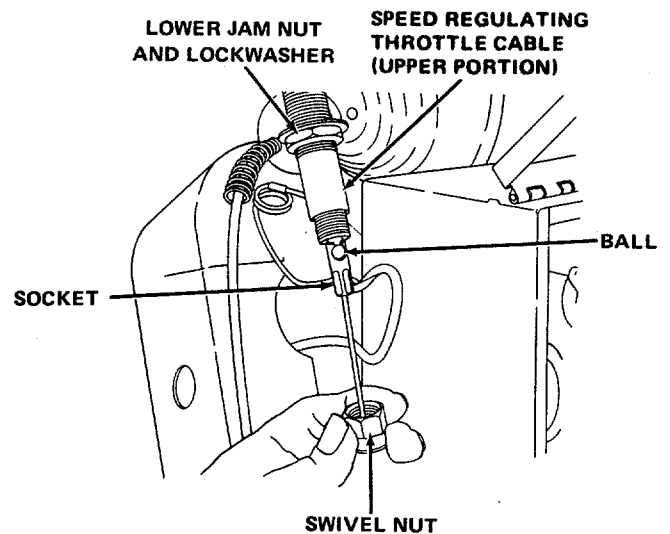
4-24. SPEED REGULATING THROTTLE CABLE (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|---------------------------|--|--|
| 3. Throttle cable control | Depress pushbutton and push in throttle cable control. | |
|---------------------------|--|--|



- | | | |
|-----------------------------------|---|--|
| 4. Throttle cable (lower portion) | Pull lower portion of throttle cable away enough to be able to tilt it. Slip socket off ball in upper portion of cable. | |
|-----------------------------------|---|--|



- | | | |
|-----------------------------------|---|--|
| 5. Throttle cable (upper portion) | Remove lower jam nut and lockwasher. Lift throttle control out of mounting hole in control panel. | |
|-----------------------------------|---|--|

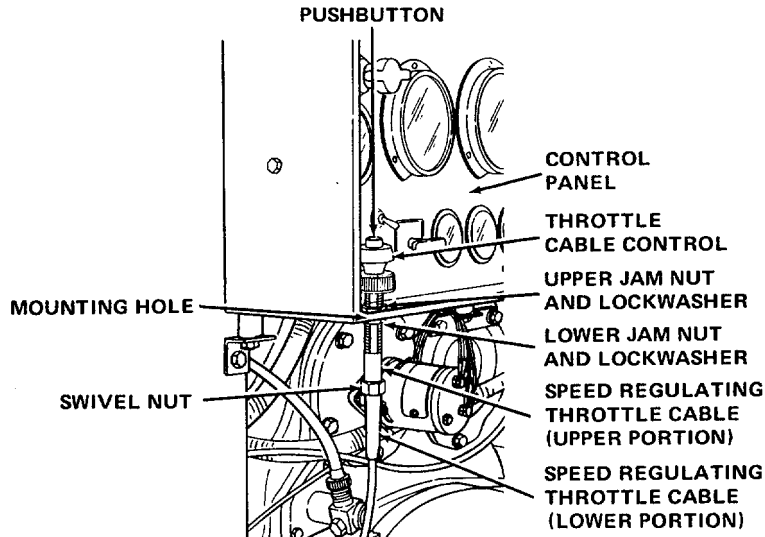
REPLACEMENT

- | | | |
|-----------------------------------|--|--|
| 6. Throttle cable (upper portion) | Insert into mounting hole with upper jam nut and lockwasher in position. Turn jam nut to raise or lower upper portion of cable to desired height. Loosely install lower jam nut and lockwasher (upper portion of throttle cable will have to be loose enough to tilt). | |
|-----------------------------------|--|--|

4-24. SPEED REGULATING THROTTLE CABLE (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|---------------------------|---|--|
| 7. Throttle cable control | Depress pushbutton and push throttle cable control in all the way to expose the ball. | |
|---------------------------|---|--|

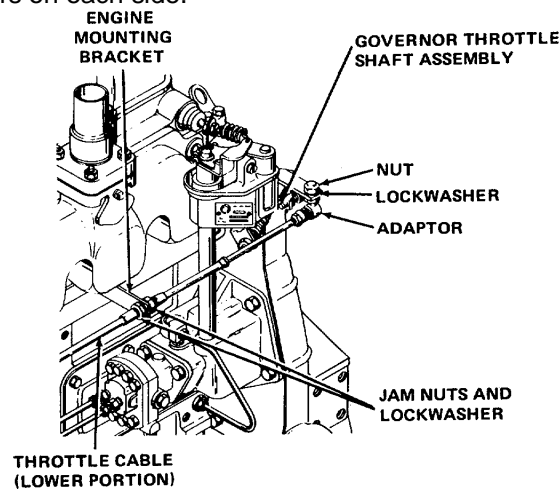


- | | | |
|-----------------------------------|--|--|
| 8. Throttle cable (lower portion) | Connect ball with socket on lower portion of throttle cable, and tighten swivel nut. | |
|-----------------------------------|--|--|

NOTE

As engine speed is set, the throttle cable pushbutton will be pulled upward. Make sure that the set height of throttle cable upper portion will not block the tachometer when pushbutton is raised.

- | | | |
|------------------------------------|---|--|
| 9. Throttle cable (upper portion) | Tighten lower jam nut on upper portion of throttle cable at control panel mounting hole. | |
| 10. Throttle cable (lower portion) | Slide into slot on engine mounting bracket and tighten jam nuts and lockwashers on each side. | |



- | | | |
|----------------------------|--|--|
| 11. Throttle cable adaptor | Insert threaded segment into governor throttle shaft assembly, insert washer, and tighten nut. | |
|----------------------------|--|--|

4-25. AIR SHUTDOWN SOLENOID

This task covers:

- a. Removal
- b. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033
 Shop equipment automotive maintenance
 and repair, common no. 1
 NSN 4910-00-754-0654

Materials/Parts

Air shutdown solenoid

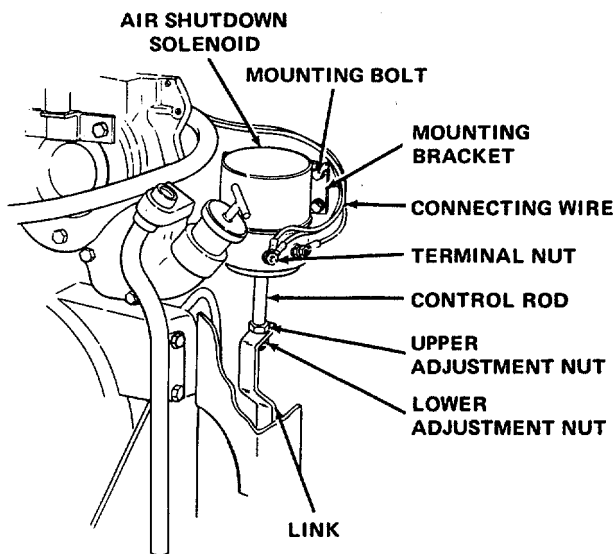
Equipment Condition

Engine right side panel removed.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|------------------------------|--------------------------------------|
| 1. Solenoid connecting wires | Tag and disconnect at terminal nuts. |
|------------------------------|--------------------------------------|



- | | | |
|----------------|--|------------------------------------|
| 2. Control rod | Remove lower control rod adjusting nut and slip link off control rod. | |
| 3. Solenoid | Support solenoid and remove mounting bolts from mounting bracket. Remove solenoid. | Notify direct support maintenance. |

4-25. AIR SHUTDOWN SOLENOID (CONT)

Location/Item	Action	Remarks
REPLACEMENT		
4. Solenoid	Support replacement solenoid and install mounting bolts in mounting bracket. Tighten securely.	
5. Solenoid connecting wires	Reconnect tagged connecting wires to solenoid terminal nuts. Tighten securely.	
6. Control rod	Screw upper adjustment nut as far as it will go on control rod of replacement solenoid, then remove lower adjustment nut. Install link onto control rod. Reinstall lower adjustment nut and tighten securely.	

NOTE

Link should now be positioned on control rod of replacement solenoid in same position as on control rod of replaced solenoid. If rough operation occurs, it may be necessary to raise or lower the link on the control rod with the upper and lower adjustment nuts.

4-26. FUEL TANK

This task covers:

- a. Removal
- b. Replacement
- c. Priming the fuel system

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033
 Fuel system primer (J5956)

General Safety Instructions

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Materials/Parts

Fuel tank

Diesel fuel oil (Item 6, Appendix E)

Troubleshooting References

Malfunction 3, step 2

Malfunction 5, step 1

Location/Item

Action

Remarks

REMOVAL

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

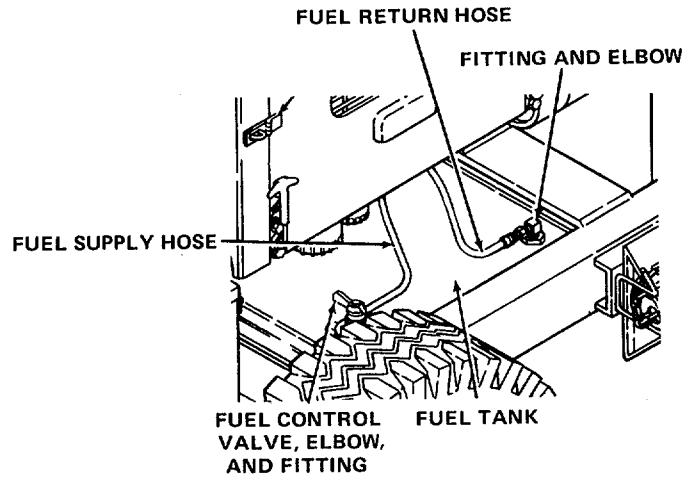
- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

1. Fuel supply and fuel return hoses Tag and disconnect.

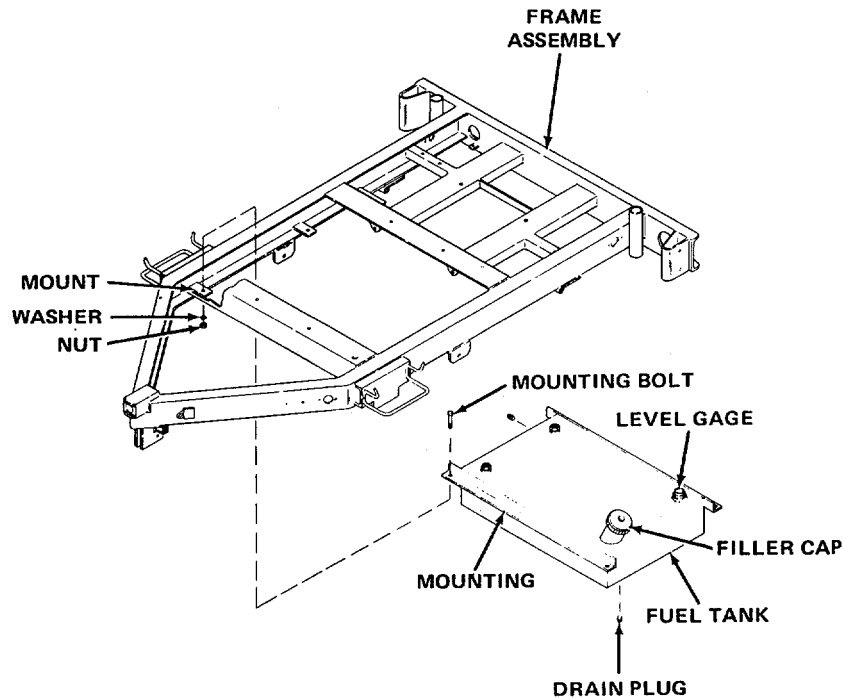
4-26. FUEL TANK (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|---|-----------------------|--|
| 2. Fuel control valve, fittings, and elbows | Remove and set aside. | |
|---|-----------------------|--|



- | | | |
|-----------------------------|---|--|
| 3. Fuel tank drain plug | Remove drain plug and drain fuel completely into metal container. Replace drain plug. | |
| 4. Bolts, nuts, and washers | Remove. | |



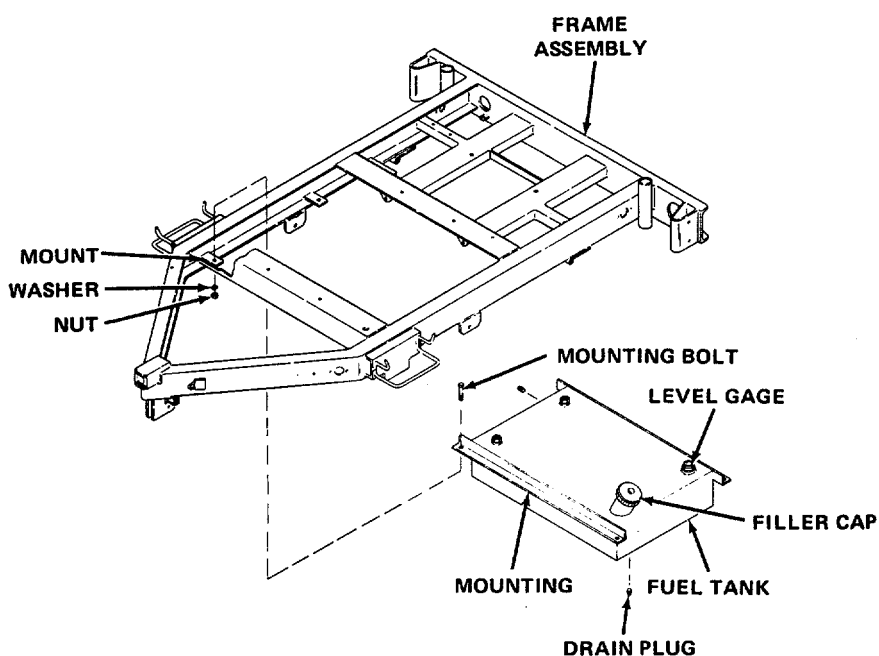
- | | | |
|--------------|--|------------------------------------|
| 5. Fuel tank | Support the fuel tank and move it toward rear of trailer until tank clears mounts on frame assembly. Lower tank to ground and pull out from under trailer. | Notify direct support maintenance. |
|--------------|--|------------------------------------|

4-26. FUEL TANK (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

REPLACEMENT

- | | | |
|-----------------------------|--|--|
| 6. Fuel tank | Position replacement tank under trailer. Support tank and position mountings on frame assembly mounts. | |
| 7. Bolts, nuts, and washers | Install mounting bolts, washers, and nuts. Tighten securely. | |



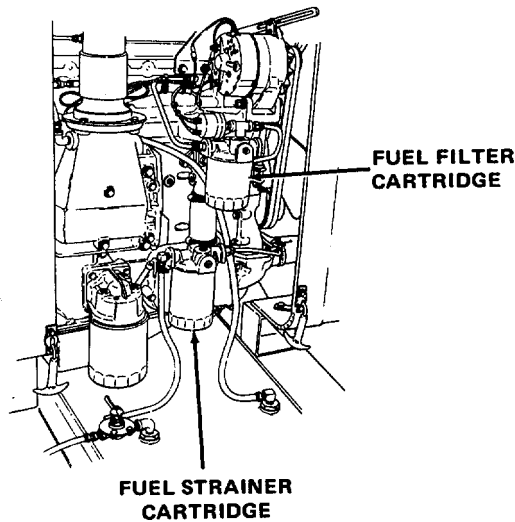
- | | | |
|---|---|--|
| 8. Fuel tank drain plug | Tighten securely. | |
| 9. Fuel control valve, elbows, and fittings | Reinstall on fuel tank. | |
| 10. Fuel supply and fuel return hoses | Reconnect. Remove tags. | |
| 11. Fuel tank | Fill fuel tank and prime the fuel system. | |

4-26. FUEL TANK (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

PRIMING THE FUEL SYSTEM

- | | | |
|--|---|--|
| 12. Fuel strainer and fuel filter cartridges | <p>Remove cartridges and fill each with VV-F-800 diesel fuel oil. Reinstall cartridges hand tight. Remove plug from fuel filter cover. Install fuel system primer. Prime the fuel system. Remove primer and install plug. Tighten securely.</p> | |
|--|---|--|



- | | | |
|------------|---|--|
| 13. Engine | <p>Start engine. If engine does not run smoothly after warmup, notify direct support maintenance.</p> | |
|------------|---|--|

4-27. FUEL LINES, HOSES, AND FITTINGS

This task covers:

- a. Removal
- b. Installation
- c. Priming

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

**Equipment
Condition****Para****Condition Description**

4-23

Alternator drive belts removed.

Materials/Parts

Strainer-to-fuel pump line assembly
Fuel pump-to-filter line assembly
Fuel filter outlet line assembly
Fuel supply-to-strainer hose
Fuel drain hose
Diesel fuel oil (Item 6, Appendix E)
Tie wraps

Special Environmental Conditions

Well-ventilated area required.

General Safety Instructions**WARNING**

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Do not handle fuel near open flame, sparks, or excessive heat.**
- **Be certain fuel lines and connections are secure.**
- **Do not overfill fuel tank.**
- **Work in a well-ventilated area.**

References

Para 4-23 Alternator and fan drive belts
Para 4-28 Fuel strainer and filter

Troubleshooting References

Malfunction 2, step 2

Malfunction 4, step

4-27. FUEL LINES, HOSES, AND FITTINGS (CONT)

Location/Item	Action	Remarks
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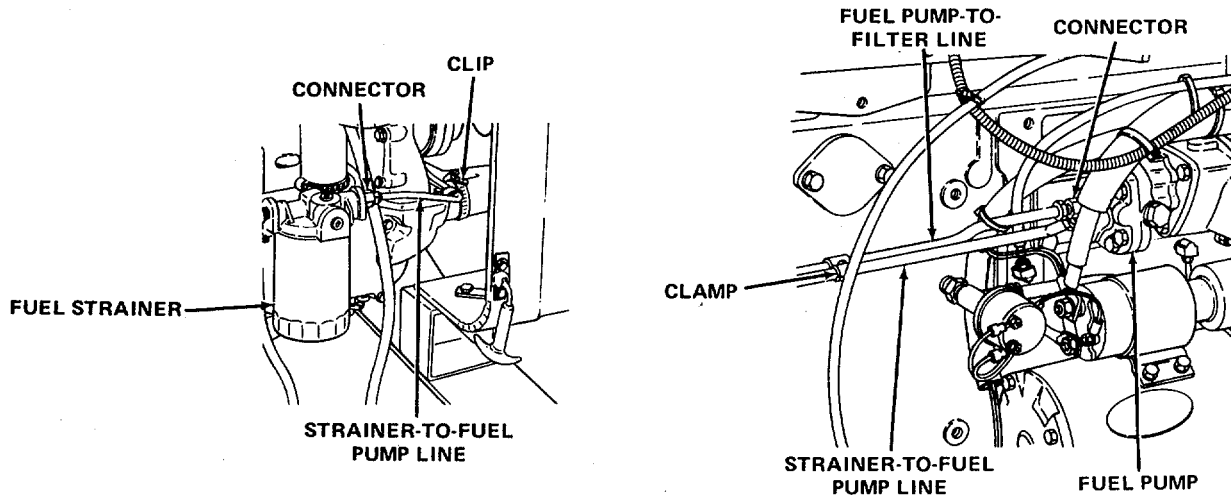
REMOVAL

- | | | |
|-------------------------------|--|--|
| 1. Strainer-to-fuel pump line | Remove clip that secures line to engine block and the clamp that secures it to fuel pump-to-filter line. | |
|-------------------------------|--|--|

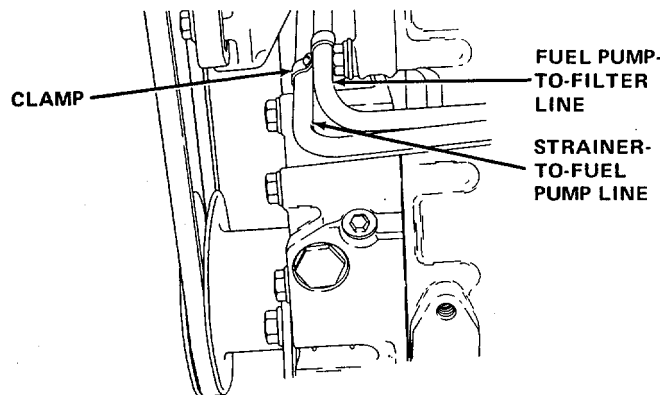
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.



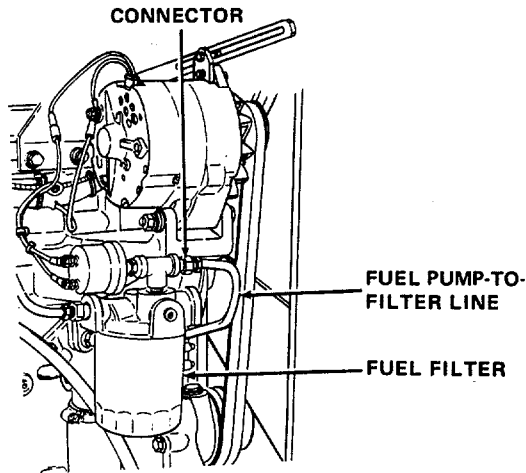
Loosen connectors at fuel strainer and fuel pump, and remove line.



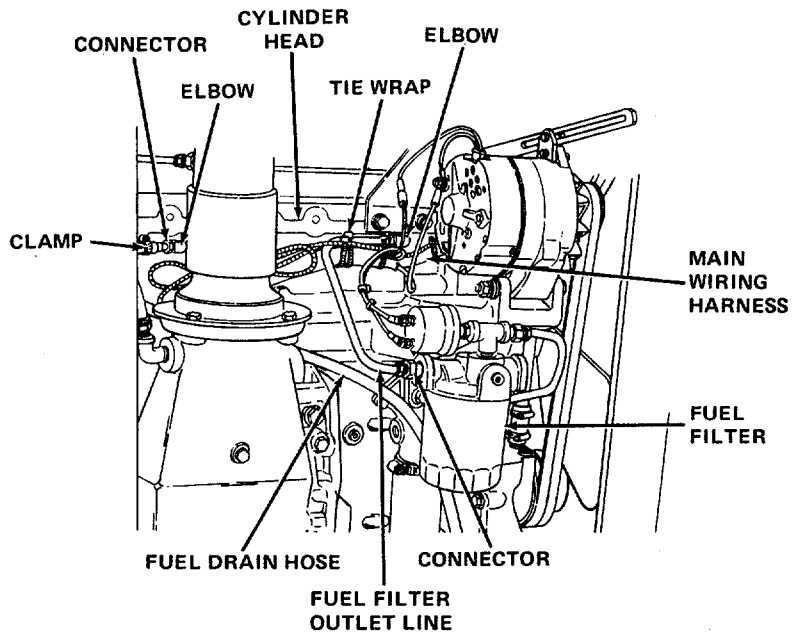
4-27. FUEL LINES, HOSES, AND FITTINGS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-----------------------------|---|--|
| 2. Fuel pump-to-filter line | Remove clip that holds line to engine block and the clamp that secures it to strainer-to-fuel pump line. Loosen connectors at fuel pump and fuel filter, and remove line. | |
|-----------------------------|---|--|



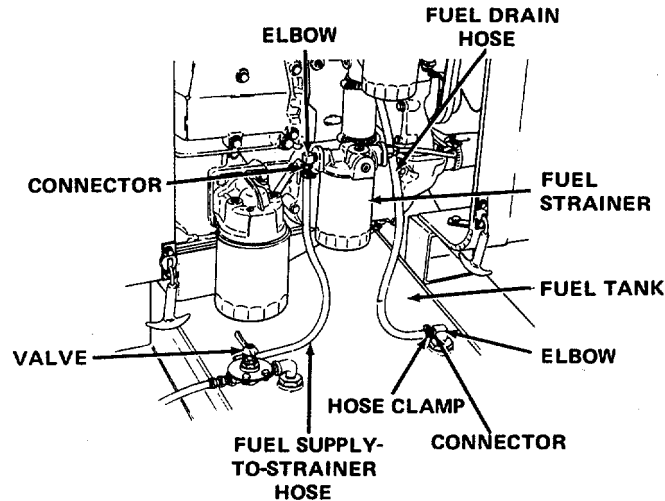
- | | | |
|----------------------------|--|--|
| 3. Fuel filter outlet line | Cut tie wraps fastening main harness to fuel filter outlet line. | |
|----------------------------|--|--|



Loosen connectors at fuel filter and cylinder head elbow, and remove line.

4-27. FUEL LINES, HOSES, AND FITTINGS (CONT)

Location/Item	Action	Remarks
4. Fuel supply-to-strainer hose	Slightly loosen hose clamps at each end of hose. This allows hose connectors to be unscrewed without tangling the hose. Loosen connector at fuel strainer elbow. Allow fuel to drain from hose into tank. Disconnect hose. Remove hose clamps. Remove connector, from hose ends and discard hose.	



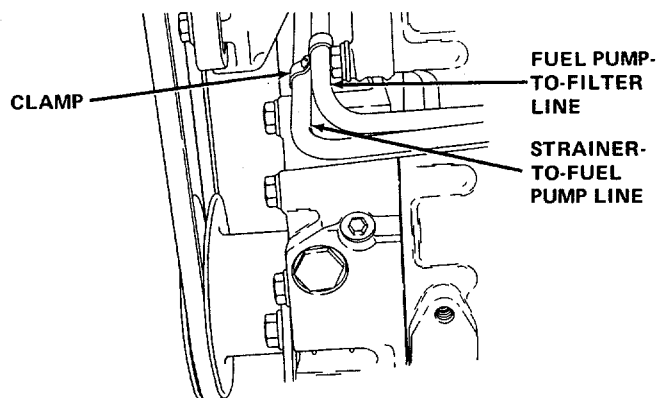
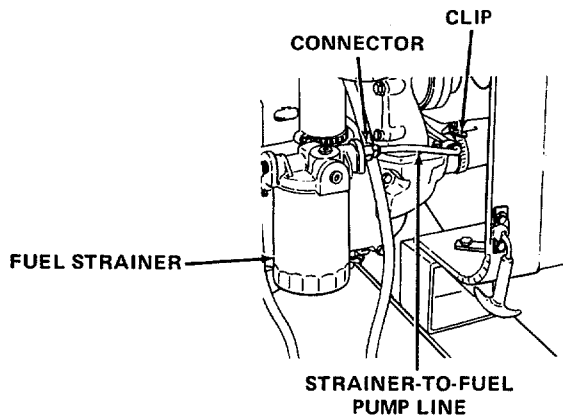
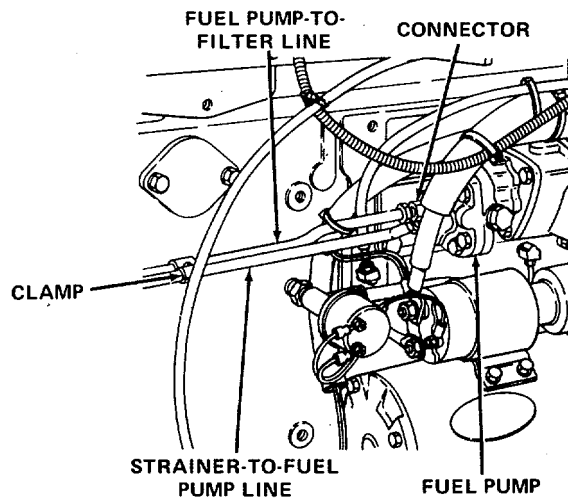
5. Fuel drain hose	Loosen hose clamps and connector at cylinder head elbow, and allow fuel to drain from hose into fuel tank. Then loosen hose clamp and connector at fuel tank elbow and detach hose from both elbows. Remove hose clamps. Remove connectors from hose ends, and discard hose. Inspect connectors and hose clamps for blockage or damage. Replace if necessary.	
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4-27. FUEL LINES, HOSES, AND FITTINGS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSTALLATION

- | | | |
|-------------------------------|---|--|
| 6. Strainer-to-fuel pump line | Carefully position replacement line and connectors near connection points. Loosely connect one end of line to fuel pump and other end to fuel strainer. Loosely attach line to engine block with clip and to fuel pump-to-filter line with clamp. Then securely tighten connectors at fuel strainer and at fuel pump. Tighten clip holding line to engine block and clamp holding line to fuel pump-to-filter-line. | |
|-------------------------------|---|--|

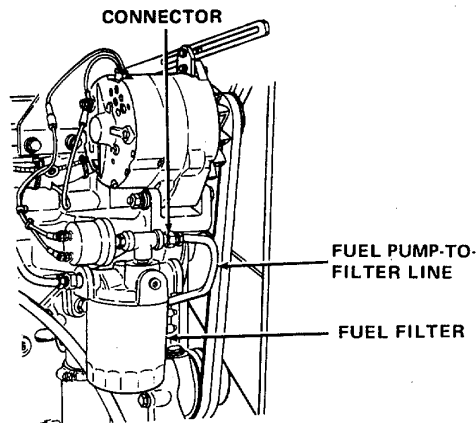


NOTE

If no other lines are to be replaced, install alternator drive belts and adjust tension as described in paragraph 4-23.

4-27. FUEL LINES, HOSES, AND FITTINGS (CONT)

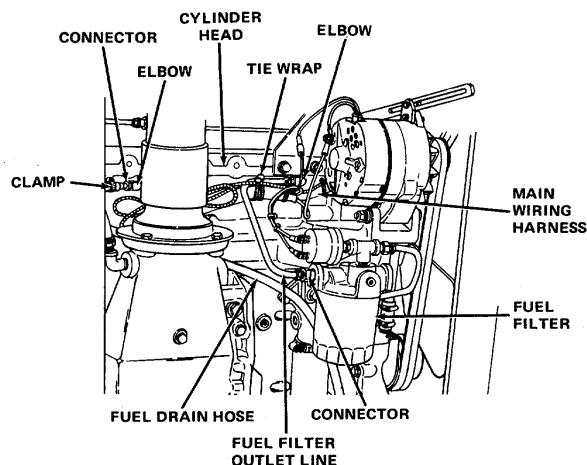
Location/Item	Action	Remarks
7. Fuel pump-to-filter line	Carefully position replacement line between fan drive belts and engine block, and near connection points. Loosely connect one end of line to fuel pump and other end to fuel filter. Loosely attach line to engine block with clip and to strainer-to-fuel pump line with clamp. Then tighten connectors at fuel filter and fuel pump. Tighten clamp holding line to strainer-to-fuel pump line.	



NOTE

If no other lines are to be replaced, install alternator drive belts as described in paragraph 4-23.

8. Fuel filter outlet line	Loosely connect one end of replacement line to cylinder head elbow and other end to connector at fuel filter. Tighten both ends of line securely. Use new tie wraps to secure main wiring harness to fuel filter outlet line.
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4-27. FUEL LINES, HOSES, AND FITTINGS (CONT)

Location/Item	Action	Remarks
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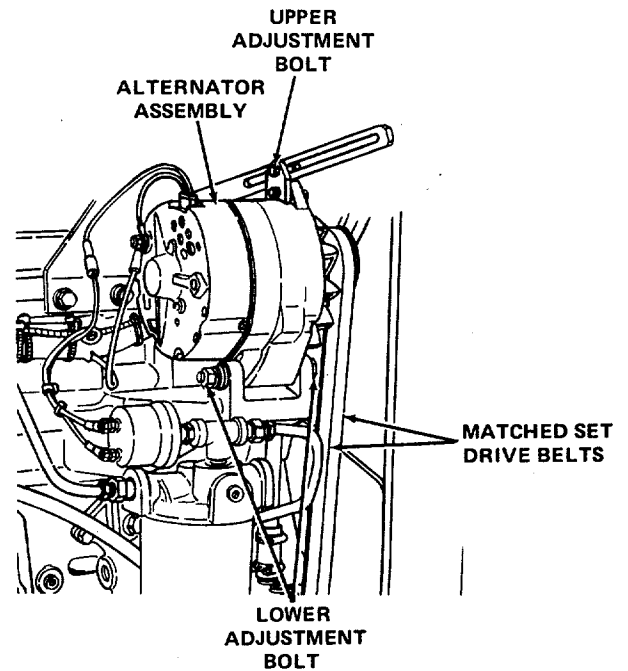
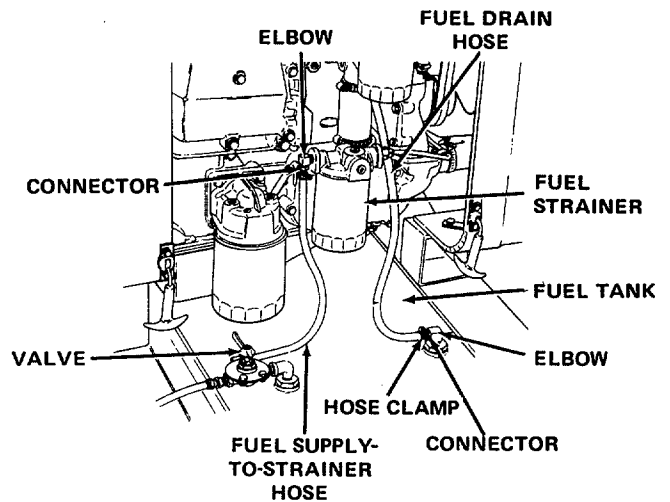
CAUTION

Damage to hoses will result if hose clamps are overtightened. Tighten hose clamps until hoses are snug.

9. Fuel supply-to-strainer hose
Loosely connect one end of hose to fuel tank valve, and other end to fuel strainer elbow. Tighten connectors and straighten hose before tightening hose clamps.

10. Fuel drain hose
Install connectors in hose ends. Position and tighten hose clamps slightly. Connect one end of hose to fuel tank elbow and other end to cylinder head elbow. Tighten connectors. Straighten hose before tightening hose clamps.

11. Alternator drive belts
Install alternator drive belts as described in paragraph 4-23.



4-27. FUEL LINES, HOSES, AND FITTINGS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

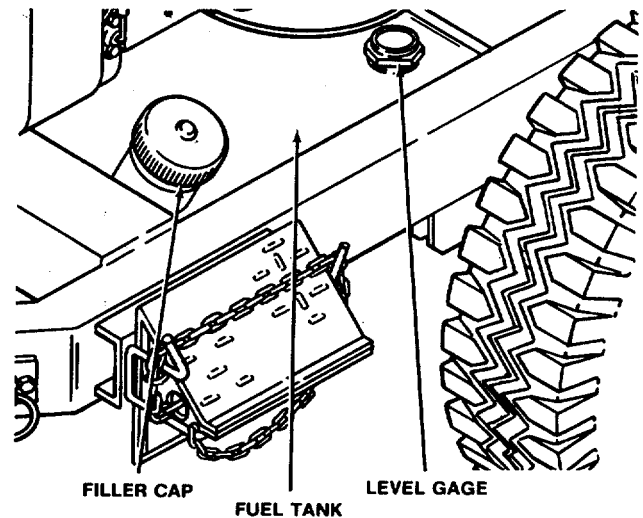
PRIMING

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

- | | |
|---------------|--|
| 12. Fuel tank | Fill fuel tank with a minimum of 10 gallons of VV-F-800 diesel fuel. |
|---------------|--|

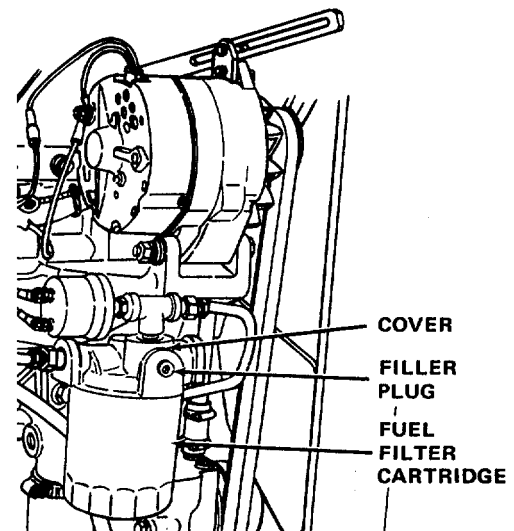


- | | |
|------------------------------|---|
| 13. Fuel strainer and filter | Remove fuel strainer and fuel filter cartridges, and fill each with diesel fuel. Install both cartridges. |
|------------------------------|---|

- | | |
|-----------------|---|
| 14. Filler plug | Remove filler plug in fuel filter cover and install a fuel system primer. |
|-----------------|---|

- | | |
|------------------------|--------------------------------------|
| 15. Fuel system primer | Prime the system. Remove the primer. |
|------------------------|--------------------------------------|

- | | |
|-----------------|---|
| 16. Filler plug | Replace filler plug in fuel filter cover. |
|-----------------|---|



4-27. FUEL LINES, HOSES, AND FITTINGS (CONT)

Location/Item	Action	Remarks
WARNING		
Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.		
Fumes from engines become concentrated with poor ventilation.		
<ol style="list-style-type: none"> <li>1. Operate engine in a ventilated area only. <li>2. Ventilate personnel compartments when idling engine. <li>3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available. 		
GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.		
17. Fuel lines, strainer, and filter	Start engine and check for leaks at fuel line, filter, and strainer connection points. If leaks are present, tighten connections slightly. If leakage continues, replace connector, line, strainer cartridge, or filter cartridge as needed.	

4-28. FUEL STRAINER AND FILTER,

This task covers:

- a. Cartridge removal
 - b. Cartridge replacement
-

INITIAL SETUP
Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Materials/Parts

Fuel strainer cartridge
Fuel filter cartridge

Diesel fuel oil (Item 6, Appendix E)

Troubleshooting References

Malfunction 2, step 2

Equipment Condition

Engine right side panel removed.

Special Environmental Conditions

Well-ventilated area required.

General Safety Instructions
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

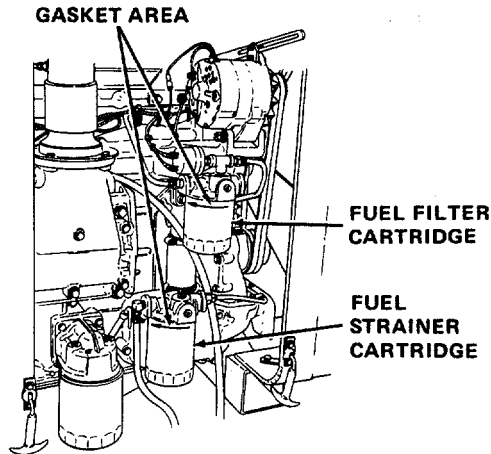
1. Operate engine in a ventilated area only.
 2. Ventilate personnel compartments when idling engine.
 3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.
- GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.**

4-28. FUEL STRAINER AND FILTER (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|--------------------------------------|---|
| 1. Fuel filter or strainer cartridge | Unscrew fuel strainer or filter counterclockwise and discard. |
|--------------------------------------|---|



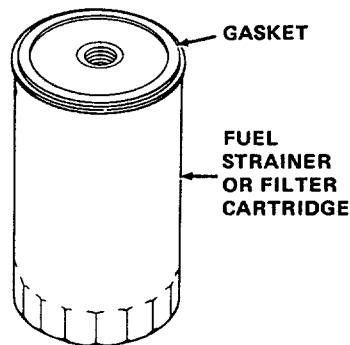
REPLACEMENT

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

- | | |
|--------------------------------------|--|
| 2. Fuel filter or strainer cartridge | Fill replacement filter or strainer cartridge about two-thirds full of clean fuel oil. Coat gasket lightly with clean fuel oil. Install strainer or filter hand tight. |
|--------------------------------------|--|



- | | |
|------------------------|---|
| 3. Engine gasket area. | Start engine and check for leakage around |
|------------------------|---|

4-29. FUEL INJECTORS

This task covers:

a. In-Place Inspection

INITIAL SETUP

Equipment Condition

Engine right side panel removed.

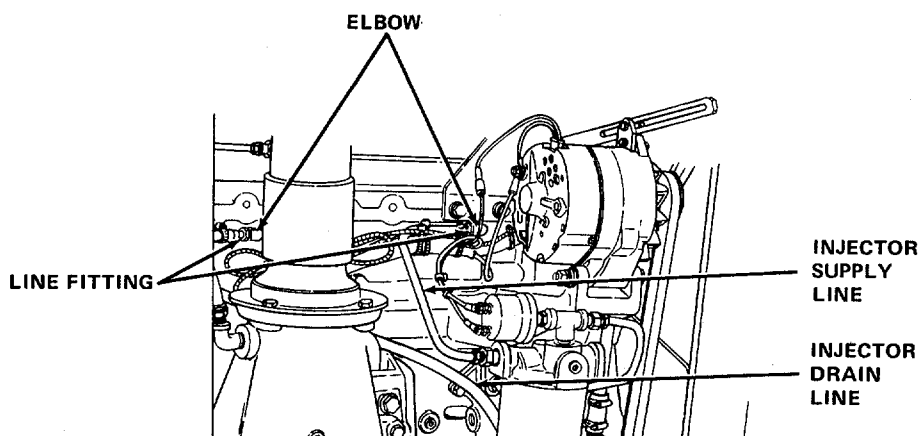
Troubleshooting Reference

Malfunction 3, step 3

Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

- | | | |
|-------------------------|---|--|
| 1. Injector supply line | Inspect for leaks at elbow and line fitting. | |
| 2. Injector drain line | Inspect for leaks at elbow and line fitting. | |
| 3. Crankcase oil level | Inspect for overfull condition caused by fuel oil leaking from injectors. Fuel oil may also be present on dipstick. | |



4-30. STARTING AID CONTROL CABLE

This task covers:

a. Removal

b. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Troubleshooting References

Malfunction 2, step 1

Materials/Parts

Starting aid control cable
Tie wraps

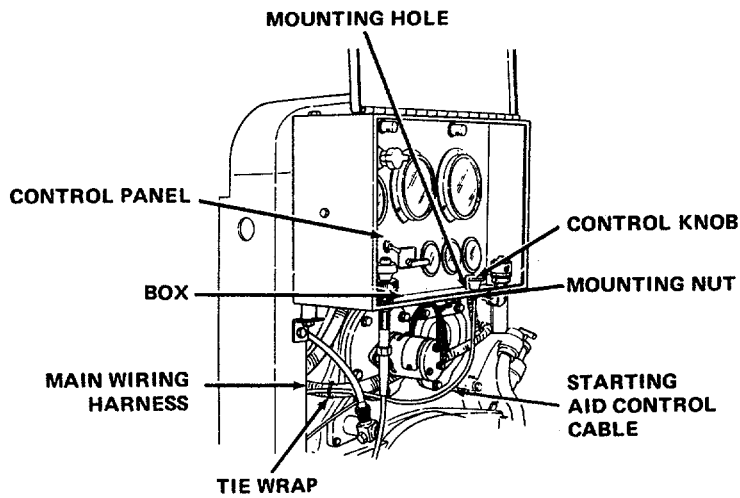
Equipment Condition

Engine left side panel removed.

Location/Item	Action	Remarks
---------------	--------	---------

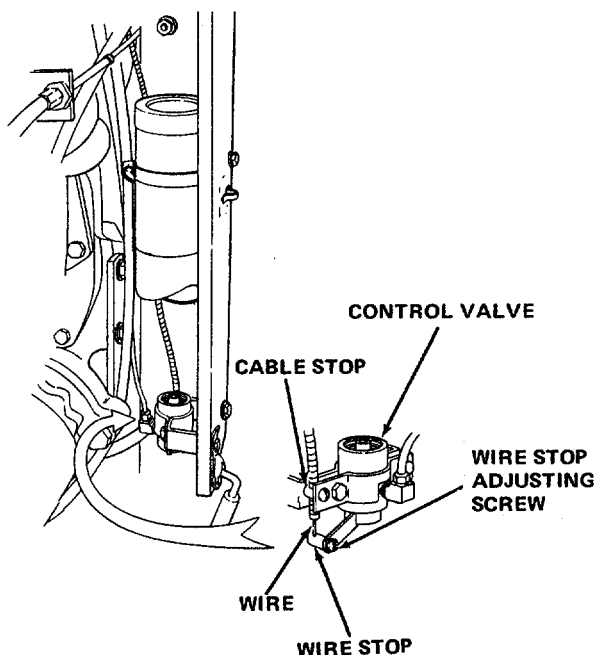
REMOVAL

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Mounting nut 2. Tie wraps | <p>Loosen; let nut slide down on cable.</p> <p>Cut tie wraps securing control cable to main wiring harness.</p> |
|---|---|



4-30. STARTING AID CONTROL CABLE (CONT)

Location/Item	Action	Remarks
3. Wire stop adjusting screw	Loosen several turns until wire slides away from control valve, out of wire stop and cable guide.	
4. Control cable	Slide up and out of control panel box. Remove mounting nut from cable.	

**REPLACEMENT**

5. Control cable Remove mounting nut from replacement control cable. Slide cable through mounting hole in control panel box.
6. Mounting nut Slide nut up control cable and tighten.
7. Control cable Push control knob in all the way. Route cable over to control valve; slip cable into cable guide and wire into wire stop.
8. Wire stop Adjust for maximum wire length between wire stop and cable guide. Tighten wire stop adjusting screw.
9. Tie wraps Use new tie wraps to secure control cable to main wiring harness.
10. Control cable Test cable operation. If necessary, adjust wire in wire stop.

4-31. ETHER CYLINDER

This task covers:

a. Removal

b. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Equipment Condition

Engine left side panel removed.

General Safety Instructions

WARNING

Materials/Parts

Ether cylinder

Troubleshooting References

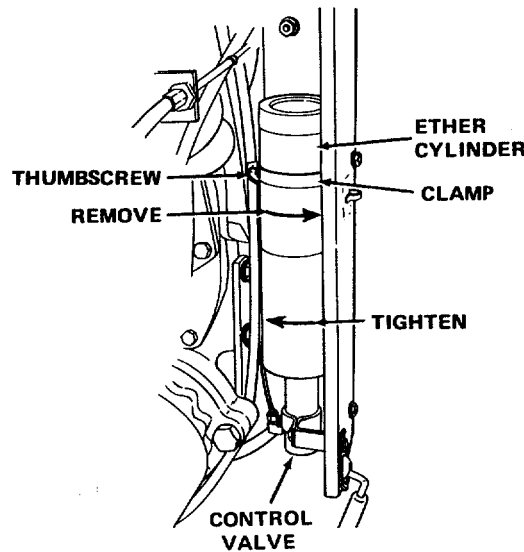
Malfunction 2, step 1

Handle ether starting aid fluid cylinder carefully. Ether is highly flammable. Do not use near sparks or open flames. Do not inhale fumes.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

1. Ether cylinder
Loosen thumbscrew several turns and unscrew cylinder counterclockwise.



REPLACEMENT

2. Ether cylinder
Slip replacement cylinder through clamp and into control valve assembly. Tighten. Tighten thumbscrew on clamp. If cylinder leaks at control valve, tighten cylinder slightly.

4-32. ATOMIZER

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Troubleshooting References

Malfunction 2, step 1

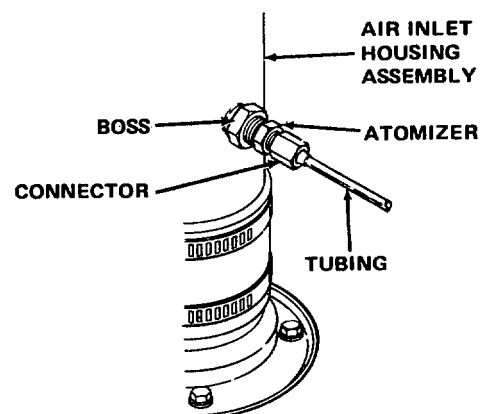
Materials/Parts

Atomizer

Equipment Condition

Engine right side panel removed.

Location/Item	Action	Remarks
REMOVAL		
1. Atomizer tubing	Disconnect atomizer tubing from atomizer at connector.	
2. Atomizer	Remove atomizer from boss on air inlet housing pipe.	



REPLACEMENT

- | | |
|----------------------|---|
| 3. Atomizer tighten. | Screw replacement atomizer into boss and tighten. |
| 4. Atomizer tubing | Connect tubing to atomizer at connector. Tighten. |

4-33. OIL FILTER

This task covers:

- a. Cartridge Removal
- b. Cartridge Installation

INITIAL SETUP:

Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Troubleshooting References

Malfunction 6, step 3

Materials/Parts

Oil filter
Lubricating oil (Item 10, Appendix E)

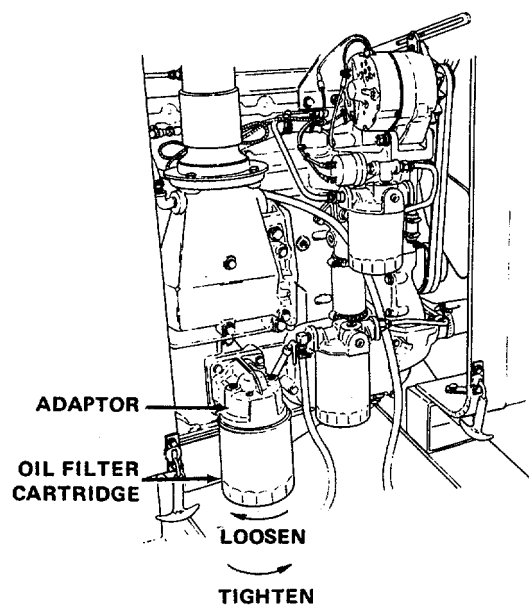
Equipment Condition

Engine right side panel removed

Location/Item	Action	Remarks
---------------	--------	---------

CARTRIDGE REMOVAL

- | | |
|-------------------------|--|
| 1. Oil filter cartridge | Unscrew cartridge counterclockwise and -j discard. |
|-------------------------|--|

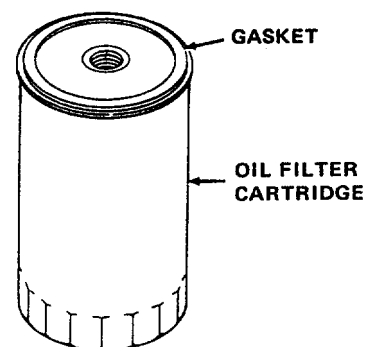


4-33. OIL FILTER (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CARTRIDGE INSTALLATION I

- | | | |
|-------------------------|---|--|
| 2. Oil filter cartridge | Coat the gasket of replacement cartridge with clean lubricating oil (MIL-L-2104) and install. Tighten hand tight. | |
|-------------------------|---|--|



4-34. LOW OIL PRESSURE CUTOUT SWITCH

This task covers:

- a. Test
 - b. Removal
 - c. Installation
-

INITIAL SETUP:
Test Equipment

Multimeter

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop equipment, automotive maintenance
and repair, common no. 1
NSN 4910-00-734-0654

Materials/Parts

Low oil pressure cutout switch
Personnel Required: 2

Mechanic will crank engine and read oil
pressure gage.

Equipment Condition

Engine left side panel removed.

Special Environmental Conditions

Well-ventilated area required.

General Safety Instructions
WARNING

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation .

1. **Operate engine in a ventilated area only.**
2. **Ventilate personnel compartments when idling engine.**
3. **While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still, give artificial respiration if needed. Seek medical attention. Administer oxygen, if available .**

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING .

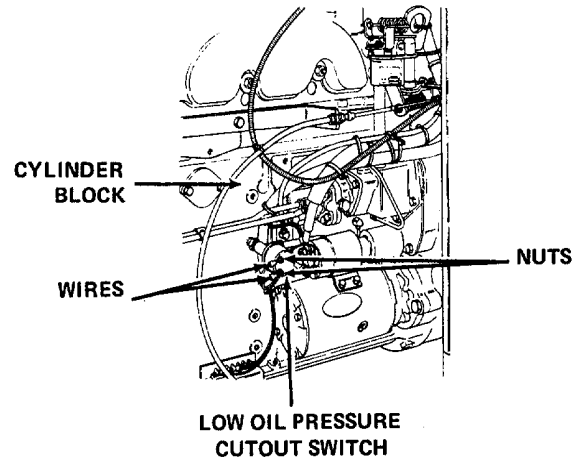
4-34. LOW OIL PRESSURE CUTOUT SWITCH (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

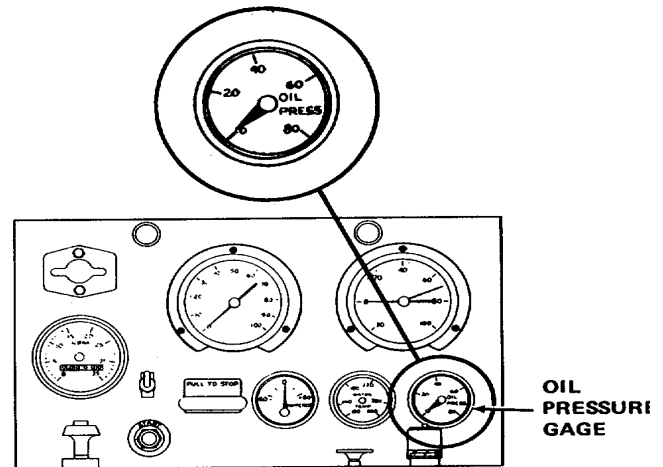
TEST

1. Low oil pressure cutout switch

Tag wires on switch for easy identification during reconnection. Remove nuts and wires from switch terminals. Using a multimeter, test switch as follows:



- a. Select OHMS function on meter and plug leads into OHMS jacks. Turn range switch to RX10 scale. Short the two leads together and set the indicator pointer to zero ohms.
- b. Simultaneously touch one lead to each terminal. Meter shall indicate INFINITY (NO CONTINUITY).
- c. While holding leads to terminals, crank engine to produce 10 psi reading on oil pressure gage. At 10 psi oil pressure the switch should close (meter reads 0).



If meter does not indicate 0 (zero) at 10 psi oil pressure, replace switch. If switch operation is satisfactory, connect wires to appropriate terminals on switch, install nuts and tighten securely.

4-34. LOW OIL PRESSURE CUTOUT SWITCH (CONT)

Location/Item	Action	Remarks
REMOVAL		
2. Wires	Tag wires for identification. Remove terminal nuts. Remove wires. Note relative position of terminals.	
3. Low oil pressure cutout switch	Unscrew switch from female pipe tee on cylinder block, and discard.	
INSTALLATION		
4. Low oil pressure cutout switch	Screw replacement switch into female pipe tee in cylinder block. Tighten securely. Make sure terminals are positioned approximately the same as observed in step 2, above.	
5. Wires	Install wires as described on tags. Remove tags. Install terminal nuts and tighten securely.	

4-35. OIL LINES, FITTINGS, AND OIL PRESSURE GAGE TUBE ASSEMBLY

This task covers:

- a. Removal
- b. Installation
- c. Test

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Troubleshooting References

Malfunction 6, step 3

Malfunction 7, step 3

Materials/Parts

Oil line
Fittings (4)
Oil pressure gage tube assembly
Tie wraps

Equipment Condition

Engine left side panel removed.

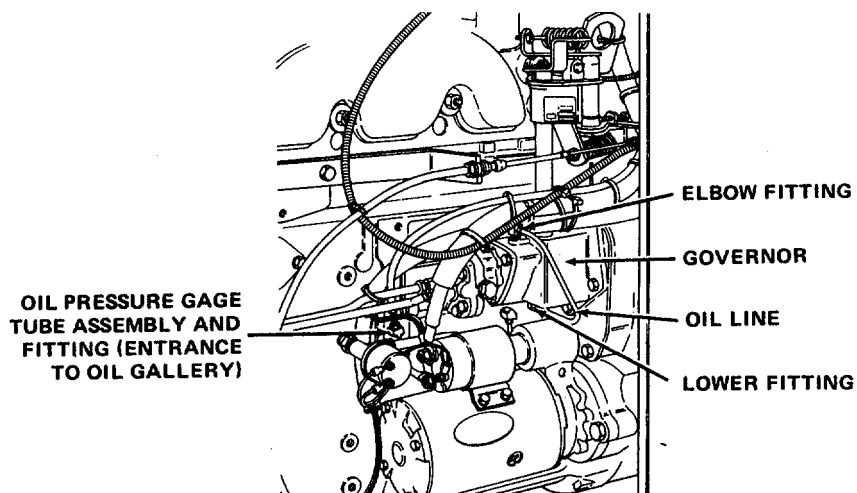
Special Environmental Conditions

Well-ventilated area required.

Location/Item	Action	Remarks
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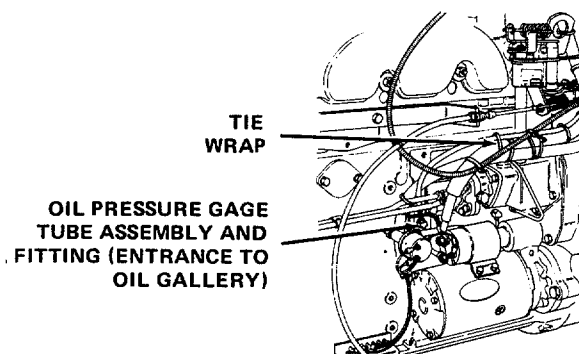
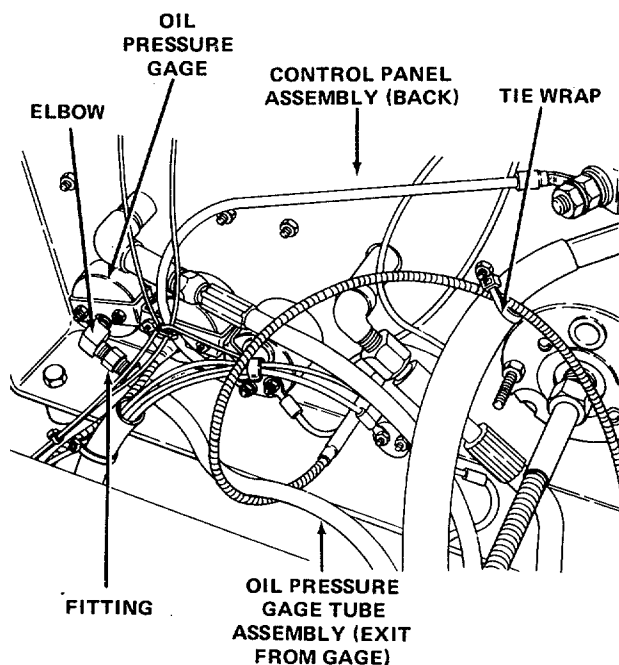
REMOVAL

- | | | |
|----------------------|--|--|
| 1. Governor oil line | Loosen and disconnect at lower fitting and at elbow fitting. Remove. | |
|----------------------|--|--|



4-35. OIL LINES, FITTINGS, AND OIL PRESSURE GAGE TUBE ASSEMBLY (CONT)

Location/Item	Action	Remarks
2. Oil pressure gage tube assembly	Remove tube assembly from elbow on back of oil pressure gage. Cut tie wraps as necessary to remove tube. Remove tube end from female pipe tee on cylinder block.	



INSTALLATION

3. Governor oil line
Position and loosely connect governor oil line at elbow fitting and at lower fitting. Tighten oil line securely at both fittings.
4. Oil pressure gage tube assembly
Install male pipe thread end of hose into female pipe tee on cylinder block. Tighten securely. Using tie wraps, attach tube to main wiring harness. Run tube to back of oil pressure gage located in control panel assembly. Thread hose fitting onto elbow on pressure gage. Bleed air from the tube assembly by cranking the engine. Tighten tube swivel securely on elbow when bleeding is completed.

4-35. OIL LINES, FITTINGS, AND OIL PRESSURE GAGE TUBE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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TEST

WARNING

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

- 1. Operate engine in a ventilated area only.**
- 2. Ventilate personnel compartments when idling engine.**
- 3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.**

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

- | | |
|------------------------------------|--|
| 5. Oil pressure gage tube Assembly | Start engine. Check tube and fittings for signs of leakage. Tighten as necessary to stop leaks. |
| 6. Governor oil line leaks. | With engine running, check line and fittings for signs of leakage. Tighten as necessary to stop Stop engine. |

4-36. COOLING FAN ASSEMBLY

This task covers:

- a. Removal
- b. Inspection/Replacement
- c. Installation

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Materials/Parts

Cooling fan assembly
Diesel fuel oil (Item 6, Appendix E)

Equipment Condition

Para

Condition Description

4-38

Radiator and shell removed.

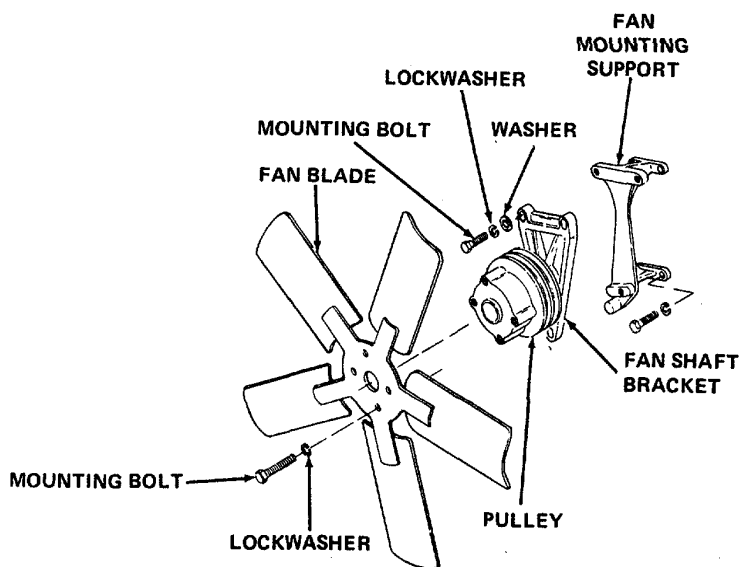
4-23

Fan drive belt removed.

Location/Item	Action	Remarks
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REMOVAL

1. Fan blade Remove mounting bolts and lockwashers. Remove fan blade.
2. Fan shaft bracket Remove mounting bolts, lockwashers, and washers. Remove fan shaft bracket, shaft assembly, and pulley as a unit.
3. Fan mounting support Do not remove unless damaged and replacement is necessary.



4-36. COOLING FAN ASSEMBLY (CONT)

Location/Item	Action	Remarks
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INSPECTION/REPLACEMENT**WARNING**

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | | |
|-----------------------|---|--|
| 4. Fan shaft assembly | Clean fan blade; assembled pulley, shaft bracket, and shaft assembly; and mounting hardware with clean VV-F-800 diesel fuel. Dry with compressed air. Rotate fan shaft assembly and bearings. If bearings are rough or tight notify direct support maintenance. | |
| 5. Pulley | Inspect pulley for excessive rust, corrosion, worn grooves, cracks, or other damage. Notify direct support maintenance if pulley is damaged. | |
| 6. Fan blade | Inspect fan blade for excessive rust or corrosion, bends, cracks, or other damage. Replace fan blade if damaged. | |
| 7. Fan shaft bracket | Inspect fan shaft bracket for excessive rust, corrosion, or other damage. If bracket is damaged, notify direct support maintenance. | |
| 8. Mounting hardware | Inspect mounting hardware for rust, corrosion, or damaged or stripped threads. Replace hardware if damaged. | |

INSTALLATION

- | | | |
|---|--|--|
| 9. Fan shaft bracket assembly and pulley unit | Position fan shaft bracket assembly, and pulley as a unit on engine. Install mounting bolts, lockwasher, and washers and tighten hand tight. Slip fan drive belts over pulley. | |
| 10. Fan blade | Position fan blade on pulley with holes alined and install mounting bolts and lockwashers. Adjust belt tension in accordance with table 4-1, Item 1. | |
-

4-37. WATER PUMP

This task covers:

- a. Removal
- b. Installation/Replacement
- c. Test

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Gaskets (2)
Lockwashers (5)
Antifreeze (Item 3, Appendix E)

Shop equipment, automotive maintenance
and repair, common no. 1
NSN 4910-00-754-0654

**Equipment
Condition**

Para	Condition Description
4-23	Alternator drive belts loosened.

Materials/Parts

Water pump
Mounting bolts (5)

Special Environmental Conditions
Well-ventilated area required

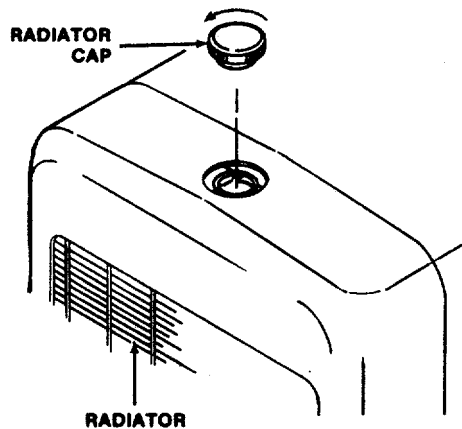
Location/Item	Action	Remarks
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REMOVAL

WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in coolant system is released, then remove cap.

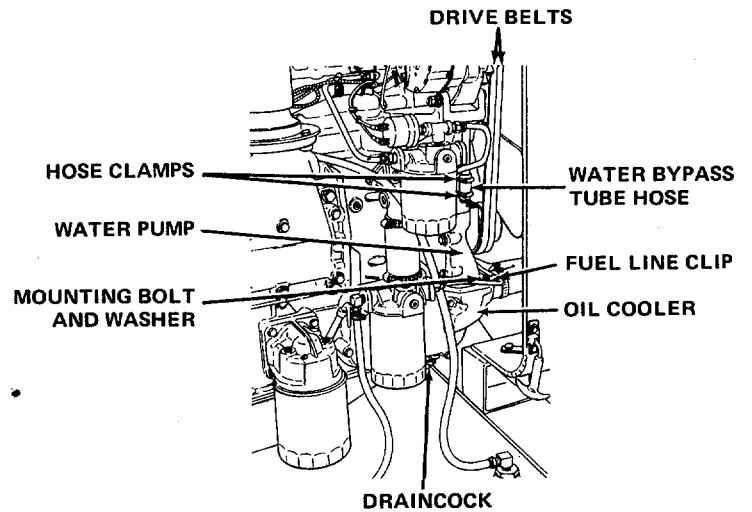
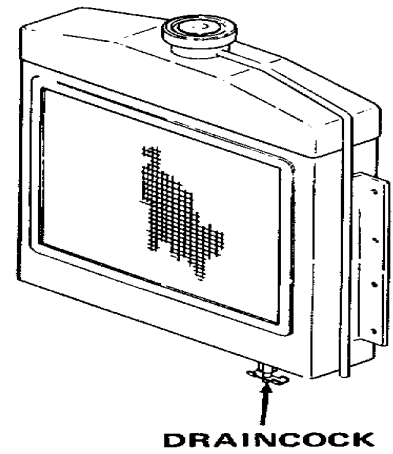
1. Radiator cap Remove.



4-37. WATER PUMP (CONT)

Location/Item	Action
2. Draincock	Loosen. Drain contents of coolant system into suitable container.
3. Drive belts	Remove from water pump pulley.
4. Water bypass tube hose	Loosen hose clamps and remove hose.

Remarks



4-37. WATER PUMP (CONT)

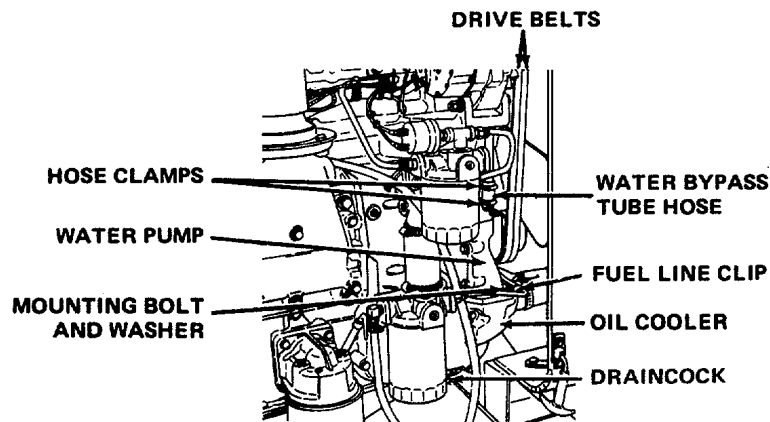
Location/Item	Action	Remarks
5. Mounting bolts and lockwashers	Remove from base of water pump. Move fuel line clip away from base of pump.	
6. Water pump	Remove from parting surface of oil cooler.	
7. Gasket	Remove. Scrape surface of oil cooler as required to remove all portions of gasket remaining on parting surface.	

INSTALLATION/REPLACEMENT

NOTE

Make sure that surfaces of pump and oil cooler that contact gasket are free of cracks and damage that may prevent seal.

8. Gasket	Place gasket on parting surface of oil cooler, align holes.
9. Water pump	Place pump on gasket and align holes in pump body with those in gasket and oil cooler. Position fuel line clip onto bolt hole, as before.
10. Mounting bolts and lockwashers	Install through base of pump and into oil cooler threaded holes. Make sure that fuel line clip is held by bolt. Tighten securely.
11. Water bypass tube hose	Place clamp over hose ends. Install onto pump and tube. Position clamps over ends of hose and tighten securely.



4-37. WATER PUMP (CONT)

Location/Item	Action	Remarks
12. Drive belts	Place onto water pump pulley and tighten as described in paragraph 4-23.	
13. Draincock	Close.	
14. Cooling system	Fill. Use coolant drained in step 2, above, or fill with a fresh solution of 50% water and 50% antifreeze conforming to MIL-A-46153.	
15. Radiator cap	Install.	

TEST**WARNING**

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

- 1. Operate engine in a ventilated area only.**
- 2. Ventilate personnel compartments when idling engine.**
- 3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.**

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

- | | | |
|-----------|--|--|
| 16. Leaks | Start engine and check for leaks at pump parting surface and hose clamps. Inspect draincocks for leakage. Tighten mounting bolts, hose clamps, and draincocks as required to stop leaks. Do not overtighten. | |
|-----------|--|--|

4-38. RADIATOR

This task covers:

- a. Removal
- b. Installation/Replacement
- c. Test

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop equipment, automotive maintenance
and repair, common no.
NSN 4910-00-754-0654

Materials/Parts

Radiator assembly
Antifreeze (Item 3, Appendix E)

Equipment Condition

Engine side panels removed.

1

Special Environmental Conditions

Well-ventilated area required.

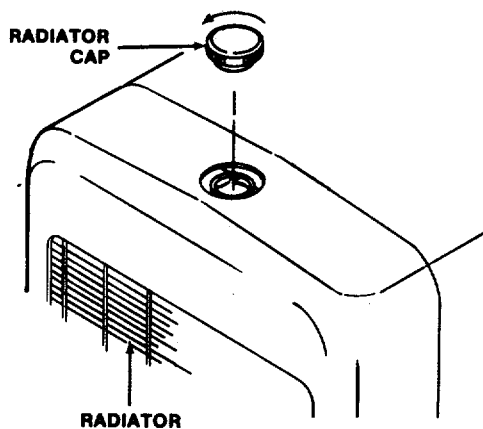
Location/Item	Action	Remarks
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REMOVAL

WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in coolant system is released, then remove cap.

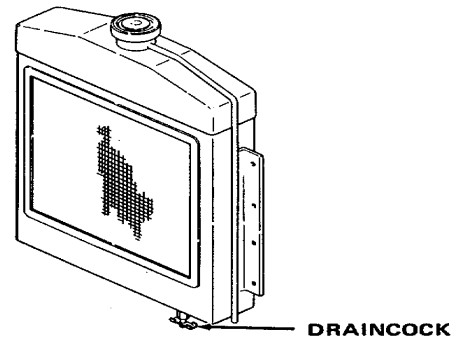
1. Radiator cap Remove.



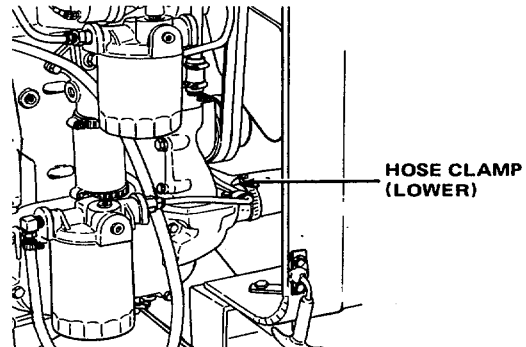
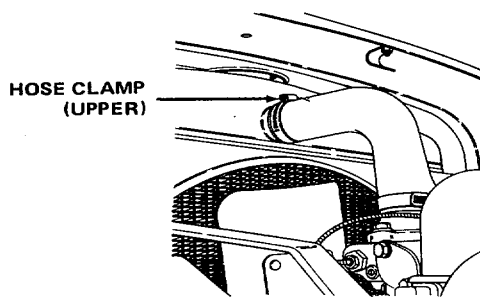
4-38. RADIATOR (CONT)

Location/Item	Action	Remarks
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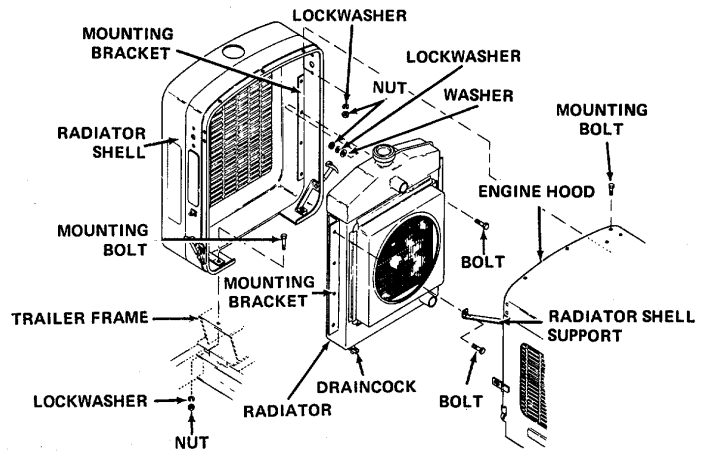
- | | | |
|--------------|---|--|
| 2. Draincock | Loosen. Drain coolant into a container. | |
|--------------|---|--|



- | | | |
|-------------------------------------|---|--|
| 3. Radiator hoses (upper and Lower) | Loosen hose clamps at radiator. Remove hoses from radiator. | |
|-------------------------------------|---|--|



- | | | |
|----------------|--|--|
| 4. Engine hood | Support during disassembly by placing a wooden block between top of engine and under-side of hood. Make sure that hood is not stressed during removal of radiator shell. Remove mounting bolts, lockwashers, and nuts from radiator end of hood. | |
|----------------|--|--|

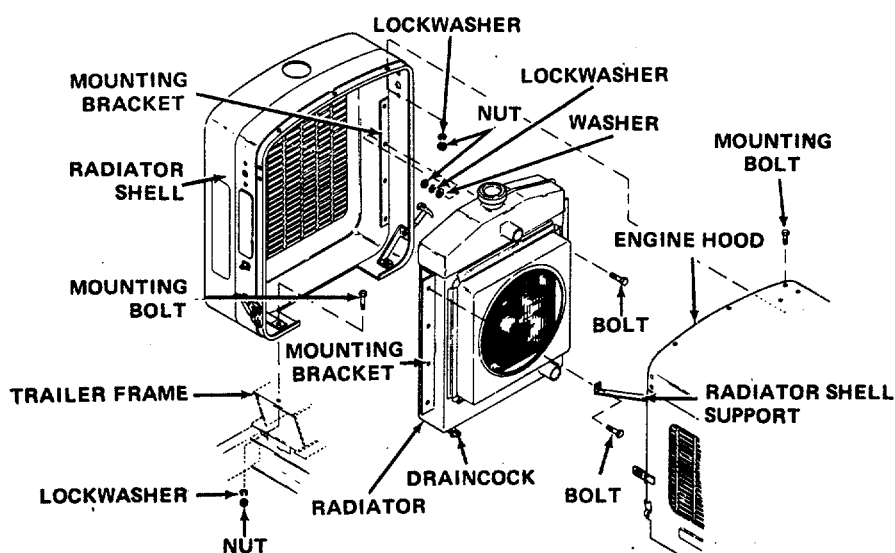


4-38. RADIATOR (CONT)

Location/Item	Action	Remarks
5. Radiator shell with radiator	Support shell and radiator during removal. Remove mounting bolts, lockwashers, and nuts attaching base of shell to trailer frame. Remove bolts, lockwashers, and nuts attaching radiator shell support to radiator.	-
6. Radiator	Remove from shell by removing remaining bolts, lockwashers, and nuts from mounting brackets.	

INSTALLATION/REPLACEMENT

7. Radiator
 Install into radiator shell and attach using bolts, lockwashers, and nuts removed in step 6, above. Tighten securely. Do not install bolts used to attach shell support to shell at this time.

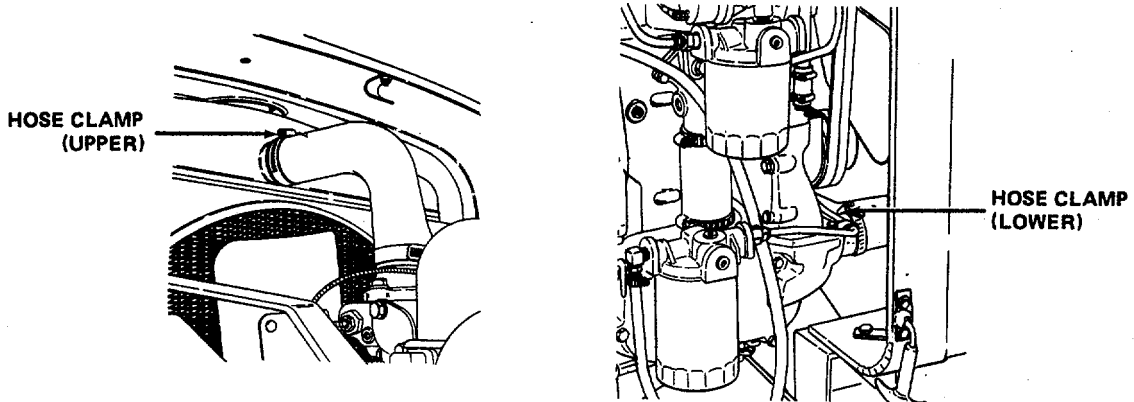


8. Radiator shell
 Place assembled shell and radiator onto with radiator trailer frame. Install bolts through shell and into frame; secure with lockwashers and nuts. Tighten securely. Install bolts through radiator shell support and into mounting brackets for radiator; secure with washers and nuts. Tighten securely.

4-38. RADIATOR (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-------------------------------------|---|--|
| 9. Radiator hoses (upper and lower) | Place radiator hose ends over respective ports. Install and tighten clamps. | |
|-------------------------------------|---|--|



- | | | |
|--------------------|--|--|
| 10. Engine hood | Remove hood support block. Using mounting bolts, lockwashers, and nuts, assemble hood to radiator shell. Tighten securely. | |
| 11. Draincock | Close. | |
| 12. Cooling system | Fill. Use coolant drained in step 2, above, or fill with a fresh solution of 50% water and 50% antifreeze conforming to MIL-A-46153. | |
| 13. Radiator cap | Install. | |

4-38. RADIATOR (CONT)

Location/Item	Action	Remarks
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TEST**WARNING**

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

1. Operate engine in a ventilated area only.
2. Ventilate personnel compartments when idling engine.
3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

- | | | |
|-----------|---|--|
| 14. Leaks | Start engine and check for leaks at hose ends and in radiator core. Tighten hose clamps as required. Replace radiator if leak is in core. | |
|-----------|---|--|
-

4-39. THERMOSTAT

This task covers:

- a. Removal
- b. Installation/Replacement
- c. Test

INITIAL SETUP:

Test Equipment

None

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Materials/Parts

Thermostat
Water outlet flange gasket
Antifreeze (Item 3, Appendix E)

Troubleshooting References

Malfunction 1, step 4
Malfunction 4, step 2
Malfunction 5, step 3
Malfunction 8, step 2

Equipment Condition

Engine side panels will be removed.

Special Environmental Conditions

Sufficient ventilation will be provided.

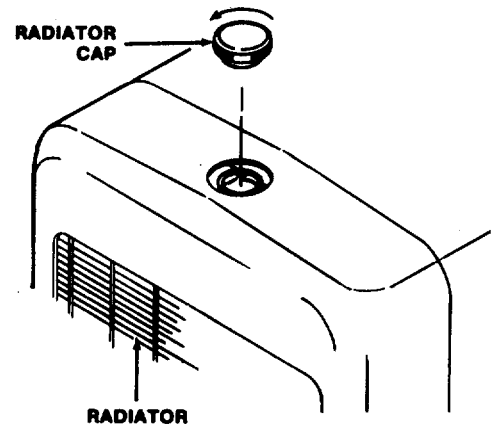
Location/Item	Action	Remarks
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REMOVAL

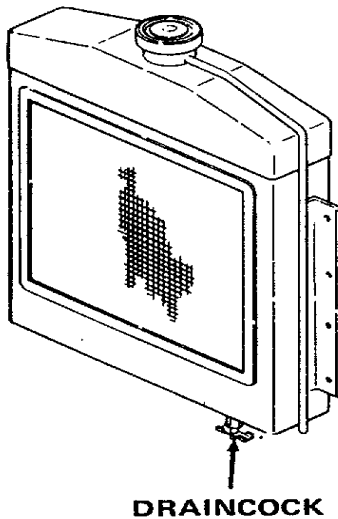
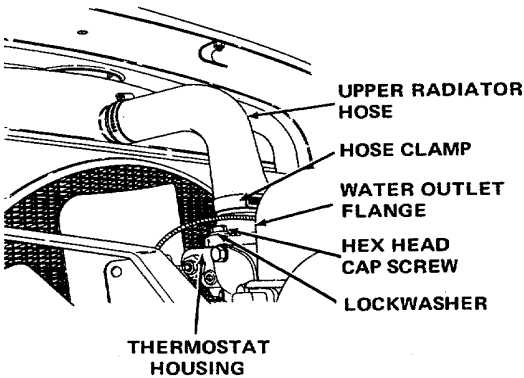
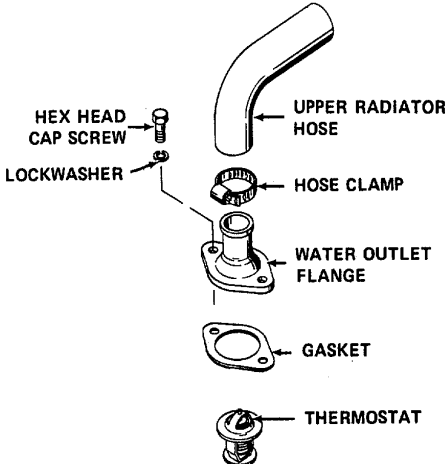
WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in coolant system is released, then remove cap.

1. Radiator cap Remove.



4-39. THERMOSTAT

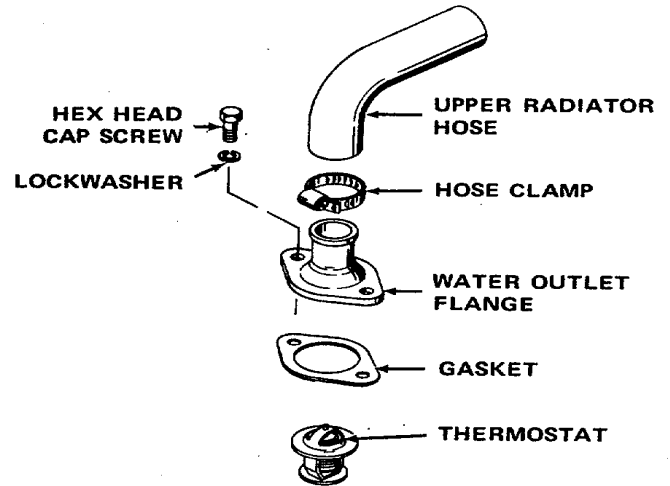
Location/Item	Action	Remarks
2. Draincock	Loosen and drain coolant into a container, until coolant is below level of thermostat housing.	 <p>DRAINCOCK</p>
3. Radiator hose (upper)	Loosen hose clamp on water outlet flange. Remove hose from flange.	 <p>UPPER RADIATOR HOSE HOSE CLAMP WATER OUTLET FLANGE HEX HEAD CAP SCREW LOCKWASHER THERMOSTAT HOUSING</p>
4. Water outlet flange	Remove hex head cap screws and lockwashers from flange. Remove flange.	 <p>HEX HEAD CAP SCREW LOCKWASHER UPPER RADIATOR HOSE HOSE CLAMP WATER OUTLET FLANGE GASKET THERMOSTAT</p>
5. Water outlet flange gasket	Remove.	<p>NOTE It may be necessary to scrape gasket from mating surfaces. Make sure surfaces are clean and free of damage that would prevent a good seal during assembly.</p>
6. Thermostat	Remove and discard.	

4-39. THERMOSTAT

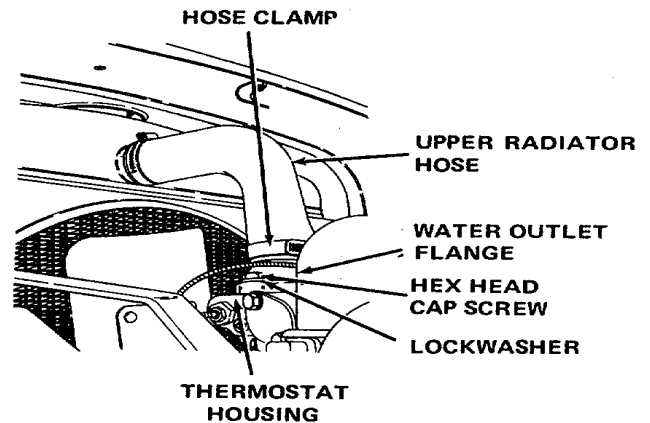
Location/Item	Action	Remarks
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INSTALLATION/REPLACEMENT

- 7. Thermostat Install, spring first, into thermostat housing.
- 8. Water outlet flange gasket Install onto thermostat housing; aline screw holes.
- 9. Water outlet flange Install, over gasket and thermostat, onto housing. Aline screw holes. Install cap screws, with lockwashers, through flange and into housing. Tighten securely.



- 10. Radiator hose (upper) Place hose clamp loosely over hose. Place hose end over flange outlet. Position clamp over end of hose. Tighten securely.



- 11. Draincock Close.
- 12. Cooling system Fill. Use coolant drained in step 2, above, or fill with a fresh solution of 50% water and 50% antifreeze conforming to MIL-A-46153.
- 13. Radiator cap Install.

4-39. THERMOSTAT

Location/Item	Action	Remarks
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TEST

WARNING

Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

1. Operate engine in a ventilated area only.
2. Ventilate personnel compartments when idling engine.
3. While running vehicle, be alert for fumes. Keep compartments ventilated. If someone is overcome, expose to fresh air; keep warm and still; give artificial respiration if needed. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

14. Leaks	Start engine and check for leaks at hose end and around flange. Tighten hose clamps as required to stop leaks.	
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4-40. SUCTION AND DISCHARGE COMPANION (COUPLING) FLANGES

This task covers:

- a. Removal
- b. Repair
- c. Installation

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop equipment, automotive maintenance
and repair, common no. 1
NSN 4910-00-754-0654

Materials/Parts

Suction companion flange

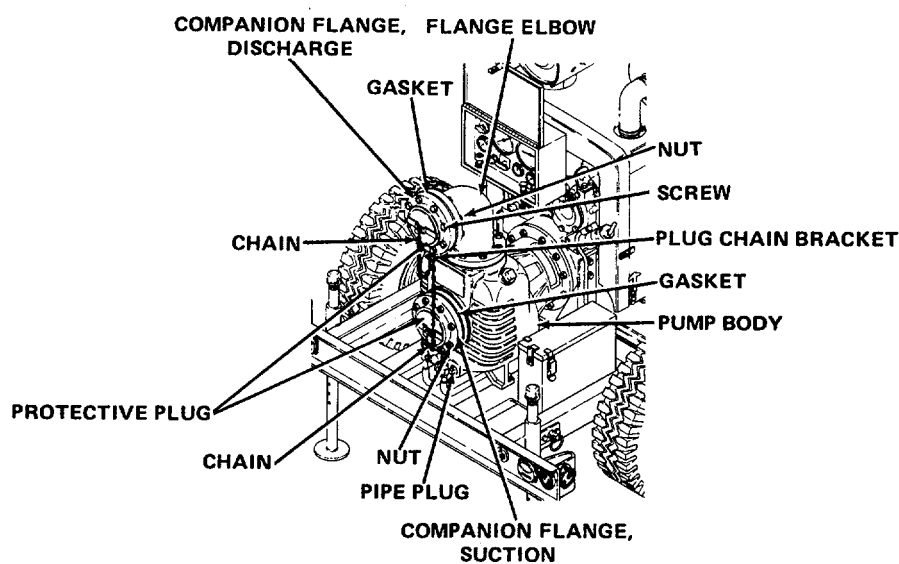
Discharge companion flange

Gaskets

Location/Item	Action	Remarks
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REMOVAL

1. Pipe plug Remove. Drain any liquid present in pump body into suitable container.



2. Protective plugs Remove from suction and discharge companion flanges. If necessary to remove plugs from centrifugal pump unit remove screw, nut, and washers from plug chain bracket.

4-40. SUCTION AND DISCHARGE COMPANION (COUPLING) FLANGES (CONT)

Location/Item	Action	Remarks
3. Companion flange, suction	Remove nuts attaching flange to pump body. Remove flange. Remove and discard gasket. Make sure mating surfaces are clean and free of gasket remnants.	
4. Companion flange, discharge	Support the flange, and remove screws and nuts attaching flange to flange elbow. Remove and discard gasket. Make sure mating surfaces are clean and free of gasket remnants.	

REPAIR

5. Nuts, screws, and washers	Inspect threaded components for damage. Replace if damaged. Inspect washers for distortion and burrs. Replace if damaged. Screws attaching chain S hooks to plugs shall be tight.	
6. Plug chain and chain S hooks	Inspect chains for broken and/or damaged links. Replace damaged chains. Chain S hooks shall show no evidence of distortion and/or cracking. Discard if damaged.	
7. Protective plugs	Inspect for damaged threads. If threads cannot be repaired adequately to permit installation into companion flange, discard plug.	
8. Companion flanges	Inspect for damaged threads; discard if leak would result during use. Inspect for damage to gasket mating surface that would prevent leakproof seal; discard if leakage would result during use.	

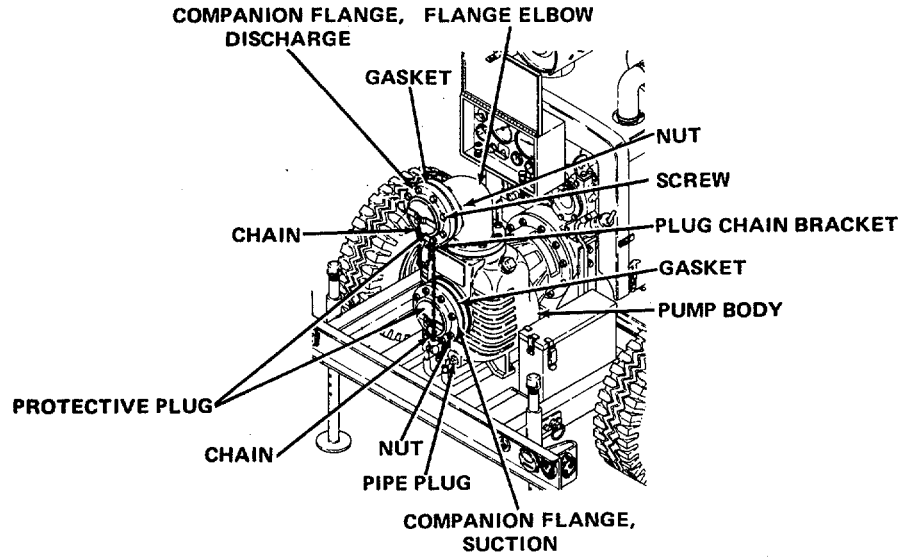
INSTALLATION

9. Companion flange, discharge	Place gasket and flange onto flange elbow. Aline holes in flanges with those in gasket. Install screws through flanges. Thread nuts onto screws. Tighten nuts securely, in an alternating pattern.	
10. Companion flange, suction	Install gasket over studs and onto pump body. Place flange over studs, against gasket. Thread nuts onto studs. Tighten nuts securely, in an alternating pattern.	
11. Protective plugs	If necessary, attach chain S hooks to plug chain bracket using screw, nut, and washers. Tighten securely. Thread plugs into respective ports.	

4-40. SUCTION AND DISCHARGE COMPANION (COUPLING) FLANGES (CONT)

Location/Item	Action	Remarks
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12. Pipe plug	Install. Tighten securely.	
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4-41. CONTROL (INSTRUMENT) PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES

This task covers:

- a. Removal
- b. Repair
- c. Installation

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033
 Shop equipment, automotive maintenance
 and repair, common no. 1
 NSN 4910-00-754-0654

Troubleshooting References

Malfunction 1, step 4
 Malfunction 6, step 3
 Malfunction 7, step 3

Materials/Parts

Control panel assembly

Equipment Condition

Suction and discharge hoses removed
 from gages.

References

Para 4-13 Air Cleaner Assembly
 Para 4-24 Speed Regulating Throttle Cable
 Para 4-30 Starting Aid Control Cable

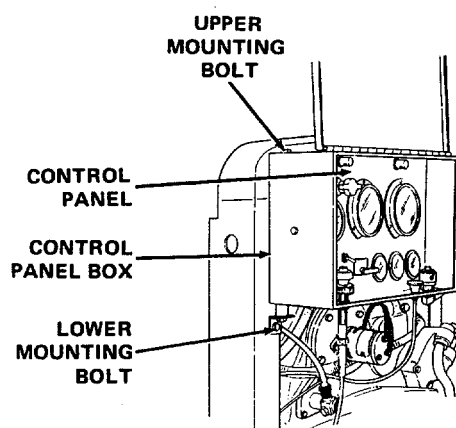
Negative cable removed from battery

Location/Item	Action	Remarks
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REMOVAL

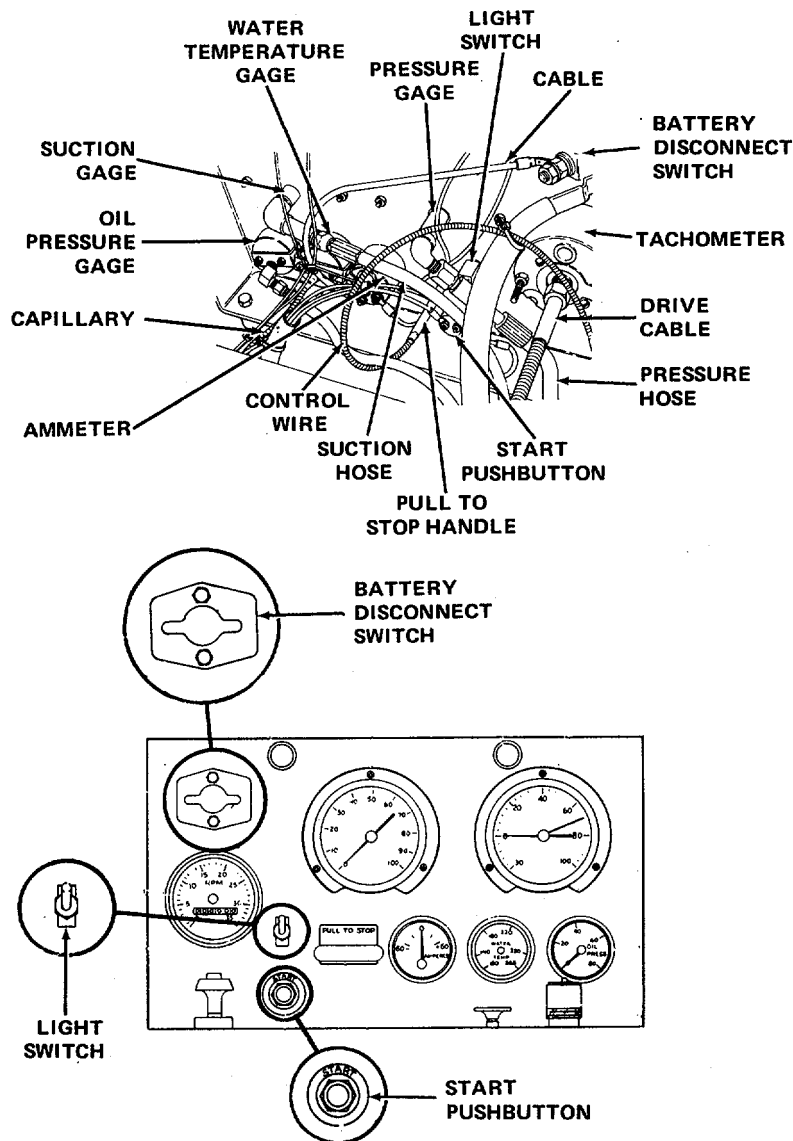
NOTE

To facilitate removal of control panel components, remove upper and lower mounting bolts, washers, and nuts from control panel box. Carefully swing box down from top so that it lies at an angle.

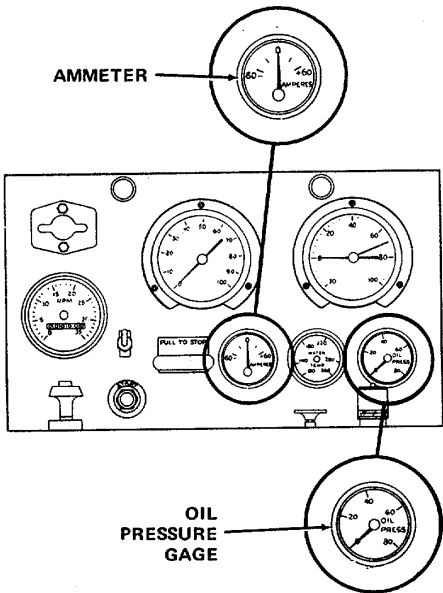
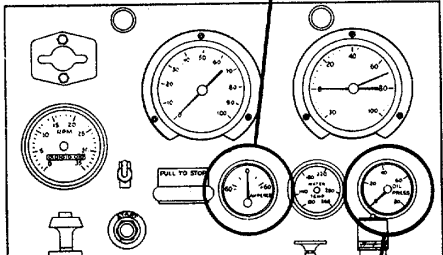
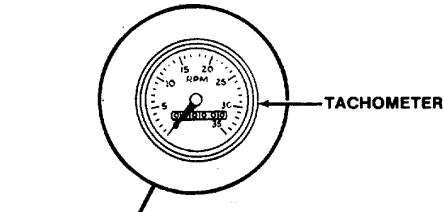
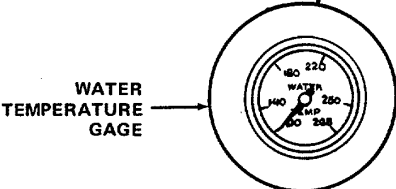


4-41. CONTROL (INSTRUMENT) PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
1. Speed regulating throttle cable	Remove in accordance with paragraph 4-24.	
2. Starting aid control cable	Remove in accordance with paragraph 4-30.	
3. Battery disconnect switch, light switch, and START pushbutton	Remove switch terminal nuts and tag cables or connecting wires. Remove mounting bolts and nuts, and remove battery disconnect switch through front of panel. Remove mounting nuts, and remove light switch and START pushbutton from back of panel.	



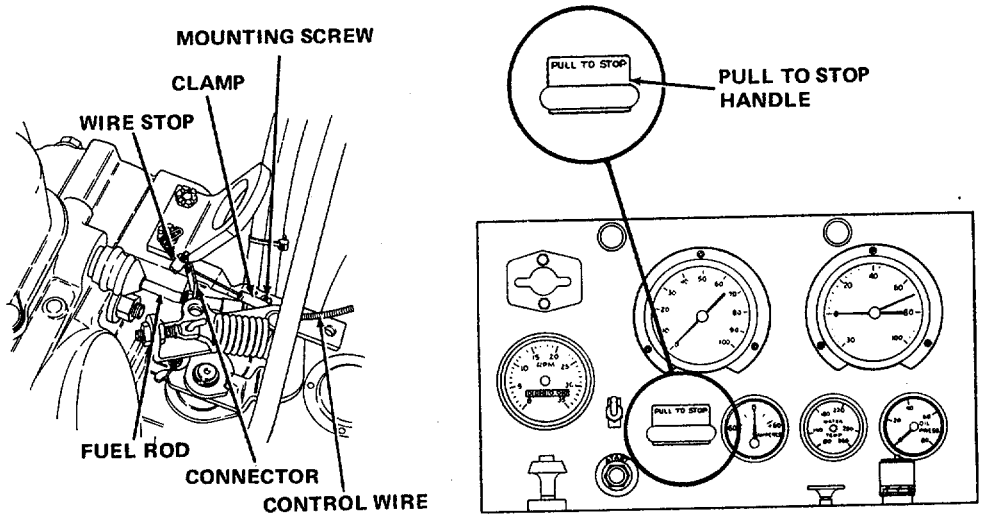
4-41. CONTROL (INSTRUMENT) PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
4. Oil pressure gage	Disconnect from gage tube assembly connector at elbow at back of gage. Remove mounting nuts and washers from studs. Remove bracket and remove gage from front of panel.	
5. Ammeter	Tag connecting wires and disconnect by removing terminal nuts and washers and sliding the wire off. Remove mounting nuts and washers from studs. Remove bracket and slide ammeter from front of panel.	
6. Tachometer	Disconnect drive cable at fitting at rear of tachometer. Remove clamp mounting nuts from studs, and remove tachometer from front of panel.	
7. Water temperature gage	Disconnect capillary fitting from back of gage. Remove mounting nuts and washers. Remove bracket and remove gage from front of panel.	

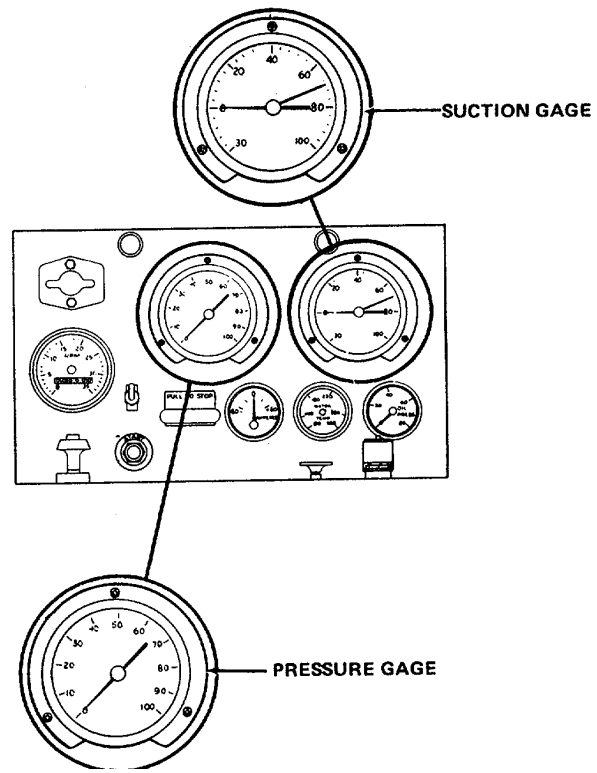
4-41. CONTROL (INSTRUMENT) PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-----------------------------|--|--|
| 8. PULL TO STOP handle STOP | Disconnect control wire clamp by removing mounting screw. Remove control wire from wire stop. Loosen mounting nut at back of PULL TO STOP handle mounting, and slide nut off control wire. Remove handle and control wire from front of panel. | |
|-----------------------------|--|--|



- | | | |
|-----------------------------|---|--|
| 9. Pressure or suction gage | Tag and disconnect lines. Remove mounting screws, nuts, and lockwashers. Remove gage from front of panel. | |
|-----------------------------|---|--|



4-41. CONTROL (INSTRUMENT) PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CAUTION

Support control panel box to keep it from falling when restriction indicator is removed.

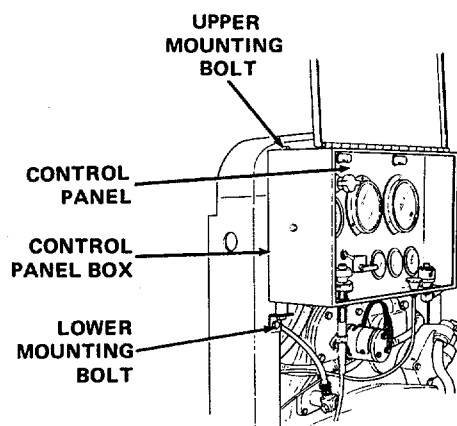
- | | | |
|---------------------------|---|--|
| 10. Restriction indicator | Remove in accordance with paragraph 4-13. | |
| 11. Control panel box | Remove. | |

REPAIR

- | | | |
|-----------------------|--|--|
| 12. Control panel box | Remove minor rust and corrosion with a wire brush or sandpaper. Refinish as necessary. If control panel or box is severely dented, rusted, corroded, or otherwise damaged, replace unit. | |
|-----------------------|--|--|

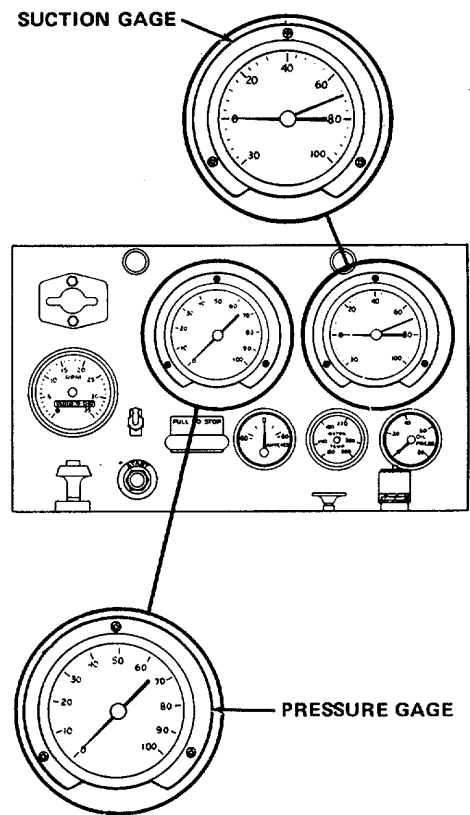
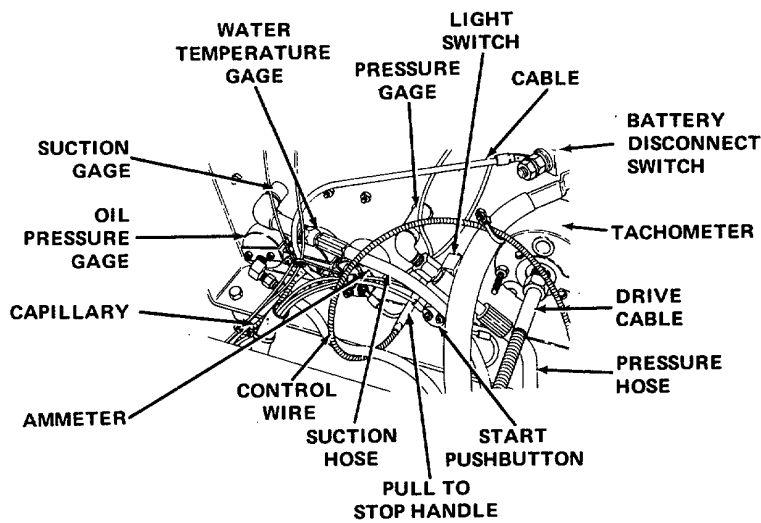
INSTALLATION

- | | | |
|-----------------------|---|--|
| 13. Control panel box | Support box and loosely install lower mounting bolts, washers, and nuts. Allow box to hang forward at a slight angle. | |
|-----------------------|---|--|



4-41. CONTROL (INSTRUMENT) PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

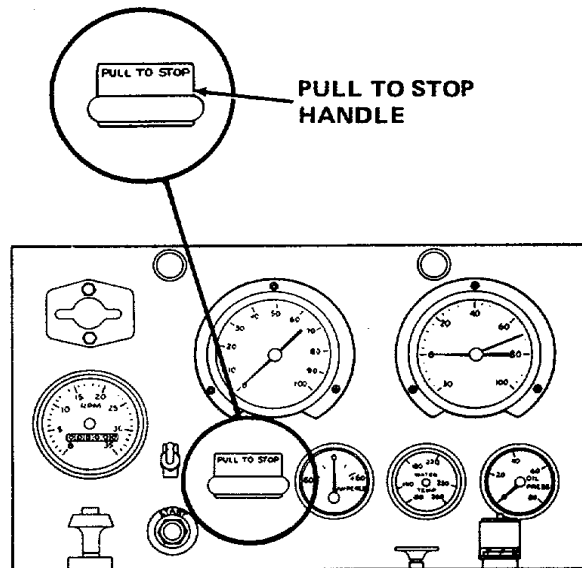
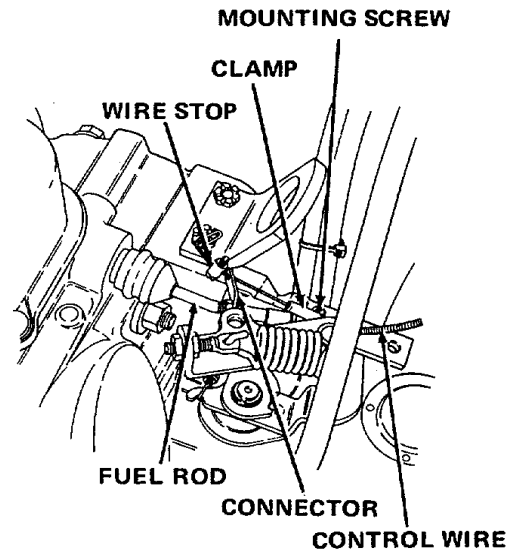
Location/Item	Action	Remarks
14 Restriction indicator	Install in accordance with paragraph 4-13.	
15. Pressure or suction gage	Place in mounting space on front of panel and install mounting nuts. Tighten nuts securely. Connect correct hose to back of gage with fitting at elbow. Remove tags.	



4-41. CONTROL (INSTRUMENT) PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

16. PULL TO STOP handle
 Place handle and control wire in mounting space on front of panel. Slide mounting nut onto control wire and tighten securely at back of handle mounting. Connect control wire to wire stop. Push PULL TO STOP handle in all the way. Install control wire clamp and tighten mounting screw. Test handle and control wire. If pulling on handle does not pull out fuel rod until it stops, reposition wire in wire stop closer to end of control wire with PULL TO STOP handle pushed all the way in.

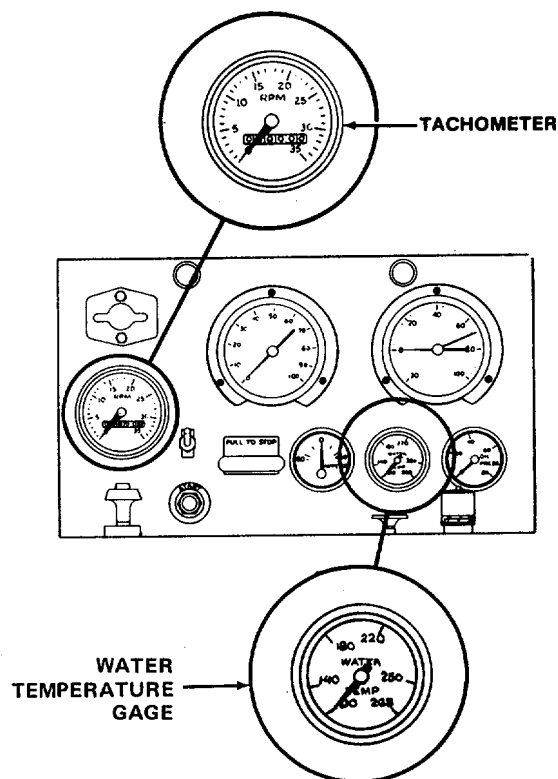


4-41. CONTROL (INSTRUMENT) PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
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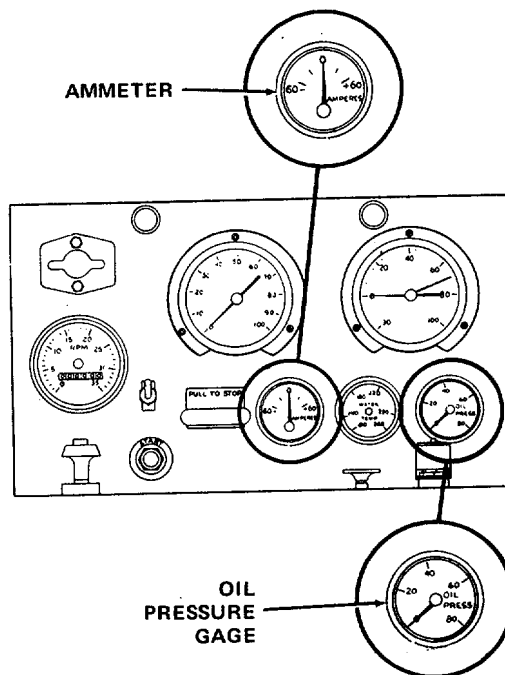
17. Water temperature gage
Place in mounting space in front of panel and install bracket. Install washers and mounting nuts; tighten nuts securely. Reconnect capillary fitting to back of gage.

18. Tachometer
Place in mounting space on front of panel and slide tachometer studs through holes in bracket. Tighten mounting nuts securely. Connect drive cable to the back of tachometer and tighten fitting securely.



19. Ammeter
Place in mounting space in front of panel and install bracket. Install washers and mounting nuts on studs; tighten nuts securely. Reconnect connecting wires to terminals and install washers and nuts; tighten nuts securely. Remove tags.

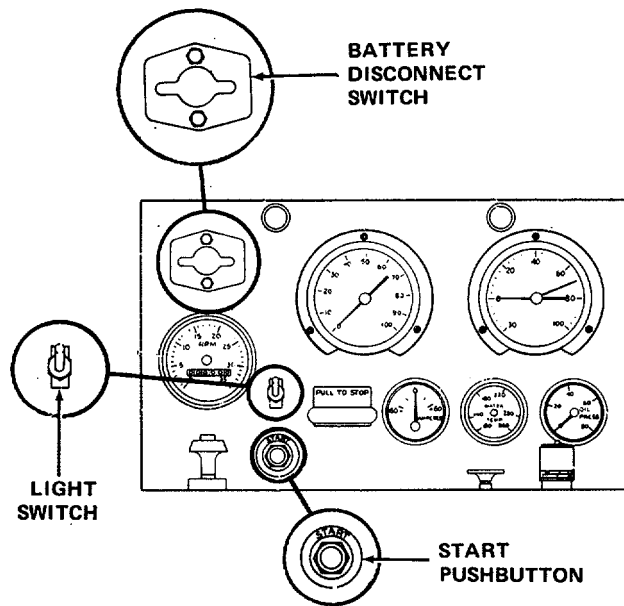
20. Oil pressure gage
Place in mounting space on front of panel. Install bracket, washers, and mounting nuts. Tighten nuts securely. Reconnect gage tube assembly connector to elbow at back of gage.



4-41. CONTROL (INSTRUMENT) PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|---|--|--|
| 21. Battery disconnect switch, light switch, and START pushbutton | Place battery disconnect in mounting space on front of panel and tighten mounting bolts and nuts securely. Install light switch and START pushbutton from back of panel, and tighten mounting nuts securely. Attach cables or connecting wires to switch terminals. Install terminal nuts and tighten securely. Remove tags. | |
|---|--|--|



- | | | |
|-------------------------------------|--|--|
| 22. Starting aid control cable | Install in accordance with paragraph 4-30. | |
| 23. Speed regulating throttle cable | Install in accordance with paragraph 4-24. | |
| 24. Control panel box | Carefully swing box up and insert upper mounting bolts, washers, and nuts. Tighten upper and lower bolts securely. | |

4-42. TIME DELAY RELAY

This task covers:

- a. Test
- b. Removal
- c. Installation

INITIAL SETUP:

Test Equipment

Multimeter

Materials/Parts

Time delay relay

Tools

Tool kit, general mechanics, automotive
NSN 5180-00-177-7033

Shop equipment, automotive maintenance
and repair, common no. 11
NSN 4910-00-754-0654

Equipment Condition

Engine left side panel removed.

Location/Item	Action	Remarks
---------------	--------	---------

TEST

- | | |
|---------------------|---|
| 1. Time delay relay | Tag and remove leads from terminals 1 and 5. Using a multimeter set to the X1 scale, test for continuity between terminals 1 and 5. Test for continuity on all resistance scales of meter. All scales shall read infinity. If resistance value on any scale is less than infinity, discard the relay. |
|---------------------|---|

REMOVAL

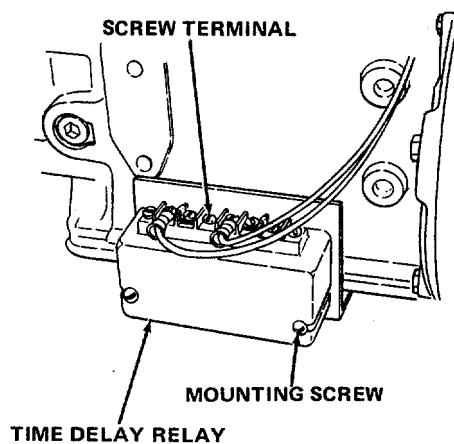
- | | |
|---------------|--|
| 2. Time delay | Tag and remove leads from terminals 1 and 5. Relay Remove mounting screws. Remove relay. |
|---------------|--|

4-42. TIME DELAY RELAY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSTALLATION

3. Time delay relay Position relay and install mounting screws. Install leads onto respective terminals 1 and 5 and remove tags. Tighten screw terminals securely.



4-43. TRAILER ASSEMBLY AND FRAME

This task covers:

- a. Inspection
- b. Repair

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

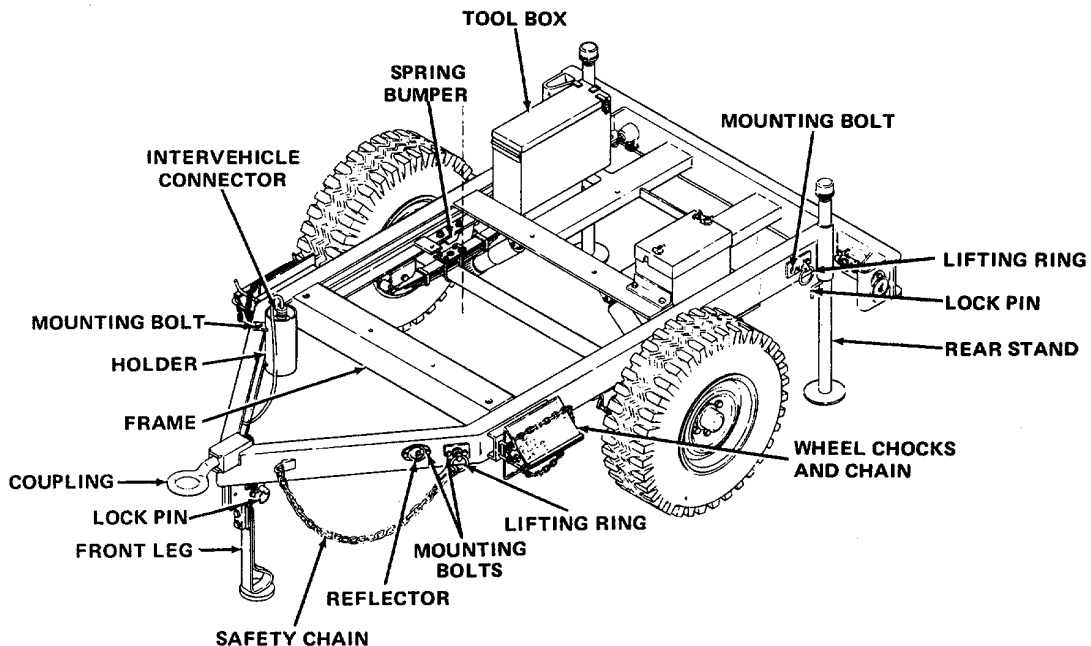
Shop equipment, automotive maintenance
and repair, common no. 11
NSN 4910-00-754-0654

Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

1. Trailer assembly
Inspect coupling, front leg and lock pin, safety chain, reflector, wheel chocks and chain, tool box, lifting rings, rear stands and lock pins, and intervehicle connector holder for rust, deterioration, and other damage. Inspect rubber spring bumpers for cracks, wear, or deterioration.

2. Frame
Inspect for cracks, distortion, or broken welds.



4-43. TRAILER ASSEMBLY AND FRAME (CONT)

Location/Item	Action	Remarks
REPAIR		
3. Metallic components	Remove rust and corrosion.	
4. Reflectors	Remove road dirt or residue. If a reflector lens is cracked or broken, remove mounting bolts, replace lens, and reinstall mounting bolts.	
5. Frame	Straighten minor bends or distortions. Repair cracked weldments using arc welding methods.	
6. Spring bumpers	Remove screw, lockwasher, and nut that secure each bumper to bottom of frame. Install new bumper; secure with mounting hardware.	
7. All other	If damaged beyond repair, remove mounting parts hardware, install new component, and reinstall mounting hardware.	

4-44. AXLE, WHEELS, AND TIRES

This task covers:

- a. Jacking up trailer
- b. Removal
- c. Inspection
- d. Repair
- e. Installation

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop equipment, automotive maintenance
and repair, common no. 11,
NSN 4910-00-754-0654

Troubleshooting References

Malfunction 11, steps 1 and 2

**Equipment
Condition**

Para	Condition Description
4-46	Springs removed.
4-47	Shock absorbers removed.

Materials/Parts

Tire (2)

Wheel (2)

Axle

Inner tube (2)

Flap (2)

Grease seal

Dry cleaning solvent (Item 6, Appendix E)

Grease (Item 7, Appendix E)

Special Environmental Conditions

Well-ventilated area required during cleaning.

General Safety Instructions

WARNING

**Use jack stands to support trailer after
jack has raised trailer to working height.
Unit could drop from jack and cause
personal injury.**

4-44. AXLE, WHEELS, AND TIRES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

JACKING UP TRAILER

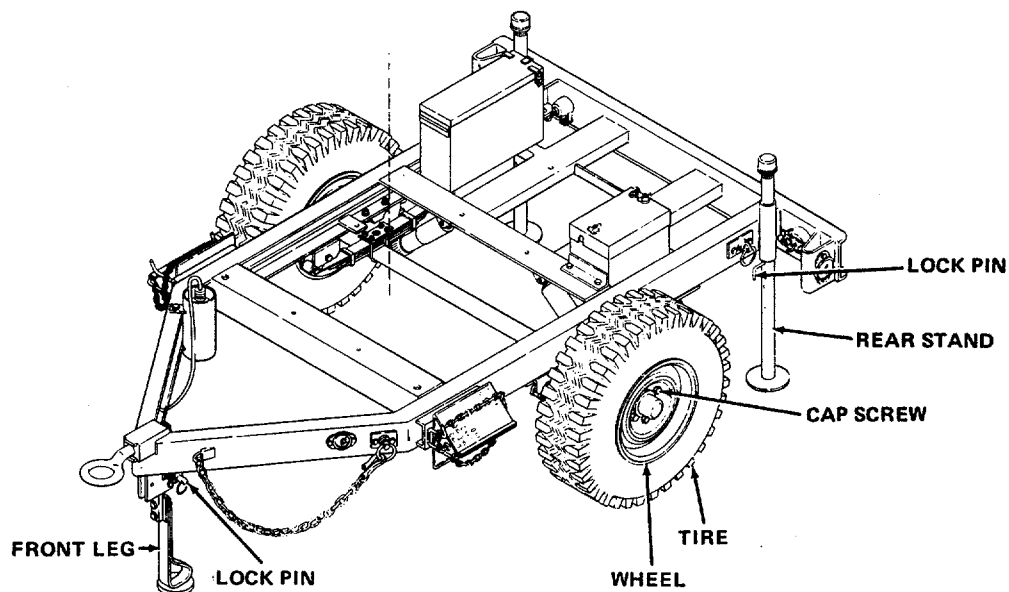
WARNING

Use jack stands to support trailer after jack has raised trailer to working height. Unit could drop from jack and cause personal injury.

CAUTION

Remove and insert pin from rear stand assemblies with the handle end of the pin facing upward. The pin locking mechanism will stick within the rear stand if pin is inserted and removed any other way.

- | | |
|------------------------------|---|
| 1. Rear stands and front leg | Lower and pin rear stands. Lower front leg and insert lock pin. |
|------------------------------|---|



- | | |
|---------|--|
| 2. Jack | Position jack under frame between wheel to be raised and wheel chock. Loosen wheel cap screws slightly. Raise wheel from the ground, then lower and pin rear stand on same side. Put block of wood under front leg if necessary. |
|---------|--|

4-44. AXLE, WHEELS, AND TIRES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

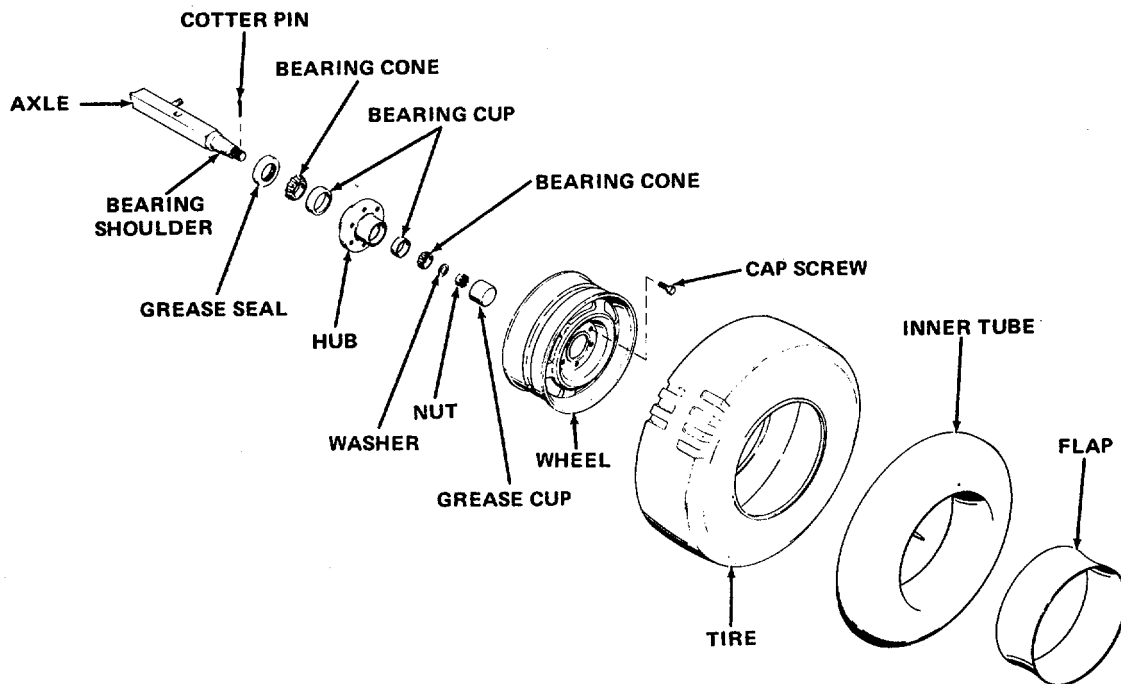
WARNING

Personal injury could occur if trailer front leg and rear stand do not make solid contact with ground or block of wood. Unit could drop on leg or stand.

- 3. Jack stand Position jack stand next to jack. Lower jack to allow weight to rest on jack stand. Leave front leg, rear stand, and jack stand positioned to supply support during work.

REMOVAL

- 4. Wheel Remove cap screws and wheel.



- 5. Tire Deflate inner tube, and remove tire, tube, and flap from wheel.
- 6. Grease cup Pry off to provide access to cotter pin and nut.

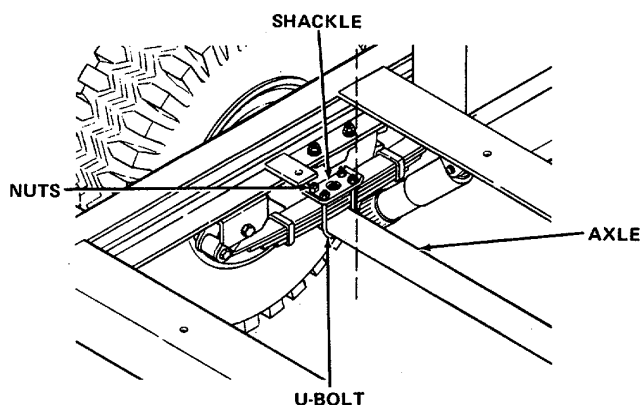
4-44. AXLE, WHEELS, AND TIRES (CONT)

Location/Item	Action	Remarks
7. Bearing cups and cones, hub, and grease seal	Remove from axle. Discard grease seal.	

NOTE

Do not remove axle from frame unless it is cracked or distorted, has severely damaged threads or scored or pitted bearing shoulders.

8. Axle
- Leave frame supported on jack stand, rear stand, and front leg. Remove lock pin from rear stand. Place jack under frame between chock block and wheel on other side and raise frame slightly. Install jack stand next to jack and lower jack slightly to allow weight to rest on jack stand. Adjust front leg and rear stand so that they rest firmly on the ground. Support axle and remove nuts, shackles, and U-bolts from axle. Remove axle.

**INSPECTION**

9. Tires and inner tubes
- Inspect tires for cuts, bruises, punctures, worn treads, imbedded stones, and severe abrasions. Skive around cuts and imbedded stones with a sharp knife to remove all edges which could catch against sharp rocks and result in further tearing. Inspect inside of tires for broken cords and punctured walls. Replace tires which are damaged beyond repair. Check inner tubes by filling with air and immersing in water to locate any leaks. Check tubes for cracks, brittleness, and signs of deterioration. Replace defective tubes or tubes with more than four patches.

4-44. AXLE, WHEELS, AND TIRES (CONT)

Location/Item	Action	Remarks
10. Wheels	Inspect the wheel for cracks, distortion, burrs on bead rim, and other damage. Remove all burrs with a file or fine stone. Replace damaged wheels.	

WARNING

Cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

11. Bearing cups	Clean bearing sets by placing them in a wire and cones basket and agitating them in a container of P-D-680 dry cleaning solvent. Inspect bearing cones for rough, scored, or brinnelled rollers, scored races, and bent cages. Inspect bearing cups for wear and scoring. If either the cone or cup of a bearing set is damaged, replace both parts. They are a matched set.	
12. Axle	Inspect axle for cracks, distortion or damaged threads, and for scored or damaged bearing surfaces. Replace a damaged axle.	

REPAIR

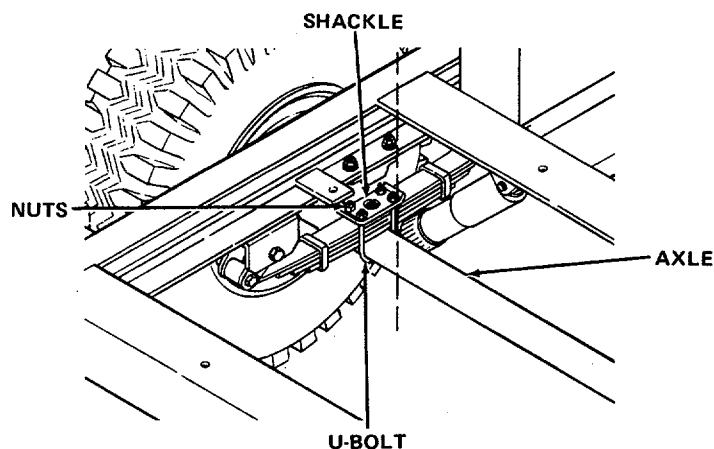
13. Wheels	Remove rust or corrosion from wheels with a wire brush or sandpaper.	
14. Tire, tube, and flap	Patch any small holes on tubes, tires, and flaps.	

4-4. AXLE, WHEELS, AND TIRES (CONT)

Location/Item	Action	Remarks
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INSTALLATION

15. Axle Position and support axle. Install U-bolts, shackles, and nuts. Tighten securely.



WARNING

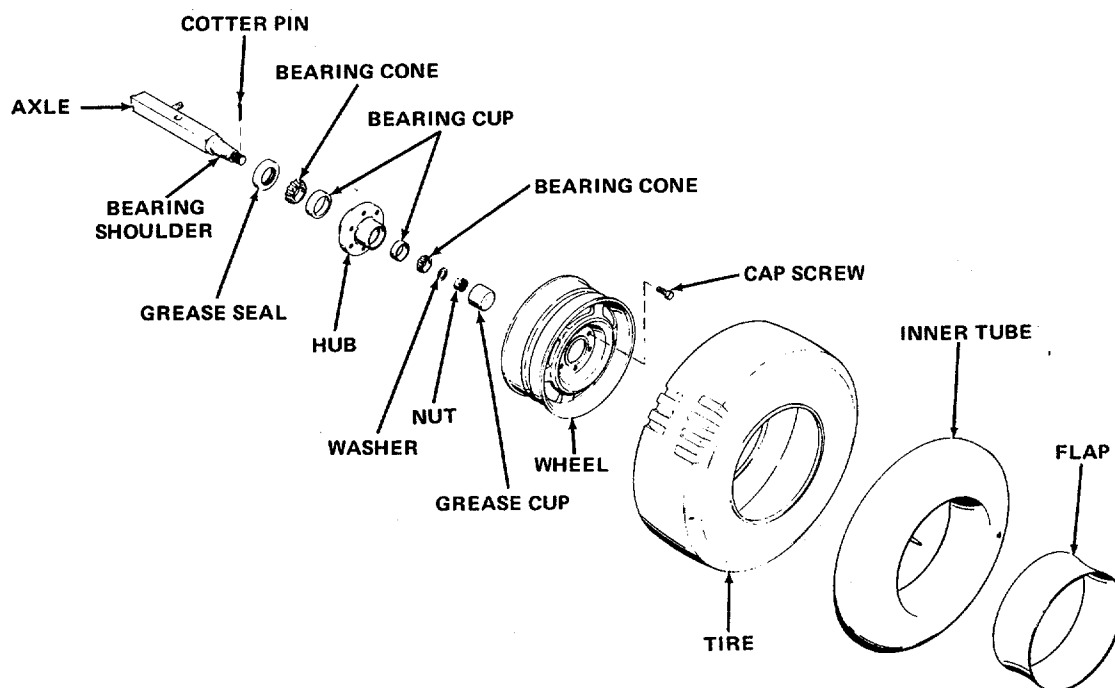
Cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 1380F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Wipe axle bearing shoulders with a cloth moistened with P-D-680 dry cleaning solvent. Install grease seals on axle.

4-4. AXLE, WHEELS, AND TIRES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

16. Bearings Pack bearings about 1/3 full of MIL-G-10924 grease, and install them in the hubs. Take care to avoid damaging lips of grease seal when installing hub on axle. Install washers and nuts on axle. Tighten nuts slightly to seat the bearings. Then, back off the nuts and tighten them hand tight.



17. Wheels Reinstall flaps on wheels and put tubes into tires. Place tires on wheels and inflate to 45 psi (310.3 kPa) maximum. Mount wheels on hubs and install wheel rim cap screws hand tight. Spin the wheels and hand adjust the axle nuts until the wheels spin freely but without any looseness on the axle. Insert cotter pins and bend over to lock nuts in position. Drive grease cups onto hubs. Tighten cap screws evenly and alternately.

18. Frame Jack up each side of frame in turn and remove jack stands. Remove wood blocks from under front leg. Re-level rear stands ONE AT A TIME. Again tighten cap screws evenly and alternately.

4-45. TRAILER WIRING HARNESS

This task covers:

- a. Removal
- b. Repair
- c. Installation

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop equipment, automotive maintenance
and repair, common no. 11
NSN 4910-00-754-0654

Troubleshooting References

Malfunction 12, steps 1, 2, and 3

Materials/Parts

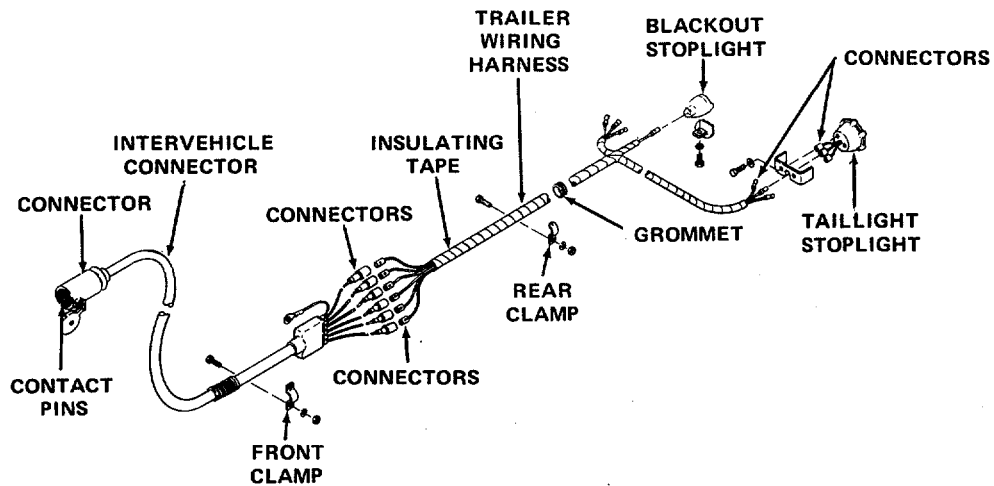
Equipment Condition
Trailer wiring harness assembly
Insulating tape (Item 19, Appendix E)

Intervehicle connector disconnected.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

1. Trailer wiring harness
Disconnect trailer wiring harness from tail-light stoplights and blackout stoplight at connectors. Remove trailer wiring harness mounting bolts, nuts, lockwashers, and clamps.



4-44. TRAILER WIRING HARNESS (CONT)

Location/Item	Action	Remarks
2. Ground lug 3. Trailer wiring harness	Detach ground lug from frame assembly. Carefully disconnect intervehicle connector from trailer wiring harness. Slide trailer wiring out of grommets.	

REPAIR

- | | | |
|----------------------------|---|--|
| 4. Trailer wiring harness | Inspect trailer wiring harness for broken or burned insulation, frayed wires, and loose or broken connectors. If insulation is damaged, remove damaged section and inspect the individual wires. Replace any damaged wires. Replace damaged or loose connectors. Install replacement wires and retape trailer wiring harness with several layers of MIL-T-50886 insulating tape. | |
| 5. Grommets | Check for brittleness. Replace brittle or damaged grommets. | |
| 6. Interverhicle connector | Inspect for broken or burned insulation, frayed wires, and loose or broken contacts. Inspect for missing or broken contact pins. If insulation is damaged, remove damaged section and inspect individual wires. Remove any damaged wires. Replace damaged or loose connectors. Install replacement wires and retape intervehicle connector wires with several layers of MIL-T-50886 insulating tape. If contacts are missing or broken, disconnect connector from wires; install new connector. | |

INSTALLATION

- | | | |
|----------------------------------|--|--|
| 7. Trailer wiring harness | After repair or replacement, slide trailer wiring harness through grommets. Reconnect trailer wiring harness and intervehicle connector. Install front clamp, mounting bolt, nut, and lockwasher with ground lug under lockwasher. Tighten securely. Install rear clamp, mounting bolt, lockwasher, and nut, and tighten securely. | |
| 8. Taillights and blackout light | Reconnect taillight stoplights and blackout stoplight at connectors. Check operation of all lights. | |

4-46. SPRINGS

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP:

Tools

Shop equipment, automotive maintenance and repair, common no. 11
 NSN 4910-00-754-0654
 Use jack stands to support trailer after

General Safety Instructions

WARNING

jack has raised trailer to working height. Unit could drop from jack and cause personal injury.

Materials/Parts

Springs (2)

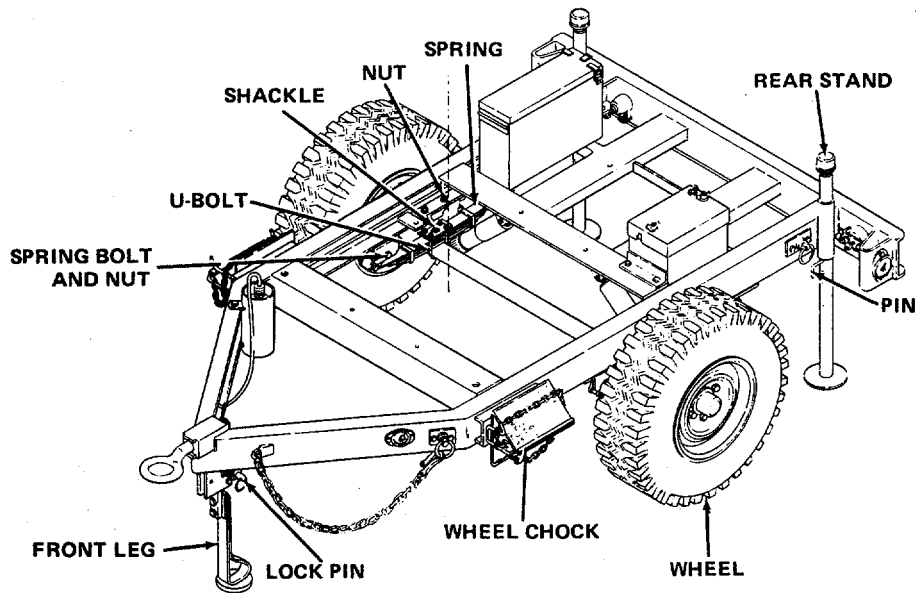
Location/Item	Action	Remarks
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REMOVAL

WARNING

Use jack stands to support trailer after jack has raised trailer to working height. Unit could drop from jack and cause personal injury.

1. Front leg Lower front leg and insert lock pin.



4-46. SPRINGS (CONT)

Location/Item	Action	Remarks
2. Frame	Position jack under frame between wheel to be raised and wheel chock. Jack up frame enough to relieve tension on spring (usually just as wheel clears ground) and place jack stands under frame. Put a wood block under front leg if necessary, to further support trailer. The jack may have to be raised slightly to accomplish this.	
3. Rear stand	Lower and pin rear stand if possible on same side.	
4. Springs	Loosen nuts on U-bolts securing spring to axle. If much tension is noticed, adjust jack and jack stand support height to lessen tension. Remove nuts and shackle. Remove spring bolts and nuts. Remove spring.	

INSTALLATION

- | | | |
|---------------|---|--|
| 5. Spring | Position replacement spring and install spring bolts and nuts. Tighten securely. Install U-bolts from the bottom side of the axle, and install shackle and mounting nuts. Tighten securely. | |
| 6. Rear stand | If rear stand was raised on same side, remove pin. | |
| 7. Front leg | Remove wood block from under front leg if necessary. Raise jack enough to remove jack stands. | |
| 8. Trailer | Lower trailer to ground. | |

4-47. SHOCK ABSORBERS

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP:

Tools

Shop equipment, automotive maintenance and repair, common no. 11
NSN 4910-00-754-0654

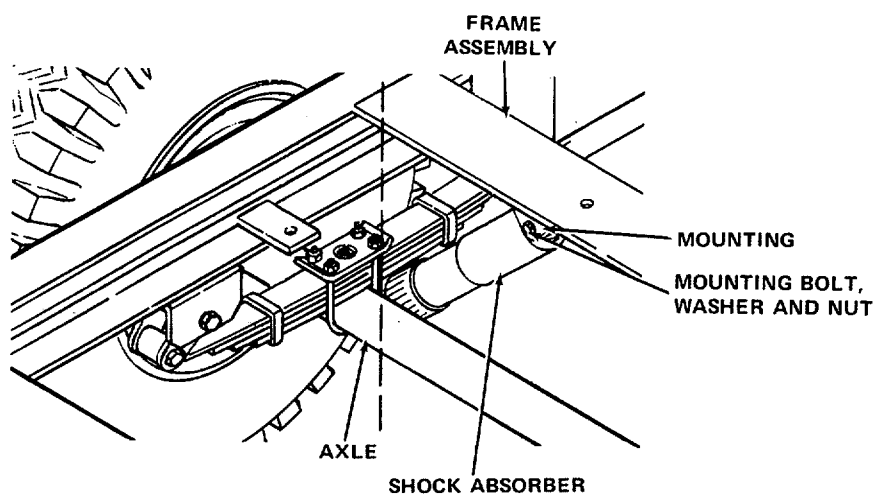
Materials/Parts

Shock absorbers (2)

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

1. Shock absorbers
Remover mounting bolts, nuts, and washers from the axle and frame assembly. Remove shock absorbers.



INSTALLATION

2. Shock absorbers
Mount on frame assembly and axle. Secure with bolts, washers, and nuts.

4-48. TAILLIGHT STOPLIGHTS AND BLACKOUT SPOTLIGHT

This task covers:

- a. Removal
- b. Inspect/Repair
- c. Installation

INITIAL SETUP:

Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Troubleshooting References

Malfunction 12, step 1

Materials/Parts

Taillight stoplight (2)
Blackout stoplight

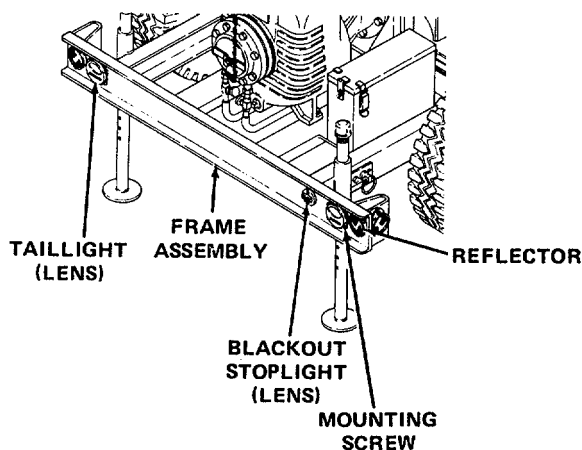
Equipment Condition

Intervehicle connector disconnected from towing vehicle.

Location/Item	Action	Remarks
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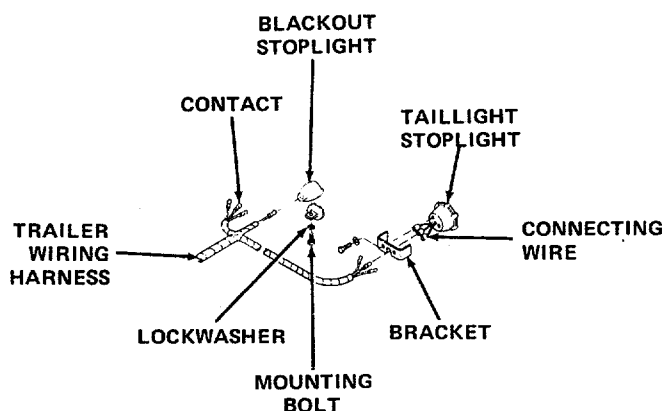
REMOVAL

1. Taillight stoplights and blackout stoplight
Remove a stoplight lens by removing mounting screws. Remove bulbs and set aside. Remove stoplight by removing mounting bolt brackets and lockwashers on inside of frame assembly.



4-48. TAILLIGHT STOPLIGHTS AND BLACKOUT STOPLIGHT (CONT)

Location/Item	Action	Remarks
2. Connecting wires stop light.	Tag and disconnect connecting wires from trailer wiring harness at contacts. Remove	



INSPECT/REPAIR

- 3. Taillight stoplights and blackout stoplight
Inspect for rust, dents, or other exterior damage. Replace if necessary.
- 4. Connecting wires
Inspect for breaks or deteriorated insulation. Replace if necessary.
- 5. Bulbs
Inspect for broken filaments, corroded bases, broken or discolored envelopes. Replace damaged bulbs.
- 6. Lenses
Inspect for cracks or brittleness. Replace if necessary.

INSTALLATION

- 7. Taillights and blackout stoplight
Position lights on outside of frame assembly and install mounting bolts, lockwashers, and bracket (stoplight only) from inside of frame assembly. Install bulbs. Mount lens on lights and install mounting screws.
- 8. Connecting wires
Reconnect at contacts.

Section VI. PREPARATION FOR STORAGE OR SHIPMENT**4-49. GENERAL**

This section provides instructions for preparing the centrifugal pump unit for short term and intermediate storage or shipment.

4-50. ADMINISTRATIVE STORAGE

Administrative storage shall be in accordance with AR 750-1.

4-51. SHORT TERM STORAGE (30 days or less)**NOTE**

When centrifugal pump unit is taken out of service, take special precautions to protect the interior and exterior of the unit from rust accumulation and corrosion.

- a. Lower the back of the frame assembly.

WARNING

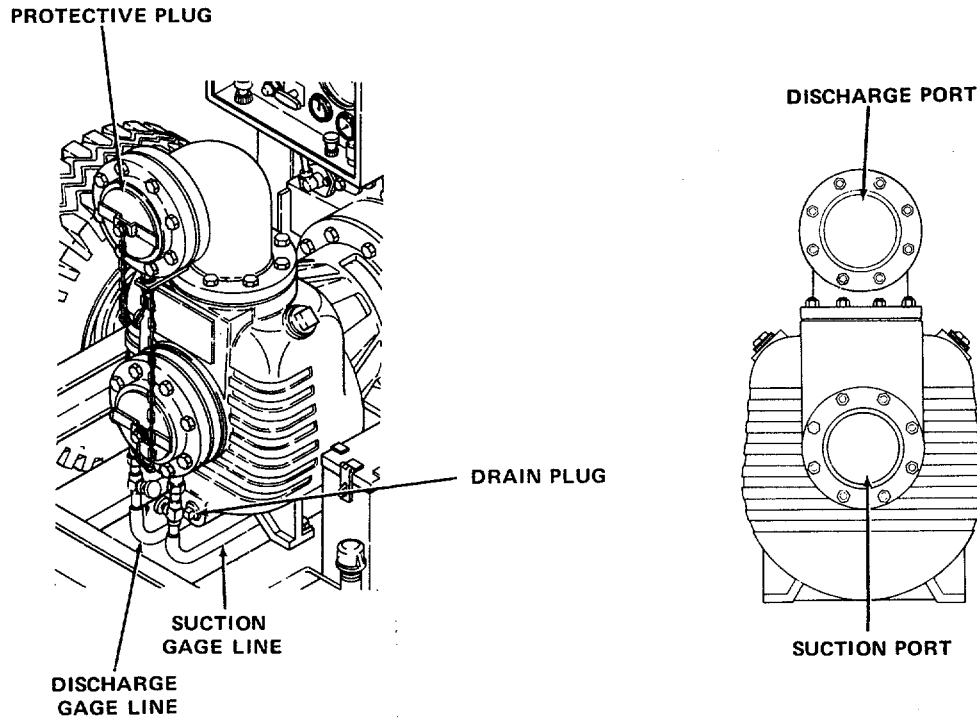
Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- **Do not inhale vapor.**
 - **Do not refuel near open flame, sparks, or excessive heat.'**
 - **Be certain fuel lines and connections are secure.**
 - **Do not overfill fuel tank.**
 - **Work in a well-ventilated area.**
- b. Fill fuel tank with VV-F-800 diesel fuel oil. Connect centrifugal pump unit to a water supply. Operate the engine for 2 minutes at 1200 rpm and no load.

NOTE

Do not drain the fuel system after this run. Remove water supply after this run.

c. Remove pump drain plug and drain pump body. Replace drain plug.



d. Disconnect and drain suction and discharge gage lines. Reconnect lines.

e. Remove suction and discharge hoses at ports.

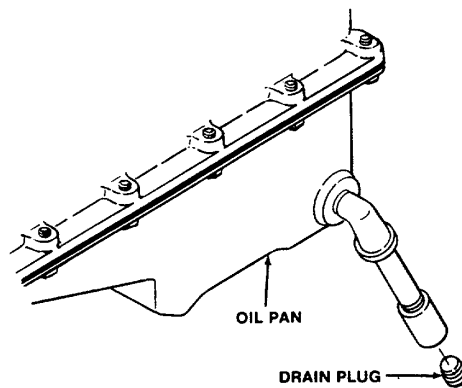
f. Clean suction and discharge port threads using a wet cloth.

g. Install protective plugs in the discharge and suction ports.

CAUTION

Do not overfill crankcase. Oil may be blown out through the crankcase breather.

h. Remove drain plug from oil pan and drain crankcase. Replace drain plug and fill crankcase to the proper level with the recommended viscosity and grade of oil in accordance with LO 5-4320-300-12 (figure 4-1).



- i. Clean air cleaner assembly in accordance with table 2-2, item 6.

WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.

- j. Add MIL-A-46153 ethylene glycol antifreeze solution to the cooling system to bring it to the proper level. Recommended solution is 50% antifreeze and 50% water.
- k. Tape the weather cap in place and oil the cap surfaces. Seal all engine openings with moistureproof, vaporproof tape, strong enough to resist puncture and damage from the expansion of entrapped air.
- l. Remove pipe plugs and clean pipe plug threads with a damp cloth. Replace pipe plugs.

4-52. INTERMEDIATE TERM STORAGE (More than 30 days)

WARNING

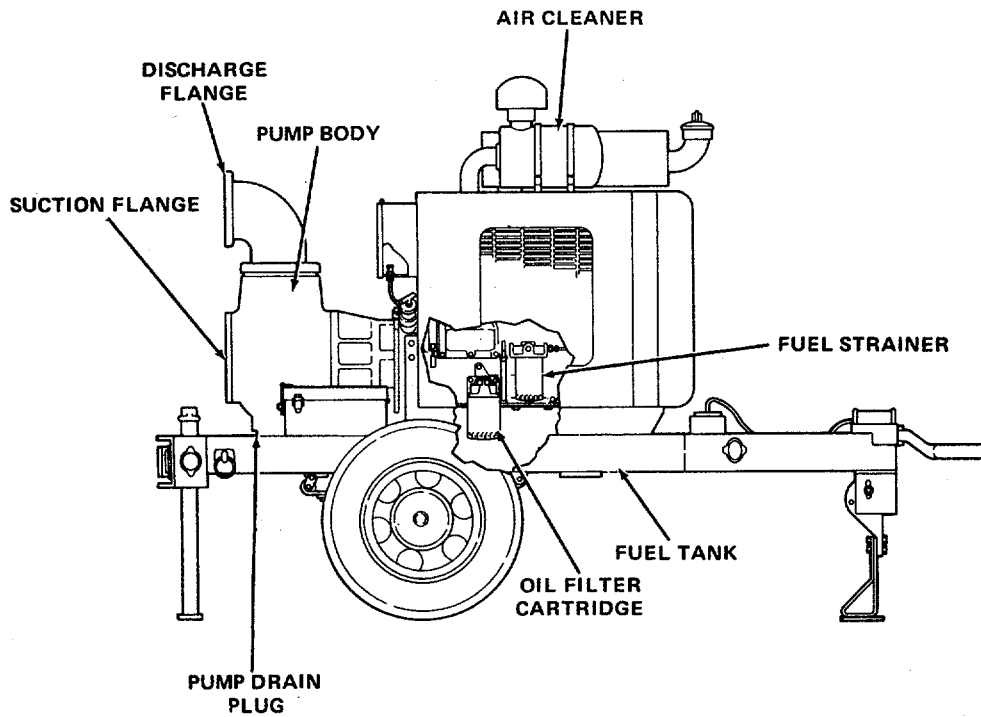
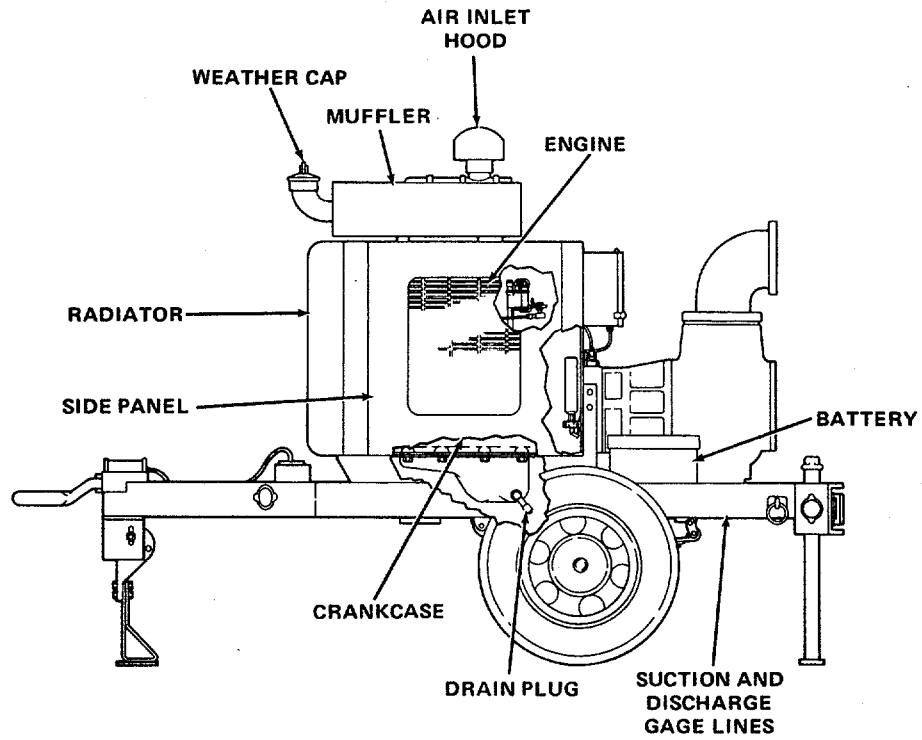
Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.

- a. Drain, flush, and fill cooling system as described in table 4-1, item 16.
- b. Start engine and allow to operate at idle (1500 rpm) for 10 to 12 minutes or until normal operating temperature is reached. Shut down engine.
- c. Drain engine crankcase and replace oil filter cartridge as described in table 4-1, item 3. Then, fill crankcase to proper level using preservative lubricating oil (MIL-L-21260, Grade 2, or equivalent).

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- **Do not inhale vapor.**
 - **Do not handle fuel near open flame, sparks, or excessive heat.**
 - **Be certain fuel lines and connections are secure.**
 - **Work in a well-ventilated area.**
- d. Remove fuel tank cap and drain plug in bottom of fuel tank. Collect fuel in a suitable metal container.
- e. Replace fuel strainer and filter cartridges and fill cartridges 2/3 full with corrosion-inhibited preservative oil (Military Specification MIL-L-46002, Grade 1) in accordance with paragraph 4-28.



- f. Remove cap and fill fuel tank with sufficient MIL-L-46002 preservative oil, Grade 1 to permit 10 to 15 minutes of operation. Start engine and allow to operate at idle (1500 rpm) for not less than 5 minutes. Shut down engine.
- g. Service air cleaner in accordance with table 2-2, item 6.
- h. Lower the back of the frame assembly. Remove pump drain plug and drain pump body. Replace drain plug.
- i. Remove suction and discharge hoses from flanges.
- j. Coat all accessible flange and part surfaces with MIL-L-21260 preservative oil, Type 1, Grade 30. Wipe excess oil from suction and discharge port threads and install protective plugs.
- k. Remove pipe plug and pour approximately one quart of MIL-L-21260 preservative oil, Type 1, Grade 30, into pump body. Replace pipe plug.

WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.

- l. Drain engine cooling system, crankcase, and fuel tank into suitable metal containers.
- m. Remove drain plug at bottom of pump and drain preservative oil. This will leave a protective coating of preservative oil on interior surface of pump. Replace drain plug.
- n. Disconnect suction and discharge gage lines at pump and drain any excess preservative oil. Reconnect lines.
- o. Tape weather cap in place and oil the cap surfaces. Seal air inlet hood with a moistureproof, vaporproof tape.

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 1000 to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

- p. Inspect exterior of centrifugal pump unit for damaged paint. Refinish in accordance with Military Specification MIL-T-704, Type A, color as specified. Allow finish to dry.
- q. Remove and clean battery in accordance with table 4-1, items 12 and 13.

**CHAPTER 5
DIRECT SUPPORT MAINTENANCE INSTRUCTIONS**

INTRODUCTION

This chapter contains the following frequently used maintenance information:

- a. Troubleshooting
- b. Maintenance procedures

The Symptom Index on page 5-2 is a guide to the troubleshooting information. There is also an index to the maintenance procedures on page 5-6.

Section	Title	Page
I	Troubleshooting	5-1
II	Maintenance Procedures.....	5-6

Section I. TROUBLESHOOTING

5-1. TROUBLESHOOTING

a. Table 5-1 contains troubleshooting information for locating and correcting most of the operating troubles which are the responsibility of direct support maintenance. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. Perform the tests/inspections and corrective actions in the order listed.

NOTE

All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

c. Only those functions within the scope of direct support maintenance are listed. For troubleshooting procedures within the scope of operator/crew maintenance, refer to table 3-1. For troubleshooting procedures within the scope of organizational maintenance, refer to table 4-2.

5-2. SYMPTOM INDEX

Refer to the Symptom Index below. Locate the malfunction which is the same, or most nearly the same, as the trouble you are having with the pump assembly. The Symptom Index lists the first page of troubleshooting information for that malfunction. Follow the steps one by one, and perform the corrective actions listed.

Malfunction Number	Description	Page
1	Engine fails to crank or cranks at low speed	5-2
2	Engine cranks but fails to start	5-2
3	Engine starts but runs unevenly, stalls, or surges	5-3
4	Engine stops running or produces black, white, or grey smoke	5-3
5	Engine consumes excessive lube oil	5-4
6	Pump does not discharge or has low discharge pressure	5-5
7	Pump makes excessive noise	5-5

Table 5-1. Direct Support Troubleshooting

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

1. ENGINE FAILS TO CRANK OR CRANKS AT LOW SPEED

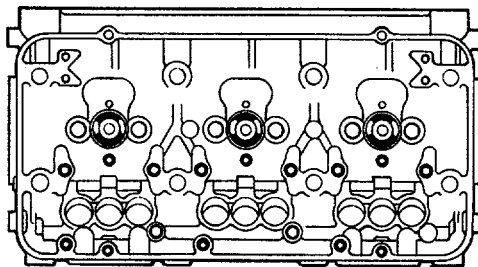
Step 1. Check for faulty starter motor. Remove and test (para 5-6).

Repair faulty starter motor (para 5-6).

2. ENGINE CRANKS BUT FAILS TO START

Step 1. Check for loose cylinder head bolts.

If loose, tighten in the sequence shown to 170 to 180 ft lb (231 to 244 N•m).



Step 2. Check for compression gasket leakage. Remove radiator cap and crank the engine. A steady flow of gases bubbling to the surface of the coolant indicates either a damaged compression gasket or cracked cylinder head.

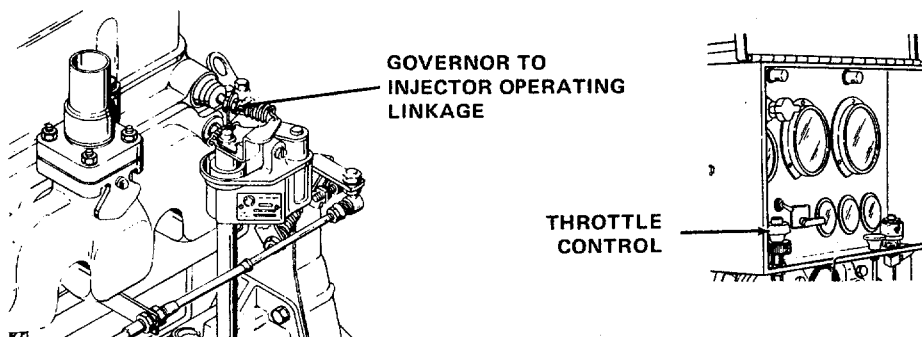
Remove cylinder head and replace compression gaskets (para 5-18). If replacing compression gaskets does not eliminate gas bubbles at coolant surface, replace the cylinder head (para 5-18).

Table 5-1. Direct Support Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

3. ENGINE STARTS BUT RUNS UNEVENLY, STALLS, OR SURGES

Step 1. Check for binding governor to injector operating linkage. Start engine. Watch the moving governor to injector operating linkage components while increasing and decreasing engine speed with the throttle control.



If components bind, adjust the governor linkages (para 5-15).

Step 2. Check for mistimed injectors.

Time injectors (para 5-12).

Step 3. Check for faulty injectors. Remove and test injectors (para 5-12).

Repair or replace faulty injectors (para 5-12).

Step 4. Check for malfunctioning mechanical governor.

Service or replace governor (para 5-15).

4. ENGINE STOPS RUNNING OR PRODUCES BLACK, WHITE, OR GREY SMOKE

Step 1. Check for faulty injectors. Remove and test injectors (para 5-12).

Repair or replace faulty injectors (para 5-12).

Step 2. Check for cracked suction line in fuel tank. Loosen hose clamp and remove fuel supply hose from fuel control valve at fitting. Remove fuel control valve with suction line from fuel tank. Inspect suction line.

If line is cracked, bent, clogged, or damaged, replace it (para 5-10).

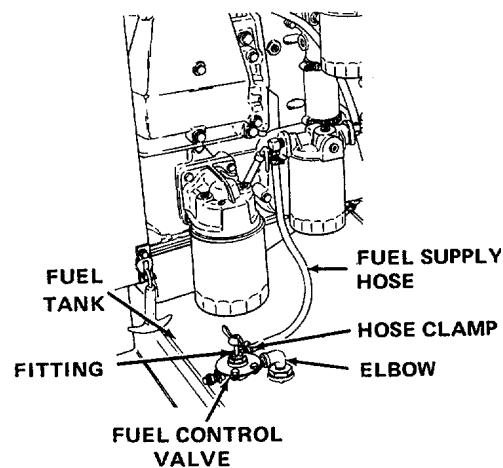


Table 5-1. Direct Support Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 3. Check for faulty fuel pump.

Repair or replace damaged fuel pump (para 5-11).

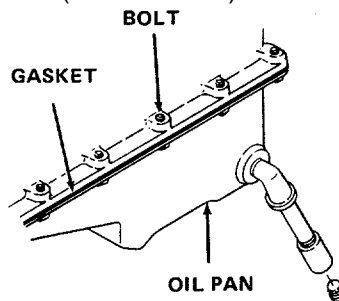
NOTE

The wrong grade of fuel oil will also not undergo complete combustion. This condition may result in black or grey smoke.

5. ENGINE CONSUMES EXCESSIVE LUBE OIL (MAY PRODUCE BLUE SMOKE)

Step 1. Check for leaking oil pan gasket.

If oil pan gasket is leaking, tighten bolts to 10 to 20 ft lb (14 to 27 N•m) in the sequence shown.



If gasket continues to leak, replace it. If gasket still leaks, replace oil pan.

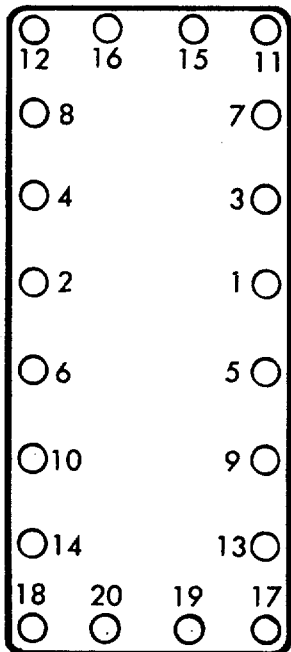
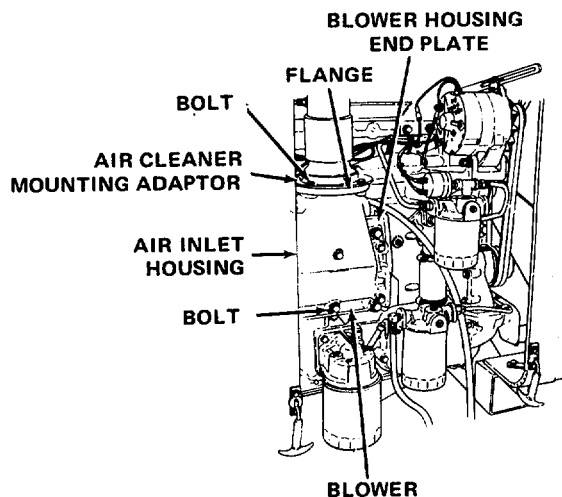


Table 5-1. Direct Support Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

Step 2. Check for damaged blower oil seals. Remove air cleaner mounting adaptor bolts. Remove air inlet housing bolts and carefully slide housing from beneath adaptor.



NOTE

The gasket between air cleaner mounting adaptor and air inlet housing flange may stick when air inlet housing is removed.

Start engine and inspect blower front and rear plates while the engine is operating. If oil is seen on the plates radiating away from the oil seals, replace blower assembly (para 5-9).

Step 3. Check for oil cooler core leaks.

WARNING

Hot coolant may be released when radiator cap is removed. Allow engine to cool before removing cap. Open cap part way to ensure that pressure in cooling system is released, then remove cap.

Inspect engine coolant at radiator cap. If coolant contains oil, notify general support maintenance.

6. PUMP DOES NOT DISCHARGE OR HAS LOW DISCHARGE PRESSURE

Step 1. Check for broken impeller. Disassemble pump (para 5-21). Inspect impeller.

Replace impeller if necessary.

7. PUMP MAKES EXCESSIVE NOISE

Step 1. Check for foreign matter in pump. Disassemble pump (para 5-21). Inspect for foreign matter.

Remove foreign matter.

Section II. MAINTENANCE PROCEDURES

INDEX

	Para		Para
Air shutdown solenoid	5-8	Fuel tank and suction line	5-10
Alternator assembly	5-5	Impeller, shaft, seals, and	
Blower assembly	5-9	check valve	5-21
Cooling fan shaft bracket, shaft		Main wiring harness	5-7
assembly, and pulley	5-17	Mechanical governor	5-15
Cylinder head and block	5-18	Overspeed governor	5-14
Engine assembly	5-16	Pump assembly	5-20
Exhaust heat shield	5-4	Starter motor assembly	5-6
Fuel control tube assembly	5-13	Suction and discharge gage valves,	
Fuel injectors	5-12	lines, hoses, and fittings	5-19
Fuel pump assembly	5-11	Trailer assembly	5-22

5-3. GENERAL INSTRUCTIONS

Most maintenance instructions in this section will list resources required, personnel required, and equipment condition for the start of the procedure. Note the following:

- Resources required are not listed unless they apply to the procedure.
- Personnel required are listed only if the task requires more than one. If PERSONNEL is not listed, it means one person can do the task.
- The normal standard equipment condition to start a maintenance task is engine stopped and battery disconnect switch off. EQUIPMENT CONDITION is not listed unless some other condition is required besides the power being off.

5-4. EXHAUST HEAT SHIELD

This task covers:

- a. Inspection
- b. Repair

INITIAL SETUP:

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705
Tool kit, master mechanics
NSN 5180-00-699-5273

References

MIL-T-704 Treatment and Painting of Material

Equipment Condition

Para

Condition Description

Materials/Parts

Material required by MIL-T-704

4-14

Exhaust heat shield removed from muffler.

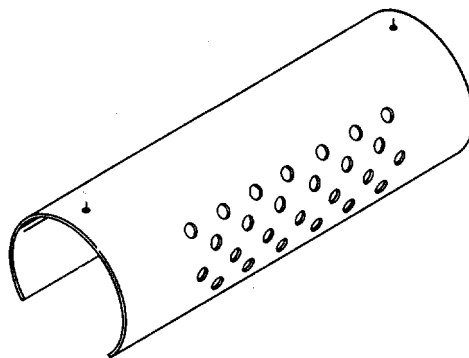
Location/Item

Action

Remarks

INSPECTION

Inspect heat shield for dents, rust, or other damage.



REPAIR

Pound out dents. Remove rust with fine sandpaper, then clean, treat, and refinish the heat shield in accordance with MIL-T-704, Type A, color as specified. Allow finish to dry.

5-5. ALTERNATOR ASSEMBLY

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection and repair
- d. Test
- e. Reassembly

INITIAL SETUP:

Test Equipment

Multimeter

Materials/Parts

Commutator surfacing stone (Item 17, Appendix E)
 Crocus abrasive cloth (Item 1, Appendix E)

Tools

Rosin flux core solder (Item 15, Appendix E)
 Shop set, automotive repair,
 field maintenance, basic
 NSN 4910-00-754-0705

**Equipment
 Condition**

Tool kit, master mechanics
 NSN 5180-00-699-5273

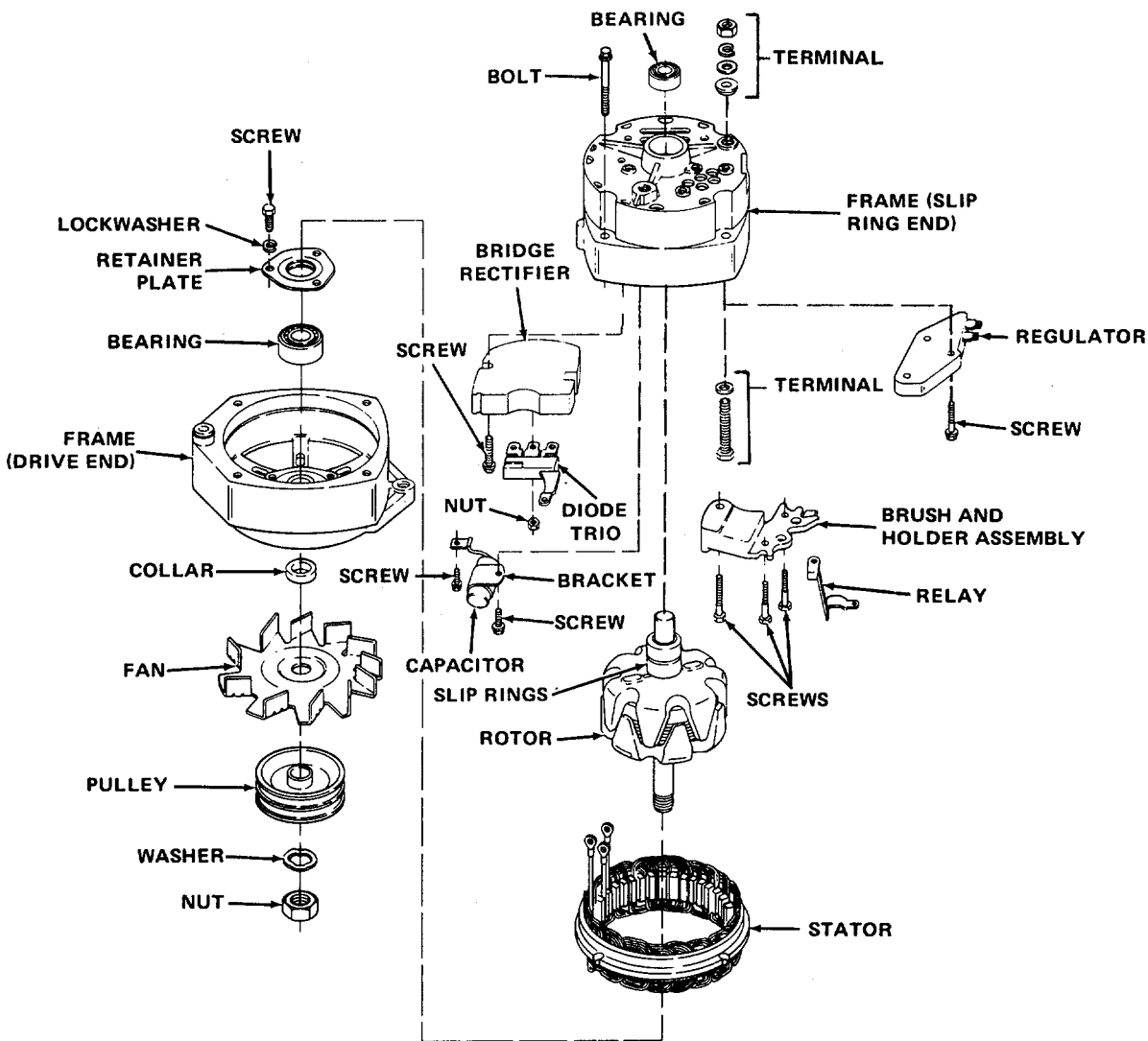
Para	Condition Description
4-20	Alternator removed from engine.

5-5. ALTERNATOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
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DISASSEMBLY

1. Pulley, fan, and collar
Remove pulley retaining nut and washer. Remove pulley, fan, and collar from alternator assembly.



2. Frames
Remove screws securing slip ring end (SRE) frame to drive end (DE) frame. Separate frames.

5-5. ALTERNATOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
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3. Rotor	Carefully slide rotor out of SRE frame.	
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NOTE

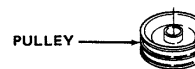
The brushes are spring loaded and will slip out of the brush holders when the rotor is removed.

CLEANING

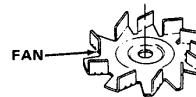
Wipe all components with a clean dry cloth.

INSPECTION AND REPAIR

4. Pulley	Inspect for cracks and groove wear. Replace a damaged pulley.	
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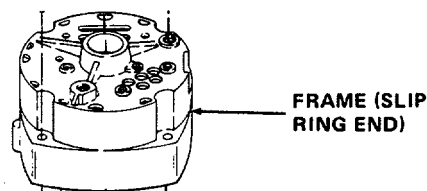
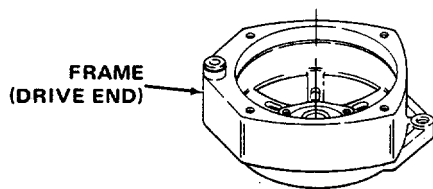


5. Fan	Check for bent or missing fins and mounting hole wear. Replace if damaged.	
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6. Terminals	Inspect for cracks, separations, stripped threads, and other damage. Replace as necessary.	
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7. Frames	Inspect for cracks, bearing bore wear, distortion, damaged threads, and other obvious damage. Remove any burrs with a fine stone (Military Specification MIL-S-17243). Replace either frame if not repairable.	
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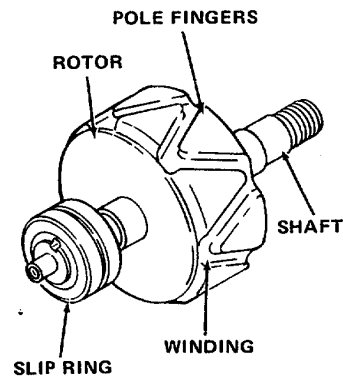


5-5. ALTERNATOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
8. Stator and rotor	Inspect for gouged or discolored windings. Discoloration of winding insulation indicates an overheated stator or rotor that may result in shorted or grounded windings.	
9. Rotor slip rings	Inspect for cracks, wear grooves, or other damage. You can restore a smooth surface to the slip rings with fine crocus cloth (Federal Specification P-C-458). Wipe all residue from slip rings.	
10. Rotor shaft and body	Inspect shaft for stripped threads, cracks, wear, or other damage. Inspect body for cracked or marred pole fingers. Replace rotor if damaged.	
11. All other parts	Inspect for cracks, distortion, or damaged threads. Replace damaged parts.	

TEST

12. Rotor
 Set multimeter to resistance scale, touch probes together, and adjust OHMS ADJUST for zero resistance. Place a probe on each slip ring. A reading of zero resistance indicates a short circuit in rotor winding. If winding has a short circuit, replace rotor. A reading of infinite resistance indicates an open circuit in rotor winding. If winding has an open circuit, replace rotor. Place one test probe on one of the slip rings and the other probe on a rotor pole finger. The multimeter should indicate infinite resistance. If anything less than infinite resistance is indicated, replace rotor.



13. Bridge rectifier diodes
 Test the diodes with a multimeter.

5-5. ALTERNATOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
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CAUTION

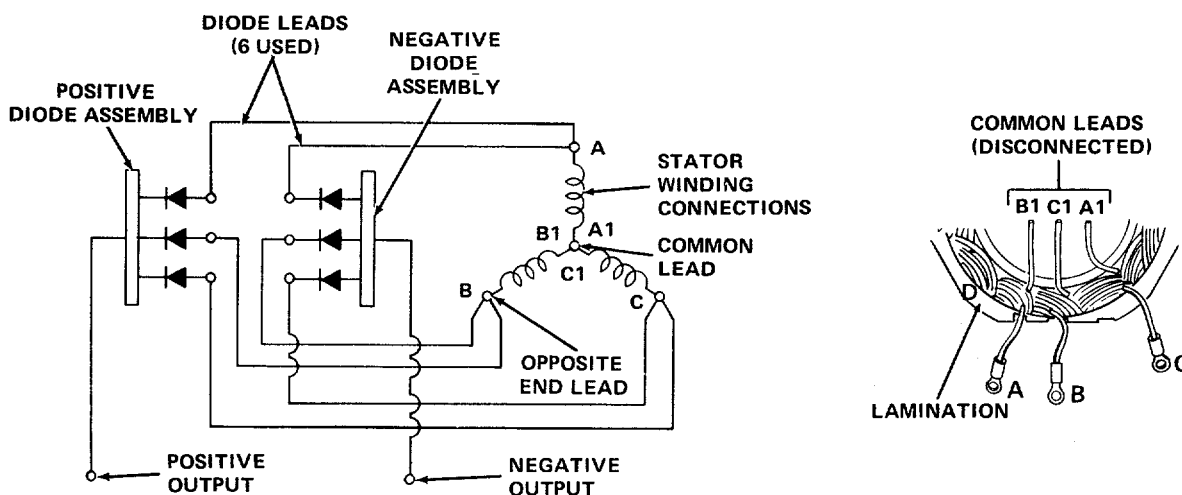
Equipment damage may occur if acid core solder is used to solder diodes to stator leads. Use only rosin core solder (ASTM Specification B 284-79).

NOTE

To test, it will be necessary to unsolder the leads from stems of positive and negative diode assemblies for individual testing. When you solder and unsolder leads from the diodes, use long nose pliers to grasp diode stem between the diode and stator lead to be removed. This will give better heat dissipation and protect diode from damage. Make note of diode to stator lead connections to facilitate reassembly. If one diode is bad, replace entire diode assembly. The positive diode assembly has red printing on the diode body; the negative diode assembly has black printing.

- | | |
|---------------------|--|
| 14. Stator windings | Disconnect stator winding terminals from diode assemblies, and test stator windings for leakage and continuity. Set multimeter to read resistance on the X1 scale. Connect multimeter leads to each pair of the following test points. |
|---------------------|--|

- Point A to point B
- Point A to point C
- Point B to point C
- Point A to point D
- Point B to point D
- Point C to point D



The resistance should be infinite in all of the above tests. If the resistance reading is not infinite in any test, high leakage or a short exists between stator windings, or between a

5-5. ALTERNATOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
	<p>stator winding and the lamination. Replace the stator. Test for stator continuity by connecting the ohmmeter probes to each pair of the following test points:</p> <p style="text-align: center;">Point A to point A¹ Point B to point B¹ Point C to point C¹</p> <p>You should have a low resistance reading (approximately an ohm or less) in each test. Infinite resistance indicates an open winding. Replace the stator if it fails any of the above tests or, if the alternator has been disassembled because of an electrical malfunction, replace the stator after all other components have been checked and found to be satisfactory.</p>	
15. Bearings	Insert the rotor shaft into SRE frame bearing and rotate rotor. Check for looseness, binding, or noise during rotation, and for other damage. Check drive end bearing in the same way. Replace faulty bearing.	
16. Brush and holder assembly	Remove brush and holder assembly and leads from SRE frame. Inspect the brush and holder assembly for cracks, signs of overheating, and distortion. Inspect the brushes for cracks, oil saturation, and wear. If brushes are worn, oil soaked, or cracked, replace the brush and holder assembly. Depress brushes in brush holders. Brushes should slide freely in brush holders. Replace brush springs if weak. Check that continuity exists between each brush and its respective lead wire. If brush and holder assembly is electrically faulty, replace it.	
REASSEMBLY		
17. Brush and holder assembly	Install brush and holder assembly and leads into SRE frame. Tighten mounting and lead hardware securely.	
18. Rotor frame.	Carefully aline rotor shaft with bearing in SRE. Depress brushes in holders and slide rotor into frame.	
19. Frames	Insert and tighten screws that secure SRE frame to DE frame.	
20. Collar, fan, and pulley	Install collar, fan, and pulley on rotor shaft; secure with washer and nut. Torque to 50 to 60 ft lb (68 to 81 N•m).	

5-6. STARTER MOTOR ASSEMBLY

This task covers:

- a. Test
- b. Disassembly
- c. Inspection
- d. Repair
- e. Assembly

INITIAL SETUP:

Test Equipment

Starter switch w/leads
 Battery (12V)

Tools

Shop set, automotive repair,
 field maintenance, basic
 NSN 4910-00-754-0705
 Tool kit, master mechanics
 NSN 5180-00-699-5273

Materials/Parts

Rosin flux core solder (Item 15, Appendix E)

Troubleshooting Reference

Malfunction 1, step 1

Equipment Condition

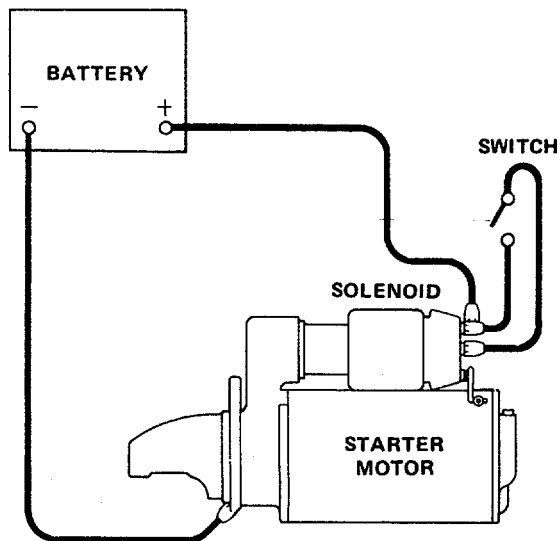
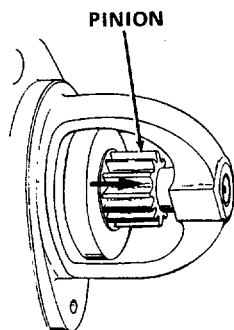
Para	Condition Description
4-21	Starter motor assembly removed from engine.

Location/Item	Action	Remarks
---------------	--------	---------

TEST

1. Starter

Connect starter in series with a fully charged battery and connect a spare starting switch as shown. Energize starter by depressing switch; observe whether pinion moves forward and begins rotating at a high rate of speed. If it does not, consult the following symptom chart.

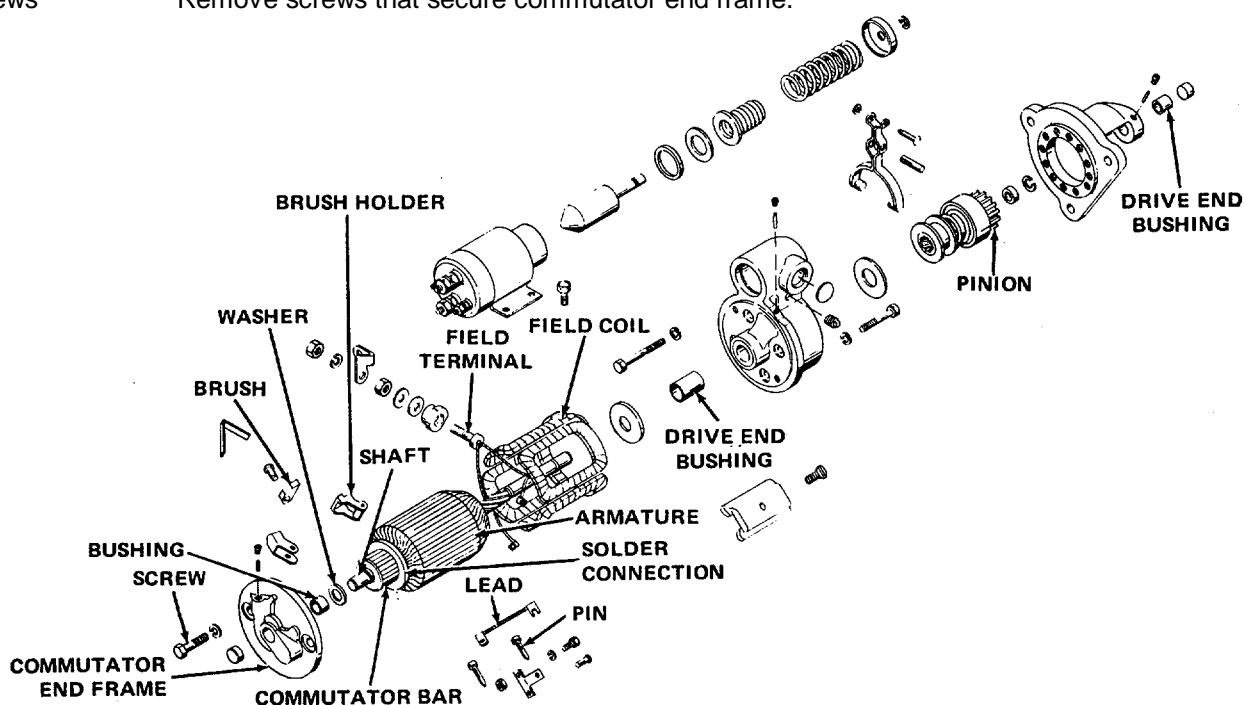


5-6. STARTER MOTOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
SYMPTOM	REASON	
Pinion rotates slowly	Damaged bearings, poor connections, dirty or damaged commutator, damaged leads.	
Pinion does not rotate	Frozen bearings, poor contact between brushes and commutator, field terminal shorted out to starter motor frame.	

DISASSEMBLY

- Screws Remove screws that secure commutator end frame.



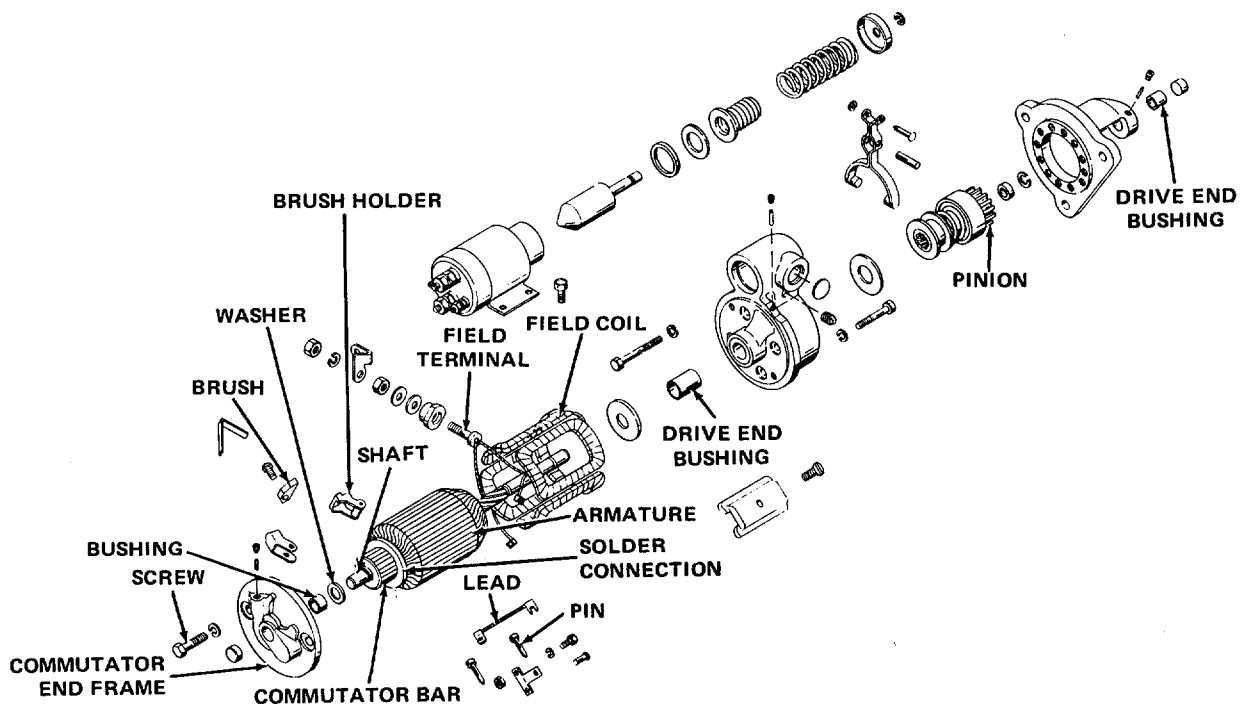
- End frame and bushing Rotate commutator end frame on end of armature shaft after pulling end frame and armature out and away from motor frame. If end frame cannot be pulled loose from armature shaft, or shaft will not rotate in bushings, bushing is frozen and must be replaced. Remove washer from commutator end of shaft.
- Brushes and brush components Remove pins, then remove brushes and leads, brush holders, and brush components.

5-6. STARTER MOTOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
INSPECTION		
5. Brushes and brush components	Remove accumulated dirt, carbon, or other foreign material from brushes and brush components. Inspect for excessive wear or damage. Inspect commutator end of brushes for dirt, glaze, or other material preventing good electrical contact with commutator.	
6. Commutator	Inspect commutator for excessive wear, missing bars, or broken solder connections.	
7. Drive end bushings	Rotate armature in drive end bushings to determine if bushings are frozen or excessively worn. Worn bushing will permit the shaft to be moved sideways.	
8. Field coil	Inspect field coil at connection points for looseness and for frayed or shorted wires.	
9. All other parts	Inspect for excessive wear or damaged.	
REPAIR		
10. Brushes or brush components broken.	Replace glazed brushes or brush components that are excessively worn or damaged. Replace brushes and leads if leads are frayed or broken.	
11. Armature and commutator	Remove dirt and carbon from between commutator bars. Replace armature if commutator is excessively worn or has missing commutator bars. Repair any loose or frayed solder connections at commutator.	
12. Bushings	Replace bushings if excessively worn or frozen.	
13. Field coil	Repair frayed or loose wires or connections on field coil. Replace field coil if shorted or otherwise damaged.	

5-6. STARTER MOTOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
ASSEMBLY		
14. Brushes and brush components	Install brush components in frame and replace pins.	
15. Armature shaft	Install washer on commutator end of armature shaft.	
16. Frame	Install frame and secure with screws.	



5-7. MAIN WIRING HARNESS

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705
Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Tie wraps

Equipment Condition

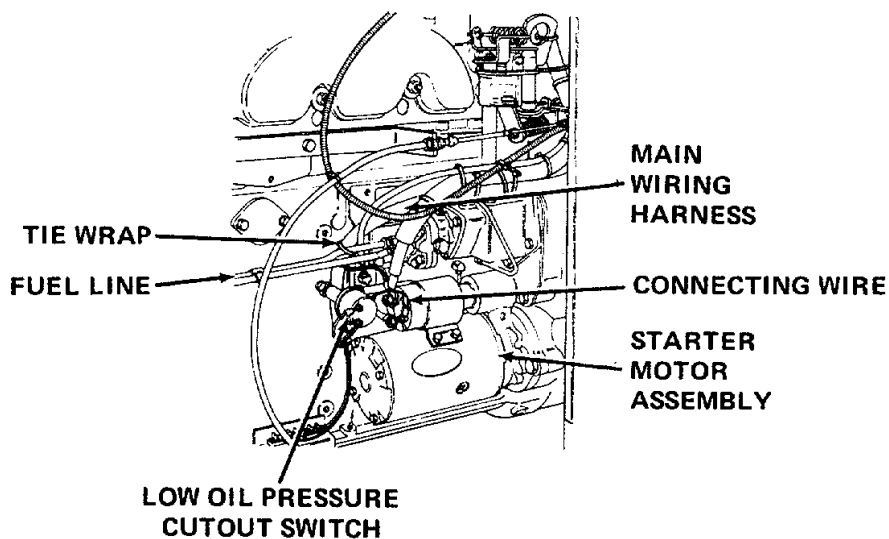
Engine side panels removed.

Negative terminal removed from battery.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

1. Main wiring harness connecting wires
 - TAG and disconnect wires from:
 - a. starter motor assembly

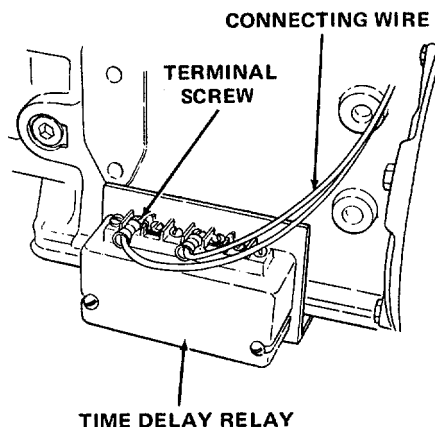


- b. low oil pressure cutout switch

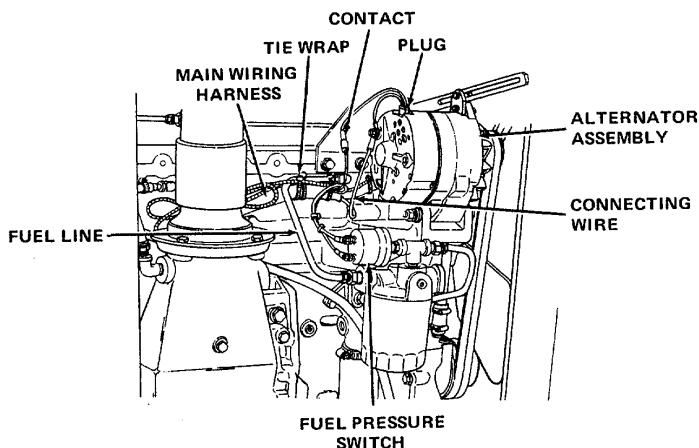
5-7. MAIN WIRING HARNESS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

c. time delay relay

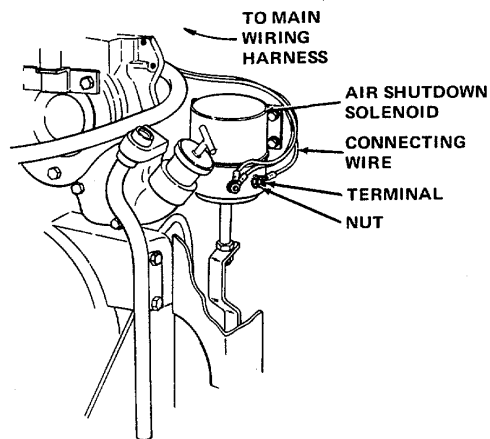


d. alternator assembly



e. fuel pressure switch

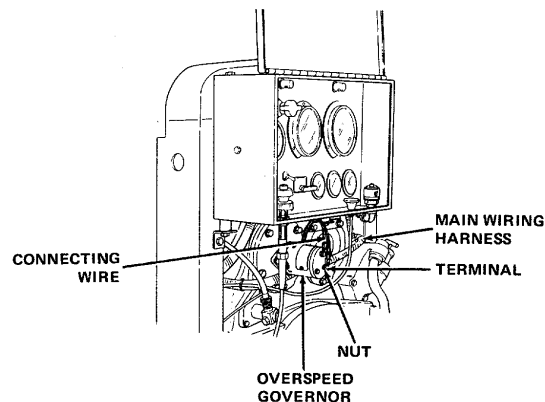
f. air shutdown solenoid



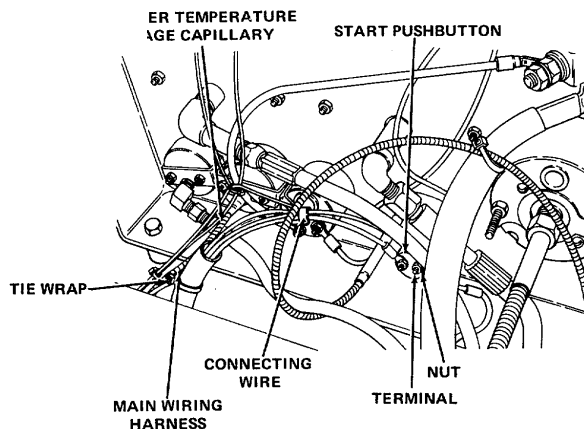
5-6. STARTER MOTOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

g. overspeed governor



h. START pushbutton



NOTE

For ease of replacement, mark route of main wiring harness with string before removing tie wraps and harness. Cut all tie wraps securing main wiring harness to fuel lines, water temperature gage capillary, or other attachment points.

- | | |
|------------------------|---|
| 2. Main wiring harness | Carefully remove main wiring harness from engine. If connecting wires on replacement harness are not tagged, transfer tags to the same connecting wires on replacement harness. |
|------------------------|---|

5-6. STARTER MOTOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSTALLATION

3. Main wiring harness Begin at control panel and route main wiring harness, in a clockwise direction, close to its connecting points.

NOTE

If string was used as a tracer, pull and remove string as harness is installed. Attach tie wraps as needed to secure harness, but do not tighten them.

4. Main wiring harness connecting wires Connect wires to electrical components. Tighten terminal nuts or screws firmly, and attach plugs or contacts firmly. Tighten tie wraps.

5-8. AIR SHUTDOWN SOLENOID

This task covers:

a. Inspection/Repair

INITIAL SETUP:

Test Equipment

Multimeter

Equipment

Condition

Para

Condition Description

Tools

Shop set, automotive repair,
Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705
Tool kit, master mechanics
NSN 5180-00-699-5273

4-25

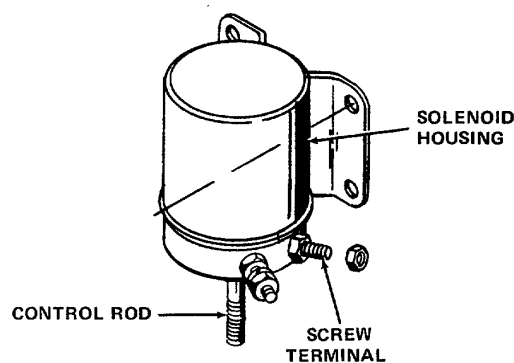
Air shutdown solenoid re-
moved from engine.

Location/Item Action

Remarks

INSPECTION/REPAIR

1. Solenoid housing
Inspect for dents, rust, corrosion or other damage. Discard solenoid if badly damaged.
2. Screw terminals and control rod
Inspect terminals and threaded portion of control rod for dirty or damaged threads. Chase threads. Discard solenoid if a nut of the same size and thread cannot be easily threaded onto threaded portion of terminals and control rod.
3. Solenoid continuity test
Using a multimeter, test solenoid coil resistance. Set meter to X1 scale. Short meter probes together and adjust for zero indication. Measure electrical resistance between terminals. Meter shall indicate continuity. If meter indicates infinity, discard the solenoid.
4. Solenoid short circuit test
Using a multimeter, test solenoid coil for short circuits. Short meter probes together and adjust for zero indication. Measure electrical resistance between either terminal and the solenoid housing. Meter shall indicate infinity all scales. Discard solenoid if short circuit is indicated.



5-8. AIR SHUTDOWN SOLENOID (CONT)

Location/Item	Action	Remarks
5. Solenoid operational test	Connect a 12-volt DC electrical source across terminals of solenoid. Energize solenoid; control rod must pull into housing. Discard solenoid if it does not operate properly.	

5-9. BLOWER ASSEMBLY

This task covers:

- a. Inspection
- b. Removal
- c. Installation
- d. Checking backlash

INITIAL SETUP:

Tools

Shop set, automotive repair, field maintenance, basic, NSN 4910-00-754-0705

Troubleshooting Reference

Malfunction 5, step 2

Materials/Parts

Sealing compound (Item 14, Appendix E)

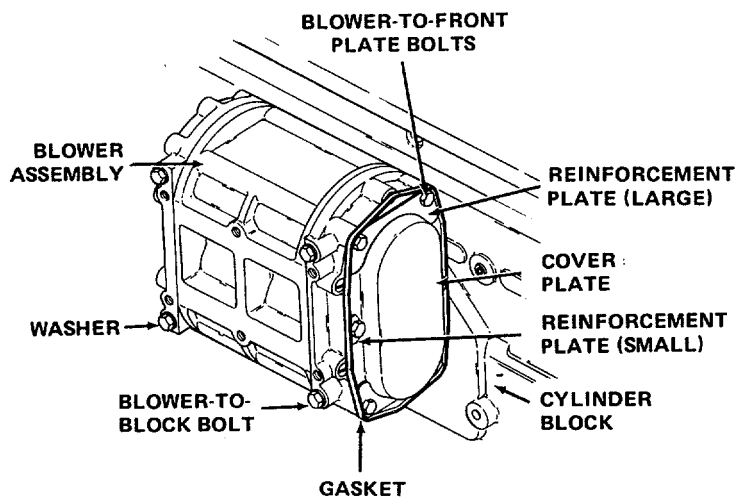
Equipment Condition

Engine side panels removed.

Location/Item	Action	Remarks
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INSPECTION

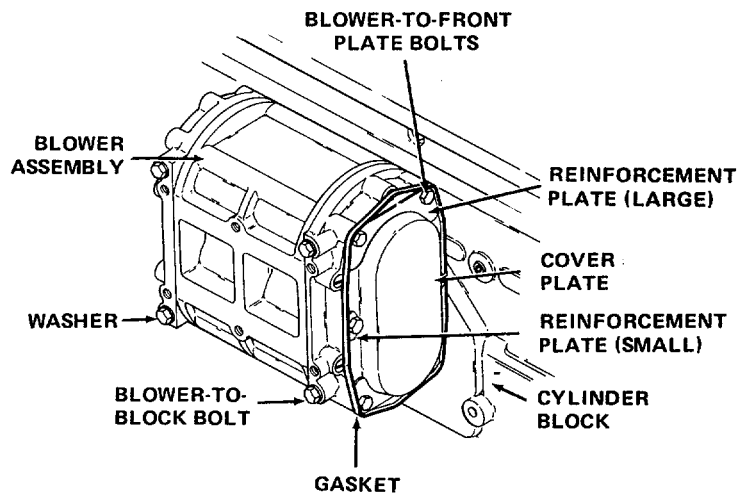
1. Blower assembly
 Inspect exterior for cracks, corrosion, or other damage. Replace blower if damaged. Remove blower-to-front plate bolts and reinforcement plates. Remove cover plate and gasket. Discard gasket.



2. Oil seals
 Inspect surface of front plate for oil radiating from oil seals. Replace blower if there is oil on front plate.

5-9. BLOWER ASSEMBLY (CONT)

Location/Item	Action	Remarks
REMOVAL		
3. Blower assembly	Remove blower-to-block bolts and washers. Remove blower assembly from cylinder block.	
INSTALLATION		
4. Blower-to-block gasket	Apply MIL-S-45180 sealing compound to block side only of gasket, and position gasket on block.	
5. Front plate-to-blower gasket	Install over threaded ends of bolts. Apply MIL-S-45180 sealing compound to front plate side of gasket.	
6. Blower assembly	Place on cylinder block locating flanges, and support while threading mounting bolts through blower and into the engine end plate and flywheel housing. Tighten hand tight.	



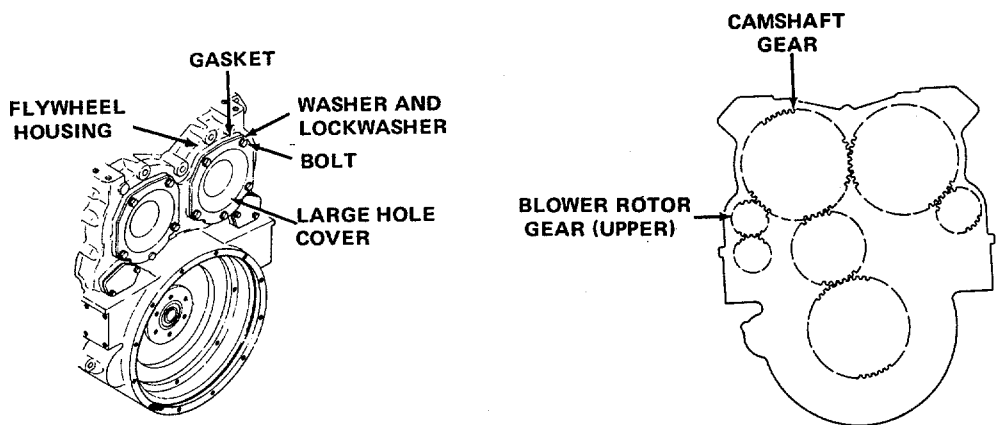
7. Blower-to-block bolts	Torque to 10 to 15 ft lb (14 to 20 N•m).
8. Center blower-to-front plate bolts	Torque to 20 to 25 ft lb (27 to 34 N•m).
9. Top and bottom blower-to-front plate bolts	Torque to 20 to 25 ft lb (27 to 34 N•m).
10. Blower-to-block bolts	Torque to 55 to 60 ft lb (75 to 81 N•m).

5-9. BLOWER ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CHECKING BACKLASH

- 11. Flywheel housing large hole cover mounting bolts and washers Remove.



- 12. Large hole cover and gasket Remove. Discard gasket.
- 13. Camshaft gear and upper rotor gear Check backlash between upper rotor gear and camshaft gear. The backlash should be 0.003 to 0.007 inch (0.076 to 0.178 mm). Replace gears if necessary.
- 14. Large hole cover and gasket Position replacement gasket. Hold in place with cover.
- 15. Flywheel large hole cover mounting bolts and washers Install and tighten securely.

5-10. FUEL TANK AND SUCTION LINE

This task covers:

- a. Inspection
- b. Repair

INITIAL SETUP:

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273
frame assembly.

Troubleshooting Reference

Malfunction 4, step 2

Equipment Condition

Para	Condition Description
4-26	Fuel tank removed from

References

MIL-T-704 Treatment and Painting of Material

Special Environmental Conditions

Well-ventilated area required.

Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

- 1. Fuel tank Inspect exterior of tank for dents, broken welds, flaking paint, excessive rust, or other damage. If fuel tank is severely dented or rusted, replace it.
- 2. Suction line Inspect suction line for cracks, clogs, or other damage. If suction line is cracked, or has an obstruction that cannot be removed, replace suction line.

REPAIR

WARNING

Explosion hazard exists when fuel tank is welded. Purge all fumes from tank before attempting repair involving heat or flame.

- 3. Fuel tank If tank has broken welds, dry it thoroughly before reworking the cracked weld. If the tank has flaking paint or severe rust, sandpaper an area larger than the damaged area. Sandpaper to bare metal. Then clean, treat, and paint tank in accordance with MIL-T-704, Type A, color as specified. Allow paint to dry.

5-11. FUEL PUMP ASSEMBLY

This task covers:

- a. Removal
 - b. Replacement
 - c. Disassembly
 - d. Inspection
 - e. Repair
 - f. Reassembly
 - g. Installation
 - h. Priming
-

INITIAL SETUP:**Tools**

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Diesel fuel oil (Item 6, Appendix E)
Emery abrasive cloth (Item 2, Appendix E)
Crocus abrasive cloth (Item 1, Appendix E)
Lubricating oil (Item 10, Appendix E)

Troubleshooting Reference

Malfunction 4, step 3

*

Equipment Condition

Engine side panels removed.

Special Environmental Conditions

Well-ventilated area required.

General Safety Instructions**WARNING**

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

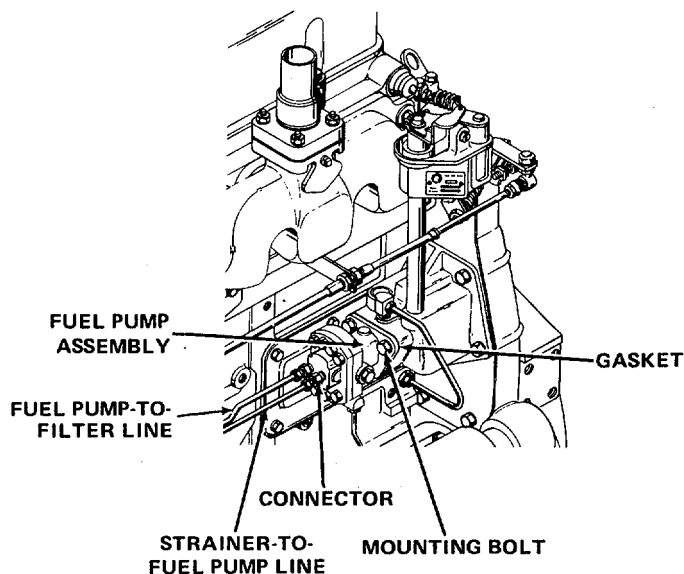
- Do not inhale vapor.
 - Do not handle fuel near open flame, sparks, or excessive heat.
 - Be certain fuel lines and connections are secure.
 - Work in a well-ventilated area.
-

5-11. FUEL PUMP ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | | |
|---------------|--|--|
| 1. Fuel lines | Remove fuel lines from fuel pump assembly. | |
|---------------|--|--|



- | | | |
|--------------|---|--|
| 2. Fuel pump | Remove pump mounting bolts, gasket, and pump. | |
|--------------|---|--|

REPLACEMENT

- | | | |
|-----------------------|--|--|
| 3. Fuel pump assembly | If fuel pump is defective, proceed to steps 17 thru 19, and install a new pump. Prime in accordance with steps 20 thru 22. | |
|-----------------------|--|--|

DISASSEMBLY

CAUTION

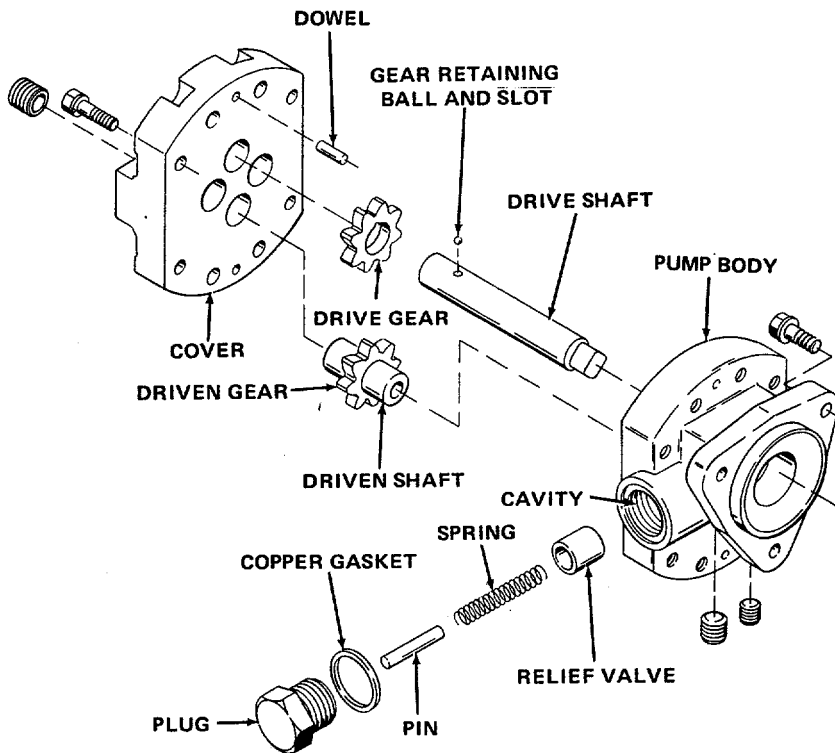
Do not scratch or mar mating surfaces of pump body or cover. The pump may leak or otherwise malfunction after reassembly.

- | | | |
|---------------|---|--|
| 4. Pump cover | Remove eight cover bolts. Remove pump cover from pump body. | |
|---------------|---|--|

5-11. FUEL PUMP ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|--------------|---|--|
| 5. Pump body | Remove drive shaft, drive gear, and gear retaining ball from pump body. | |
|--------------|---|--|



- | | | |
|----------------|---|--|
| 6. Drive shaft | Press drive shaft far enough to remove retaining ball. Remove shaft and gear as an assembly. Press shaft from gear. | |
|----------------|---|--|

CAUTION

Do not remove driven gear from driven shaft. They are serviced only as an assembly.

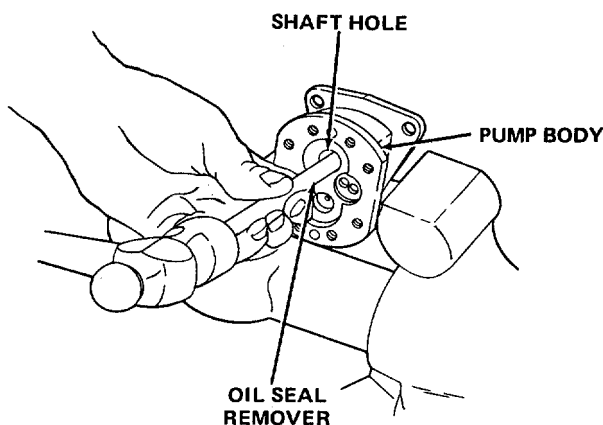
- | | | |
|---------------------------------|--|--|
| 7. Driven shaft | Remove driven shaft and gear as an assembly. | |
| 8. Relief valve plug and gasket | Remove. | |

5-11. FUEL PUMP ASSEMBLY (CONT)-

Location/Item	Action	Remarks
9. Valve spring, pin, and relief valve	Remove from pump body cavity.	

NOTE

If oil seals need replacing, observe position of oil seal lips. Insert an oil seal remover in shaft holes in pump body. Tap end of seal remover to remove inner and outer seals.

**INSPECTION/REPAIR****WARNING**

Do not direct compressed air against skin.

10. Interior and exterior parts

Clean all parts in clean fuel oil and dry with compressed air.

Check pump gear teeth for scoring, chipping, or wear. Check ball slot in drive gear for wear. If gear is damaged or worn, replace it. Inspect drive and driven shafts for scoring or wear. Replace if necessary. Driven shaft and driven gear must be replaced as an assembly.

Inspect mating faces of pump body and cover for roughness or other damage. Scratches or other damage may result in pressure leaks. Also check for wear at gear and shaft contact areas. Replace pump cover or body if necessary.

Relief valve must be free from score marks and burrs and fit its seat in pump body. If valve is scored and cannot be cleaned with fine emery cloth (Federal Specification P-C-1673) or crocus cloth (Federal Specification P-C-458), replace valve.

5-11. FUEL PUMP ASSEMBLY (CONT)-

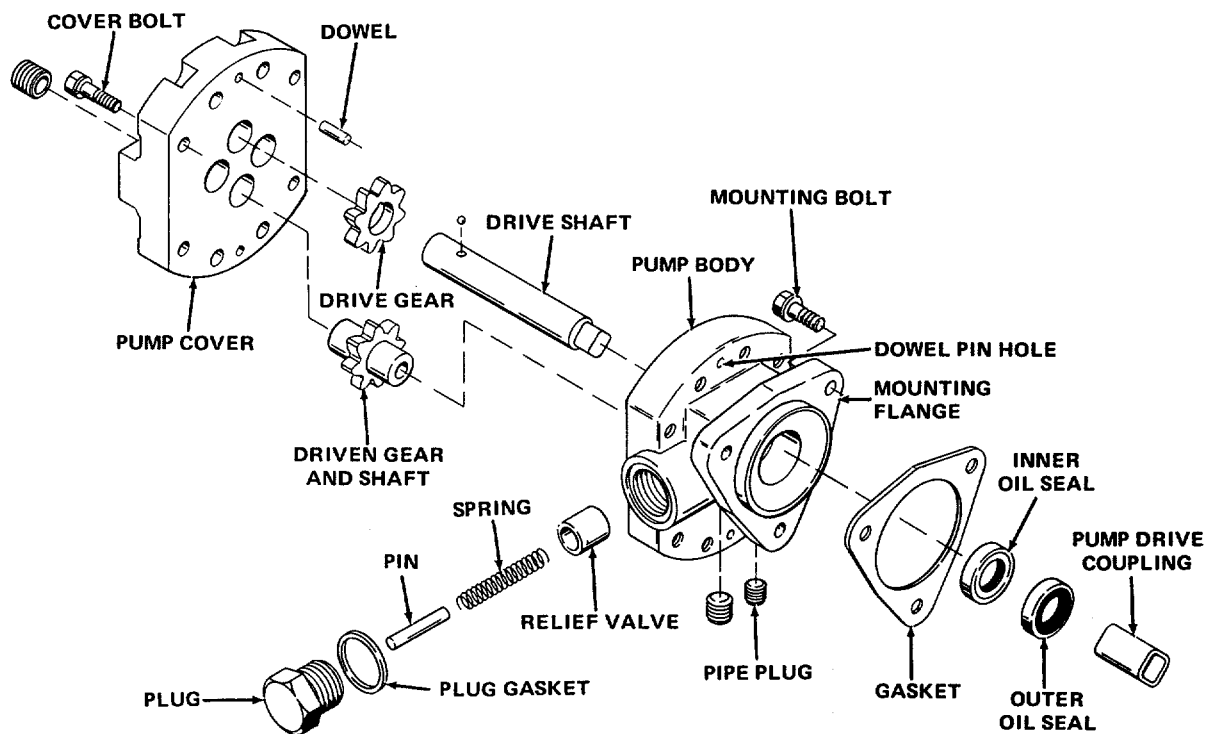
Location/Item	Action	Remarks
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REASSEMBLY

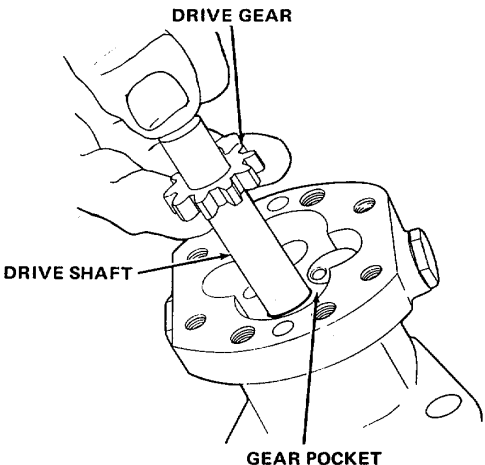
11. Oil seals
 Lubricate the lips of the new oil seals with a light coat of MIL-L-2104 oil. With pump body supported on wood blocks insert inner seal into pump body so seal starts straight into pump mounting flange. Then drive seal in until it bottoms.

Place outer oil seal into pump body and drive it in.

12. Relief valve
 Clamp pump body in a bench vise with relief cavity up. Lubricate outside diameter of relief valve and place it in the cavity with hollow end up. Insert spring inside valve and then insert pin inside spring. With a new plug gasket in place next to head of valve plug, place plug over spring and thread it into pump body. Torque plug to 18 to 22 ft lb (24 to 30 N•m).



5-11. FUEL PUMP ASSEMBLY (CONT)-

Location/Item	Action	Remarks
13. Pump drive gear and shaft	Install pump drive gear over round end of drive shaft so slot in gear will face plain end of shaft. Press gear beyond gear retaining ball detent. Then place ball in detent and press gear back until end of slot contacts ball. Lubricate pump shaft and insert square end of shaft into opening at gear side of pump body and through the oil seals.	
14. Pump driven gear and shaft	Place driven shaft and gear assembly in pump body.	

NOTE

Driven gear must be centered on shaft to give proper end clearance. Also, chamfered end of gear teeth of production gear must face pump body. If a service replacement gear with a slot is used, slot must face toward pump cover.

Lubricate gear and shaft with clean VV-F-800 fuel oil.

CAUTION

Damage to pump gears and shaft may occur if sealant is squeezed into the gear compartment. Use sealant sparingly.

15. Pump body and cover	Apply a thin coat of sealing compound (Military Specification MIL-S-45180) on face of pump cover outside of the gear pocket area. Then place cover against pump body with two dowel pins in cover entering holes in pump body. Cover can be installed in only one position over the two shafts.
-------------------------	---

NOTE

The coating of sealant must be extremely thin since the pump clearances have been set up on the basis of metal-to-metal contact. Too much sealant could increase the clearances and affect pump efficiency.

5-11. FUEL PUMP ASSEMBLY (CONT)-

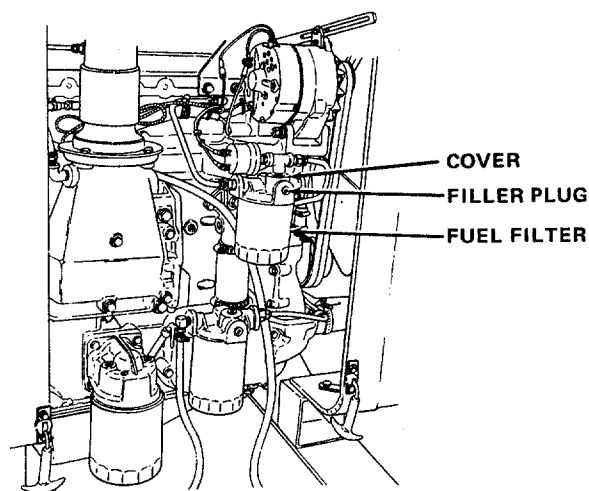
Location/Item	Action	Remarks
	Secure cover in place with eight bolts and lock washers, tightening bolts alternately and evenly. Rotate pump shaft by hand to make certain that parts rotate freely. If shaft does not rotate freely, attempt to free it by tapping a corner of the pump.	
16. Pipe plugs	Install in drain holes.	
INSTALLATION		
17. Gasket, drive coupling, and drive shaft	Position a new gasket on pump body mounting flange and locate pump drive coupling over square end of fuel pump drive shaft.	
18. Fuel pump	Install on engine and secure with mounting bolts.	
19. Inlet and outlet fuel lines	Connect inlet and outlet fuel lines to fuel pump.	

CAUTION

Prime fuel system after installing fuel pump. This will promote trouble-free engine performance and prevent the possibility of fuel pump seizure during initial starting.

PRIMING

20. Fuel filter filler plug	Remove filler plug in fuel filter cover and install hand primer pump. Prime the system. Remove primer pump. Install filler plug.
-----------------------------	--



5-11. FUEL PUMP ASSEMBLY (CONT)-

Location/Item	Action	Remarks
21. Engine	Start.	
22. Fuel line connectors	Check for leaks at fuel line connectors. Tighten leaking connectors slightly. If leakage continues, replace connector(s).	
23. Engine	Shut down.	

5-12. FUEL INJECTORS

This task covers:

- a. Timing
- b. Bleeding the Fuel System

INITIAL SETUP:

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Fuel system primer (J5956)

Troubleshooting References

Malfunction 3, steps 2 and 3

Malfunction 4, step 1

Equipment Condition

Valve cover removed.

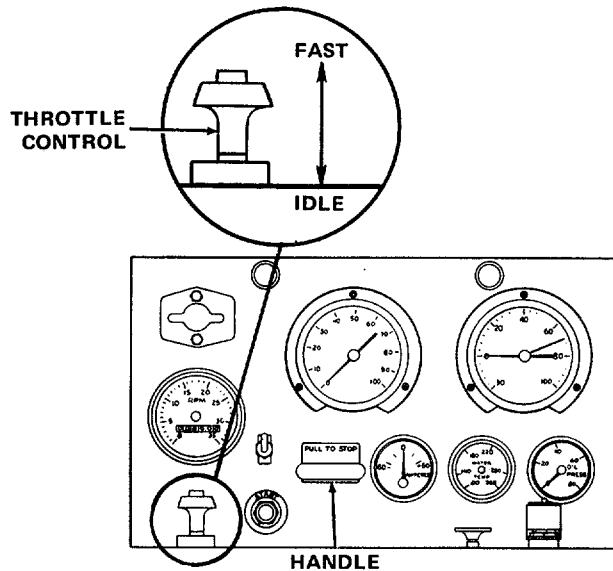
Special Environmental Conditions

Well-ventilated area required.

Location/Item	Action	Remarks
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TIMING'

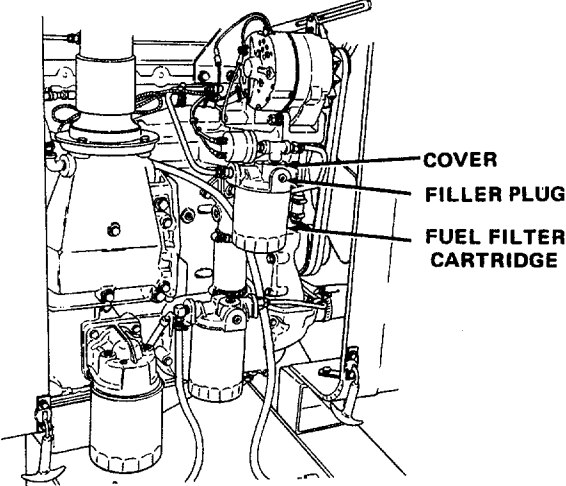
1. Throttle control Adjust throttle control to idle speed position.
2. PULL TO STOP handle Pull handle out.



5-12. FUEL INJECTORS (CONT)

Location/Item	Action	Remarks
3. Crankshaft	Rotate crankshaft with starter motor to depress exhaust valves on each side of the injector to be timed.	
4. Injector body	Adjust timing gage for a timing dimension of 1.460 inches (37.084 mm). Place small end of injector timing gage in the hole in the top of the injector body. Turn the flat of the gage toward injector follower.	
5. Push rod and injector rocker arm	Loosen injector rocker arm push rod lock nut. Turn push rod and adjust injector rocker arm until extended part of gage will just pass over the top of the injector follower. Hold push rod and tighten lock nut. Check adjustment (gage will just pass over the top of injector follower). If necessary, readjust push rod. Time remaining injectors in the same manner.	

5-12. FUEL INJECTORS (CONT)

Location/Item	Action	Remarks
BLEEDING AIR FROM FUEL SYSTEM		
6. Fuel filter cover filler plug	Remove from filter cover.	
		
7. Fuel system primer	Install into plug hole. Prime system. Remove primer.	
8. Fuel filter cover filler plug	Install filler plug into filter cover.	

5-13. FUEL CONTROL TUBE ASSEMBLY

This task covers:

- a. Removal
- b. Disassembly
- c. Inspection
- d. Repair
- e. Assembly
- f. Installation
- g. Adjustment

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705
Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Diesel fuel oil (Item 6, Appendix E)

Equipment Condition

Engine side panels removed.

Special Environmental Conditions

Well-ventilated area required.

General Safety Instructions

WARNING

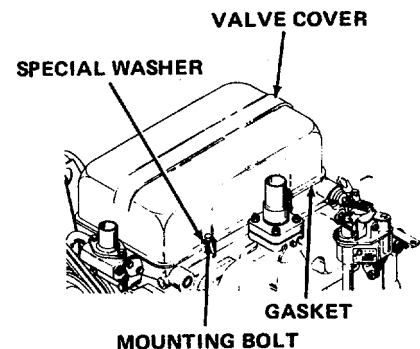
Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly.. Observe the following precautions:

- Do not inhale vapor.
- Do not handle near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

Location/Item	Action	Remarks
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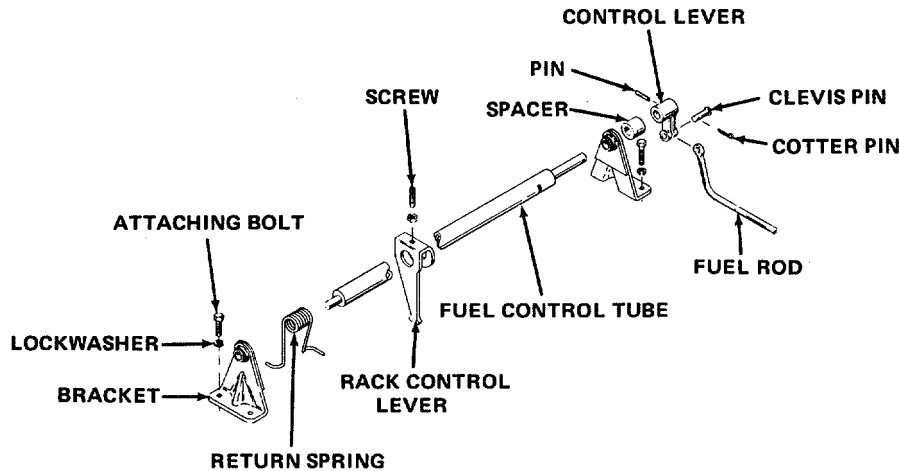
REMOVAL

1. Valve cover and gasket
Wipe off valve cover. Remove valve cover mounting bolts, valve cover, and gasket. Discard gasket



5-13. FUEL CONTROL TUBE ASSEMBLY (CONT)

Location/Item	Action	Remarks
2. Fuel control tube assembly	Remove cotter pin and clevis pin that connect fuel rod to fuel control tube control lever. Remove two attaching bolts and lockwashers at each bracket. Disengage rack control levers from control racks and lift the fuel control tube assembly from the cylinder head.	



DISASSEMBLY

NOTE

The fuel control tube, one mounting bracket, a spacer, and fuel control tube control lever are available as a service assembly. When any part of this assembly needs replacing, it is recommended the complete service assembly be replaced. Therefore, disassembly and assembly procedures for these items are not included.

3. Fuel control tube
Remove bracket from the fuel control tube.
4. Rack control lever
Loosen the adjusting screws or adjusting screw and lock nut at each rack control lever. Disconnect return spring from bracket and front or rear rack control lever.
5. Return spring and rack
Then remove return spring and rack control levers from the fuel control tube control lever

5-13. FUEL CONTROL TUBE ASSEMBLY (CONT)

Location/Item	Action	Remarks
INSPECTION		
6. All parts	Wash all of the fuel control tube parts in clean VV-F-800 fuel oil and dry them with compressed air. Then, examine fuel control tube, control lever, rack control levers, bracket and bearing assemblies, and return springs for excessive wear, cracks, or damage.	
REPAIR		
7. Fuel control tube assembly	If the fuel control tube, control lever, or either of the bracket and bearing assemblies is worn or damaged, replace as an assembly.	
8. Rack control levers	If rack control levers are worn or damaged, replace separately.	

ASSEMBLY**CAUTION**

Equipment damage may occur if fuel control tube assembly does not return to OFF position by action of the return spring. Do not bend the spring. Replace spring, or loosen and shift the position of the brackets. Tighten when binding is eliminated.

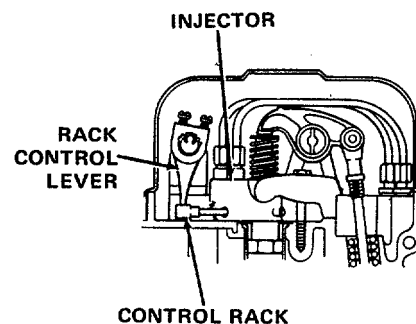
9. Fuel control tube	Install rack control levers on fuel control tube, with levers facing the front bracket position. Turn adjusting screws into the slots in the fuel control tube far enough to position the levers.
10. Return spring and front bracket	Install return spring and front bracket on the fuel control tube. Attach curled end of return spring to rack control lever and extended end of the spring behind the front bracket.

5-13. FUEL CONTROL TUBE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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INSTALLATION

11. Fuel control tube Engage the rack control levers with control racks and place brackets over mounting holes on cylinder head. Install attaching bolts and lockwashers at each bracket. Torque bolts to 10 to 12 ft lb (14 to 16 N•m). Check for freeness in the brackets. Tap control tube lightly to aline bearings in the bracket, if necessary.



ADJUSTMENT

WARNING

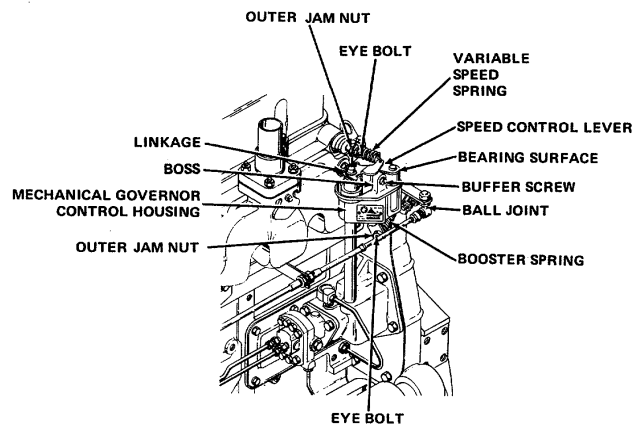
Exposure to exhaust gases produces symptoms of headache, dizziness, loss of muscular control, drowsiness, or coma. Brain damage or death can result from severe exposure.

Fumes from engines become concentrated with poor ventilation.

Operate engine in a ventilated area only.

Do not start the engine if rack control levers cannot be placed in the no-fuel position. The loss of shutdown control could result in a runaway engine, causing personal injury.

12. Mechanical governor Clean and lubricate linkages, ball joints, and bearing surfaces. Back out buffer screw until it projects 9/16 inch (14.3 mm) from the boss on the control housing. Back out booster spring eye bolt until flush with the outer jam nut.



5-13. FUEL CONTROL TUBE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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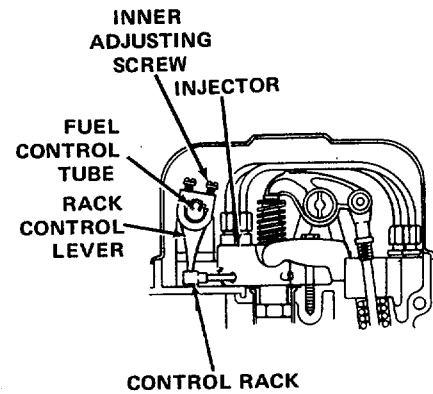
NOTE

The following setting of the eye bolt will produce approximately 7% droop in engine speed from no load to full load. This is the optimum droop adjustment for most applications. The droop may be lowered by increasing spring tension and raised by decreasing spring tension.

Changing the variable speed spring tension will change engine idle speed and maximum no load speed, which must then be readjusted.

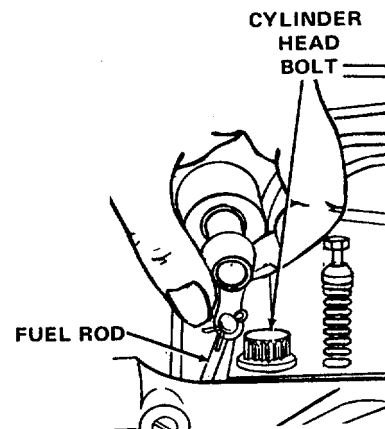
Adjust variable speed spring eye bolt until 1/8 inch (3 mm) of threads project from outer jam nut. Tighten both jam nuts to retain adjustment.

- | | | |
|-------------------------|------------------------------|--|
| 13. Rack control levers | Loosen all adjusting screws. | |
|-------------------------|------------------------------|--|



- | | | |
|---|--|--|
| 14. Speed control lever | Move to maximum speed position. | |
| 15. Rack control lever adjusting screws (lever closest to governor) | Adjust until both screws are equal in height and tight on fuel control tube. | |

- | | | |
|--|---|--|
| 16. Rear control rack (rack closest to governor) | Move into full-fuel position, and note clearance between fuel rod and cylinder head bolt. Adjust clearance to 1/32 to 1/16 inch (0.79 to 1.58 mm) by adjusting the rack control lever adjusting screws. Tighten screws when adjustment is complete. | |
|--|---|--|



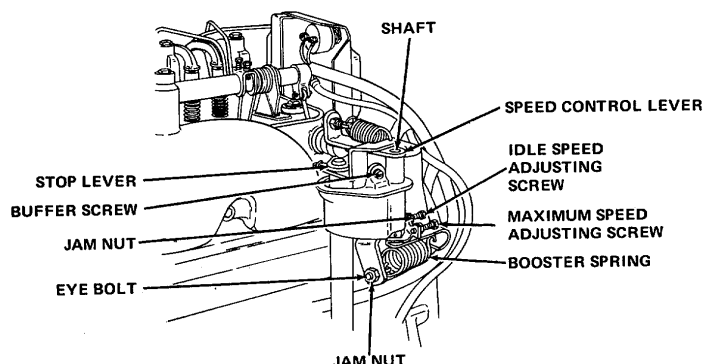
5-13. FUEL CONTROL TUBE ASSEMBLY (CONT)

Location/Item	Action	Remarks
17. Ball joint	Loosen jam nut.	
18. Fuel rod and ball joint	<p>Hold fuel rod in full-fuel position and adjust ball joint until it is aligned, and will slide on the ball stud on the stop lever. Tighten ball joint jam nut to retain adjustment. Push fuel rod toward the engine and check that injector control rack is in full-fuel position. Readjust ball joint jam nut if necessary.</p>	
19. Rear control rack	<p>Manually hold in full-fuel position with fuel control tube control lever, and turn down the inner adjusting screw of adjacent rack control lever until control rack moves into full-fuel position. Turn down the outer adjusting screw until it bottoms lightly on the fuel control tube. Alternately tighten both the inner and outer adjusting screws to 24 to 36 in. lb (2.7 to 41. N•m). Recheck rack to make sure that it has remained snug on end of the rack control lever while adjusting the adjacent rack. If the rack of the rear injector has loosened, back off inner adjusting screw slightly on adjacent rack control lever, and tighten outer adjusting screw. When settings are correct, the racks of both injectors must be snug on the end of their respective control levers.</p>	
20. Remaining rack control levers	<p>Position remaining rack control levers in the same manner.</p>	

5-13. FUEL CONTROL TUBE ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-------------------------|-----------------------|--|
| 21. Stop lever | Put in run position. | |
| 22. Speed control lever | Put in idle position. | |



NOTE

If adjustments to the governor are made while the pump is under load (pumping water), erroneous tachometer readings will result. To accurately set the idle and no load speed, the pump should be separated from the engine.

- | | | |
|-----------------------------------|--|--|
| 23. Pump | Separate from engine at flexible coupling in accordance with paragraph 5-20. | |
| 24. Idle speed adjusting screw | Start engine. Loosen jam nut and turn in or out until engine idles at 550 rpm. Hold screw tight and tighten jam nut. Leave engine running. | |
| 25. Speed control lever | Move it to the maximum speed position. | |
| 26. Maximum speed adjusting screw | Loosen jam nut and adjust until 2300 rpm is obtained. Hold screw tight and tighten jam nut. Leave engine running. | |

CAUTION

Equipment damage may occur if idle speed is raised more than 20 rpm with buffer screw. After adjusting, also check maximum no load speed to make sure that it has not increased over 20 rpm by buffer screw adjustment.

- | | | |
|------------------|--|--|
| 27. Buffer screw | Reduce engine speed to 550 rpm and turn screw so that it contacts the stop lever very lightly, and still eliminates engine roll. | |
|------------------|--|--|

5-13. FUEL CONTROL TUBE ASSEMBLY (CONT)

Location/Item	Action	Remarks
28. Speed control lever	Move to idle speed position.	
29. Booster spring eye bolt	Back off outer jam nut until bolt is flush with end of nut. Adjust eye bolt so that a lengthwise centerline through the spring will align with the center of speed control shaft. Tighten outer jam nut to retain the adjustment.	
30. Speed control lever	Move to maximum speed position and note the force required to move it. To reduce force back off inner jam nut and tighten outer jam nut on booster spring eye bolt. Realine booster spring with speed control shaft if necessary.	

NOTE

The adjustment is correct when the speed control lever can be moved from idle speed to maximum speed position with constant force, with engine running, and when released it will return to idle speed position.

Check force necessary to move speed control lever and return to idle speed position. Adjust and realine booster spring if necessary.

5-14. OVSPEED GOVERNOR

This task covers:

- a. Removal
- b. Disassembly
- c. Inspection
- d. Repair
- e. Assembly
- f. Installation

INITIAL SETUP

Tools

Tool kit, master mechanics
NSN 5180-00-699-5273

Gasket
Preformed packing

Materials/Parts

Ball and roller bearing grease
(Item 8, Appendix E)

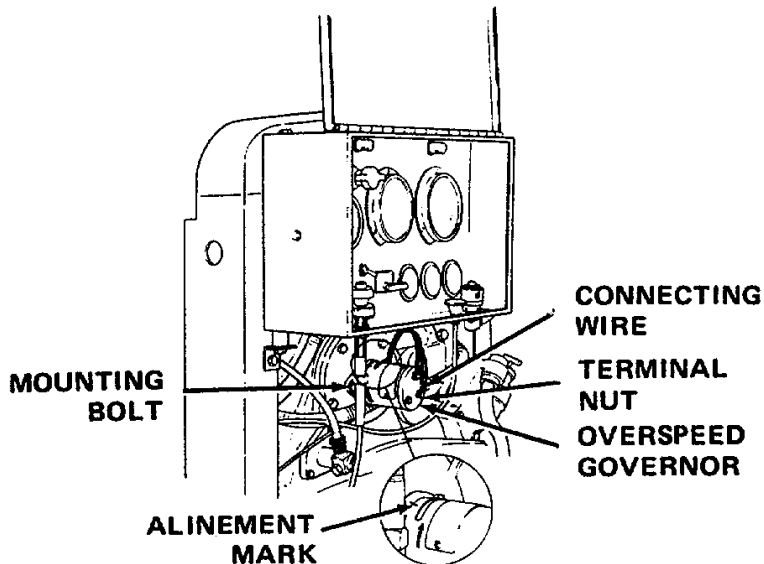
Special Environmental Conditions

Well-ventilated area required.

Location/Item	Action	Remarks
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REMOVAL

1. Overspeed governor governor. Tag and remove connecting wires from overspeed governor. Remove mounting bolts. Remove

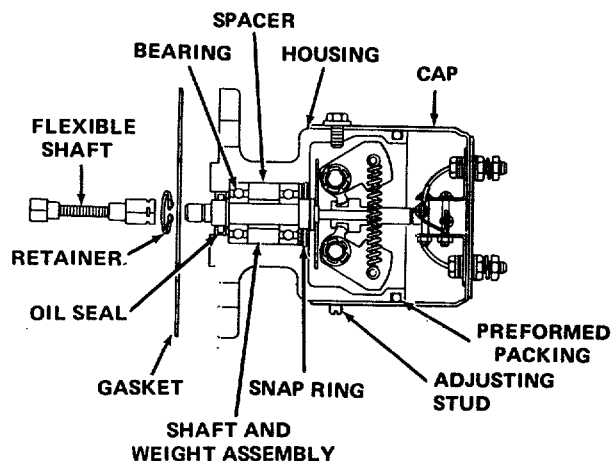


5-14. OVERSPEED GOVERNOR (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

DISASSEMBLY

- | | |
|--------------------------------|---|
| 2. Cap | Matchmark governor cap and housing. Remove adjusting stud and screw. Remove cap from housing. |
| 3. Preformed packing | Remove and discard. |
| 4. Retainer and flexible shaft | Pull retainer from shaft. Remove shaft. |
| 5. Snap ring | Remove from groove in housing. |
| 6. Shaft and weight assembly | Remove. |
| 7. Gasket | Remove and discard. |
| 8. Bearings and spacer | Remove. |



INSPECTION

- | | |
|--------------|--|
| 9. Oil seal | Inspect for wear, cracks, or other damage. If seal is damaged, replace it as follows:

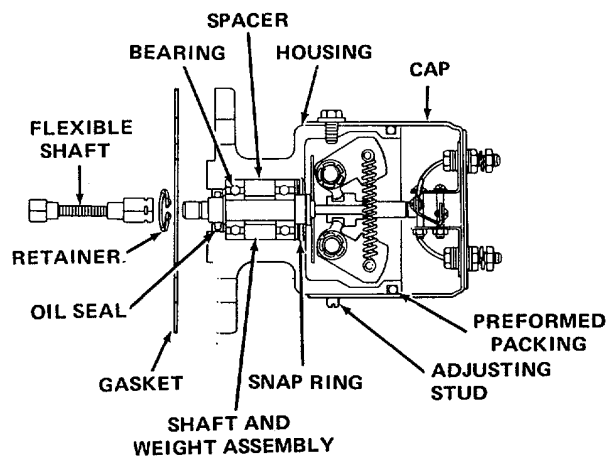
Place governor housing in arbor press with mounting flange facing down. Use a 9/16 inch (14.3 mm) diameter rod to press oil seal from housing. Press new oil seal in place, 3/64 inch (1.2 mm) from bottom of bearing cavity. |
| 10. Bearings | Inspect for roughness or binding, and for rust, corrosion, or other damage. If bearings are damaged, replace overspeed governor. |

REASSEMBLY/SERVICE

- | | |
|-------------------------|---|
| 11. Bearings and spacer | Insert in bearing cavity. Fill the grease reservoir between the bearings only 3/4 full with MIL-G-18709 grease. |
|-------------------------|---|

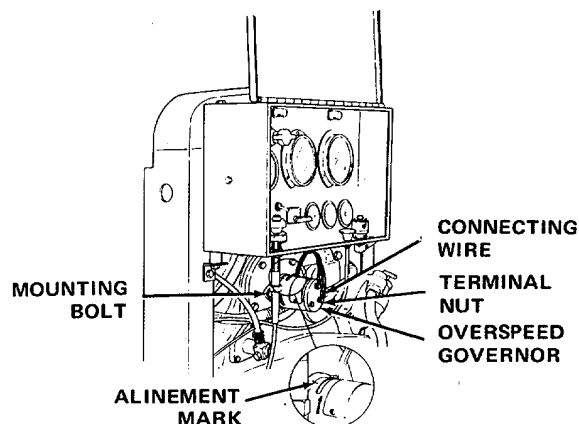
5-14. OVERSPEED GOVERNOR (CONT)

Location/Item	Action	Remarks
12. Shaft and weight assembly shaft.	Slide through bearings; install snap ring on.	
13. Governor cap	Position cap on housing, matching the alignment marks made during disassembly. Install and tighten adjusting stud and screw.	
14. Flexible shaft and retainer	Slip flexible shaft onto governor shaft; secure with retainer.	



INSTALLATION

15. Governor and gasket	Hold governor and gasket in position, and slide socket end of flexible shaft over end of cam-shaft. Install mounting bolts and tighten securely. Install connecting wires.
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ADJUSTMENT

16. Adjusting stud and screw	Loosen adjusting stud and screw and turn cap clockwise or counterclockwise from the alignment mark until desired trip speed is reached. Clockwise rotation of cap lowers the trip speed and counterclockwise rotation increases the trip speed. The total range of adjustment of the governor is indicated on governor nameplate. The governor should not be adjusted to trip below 100 rpm above the normal running speed of the governor. Make sure the adjusting stud and screw are tightened after adjustment has been completed.
------------------------------	---

5-15. MECHANICAL GOVERNOR

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation
- e. Adjustment

INITIAL SETUP

Tools

Tool kit, master mechanics

NSN 5180-00-699-5273

Materials/Parts

Diesel fuel oil (Item 10, Appendix E)

Gasket (governor control housing-to-engine rear end plate)

References

Para 4-24 Speed regulating throttle cable

Para 5-13 Fuel control tube assembly

Troubleshooting Reference

Malfunction 3, step 1

Equipment Condition

Engine left side panel removed.

Stop cable disconnected from governor.

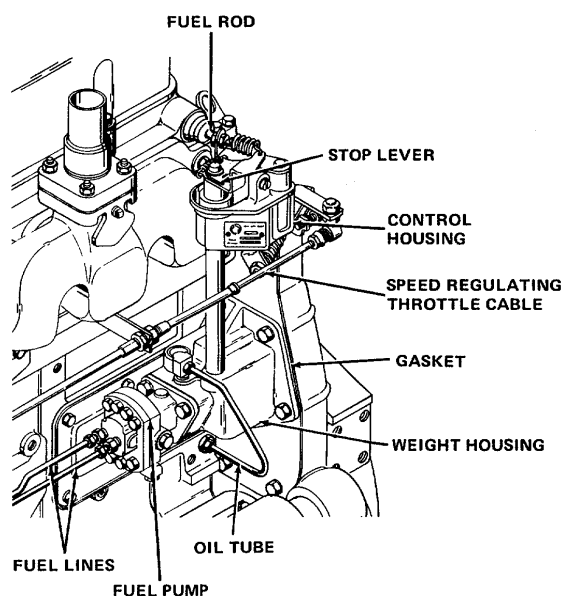
Special Environmental Conditions

Well-ventilated area required for cleaning.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|------------------------------------|---|
| 1. Fuel rod | Disconnect from stop lever. |
| 2. Speed regulating throttle cable | Disconnect from speed control lever as described in paragraph 4-24. |
| 3. Fuel lines and fuel pump | Disconnect fuel lines. Remove fuel pump from weight housing. |
| 4. Oil tube | Remove. |
| 5. Governor housings and gasket | Remove bolts from weight housing and control housing; remove governor and gasket from engine. Discard gasket. |



5-15. MECHANICAL GOVERNOR (CONT)

Location/Item	Action	Remarks
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CLEANING**WARNING**

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions :

- Do not inhale vapor.
- Do not handle near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

- | | |
|--------------|---|
| 6. All parts | Wipe with cloth dampened with VV-F-800 diesel fuel oil. Dry thoroughly. |
|--------------|---|

INSPECTION

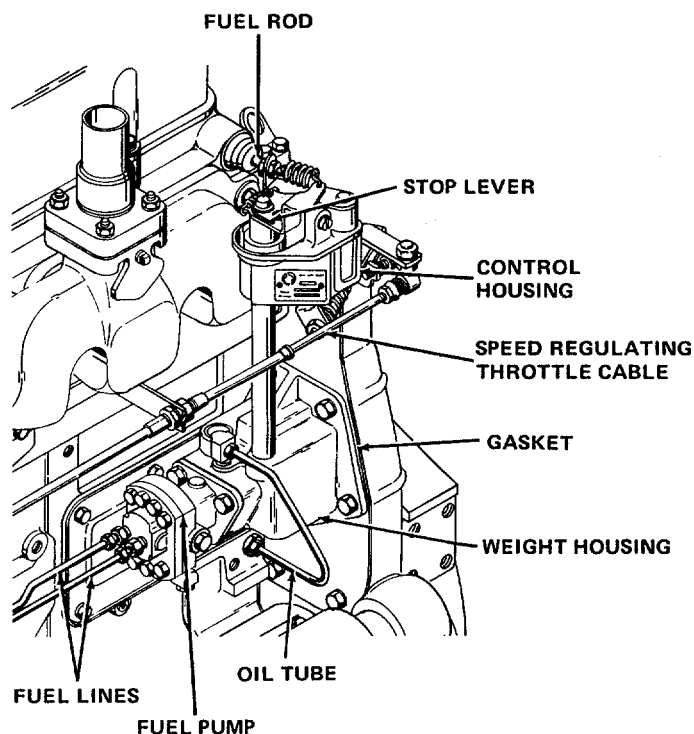
- | | |
|---|--|
| 7. Levers and controls necessary. | Operate manually to check for internal binding or rough operation. Replace governor if necessary. |
| 8. Drive gear (inside weight housing, at mating flange end) | Inspect for worn, cracked, or broken teeth. Rotate by hand to check for binding. Replace governor if gear binds or is damaged. |
| 9. All other parts | Inspect for cracks, distortion, worn threads, and other damage. Replace governor if necessary. |

5-15. MECHANICAL GOVERNOR (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSTALLATION

- | | | |
|------------------------------|---|--|
| 10. Governor weight housing | Attach a new gasket to governor weight housing, and position against engine rear end plate. The teeth on the governor drive gear must mesh with the teeth on the camshaft gear or balance shaft gear. Secure housing with bolts and washers. Torque the bolts to 35 ft lb (47.5 N•m). | |
| 11. Governor control housing | Install the two control housing attaching bolts and lockwashers. Torque the bolts to 35 ft lb (47.5 N•m). | |
| 12. Fuel rod | Attach fuel rod to stud on stop lever. | |
| 13. Fuel pump and fuel lines | Install fuel pump and fuel lines. | |
| 14. Oil tube and fittings | Install oil tube and fittings. | |



ADJUSTMENT

- | | | |
|------------------------------------|---|--|
| 15. Fuel control tube and governor | Adjust in accordance with paragraph 5-13. | |
|------------------------------------|---|--|

5-16. ENGINE ASSEMBLY

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Equipment Condition

Para	Condition Description
4-8	Engine side panels removed. Engine lubrication system drained. (Table 4-1, item 3.)
4-19	Battery disconnected.
4-27	Fuel supply-to-strainer hose and fuel drain hose disconnected from engine.
4-38	Cooling system drained.

Materials/Parts

Muffler seal clamp

Tie wraps

Tie wraps

General Safety Instructions

WARNING

Lower and pin rear stands before disconnecting centrifugal pump unit .

References

Para 4-38 Radiator

Location/Item

Action

Remarks

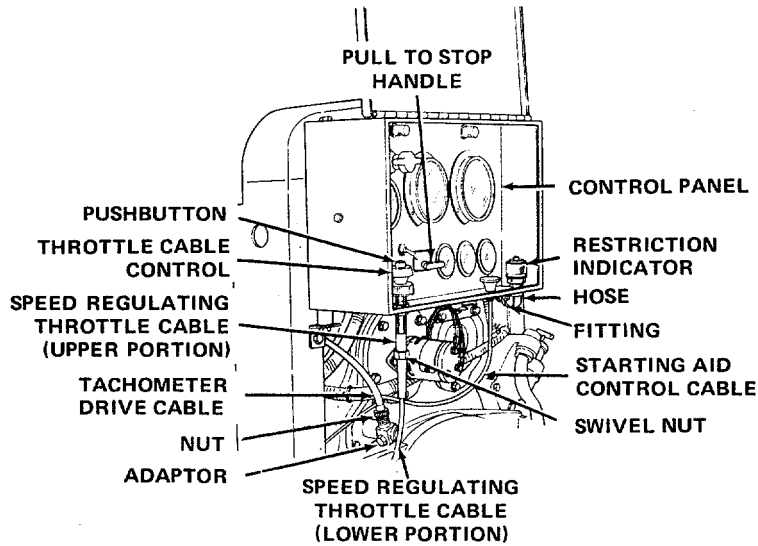
REMOVAL

- | | |
|--|---|
| 1. Radiator hoses, radiator, and shell | Remove in accordance with paragraph 4-38. Do not disassemble radiator from shell. |
|--|---|

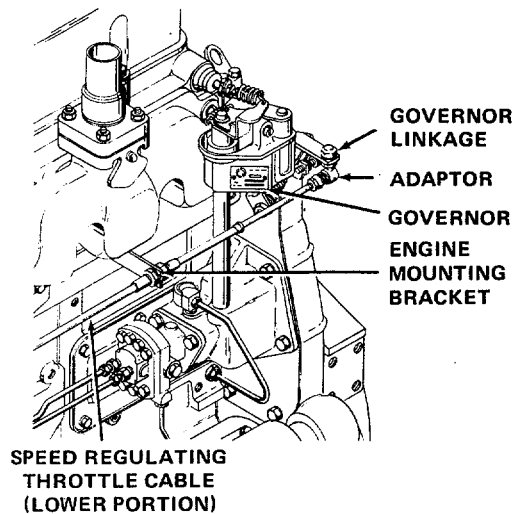
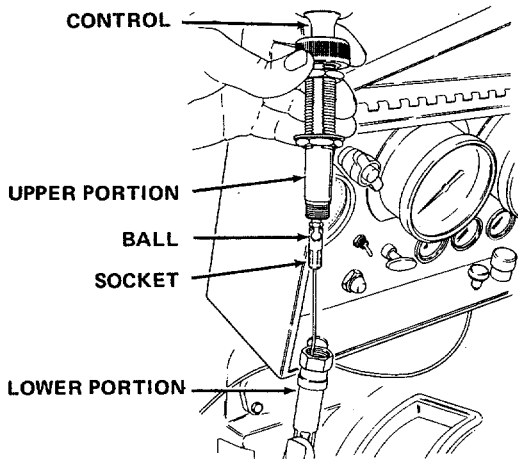
5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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- | | | |
|-------------------------------|---|--|
| 2. Restriction indicator hose | Disconnect from restriction indicator at fitting beneath control panel. | |
|-------------------------------|---|--|



- | | | |
|--|--|--|
| 3. Speed regulating throttle cable (lower portion) | Remove cable lower portion from upper portion by unscrewing swivel nut, pressing and holding pushbutton while pushing control down, and disconnecting ball and socket joint. Disconnect lower portion from governor linkage at adaptor and remove from engine mounting bracket. Reconnect lower portion to upper portion and pull cable so that it hangs free beneath control panel. | |
|--|--|--|



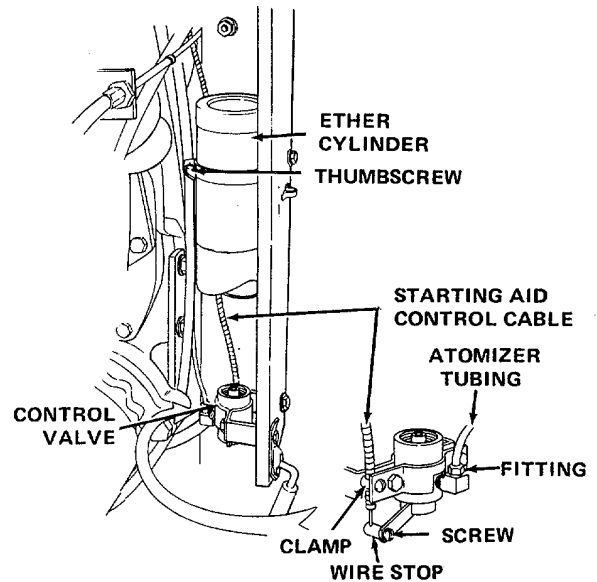
5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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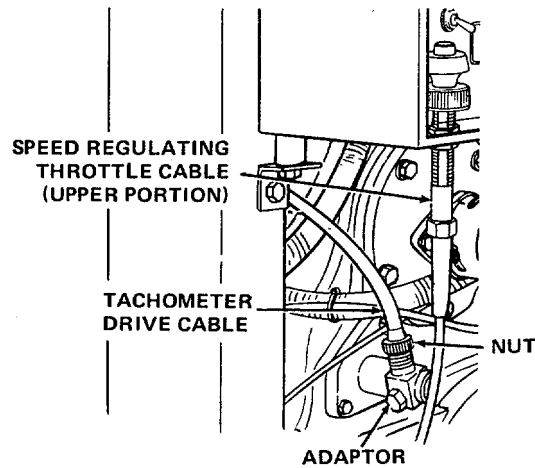
4. Ether cylinder
Remove by loosening thumbscrew.

5. Starting aid control cable
Disconnect at ether cylinder control valve wire stop and remove from clamp. Pull cable out so that it hangs free beneath control panel.

6. Atomizer tubing
Disconnect at control valve fitting.



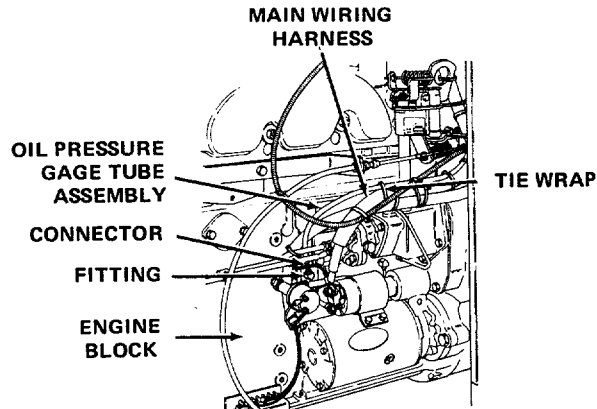
7. Tachometer drive cable
Disconnect from adaptor by loosening nut. Cut all tie wraps holding cable in place. Pull cable out so that it hangs free beneath control panel.



5-16. ENGINE ASSEMBLY (CONT)

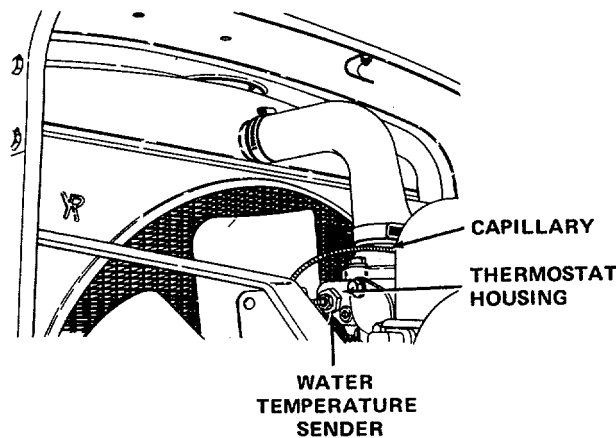
Location/Item	Action	Remarks
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- | | | |
|------------------------------------|--|--|
| 8. Oil pressure gage tube assembly | Disconnect tube assembly at connector on engine block fitting and plug the hole. Cut tie wraps and pull tube assembly out so that it hangs free beneath control panel. | |
|------------------------------------|--|--|



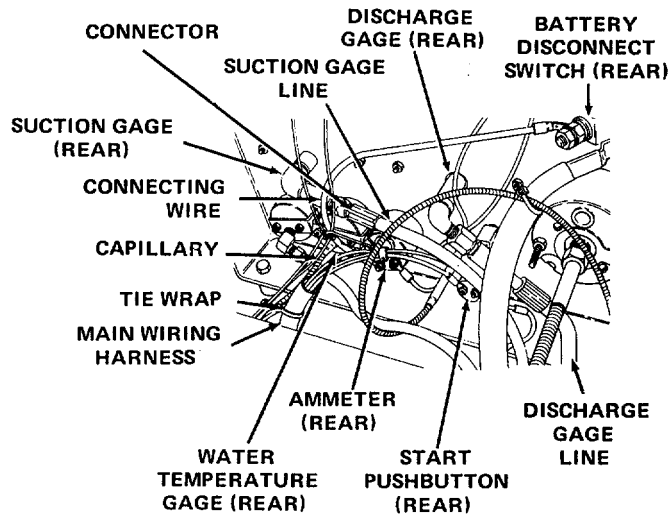
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| 9. Water temperature sender and capillary capillary. | Remove sender from thermostat housing. Cut tie wraps and pull capillary out so that it hangs free beneath control panel. | |
|--|--|--|

Water temperature sender will remain attached to



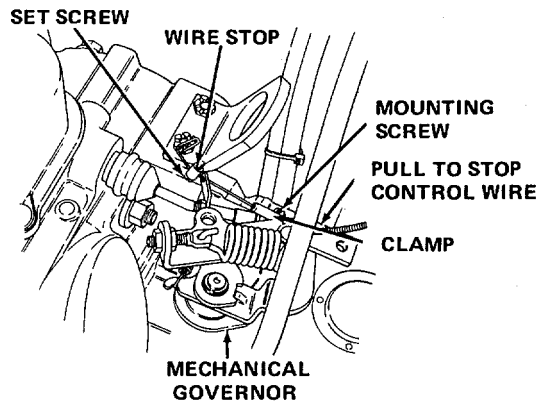
5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
10. Suction and discharge gage lines	Tag and remove gage lines from connectors on rear of gages (behind control panel). Cut tie wraps and pull gage lines down so they hang free beneath trailer.	
11. Instrument and switch connecting wires.	Tag and disconnect from rear of ammeter and start pushbutton; id from rear of battery disconnect and light switch.	



12. PULL TO STOP control wire

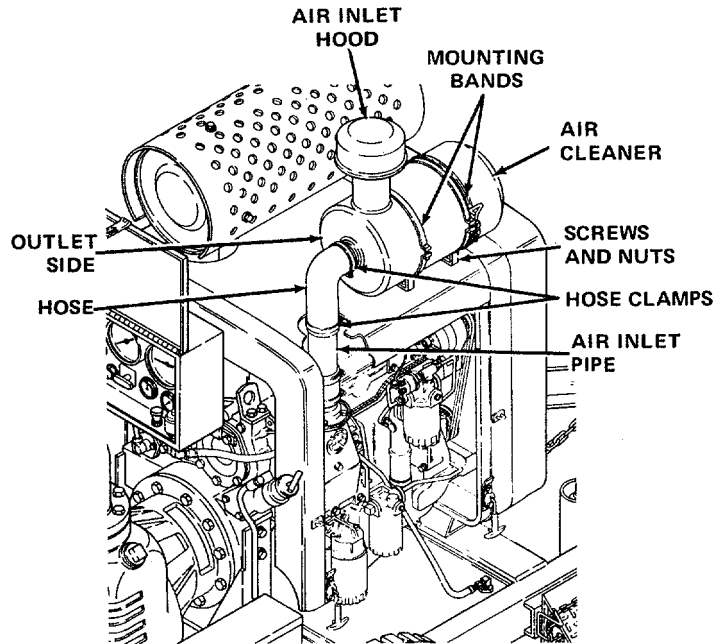
Disconnect at the wire stop. Remove mounting screw from clamp and pull control wire so that it hangs free beneath control panel.



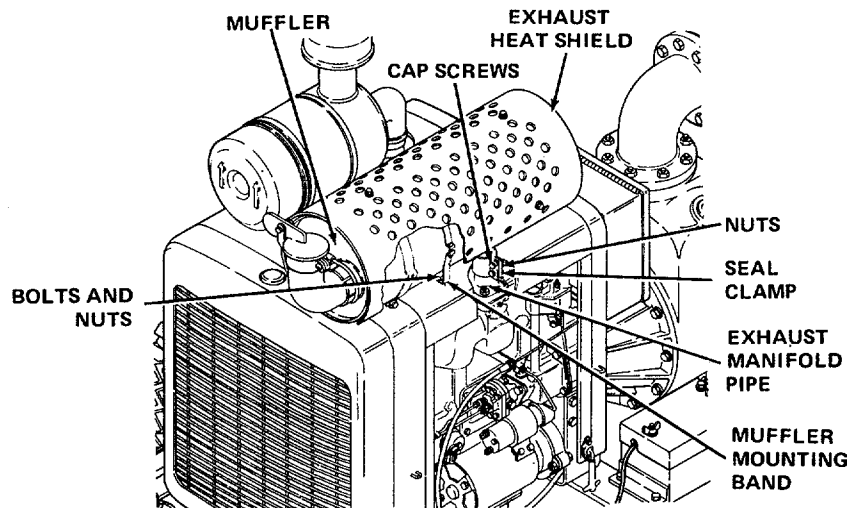
5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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- | | | |
|--------------------------|--|--|
| 13. Air cleaner assembly | Loosen lower hose clamp on outlet side of cleaner. Remove mounting band screws and nuts. Remove assembled air cleaner, air inlet hood, and hose. | |
|--------------------------|--|--|



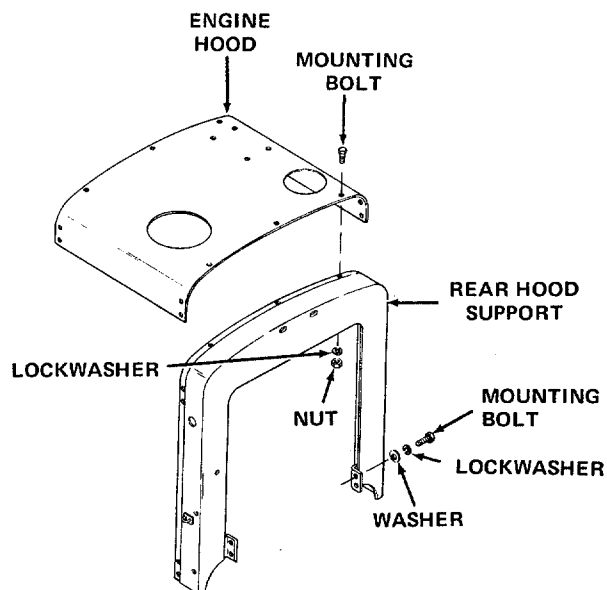
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|-------------------------------------|---|--|
| 14. Muffler and exhaust heat shield | Remove bolts and nuts from muffler mounting band. Remove cap screws and nuts from seal clamp. Loosen clamp and slide down exhaust manifold pipe. Remove muffler (with exhaust heat shield attached) and set aside. Remove seal clamp and discard. | |
|-------------------------------------|---|--|



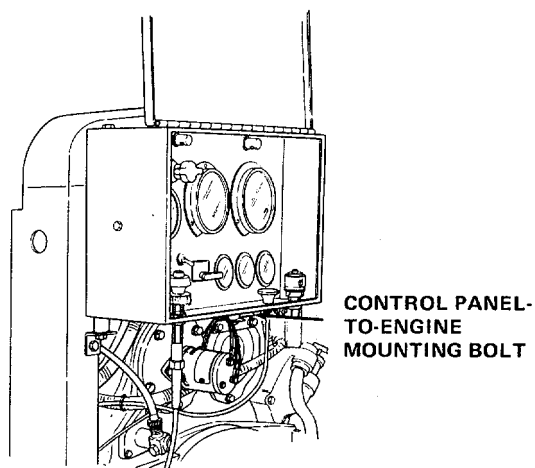
5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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15. Engine hood Remove mounting bolts, lockwashers, and nuts. Remove hood from rear hood support.

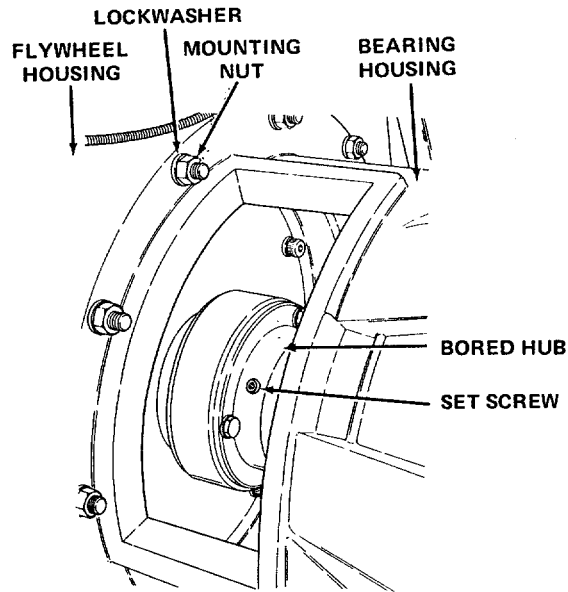


16. Rear hood support and control panel Remove support mounting bolts, lockwashers, and washers. Remove control panel-to-engine mounting bolts. Remove rear hood support and control panel as a unit.



5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
17. Bearing housing	Remove mounting nuts and lockwashers securing bearing housing to flywheel housing. Loosen, but do not remove, set screw in bored hub.	



WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to engine assembly. Before lifting, be sure load is balanced.

CAUTION

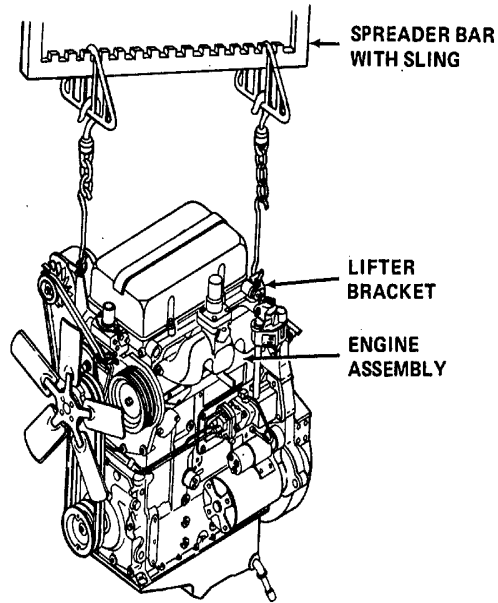
Engine damage will occur if engine is set on oil pan. Provide adequate blocking to support engine after removal from frame assembly.

5-16. ENGINE ASSEMBLY (CONT)

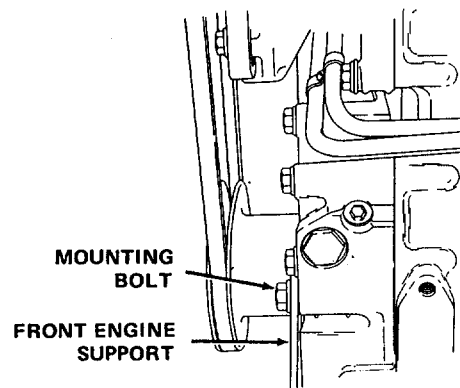
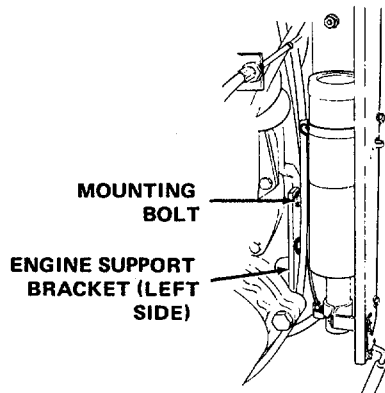
Location/Item	Action	Remarks
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18. Engine

Position a assembly lifting device equipped with a spreader bar and slings over engine assembly. Attach slings to brackets and put tension on slings. With the engine properly supported, remove mounting bolts from left and right side engine support brackets and from front engine support. Lift engine assembly from frame assembly and lower onto blocks on a stable, level work platform.



Spread slings suitable on spreader bar so that slings hang vertically when attached to engine assembly lifter brackets.



5-16. ENGINE ASSEMBLY (CONT)

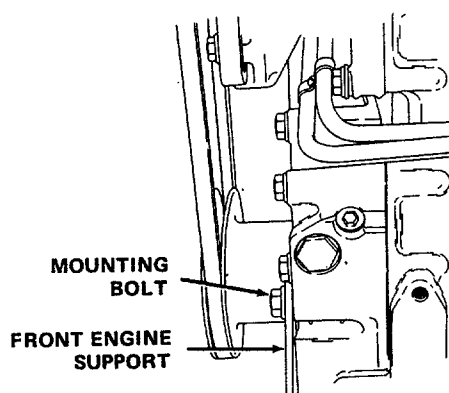
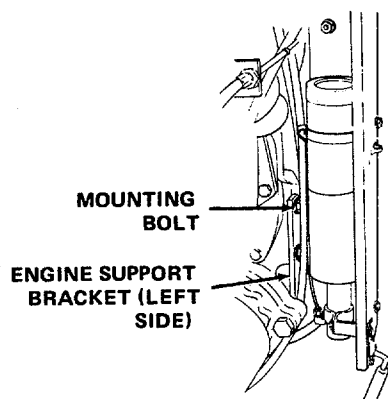
Location/Item	Action	Remarks
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INSTALLATION

WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to engine assembly. Before lifting, be sure load is balanced.

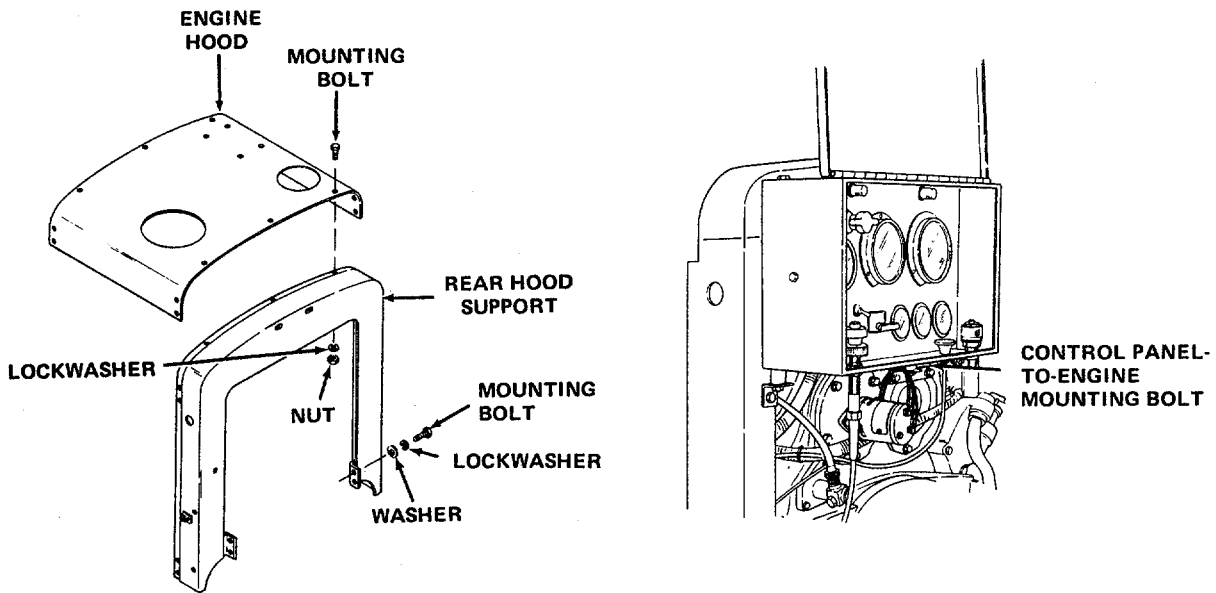
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| 19. Engine assembly | <p>Attach lifting equipment. Lift and carefully lower engine assembly onto engine mounting brackets and front engine support on trailer assembly, while aligning studs in flywheel housing with holes in bearing housing. Insert engine mounting bolts and tighten securely.</p> |
|---------------------|--|



- | | |
|---------------------|---|
| 20. Bearing housing | <p>Install mounting nuts and lockwashers securing bearing housing to flywheel housing. Tighten set screw.</p> |
|---------------------|---|

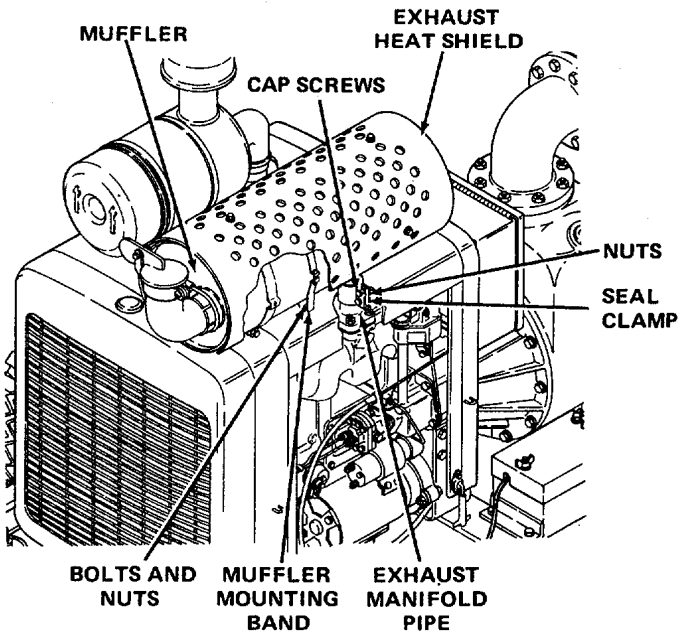
5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
21. Rear hood support and control panel	Install on engine by attaching support mounting bolts, lockwashers, and washers. Attach control panel-to-engine mounting bolts. Tighten all bolts securely.	



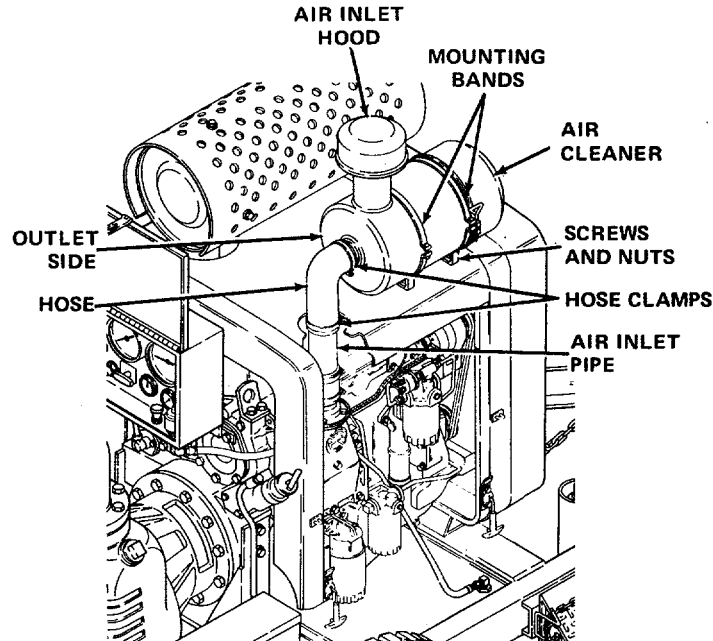
22. Engine hood	Install on rear hood support. Attach mounting bolts, lockwashers, and nuts. Tighten bolts securely.	
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23. Muffler and exhaust heat shield	Install new seal clamp over exhaust manifold pipe. Slide clamp down pipe to clear muffler inlet. Place muffler (with exhaust heat shield attached) in position, aligning muffler inlet with exhaust manifold pipe. Install bolts and nuts on muffler mounting band.	
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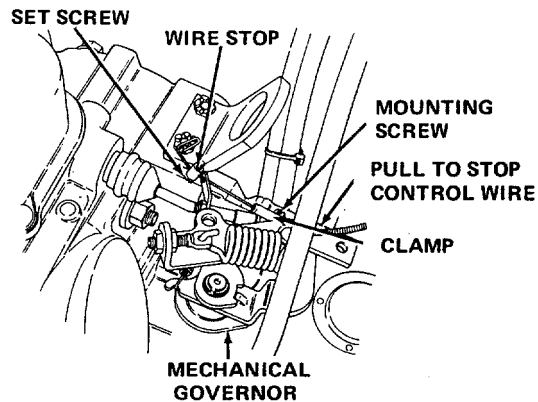


5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
24. Air cleaner assembly	Position air cleaner assembly on engine hood and attach hose to air inlet pipe. Tighten lower hose clamp. Install mounting band screws and nuts; tighten securely.	



25. PULL TO STOP control wire	Attach to wire stop on fuel rod connector. Tighten set screw. Install control wire clamp on engine block, and tighten mounting screw.	
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5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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26. Instrument and switch connecting wires

Connect to control panel light switch, battery disconnect switch, start push-button, and ammeter. Tighten terminal nuts securely. Remove tags.

27. Suction and discharge gage lines

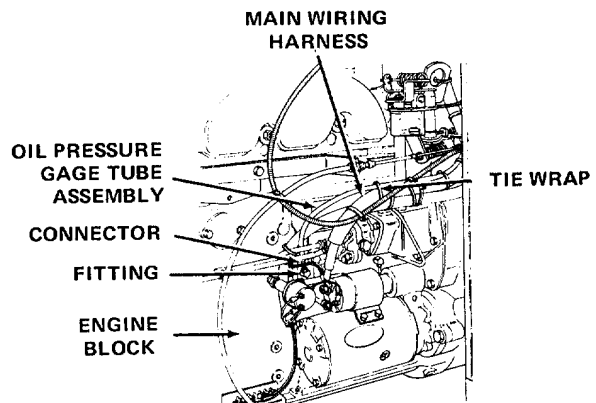
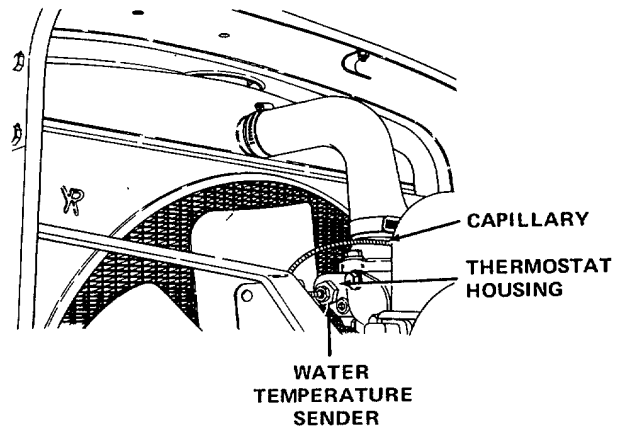
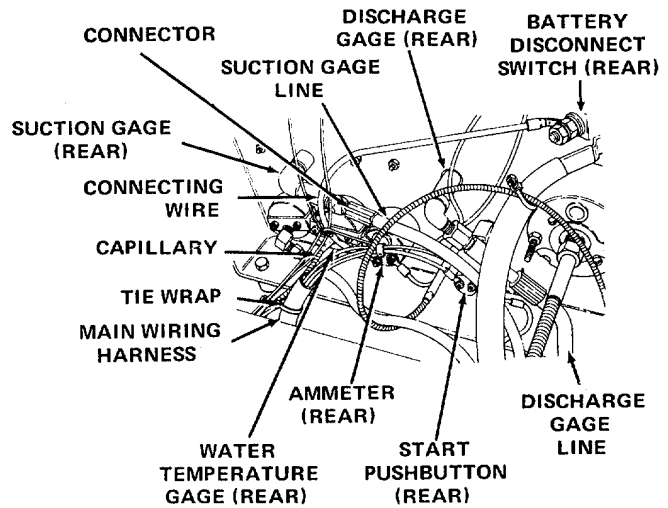
Attach lines to connectors at rear of gages. Tighten connectors; remove tags.

28. Water temperature sender and capillary

Route capillary (with sender attached) to thermostat housing. Install sender and tighten. Install new tie wraps to hold capillary in place.

29. Oil pressure gage tube assembly

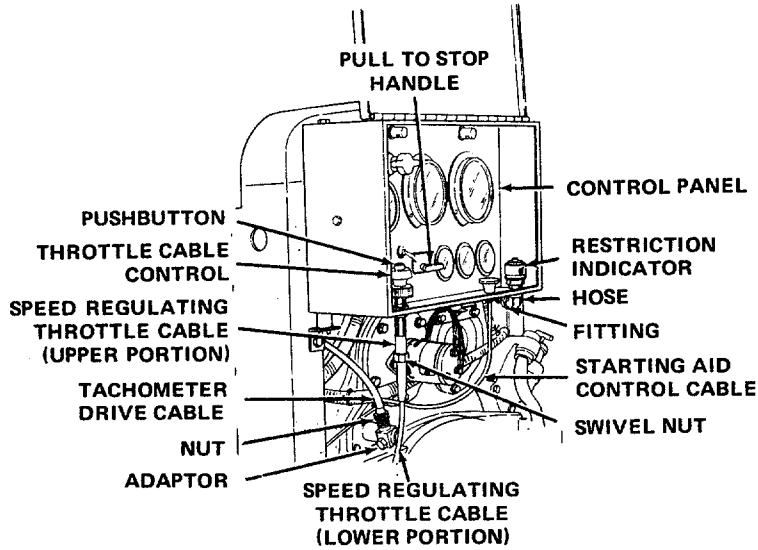
Route assembly from control panel down to fitting on engine block. Remove plug and install tube assembly connector in fitting. Install new tie wraps.



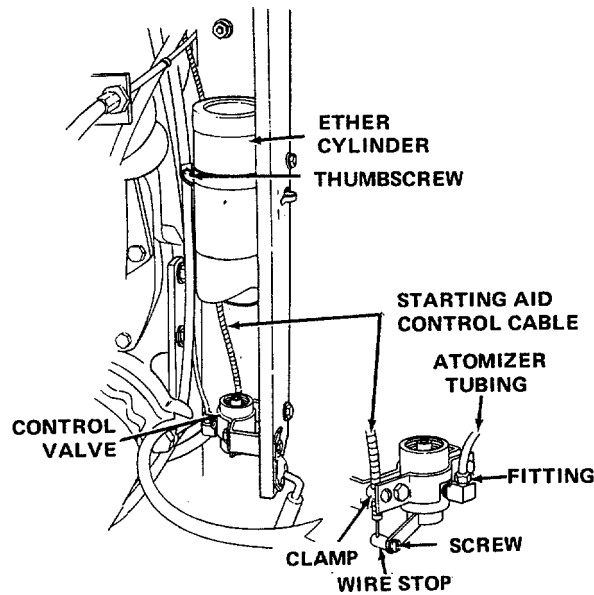
5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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30. Tachometer drive cable	Route cable to adaptor and install. Tighten cable nut; install new tie wraps.	
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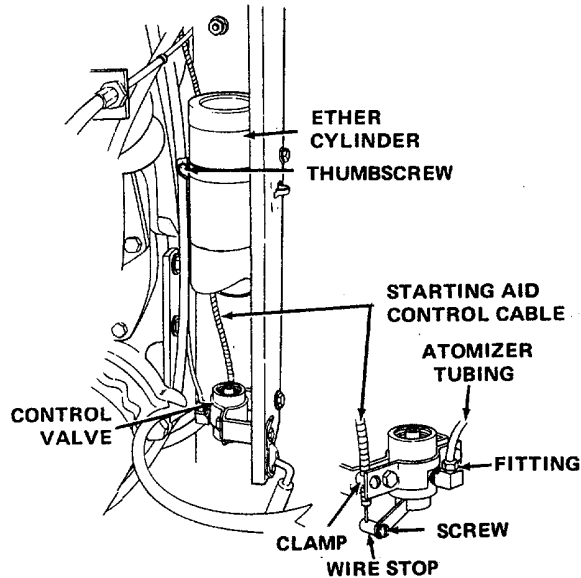
31. Atomizer tubing	Route to ether cylinder control valve and connect at fitting. Tighten securely.	
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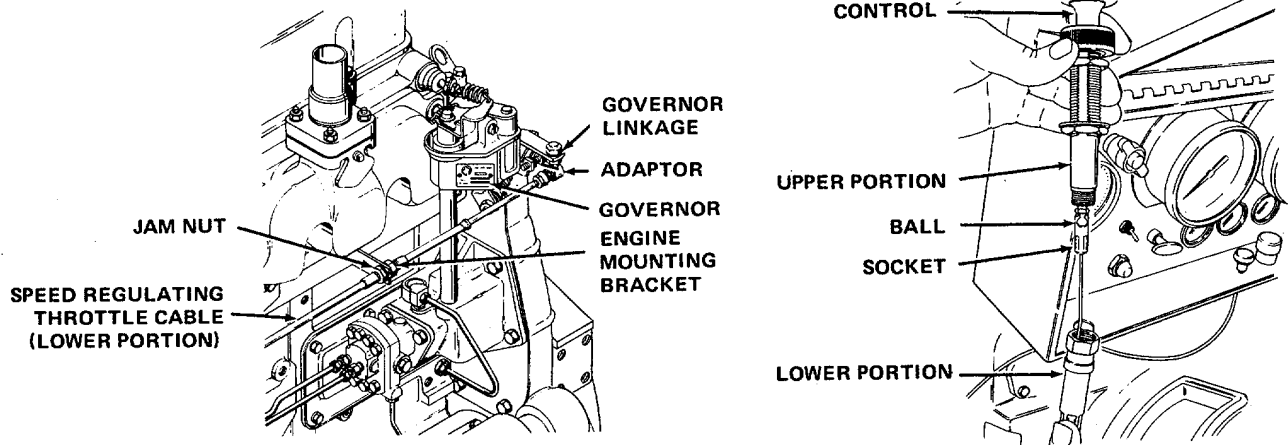
5-16. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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- 32. Starting aid control cable
Route cable to ether cylinder control valve. Install and adjust wire end in wire stop and secure cable in clamp. Tighten screws on wire stop and clamp.
- 33. Ether cylinder
Install; tighten thumbscrew.



- 34. Speed regulating throttle cable
Connect lower portion to governor linkage at adaptor. Slide cable engine mounting bracket and tighten jam nut. Route lower portion of throttle cable to the control panel. Push throttle cable control in to expose the ball. Slip ball into socket in lower portion and secure connection by tightening swivel nut.



- 35. Restriction indicator hose
Connect to restriction indicator at fitting beneath control panel.
- 36. Radiator hoses, radiator, and shell
Install in accordance with paragraph 4-38.

5-17. COOLING FAN SHAFT BRACKET, SHAFT ASSEMBLY, AND PULLEY

This task covers:

- a. Disassembly
- b. Assembly

INITIAL SETUP:

Tools

Shop set, automotive repair, field maintenance, basic
 NSN 4910-00-754-0705
 Tool kit, master mechanics
 NSN 5180-00-699-5273

Fan shaft bracket
 5/16-18 bolts (2)

Equipment Condition

Para
 4-36

Condition Description

Cooling fan assembly removed as a unit from engine assembly. Fan removed from assembled fan shaft bracket, shaft assembly, and pulley.

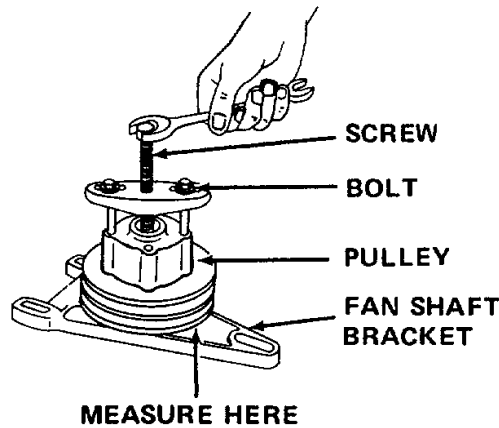
Materials/Parts

Pulley
 Fan shaft assembly

Location/Item	Action	Remarks
---------------	--------	---------

DISASSEMBLY

1. Fan shaft bracket, shaft assembly, and pulley unit
 Place fan shaft bracket, shaft assembly, and pulley unit on a clean, flat surface. Measure distance between lower edge of pulley and fan shaft bracket. Record the dimension. Thread two 5/16-18 bolts of suitable length through a gear pulling tool and into opposite holes on the pulley. Rotate screw on pulling tool to push fan shaft assembly out of pulley.

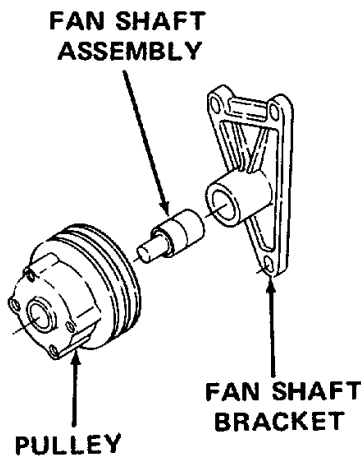


5-17. COOLING FAN SHAFT BRACKET, SHAFT ASSEMBLY, AND PULLEY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

ASSEMBLY

2. Fan shaft assembly and bracket
To install a new fan shaft assembly use an arbor press. Press fan shaft assembly bearing into bracket until outer race of bearing is flush with back side of fan shaft bracket.
3. Pulley
Position assembled fan shaft assembly and bracket, bracket side down, on bed of arbor press.



CAUTION

Bearing damage will occur if pulley is pushed on against outer race of bearing. Push pulley on shaft with shaft opposite end on arbor press table.

Position opposite end of shaft on arbor press bed. Press pulley on shaft to dimension recorded prior to disassembly.

5-18. CYLINDER HEAD AND BLOCK

This task covers:

- a. Removal**
- b. Cleaning**
- c. Inspection**
- d. Installation**

INITIAL SETUP:

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705
Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Valve cover gasket
Exhaust manifold gasket
Flange gasket
Cylinder head oil seals

Cylinder head oil seal ring

Cylinder head water seals
Cylinder head compression gaskets
Diesel fuel oil (Item 6, Appendix E)

Thread compound (Item 20, Appendix E)
Lubricating oil (Item 10, Appendix E)

References

Para 5-12 Fuel injectors

Troubleshooting References

Malfunction 2, steps 1 and 2

**Equipment
Condition**

Para	Condition Description
4-13	Air cleaner removed.
4-17	Muffler removed.
4-19	Battery disconnected.
4-27	Fuel lines disconnected.
4-39	Thermostat housing and water bypass tube removed.
5-16	Side panels and engine hood removed.

Special Environmental Conditions

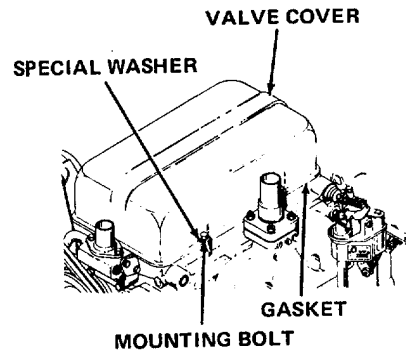
Well-ventilated area required during cleaning.

5-18. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

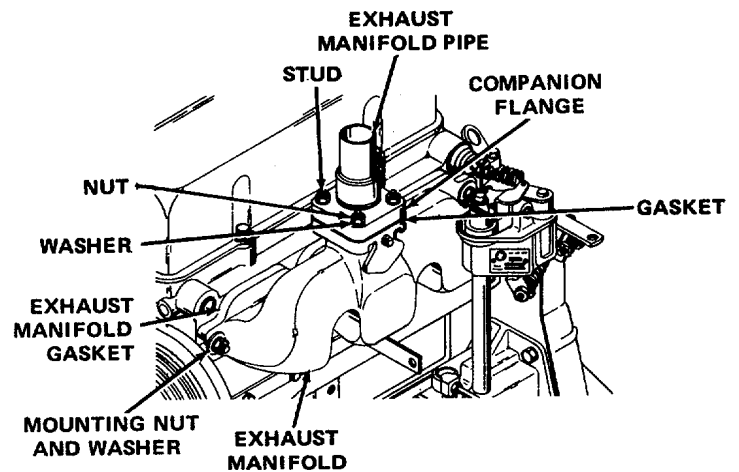
REMOVAL

1. Valve cover Remove mounting bolts, special washers, valve cover, and gasket. Discard the gasket.



2. Exhaust manifold Remove mounting nuts, washers, gasket, and exhaust manifold. Discard gasket.

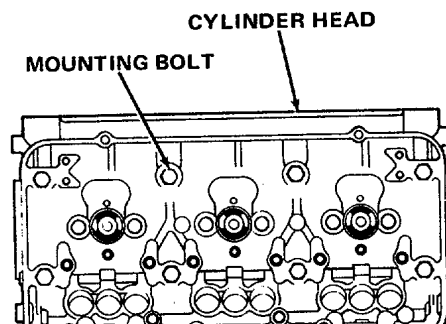
3. Exhaust manifold companion flange and pipe Remove mounting nuts. Remove companion flange and pipe as a unit from manifold. Remove and discard gasket.



WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to cylinder head. Before lifting, be sure load is balanced.

4. Cylinder Attach a suitable lifting device equipped with a sling to the cylinder head. Remove mounting bolts, and lift cylinder head from engine.



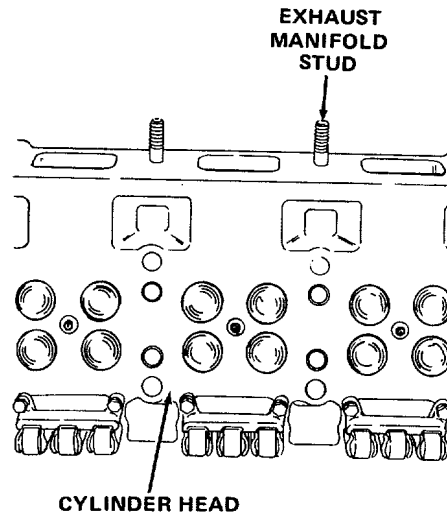
5-18. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
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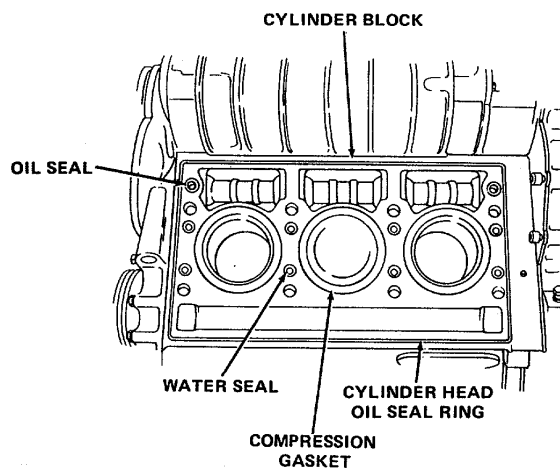
CAUTION

When setting the cylinder head down on the valve side, support it on 2 inch (51 mm) thick wood blocks to protect cam followers and injector spray tips. Equipment damage could result if this procedure is not followed.

- 5. Cylinder head placement
Set cylinder head on its side with exhaust manifold studs in an upright position. Then tip the head over and position it (with exhaust valves down) on wood blocks.



- 6. Cylinder head oil seal ring, compression gaskets, oil seals, and water seals
Remove from cylinder block and discard.



5-18. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

**CLEANING/
INSPECTION**

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

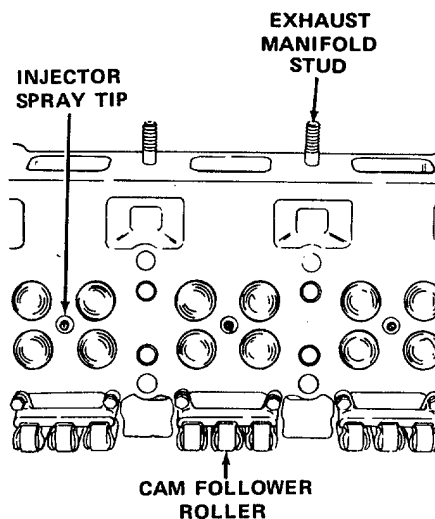
- * Do not inhale vapor.
- * Work in a well-ventilated area.
- * Do not use near open flame, sparks, or excessive heat.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

7. Cylinder head
Clean head with a clean cloth dampened with VV-F-800 diesel fuel. Use wire brush where necessary. Dry with compressed air. Inspect for cracks, rust, corrosion, and excessive heat damage. Inspect for accumulated carbon around injector spray tips. Replace cylinder head if it is damaged.

8. Cam follower rollers
Inspect for excessive wear or scoring. Replace cylinder head if rollers are scored, worn, or damaged.

9. Exhaust manifold
Remove all carbon from inside of manifold with stiff bristled brush. Inspect manifold for excessive rust, corrosion, cracks, or holes. If manifold is damaged, replace it.



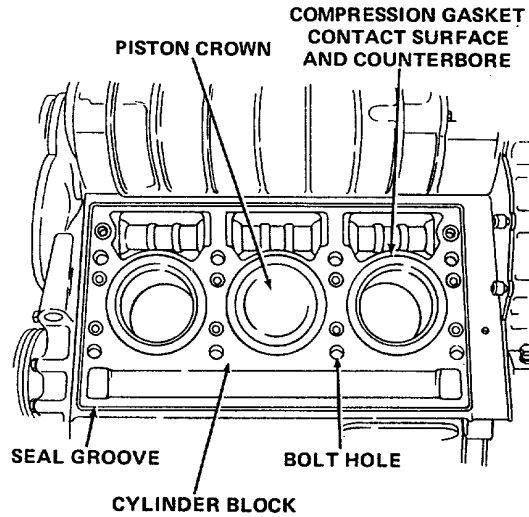
10. Valve cover
Clean cover with a clean cloth dampened with VV-F-800 diesel fuel and dry with compressed air. Inspect for dents, rust, corrosion, or other damage. Inspect bolt holes for chipped or cracked edges. Replace valve cover if it is damaged.

5-18. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

11. Cylinder block

Clean upper surface with a clean cloth dampened with VV-F-800 diesel fuel and dry with compressed air. Visually inspect for cracks, wear, and signs of overheating. Inspect piston crowns, compression gasket contact surfaces, counterbores, seal grooves, and bolt holes for water, oil, or foreign material. Remove water, oil, or foreign material; replace block if it is damaged.

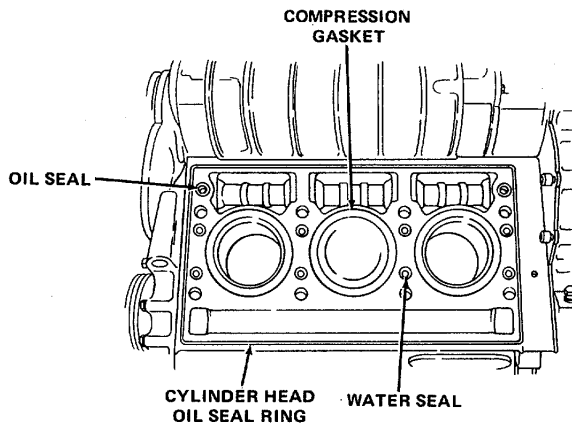


INSTALLATION

12. Cylinder head oil seal ring, compression gaskets, oil seals, and water seals

Install new seals, gaskets, and oil seal ring on cylinder block.

Face colored stripe on oil seal ring away from the cylinder bores.



5-18. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

WARNING

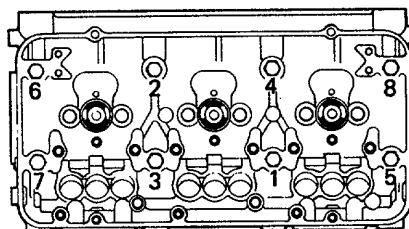
Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to cylinder head. Before lifting, be sure load is balanced.

- | | | |
|-------------------|--|--|
| 13. Cylinder head | Ensure that all seals are in place and wipe mating surface of cylinder head clean. Attach lifting device to cylinder head and lower head to approximately 1/2 inch (12.7 mm) above cylinder block. | |
|-------------------|--|--|

CAUTION

Engine damage may result if ordinary bolts are used to secure cylinder head. Cylinder head bolts are specially designed for this purpose. Compression leaks may result if bolts are torqued beyond recommended limits, or if they are tightened in one step.

- | | | |
|-------------------------|---|--|
| 14. Cylinder head bolts | Apply a small quantity of MIL-T-22361 thread compound to threads and underside head of each bolt. Install bolts hand tight as head is lowered onto the block. Torque all bolts to 15 to 20 ft lb (20 to 27 N.m). Then torque bolts to 170 to 180 ft lb (231 to 244 N.m) in 50 ft lb (68 N.m) increments in the order shown. | |
|-------------------------|---|--|

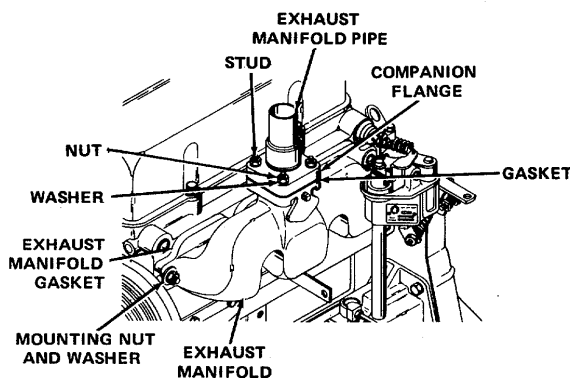


NOTE

Repeat tightening sequence at least once, because first bolts tightened in sequence tend to lose significant clamp load during tightening of remaining bolts. Apply a steady pressure of 2 or 3 seconds at the prescribed torque to allow bolts to turn while gaskets yield to their final designed thickness. Begin on cam follower side of head to take up tension in push rod springs. Torque bolts to the high side of the torque specification.

5-18. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
15. Exhaust manifold companion flange and pipe	Clean gasket surfaces of exhaust manifold flange and companion flange. Position a new gasket on exhaust manifold flange. Align companion flange and pipe, and install on manifold flange. Tighten mounting nuts securely.	

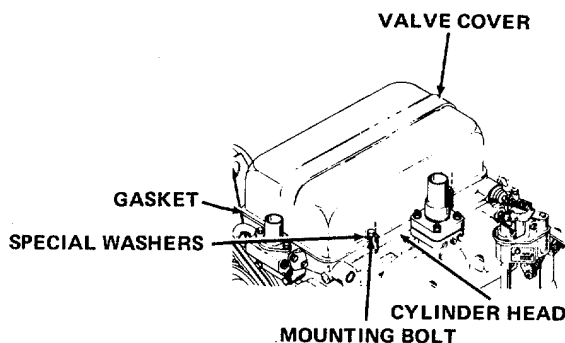


16. Exhaust manifold	Clean gasket surfaces. Position a new gasket on exhaust manifold mounting studs. Position manifold on gasket and studs and hold against cylinder head. Install washers and mounting nuts on studs and tighten hand tight. Then torque nuts to 30 to 35 ft lb (41 to 47 N-m), beginning with nuts in center of manifold and working alternately toward each end.	
----------------------	---	--

CAUTION

Oil leaks may result if valve cover gasket is not positioned correctly, or if gasket becomes twisted during valve cover installation.

17. Valve cover	Lightly coat new gasket with MIL-L-2104 oil and position on cylinder head. Install valve cover over gasket. Install special washers and mounting bolts. Tighten bolts securely.	
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5-19. SUCTION AND DISCHARGE GAGE VALVES, LINES, HOSES, AND FITTINGS

This task covers:

- a. Inspection
- b. Replacement

INITIAL SETUP:

Tools

Shop set, automotive repair, field maintenance, basic
 NSN 4910-00-754-0705
 Tool kit, master mechanics
 NSN 5180-00-699-5273

Suction gage valve

Discharge gage valve

Suction hose

Discharge hose

Fittings

Materials/Parts

Suction gage valve line

Equipment Condition

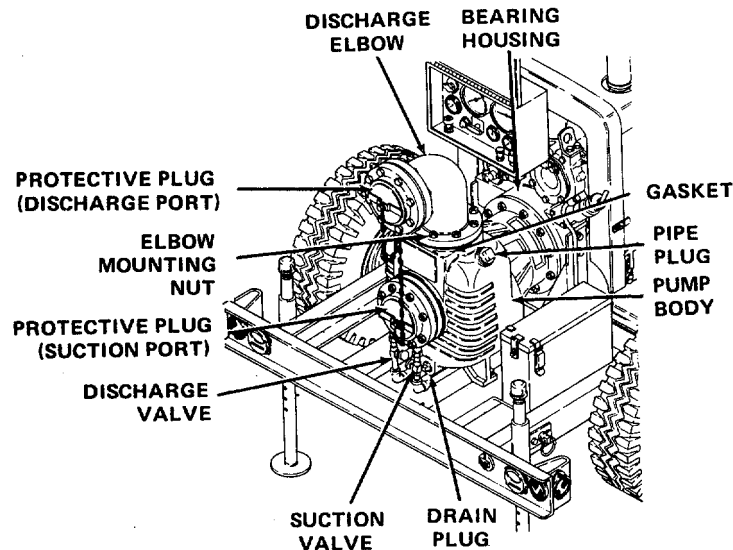
Discharge gage valve line

Pump body drained.

Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

1. Suction and discharge gage valves, lines, hoses, and fittings
 Inspect lines, hoses, and fittings for damaged threads, dents, cracks, or other damage. Open and close valves several times. Replace valves if handles are frozen or hard to turn.



**5-19. SUCTION AND DISCHARGE GAGES VALVES, LINES, HOSES,
AND FITTINGS (CONT)**

Location/Item	Action	Remarks
REPLACEMENT		
2. Discharge gage valve lines	Remove nuts, washers, and U-bolts; disconnect line from elbow and street elbow at opposite ends of line. Install replacement line and tighten.	
3. Hoses	Disconnect at coupling and elbow. Install replacement hose and tighten.	
4. Valves	Disconnect from union and nipple on each end of valve. Install replacement valve and tighten.	
5. All fittings	Disconnect fitting from base, valve line, or valve. Install replacement fitting and tighten.	

5-20. PUMP ASSEMBLY

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP:

Tools

Shop set, automotive repair, field maintenance, basic
 NSN 4910-00-754-0705
 Tool kit, master mechanics
 NSN 5180-00-699-5273

Equipment Condition

Para

Condition Description

5-16

Pump bearing housing disconnected from engine assembly.

General Safety Instructions

Materials/Parts

Discharge elbow gasket

WARNING

References

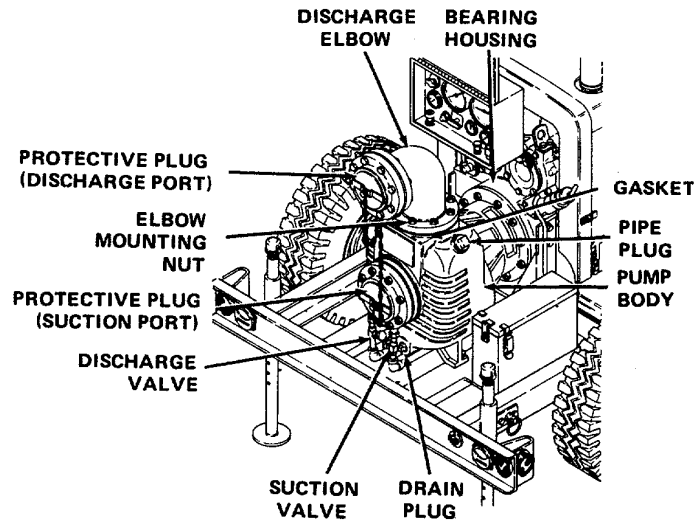
Para 5-19 Suction and Discharge Gage Valves, Lines, Hoses, and Fittings

Lower and pin rear stands before disconnecting centrifugal pump unit.

Location/Item	Action	Remarks
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REMOVAL

1. Discharge and suction port protective plugs Remove.



5-20. PUMP ASSEMBLY (CONT)

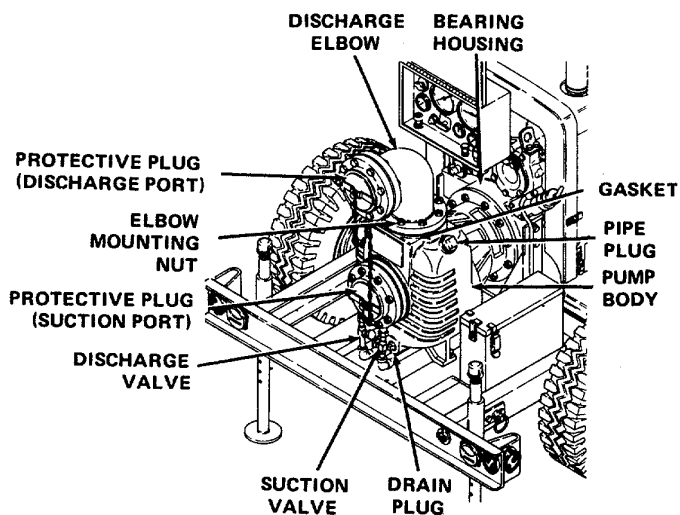
Location/Item	Action	Remarks
WARNING		
<p>Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment. Before lifting, be sure load is balanced.</p>		
2. Discharge elbow	Remove mounting nuts. Attach lift equipment and remove elbow. Remove and discard gasket.	
3. Pipe plugs and drain plug	Remove. Allow fluid to drain into suitable container.	
4. Suction and discharge gage valves, lines, and fittings	Remove in accordance with paragraph 5-19.	
5. Pump body and bearing housing	Loosen mounting bolts. Attach lift equipment and remove mounting bolts. Lift pump body and bearing housing from frame assembly and place on a suitable platform.	

INSTALLATION

WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment. Before lifting, be sure load is balanced.

- | | |
|----------------------------------|--|
| 6. Pump body and bearing housing | Attach lift equipment. Lift pump body and bearing housing into position over the frame assembly and lower into place. Install mounting bolts and tighten securely. |
|----------------------------------|--|



5-20. PUMP ASSEMBLY (CONT)

Location/Item	Action	Remarks
7. Suction and discharge gage valves, lines, and fittings	Install in accordance with paragraph 5-19.	
8. Pipe plugs and drain plug	Install.	
9. Discharge elbow	Position new gasket on pump body. Lower discharge elbow into position with lift equipment. Install and tighten mounting nuts securely.	
10. Discharge and suction port protective plugs	Install and tighten securely.	

5-21. IMPELLER, SHAFT, SEALS, AND CHECK VALVE

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Assembly

INITIAL SETUP:

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Dry cleaning solvent (Item 16, Appendix E)
Grease (Item 7, Appendix E)
Lubricating oil (Item 10, Appendix E)

Tool kit, master mechanics
NSN 5180-00-699-5273

Troubleshooting References

Malfunction 6
Malfunction 7

Materials/Parts

Grease seal (2)

Companion flange gasket

Volute gasket
Shaft seal

Bearing cap preformed packing

Equipment Condition

Para **Equipment Condition**

5-20 Pump and bearing housing removed from trailer assembly.

Special Environmental Conditions

Well-ventilated area required during cleaning.

Location/Item

Action

Remarks

REMOVAL

- | | |
|--------------------|--|
| 1. Bearing housing | Remove from pump body by removing mounting nuts and lockwashers. Remove and discard grease seal. |
|--------------------|--|

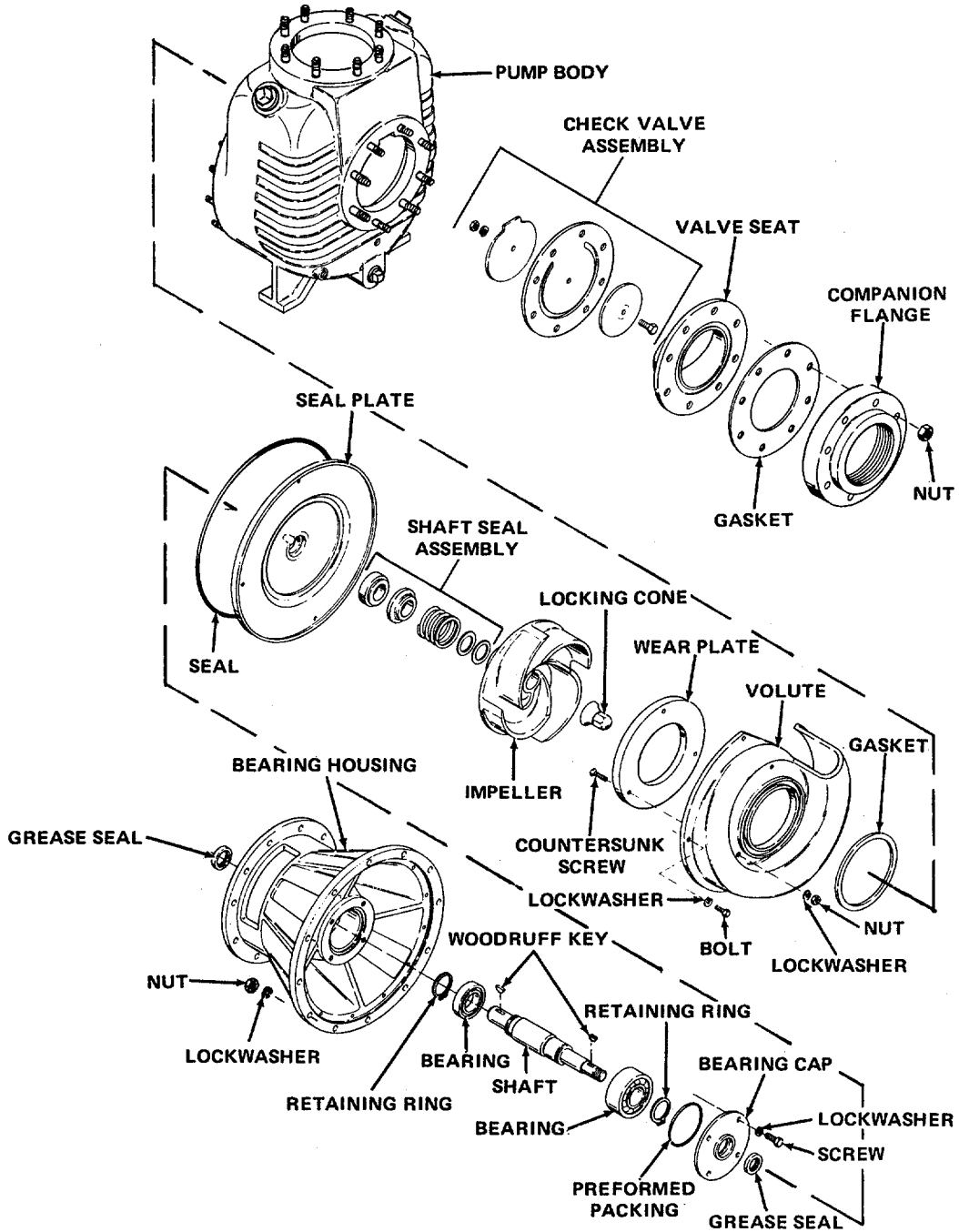
NOTE

Seal plate, impeller, volute, wear plate, shaft, shaft seal, and mounting hardware will stay with bearing housing as it is removed.

- | | |
|--|--|
| 2. Suction port companion flange | Remove nuts, flange, and gasket. Discard gasket. |
| 3. Valve seat and check valve assembly | Remove. |
| 4. Volute and wear plate | Remove bolts securing volute and wear plate to seal plate. Remove volute gasket and discard. Remove wear plate from volute by removing countersunk screws. |

5-21. IMPELLER, SHAFT, SEALS, AND CHECK VALVE (CONT)

Location/Item	Action	Remarks
---------------	--------	---------



5-21. IMPELLER, SHAFT, SEALS, AND CHECK VALVE (CONT)

Location/Item	Action	Remarks
5. Impeller	Prevent shaft from moving at coupling end and remove locking cone from opposite end of shaft. Remove impeller, shims, and Woodruff key.	
6. Seal plate and shaft seal assembly	Remove nuts and lockwashers. Slide seal plate with seal and shaft seal assembly from shaft. Discard shaft seal assembly and seal plate seal.	
7. Bearing cap	Remove bearing cap, grease seal, and packing. Discard grease seal and packing.	
8. Retaining rings	Remove from each end of shaft.	
9. Bearings	Remove.	
10. Shaft	Remove.	

CLEANING**WARNING**

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 1380F (380 to 590C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Compressed air used for cleaning shall not exceed 100 psi (690 lPa). Use goggles, or face shield for eye protection. Do not direct airstream against skin.

- | | | |
|---------------------|--|--|
| 11. All metal parts | Clean with P-D-680 dry cleaning solvent and dry with compressed air. | |
|---------------------|--|--|

INSPECTION

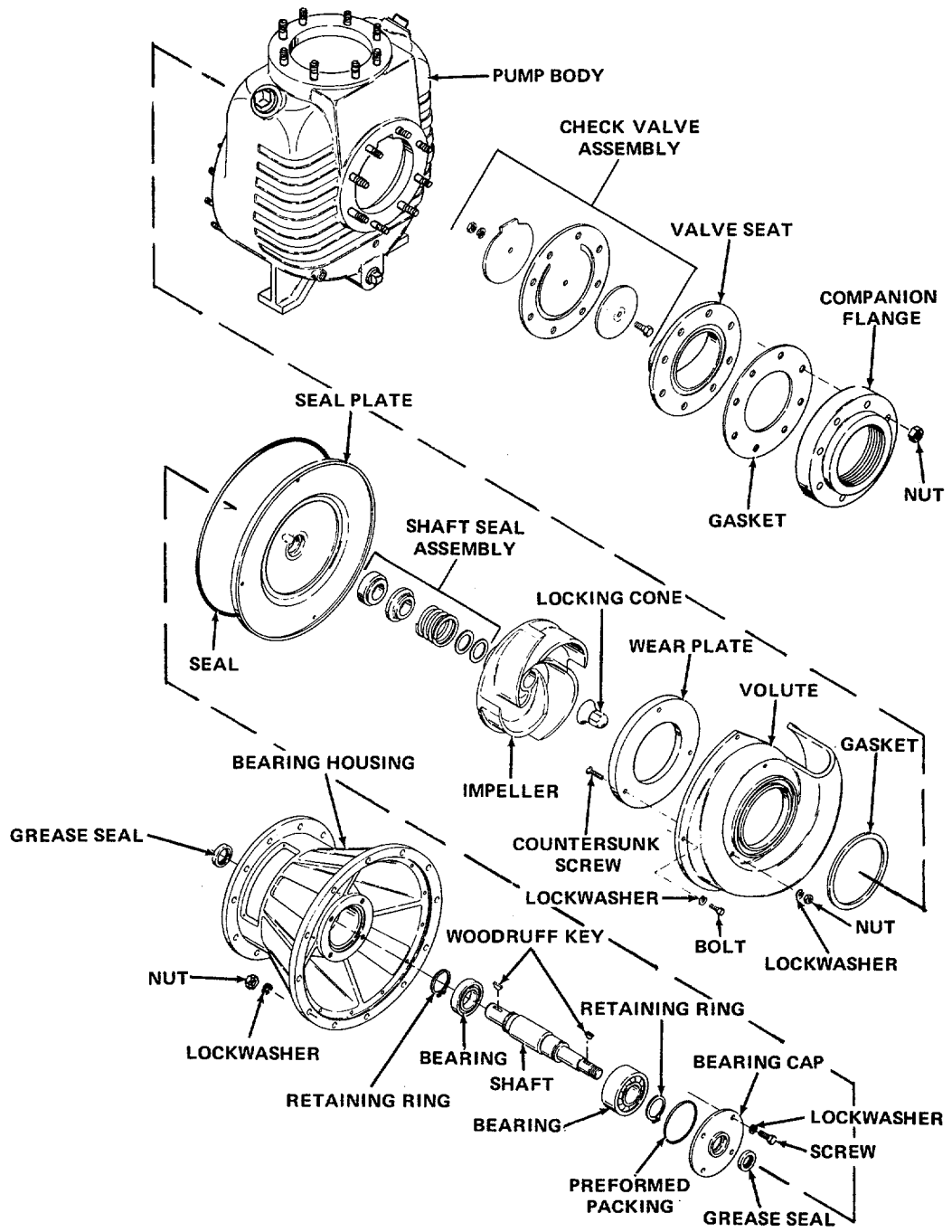
- | | | |
|--------------------------|--|--|
| 12. Check valve assembly | Inspect for trapped dirt or other foreign material, deteriorated or cracked rubber, corroded metal, and damaged or missing hardware. Replace damaged or missing parts. | |
|--------------------------|--|--|

5-21. IMPELLER, SHAFT, SEALS, AND CHECK VALVE (CONT)

Location/Item	Action	Remarks
13. Impeller, volute, seal plate, and wear plate	Inspect for excessive wear, rust, corrosion, or other damage. Replace any worn or damaged parts.	
14. Bearings	Slide bearings onto shaft, rotate shaft, and notice any rough or tight spots in bearings. Replace bearings if rough or tight. Inspect bearing exterior for rust, corrosion, or other damage. Replace bearings if damaged in any way.	
15. Shaft	Remove bearings. Inspect shaft for excessive wear, rust, corrosion, or other damage. Replace shaft if damaged in any way.	
ASSEMBLY		
16. Check valve assembly	Install check valve assembly, valve seat and gasket on suction flange. Then, install new gasket, companion flange, and mounting nuts. Tighten nuts securely in an alternating pattern.	
17. Bearings	Pack about 1/3 full of MIL-G-10924 grease. Press bearings onto shaft.	Rotate bearing to distribute grease.
18. Retaining rings	Install on shaft.	
19. Grease seals	Press a replacement grease seal into the bearing housing and bearing cap.	
20. Shaft	Pack grease into space between bearings in bearing housing. Install shaft with bearings and retaining rings in bearing housing.	
21. Bearing cap	Install new grease seal and packing. Fill cap with MIL-G-10924 grease. Slide it onto shaft, and install screws. Tighten screws securely.	
22. Seal plate and shaft seal assembly	Install a new shaft seal assembly and seal plate seal in seal plate. Lightly seat shaft with MI L-L-2104 oil and slide seal plate with seal and shaft seal assembly onto the shaft. Attach seal plate to bearing housing with nuts and lockwashers. Tighten securely.	

5-21. IMPELLER, SHAFT, SEALS, AND CHECK VALVE (CONT)

Location/Item	Action	Remarks
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5-21. IMPELLER, SHAFT, SEALS, AND CHECK VALVE (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

NOTE

If the same impeller and wear plate are reassembled and no clearance change is indicated, make sure that the same thickness of shims is used. If a new impeller and/or wear plate is to be installed, or if the impeller clearance is to be changed, determine the shim thickness required to obtain a clearance of 0.010 to 0.020 inch (0.254 to 0.508 mm) between the impeller and wear plate as follows:

- a. Install impeller on shaft without shims. Be sure that it is seated firmly against the shaft shoulder.**
- b. Install volute with wear plate assembled, and secure with attaching bolts and lockwashers.**
- c. Measure from the face of the impeller to the face of the wear plate using a feeler gage.**
- d. Select shims to equal the dimension obtained less 0.010 to 0.020 inch (0.254 to 0.508 mm) for clearance.**

23. Impeller	Put Woodruff key into slot in shaft and install impeller. Install and tighten locking cone.	
24. Volute and wear plate	Fasten wear plate to volute with countersunk screws. Install on seal plate with bolts. Tighten securely. Install new volute gasket on outside of volute.	
25. Bearing housing	Install on pump body. Install mounting nuts and lockwashers, and tighten securely.	
26. Valve seat and check valve assembly	Install on suction flange.	
27. Suction port companion flange	Install new gasket, companion flange, and mounting nuts. Tighten nuts securely in an alternating pattern.	

5-22. TRAILER ASSEMBLY

This task covers:

- a. Replacement

INITIAL SETUP:

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

**Equipment
Condition**

Para

Condition Description

- | | |
|------|--------------------------------|
| 4-45 | Trailer wiring harness removed |
| 4-48 | Taillights removed |
| 5-16 | Engine assembly removed |
| 5-20 | Pump assembly removed |

Location/Item

Action

Remarks

REPLACEMENT

- | | |
|---------------------|--|
| 1. Trailer assembly | Remove items as listed under equipment condition. Obtain replacement trailer assembly and install items. |
|---------------------|--|

**CHAPTER 6
GENERAL SUPPORT MAINTENANCE INSTRUCTIONS**

INTRODUCTION

This chapter contains the following frequently used maintenance information:

- a. Troubleshooting
- b. Maintenance procedures

The Symptom Index on page 6-2 is a guide to the troubleshooting information. There is also an index to the maintenance procedures on page 6-5.

Section	Title	Page
I	Troubleshooting	6-1
II	Maintenance Procedures.....	6-5

Section I. TROUBLESHOOTING

6-1. TROUBLESHOOTING

a. Table 6-1 contains troubleshooting information for locating and correcting most of the operating troubles which are the responsibility of general support maintenance. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. Perform the tests/inspections and corrective actions in the order listed.

NOTE

All TEST OR INSPECTION or CORRECTIVE ACTION steps assume that engine side panels have been removed if necessary for access.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

c. Only those functions within the scope of general support maintenance are listed. For troubleshooting procedures within the scope of operator/crew maintenance, refer to table 3-1. For troubleshooting procedures within the scope of organizational maintenance, refer to table 4-2. For troubleshooting procedures within the scope of direct support maintenance, refer to table 5-1.

6-2. SYMPTOM INDEX

Refer to the Symptom Index below. Locate the malfunction which is the same, or most nearly the same, as the trouble you are having with the pump assembly. The Symptom Index lists the first page of troubleshooting information for that malfunction. Follow the steps one by one, and perform the corrective actions listed.

Malfunction Number	Description	Page
1.	Engine is hard to start	6-2
2.	Engine consumes excessive lube oil (may produce blue smoke)	6-3
3.	Engine produces excessive crankcase pressure	6-4
4.	Engine has low oil pressure	6-4

Table 6-1. General Support Maintenance Troubleshooting

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

1. ENGINE IS HARD TO START

Step 1. Check for sticking or burned exhaust valves. Inspect valves (para 6-7).

Repair or replace faulty valves (para 6-9).

Step 2. Check for broken or worn compression rings. Inspect pistons and rings (para 6-10). Inspect cylinder liners (para 6-8).

Repair or replace pistons (para 6-10) and cylinder liners (para 6-8). Replace compression rings (para 6-10).

Step 3. Check for improper exhaust valve clearance.

- a. Wipe off valve cover. Remove mounting bolts, valve cover, and gasket. Discard gasket.

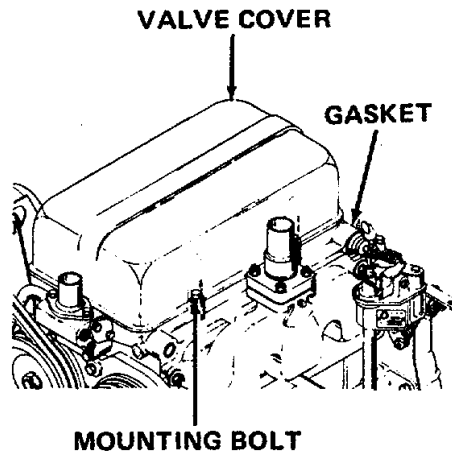
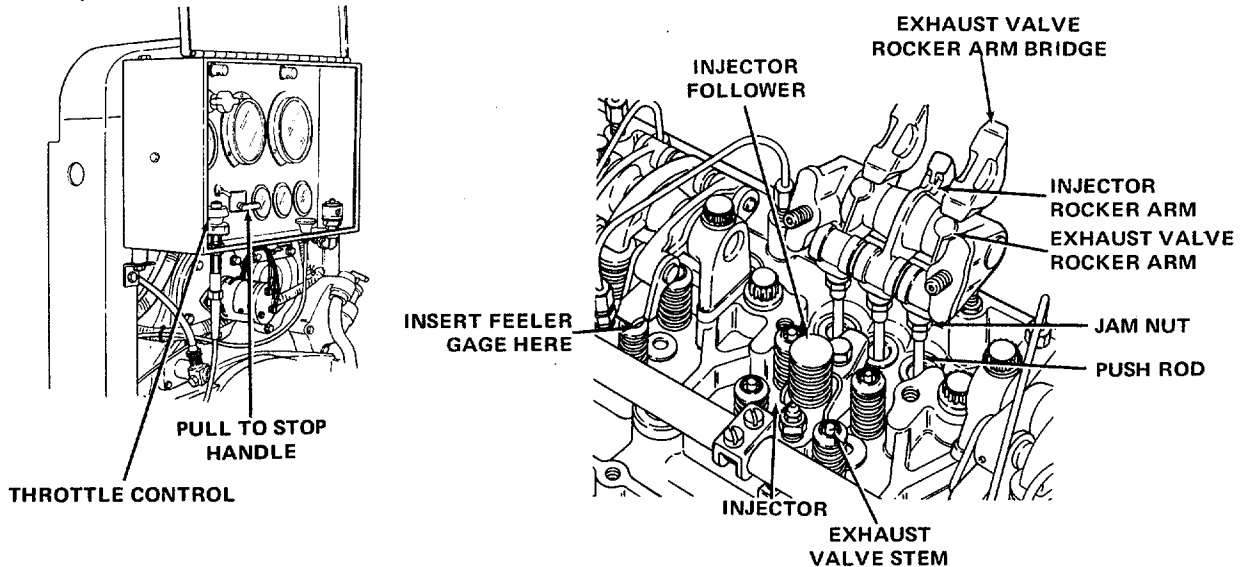


Table 6-1. General Support Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

- b. Put throttle control in idler position. Pull out PULL TO STOP handle. Rotate crankshaft with starting motor until injector follower is fully depressed. Loosen jam nut between exhaust valve rocker arm and push rod.



- c. Slide a 0.027 inch feeler gage between end of exhaust valve stem and rocker arm bridge. If gage moves freely between valve stem and bridge, the exhaust valve adjustment is incorrect.

Adjust push rod to obtain a smooth pull on feeler gage. Remove feeler gage, hold push rod, and tighten jam nut. Recheck clearance; if adjustment is correct, gage will not pass through. Readjust push rod if necessary. Adjust remaining exhaust valves as necessary. Install valve cover, new gasket, and mounting bolts.

2. ENGINE CONSUMES EXCESSIVE LUBE OIL (MAY PRODUCE BLUE SMOKE)

Step 1. Check for worn or broken oil control rings. Inspect pistons and rings (para 6-10). Inspect cylinder liners (para 6-8).

Repair or replace faulty pistons (para 6-10) and cylinder liners (para 6-8). Replace oil control rings (para 6-10).

Step 2. Check for scored cylinder liners or pistons. Inspect cylinder liners (para 6-8). Inspect pistons (6-10).

Repair or replace faulty cylinder liners (para 6-8) and pistons (para 6-10).

Step 3. Check for loose piston pin retainers. Inspect piston pin retainers (para 6-10). Replace a loose piston pin retainer (para 6-10).

Table 6-1. General Support Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Step 4. Check for piston and rod alignment. Inspect pistons and connecting rods (para 6-10). Check crankshaft thrust surfaces and thrust washers for wear or grooving (para 6-11).	Replace a faulty piston or connecting rod (para 6-10). If necessary, regrind and polish crankshaft and install oversize thrust washers (para 6-11).	
3. ENGINE PRODUCES EXCESSIVE CRANKCASE PRESSURE		
Step 1. Check for worn piston rings, a hole or crack in a piston crown, worn blower oil seals, defective blower, or excessive exhaust back pressure.		Replace worn or damaged parts (para 6-4 and 6-11).
4. ENGINE HAS LOW OIL PRESSURE		
Step 1. Check for clogged oil cooler core. Inspect oil cooler core (para 6-4).	Replace a clogged or otherwise faulty oil cooler core (para 6-4).	
Step 2. Check for malfunctioning oil cooler bypass valve or pressure regulator valve. Inspect valves (para 6-6).	Repair or replace faulty valves (para 6-6).	
Step 3. Check for partially clogged oil pump inlet screen. Inspect oil pump inlet screen (para 6-6).	Replace a screen that is damaged or cannot be cleaned adequately (para 6-6).	
Step 4. Check for air leak in oil pump inlet pipe and screen assembly. Inspect oil pump inlet pipe and screen assembly (para 6-6).	Repair or replace a faulty oil pump inlet pipe and screen assembly (para 6-6).	
Step 5. Check for worn or damaged oil pump. Inspect oil pump (para 6-6).	Repair or replace a faulty oil pump (para 6-6).	
Step 6. Check for missing crankshaft oil plugs, or excessive wear on crankshaft main bearing journals or bearings. Inspect crankshaft (para 6-11). Inspect main bearings (para 6-12).	Replace missing crankshaft plugs. Regrind or replace faulty crankshaft (para 6-11). Replace main bearings, if necessary (para 6-12).	
Step 7. Check for missing camshaft plugs. Inspect camshaft (para 6-9). Replace missing camshaft plugs (para 6-9).		

Section II. MAINTENANCE PROCEDURES

INDEX

Bearings	Para 6-12	Oil pump	Para 6-6
Blower assembly	6-4	Pistons and connecting rods	6-10
Crankshaft and flywheel	6-11	Radiator	6-14
Cylinder head and block	6-7	Valves, camshaft, and	
Cylinder liner	6-8	timing gears	6-9
Oil cooler	6-5	Water pump	6-13

6-3. GENERAL INSTRUCTIONS

Most maintenance instructions in this section will list resources required, personnel required, and equipment condition for the start of the procedure. Note the following:

- Resources required are not listed unless they apply to the procedure.
- Personnel required are listed only if the task requires more than one. If PERSONNEL is not listed, it means one person can do the task.
- The normal standard equipment condition to start a maintenance task is engine stopped and battery disconnect switch off. EQUIPMENT CONDITION is not listed unless some other condition is required besides the power being off.

6-4. BLOWER ASSEMBLY

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection/Repair
- d. Assembly

INITIAL SETUP

Tools

Emery abrasive cloth (Item 2, Appendix E)
 Shop set, automotive repair, field maintenance, basic
 NSN 4910-00-754-0705
 Tool kit, master mechanics
 NSN 5180-00-699-5273

Plain washers, 3/8 inch (2)

Lubricating oil (Item 10, Appendix E)
 Nuts, 3/8-16 inch (4)
 Troubleshooting References
 Malfunction 3, step 1

Materials/Parts

Rear plate-to-engine end plate gasket

Cover plate gasket

Blower-to-block gasket

Oil seals

Plain washers, 5/16 inch (2)

Malfunction 4, step 1

Equipment

Condition

Para

Condition Description

5-9 Blower assembly removed from engine.

Special Environmental Conditions

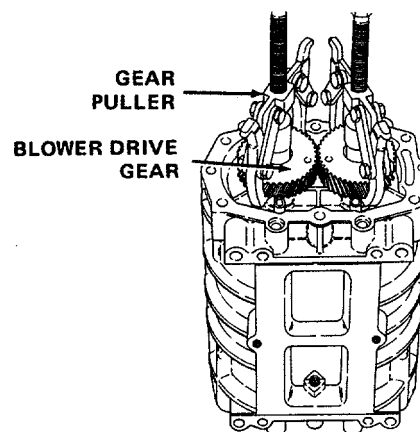
Well-ventilated area required during cleaning.

Location/Item	Action	Remarks
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DISASSEMBLY

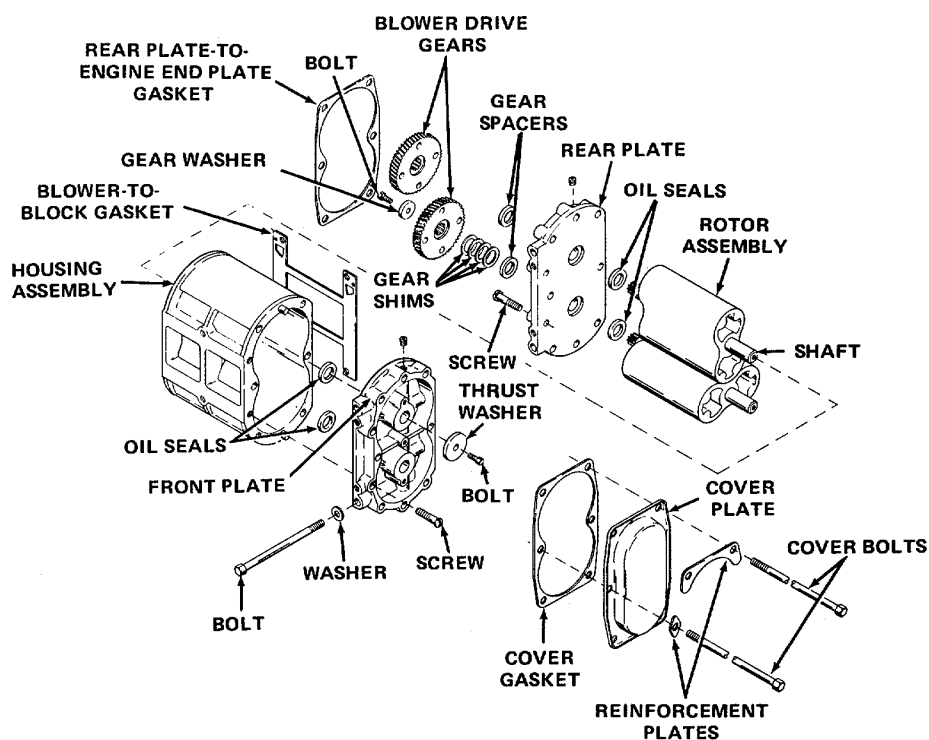
1. Blower drivegears

Wedge a clean cloth between rotor assemblies to prevent them from turning. Remove drive gear bolts and washers. Mark right-hand helix gear (for



6-4. BLOWER ASSEMBLY (CONT)

Location/item	Action	Remarks
2. Gear shims and spacers	Remove. Place with respective gears.	
3. Cover plate	Remove bolts, reinforcement plates, cover plate, and gasket. Discard gasket.	
4. Front plate	Remove bolts and thrust washers from rotor shafts. Remove screws to remove front plate from blower housing assembly.	
5. Rotor	Remove assemblies	
6. Rear plate	Remove screws to remove rear plate. Remove rear plate-to-engine end plate gasket. Discard gasket.	Rear plate-to-engine end plate gasket may have been removed during removal from engine.
7. Oil seals	Remove from front and rear plate, and discard.	
8. Blower-to-block gasket	Remove from blower housing assembly, and discard.	Blower-to-block gasket may have been removed during removal from engine.



6-4. BLOWER ASSEMBLY (CONT)

Location/item	Action	Remarks
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CLEANING

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138OF (380 to 590C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- 9. All parts Clean with P-D-680 dry cleaning solvent and dry with compressed air.

INSPECTION/REPAIR I

- 10. Front and rear plates Ensure plugs are in place. Inspect inside surfaces for roughness and scoring. Remove slight scoring with fine grit P-C-1673 emery cloth. Inspect bearing surfaces and oil seal contact surfaces for scoring, wear, or nicks. Replace badly worn or scored plates.
- 11. Housing assembly Inspect surfaces for burrs and scratches. Remove burrs or scratches with an oil stone. Remove any remaining gasket material.
- 12. Rotor assemblies Inspect surfaces for burrs and scratches. Inspect shafts for burrs and worn splines. Remove burrs with an oil stone. Inspect shaft oil seal and bearing contact areas. If contact area is slightly worn, install an oil seal sleeve on shaft and an oversize oil seal in front or rear plate, as needed. If oil seal or bearing contact surface on shaft is excessively worn, replace rotor assembly.
- 13. Blower drive Inspect for excessive wear and damage. Replace gears if necessary.

6-4. BLOWER ASSEMBLY (CONT)

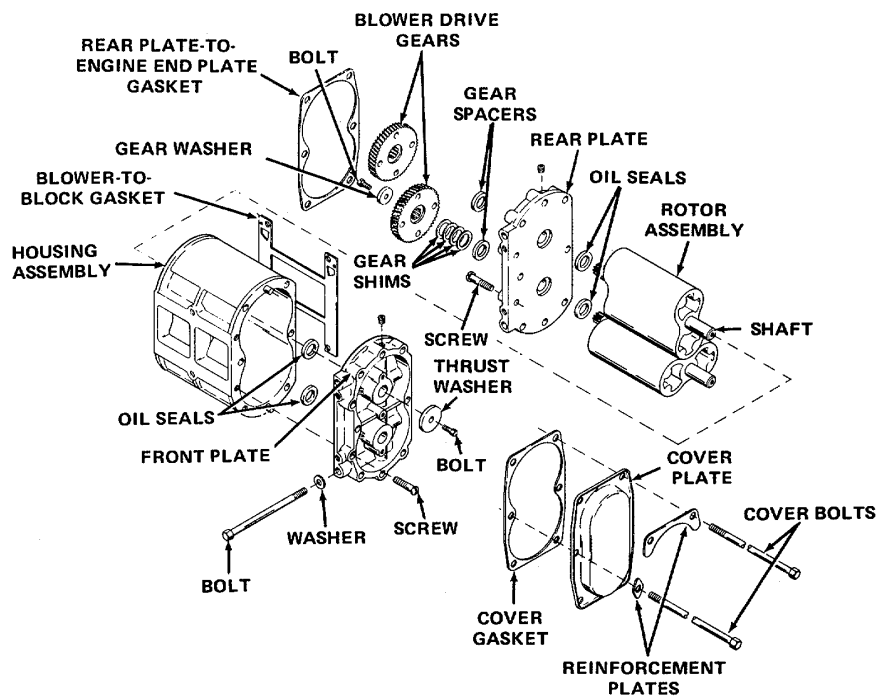
Location/item	Action	Remarks
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ASSEMBLY

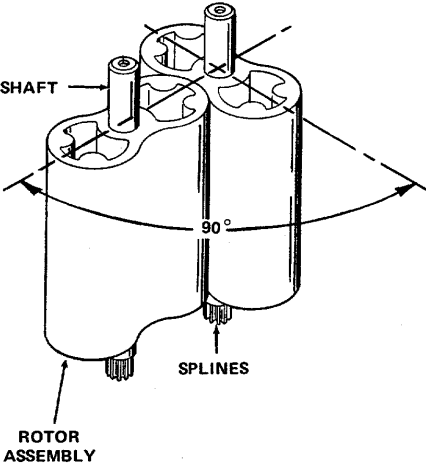
CAUTION

Equipment damage may occur through low oil pressure if front and rear plates are mixed during assembly. The rear plate does not have tapped holes for the thrust washer bolts or holes for thrust washer lubrication.

- | | | |
|-----|---------------------------------------|--|
| 14. | Front and rear plate oil seals | Place plate on an arbor press. Lubricate inner and outer diameter of seals with MIL-L-2104 oil and press seals (lip facing down) into place in counter-bored hole. |
| 15. | Rotor assemblies | Place front plate on two wood blocks. Install rotor assemblies gear end up, on plate. |
| 16. | Housing assembly rear plate | Remove any foreign material from inner surface and install over rotor assemblies. Install over rotor assembly shafts. Secure to housing assembly with screws. Install two cover bolts and plain washers. |
| 17. | Thrust washers and front plate screws | Install screws on front plate. Mount thrust washers by threading bolts into rotor shaft. Torque bolts to 54 to 59 ft lb (73 to 80 N.m). |



6-4. BLOWER ASSEMBLY (CONT)

Location/item	Action	Remarks
18. Rotor assembly adjustment	Position rotor assemblies so that missing splines on gear end of shafts are 90 degrees apart.	
19. Gear shims and spacers	Install in counterbore in face of blower drive gears.	
20. Blower drive gears	Install on shafts with missing gear splines in line with missing splines on shafts. Tap gears lightly to seat them on shafts. Rotate gears until matchmarks on gear faces aline. Reposition gears if necessary. Wedge a clean cloth between rotor assemblies. Install bolts and plain washers. Turn bolts uniformly until gears are tight against shoulders on shafts. Remove bolts and plain washers. Install bolts with gear washers. Torque bolts to 25 to 30 ft lb (34 to 41 N.m).	
FINAL INSPECTION		
21. Blower drive gear backlash	Check backlash between gears with dial indicator. Backlash should be between 0.0005 and 0.0025 inch (0.0127 and 0.0635 mm) with new gears, or a maximum of 0.0035 inch (0.0889 mm) with used gears. Replace gears if necessary.	

6-4. BLOWER ASSEMBLY (CONT)

Location/item	Action	Remarks
22. Clearance between rotor assemblies	Adjust clearance by moving one of the gears out/in on shaft and advancing/retarding gear teeth relative to teeth on other gear. Take measurements of clearance the entire length of each rotor lobe and housing gap. A minimum clearance of 0.0075 inch (0.1905 mm) should exist at air inlet side, a minimum clearance of 0.004 inch (0.1016 mm) should exist at air outlet side, and a minimum clearance of 0.010 inch (0.254 mm) should exist between rotor assemblies.	Move gears out/in by adding/removing gear shims between gear hub and gear spacers.
23. Clearance between rotor assemblies and front and rear plates	Measure. Clearance between front plate and rotor assemblies should be 0.006 inch (0.1524 mm). Clearance between rear plate and rotor assemblies should be 0.008 inch (0.2032 mm).	
24. Rotor assemblies	Turn assemblies by hand to ensure they move freely. If assemblies do not turn freely, check for presence of foreign material, and disassemble blower assembly if necessary.	
FINAL ASSEMBLY		
25. Cover plate	Install new gasket on front plate. Install cover plate, reinforcement plates, and bolts. Loosely retain bolts with nuts.	
26. Front and rear plate bolts and washers	Loosely install.	
27. Housing assembly and rear plate gasket surfaces	Ensure surfaces are clean and free of remaining gasket material.	

6-5. OIL COOLER

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop equipment automotive maintenance
and repair, common no.

NSN 4910-00-754-0654

Materials/Parts

Oil cooler gaskets

Dry cleaning solvent (Item 16, Appendix E)

References

LO 5-4320-300-12 (figure 4-1)

Equipment Condition

1	
Para	Condition Description
4-28	Fuel strainer removed.
4-37	Water pump removed.
4-38	Engine coolant drained.

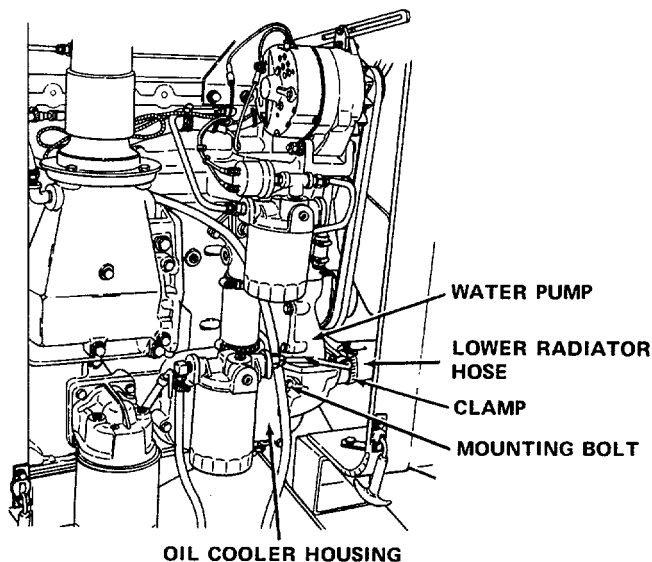
Special Environmental Conditions

Well-ventilated area required during cleaning.

Location/Item	Action	Remarks
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REMOVAL

1. Oil cooler Loosen clamp on lower radiator hose closest to oil cooler. Remove oil cooler mounting bolts. Remove cooler.



6-5. OIL COOLER (CONT)

Location/item	Action	Remarks
2. Oil cooler core	Matchmark core to oil cooler housing. Remove core.	
3. Gaskets	Discard. Remove any trace of gasket material from sealing surfaces.	

CLEANING

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 1000 to 138°F (380 to 590C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

CAUTION

Do not attempt to clean an oil cooler core which has been in contact with oil containing metal particles from worn or broken engine parts. Engine damage may occur. Replace the oil cooler core.

- | | |
|-----------------------|---|
| 4. Oil cooler core | To remove carbon and sludge, circulate P-D-680 dry cleaning solvent through oil passages. Thoroughly dry oil passages with compressed air. Clean core exterior with dry cleaning solvent and dry with compressed air. Then circulate clean water through core passages. Dry core passages with compressed air until all water evaporates. |
| 5. Oil cooler housing | Clean housing thoroughly with P-D-680 dry cleaning solvent and dry with compressed air. Then flush thoroughly with clean water. Dry with compressed air. Set housing aside. |

6-5. OIL COOLER (CONT)

Location/item	Action	Remarks
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INSPECTION

CAUTION

If there is leakage between the lubrication system and cooling system, change the oil and filter. Also flush the cooling system to remove oil contaminants. Refer to LO 5-4320-300-12 (figure 4-1).

- | | | |
|---------------------------------|---|--|
| 6. Oil cooler core and pitting. | Inspect for corrosion, holes, cracks, or other damage. Inspect sealing surfaces for corrosion | |
| 7. Oil cooler housing pitting. | Inspect for corrosion, cracks, or other damage. Inspect sealing surfaces for corrosion and | |

INSTALLATION

- | | | |
|------------|--|--|
| 8. Gaskets | Position new gaskets on sealing surfaces of oil cooler core and housing. | |
|------------|--|--|

CAUTION

Engine damage may occur if the core is installed with inlet and outlet openings in the reverse position. Aline matchmarks to prevent any remaining foreign particles and sludge from entering and circulating through the engine.

- | | | |
|---------------------------------------|---|------------------------------|
| 9. Oil cooler core gaskets, and core. | Aline matchmarks and insert core into housing. Insert mounting bolts through holes in housing, | |
| 10. Oil cooler | Clean any remaining gasket material from mating sealing surface on bottom of water pump. assembled oil cooler on engine. bolts and torque to 13 to 17 ft lb (18 to 23 N.m). Install lower radiator hose on oil cooler housing and tighten clamp securely. | Position
Install mounting |

6-6. OIL PUMP

This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Repair
- f. Reassembly
- g. Installation

INITIAL SETUP:

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705
Crocus abrasive cloth (Item 1, Appendix E)

Took kit, master mechanics
NSN 5180-00-699-5273

Oil pump drive gear
Diesel fuel oil (Item 6, Appendix E)
Lubricating oil (Item 10, Appendix E)

Emery abrasive cloth (Item 2, Appendix E)

Materials/Parts

Cover plate drive screws
Engine lower front cover gasket
Oil pump inlet pipe gasket

Oil pump inlet pipe seal ring

Oil pressure regulator valve gasket

Oil cooler bypass valve gasket
Oil pan gasket

Troubleshooting References

Malfunction 4, steps 2, 3, 4, and 5

Equipment

Condition

Para	Condition Description
5-16	Engine removed from pump assembly and trailer assembly.

Special Environmental Conditions

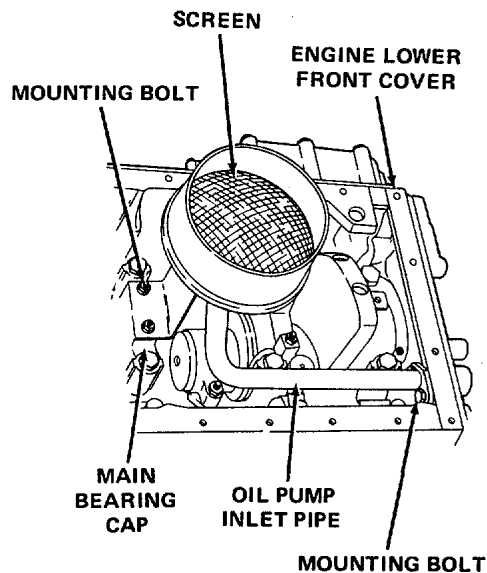
Well-ventilated area required during cleaning.

6-6. PUMP (CONT)

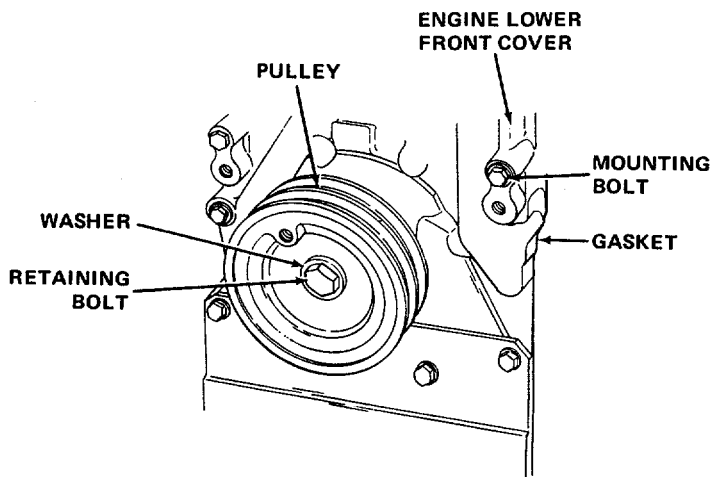
Location/item	Action	Remarks
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REMOVAL

- | | |
|--|--|
| 1. Oil pan | Remove. Discard gasket. |
| 2. Oil pump inlet pipe and screen assembly | Remove flange mounting bolts and lockwashers. Support screen and pipe. Remove bracket mounting bolts and lockwashers. Remove inlet pipe and screen assembly. |



- | | |
|-----------------------------|---|
| 3. Crankshaft pulley | Remove pulley, retaining bolt, and washer. |
| 4. Engine lower front cover | Remove mounting bolts, gasket, and cover. Discard gasket. |



6-6. OIL PUMP (CONT)

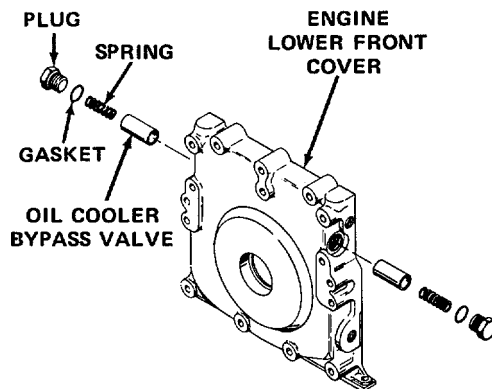
Location/item	Action	Remarks
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DISASSEMBLY

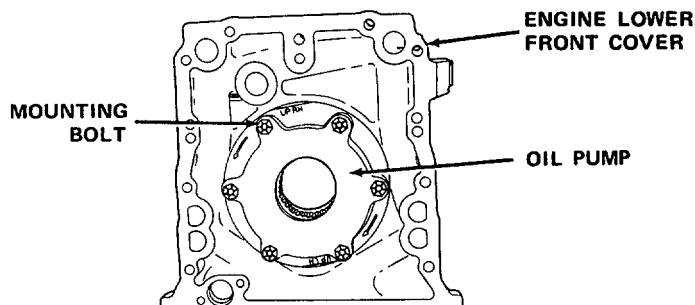
CAUTION

Do not mix parts from bypass valve with parts from pressure regulator valve, or valve malfunction may result after the parts are reinstalled.

- 5. Oil pressure regulator valve
Remove plug from left side of engine lower front cover. Remove valve, spring, and gasket. Discard gasket.
- 6. Oil cooler bypass valve
Remove plug from right side of engine lower front cover. Remove valve, spring, and gasket. Discard gasket.



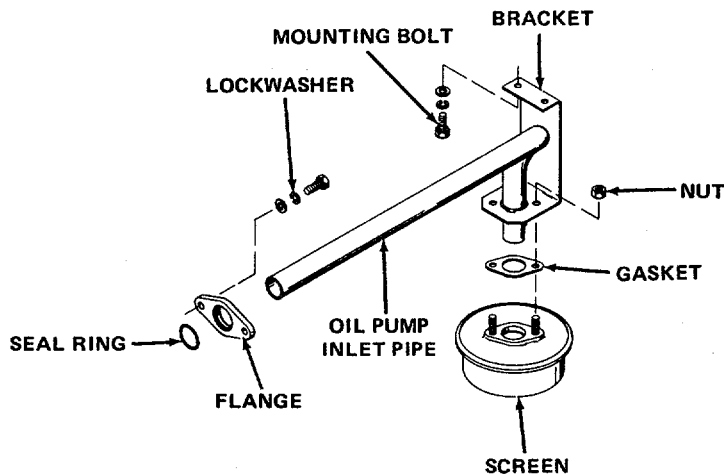
- 7. Oil pump
Remove mounting bolts. Remove oil pump.



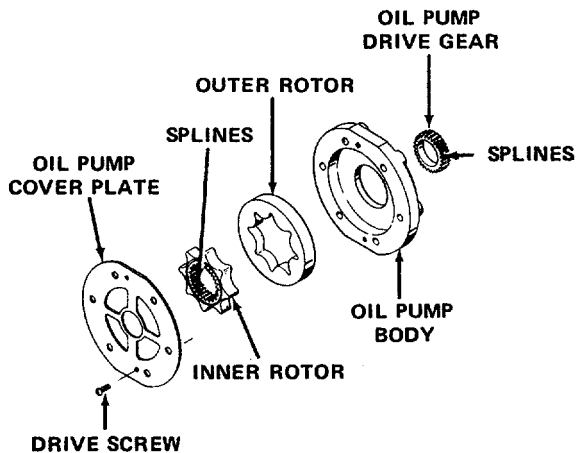
6-6. OIL PUMP (CONT)

Location/item	Action	Remarks
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- 8. Oil pump inlet pipe and screen assembly
Remove mounting nuts attaching screen to bracket. Discard gasket. Discard seal ring. Remove flange.



- 9. Cover plate
Remove drive screws. Remove cover plate from pump body.
- 10. Inner and outer rotors
Remove.



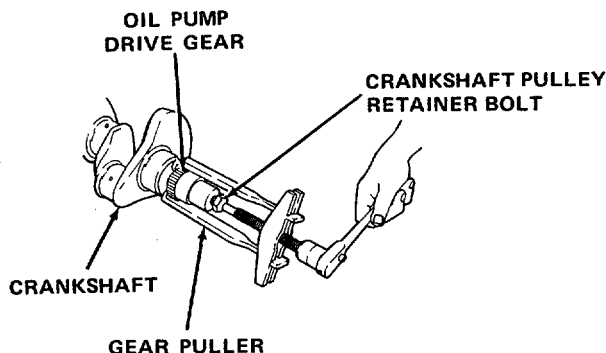
6-6. OIL COOLER (CONT)

Location/item	Action	Remarks
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CAUTION

Do not remove the oil pump drive gear unless it is damaged enough to be replaced. Equipment malfunction may result if a used gear is reinstalled.

- | | |
|----------------|---|
| 11. Drive gear | Reinstall crankshaft pulley retainer bolt and washer in the end of crankshaft. Attach the jaws of a suitable gear puller behind the gear and locate end of puller screw in center of pulley retainer bolt. Turn puller screw clockwise and remove gear from crankshaft. |
|----------------|---|



CLEANING

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not handle fuel near open flame, sparks, or excessive heat.

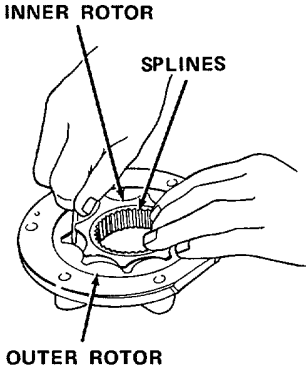
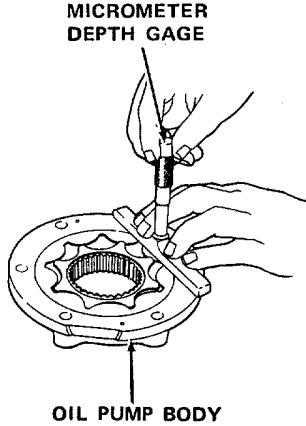
Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
|---------------|---|
| 12. All parts | Wash in clean VV-F-800 diesel fuel and dry with compressed air. |
|---------------|---|

INSPECTION

- | | |
|-------------------------|--|
| 13. Oil pump inlet pipe | Inspect bracket and pipe for cracks, damaged sealing surfaces, and distortion. Inspect flange for warpage and seal surface damage. Replace if damaged. |
|-------------------------|--|

6-6. OIL PUMP (CONT)

Location/item	Action	Remarks
14. Screen	Inspect seal surface for damage. Inspect screening for tears or obstructions. Clean to remove obstructions. Replace if damaged.	
15. Mounting	Inspect bolts for damaged threads. Replace if bolts and damaged. Inspect lockwashers. Replace if damaged lockwashers or missing.	
16. Pump rotors,	Inspect the lobes and faces body, and of pump rotors for scratches cover plate or burrs and the surfaces of pump body and cover plate for scoring. Slight scratches or score marks may be removed with P-C-458 crocus cloth.	 <p>INNER ROTOR SPLINES OUTER ROTOR</p>
	Measure the clearance between inner and outer rotors at each lobe. The clearance should not be less than 0.004 inch (0.1016 mm) or more than 0.011 inch (0.279 mm). Measure the clearance from the face of pump body to the side of inner and outer rotor with a micrometer depth gage. The clearance should be not less than 0.001 inch (0.0254 mm) or more than 0.0035 inch (0.0889 mm).	 <p>MICROMETER DEPTH GAGE OIL PUMP BODY</p>
NOTE		
Wear on pump rotors may be kept to a minimum by using clean oil. If dirt and sludge are allowed to accumulate in the lubricating system, excessive rotor wear may occur in a comparatively short period of time.		
17. Inner rotor and oil pump drive gear splines	Inspect for excessive wear.	

6-6. OIL PUMP (CONT)

Location/item	Action	Remarks
18. Oil pressure regulator and oil cooler bypass valves	Check that valves move freely in bores in engine lower front cover. If a valve sticks slightly, remove roughness with P-C-458 crocus cloth. Inspect plug and spring for excessive wear or other damage.	

REPAIR

19. Pump rotors, body, and cover plate	If the lobes and faces of the rotors have deep scratches or burrs, replace rotors as a matched set. If the pump body and cover plate are deeply scored, replace them.
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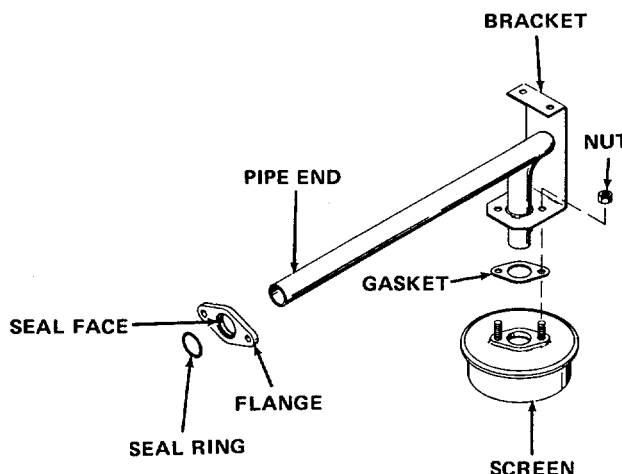
NOTE

Minor scratches on the pump rotors, body, or cover plate may be removed with P-C-1673 emery cloth.

20. Inner rotor and oil pump drive gear splines	If splines are excessively worn, replace both rotors (matched set), and replace the drive gear.
21. Oil pressure regulator and oil cooler bypass valves	If after polishing with crocus cloth, valves do not move freely in bores in engine lower front cover, replace the valves. If plugs or springs are excessively worn or damaged, replace them.

REASSEMBLY

22. Flange	Install flange over pipe end, seal face out. Lubricate new seal ring with MIL-L-2104 oil and place against flange seal face.
23. Screen	Install new gasket over studs on back of screen. Join screen to bracket on end of pipe and secure with two nuts.

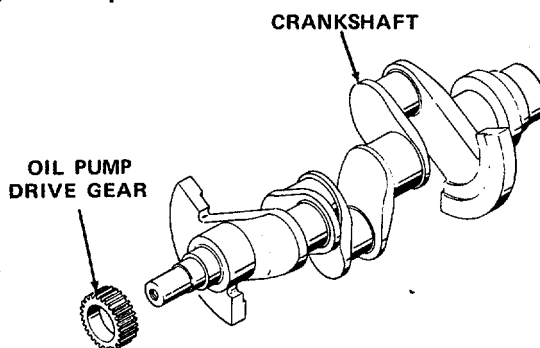


6-6. OIL PUMP (CONT)

Location/item	Action	Remarks
24. Inner and outer rotors	Lubricate outer rotor with MIL-L-2104 oil and place in pump body. Lubricate inner rotor and place inside of outer rotor.	
25. Cover plate	Place cover plate on pump body and align drive screw and bolt holes with holes in pump body. Since holes are offset, cover plate can be installed in only one position. Install new drive screws.	
26. Drive gear	Lubricate the inside diameter of a new drive gear with MIL-L-2104 oil. Then start the gear straight on the crankshaft with chamfered edge of gear toward butt end of crankshaft.	

CAUTION

Check the fit of oil pump drive gear on crankshaft. Drive gear should not slip on crankshaft at a torque of 100 foot pounds (136 N.m). If gear slips, replace it. Position the drive gear over the end of crankshaft and force the gear into position.



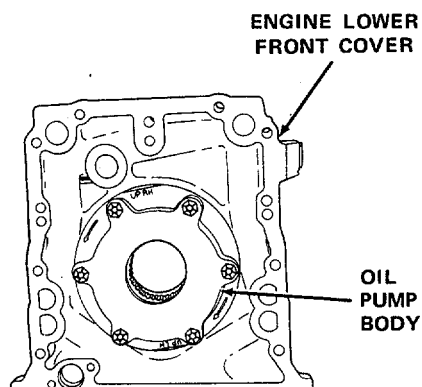
- 27. Oil pressure regulator and oil cooler bypass valves
 Insert valves in bores in engine lower front cover. Then install springs, new gaskets, and plugs. Tighten plugs securely.

6-6. OIL PUMP (CONT)

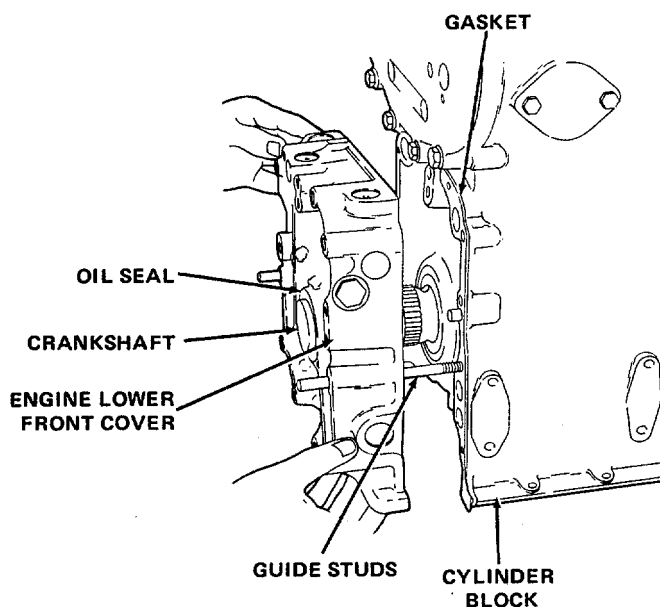
Location/item	Action	Remarks
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INSTALLATION

28. Oil pump
 Install pump body in engine lower front cover with the letters UP LH at the top. Install mounting bolts and torque to 12 to 17 ft lb (18 to 23 N.m).



29. Engine lower front cover
 Position replacement gasket on cylinder block. Thread guide studs into block. Lubricate crankshaft end with MIL-L-2104 oil. Carefully expand oil seal and position cover against block. Remove guide studs. Install mounting bolts and torque to 30 to 35 ft lb (41 to 47 N.m).

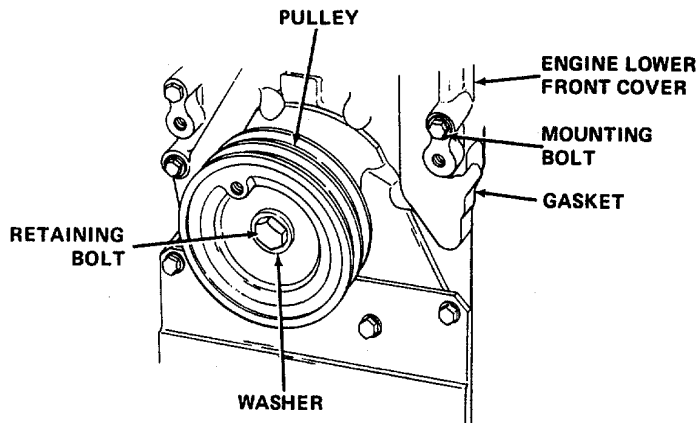


6-6. OIL PUMP (CONT)

Location/item	Action	Remarks
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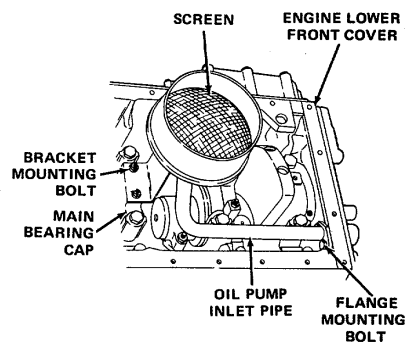
30. Crankshaft pulley

Install pulley, washer, and retaining bolt. Torque to 200 to 220 ft lb (271 to 298 N.m).



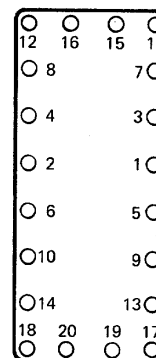
31. Oil pump inlet pipe and screen assembly

Place flange end of inlet pipe into engine lower front cover. Loosely install bracket mounting bolts, with lockwashers, through bracket and into main bearing cap. Loosely install flange mounting bolts, with lockwashers, through flange and into engine front cover. Torque all mounting bolts to 13 to 17 ft lb (18 to 23 N.m).



32. Oil pan

Coat gasket lightly with MIL-L-2104 oil. Install gasket and oil pan. Install mounting bolts hand tight. Torque bolts to 20 ft lb (27 N.m) in sequence shown.



6-7. CYLINDER HEAD AND BLOCK

This task covers:

- a. Disassembly
 - b. Cleaning/Inspection
 - c. Repair/Replacement
 - d. Reassembly
 - e. Installation
-

INITIAL SETUP:**Tools**

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Valve guide oil seals
Air box cover gasket
Cylinder block end plate gasket
Oil pan gasket

Diesel fuel oil (Item 6, Appendix E)
Lubricating oil (Item 10, Appendix E)
Crocus cloth (Item 1, Appendix E)
Rust arresting coating (Item 5, Appendix E)

Thread compound (Item 20, Appendix E)
Sealing compound (Item 14, Appendix E)

Cindol 1705 (Item 9, Appendix E)

References

Para 5-18 Cylinder head and block
Para 6-8 Cylinder liner
Para 6-9 Valves, camshaft, and timing gears
Para 6-10 Pistons and connecting rods
Para 6-11 Crankshaft and flywheel
MIL-1-6868 Magnetic Particle Inspection

Troubleshooting References

Malfunction 1, step 1

Special Environmental Conditions

Well-ventilated area required during cleaning.

6-7. CYLINDER HEAD AND BLOCK(CONT)

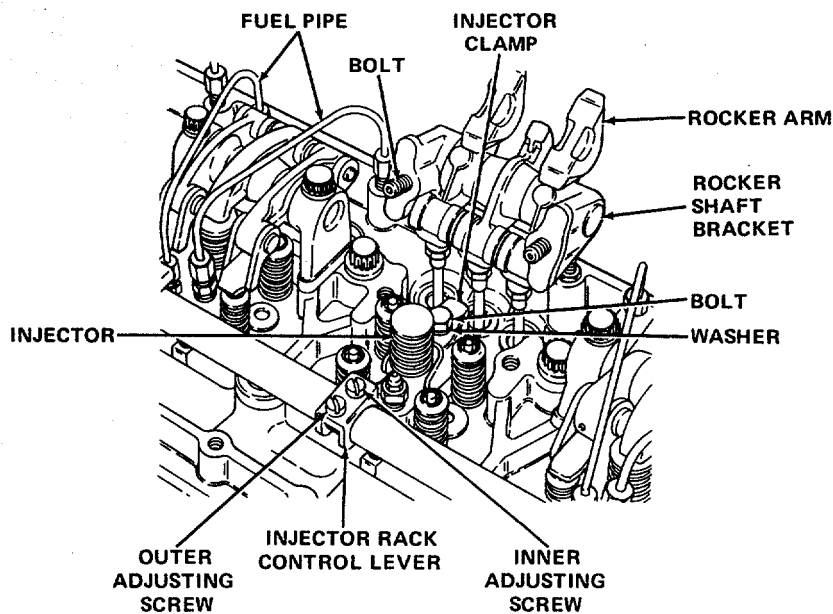
Location/item	Action	Remarks
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DISASSEMBLY OF CYLINDER HEAD

CAUTION

Cover injector filter caps to prevent dirt from entering injector.

- | | |
|--------------------------|--|
| 1. Remove fuel injectors | <p>Remove fuel pipes from injectors.</p> <p>Remove rocker shaft bracket bolts. Swing rocker arms away from injector.</p> <p>Remove injector clamp, bolt, and washer.</p> <p>Loosen inner and outer adjusting screws on injector rack control lever.</p> <p>Slide lever away from injector.</p> <p>Remove injector.</p> |
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6-7. CYLINDER HEAD AND BLOCK(CONT)

Location/item	Action	Remarks
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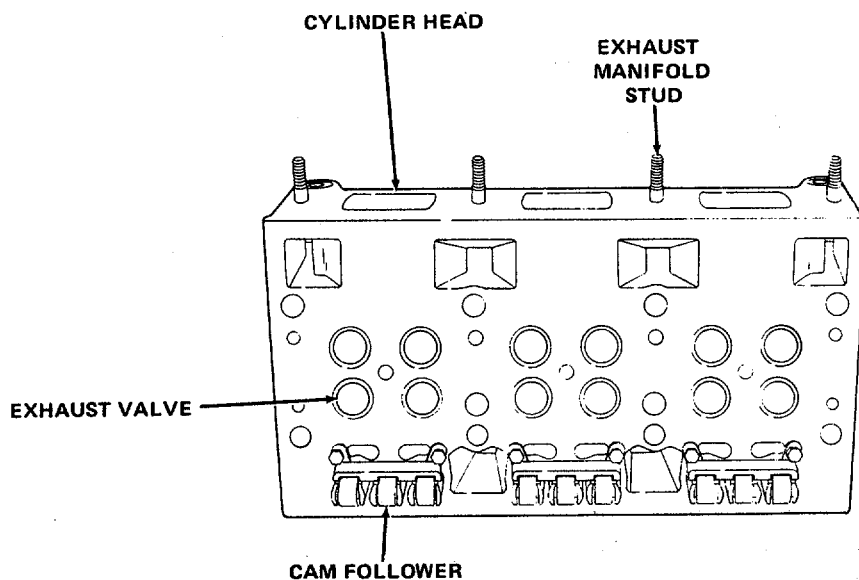
NOTE

If cylinder head has not been removed from engine, remove it per paragraph 5-18.

CAUTION

When setting the cylinder head down on the valve side, support it on 2 inch (51 mm) thick wood blocks to protect cam followers. Equipment damage could result if this procedure is not followed.

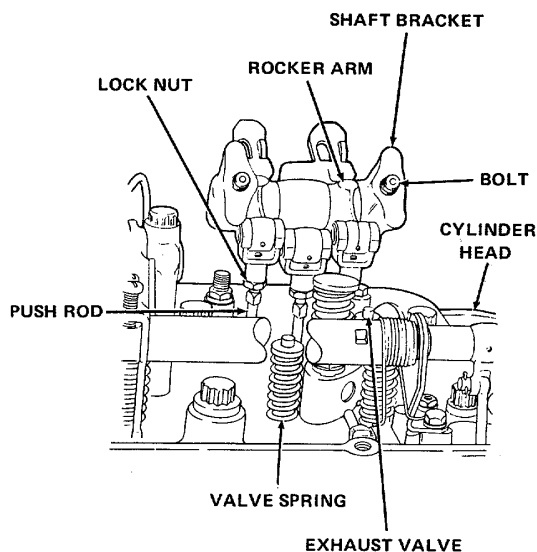
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| 2. Cylinder head placement | Set cylinder head on its side with exhaust manifold studs in an upright position. Then tip the head over and position it (with exhaust valves down) on wood blocks. |
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6-7. CYLINDER HEAD AND BLOCK(CONT)

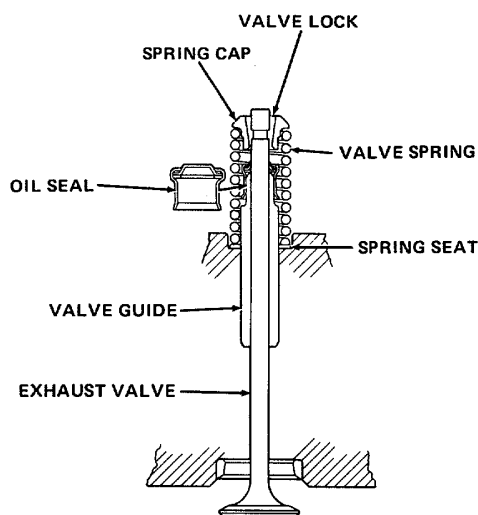
Location/item	Action	Remarks
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| 3. Rocker arms | Remove bolts holding brackets to the cylinder head. Loosen push rod lock nuts. Unscrew push rods enough to release rocker arms. Then remove brackets, shaft, and rocker arms. | |
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NOTE
Slide wood blocks under valves to keep them from falling out of cylinder head after valve locks are removed.

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| 4. Valve springs, locks, caps, and seats | Compress spring and remove two-piece valve lock. Remove valve spring cap, spring, and seat. Repeat for each valve spring. | |
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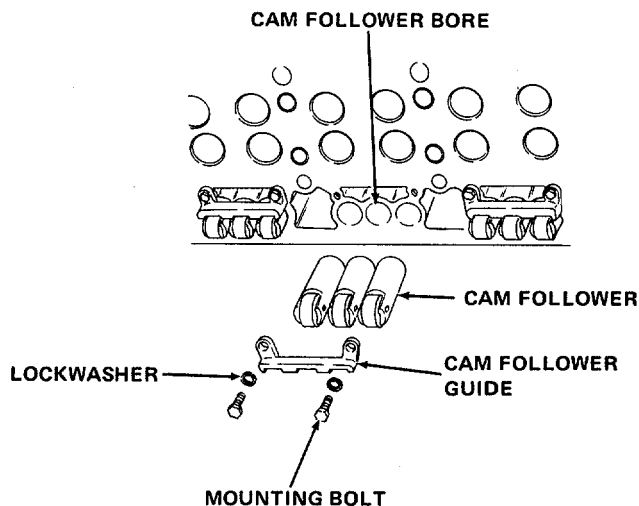
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| 5. Valves | Turn cylinder head over, using care to keep valves from falling out of head. Number each valve to facilitate reinstallation in the same location. Then withdraw valves from cylinder head. Reposition the cylinder head on its side. | |
|-----------|--|--|

Valve guides and valve seat inserts can be inspected and cleaned without being removed from cylinder head.

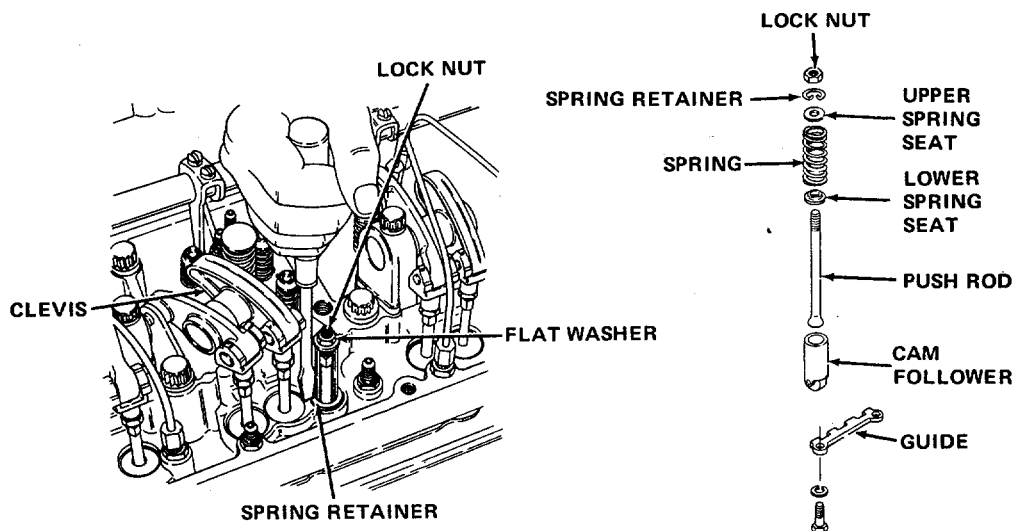
6-7. CYLINDER HEAD AND BLOCK(CONT)

Location/item	Action	Remarks
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| 6. Cam follower | Remove mounting bolts and lockwashers and remove each cam follower guide from its bore. Pull each cam follower out of the cylinder head. | |
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|------------------------|--|--|
| 7. Push rod assemblies | Loosen each push rod lock nut and unscrew push rod from the rocker arm clevis. Pull push rod assembly from bottom of cylinder head. Remove lock nut, spring retainer, spring, and spring seats from each push rod. | |
|------------------------|--|--|



6-7. CYLINDER HEAD AND BLOCK(CONT)

Location/item	Action	Remarks
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CLEANING/INSPECTION OF VALVE PARTS

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Work in a well-ventilated area.

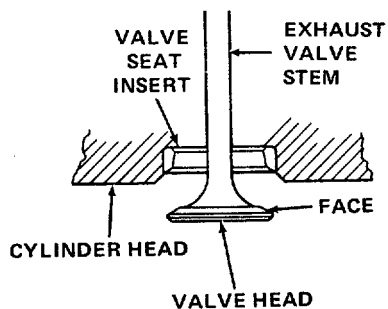
Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
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| 8. All disassembled valve parts | Wash in clean VV-F-800 diesel fuel and dry with compressed air. |
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NOTE

If valve parts are damaged in any way, repair or replace them in accordance with paragraph 6-9.

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| 9. Exhaust valve heads | Inspect for warping, burning, or other damage. |
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|-----------------|--|
| 10. Valve stems | Inspect for scratches, scuff marks, or other damage. |
| 11. Valve faces | Inspect for pitting, ridges, or cracks. |

6-7. CYLINDER HEAD AND BLOCK(CONT)

Location/item	Action	Remarks
12. Valve guides	Use a guide brush to clean the inside of valve guides, and inspect the guides for fractures, chipping, scoring, or excessive wear. Then measure the inside diameter of each valve guide and record the reading from the cylinder head.	Valve guides and valve seat inserts can be inspected and cleaned without being removed
13. Valve stem and guide differential	Measure outside diameter of valve stem and record the reading. Subtract stem diameter reading from guide reading. The difference should be no greater than 0.005 inch (0.127 mm).	
14. Valve springs, locks, caps, and seats	Inspect for pitting, fracture, excessive wear, or other damage.	
15. Spring load	If springs are in good condition, check spring load. A load of 25 pounds (11.34 kg) should compress a four-valve cylinder head spring to 1.93 inches (49.02 mm) maximum. The difference in the load between any pair of valve springs should not exceed 6 pounds (2.7 kg).	
16. Valve guide	Remove and discard oil seals	
17. Valve seat inserts	Inspect for wear, pitting, cracking, and proper valve seat angle (31 degrees).	

6-7. CYLINDER HEAD AND BLOCK(CONT)

Location/item	Action	Remarks
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**CLEANING/INSPECTION OF
ROCKER ARMS SHAFTS
AND BRACKETS**
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

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|---------------------------------------|--|
| 18. Injectors | Clean injectors with clean VV-F-800 diesel fuel. |
| 19. Rocker arms, shafts, and brackets | Wash rocker arms, shaft, brackets, and bolts with clean VV-F-800 diesel fuel. Use a small wire to clean drilled oil passages in rocker arms and rocker shaft bolts. Dry parts with compressed air. Inspect rocker arm shaft, injector rocker arm bushings, and valve rocker arm bores for wear. A maximum shaft to bushing (or bore) clearance of 0.004 inch (0.1016 mm) is allowable with used parts. Inspect rocker arms for galling or wear on the pallets (valve or injector contact surfaces). Also inspect valve bridges for wear. |

6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION OF CAM FOLLOWERS

CAUTION

Do not wash cam followers with diesel fuel because, at startup, equipment damage may occur due to lack of lubrication.

CAM FOLLOWER

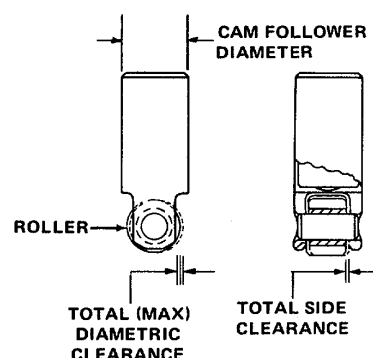


20. Cam followers

Wash with MIL-L-2104 oil and wipe dry.

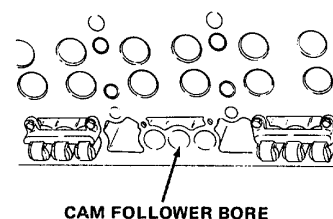
21. Cam follower rollers

Inspect rollers for scoring, pitting, and flat spots. Rollers must turn freely on their pins. Measure total diametric clearance and side clearance. Diametric clearance should not exceed 0.010 inch (0.254 mm). Side clearance should be within 0.011 to 0.023 inch (0.279 to 0.584 mm).



22. Cam follower and bore measurement

Measure diameter of bores and cam followers. Record the readings.



23. Cam follower and bore differential

Subtract diameter of cam follower from inside diameter of cam follower bore. The difference should be between 0.0016 and 0.0036 inch (0.0406 and 0.0914 mm).

24. Cam follower springs

Examine springs for wear or damage and check the spring load. Springs should not compress below 2.1406 inches (54.371 mm) while supporting a load of 250 pounds (113.4 kg).

6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION OF PUSH RODS

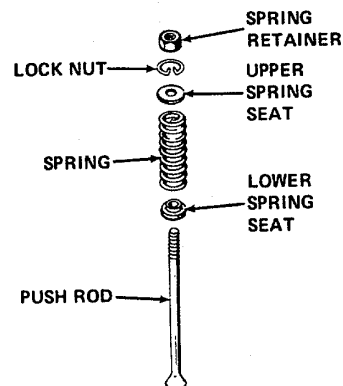
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

25. Push rods	Wash push rods, springs, spring seats, and other hardware with clean VV-F-800 diesel fuel and dry with compressed air. Inspect push rods and spring seats for wear.
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CLEANING/INSPECTION OF CYLINDER HEAD

26. Cylinder head plugs	Remove all plugs from cylinder head (except cup plugs).
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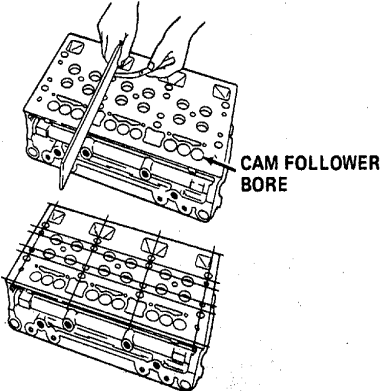
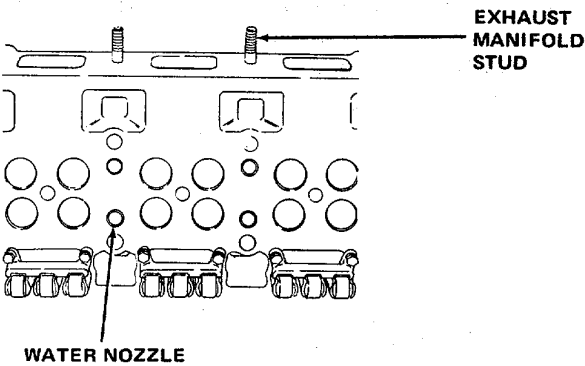
WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

27. Cylinder head	Steam clean cylinder head and dry with compressed air. Check cylinder head for cracks according to MIL-I-6868 magnetic particle inspection.
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6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
28. Cylinder head bottom	With a heavy straightedge and feeler gage, check bottom of cylinder head for flatness along all lines shown. The maximum allowable longitudinal warpage is 0.005 inch (0.127 mm), and the maximum allowable transverse warpage is 0.004 inch (0.1016 mm).	
29. Cam follower bores	Inspect for scoring or wear.	
30. Water nozzles	Inspect for tightness.	
31. Exhaust manifold studs	Inspect for excessive rust, corrosion, or other damage.	

REPAIR/REPLACEMENT OF CYLINDER HEAD

32. Rocker arms, shaft, and brackets
- Replace shaft, bushings, or rocker arm if extremely worn or damaged. Replace arms or bushings if clearance to rocker arm shaft is greater than 0.004 inch (0.1016 mm). Replace rocker arms if pallets are galled or worn. Replace any worn valve bridges. Reassemble rocker arm and shaft assembly prior to installation.

6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
33. Cam follower rollers	Replace any cam follower rollers that are scored, pitted, have flat spots, or do not turn freely on their pins. Replace any rollers that have a diametric clearance greater than 0.010 inch (0.254 mm), or side clearance greater than 0.011 to 0.023 inch (0.279 to 0.584 mm).	
34. Cam followers	Replace any cam followers that have a diameter less than 1.0600 inches (26.924 mm).	

NOTE

Increasing clearance between the cam follower and bore is the result of wear of the bore. If bore diameter is greater than 1.063 inches (27.015 mm), the cylinder head should be reconditioned or replaced.

35. Push rods, spring seats, and cam follower springs	Replace any push rods, spring seats, or cam follower springs that are excessively worn or damaged. Replace any cam follower springs that can be compressed to less than 2.1406 inches (54.371 mm) with a load of 250 pounds (1112 N). Reassemble cam follower and push rod assemblies prior to installation.	
36. Cylinder head	<p>Replace if:</p> <p>Cylinder head shows cracks or leaks of any type.</p> <p>Bottom has a longitudinal warpage greater than 0.005 inch (0.127 mm) and a transverse warpage greater than 0.004 inch (0.1016 mm).</p> <p>Cam follower bores are seriously scored, scratched, or damaged. Slight scratches and score marks can be removed with P-C-458 crocus cloth.</p>	
37. Water nozzles	Tighten any loose water nozzles. Replace water nozzles if rusty, corroded, or plugged.	
38. Exhaust manifold studs	Replace if excessively rusty, corroded, or damaged. Install replacement studs after coating threads with MIL-T-22361 thread compound and driving studs 25 to 40 ft lb (34 to 54 N•m) torque, 1.40 to 1.50 inches (35.6 to 38.1 mm) in height.	

6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
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REASSEMBLY OF CYLINDER HEAD

39. Valves	Install in accordance with paragraph 6-9.	
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WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

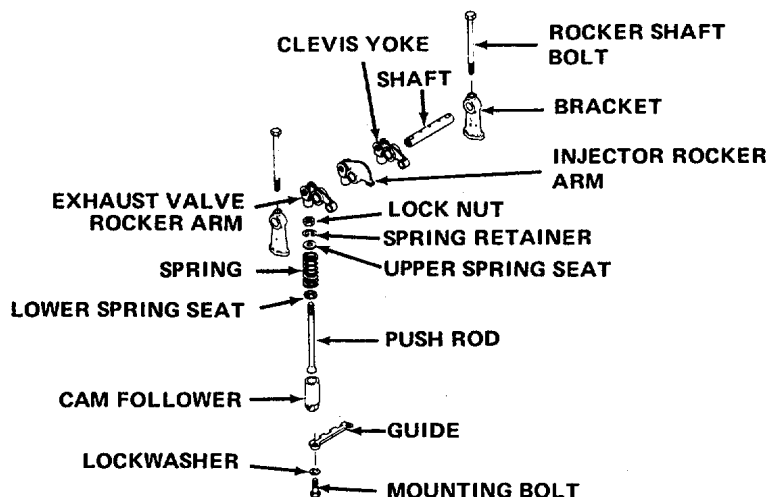
- **Do not inhale vapor.**
- **Do not handle near open flame, sparks, or excessive heat.**
- **Be certain fuel lines and connections are secure.**
- **Work in a well-ventilated area.**

40. Injectors	Fill each injector with clean VV-F-800 diesel fuel until it runs out of filter cap. Insert injector into injector tube in cylinder head.	
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NOTE

Be certain the dowel in injector body registers with locating hole in cylinder head.

41. Push rod assembly	Position lower spring seat, spring, upper spring seat, and lock nut on the push rod. Install spring retainer in cylinder head. Slide push rod assembly into place from bottom of cylinder head.	Lower spring seat is serrated; upper spring seat is cup shaped.
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6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
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CAUTION

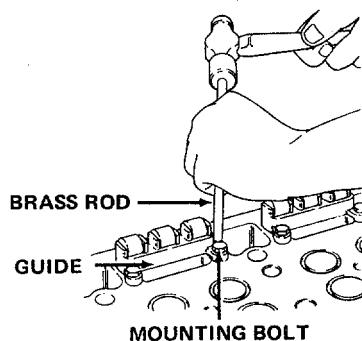
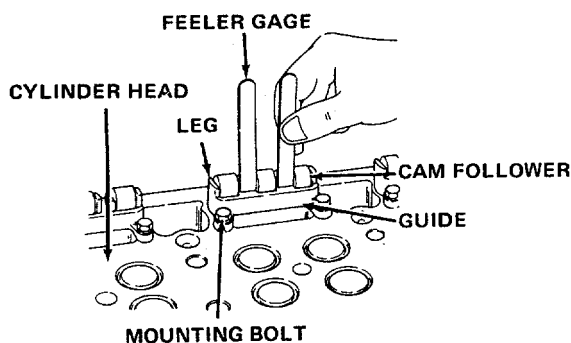
Cam follower or bore damage may occur if cam followers are not returned to their original bores.

NOTE

Before cam followers are installed, immerse them in a small pail with a screen insert containing clean Cindol 1705 (heated to 100° to 125°F [38° to 52°C]) one hour to ensure initial lubrication of cam roller pins and bushings. Rotate cam rollers during the soaking period.

42. Cam followers

Slide cam follower into position with oil hole at bottom directed away from exhaust valve. Install two more cam followers to complete the set. Install follower guide and lockwashers, and torque mounting bolts to 13 to 15 ft lb (18 to 20 N•m). Check that there is at least 0.005 inch (0.127 mm) clearance between cam follower legs and cam follower guide. If clearance is less, loosen mounting bolts slightly and tap each corner of the guide with a brass rod. Retorque bolts.



CAUTION

Equipment damage may occur if the injector rocker arm is not installed between the exhaust valve rocker arms. Position left- and right-hand valve rocker arms with extended bosses facing the injector rocker arm.

43. Rocker arm and shaft assembly

Thread rocker arm on push rod until rod end is flush with, or above, inner side of clevis yoke.

6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
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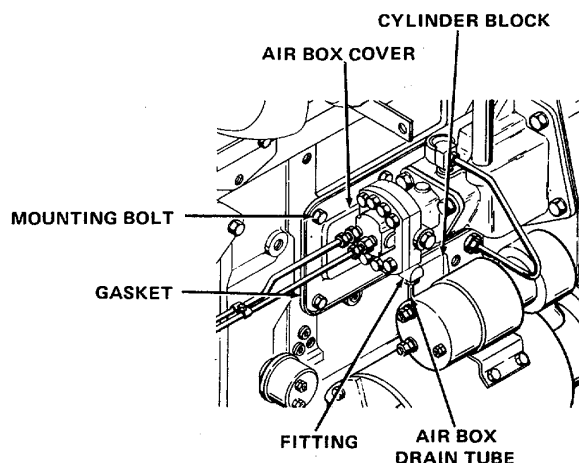
CAUTION

Valve damage may occur if bridge is not resting on valve ends when tightening rocker arm shaft bracket bolts. Position bridge on valve ends prior to tightening bolts. Note position of bridge during and after installation.

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| 44. Rocker arm and shaft installation | Lubricate rocker arm shaft with clean MIL-L-2104 oil. Slide shaft into rocker arms. Install brackets with finished face toward rocker arm. Insert bracket mounting bolts through brackets and shaft. Torque bolts to 50 to 55 ft lb (58 to 75 N•m). Check that there is some clearance between rocker arms. Adjust if necessary. |
| 45. Cylinder head plugs | Install all plugs removed during disassembly. |

DISASSEMBLY OF CYLINDER BLOCK

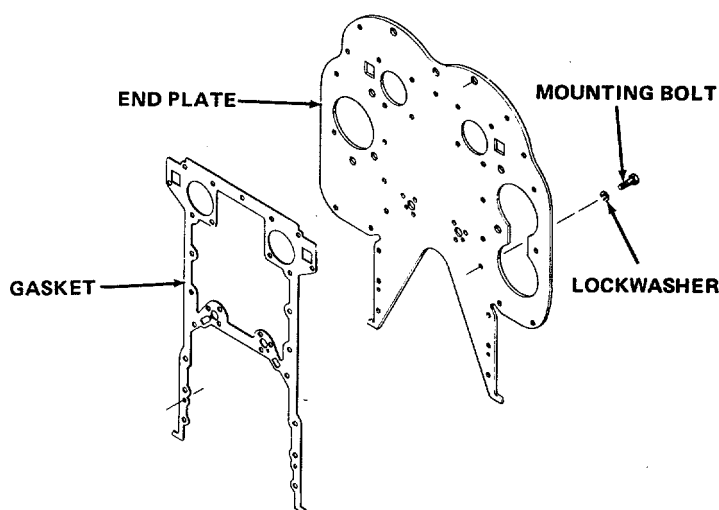
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|-----------------------------------|--|
| 46. Flywheel and flywheel housing | Remove in accordance with paragraph 6-11. |
| 47. Air box cover | Remove mounting bolts, lockwashers, cover, and gasket. Discard gasket. |



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| 48. Air box drain tube and fitting | Detach tube at fitting. Remove fitting from block. |
| 49. Oil pan | Remove. Discard gasket. |
| 50. Pistons, connecting rods, and cylinder liners | Remove in accordance with paragraphs 6-8 and 6-10. |

6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
51. Crankshaft, main bearing caps, and shells	Remove in accordance with paragraph 6-11.	
52. Cylinder block end plate	Remove mounting bolts, lockwashers, gasket, and end plate. Discard gasket. Remove all traces of oil gasket material from both sides of end plate.	



CLEANING/INSPECTION OF CYLINDER BLOCK END PLATE

WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

53. Cylinder block end plate	Clean end plate with live steam and dry with compressed air. Inspect both surfaces of end plate for nicks, dents, scratches, score marks, and warpage. Check plug nuts in end plate for cracks or damaged threads.
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6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION OF CYLINDER BLOCK

54. Cylinder block plugs	Remove all plugs (except cup plugs) and old gasket material from block.	
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WARNING

Live steam used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

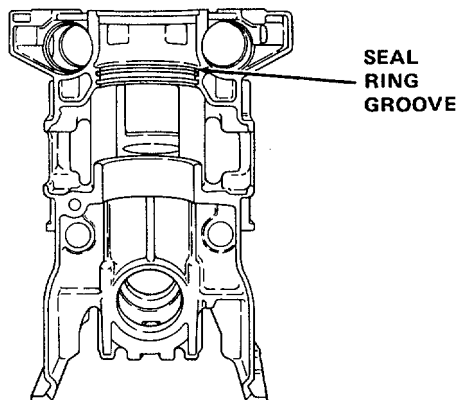
55. Cylinder block pressure test	Clean block with live steam. Make sure oil galleries, air box floor, and air box drain openings are thoroughly cleaned. Dry block with compressed air. Pressure test block.	
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WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

56. Seal ring grooves	Wipe with clean VV-F-800 diesel fuel and dry with compressed air. Inspect grooves for pitting and corrosion.	
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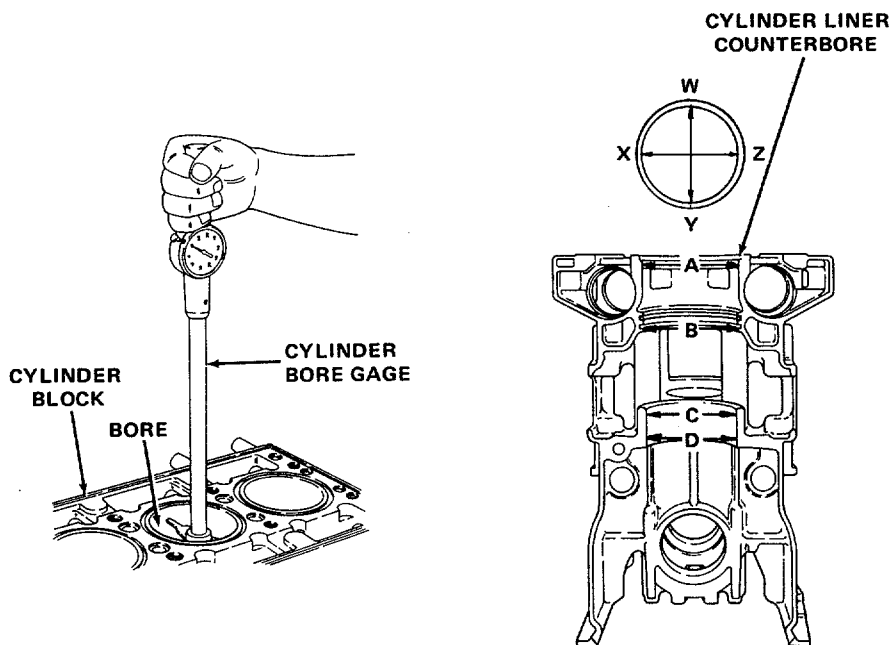


6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
57. Cylinder bore inside diameter	Measure the entire bore of each cylinder with a cylinder bore gage which has a dial indicator calibrated in 0.0001 inch (0.00254 mm) increments. Measure inside diameter of bore at places A, B, C, and D on XZ and WY axis. Bore diameter at position A should not exceed 4.5235 inches (114.897 mm), at position B 4.490 inches (114.046 mm), or at position C and D 4.3595 inches (110.731 mm).	

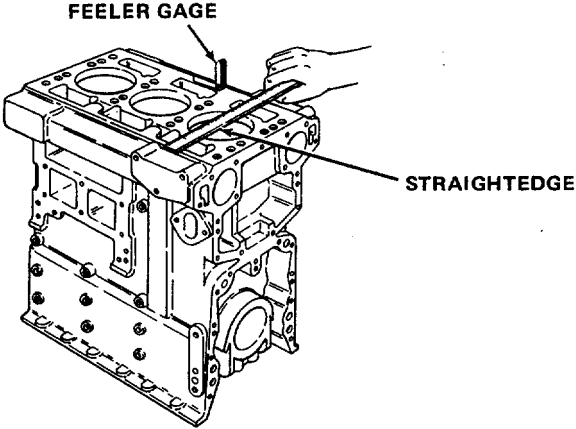
NOTE

If a sealing problem has occurred with the above dimensions at positions A and B, the block must be replaced.



58. Cylinder bore out-of-round and taper	Check bores for out-of-round and taper. Out-of-round and taper must not exceed 0.0015 inch (0.0381 mm).	
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6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
59. Cylinder block surface	Check the top of block for flatness with an accurate straightedge and a feeler gage. The top surface must not vary more than 0.003 inch (0.0762 mm) transversely and not over 0.006 inch (0.1524 mm) longitudinally.	
 <p>The diagram illustrates the inspection process for the cylinder block's top surface. A hand is shown holding a straightedge across the top of the block. A feeler gage is inserted between the straightedge and the block's surface to measure the flatness. Labels 'FEELER GAGE' and 'STRAIGHTEDGE' point to their respective tools.</p>		
60. Cylinder liner counterbores	Wash in clean VV-F-800 diesel fuel and dry with compressed air. Check counterbore depth. The depth must be 0.300 to 0.302 inch (7.620 to 7.671 mm) and must not vary more than 0.0015 inch (0.0381 mm) throughout the entire circumference. The counterbored surfaces must be smooth and square with the cylinder bore within 0.001 inch (0.0254 mm) total indicator reading. There must not be over 0.001 (0.0254 mm) difference between any two adjacent cylinder counterbores, when measured along the cylinder longitudinal centerline of the cylinder block.	

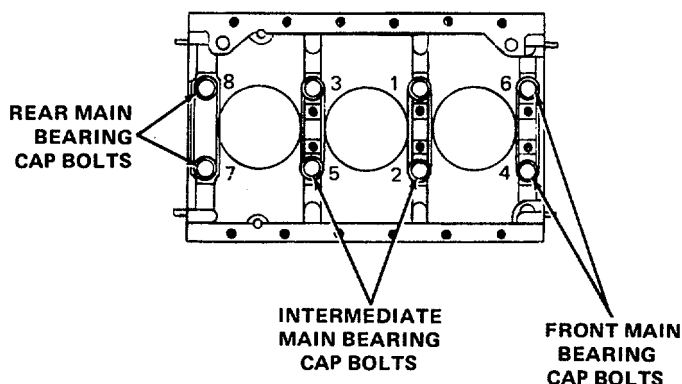
6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
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CAUTION

Equipment damage could occur if bearing caps are not returned to their original positions. Follow directions noted during disassembly.

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| 61. Bearing bore diameter | <p>Install main bearing caps. Torque front and intermediate main bearing cap bolts to 120 to 130 ft lb (163 to 176 N•m), in an alternating pattern as shown. Torque rear main bearing cap bolts to 40 to 50 ft lb (54 to 68 N•m). Check main bearing bores for proper diameter. The specified bore diameter is 3.251 to 3.252 inches (82.575 to 82.60 mm). If the bores do not fall within these limits, the cylinder block must be replaced.</p> |
|---------------------------|---|



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|----------------------------|--|
| 62. Bearing bore alinement | <p>Check bearing bore alinement by installing new bearing shells, installing the crankshaft and bearing caps, tightening the cap bolts to the specified torque, and rotating the crankshaft by hand in accordance with paragraph 6-11.</p> |
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REPLACEMENT OF CYLINDER BLOCK END PLATE

- | | |
|------------------------------|--|
| 63. Cylinder block end plate | <p>Replace end plate if seriously nicked, dented, scratched, or scored. Replace end plate plug nuts having cracks or damaged threads. Replace end plate if seriously warped.</p> |
|------------------------------|--|

6-7. CYLINDER HEAD AND BLOCK (CONT)

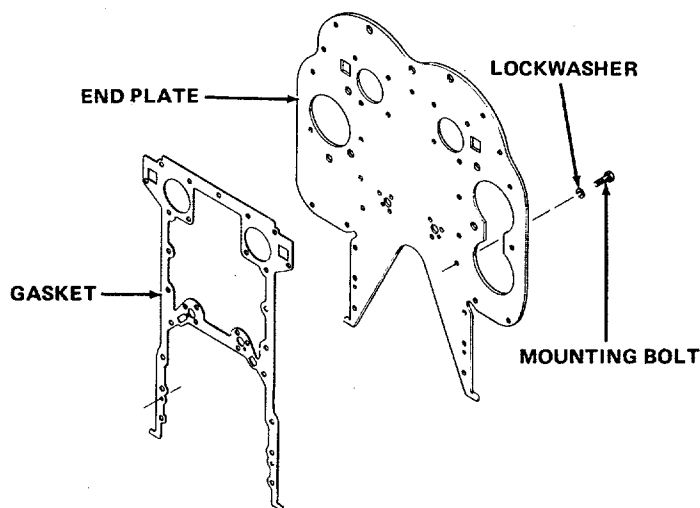
Location/Item	Action	Remarks
REPAIR/REPLACEMENT OF CYLINDER BLOCK		
64. Cylinder block	<p>Replace if:</p> <p>Block shows cracks or leaks of any type during the pressure test.</p> <p>Seal rings or grooves are seriously pitted or corroded.</p> <p>Cylinder bores exceed 4.5235 inches (114.897 mm) at position A.</p> <p>Cylinder bores exceed 4.490 inches (114.046 mm) at position B.</p> <p>Cylinder bores exceed 4.3595 inches (110.731 mm) at positions C and D.</p> <p>Block leaks, even if bore dimensions are below the maximum.</p> <p>Bore taper or out-of-round dimension exceeds 0.0015 inch (0.0381 mm).</p> <p>Top varies more than 0.003 inch (0.0762 mm) transversely, or 0.006 inch (0.1524 mm) longitudinally.</p> <p>Cylinder liner counterbore dimension depth is not within 0.300 to 0.302 inch (7.620 to 7.67 mm).</p> <p>There is more than 0.001 inch (0.0255 mm) difference between any two adjacent cylinder counterbores when measured along the cylinder longitudinal centerline.</p> <p>Main bearing bores are outside of the 3.251 to 3.252 inch (82.57 to 82.601 mm) range.</p> <p>Crankshaft cannot be turned freely by hand after installing new bearing shells, and installing the bearing caps, bolts, and tightening them to the specified torque.</p> <p>Block has seriously corroded or rusty machined surfaces.</p>	<p>If the crankshaft cannot be rotated by hand, an out of alignment condition exists between the main bearing bores.</p>
65. Cylinder block threaded holes	<p>Clean and retap, or use threaded inserts in, any damaged threaded hole in the engine block.</p>	

6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
66. Cylinder block plugs and dowels	Install any removed plugs and dowels prior to installation of other engine components.	
67. Cylinder block final check	Check all machined surfaces and threaded holes for nicks and burrs.	
68. Preparation for storage	If block is not to be used immediately, spray machined surfaces with MIL-L-2104 oil. If block is to be stored for an extended period of time, spray or dip in QPL-10036-10 rust arresting coating.	

INSTALLATION OF CYLINDER BLOCK END PLATE

69. Cylinder block end plate gasket	Position a new gasket on the end of the cylinder block, and secure it with MIL-S-45180 sealing compound. Apply a coating of sealing compound to outer side of gasket.	Ensure that all traces of old gasket material has been removed.
70. Cylinder block end plate	Aline dowel pin holes in end plate with dowel pins in cylinder block. Push end plate over pins and up against cylinder block.	



71. Mounting bolts and lockwashers	Install. Torque bolts to 30 to 35 ft lb (41 to 47 N•m).	
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6-7. CYLINDER HEAD AND BLOCK (CONT)

Location/Item	Action	Remarks
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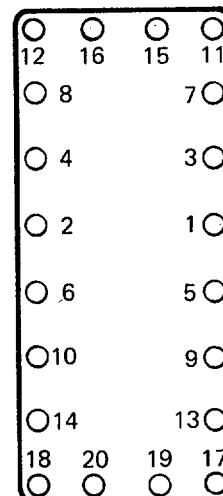
REASSEMBLY OF CYLINDER BLOCK

72. Pistons, connecting rods, and cylinder liners

Install in accordance with paragraphs 6-8 and 6-10.

73. Oil pan

Coat gasket lightly with MIL-L-2104 oil. Install gasket and oil pan. Install mounting bolts hand tight. Torque bolts to 20 ft lb (27 N•m) in sequence shown.



74. Air box drain tube and fitting

Install tube. Install fitting hand tight.

75. Air box cover

Place cover and new gasket on air box. Install mounting bolts and lockwashers. Tighten bolts securely.

6-8. CYLINDER LINER

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Repair
- e. Reassembly/Adjustment
- f. Installation

INITIAL SETUP:

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Seal ring

Dry cleaning solvent (Item 16, Appendix E)

Lubricating oil (Item 10, Appendix E)

Antifreeze (Item 3, Appendix E)

References

Para 6-10 Pistons and connecting rods

Troubleshooting References

Malfunction 2, steps 1 and 2

Equipment Condition

Para	Condition Description
6-7	Cylinder head removed from block.

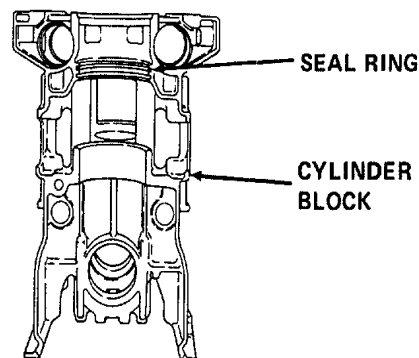
Special Environmental Conditions

Well-ventilated area required during cleaning.

Location/Item	Action	Remarks
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REMOVAL

- | | |
|--------------------------------|--|
| 1. Pistons and connecting rods | Remove per paragraph 6-10. |
| 2. Cylinder | Remove from cylinder block. |
| 3. Seal ring | Remove from groove in cylinder block bore and discard. |



6-8. CYLINDER LINER (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION OF CYLINDER LINER

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

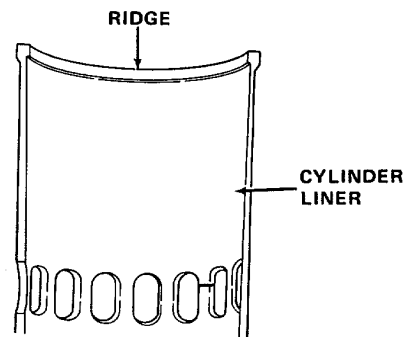
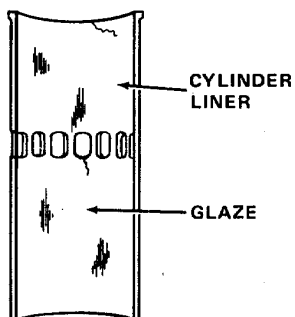
Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

4. Cylinder liner

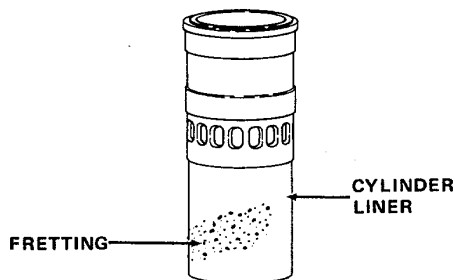
Clean cylinder liner in dry cleaning solvent and dry with compressed air. Inspect for:

Cracks.

Scoring, glazing, or a ridge on the upper portion of inner surface.



Adhering metal particles (fretting) on outer surface.



6-8. CYLINDER LINER (CONT)

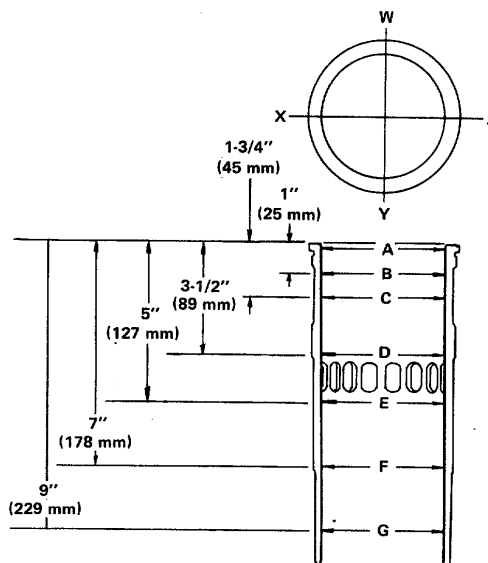
Location/Item	Action	Remarks
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NOTE

Measure inside diameter, out-of-round, and taper, at the WY and XZ axis, for each point (A through G) shown.

5. Inside diameter

With a bore gage measure inside diameter of liner. It should not exceed 3.8767 inches (98.468 mm).



6. Outside diameter

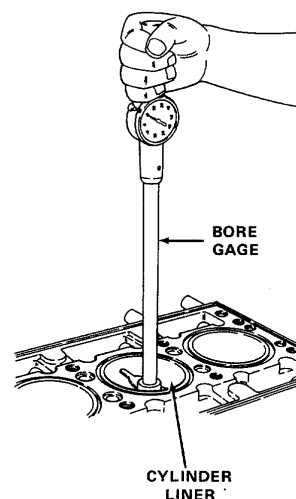
Measure outside diameter at seal ring surface. It should be between 4.4850 and 4.4860 inches (113.919 and 113.944 mm).

7. Out-of-round

Measure inside diameter out-of-round. It should not exceed 0.002 inch (0.0508 mm).

8. Taper

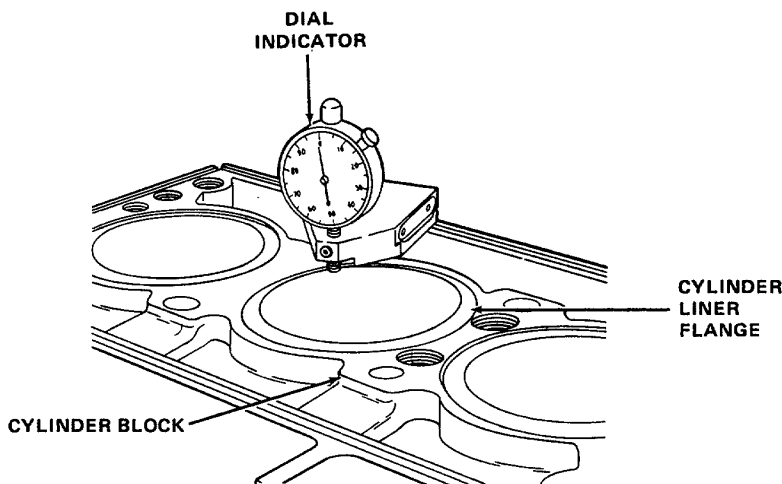
Measure inside diameter taper. It should not exceed 0.001 inch (0.0254 mm).



6-8. CYLINDER LINER (CONT)

Location/Item	Action	Remarks
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- | | | |
|-----------------|---|--|
| 9. Flange depth | Wipe off block bore, counterbore, and inside and outside of cylinder liner. Slide liner into block until flange rests on bottom of counterbore. Tap liner flange lightly all around with a soft hammer to seat liner flange on bottom of counterbore. Use dial indicator to measure depth of flange below block. Flange depth should be 0.0465 to 0.0500 inch (1.181 to 1.27 mm). | |
|-----------------|---|--|



- | | | |
|----------------------------|--|--|
| 10. Flange depth variation | Measure variation in flange depth between adjacent liners. The maximum tolerable variation is 0.002 inch (0.0508 mm). Remove dial indicator. | |
|----------------------------|--|--|

REPAIR

- | | | |
|--------------------------------|--|--|
| 11. Cylinder liner replacement | <p>Replace a cylinder liner if:</p> <ul style="list-style-type: none"> It is cracked, severely scored, or has a high ridge at the top of its inner surface. Out-of-round or inside taper exceeds the tolerable limit. Inside diameter exceeds the tolerable limit. Outside diameter of seal ring area exceeds the tolerable limit. | |
|--------------------------------|--|--|

6-8. CYLINDER LINER (CONT)

Location/Item	Action	Remarks
NOTE		
Cylinder liners can be tried in different bores to bring adjacent cylinder liner flange depths within tolerance.		
12. Correction of flange depth variation	If flange depth variation between adjacent cylinders is greater than 0.002 inch (0.0508 mm), install the liners in different bores and recheck. If flange depth is still not within limits, replace cylinder liners. Once optimum position is determined, matchmark liner and cylinder block so liner may be reinstalled in same position in same block bore. Place matchmarks on engine serial number side of block.	
13. Cylinder liner honing	Remove slight ridges, score marks, and glaze with a hone equipped with 120-grit stones. Work hone up and down rapidly the full length of the liner several times in a criss-cross pattern prevent formation of ridges.	Criss-cross pattern produces hone marks on a 45 degree axis, which aids piston movement and helps

CLEANING OF CYLINDER LINER AND PISTON**WARNING**

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38 to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
|--------------------|---|
| 14. Cylinder liner | Clean each liner with P-D-680 dry cleaning solvent and dry with compressed air. Remove any burrs. |
| 15. Piston | Clean each piston with P-D-680 dry cleaning solvent and dry with compressed air. |

6-8. CYLINDER LINER (CONT)

Location/Item	Action	Remarks
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REASSEMBLY/ADJUSTMENT

- | | | |
|----------------------------|---|--|
| 16. Cylinder liner recheck | Recheck cylinder liner inside diameter, taper, and out-of-round as previously described. Replace liners if necessary. | |
|----------------------------|---|--|

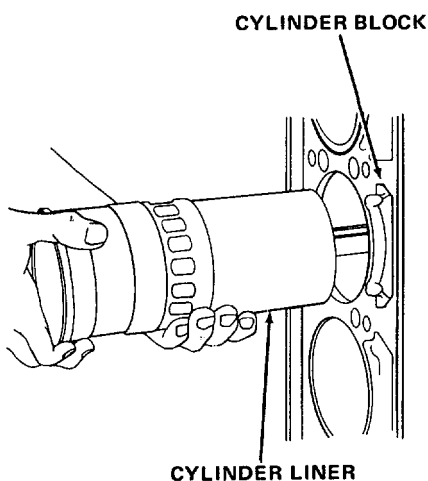
CAUTION

Piston and liner damage may result if pistons are not returned to their original liners. Observe matchmarks so that mixups do not occur.

- | | | |
|---|--|--|
| 17. Piston and liner clearance | Insert each piston in its respective cylinder liner or replacement liner and measure the piston skirt-to-cylinder liner clearance. If clearance is not within 0.0031 to 0.0068 inch (0.0787 to 0.1727 mm), inspect pistons and replace if necessary. | |
| 18. Cylinder liner within block measurement | Install liner (new or replacement) in proper bore of cylinder block and measure inside diameter, out-of-round, and taper with a bore gage at the locations shown in step 5. Rehone or replace liners as needed. | |

NOTE

Taper on a used liner must not exceed 0.002 inch (0.0508 mm) and out-of-round must not exceed 0.003 inch (0.0762 mm).



6-8. CYLINDER LINER (CONT)

Location/Item	Action	Remarks
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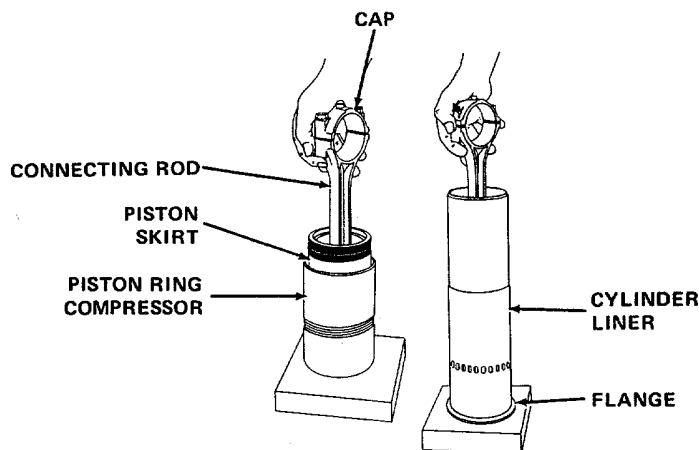
INSTALLATION

CAUTION

Piston ring damage may occur if piston ring compressor has burrs or nicks on inside surface. Check compressor before using.

- 19. Piston and rod assembly in compressor

Lubricate piston, rings, and inside surface of piston ring compressor with clean MIL-L-2104 oil. Place piston ring compressor on a wood block, with open taper facing up. Stagger the piston ring gaps around the piston. Check that ends of oil control ring are not overlapped. Carefully push piston in and down until it contacts the wood block. Remove piston and compressor from wood block.



- 20. Piston and rod assembly in cylinder liner

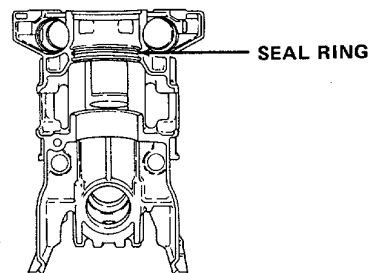
Place cylinder liner, flange end down, on the block. Put ring compressor (with piston and rod assembly inside of it) on bottom of liner so that numbers on rod and cap are aligned with matchmarks on liner. Push piston into liner until piston is free of ring compressor. Remove connecting rod cap and ring compressor. Push piston in further until compression rings pass cylinder liner ports.

6-8. CYLINDER LINER (CONT)

Location/Item	Action	Remarks
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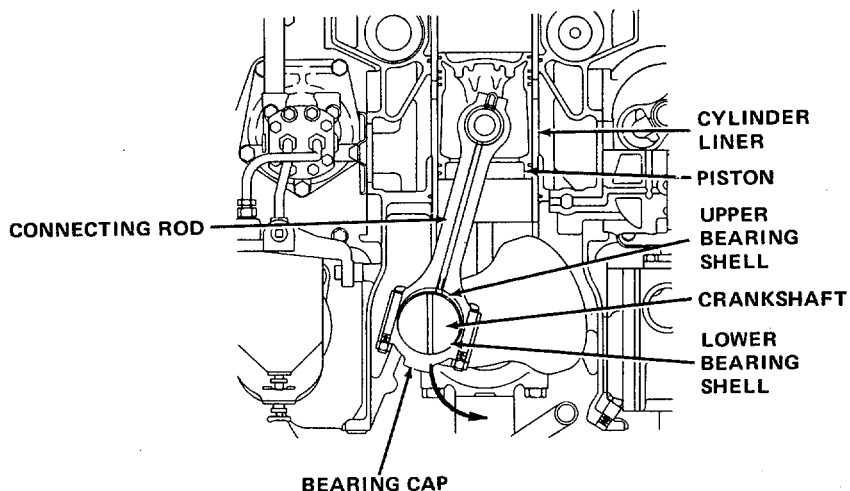
21. Seal ring

Clean seal ring groove in cylinder block of any dirt or other debris. Install new seal ring. Lubricate surface of seal ring with a fresh solution of 50% water and 50% antifreeze conforming to MIL-A-46153.



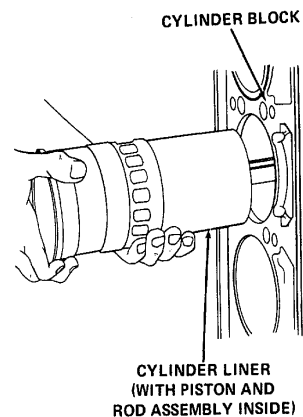
22. Upper bearing shell

Rotate crankshaft until connecting rod journal of the cylinder being worked on is at the bottom of its travel. Wipe journal clean and lubricate it with clean MIL-L-2104 oil. Install upper bearing shell in connecting rod. Lubricate bearing shell with clean MIL-L-2104 oil.



23. Piston, rod, and cylinder liner

Position piston, rod, and liner assembly in line with the block bore so that identification number on rod is facing engine serial number side. Aline matchmarks on liner and block. Slide assembly into block bore and seal ring. Push or pull piston and connecting rod into liner until upper bearing shell is firmly seated on crankshaft journal.



6-8. CYLINDER LINER (CONT)

Location/Item	Action	Remarks
24. Lower bearing shell in cap	Place lower bearing shell in bearing cap, with tang on shell in notch in cap. Lubricate bearing shell with clean MIL-L-2104 oil.	
CAUTION		
Equipment damage may occur if connecting rod bolt turns before torque is applied to nut. Make sure that bolt head is properly seated on connecting rod before tightening nut.		
25. Bearing cap and shell	Install bearing cap with bearing shell on connecting rod with identification numbers on cap and rod adjacent to each other. Torque nuts to 40 to 45 ft lb (54 to 61 N•m).	
26. Remaining liner, piston, and rod assemblies	Install remaining assemblies as described above.	

6-9. VALVES, CAMSHAFT, AND TIMING GEARS

This task covers:

- a. Removal
 - b. Disassembly
 - c. Cleaning
 - d. Inspection
 - e. Assembly
 - f. Replacement
 - g. Installation
-

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705
Tool kit, master mechanics
NSN 5180-00-699-5273

Prussian blue paste (Item 13, Appendix E)

Sulphurized oil (E.P. type)

References

Para 6-7 Cylinder head and block

Troubleshooting References

Malfunction 4, step 7

Equipment

Condition

Para	Condition Description
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Materials/Parts

Engine upper front cover gasket
Camshaft plugs
Valve guide oil seals

Crocus abrasive cloth (Item 1, Appendix E)

Lubricating oil (Item 10, Appendix E)

Diesel fuel oil (Item 6, Appendix E)

Dry cleaning solvent (Item 16, Appendix E)

Grease (Item 7, Appendix E)

5-16	Engine removed from pump assembly and trailer assembly.
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5-18	Cylinder head removed.
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6-7	Fuel injectors removed.
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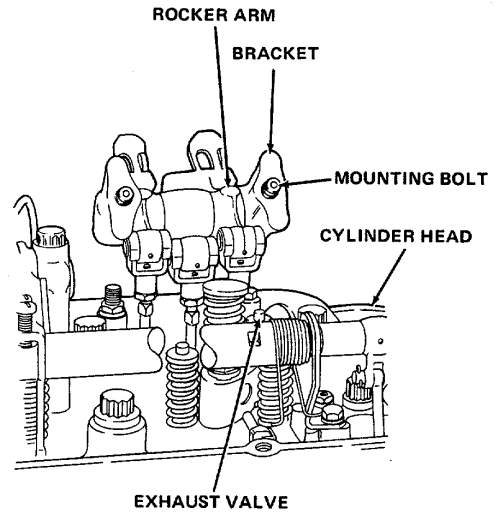
6-11	Flywheel housing removed.
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6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

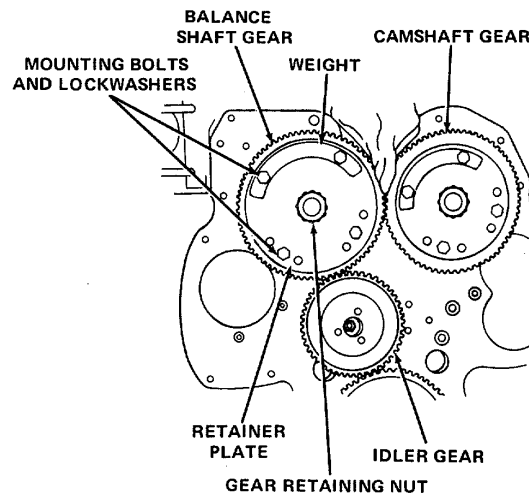
Location/Item	Action	Remarks
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REMOVAL

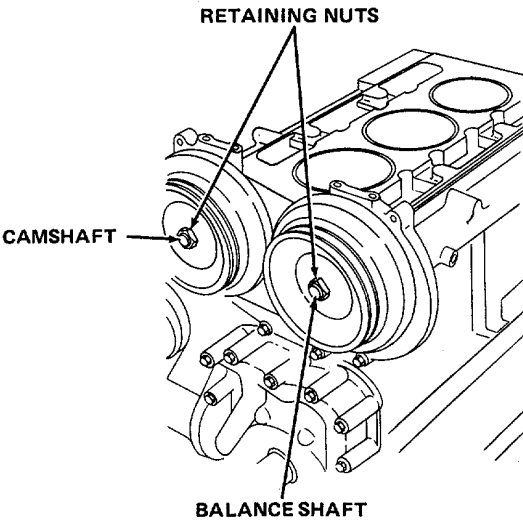
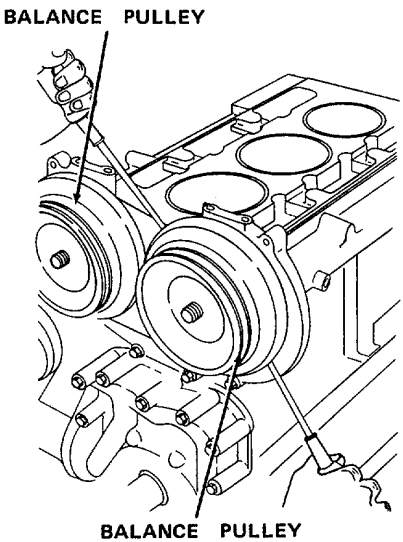
- | | |
|------------------------------------|---|
| 1. Rocker arms, shaft, and bracket | Remove mounting bolts holding brackets to cylinder head. Then lift brackets and rocker arms away from exhaust valves. |
|------------------------------------|---|



- | | |
|--------------------------------|---|
| 2. Weights and retainer plates | Remove mounting bolts, lockwashers, weights, and retainer plates from camshaft and balance shaft gears. Wedge a clean rag between gears to keep them from shifting. |
|--------------------------------|---|



6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
3. Balance pulley retaining nuts camshaft.	Remove from ends of balance shaft and	 <p>RETAINING NUTS</p> <p>CAMSHAFT</p> <p>BALANCE SHAFT</p>
4. Balance pulleys	With a plastic hammer, tap edge of pulleys all around to loosen them. Remove pulleys with screwdrivers as shown.	 <p>BALANCE PULLEY</p> <p>BALANCE PULLEY</p>
5. Engine upper front cover	Remove mounting bolts, front cover, and gasket. Discard gasket.	
6. Woodruff keys and oil slingers	Remove.	
7. Thrust washers, retaining bolts, and spacers	Remove.	
8. Camshaft and balance shaft	Remove from cylinder block.	

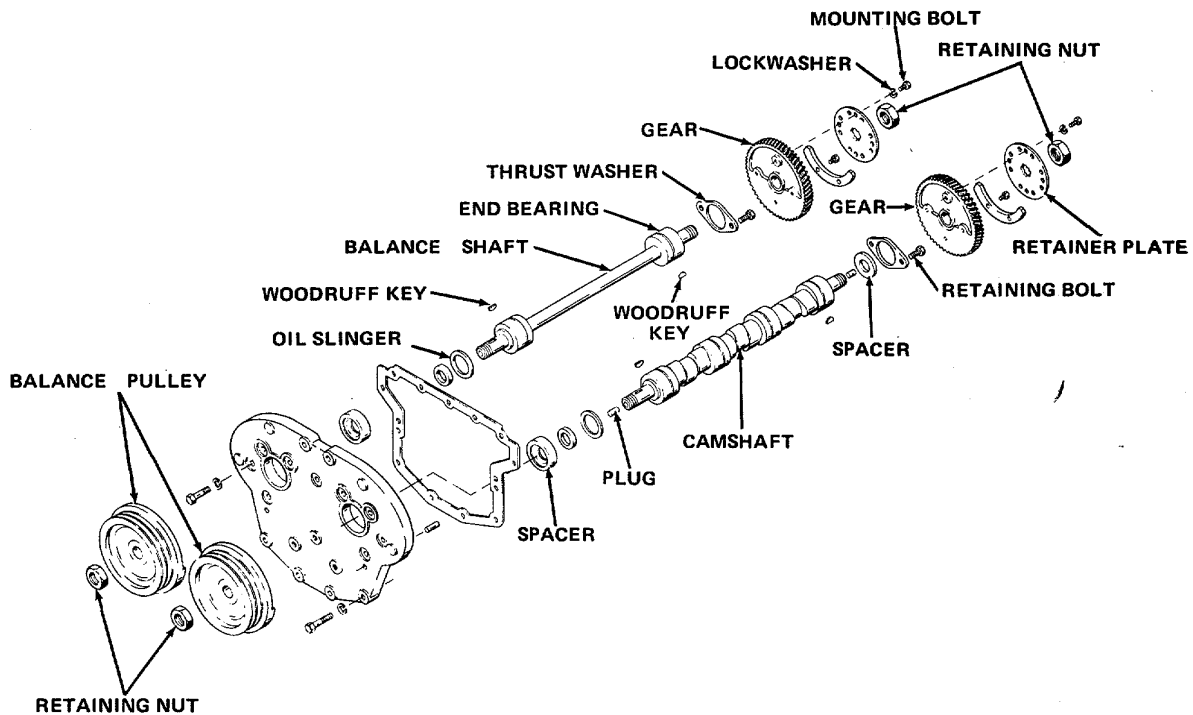
6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
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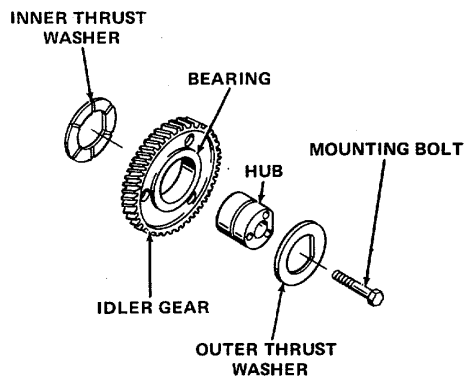
CAUTION

Equipment damage may occur if timing gears are not reinstalled in their original positions. Before removing any gear, align timing marks and note their location so gears can be reinstalled correctly.

- | | |
|-------------------------------------|---------------------|
| 9. Camshaft and balance shaft gears | Remove from shafts. |
|-------------------------------------|---------------------|



- | | |
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| 10. Idler gear and outer thrust washer | Remove outer thrust washer from hub, and remove gear. |
| 11. Hub and inner thrust washer | Remove mounting bolt. Remove hub and inner thrust washer as an assembly. |



- | | |
|---------------------|--------------------|
| 12. Crankshaft gear | Remove from shaft. |
|---------------------|--------------------|

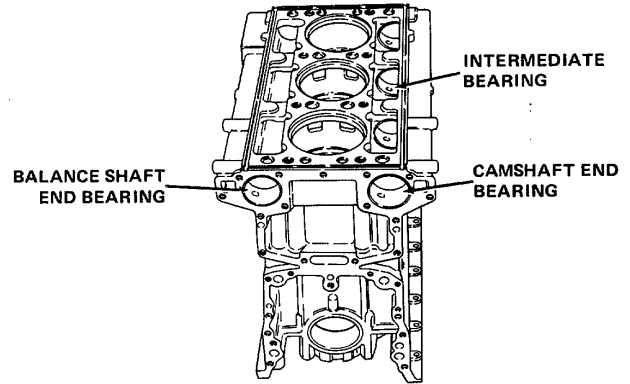
6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
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CAUTION

End bearings must be removed before intermediate bearings. Note position of bearings in bore with respect to notch in bearings. Replacement bearings must be installed in the same position.

- | | |
|---|------------------------------|
| 13. Camshaft and balance shaft and bearings | Drive out of cylinder block. |
| 14. Camshaft intermediate bearings | Drive out of cylinder block. |



DISASSEMBLY

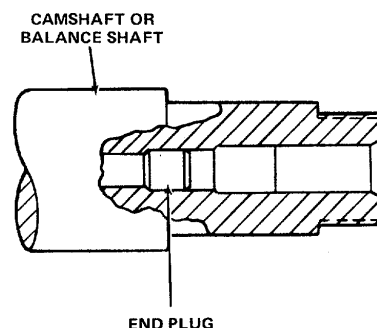
- | | |
|--------------|--|
| 15. Camshaft | To disassemble camshaft, remove plugs as follows:
a. Clamp camshaft in a vise equipped with soft jaws.
b. Make an indentation in center of camshaft end plug with a 31/64 inch drill.
c. Punch a hole in the end plug with a center punch. Then drill a hole straight through center of plug with a 1/4 inch drill.
d. Redrill the plug with a 5/16 inch drill, and tap with a 3/8-16 inch tap.
e. Thread a 3/8-16 inch adaptor into the plug. Remove plug. |
|--------------|--|

Use carbide tipped drill when available.

6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
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f. Insert a length of 3/8 inch steel rod in camshaft oil gallery and drive remaining plug out. Discard plugs.



CLEANING OF CAMSHAFT AND BALANCE SHAFT

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

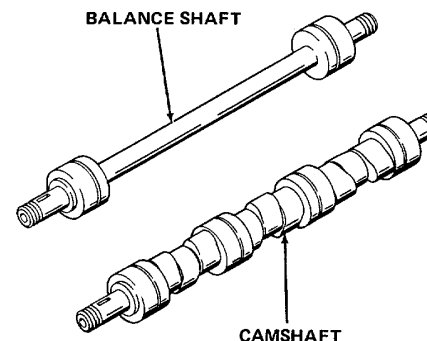
- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

Live steam used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

16. Camshaft and balance shaft

Soak camshaft and balance shaft in clean VV-F-800 diesel fuel. Then run a wire brush through the camshaft oil gallery to remove any foreign material or sludge. Clean exterior of camshaft and balance shaft and blow through the camshaft oil gallery and oil holes with compressed air. Clean all gears, bearings, and related parts with diesel fuel and dry them with compressed air.



NOTE

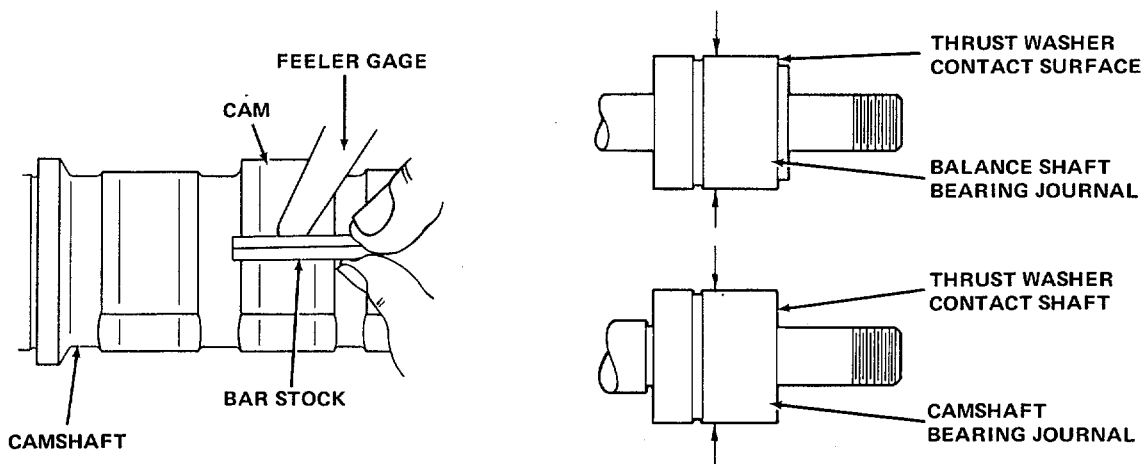
If a new camshaft is to be installed, steam clean it to remove the rust preventive and blow out the oil passages with compressed air.

6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
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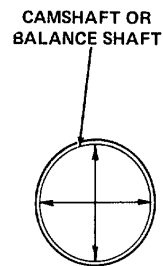
INSPECTION OF CAMSHAFT AND BALANCE SHAFT

17. Cams and journals
 Inspect for wear and scoring. If cams are scored, inspect cam follower rollers in accordance with paragraph 6-7. Replace camshaft if cams or journals are worn or scored. Replace balance shaft if journals are worn or scored.



18. Camshaft and balance shaft
 Replace camshaft or balance shaft if either is bent or damaged.
 19. Contact surfaces
 Examine surfaces which thrust washers contact; if surfaces are scratched but not severely scored, smooth them down with an oil stone. If the score marks are too deep to be removed, replace camshaft or balance shaft.

20. Shaft and bearing clearance
 Measure the inside diameter of the camshaft or balance shaft bearing at 90 degree axis as shown. Then measure the outside diameter of the appropriate camshaft or balance shaft bearing journal. The clearance (difference between measurements) for new camshaft or balance shaft bearings should be 0.0045 to 0.006 inch (0.1143 to 0.1524 mm) or for worn parts a maximum of 0.008 inch (0.2032 mm). Replace shafts or bearings as needed to restore tolerance.



6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
21. Cam lobes	<p>Measure slight cam lobe wear with a tapered leaf set of feeler gages, 0.0015 to 0.0100 inch (0.0381 to 0.254 mm). Slide feeler gage leaves between the flat on injector rise side of cam lobes and a piece of square bar stock, 1/8 x 3/8 x 1 inch (3.175 x 9.525 x 25.4 mm). If flats measure less than 0.003 inch (0.0762 mm) in depth, camshaft is satisfactory for further service. Smooth over a slightly worn lobe with a fine stone and P-C-458 crocus cloth prior to installation.</p>	

CLEANING OF
TIMING GEARS

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
|------------------|--|
| 22. Timing gears | Wash camshaft, balance shaft, crankshaft, and idler gears with clean VV-F-800 diesel fuel and dry with compressed air. |
|------------------|--|

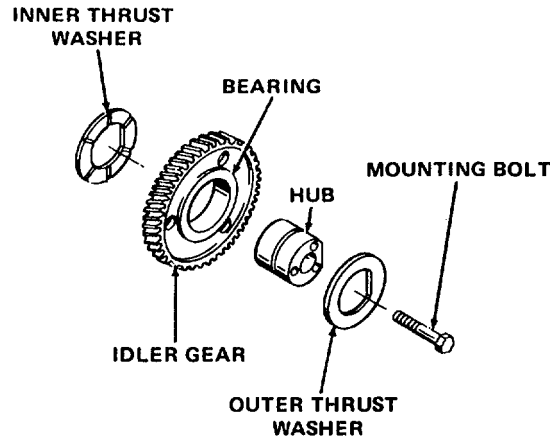
INSPECTION OF
TIMING GEARS

- | | |
|------------------|---|
| 23. Timing gears | Examine all gear teeth for scoring, pitting, or wear. Replace any gears which are damaged or worn, or which have missing teeth' |
|------------------|---|

6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
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24. Idler gear bearing	Inspect for wear, pitting, and scoring. Replace bearing with excessive wear or damage. Remove slight scoring with P-C-458 crocus cloth.	
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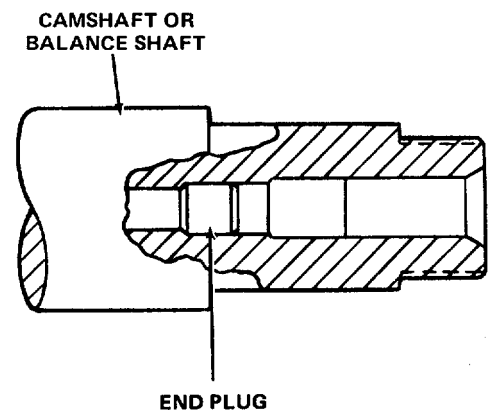
NOTE

When a new bearing is installed in the idler gear, it must not protrude beyond the gear face on either side and must sustain an axial load of 200 pounds (907 kg) minimum without pushing out of the gear.

25. Idler gear thrust washers	Examine both faces of thrust washers. If either face is scored or worn excessively, replace washers.	
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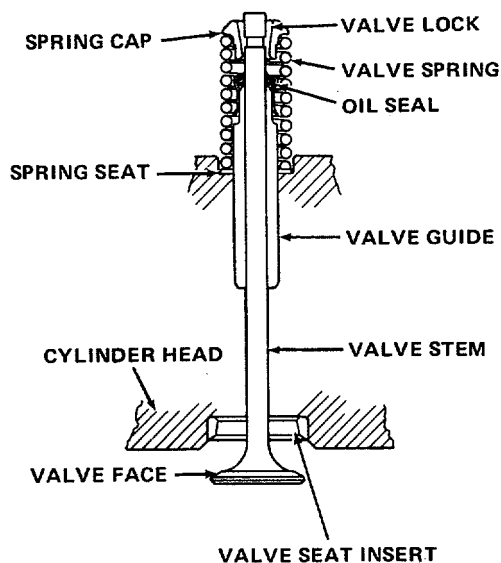
ASSEMBLY OF CAMSHAFT

26. Camshaft	Install new end plugs in camshaft and drive plugs to 1.94 to 2.06 inches (49.28 to 52.32 mm) into the shaft bores.	
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6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
REPLACEMENT OF VALVE PARTS		
27. Valves	Replace any valves that show head warping, burning, or other damage. Replace valves that have seriously scratched or scuffed stems; or pitted, ridged, or cracked faces. Remove slight scratches or scuff marks with P-C-458 crocus cloth.	
28. Valve guide	Replace any valve guides that are fractured, chipped, scored, or show excessive wear. Replace any guide with a guide-to-stem clearance greater than 0.005 inch (0.1827 mm).	
29. Valve springs, locks, caps, and seats	Replace any valve springs that are pitted, fractured, excessively worn, or damaged. Replace locks, caps, and seats that are fractured, excessively worn, or damaged. Replace any spring that can be compressed to 1.93 inches (49.02 mm) with a load less than 25 pounds (11.34 kg). Replace both valve springs if the difference between any pair of valve springs exceeds 6 pounds (2.7 kg).	
30. Valve guide oil seals	Oil seals were removed and discarded during disassembly. Replace with new oil seals prior to reassembly.	
31. Valve seat inserts	Replace any valve seat inserts that show excessive wear, cracks, pitting, or improper valve seat angle (greater or less than 31 degrees).	



6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

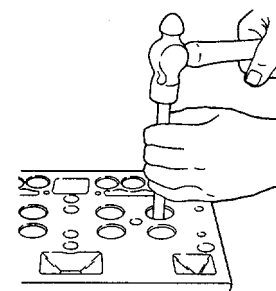
Location/Item	Action	Remarks
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REMOVAL/INSTALLATION OF VALVE GUIDE

NOTE

Only remove valve guides that have not passed inspection.

- | | |
|-------------------------|---|
| 32. Valve guide removal | Position cylinder head, bottom side up on 2 inch thick wood blocks. Drive each valve guide out of cylinder head with the valve guide remover. |
|-------------------------|---|



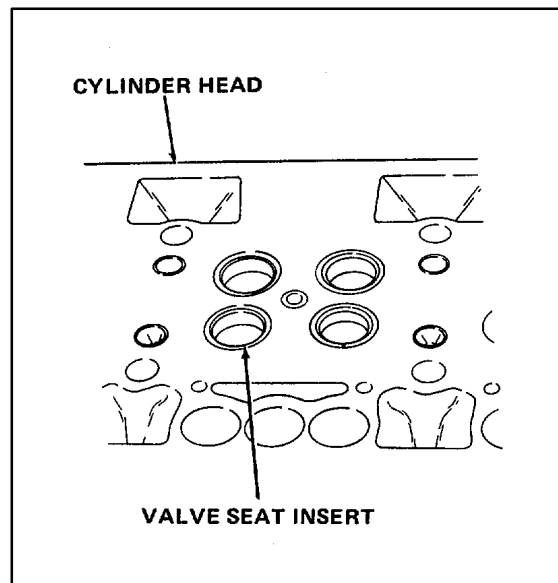
CAUTION

Top of valve guide must be 0.010 to 0.040 inch (0.254 to 1.016 mm) from top of cylinder head rail.

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|------------------------------|---|
| 33. Valve guide installation | Position valve guide squarely in bore in cylinder head and press gently with an arbor press to install guide. |
|------------------------------|---|

REMOVAL/CLEANING/INSTALLATION OF VALVE SEAT INSERT

- | | |
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| 34. Valve seat insert removal | Immerse cylinder head for 30 minutes in water heated to 180 to 200°F (82 to 93°C). Place cylinder head on workbench. Remove valve seat insert. |
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6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

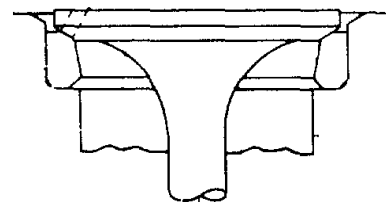
Location/Item	Action	Remarks
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WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138° F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

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|---|---|
| 35. Valve seat insert and counterbore cleaning and inspection | Clean seat inserts with P-D-680 dry cleaning solvent and dry with compressed air. Inspect counterbores for cleanliness, roundness, and flatness; inspect for cracks and other damage. |
| 36. Valve seat insert installation | If counterbores are clean, round, flat and undamaged, immerse the cylinder head for 30 minutes in water heated to 180° to 200°F (82° to 93°C). |

**CAUTION**

Damage to valve insert may result if insert is installed after the cylinder head has cooled. Install valve seat inserts immediately after removing head from water bath.

Remove cylinder head from water bath and rest it bottom side up on a bench. Place an insert in the counterbore valve seat side up. This must be done quickly while cylinder head is still hot and insert is cold (room temperature). Drive insert in place until it seats solidly in the cylinder head.

6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
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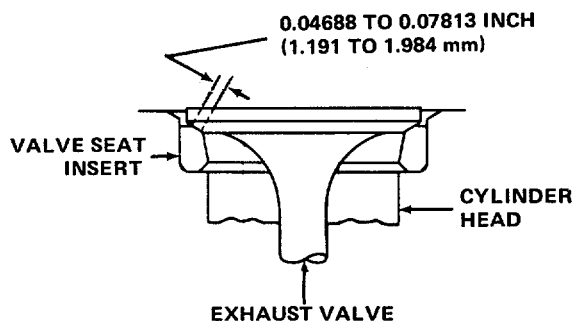
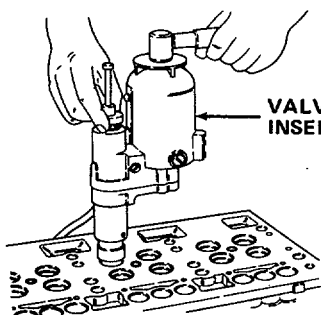
CAUTION

Equipment damage may occur if grinding wheels make contact with cylinder head. Grind valve seat inserts as true as possible.

37. Valve seat insert adjustment

Install a 31 degree grinding wheel in valve seat insert grinder and apply the wheel to the insert. Remove 31 degree grinding wheel from grinder and install a 60 degree grinding wheel. Apply wheel to insert to open throat of insert. Grind top surface of insert with a 15 degree wheel to narrow the seat width to a range between 0.04688 and 0.07813 inch (1.1908 and 1.9845 mm).

The 31 degree face of the insert may be adjusted relative to the center of the valve face with the 15 degree and 60 degree grinding wheels.



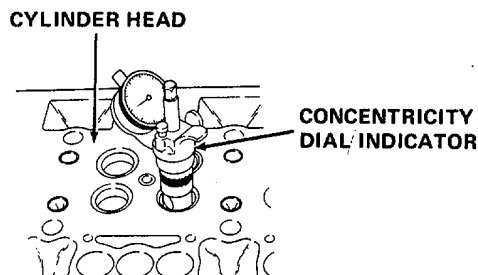
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

38. Concentricity check

Clean the valve seat insert thoroughly with VV-F-800 diesel fuel and dry it with compressed air. Set concentricity dial indicator in position and rotate it to determine the concentricity of each valve seat insert relative to the valve guide. If runout exceeds 0.002 inch (0.0508 mm), inspect valve guide for bend. If valve guide is not bent, regrind insert.

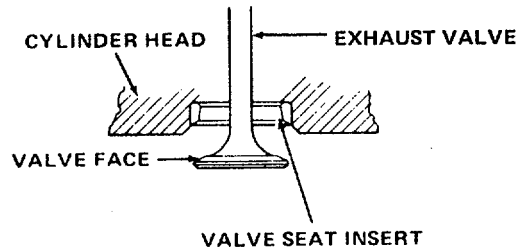


6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
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INSTALLATION

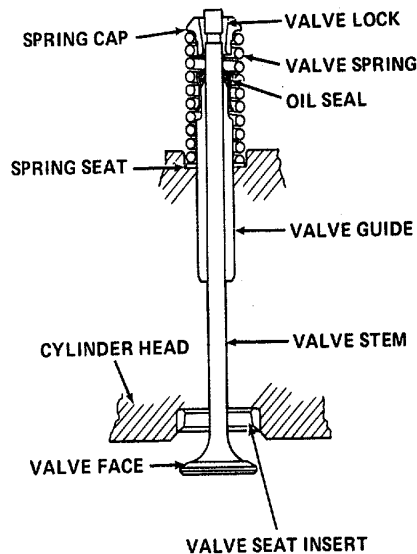
- | | | |
|------------------------------|---|---|
| 39. Valve face contact check | Apply a light coat of Prussian blue or similar paste to valve seat insert. Lower stem of replacement valve in valve guide and bounce the valve on the seat. Do not rotate the valve. This procedure will show the area of valve face contact. | The most desirable area of contact is the center of the valve face. |
|------------------------------|---|---|



- | | |
|----------------------|---|
| 40. Valve adjustment | If replacement valves do not show contact with valve seat insert at center of valve face, the valve will have to be ground. |
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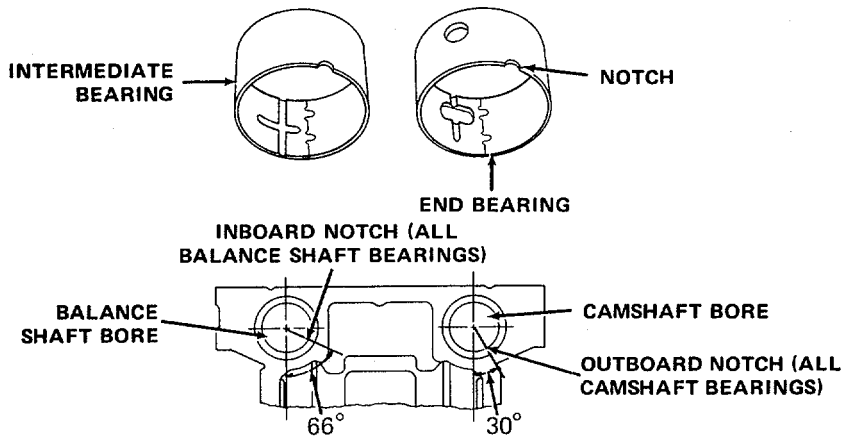
- | | |
|------------------------|---|
| 41. Valve installation | Lubricate valve stems with sulphurized oil (E.P. type) and slide valves all the way into the guides. Hold valves in place temporarily with a strip of masking tape. Turn cylinder head right side up on workbench. Place a board under the head to support valves and to provide clearance between cam followers and bench. |
|------------------------|---|

- | | |
|--------------------------|--|
| 42. Valve guide oil seal | Lubricate valve stem and new oil seal with MIL-L-2104 oil and start oil seal carefully over valve stem. Drive seal down slowly on cylinder head. |
|--------------------------|--|



6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
43. Valve springs, caps, and seats	Install.	
<p>CAUTION Oil seal damage may occur if valve spring is compressed too far. Compress spring only enough to insert valve lock.</p>		
44. Valve locks	Compress the valve and install the two-piece valve lock. Install valve locks on remaining cylinders in the same way. Check position of valves. Support cylinder head at each end with wood blocks and remove masking tape. Give ends of valve stems a sharp tap with a plastic hammer to seat the valve locks.	
45. Spring tension check	Check spring tension and record pressure reading the moment when valve opens. Replace springs if pressure to open is less than 25 pounds (11.34 kg).	
46. Camshaft intermediate bearings	Position and install intermediate bearings in camshaft bore as shown, with bearing notch in relation to the camshaft bore centerline in cylinder block.	New intermediate bearings are color coded orange.



6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

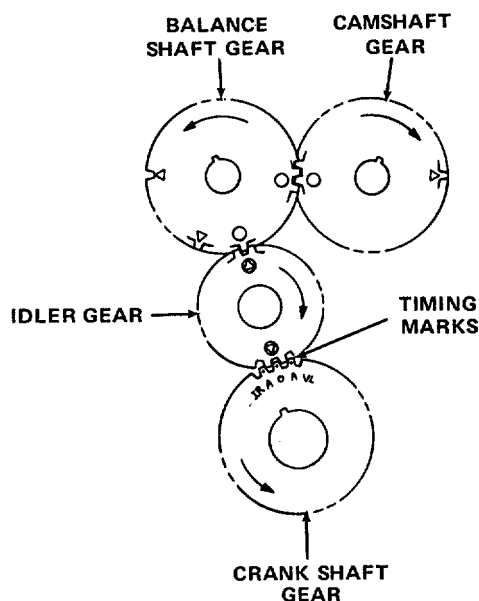
Location/Item	Action	Remarks
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NOTE

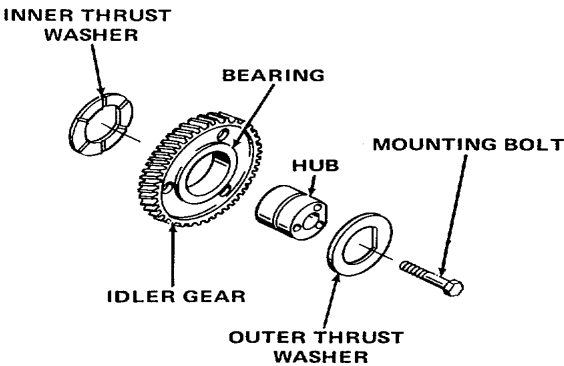
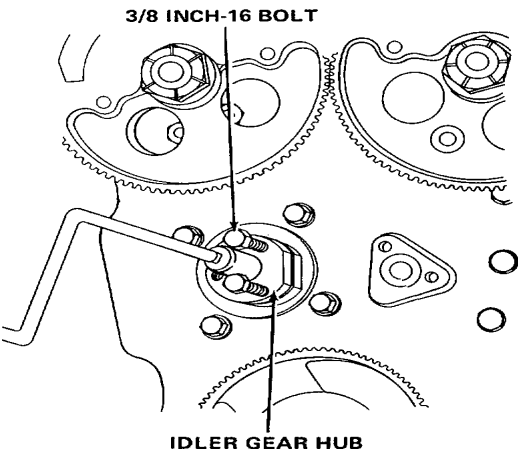
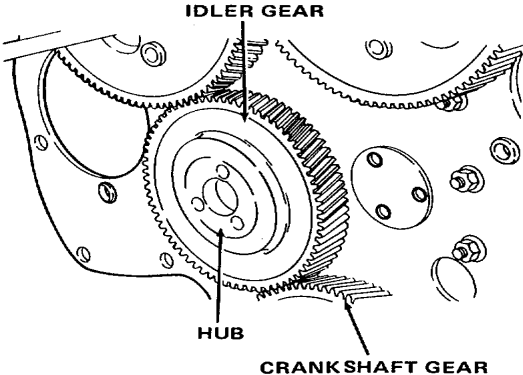
Bearings are available in 0.010 and 0.020 inch (0.254 and 0.508 mm) under-size for use with worn or reground shafts. Oversize camshaft and balance shaft bearings are available in sets, 0.010 inch (0.254 mm) oversize on the outside diameter, to permit reuse of a cylinder block having one or more scored block bearing bores. To use oversize bearings, camshaft and balance shaft block bores must be carefully line bored (machined) to dimensions shown in the chart below.

Bearing Location	Minimum		Maximum	
	inch	(mm)	inch	(mm)
End	2.385	(60.579)	2.386	(60.604)
Intermediate	2.375	(60.325)	2.376	(60.350)

- | | | |
|---|--|---|
| 47. Camshaft and balance shaft end bearings | Position and install end bearings correctly with groove in camshaft and balance shaft bores. | New end bearings for both shafts are color coded brown. |
| 48. Crankshaft gear | Start crankshaft gear over end of crankshaft with timing marks on outer rim of gear facing out. Align the proper timing mark on crankshaft gear with corresponding mark on idler gear. Drive gear up against the shoulder on crankshaft. | |

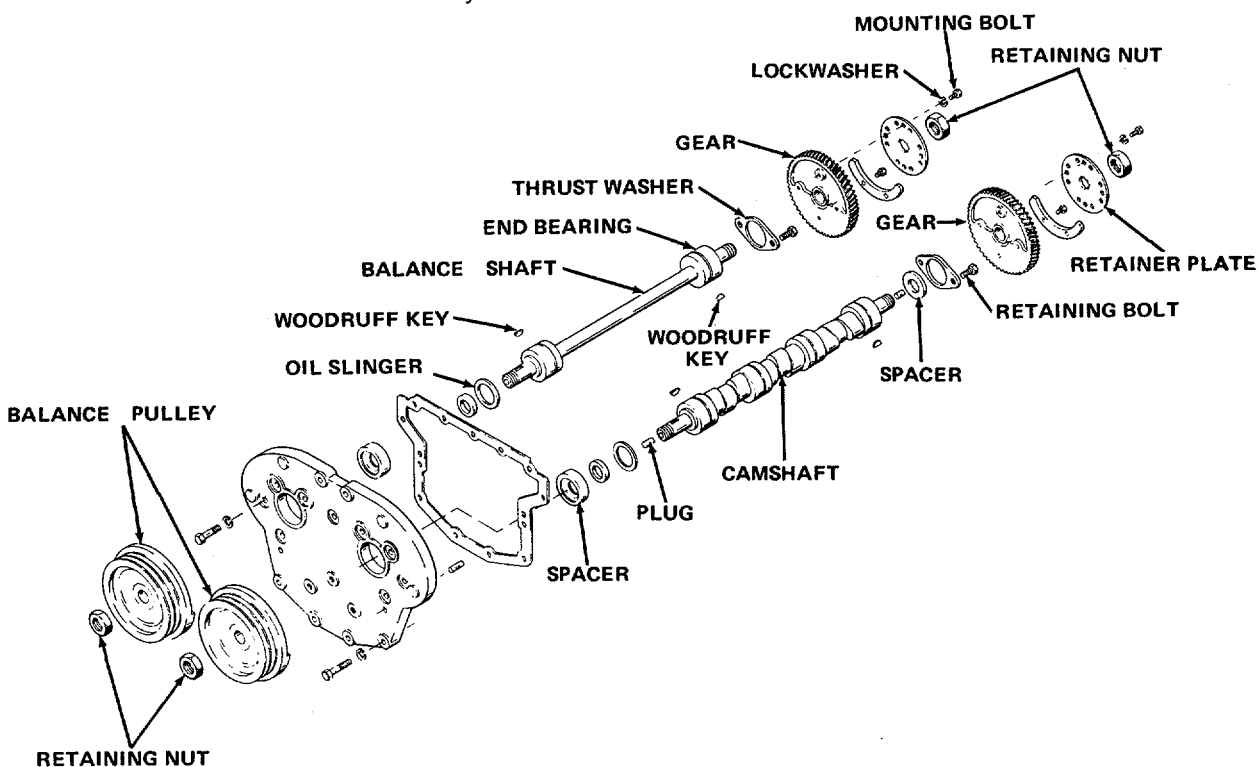


6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
49. Idler gear inner thrust washer	Place inner thrust on forward end of idler gear hub with the inner diameter flat over the gear hub end flat, and with oil grooves in thrust washer facing the idler gear.	 <p>Diagram showing exploded view of idler gear assembly components: INNER THRUST WASHER, BEARING, HUB, MOUNTING BOLT, IDLER GEAR, and OUTER THRUST WASHER.</p>
50. Hub	Place protruding end of idler gear hub through the end plate, and into counter-bore in cylinder block.	 <p>Diagram showing the idler gear hub being inserted into the cylinder block. A 3/8 INCH-16 BOLT is shown passing through the hub and into the cylinder block. The hub is labeled IDLER GEAR HUB.</p>
51. Mounting bolt	Insert two 3/8-16 bolts through hub as shown and thread them into the cylinder block. Insert mounting bolt through center of hub and thread it into the cylinder block. Torque bolt to 40 to 45 ft lb (54 to 61 N.m). Then remove the two 3/8-16 bolts previously installed for alignment of hub.	 <p>Diagram showing the idler gear hub (HUB) aligned with the CRANK SHAFT GEAR. The idler gear is also shown in the assembly.</p>
52. Idler gear	Lubricate hub and bearing with clean MIL-L-2104 oil. Position crankshaft gear so that the timing marks will align with those on the idler gear. Install idler gear with timing marks aligned.	

6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

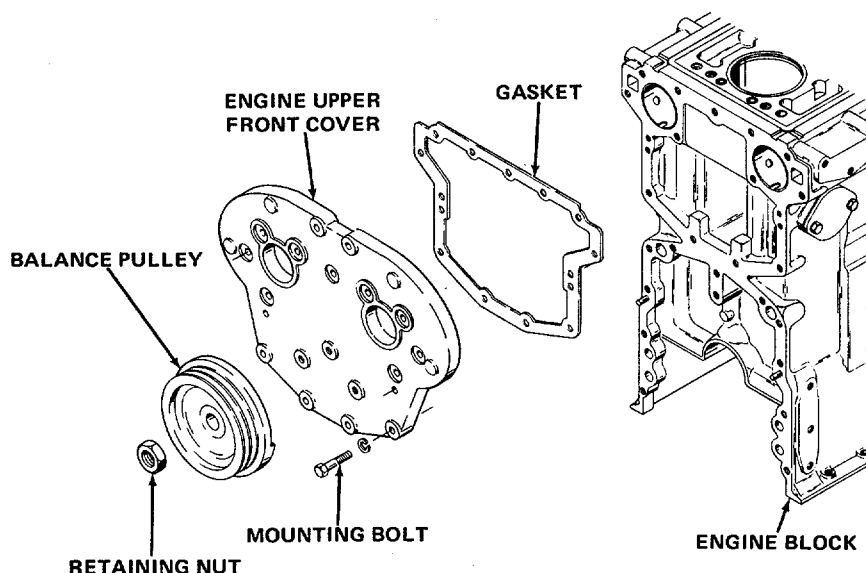
Location/Item	Action	Remarks
53. Idler gear outer thrust washer	Apply a thin film of MIL-G-10924 grease to inner face of outer thrust washer. Position thrust washer over end of hub with oil grooves in the thrust washer facing the idler gear, and the thrust washer inner diameter flat over the hub flat.	
54. Backlash between crankshaft gear and idler gear	Check backlash. It should be 0.003 to 0.005 inch (0.0762 to 0.127 mm) with new gears, or a maximum of 0.007 inch (0.1778 mm) with used gears.	
55. Camshaft and balance shaft	Lubricate bearings and shafts with MIL-L-2104 oil and install shafts in cylinder block.	



56. Camshaft spacer and thrust washer Lubricate spacer and thrust washer with MIL-L-2104 oil and attach over end of camshaft as shown. Install retaining bolts and torque to 30 to 35 ft lb (41 to 47 N.m).
57. Camshaft gear and Woodruff key Lubricate with MIL-L-2104 oil and install on camshaft end.

6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
58. Balance shaft thrust washer	Lubricate with MIL-L-2104 oil and attach over end of balance shaft as shown. Install retaining bolts and torque to 30 to 35 ft lb (41 to 47 N.m).	
59. Balance shaft gear and Woodruff key	Lubricate with MIL-L-2104 oil and install on balance shaft end.	
60. ear retaining nuts	Lubricate with MIL-L-2104 oil and install fingertight.	
61. Balance pulley end keys, oil slingers, and spacers	Lubricate Woodruff keys, oil slingers, and spacers with MIL-L-2104 oil and install as shown.	
62. Engine upper front cover	Position new gasket on engine block. Install upper front cover and mounting bolts. Torque bolts to 35 ft lb (47 N.m).	
63. Balance pulleys and retaining nuts	Install on both shafts. Install retaining nuts and tighten hand tight.	



6-9. VALVES, CAMSHAFT, AND TIMING GEARS (CONT)

Location/Item	Action	Remarks
64. Gear retaining nuts	Wedge a clean rag between gears at opposite end. Torque nuts to 300 to 325 ft lb (407 to 441 N.m).	
<p>The diagram shows a cross-section of a timing gear assembly. It features three gears of different sizes. The top gear is the largest and is secured by a gear retaining nut. A retainer plate is positioned behind the gear, held in place by mounting bolts and lockwashers. The gear itself is mounted on a shaft. Labels with leader lines point to the 'GEAR RETAINING NUT', 'RETAINER PLATE', 'MOUNTING BOLT AND LOCKWASHER', and 'GEAR'.</p>		
65. Balance pulley retaining nuts	Torque nuts to 300 to 325 ft lb (407 to 441 N.m).	
66. Retainer plates and weights	Install retainer plates and weights on gears. Install mounting bolts and lockwashers. Torque bolts to 35 to 39 ft lb (47 to 53 N.m).	
67. Clearance between thrust washers and gears	Check clearance on both shafts. It should be 0.005 to 0.015 inch (0.127 to 0.381 mm) with new parts, or a maximum of 0.010 inch (0.4826 mm) with used parts.	
68. Backlash between camshaft and balance shaft gears	Check backlash. It should be 0.003 to 0.005 inch (0.0762 to 0.127 mm) with new gears, or a maximum of 0.007 inch (0.1778 mm) with used gears.	
69. Backlash between camshaft gear and idler gear	Check backlash. It should be 0.003 to 0.005 inch (0.0762 to 0.127 mm) with new gears, or a maximum of 0.007 inch (0.1778 mm) with used gears.	

6-10. PISTONS AND CONNECTING RODS

This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Repair
- f. Reassembly
- g. Installation

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Piston rings
Piston pin retainers
Piston pin bushings
Diesel fuel oil (Item 6, Appendix E)
Lubricating oil (Item 10, Appendix E)

References

Para 6-8 Cylinder liner
Para 6-11 Crankshaft and flywheel

Troubleshooting References

Malfunction 1, step 2
Malfunction 2, steps 1 through 4
Malfunction 3, step 1

Equipment Condition

Para	Condition Description
5-16	Engine removed from pump assembly and trailer assembly.
6-6	Oil pump inlet pipe and screen assembly removed.
6-7	Cylinder head removed.

Special Environmental Condition

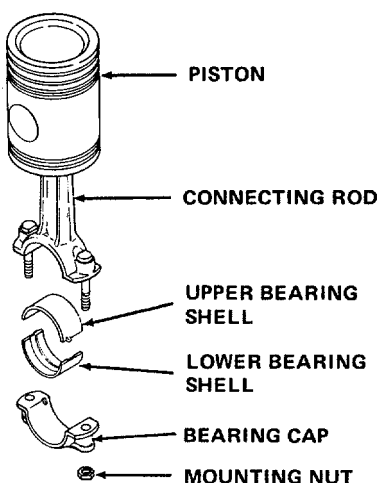
Well-ventilated area required during cleaning.

6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
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REMOVAL

- | | |
|---|--|
| 1. Connecting rod bearing caps and lower bearing shells | Remove mounting nuts. Remove each bearing cap and lower bearing shell as a unit. |
|---|--|

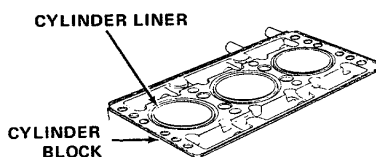


WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

- | | | |
|---------------------------------------|--|--|
| 2. Piston and connecting rod assembly | Use VV-F-800 diesel fuel to soften carbon deposits on upper inner surface of cylinder liner. Remove carbon deposits. Push piston and rod assembly out through top of cylinder block. Reassemble bearing caps and lower bearing shells to the appropriate connecting rods and upper bearing shells. | Upper bearing shells may not stay with connecting rods during piston and rod removal. Ensure that both upper and lower bearing shells are accounted for after each piston and connecting rod assembly is removed from the block. |
|---------------------------------------|--|--|



6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
DISASSEMBLY		
3. Piston rings	Note piston and ring condition. Remove rings and discard.	
4. First piston pin retainer	Secure connecting rod in vise equipped with soft jaws. Punch a hole through one of the piston pin retainers with a narrow chisel or punch. Carefully pry retainer from piston. Discard retainer.	
5. Piston pin	Remove.	
6. Piston	Remove from connecting rod.	
7. Second piston pin retainer	Remove and discard.	

CLEANING

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
|----------------------|---|
| 8. Piston components | Wash piston and connecting rod components with clean VV-F-800 diesel fuel and dry with compressed air. Remove carbon from piston ring lands and grooves with a wire brush. Clean inside surface of piston and oil drain holes in piston skirt. Slip piston pin back into bushing. Blow compressed air through the drilled oil passage in connecting rod, so that air flows through spray holes in nozzle. |
|----------------------|---|

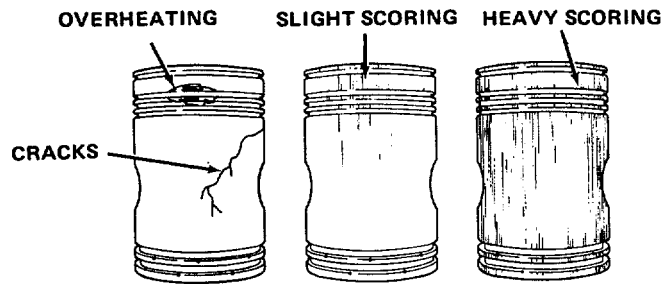
6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
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NOTE

Excessively worn pistons, rings, or cylinder liners may be an indication of abnormal maintenance practices or operating conditions. Check for and correct any abnormalities.

9. Piston
 Inspect the plate on piston skirt and all grooves for excessive wear and damage. Examine piston for scoring, cracks (especially on internal struts), damaged ring lands, or indications of overheating. Clean slight scoring with P-C-458 crocus cloth.



10. Cylinder liner
 If piston is badly worn or damaged, check cylinder liner for excessive out-of-round, taper, high spots, or other damage in accordance with paragraph 6-8.

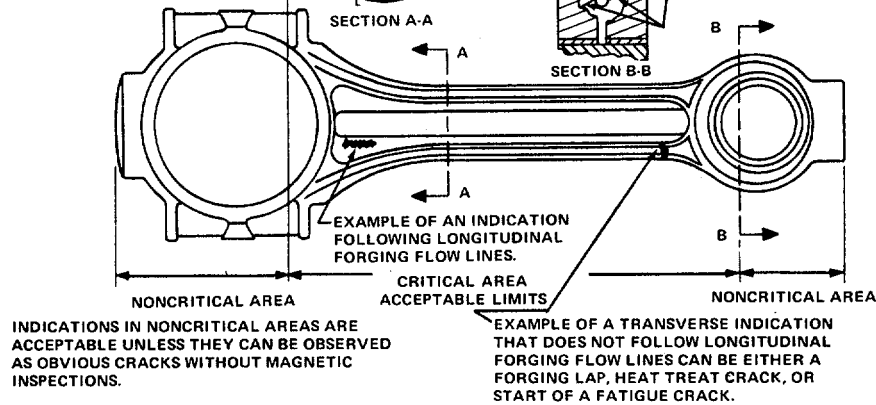
6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
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11. Connecting rod	Visually check for bend. Check for cracks using MIL-1-6868 magnetic particle inspection.	
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DO NOT USE OR ATTEMPT TO SALVAGE RODS WITH INDICATIONS OVER 0.005 INCH (0.127 mm) DEEP EXTENDING OVER EDGES OF H SECTION ON BOTH SIDES OF FLANGE. SHADED AREAS ARE MOST HIGHLY STRESSED.

START OF FATIGUE CRACK RESULTING FROM OVERLOADING (DUE TO HYDROSTATIC LOCK). DO NOT ATTEMPT TO SALVAGE. (THIS TYPE OF INDICATION IS NOT VISIBLE WITH BUSHINGS IN PLACE.)



INDICATIONS IN NONCRITICAL AREAS ARE ACCEPTABLE UNLESS THEY CAN BE OBSERVED AS OBVIOUS CRACKS WITHOUT MAGNETIC INSPECTIONS.

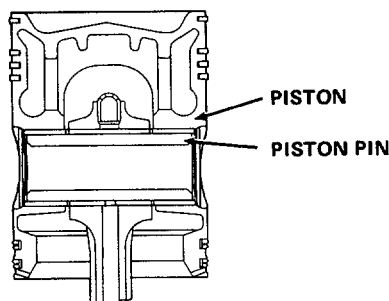
TRANSVERSE INDICATIONS (ACROSS FLOW LINES), HAVING A MAXIMUM LENGTH OF 1/2 INCH (12.7 mm), WHICH CAN BE REMOVED BY GRINDING NO DEEPER THAN 1/64 INCH (0.3969 mm) ARE ACCEPTABLE AFTER THEIR COMPLETE REMOVAL. AN EXCEPTION TO THIS IS A ROD HAVING AN INDICATION WHICH EXTENDS OVER THE EDGE OF H SECTION AND IS PRESENT ON BOTH SIDES OF THE FLANGE. IN THIS CASE MAXIMUM ALLOWABLE DEPTH IS 0.005 (SEE SECTION A-A).

LONGITUDINAL INDICATIONS FOLLOWING FORGED FLOW LINES ARE USUALLY SEAMS AND ARE NOT CONSIDERED HARMFUL IF LESS THAN 1/32 INCH (0.7938 mm) DEEP. DEPTH CAN BE DETERMINED BY GRINDING A SMALL AREA NEAR THE CENTER OF THE INDICATION.

GRINDING NOTES CARE SHOULD BE TAKEN IN GRINDING OUT INDICATIONS TO ASSURE PROPER BLENDING OF GROUND AREA INTO UNGROUND SURFACE SO AS TO FORM A SMOOTH CONTOUR.



12. Piston pin	Inspect for fretting.	
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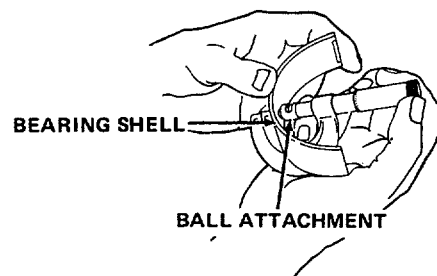
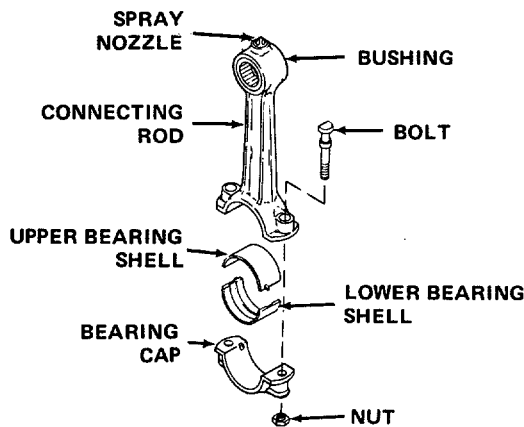
6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
13. Piston pin bushings (in piston)	Inspect for excessive wear or scoring.	
14. Pin-to-bushing clearance	Slide piston pin back into bushing and measure pin-to-bushing clearance. The maximum allowable clearance with new parts is 0.0034 inch (0.0864 mm). The maximum allowable clearance for worn parts is 0.010 inch (0.254 mm).	
15. Piston pin bushing (in connecting rod)	Inspect bushings for scoring, overheating, or other damage. Notice whether bushings have moved closer (crept) together in connecting rod.	

CAUTION

Connecting rod bearing and journal damage may occur if bearing shells and caps are mixed up. Matchmark shells and caps prior to disassembly.

16. Connecting rod bearing shells
- Remove bearing cap nuts. Remove bearing cap. Remove bearing shells. Inspect upper and lower bearing shells for excessive wear, scoring, pitting, flaking, etching, and signs of overheating. Inspect bearing shell backs for bright spots (bearing moving in supports). Measure bearing shells with a micrometer and ball attachment. The minimum thickness of a worn standard connecting rod bearing shell is 0.1230 inch (3.1242 mm).



6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
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NOTE

If undersize bearing shells were installed at an earlier date, the standard minimum worn thickness dimension will not be accurate. Compare dimensions of undersize bearings to the chart below.

Bearing Size		New Bearing Thickness		Minimum Worn Thickness	
inch	(mm)	inch	(mm)	inch	(mm)
Standard		0.1245/0.1250	(3.1623/3.175)	0.1230	(3.1242)
Undersize					
0.002	(0.0508)	0.1255/0.1260	(3.1877/3.2004)	0.1240	(3.1496)
0.010	(0.254)	0.1295/0.1300	(3.2893/3.302)	0.1280	(3.2512)
0.020	(0.508)	0.1345/0.1350	(3.4163/3.429)	0.1330	(3.3782)
0.030	(0.762)	0.1395/0.1400	(3.5433/3.556)	0.1380	(3.5052)

17. Crankshaft Before installing bearings, inspect crankshaft in accordance with paragraph 6-11.

WARNING

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

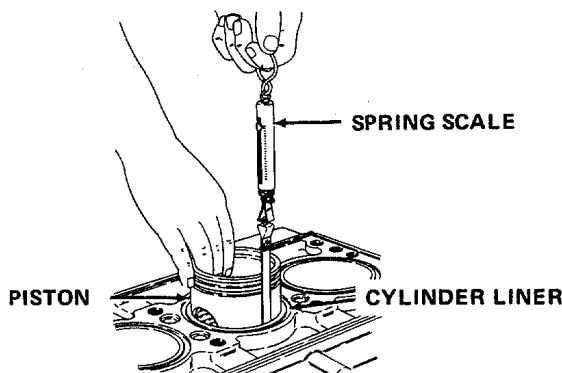
18. Connecting nozzle rod spray nozzle Blow compressed air through spray and inspect it for blockage.
19. Piston skirt diameter Measure each piston skirt diameter lengthwise and crosswise of the piston pin bore. Piston skirt must measure between 3.8699 and 3.8721 inches (98.2955 and 98.3513 mm). Piston skirt diameter measurement should be taken at a room temperature of 70°F (21 C).
20. Piston out-of-round and taper Measure piston out-of-round and taper. The out-of-round and taper must not exceed 0.0005 inch (0.0127 mm).

6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
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21. Piston-to-liner clearance

Hold piston upside down in cylinder liner (liner in block). When performing piston-to-liner clearance inspection, use a feeler gage that is perfectly flat and free of all nicks and bends. Use a spring scale to select a feeler gage with a thickness which will require a pull of 6 pounds (2.7 kg) to remove. The clearance will be 0.001 inch (0.0254 mm) greater than the thickness of the feeler gage used. If binding occurs, inspect piston and liner for burrs. Remove burrs with a fine hone and recheck clearance. Piston-to-liner clearance (with new piston and liner) should be 0.0031 to 0.0068 inch (0.0787 to 0.1727 mm). A maximum clearance of 0.010 inch (0.254 mm) is allowable with used parts.



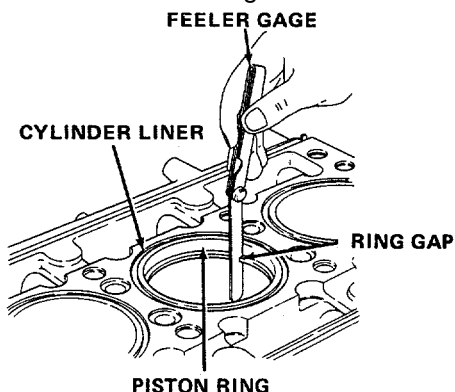
NOTE

Each piston is fitted with a fire ring, three compression rings, and two oil control rings. The top compression (fire) ring can be identified by the bright chrome on the bottom side and oxide (rust color) on the top. The second compression ring can be identified by its cast iron construction. A two-piece oil control ring is used in both oil ring grooves. All new piston rings must be installed whenever a piston is removed, regardless of whether a new or used piston or cylinder liner is installed.

22. Piston ring gap

Use piston to push new rings, one at a time, down into the cylinder liner. With a feeler gage, measure ring gap according to the following chart.

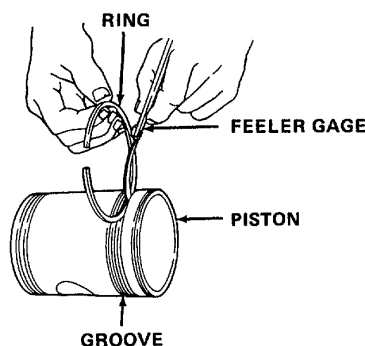
Push ring in far enough to be in the normal area of ring travel.



6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action				Remarks	
Ring	Minimum		Maximum		Limits	
	inch	(mm)	inch	(mm)	inch	(mm)
Compression:						
No. 1 (Top)	0.020	(0.508)	0.046	(1.168)	0.060	(1.524)
No. 2	0.020	(0.508)	0.036	(0.914)	0.060	(1.524)
Oil control (all)	0.010	(0.254)	0.025	(0.635)	0.044	(1.118)

23. Piston ring side clearance
 Check side clearance of piston rings in grooves. Compare dimensions to the chart below.



Ring	Minimum		Maximum		Limits	
	inch	(mm)	inch	(mm)	inch	(mm)
Compression:						
No. 1 (Top)	0.003	(0.0762)	0.006	(0.1524)	0.010	(0.254)
No. 2	0.007	(0.1778)	0.010	(0.254)	0.014	(0.3556)
No. 3 and 4	0.005	(0.127)	0.008	(0.2032)	0.013	(0.3302)
Oil control (all)	0.0015	(0.0381)	0.0055	(0.1397)	0.008	(0.2032)

REPAIR

24. Piston
 Replace piston if tin plate or ring grooves are excessively worn or damaged, ring lands are damaged, piston is heavily scored or cracked, or piston shows signs of excessive overheating.
25. Cylinder liner
 If worn or damaged, repair or replace in accordance with paragraph 6-8.

6-10. PISTONS AND CONNECTING RODS (CONT)

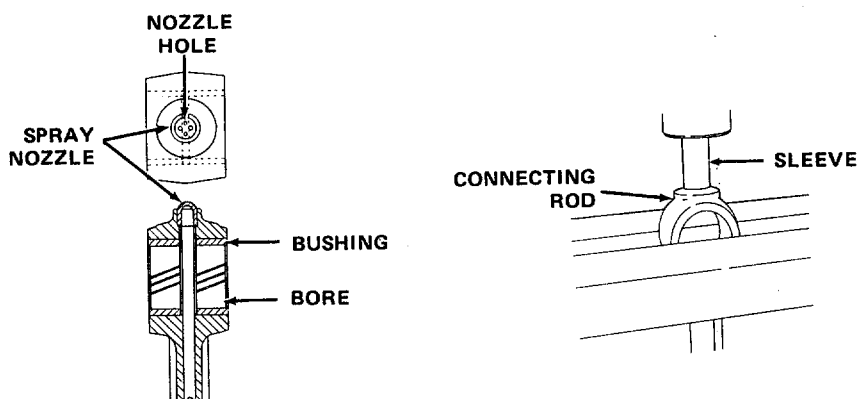
Location/Item	Action	Remarks
26. Connecting rod	Replace if twisted or bent. Grind or replace if indications of cracks are revealed by magnetic particle inspection. Stamp the cylinder number on a replacement connecting rod and cap.	
<p>NOTE Clean rust preventive from replacement connecting rod. Also make sure the split line (cap to rod) is thoroughly cleaned to prevent trapped con-</p>		
<p>CAUTION Piston pin bushing damage may result if piston pin is refinished. Do not refinish highly polished or lapped piston pin surface.</p>		
27. Piston pin	Replace if finish is destroyed or fretting is visible.	
28. Piston pin bushings (in piston)	Replace bushings which are excessively worn or scored.	
29. Piston pin bushing (in connecting rod)	Replace bushings that are scored, show overheating, or are damaged.	
30. Connecting rod bearing shells	If either bearing shell is thinner than the minimum, replace both bearing shells.	
<p>NOTE If crankshaft is to be reground, select bearing shells after checking final crankshaft dimension.</p>		
31. Crankshaft	If crankshaft is damaged, repair or replace it according to paragraph 6-11.	
32. Connecting rod spray nozzle	Replace nozzle if blockage cannot be cleared with compressed air. To replace spray nozzle, remove connecting rod bushing.	
33. Pistons	Replace piston if skirt diameter, out-of-round, or taper is not within tolerance.	
34. Piston-to-liner clearance	Replace piston, liner, or both if clearance is not within tolerance.	

6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
35. Piston rings	If gap on new compression ring is insufficient, it may be increased by filing or stoning the ends of the ring. File or stone both ends of ring so cutting action is from outer surface to inner surface. This will prevent any chipping or peeling of chrome plate on ring. The ends of the ring must remain square and chamfer on outer edge must be approximately 0.015 inch (0.381 mm). Replace a new oil control ring which fails to meet ring gap tolerance. If piston ring side clearance exceeds the limit, replace piston.	

REASSEMBLY

36. Piston pin bushings (in piston) If bushings were removed during overhaul, install new bushings.
37. Connecting rod spray nozzle Start replacement spray nozzle into connecting rod counterbore with the holes in a diamond pattern sideways to the bushing bore. Support connecting rod in an arbor press. Place a short 3/8 inch (9.53 mm) inner diameter sleeve on top of nozzle. Press nozzle into counterbore until it bottoms.



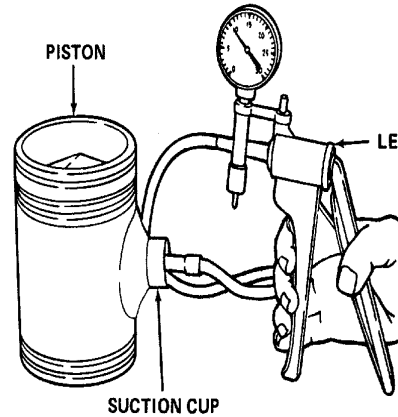
38. Connecting rod bushings Clamp upper end of connecting rod assembly. Start a replacement bushing straight into bore of connecting rod, with bushing joint at top of rod. Drive bushing in connecting rod. Turn rod over and install second bushing in the same way.

NOTE

Bushings must be able to stand an end load of 2000 pounds (907 kg). If bushing slides in easy, it probable will not stand the required end load. Replace bushings or connecting rod if necessary.

6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
39. Connecting rod and piston	<p>Lubricate piston pin bushings with clean MI L-L-2104 oil. Align piston and connecting rod piston pin bores. Insert piston pin and drive through connecting rod. Position piston pin to install both piston pin retainers. Position a new piston pin retainer and drive it into the piston. Slide connecting rod back and forth. Check for piston pin end play. If pin is cramped between retainers, remove retainers and install fresh retainers. Check retainers for seal with a leak detector. To check seal of retainers, first position detector suction cup over retainer. Hand operate lever until a vacuum of 10 inches (25.4 cm) shows on gage. If gage drops, retainer is leaking. Replace retainer if necessary.</p>	and



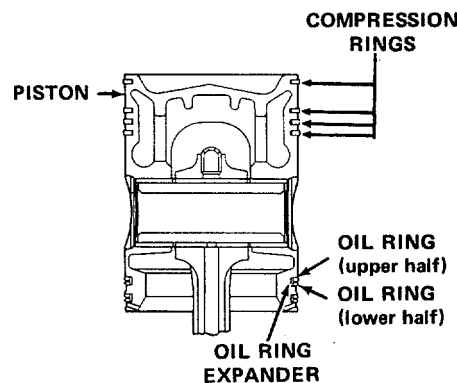
CAUTION

Piston ring breakage may occur if rings are opened more than necessary when removing or installing them.

40. Compression rings

Install bottom compression ring. Install upper compression rings towards the top of the piston. Stagger ring gaps around piston. (rust color) side towards the piston top.

The top compression ring should be installed with the oxide

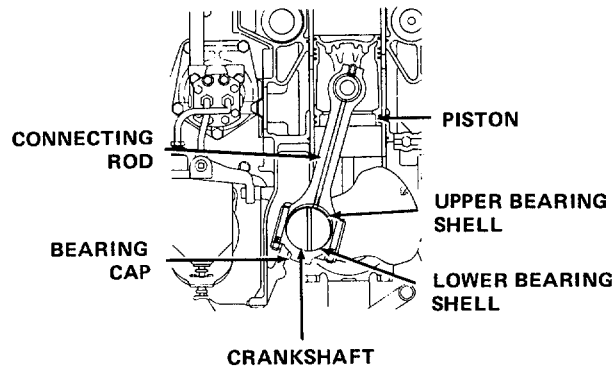


6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
41. Oil control rings	Position oil control ring expanders in oil control ring grooves, without overlapping them. If expanders overlap, replace them. Install upper and lower half of upper oil control ring by hand, with the scraper edges facing down. Adjust the upper half so that its gap is 180 degrees from the gap in the oil expander. Adjust the lower half so that its gap is 45 degrees from the gap in the upper half. Install upper and lower half of the lower oil control ring the same way.	
42. Connecting rod bearing shells, caps, nuts, and bolts	Slide upper and lower bearing shells into their original positions in the connecting rod and bearing cap. Position cap on connecting rod. Install bolts through bearing cap. Tighten nuts hand tight.	

INSTALLATION

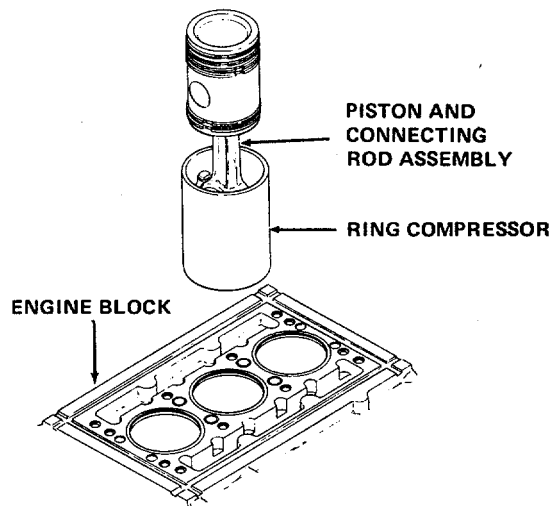
43. Connecting rod upper bearing shells
- Rotate crankshaft until connecting rod journal of the cylinder being worked on is at the bottom of its travel. Wipe journal clean and lubricate it with clean MIL-L-2104 oil. Install upper bearing shell in connecting rod. Lubricate bearing shell with clean MIL-L-2104 oil.



6-10. PISTONS AND CONNECTING RODS (CONT)

Location/Item	Action	Remarks
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- | | | |
|--|--|--|
| 44. Piston and connecting rod assemblies | Position piston and connecting rod assembly and ring compressor in line with the block bore so that identification number on rod is facing engine serial number side. Slide piston and connecting rod assembly through ring compressor and push or pull piston and connecting rod into liner until upper bearing shell is firmly seated on the crankshaft journal. | |
|--|--|--|



- | | | |
|---|--|--|
| 45. Connecting rod lower bearing shells | Place lower bearing shell in bearing cap, with tang on shell in notch in cap. Lubricate bearing shell with clean MIL-L-2104 oil. | |
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CAUTION

Equipment damage may occur if connecting rod bolt turns before torque is applied to nut. Make sure that bolt head is properly seated on connecting rod before tightening nut.

- | | | |
|---------------------------------|---|--|
| 46. Connecting rod bearing caps | Install bearing cap with bearing shell on connecting rod with identification numbers on cap and rod adjacent to each other. Torque nuts to 40 to 45 ft lb (54 to 61 N.m). | |
|---------------------------------|---|--|

6-11. CRANKSHAFT AND FLYWHEEL (CONT)

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Repair
- e. Installation/Inspection

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Sealing compound (Item 14, Appendix E)
Crocus abrasive cloth (Item 1, Appendix E)
Emery abrasive cloth (Item 2, Appendix E)

References

MIL-1-6868 Magnetic Particle Inspection

Materials/Parts

Flywheel housing gasket
Flywheel housing oil seal
Engine lower front cover gasket
Engine lower front cover oil seal
Flywheel ring gear
Oil pump drive gear
Diesel fuel oil (Item 6, Appendix E)
Grease (Item 7, Appendix E)
Grease (Item 7, Appendix E)
Thread compound (Item 20, Appendix E)
Thread compound (Item 20, Appendix E)
Lubricating oil (Item 10, Appendix E)

Troubleshooting References

Malfunction 2, step 4
Malfunction 4, step 6

Equipment

Condition

Para	Condition Description
5-16	Engine removed and inverted.
6-10	Pistons and connectings rods removed.

Special Environmental Conditions

Well-ventilated area required during cleaning and repair.

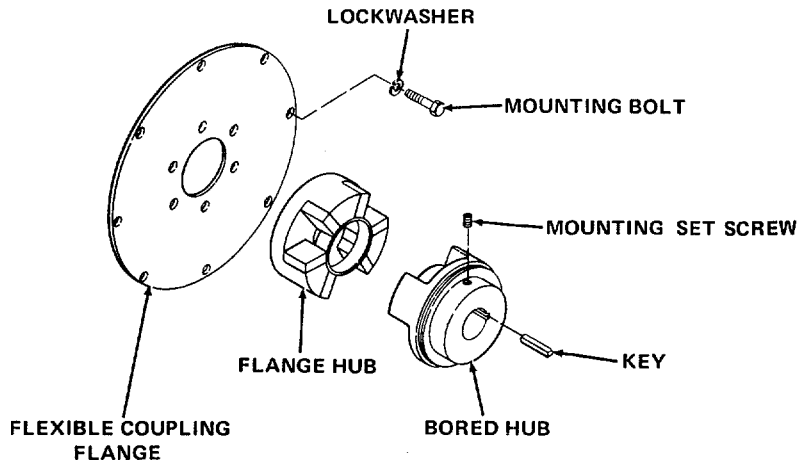
6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
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REMOVAL

1. Flexible coupling

Remove flange mounting bolts and lockwashers. Remove flange, flange hub, bored hub, set screw, and key as a unit and set aside.

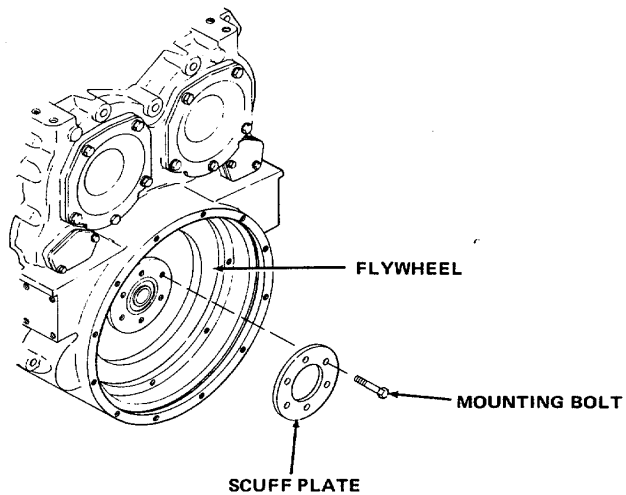


WARNING

Personal injury could occur if flywheel falls from end of crankshaft. Hold flywheel firmly against crankshaft when installing or removing mounting bolts.

2. Flywheel scuff plate

Remove flywheel mounting bolts and scuff plate while holding flywheel in position. Reinstall one bolt.



6-11. CRANKSHAFT AND FLYWHEEL (CONT)

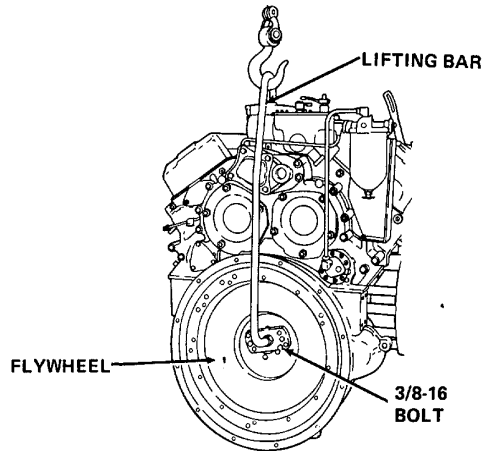
Location/Item	Action	Remarks
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WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting tool to flywheel. Before lifting, be sure load is balanced.

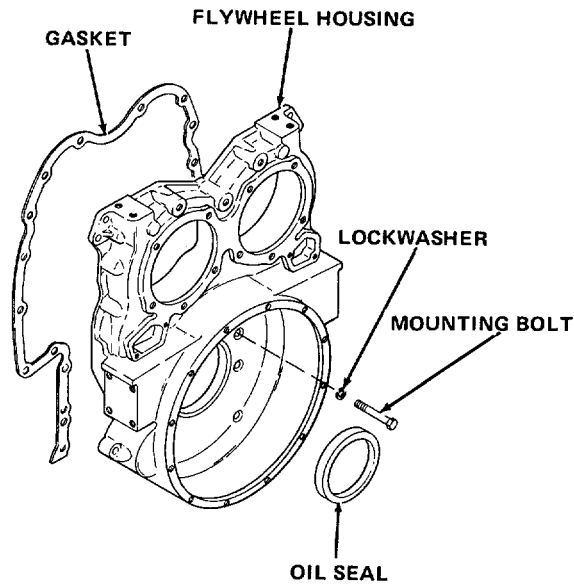
3. Flywheel

Attach a lifting bar to flywheel with two 3/8-16 bolts of suitable length. Attach a lifting device to the lifting bar. Remove remaining flywheel mounting bolt. Remove flywheel.



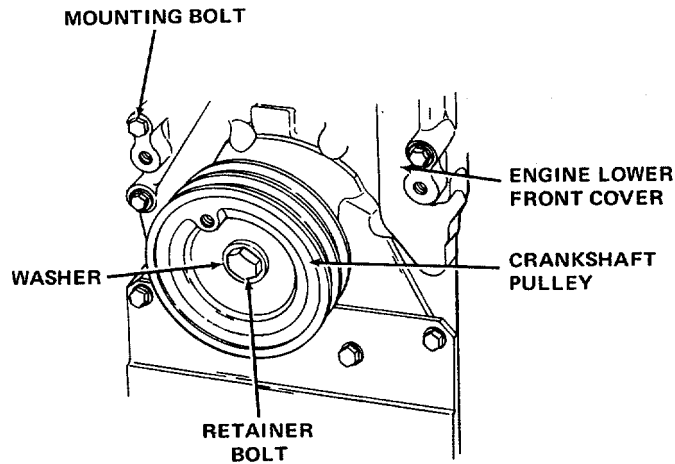
4. Flywheel housing

Remove housing mounting bolts and lockwashers. Use suitable lifting device to remove flywheel housing. Remove and discard the gasket and oil seal.

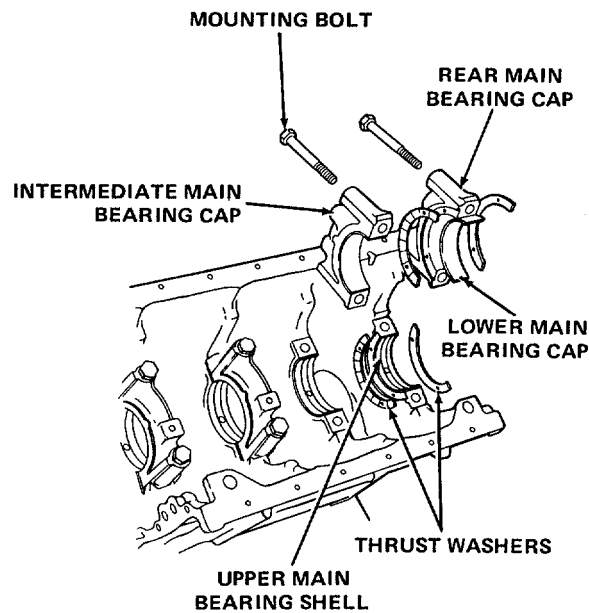


6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
5. Flywheel housing-to-end plate shim	Remove.	
6. Crankshaft pulley	Remove retainer bolt, washer, and crankshaft pulley.	



7. Engine lower front cover
Remove mounting bolts and lower front cover. Remove and discard gasket and oil seal.



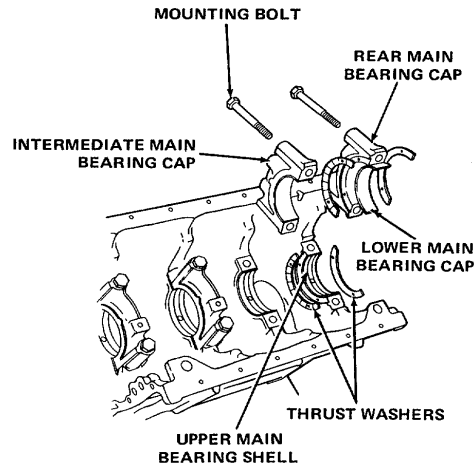
6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
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CAUTION

Equipment damage could occur if bearing caps or shells are not returned to their original positions. Main bearing caps are numbered 1, 2, 3, etc. for ease of reassembly. Bearing shells are not numbered. Note the position of each bearing cap and shell during disassembly.

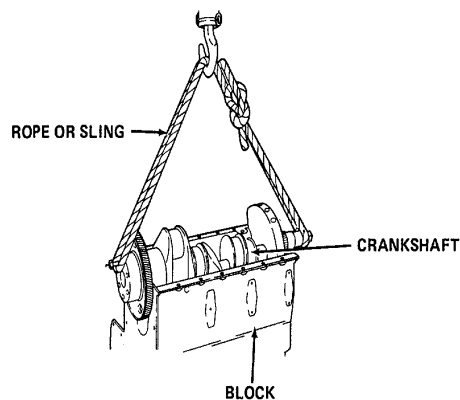
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|--|---|--|
| 8. Main bearing caps, shells, and thrust washers | Remove mounting bolts, bearing caps, and bearing shells. Remove thrust washers from each side of rear main bearing cap. | |
|--|---|--|



WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to crankshaft. Before lifting, be sure load is balanced.

- | | | |
|---------------|---|--|
| 9. Crankshaft | Remove crankshaft with a suitable lifting device and heavy rope or sling. Lower crankshaft onto a clean, dry work surface. Support crankshaft evenly. | |
|---------------|---|--|



6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
10. Oil pump	Remove using suitable gear puller. drive gear	
11. Crankshaft	Remove using suitable gear puller. timing gear	
12. Oil plugs and Wood- ruff key	Remove from crankshaft.	

CLEANING

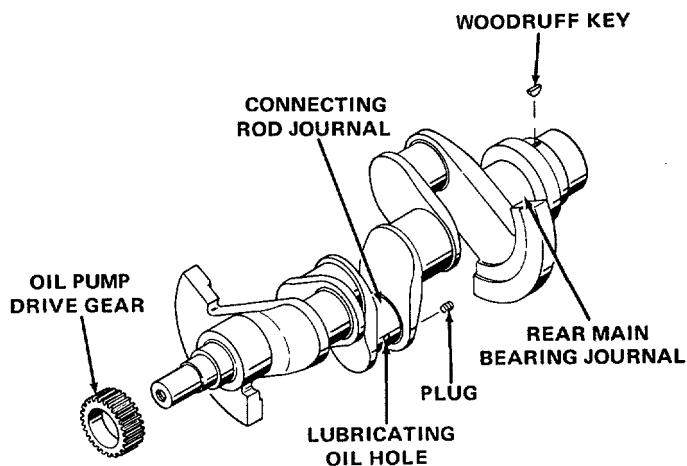
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

13. Crankshaft
Clean oil passages with a stiff wire brush. Clean crankshaft with VV-F-800 diesel fuel and dry with compressed air.



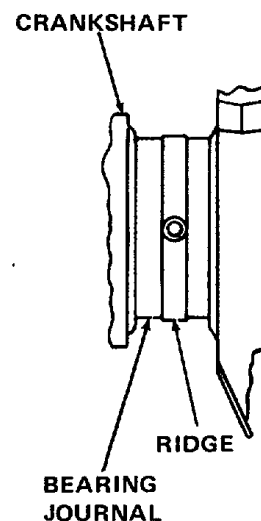
14. All remaining parts
Clean with VV-F-800 diesel fuel and dry with compressed air.

6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
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INSPECTION OF CRANKSHAFT

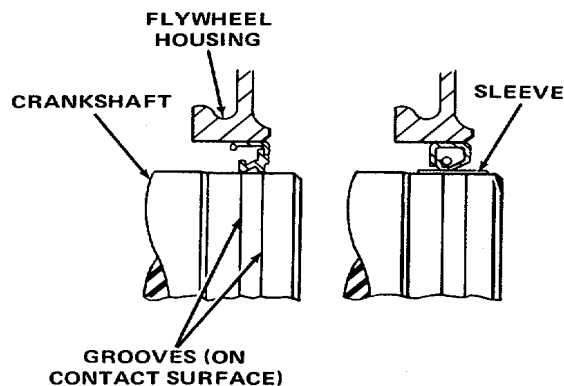
- 15. Keyway Inspect for cracks or wear. Replace crankshaft, if necessary.
- 16. Crankshaft Inspect for signs of overheating. Replace crankshaft, if necessary.
- 17. Bearing journals Inspect for ridges. Ridges exceeding 0.0002 inch (0.00508 mm) must be removed by working P-C-458 crocus cloth, wet with VV-F-800 diesel fuel, around circumference of crankshaft journal. If ridges are greater than 0.0005 inch (0.0127 mm), use P-C-1673 emery cloth, 120 grit for removing ridge and 240 grit for finishing. Polish with wet crocus cloth. If ridges are greater than 0.001 inch (0.0254 mm) regrind crankshaft. Use of a piece of rawhide or other suitable rope wrapped around the emery cloth or crocus cloth and drawn back and forth will minimize the possibility of an out-of-round condition developing (keep the strands of rawhide apart to avoid bind). If rawhide or rope is not used, the crankshaft should be rotated at intervals.



- 18. Oil seal contact area Inspect front and rear oil seal contact surfaces for grooves or ridges. Remove slight ridges as explained in step 17 above. If oil seal area cannot be cleaned satisfactorily, press the oil seals into flywheel housing or front cover 1/8 inch (3.18 mm) from their original positions, or install oil seal sleeves to give the crankshaft replaceable contact surfaces.

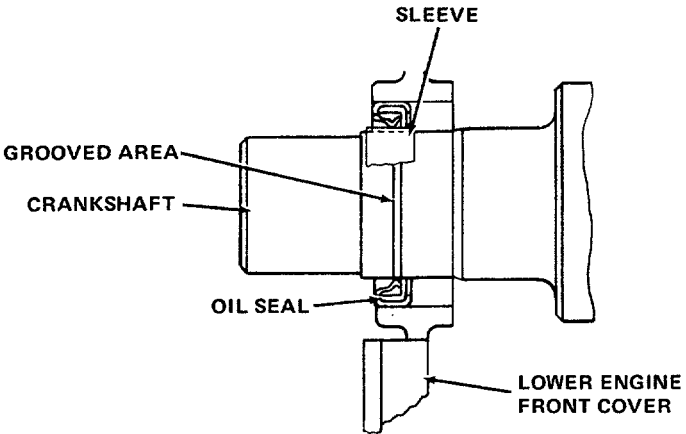
- 19. Oil seal sleeve on flywheel housing surface

- a. Stone high spots from oil seal contact surface of crankshaft.
- b. Coat contact surface with MI L-T-22361 thread compound.
- c. Drive sleeve squarely on the shaft.
- d. Wipe off any excess sealant.



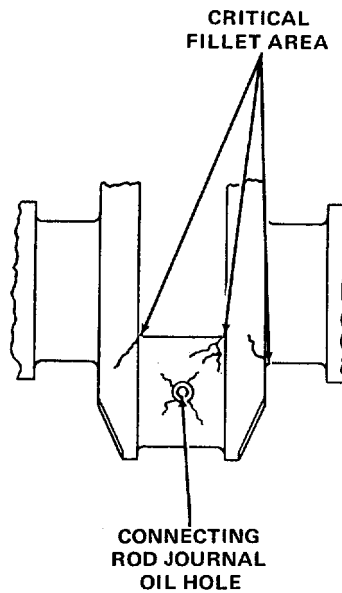
- e. Coat outside diameter of sleeve with MI L-L-2104 oil.

6-11. CRANKSHAFT AND FLYWHEEL (CONT))

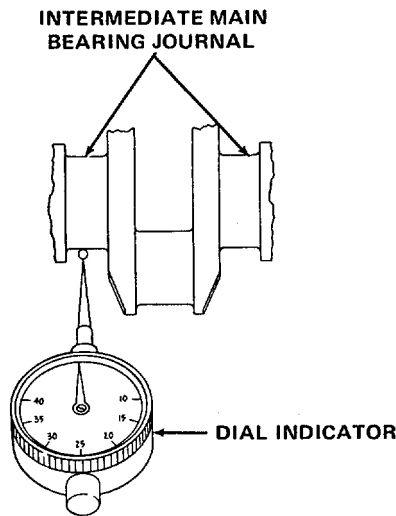
Location/Item	Action	Remarks
20. Oil seal sleeve on engine cover surface	<p>Install oil seal sleeve on front (engine cover) contact surface as follows:</p> <p>a. Stone high spots from oil seal contact surface of crankshaft.</p>	
		
	<p>b. Coat contact surface with MIL-T-22361 thread compound.</p> <p>c. Position sleeve on crankshaft with radius on sleeve facing away from engine.</p> <p>d. Drive sleeve squarely on shaft.</p> <p>e. Wipe off any excess sealant.</p> <p>f. Coat the outside diameter of sleeve with MIL-L-2104 oil.</p>	
<p>NOTE</p> <p>To remove a worn sleeve,peen the outside diameter of sleeve until it stretches sufficiently so it can be slipped off end of crankshaft.</p>		
21. Oil pump drive gear and timing gears	Check for worn or chipped teeth. Replace gears, if necessary.	
22. Thrust surfaces	Check for wear or grooving. If only slightly worn, dress surfaces with a stone. Regrind the thrust surfaces if excessively worn or grooved.	

6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
23. Bearing journal critical areas	Visually inspect for cracks which start at an oil hole and follow the journal surface at an angle of 45 degrees to the axis. Inspect for cracks in critical fillet areas as shown. Replace crankshaft if cracks are visible. Inspect for minute cracks using MIL-1-6868 Magnetic Particle Inspection.	

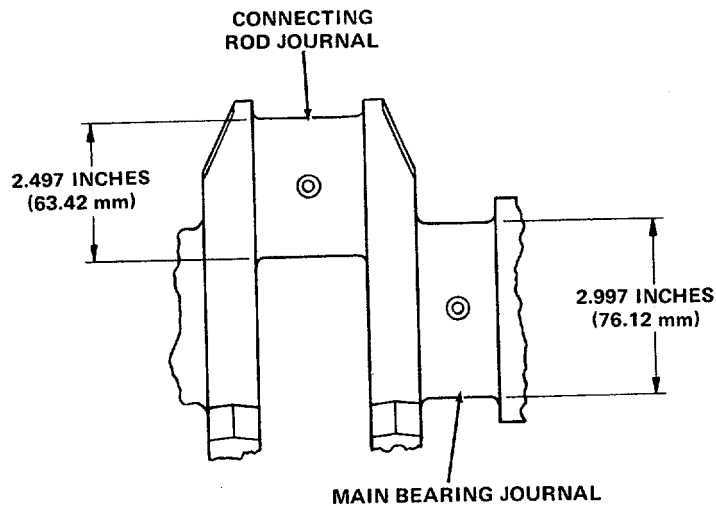


24. Intermediate main bearing journals	Check alignment at adjacent intermediate main journals with a dial indicator. Maximum allowable runout is 0.002 inch (0.0508 mm). Replace crankshaft, if necessary.
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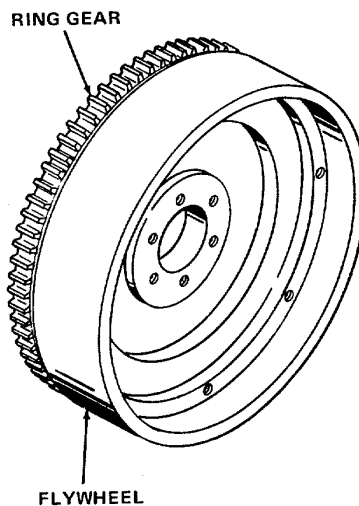
6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
25. Main and connecting rod bearing journal measurement	Measure bearing journal diameter; check for taper and out-of-round. Connecting rod journal diameter must not be less than 2.497 inches (63.42 mm). Main bearing journal diameter must not be less than 2.997 inches (76.12 mm). Journal taper or out-of-round must not exceed 0.003 inch (0.0762 mm). If journals are not within limits they must be reground.	



INSPECTION OF FLYWHEEL

26. Flywheel and ring gear	Inspect for wear and damage. Replace ring gear or flywheel if necessary.
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6-11. CRANKSHAFT AND FLYWHEEL (CONT))

Location/Item	Action	Remarks
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CAUTION

Starting motor pinion damage may occur if chamfered side of replacement ring gear is not facing same direction as chamfer on replaced gear. Note chamfered side of gear before replacement.

NOTE

Only remove a ring gear if it is to be replaced.

27. Ring gear removal	To remove ring gear from flywheel, support flywheel on a solid flat surface, position a drift punch on upper edge of ring gear, and lightly tap punch while moving it around the gear.	Support flywheel crankshaft side down.
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WARNING

Operate acetylene torches properly and be alert for leaks on any part of the equipment. Inhalation of acetylene produces headache, dizziness, nausea, and possible loss of consciousness. If acetylene is inhaled, seek fresh air immediately.

CAUTION

Ring gear damage may occur if gear is overheated. Do not heat gear over 400°F (204°C). Use minimum amount of heat required to fit ring gear on flywheel. Keep flame moving at all times.

28. Ring gear installation	<p>Mount replacement ring gear on flywheel as follows:</p> <ol style="list-style-type: none"> a. Support flywheel (ring gear side up) on a solid flat surface. b. Rest ring gear on a flat metal surface. 	
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6-11. CRANKSHAFT AND FLYWHEEL (CONT))

Location/Item	Action	Remarks
c. Heat the gear evenly with an acetylene torch. Keep moving flame rapidly over surface of gear.	Heat indicating crayons, which are placed on the ring gear and melt at a pre-determined temperature, may be obtained from most vendors. Use of crayons will ensure against overheating the gear.	
d. Use tongs to position replacement gear in identical position to old gear.		
e. Tap gear in place against shoulder. If gear will not seat flatly on shoulder, remove it and carefully repeat the heating operation.		
29. Crankshaft and flywheel contact surfaces	Inspect butt end of the crankshaft and flywheel contact surface. Lightly stone crankshaft end and flywheel contact surface to remove any fretting or brinnelling. Remove dirt and debris from contact surfaces.	

REPAIR**CAUTION**

Crankshaft damage may occur if grinding wheel coolant is not used, or wheel is crowded into work. During grinding, feed wheel into work slowly and use coolant generously.

30. Crankshaft bearing journals	If one or more main or connecting rod journals require grinding, then grind all main journals or all connecting rod journals to the same required size.
31. Journal fillets	All journal fillets must have a 0.130 to 0.160 inch (3.302 to 4.064 mm) radius between crank cheek and journal and must not have any sharp grind marks. Fillet must blend smoothly into journal and crank cheek and must be free of scratches. Check radius with a fillet gage.

6-11. CRANKSHAFT AND FLYWHEEL (CONT))

Location/Item	Action	Remarks
32. Bearing selection	Consult the bearing size chart below and select the proper bearing for new journal dimensions.	

NOTE

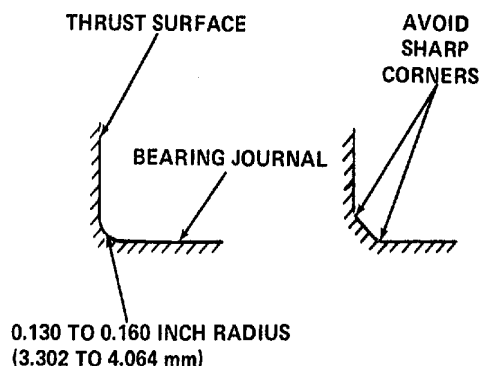
The 0.002 inch (0.0508 mm) undersize bearings are used only to compensate for slight wear on crankshafts on which regrinding is unnecessary.

Bearing Size		Connecting Rod Journal Diameter		Main Bearing Journal Diameter	
inch	(mm)	inch	(mm)	inch	(mm)
Standard		2.499/2.500	(63.475/63.500)	2.999/3.000	(76.175/76.200)
Undersize					
0.002	(0.0508)	2.497/2.498	(63.424/63.449)	2.996/2.998	(76.124/76.149)
0.010	(0.254)	2.489/2.490	(63.221/63.246)	2.989/2.990	(75.921/75.946)
0.020	(0.508)	2.479/2.480	(62.967/62.992)	2.979/2.980	(75.667/75.692)
0.030	(0.762)	2.469/2.470	(62.713/62.738)	2.969/2.970	(75.413/75.438)

33. Bearing journal oil holes
Stone edges of all oil holes in journal surfaces to provide a smooth radius of approximately 3/32 inch (2.381 mm).

34. Ground surfaces
Polish ground surfaces to an 8 to 12 RMS finish.

35. Crankshaft thrust surfaces
Measure. If worn or grooved excessively, regrind and polish surfaces. Leave a 0.130 to 0.160 inch (3.302 to 4.064 mm) radius on crankshaft between each thrust surface and bearing journal.



36. Crankshaft
To locate minute cracks due to grinding operation, reinspect crankshaft using MIL-1-6868 Magnetic Particle Inspection.

6-11. CRANKSHAFT AND FLYWHEEL (CONT))

Location/Item	Action	Remarks
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**CLEANING AFTER
REPAIR**

WARNING

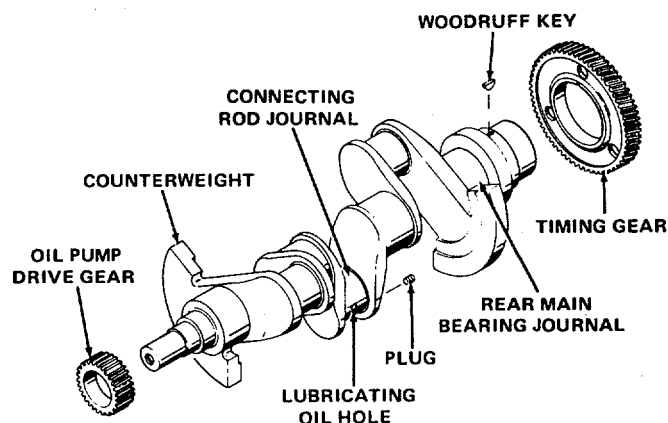
Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

Live steam used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

37. Crankshaft oil passages Clean crankshaft and oil passages with VV-F-800 diesel fuel and dry with compressed air.



NOTE

If a new crankshaft is to be installed, steam clean it to remove the rust preventive. Blow through oil passages with compressed air.

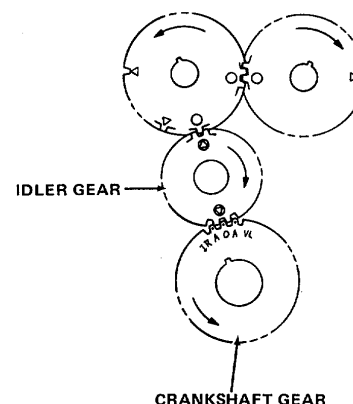
6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
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INSTALLATION/INSPECTION

38. Oil plugs and Woodruff key
Install.

39. Crankshaft timing gear
Slide crankshaft gear over end of crankshaft with timing marks on outer rim of gear facing out and keyway in gear in alignment with Woodruff key in crankshaft. Align the proper timing mark on crankshaft gear with corresponding mark on idler gear. Drive the gear up against shoulder on crankshaft.



40. Backlash between crankshaft gear and idler gear
Check backlash. It should be 0.003 to 0.005 inch (0.0762 to 0.127 mm) with new gears, or a maximum of 0.007 inch (0.1778 mm) with used gears.

CAUTION

Equipment damage may occur if a used oil pump drive gear is reinstalled. Install new gear to ensure oil pump functions at full capacity.

41. Oil pump drive gear
Lubricate inside of replacement oil pump drive with MIL-L-2104 oil. Slide gear straight on crankshaft with chamfered edge of gear toward butt end of crankshaft and drive gear into place. Gear is correctly positioned when forward face of gear is 2.680 inches (68.07 mm) from front end of crankshaft.

42. Slip torque check
Check the slip torque (press fit) of oil pump drive gear on crankshaft. Gear should not slip on crankshaft at a torque of 100 ft lb (136 N•m). If gear slips, replace it.

6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
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CAUTION

Equipment damage could occur if bearing caps or shells are not returned to their original positions. Follow directions noted during disassembly.

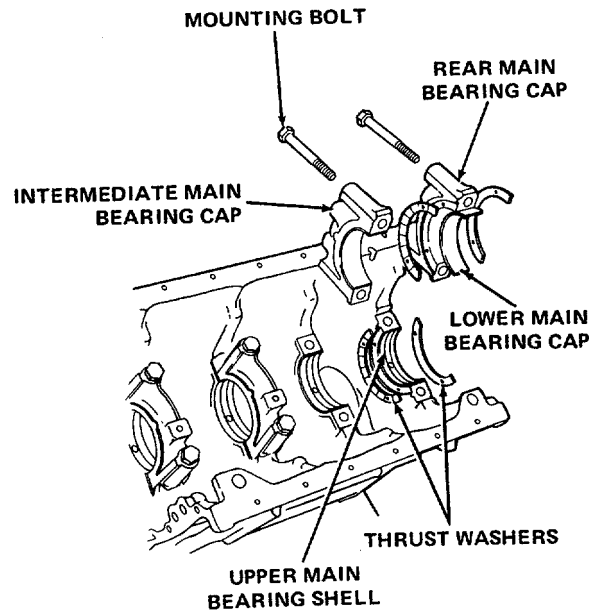
NOTE

When a new or reground crankshaft is installed, ALL new main and connecting rod (upper and lower) bearing shells and new thrust washers must also be installed.

43. Main bearing shells (upper)

Install shells in their original positions. Ensure that bearing tangs fit into grooves in bearing supports.

Upper main bearing shells have oil grooves.

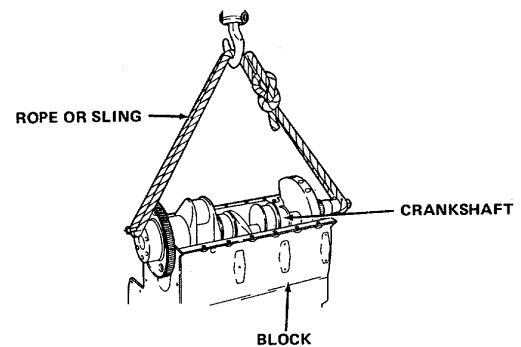


WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to crankshaft. Before lifting, be sure load is balanced.

44. Crankshaft

Apply clean MIL-L-2104 oil to all crankshaft journals. Lower crankshaft in place with a suitable lifting device equipped with heavy rope or a sling, so that timing marks on crankshaft timing gear and idler gear match.



6-11. CRANKSHAFT AND FLYWHEEL (CONT)

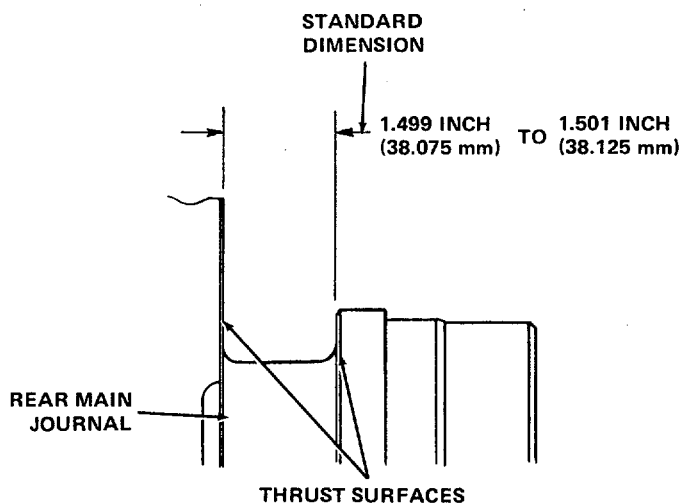
Location/Item	Action	Remarks
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CAUTION

Crankshaft damage may occur if grooved side of thrust washer is not faced toward crankshaft thrust surface during reassembly.

NOTE

If the crankshaft thrust surfaces were reground, oversize thrust washers may have to be installed on one or both sides of the rear main journal. Consult the chart below.



Thrust Washer Size		Minimum Thickness		Maximum Thickness	
inch	(mm)	inch	(mm)	inch	(mm)
Standard		0.1190	(3.023)	0.1220	(3.099)
Oversize					
0.005	(0.127)	0.1240	(3.150)	0.1270	(3.226)
0.010	(0.254)	0.1290	(3.277)	0.1320	(3.353)

- | | | |
|---------------------------------|--|--|
| 45. Thrust washers (upper half) | Carefully clean and install on each side of rear main bearing support. | |
| 46. Main bearing shells (lower) | Install in same bearing caps from which they were removed. Ensure that bearing tangs fit into grooves in bearing caps. | Lower main bearing shells have no oil grooves. |

6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
47. Main bearing caps (intermediate)	Install in their original positions.	
48. Thrust washers (lower half)	Install in their original positions.	
49. Main bearing caps (rear)	<p>Install in their original positions. Apply MIL-T-22361 thread compound to bolt threads and bolt head contact area, and tighten bolts hand tight. Strike caps sharply with a soft hammer to seat them properly. Torque all bolts (except rear main bearing bolts) to 120 to 130 ft lb (163 to 176 N.m) starting with center bearing cap bolts and working alternately towards both ends of block. Torque rear main bearing bolts to 40 to 50 ft lb (54 to 68 N.m). Strike both ends of crankshaft two or three sharp blows with a soft hammer to ensure proper positioning of rear main bearing cap. Torque all bearing bolts to 120 to 130 ft lb (163 to 176 N.m).</p>	<p>If bearings have been installed properly with all main bearing caps bolted tightly, the crankshaft will turn freely by hand.</p>
50. Crankshaft end play check	<p>Install a dial indicator near crankshaft timing pulley. Check end play by moving crankshaft toward dial indicator with screwdriver. Keep a constant pressure on pry bar and set dial indicator to zero. Move pry bar to other side of bearing cap. Force the crankshaft in opposite direction and note amount of end play on dial. The end play should be 0.004 to 0.011 inch (0.102 to 0.279 mm) with new parts or a maximum of 0.018 inch (0.457 mm) with used parts. If there is insufficient end play, check rear main bearing for misalignment. Check for dirt on thrust washers. Aline bearing or replace thrust washers if needed.</p>	<p>The diagram illustrates the setup for checking crankshaft end play. A dial indicator is positioned to measure the axial movement of the crankshaft. A hand is shown using a screwdriver to move the crankshaft towards the dial indicator. A pry bar is used to apply pressure to the bearing cap. The timing gear is also labeled in the diagram.</p>

6-11. CRANKSHAFT AND FLYWHEEL (CONT)

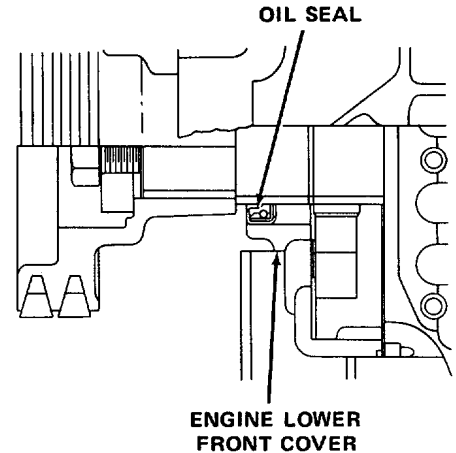
Location/Item	Action	Remarks
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CAUTION

Equipment damage through oil loss may occur if oil seals are damaged during installation.

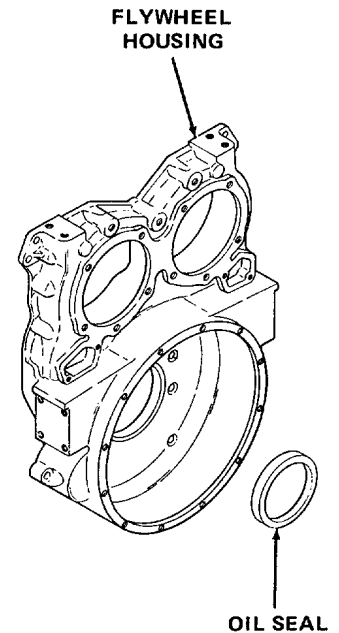
51. Front oil seal

Coat lip of new oil seal lightly with MIL-G-10924 grease. Position seal in engine lower front cover with lip of seal pointed toward inner face of cover. Place engine lower front cover in an arbor press with the inner face down. Press oil seal in until the seal is flush with outside face of cover. Remove excess sealant.



52. Rear oil seal

Support inner face of flywheel housing on a flat surface. If the new seal is not pre-coated, apply MIL-S-45180 sealing compound to the outside of metal casing. Position seal with lip pointed toward inner face of housing. Coat lip of oil seal lightly with MIL-L-2104 oil. Press oil seal into housing until seal is flush with outside of housing. Remove excess sealant.



6-11. CRANKSHAFT AND FLYWHEEL (CONT)

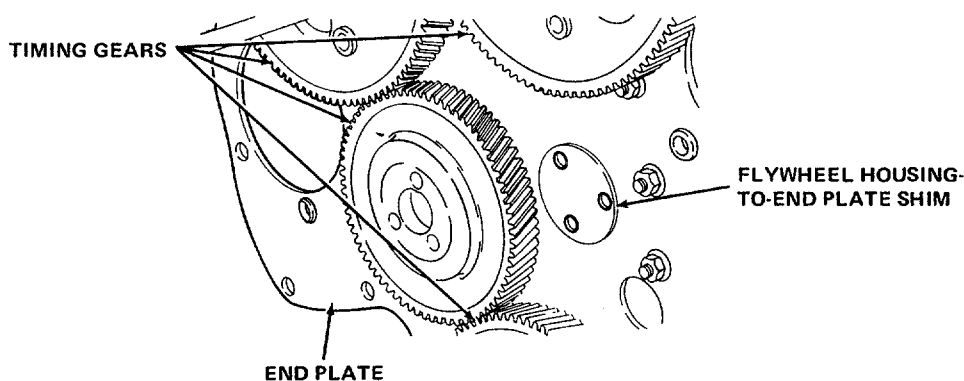
Location/Item	Action	Remarks
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WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to flywheel housing. Before lifting, be sure load is balanced.

53. Flywheel housing positioning	Support housing with a suitable lifting device and position it near the engine block.	
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54. Timing gears	Lubricate all gear teeth with MIL-L-2104 oil.	
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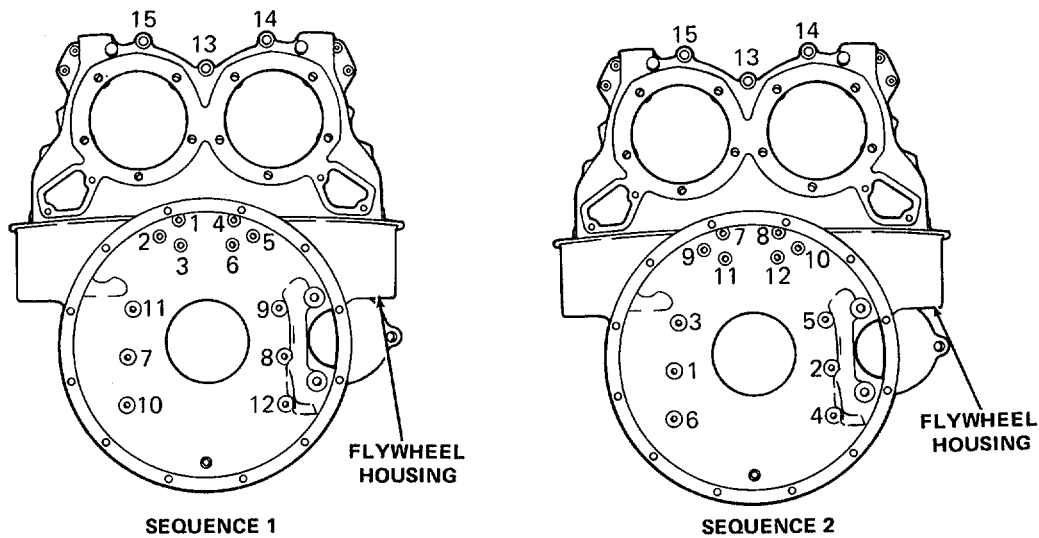


55. Flywheel housing gasket	Position new gasket on the rear face of end plate.	
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56. Flywheel housing-to-end plate shim	Apply MIL-G-10924 grease to shim and install on end plate.	
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6-11. CRANKSHAFT AND FLYWHEEL (CONT)

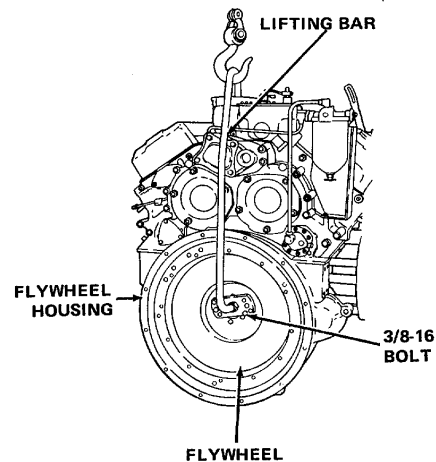
Location/Item	Action	Remarks
57. Flywheel housing	Thread pilot studs into cylinder block. Guide housing into position against end plate by sliding housing over crankshaft with an oil seal expander. Remove expander and studs. Install mounting bolts and washers. Tighten bolts fingertight, beginning with No. 4 in sequence 1. Refer to sequence 2 and torque bolts No. 11 and 12 to 19 to 23 ft lb (26 to 31 N.m) and bolts No. 7 through 10 to 40 to 45 ft lb (54 to 61 N.m). Torque remaining bolts to 25 to 30 ft lb (34 to 41 N.m).	



WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to flywheel. Before lifting, be sure load is balanced.

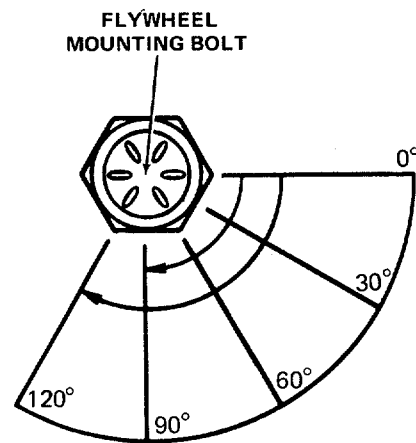
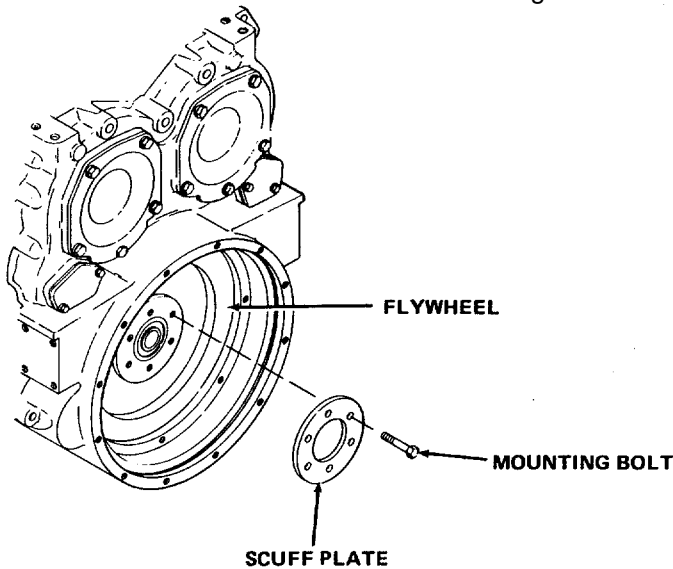
58. Flywheel	Thread guide studs into holes on crankshaft. Attach lifting bar with two 3/8-16 bolts of suitable length and lift flywheel into position on crankshaft and inside of flywheel housing. Support flywheel and remove lifting bar.
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6-11. CRANKSHAFT AND FLYWHEEL (CONT)

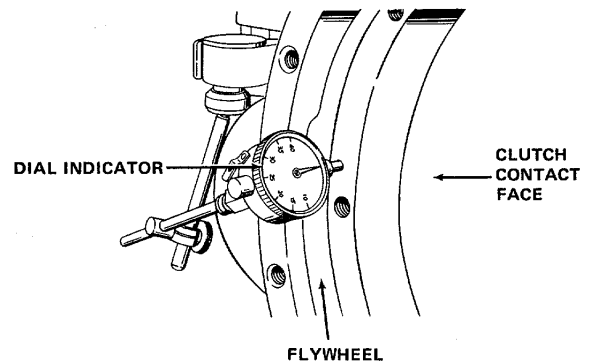
Location/Item	Action	Remarks
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59. Scuff plate
 Thread two mounting bolts (across from each other) through scuff plate and into flywheel and crankshaft. Tighten bolts hand tight. Remove guide studs. Apply MIL-T-22361 thread compound to threads and to bolt head contact areas of remaining bolts. Wipe off excess thread compound. Thread bolts in and tighten hand tight. Remove bolts used as temporary flywheel retainers, coat threads with thread compound and reinstall fingertight. Torque all bolts in an opposite (across from each other) pattern to 50 ft lb (68 N.m). Turn bolts an additional 90 to 120 degrees to obtain clamping.



60. Flywheel runout check
 Mount a dial indicator on the flywheel housing. Check flywheel runout at the clutch contact face. The maximum allowable runout is 0.001 inch (0.0254 mm) indicator reading per inch of radius. If runout exceeds limits, remove flywheel and clean flywheel-to-crankshaft mating area. Reinstall flywheel and torque bolts. Clamp bolts accurately. Recheck runout. If runout exceeds limits, replace flywheel.

The radius is measured from center of flywheel to outer edge of clutch contact surface.



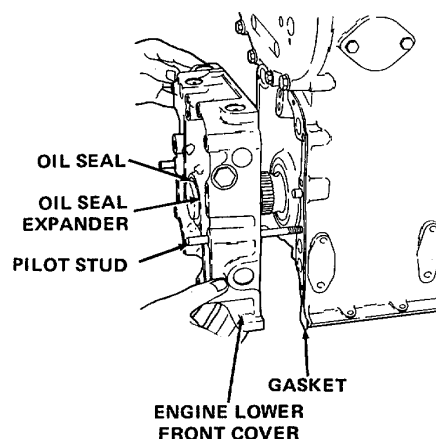
6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
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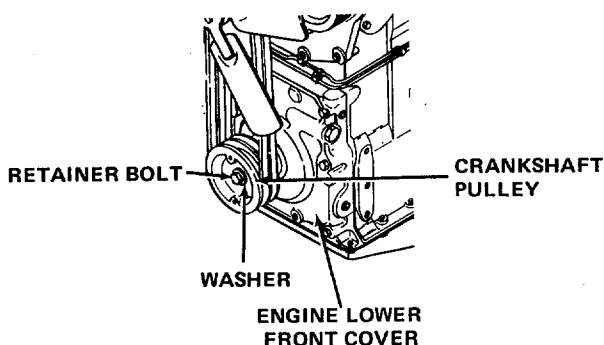
CAUTION

Damage to oil pump or drive gear will result if engine lower front cover is forced onto crankshaft. Aline gear teeth before pushing cover against gasket and block.

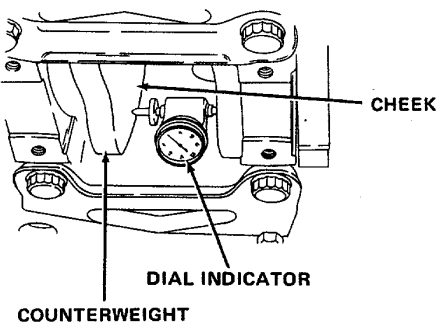
61. Engine lower front cover	<p>Position a new cover gasket on engine block. Install an oil seal expander over front end of crankshaft. Thread two 3/8-16 pilot studs approximately 8 inches (20 cm) into opposite bolt holes in the cylinder block. Apply a light coat of MIL-G-10984 grease to oil seal lip. Slide cover over oil seal expander and pilot studs. Push cover forward until inner rotor of oil pump contacts pump drive gear on crankshaft. Rotate crankshaft slightly to aline teeth, then push cover up against gasket and block. Remove oil seal expander and pilot studs. Install mounting bolts and lockwashers. Torque bolts 30 to 35 ft lb (41 to 47 N.m).</p>	
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62. Crankshaft pulley	<p>Install pulley in position on end of crankshaft with washer and retainer bolt. Torque bolt to 200 to 220 ft lb (271 to 298 N.m).</p>	
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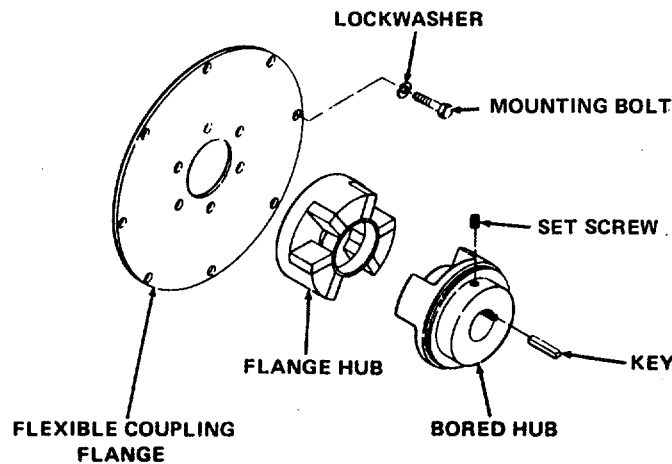
6-11. CRANKSHAFT AND FLYWHEEL (CONT)

Location/Item	Action	Remarks
63. Crankshaft counterweight check	<p>Rotate crankshaft clockwise until crankshaft counterweights at rear connecting rod journal are in the 6 o'clock position. Center punch a hole in the inside face of each counterweight cheek, 1/4 inch (6.35 mm) from lower end of each counterweight. Install a dial gage in center punch holes in cheek of each counterweight. Set dial indicator at zero. Rotate the crankshaft to the 3 and 9 o'clock positions. Note indicator readings at the 3, 6, and 9 o'clock counterweight positions. The maximum allowable variation is 0.0045 inch (0.1143 mm) total indicator reading.</p>	

CAUTION

Equipment damage due to crankshaft distortion may occur if flexible coupling is misaligned during installation. Install coupling on engine carefully.

64. Flexible coupling	<p>Position flange, flange hub, bored hub, set screw, and key as a unit against the flywheel. Install flange mounting bolts and lockwashers. Tighten bolts securely.</p>	
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6-12. BEARINGS

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

INITIAL SETUP:

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Diesel fuel oil (Item 6, Appendix E)

Lubricating oil (Item 10, Appendix E)

References

Para 6-11 Crankshaft and flywheel

Troubleshooting Reference

Malfunction 4, step 6

**Equipment
Condition**

Para 5-16	Condition Description Engine removed and inverted.
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General Safety Instructions

Well-ventilated area required during cleaning
and inspection.

Location/Item	Action	Remarks
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REMOVAL

1. Crankshaft Remove in accordance with paragraph 6-11.

CAUTION

Equipment damage could occur if bearing caps or shells are not returned to their original positions. Main bearing caps are numbered 1, 2, 3, etc. for ease of reassembly. Bearing shells are not numbered. Note the position of each bearing cap and shell during disassembly.

2. Bearing shells Remove from bearing caps and bearing supports.

6-12. BEARINGS (CONT)

Location/Item	Action	Remarks
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CLEANING OF BEARING SHELLS

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- * Do not inhale vapor.
- * Work in a well-ventilated area.
- * Do not use near open flame, sparks, or excessive heat.

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

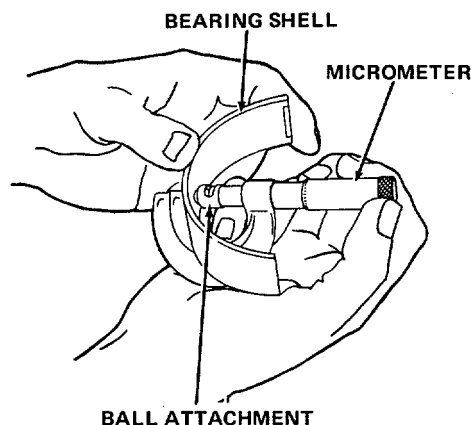
- | | | |
|----------------------------|---|--|
| 3. All main bearing shells | Wash in clean VV-F-800 diesel fuel and dry with compressed air. | |
|----------------------------|---|--|

INSPECTION OF BEARING SHELLS

- | | | |
|-------------------|---|--|
| 4. Bearing shells | Inspect for scoring, pitting, flaking, etching, loss of babbitt, signs of overheating, and bright spots on backs of shells. Replace bearings that are damaged, show excessive wear, or have bright spots. | |
|-------------------|---|--|

Bright spots indicate that shells have been moving in caps.

- | | | |
|----------------------------|---|--|
| 5. Bearing shell thickness | If bearing shells are free of excessive wear, bright spots, and damage, measure shell thickness. Shells should not be less than 0.1230 inch (3.1242 mm) thick. If any bearing shell measures less than 0.1230 inch (3.1242 mm), replace all bearing shells. | |
|----------------------------|---|--|



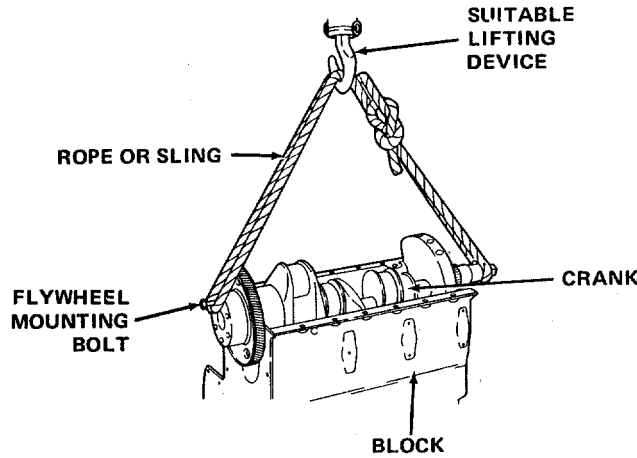
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|---|--|--|
| 6. Bearing shell and crankshaft journal preparation | Position upper main bearing shells in bearing supports. Lubricate crankshaft main bearing journals with MI L-L-2104 oil. | |
|---|--|--|

6-12. BEARINGS (CONT)

Location/Item	Action	Remarks
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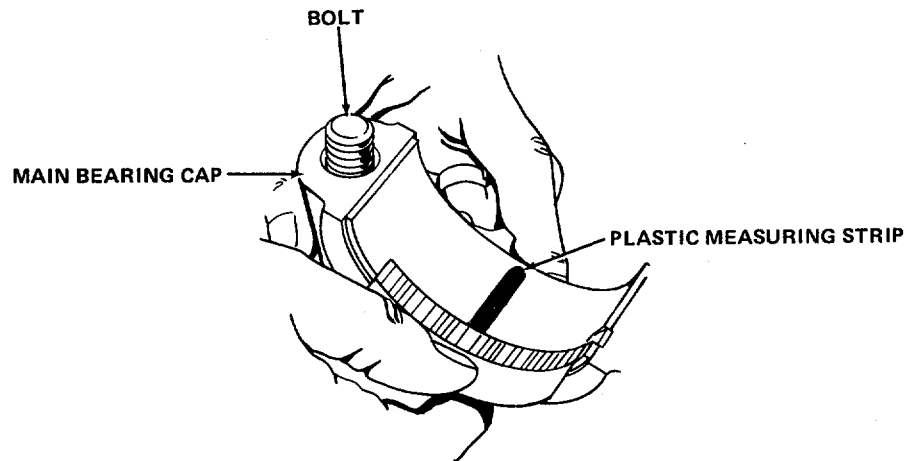
WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to crankshaft. Before lifting, be sure load is balanced.



- 7. Crankshaft mounting
Thread a flywheel mounting bolt into crankshaft at flywheel mounting. Using a suitable lifting device equipped with a rope or sling, lift and position crankshaft in block with bearing journals resting on shells.

- 8. Bearing shell and crankshaft journal clearance
Measure clearance between main bearing shells and crankshaft journals as follows:
 - a. Wipe excess oil from crankshaft journal, and place a soft plastic measuring strip the full width of the bearing shell about 1/4 inch (6.35 mm) off center.



6-12. BEARINGS (CONT)

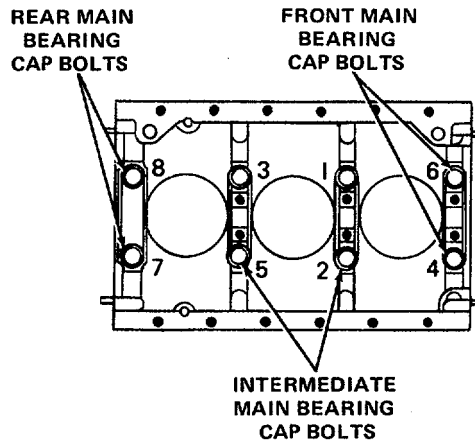
Location/Item	Action	Remarks
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- b. Rotate crankshaft about 30 degrees from bottom dead center; then install lower bearing shells and caps.

NOTE

Bolts will seat better if bolt caps are rapped sharply with a soft hammer after being installed hand tight.

- c. Torque front and intermediate main bearing cap bolts to 120 to 130 ft lb (163 to 176 N.m), in an alternating pattern as shown.



- d. Torque rear main bearing cap bolts to 40 to 50 foot pounds (54 to 68 N.m).
- e. Remove all bearing cap bolts and caps. Use lifting device to remove crankshaft, and remove the flattened plastic strip.
- f. Compare width of flattened plastic strip at its widest point with graduations on envelope gage to determine clearance encountered. The number within the graduation on the envelope indicates bearing clearance in thousandths of an inch.

9. Clearance limits

The clearance between a crankshaft journal and its bearing shell should be not greater than 0.006 inch (0.1524 mm). Replace all bearing shells if any must be replaced.

6-12. BEARINGS (CONT)

Location/Item	Action	Remarks
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CAUTION

Remove all crankshaft journal ridges before reassembling bearing shells and caps. Otherwise, damage to shells and crankshaft could occur.

NOTE

New bearing shells will allow a clearance of 0.001 to 0.004 inch (0.0254 to 0.1016 mm), between journal and shell.

- | | | |
|-------------------------|--|--|
| 10. Bearing shell taper | Taper may be indicated when one end of flattened plastic strip is wider than the other. Measure each end of the plastic; the difference between readings is the approximate amount of taper. Replace all bearing shells if taper on any shell permits a clearance of 0.006 inch (0.1524 mm) between journal and shell. | |
|-------------------------|--|--|

INSTALLATION**CAUTION**

Equipment damage could occur if bearing caps or shells are not returned to their original positions. Follow directions noted during disassembly.

- | | | |
|--------------------|---|--|
| 11. Bearing shells | Install in bearing caps and bearing supports. | |
| 12. Crankshaft | Install in accordance with paragraph 6-11. | |
-

6-13. WATER PUMP

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection/Repair
- d. Reassembly

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Shop equipment, automotive maintenance
and repair, common No. 1
SN 4910-00-754-0654

Pump mounting gasket

Sealing compound (Item 14, Appendix E)

Equipment Condition

Para	Condition Description
4-37	Water pump removed.

Materials/Parts

Pump cover gasket

Seal assembly

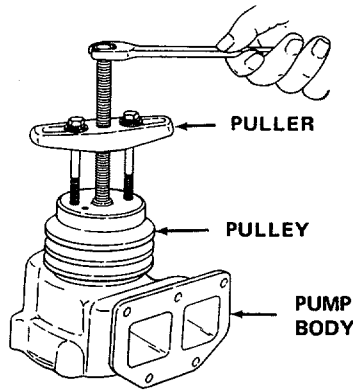
Special Environmental Condition

Well-ventilated area required during cleaning.

Location/Item	Action	Remarks
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DISASSEMBLY

1. Pulley Matchmark pulley and shaft. Remove pulley with puller.



2. Pump cover Remove mounting bolts, cover, and gasket. Discard gasket.

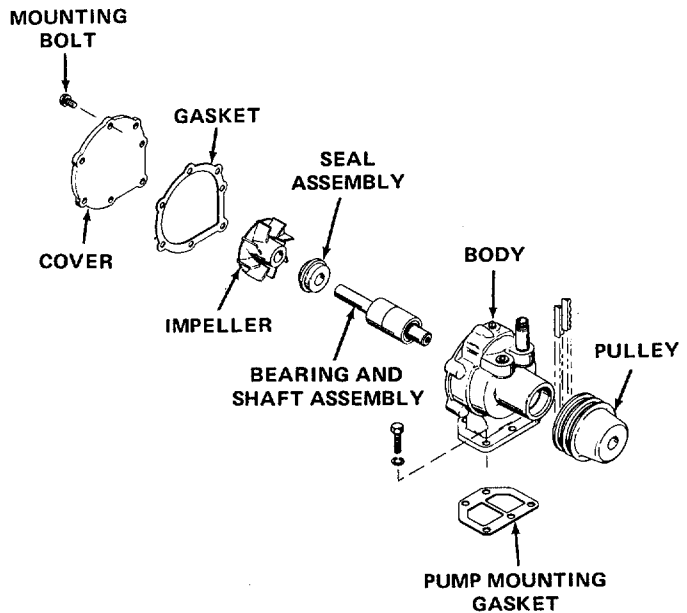
6-13. WATER PUMP (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

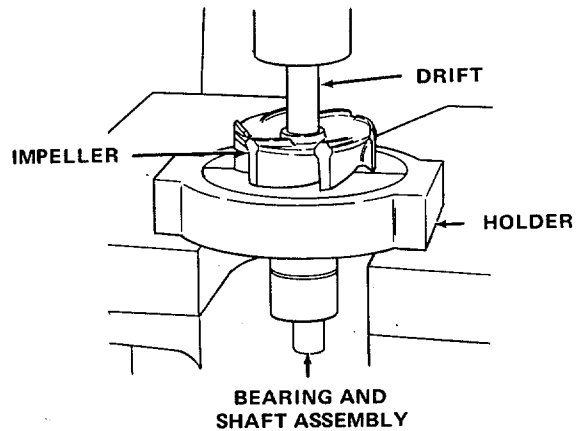
CAUTION

Bearing damage may occur if pump is disassembled by pushing on end of pump shaft.

- | | | |
|--|--|--|
| 3. Bearing and shaft assembly, seal assembly, and impeller | Remove from pump body as a unit by pressing on bearing outer race. | |
|--|--|--|



- | | | |
|--|---|--|
| 4. Bearing and shaft assembly (with seal assembly) | Remove by pressing shaft end out of impeller with drift and holder. Seal assembly will remain attached to bearing and shaft assembly. | |
|--|---|--|



- | | | |
|------------------|--|---|
| 5. Seal assembly | Remove from bearing and shaft assembly. Discard seal assembly. | Pump mounting gasket may have been removed during removal from engine. No need to re- |
| 6. Pump body | Remove and discard gasket. | move plug or connector. |

6-13. WATER PUMP (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CLEANING

- | | | |
|-------------------------------|---|--|
| 7. Bearing and shaft assembly | Clean by wiping with clean lint-free cloth. | |
|-------------------------------|---|--|

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Work in a well-ventilated area.**
- **Do not use near open flame, sparks, or excessive heat.**

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | | |
|-----------------------------|---|--|
| 8. All remaining pump parts | Wash with clean VV-F-800 diesel fuel and dry with compressed air. | |
|-----------------------------|---|--|

INSPECTION/REPAIR

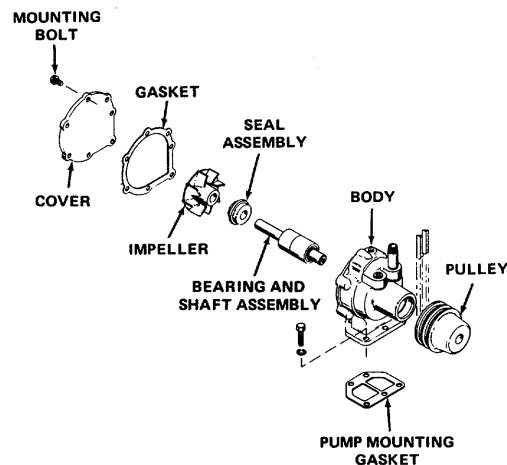
- | | | |
|-------------|---|--|
| 9. Impeller | Examine for damage and excessive wear, especially where impeller contacts seal. Replace if worn or damaged. | |
|-------------|---|--|

- | | | |
|--------------------------------|---|--|
| 10. Bearing and shaft assembly | Discard if bearing is tight, rough, or damaged. | |
|--------------------------------|---|--|

- | | | |
|------------|---|--|
| 11. Pulley | Inspect for cracks, excessive rust, or other damage. Replace if damaged in any way. | |
|------------|---|--|

- | | | |
|---------------|--|--|
| 12. Pump body | Inspect for cracks, excessive rust, or other damage. Ensure plug and connector are present and in good condition; replace if necessary. Replace pump body if damaged in any way. | |
|---------------|--|--|

- | | | |
|----------------|---|--|
| 13. Pump cover | Inspect for cracks and excessive rust. Replace if damaged in any way. Replace mounting bolts if rusty or threads are damaged. | |
|----------------|---|--|



6-13. WATER PUMP (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

REASSEMBLY

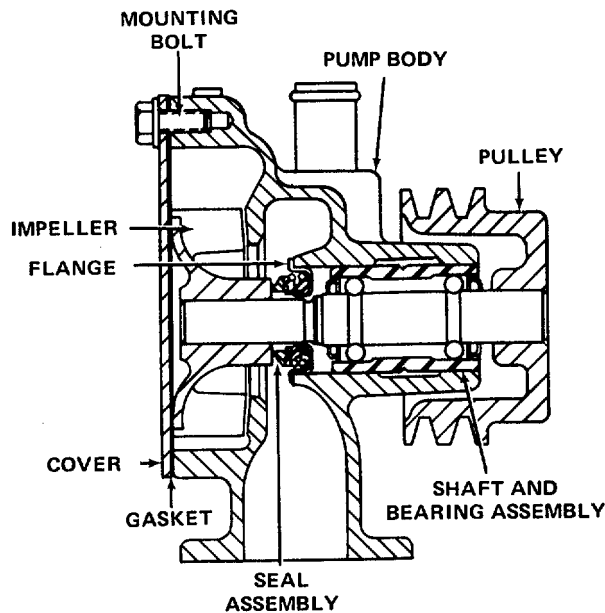
- | | | |
|---------------|---|--|
| 14. Pump body | Position with cover side down on a solid block of wood. | |
|---------------|---|--|

CAUTION

Bearing damage may occur if pump is assembled by pushing on end of pump shaft.

- | | | |
|--------------------------------|---|--|
| 15. Bearing and shaft assembly | Position at opening on top of pump body. Apply pressure to outer bearing race until it is flush with outer face of pump body. | |
|--------------------------------|---|--|

- | | | |
|-------------------|--|---|
| 16. Seal assembly | Lightly coat outside diameter of new seal assembly with MIL-S-45180 sealing compound. Support face of body and outer race of bearing. Apply pressure to seal outer flange and install seal assembly. Remove dirt and metal particles from face of seal with lint-free cloth. | Properly installed flange should contact pump body. |
|-------------------|--|---|



- | | | |
|--------------|--|--|
| 17. Impeller | Position pulley end of shaft on bed of an arbor press. Push impeller on shaft until impeller is flush with cover end of pump body. | |
|--------------|--|--|

6-13. WATER PUMP (CONT)

Location/Item	Action	Remarks
18. Pulley	Place on arbor press bed with sheave end up. Place a suitable rod between ram of press and impeller end of shaft. Aline pulley and shaft matchmarks. Press shaft into pulley until pulley is in original position.	
19. Pump cover	Position new cover gasket on pump body. Install cover over gasket with mounting bolts. Torque bolts to 6 to 7 ft lb (8 to 9 N.m).	
20. Seal assembly adjustment	Run pump dry at 1200 rpm for a minimum of 30 seconds, or as required, to seat seal assembly.	

6-14. RADIATOR

This task covers:

- a. Inspection/Repair
- b. Cleaning

INITIAL SETUP:

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

**Equipment
Condition**
Para

Condition Description

Shop equipment, automotive maintenance
and repair, common No. 1
NSN 4910-00-754-0654

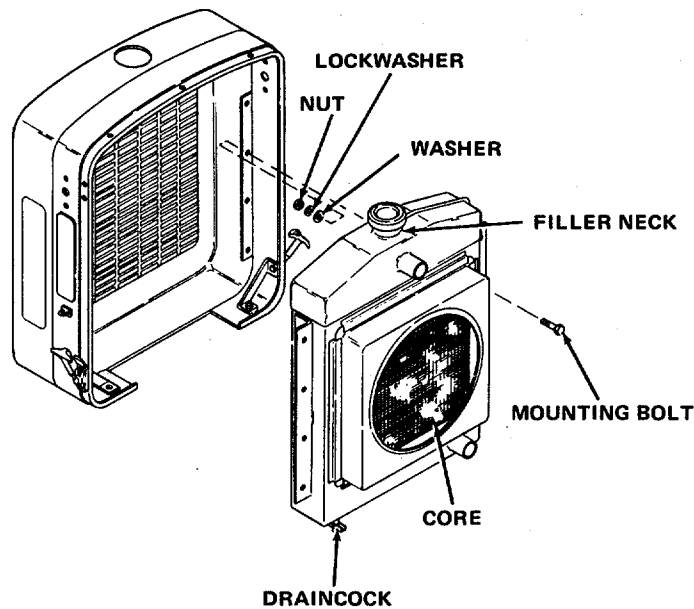
4-38

Radiator removed from engine.

Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION/REPAIR

1. Radiator core Inspect for accumulated dirt, broken tubes and fins, or damage of any kind. If radiator core is damaged, replace it.



2. Draincock Inspect for smooth closing and opening, excessive rust, corrosion, or other damage. Replace draincock if hard to close or open, or if excessively rusty or corroded. Tighten replacement draincock securely.

6-14. RADIATOR (CONT)

Location/Item	Action	Remarks
3. Mounting bolts, nuts, washers, and lockwashers	Inspect for excessive rust, corrosion, or other damage. Replace if necessary.	
4. Filler neck	Inspect for excessive corrosion or damage preventing proper seating of filler cap.	

CLEANING**WARNING**

Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

Live steam used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

CAUTION

Radiator damage may occur if gasoline, kerosene, or diesel fuel is used as a cleaning solvent.

5. Radiator core	Remove accumulated dust and dirt with compressed air. If oil is present with dirt, steam clean radiator. Dry with compressed air.	
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APPENDIX A

REFERENCES

A-1. PUBLICATIONS INDEX

The following index should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to material covered in this manual.

Index of Administrative Publications..... DA Pam 310-1

A-2 FORMS AND RECORDS

Equipment Inspection and Maintenance WorksheetDA Form 2404

Quality Deficiency Report SF 368

Recommend Changes to Publications and Blank Forms DA 2028

A-3. TECHNICAL MANUALS

Administrative Storage Requirements TM 740-90-1

Care and Maintenance of Pneumatic Tires TM 9-1870-1

Hand Portable Fire Extinguishers for Army Users.....TM 5-4200-200-10

Organizational, Direct Support and General Support

Maintenance Repair Parts and Special Tools List,

Centrifugal Pump TM 5-4320-300-24P

Procedures for Destruction of Equipment to Prevent Enemy Use TM 750-244-3

The Army Maintenance Management System (TAMMS) TM 38-750

A-4. OTHER PUBLICATIONS

Fuel, Lubricants, Oils and Waxes..... C91001L

A-1/(A-2 blank)

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. GENERAL

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance categories.

b. The Maintenance Allocation Chart (MAC) in section II designates overall responsibility for the performance of maintenance functions on the identified end item or component. The implementation of the maintenance functions upon the end item or component will be consistent with the assigned maintenance functions.

c. Section III lists the special tools and test equipment required for each maintenance function as referenced from section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. MAINTENANCE FUNCTIONS

Maintenance functions will be limited to and defined as follows:

a. *Inspect.* To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. *Test.* To verify serviceability by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. *Service.* Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d. *Adjust.* To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. *Aline.* To adjust specified variable elements of an item to bring about optimum or desired performance.

f. *Calibrate.* To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. *Install.* The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. *Replace.* The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. *Repair*. The application of maintenance services¹ or other maintenance actions² to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. *Overhaul*. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. *Rebuild*. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipments/components.

B-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II.

a. *Column (1)-Group Number*. Column 1 lists functional group code numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. *Column (2)-Component/Assembly*. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. *Column (3)-Maintenance Function*. Column 3 lists the functions to be performed on the item listed in Column 2. (For detailed explanation of these functions, see paragraph B-2.)

d. *Column (4)-Maintenance Category*. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time; and quality assurance/ quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance categories are as follows:

- C..... Operator or crew.
- O.....Organizational maintenance.
- F.....Direct support maintenance.
- H..... General support maintenance.
- D..... Depot maintenance.

e. *Column (5)-Tools and Equipment*. Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. *Column (6)-Remarks*. This column shall, when applicable, contain a letter code, in alphabetical order, which shall be keyed to the remarks contained in Section IV.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III.

a. *Column (1)-Reference Code*. The tool and test equipment reference code correlates with a code used in the MAC, Section II, Column 5.

¹ Services - inspect, test, service, adjust, aline, calibrate, or replace.

² Actions - welding, grinding, riveting, straightening, facing, remachining, or resurfacing.

- b. *Column (2)*-Maintenance Category. The lowest category of maintenance authorized to use the tool or test equipment.
- c. *Column (3)*-Nomenclature. Name or identification of the tool or test equipment.
- d. *Column (4)*-National Stock Number. The National stock number of the tool or test equipment.
- e. *Column (5)*-Tool Number. The manufacturer's part number.

B-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV.

- a. *Column (1)*-Reference Code. The code recorded in column 6, Section II.
- b. *Column (2)*-Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

Section II MAINTENANCE ALLOCATION CHART

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Category*					(5) Tools And Equipment	(6) Remarks
			C	O	F	H	D		
01	Air Cleaner Assembly	Inspect Service Replace	0.1 0.2 0.2	0.5				1	A, M
02 0201	Exhaust System Exhaust Heat Shield	Inspect Replace Repair	0.1	0.3	0.3			1, 2	B
0202	Weather Cap	Inspect Repair Replace	0.1	0.3 0.2				1	C
0203	Exhaust Pipe	Inspect Replace	0.1	0.3				1,2	G
0204	Muffler	Inspect Replace	0.1	0.5				1, 2	G
0205	Exhaust Manifold Pipe	Inspect Replace	0.1	0.5					
03 0301	Electrical System Battery Box and Cover	Inspect Replace	0.1	1.0				1,2	G
0302	Battery and Cables	Inspect Test Service Replace	0.1 0.3	0.2 0.5 1.0				1,2	D, I
0303	Alternator Assembly	Inspect Replace Test Repair	0.1	1.0	1.0 2.5			1, 2, 3	I, F, L, G
0304	Starter Motor Assembly	Inspect Replace Test Repair	0.1	0.5	0.8 2.0			1, 2, 3	I, H, G
0305	Main Wiring Harness	Inspect Replace Repair	0.2	1.0	2.0			1, 2, 3	I, J

*See footnote on page B-8

Section II MAINTENANCE ALLOCATION CHART

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Category*					(5) Tools And Equipment	(6) Remarks
			C	O	F	H	D		
0306	Alternator and Fan Drive Belts	Inspect Adjust Replace	0.2					1	E, G
04	Fuel System			0.3					
0401	Speed Regulating Throttle Cable	Inspect Replace	0.1	0.5				1,2	G
0402	Air Shutdown Solenoid	Inspect Service Replace Repair	0.2 0.2		1.0			1, 2, 3	K, I
0403	Blower Assembly	Inspect Replace Repair			1.5				
0404	Fuel Tank	Inspect Service Replace Repair	0.2 0.2		2.0	3.0		1, 3	M, B, N
0405	Fuel Lines, Hoses, and Fittings	Inspect Replace	0.1		1.5			1	G, N
0406	Fuel Strainer	Inspect Replace	0.1	0.2				2	A, N
0407	Fuel Pump Assembly	Inspect Repair Replace	0.1		1.0			3, 4	G, N
0408	Fuel Filter	Inspect Replace	0.1		3.0			2	A, N
0409	Fuel Injectors	Inspect Replace Repair	0.1	0.5				3, 4	O, N
0410	Fuel Control Tube	Inspect Replace Repair	0.1		2.5			3, 4	G, N
0411	Starting Aid Control Cable	Inspect Replace	0.1		2.0			1	G
0412	Ether Cylinder	Inspect Replace	0.1	0.4				1	A
0413	Atomizer	Inspect Replace	0.1		0.2			1	G

*See footnote on page B-8

Section II MAINTENANCE ALLOCATION CHART

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Category*					(5) Tools And Equipment	(6) Remarks
			C	O	F	H	D		
0414	Overspeed Governor	Inspect Service Replace		0.5 1.0 2.0				4	G, W
0415	Mechanical Governor	Inspect Service Replace		0.5 1.0 2.0				4	G, W
05	Engine Assembly	Inspect Service Replace Repair Overhaul	0.4 0.5	1.0	6.0 4.0	4.0	60.0	1,2,3,4	
0501	Lubrication System Oil Filter	Inspect Replace	0.1	0.2				2	A
	Oil Cooler	Inspect Replace			0.6 0.6				
	Switch, Low Oil Pressure Cutout	Inspect Test Replace	0.1	0.4 0.5				1, 2	I, P
	Oil Lines and Fittings	Inspect Replace	0.1	0.3				1	G
	Oil Pump	Inspect Replace				0.2 4.0		3, 4	G
0502	Cooling Fan	Inspect Replace Repair	0.1	1.0	2.0			1	G
0503	Crankcase, Block, and Cylinder Head	Inspect Replace Repair		0.1	4.0	6.0		3, 4	Q
0504	Valves, Camshaft, and Timing Gears	Inspect Replace Repair				2.0 10.0 10.0		3, 4	R
0505	Pistons and Connecting Rods	Inspect Replace Repair				1.0 6.0 6.0		3, 4	S
0506	Crankshaft and Flywheel	Inspect Replace Repair				3.0 15.0 20.0		3, 4	T
0507	Bearings	Inspect Replace				0.5 5.0			

*See footnote on page B-8

Section II MAINTENANCE ALLOCATION CHART

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Category*					(5) Tools And Equipment	(6) Remarks
			C	O	F	H	D		
0508	Water Pump	Inspect Repair Replace	0.1			3.0		1, 2	G
0509	Radiator	Inspect Service Replace Repair	0.1 2.0		2.5		2.0	1, 2	G
0510	Thermostat	Test Replace		0.5 0.5				1	
06	Pump Assembly	Inspect Service Replace Repair Overhaul	0.2 0.2		16.0 8.0	12.0		1,2,3,4	G
0601	Suction and Discharge Gage Valves, Lines, Hoses, and Fittings	Inspect Replace			0.2 1.0				
0602	Impeller, Shaft and Seals, Check Valve	Inspect Replace			2.0 4.0			3, 4	G, U
0603	Suction and Discharge Coupling Flanges	Inspect Replace Repair	0.1	2.0 2.0				1, 2	G
07	Control Panel Assembly	Inspect Replace Repair	0.1	1.0 2.0				1,2	G
0701	Instruments	Inspect Replace	0.1	2.0				1, 2	G
0702	Switches	Inspect Replace	0.2	1.0				1, 2	I, G
0703	Relays	Inspect Replace	0.2	1.0				1, 2	I, G
08	Trailer Assembly	Inspect Replace Repair	0.2		8.0 2.0			1, 2, 3	B
0801	Frame Assembly	Inspect Repair	0.2	1.0				1,2, 3	G

*See footnote on page B-8

Section II MAINTENANCE ALLOCATION CHART

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Category*					(5) Tools And Equipment	(6) Remarks
			C	O	F	H	D		
0802	Axle, Wheels, and Tires	Inspect	0.2					1, 2, 3	V, G
		Service	0.4						
		Replace		4.0					
0803	Trailer Wiring Harness	Repair		2.0				2	F, G, H
		Inspect	0.2						
0804	Springs	Repair		1.0				2	G
		Replace		2.0					
0805	Shock Absorbers	Inspect	0.2					2	G
		Replace		1.5					
0806	Taillight and Blackout Stoplights	Inspect	0.2					2	F, G, H
		Repair		0.5					
		Replace		0.5					

*Subcolumns are as follows:

- C-operator/crew
- O-organizational
- F-direct support
- H-general support
- D-depot

SECTION III TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL NATO STOCK NUMBER	TOOL NUMBER
1	O	Tool Kit, General Mechanics Automotive	5180-00-177-7033	
2	O	Shop Equipment, Automotive Maintenance and Repair, Common No. 1	4910-00-754-0654	
3	F, H	Shop Set, Automotive Repair Field Maintenance, Basic	4910-00-754-0705	
4	F, H	Tool Kit, Master Mechanics	5180-00-699-5273	

Section IV. REMARKS

Reference Code	Remarks
A	Replace element
B	Weld
C	Replace defective weather cap
D	Check specific gravity
E	Adjust belt tension
F	Insulation breakdown and continuity test
G	Repair by replacing defective components
H	Test for opens, grounds and shorts
I	Continuity test
J	Repair by replacing defective wire
K	Operational test
L	Test for known voltage
M	Service by cleaning filter
N	Repair by bleeding air from fuel system
O	Test timing and pressure output
P	Operational test
Q	Includes replacing valve seats, guides and main bearings
R	Includes replacing bearing, valves and gears
S	Includes replacing rings and rod bearings
T	Includes crankshaft grinding
U	Replace check valve
V	Pack wheel bearings
W	Adjust to specifications

APPENDIX C

COMPONENTS OF END ITEMS AND BASIC ISSUE ITEMS LISTS

Section I. INTRODUCTION

C-1. SCOPE

This appendix lists components of end item and basic issue items for the centrifugal pump unit to help inventory items required for safe and efficient operation.

C-2. GENERAL

The Components of End Item and Basic Issue Items are divided into the following sections:

a. *Section II.* Not applicable to this unit.

b. *Section III. Basic Issue Items.* These are the minimum essential items required to place the centrifugal pump unit in operation, to operate it, and to perform emergency repairs. Although shipped separately packaged BII must be with the centrifugal pump unit during operation and whenever it is transferred between property accounts. The illustrations will assist you with hard-to-identify items. This manual is your authority to request/requisition replacement BII, based on TOE/MTDE authorization of the end item.

C-3. EXPLANATION OF COLUMNS

The following provides an explanation of columns found in the tabular listings:

a. *Column (1)-Illustration Number (Illus Number).* This column indicates the number of the illustration in which the item is shown.

b. *Column (2)-National Stock Number.* Indicates the national stock number assigned to the item and will be used for requisitioning purposes.

c. *Column (3)-Description.* Indicates the National item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the FSCM (in parentheses) followed by the part number.

d. *Column (4)-Unit of Measure (U/M).* Indicates the measure used in performing the actual operational/maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in., pr).

e. *Column (5) Quantity required (Qty rqr).* Indicates the quantity of the item authorized to be used with/on the equipment.

Section III. BASIC ISSUE ITEMS

ILLUS NO.	NSN	Description FSCM & Part No.	Unit of Measure	Quantity Required
1	2540-00-670-2459	Bag, Pamphlet, Canvas (19207) 11676920	each	1
2	5140-00-772-4142	Bag, Tool (81349) MIL-B-43648-4	each	1
3	5120-00-223-7397	Pliers, Slip Joint, 8 inch (81348) GGG-P-471, Type II, Class 2, Style A	each	1
4	5120-00-222-8852	Screwdriver, Flat Tip, 1/4 inch Tip, 4 inch Blade lg. (81348) GGG-S-121 Type I, Style 1	each	2
5	N/A	Technical Manual TM 5-4320-300-14	each	1
6	5120-00-264-3796	Wrench, Open End, Adjustable, 0 to 1.322 inch opening, 12 inch (81348) GGG-W-631	each	2
7	5340-00-682-1508	Padlock, with Clevis, Chain, and 2 Keys	each	3

APPENDIX D**ADDITIONAL AUTHORIZATION LIST**

Section I. INTRODUCTION**D-1. SCOPE**

This appendix lists additional items you are authorized for the support of the centrifugal pump unit.

D-2. GENERAL

This list identifies items that do not have to accompany the centrifugal pump unit and that do not have to be turned in with it. These items are all authorized to you by CTA, MTOE, TDA, or JTA.

D-3. EXPLANATION OF LISTING

National stock numbers, descriptions, and quantities are provided to help you identify and request the additional items you require to support this equipment. The items are listed in alphabetical sequence by item name under the type document (i.e., CTA, MTOE, TDA, or JTA) which authorizes the item(s) to you.

D-1

SECTION II. Additional Authorization List

(1) NATIONAL STOCK NUMBER	(2) DESCRIPTION		(3)	(4)
	FSCM and PART NUMBER	USABLE ON CODE	U/M	QTY AUTH
4240-00-022-2946	(-) AUTHORIZED ITEMS Protector, Aural	DNN	Pr	1

APPENDIX E

EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

E-1. SCOPE

This appendix lists expendable supplies and materials you will need to operate and maintain the centrifugal pump unit. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

E-2. EXPLANATION OF COLUMNS

a. *Column (1)-Item Number.* This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., Dry Cleaning Solvent, Appendix E, item 4).

b. *Column (2)-Level.* This column identifies the lowest level of maintenance that requires the listed item.

C-Operator/Crew
O-Organizational Maintenance
F-Direct Support Maintenance
H-General Support Maintenance

c. *Column (3)-National Stock Number.* This is the National stock number assigned to the item; use it to request or requisition the item.

d. *Column (4)-Description.* Indicates the Federal item name, and, if required, a description to identify the item. The last line for each item indicates the part number followed by Federal Supply Code for Manufacturer (FSCM) in parentheses.

e. *Column (5)-Unit of Measure (U/M).* Indicates the measure used in performing the actual maintenance function. This measure is expressed by two-character alphabetical abbreviations (e.g., ea, in., pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

SECTION II. EXPENDABLE SUPPLIES AND MATERIAL LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	F, H		Abrasive Cloth, Crocus, P-C-458	ea
2	F, H		Abrasive Cloth, Emery, P-C-1673	ea
3	C, O, F, H	6850-00-181-7929	Antifreeze, Ethylene Glycol, MIL-A-46153	1 gal can
4	O		Baking Soda, EE-B-86	8 oz box
5	H		Coating, Rust Arresting, QPL-10036-10	gal
6	C, O, F, H		Fuel Oil, Diesel, VV-F-800	gal
7	Q, F, H	9150-00-190-0907	Grease, Automotive and Artillery, MIL-G-10924	5 gal can
8	F, H	9150-00-754-2595	Grease, Ball and Roller Bearing, MIL-G-18709	1 lb can
9	H		Lubricant, Cindol 1705 (73277)	oz
10	O, F, H	9150-00-186-6681	Oil, Lubricating, Internal Combustion Engine, MIL-L-2104	qt
11	O		Oil, Lubricating, Preservative, MIL-L-21260	qt
12	O		Oil, Preservative, Corrosion-Inhibited MIL-L-46002	qt
13	H		Prussian Blue Paste	oz
14	F, H		Sealing Compound, MIL-S-45180	oz
15	F		Solder, Rosin Flux Core, ASTM-B284-79	lb
16	O, F, H	6850-00-274-5421	Solvent, Dry Cleaning, P-D-680	5 gal can
17	F		Stone, Commutator Surfacing, MIL-S-17243	ea

SECTION II. EXPENDABLE SUPPLIES AND MATERIAL LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
18	O		Tape, Antiseize, MI L-T-27730	roll
19	O		Tape, Electrician's Insulating, MIL-T-50886	roll
20	F, H		Thread Compound, Antiseize, MIL-T-22361	oz

APPENDIX F

TORQUE LIMITS

Self-Locking Nut Breakaway Torque Values

Thread Size	Minimum Breakaway Torque (In. Lbs.)	Thread Size	Minimum Breakaway Torque (In. Lbs.)
10-32	2.0	5/8-18	32.0
1/4-28	3.5	3/4-16	50.0
5/16-24	6.5	7/8-14	70.0
3/8-24	9.5	1-12	90.0
7/16-20	14.0	1-1/8-12	117.0
1/2-20	18.0	1-1/4-12	143.0
9/16-18	24.0		

NOTE

To determine breakaway torque, thread nut onto screw or bolt until at least two threads stick out. Nut shall not make contact with a mating part. Stop the nut. Torque necessary to begin turning nut again is the breakaway torque. Do not reuse self-locking nuts that do not meet minimum breakaway torque.

F-1/(F-2 blank)

GLOSSARY
Section I. ABBREVIATIONS

amps	Amperes
°C	Degree Celsius
cm.....	Centimeter
cu	Cubic
EIR	Equipment Improvement Recommendations
°F	Degree Fahrenheit
ft	Foot; feet
ft lb	Foot pound
gal	Gallon
gpm	Gallons per minute
in	Inch
kg	Kilogram
kPa	Kilopascal
lb.....	Pound
m	Meter
mm	Millimeter
mph	Miles per hour
N•m	Newton-meter
NPT	National pipe thread
OZ	Ounce
phr	Pounds per hour
PMCS	Preventive maintenance checks and services
psi	Pounds per square inch
qt	Quart
rpm	Revolutions per minute
TMDE	Test, measurement, and diagnostic equipment

Section II. DEFINITION OF UNUSUAL TERMS

A

ABRASION-A scraped or scuffed area. A hose may become abraded if an unshielded portion of it rubs against a piece of bracket or another hose.

ACTUATE-To cause an action. When electric power is applied to a solenoid, it actuates a valve, causing a part in the valve to move.

AGITATE-To move or stir quickly.

ALINE-To arrange in a line vertically and/or horizontally.

ALLOCATION-Assignment of duties or materiels according to a plan.

APPROVED-Permitted to be used for a specific purpose by the person or group who is authorized to grant approval.

ARC-A discharge of electric current crossing a gap between two electrodes.

ASSEMBLY-A combination of parts that may be taken apart without destruction, which has no application or use of its own but is needed for the completeness of a more complex item with which it is combined, or to which it is attached.

B

BRINNELLED-A deformation of a bearing by an impact.

C

CAPACITY-The volume, amount, or quantity that can be held or contained.

CARBON MONOXIDE-A poisonous gas that is made while a fuel is burning, especially if there is not quite enough air. The gas is colorless, odorless, and tasteless, but it can cause illness or death. See the warnings on the Warning page at front of manual.

CHOCK-To place a block or wedge between a wheel or track and the ground to prevent a vehicle from moving.

COMBUSTION-A chemical change, especially oxidation, accompanied by the production of heat and light. A combustion engine functions by burning fuel to produce heat, i.e., energy.

COMPONENT-A part or a combination of parts which together accomplish a function.

COMPRESSED AIR-Air that is under pressure. When the compressed air in a hose or pipe is allowed to escape (such as when you use an air gun), the air moves very fast and is used to blow away dirt and chips for cleaning.

CONDENSATION-A liquid formed from a vapor. Moisture carried in warm air will condense when it reaches a cold area, such as the surface of a fuel tank in subzero weather.

CORROSION-A gradual wearing away caused by chemical action. Metals exposed to salt water are likely to corrode.

D

DEBRIS-The scattered remains of something broken or destroyed.

DEFLECT-To bend or move from a straight line.

DESCALING-The process of removing scale deposits from cooling system.

DETERIORATE-A worsening of condition usually as a result of age or hostile environment, as opposed to mechanical damage.

DIAMETRIC-Measurement across the center.

DISTORTION-The bending, twisting, or any other dynamic change of a surface.

E

EXHAUST-The gases that leave the engine through the tailpipe while the engine is running.

EXPENDABLE-An item that is not repairable and is discarded if damaged.

EXPOSURE-Being in the presence of something, or in contact with something. Skin is exposed to cleaning solvent when the solvent contacts the skin during cleaning operations.

F

FILTER-A device which removes dirt from the air or a fluid.

FLASH POINT-The lowest temperature at which the vapors of a solvent will ignite and burn.

FLUID-A substance that can flow; that is, either a gas or a liquid.

FORD-To cross a body of water.

FRAYED-Something which has been worn away or unraveled, usually by rubbing.

FRETTING-A wearing away or corroding of an area.

G

GASKET-A seal or packing used between matched machine parts or around pipe joints to prevent the escape of gas or fluid.

GOGGLES-A device used to protect the eyes from dust, dirt, flying chips, etc.

I

IMMERSE-To completely cover by fluid.

INHALATION-The act of breathing in. The breathing in or inhalation of carbon monoxide can cause illness or death.

INITIAL-The first or starting condition.

L

LEGIBLE-Capable of being read. A legible nameplate can be read; an illegible plate cannot.

M

MALFUNCTION-Occurs when a unit fails to operate normally.

MANUFACTURER-The company which makes an item or piece of equipment for sale.

MATERIEL-Equipment, apparatus, and supplies of an organization such as an army.

O

OBSTRUCTION-An obstacle.

P

PIVOT A short rod or shaft about which a related part rotates; the act of turning on or as if on a pivot.

PORT - A threaded hole through which fluid may pass, or pressure may be measured. Ports on the pump are used to connect hoses, and to measure pressure.

PRIME - The act of introducing a liquid into a pump to increase the pump's ability to overcome negative head pressure.

R

RACE - A grooved part of a component, such as a bearing, in which a moving part slides or rolls.

RADIATING - Spreading out from a center.

RECOMMENDATIONS - Suggestions for change; advice given usually to make an improvement.

REQUIRE - To demand or need.

RESPIRATION - The process of breathing; inhaling and exhaling.

S

SATURATED - Soaked or drenched with a liquid.

SCALDING - Burning with hot liquid or steam.

SCOPE - The extent of an activity or concept; the amount of information covered as in a book.

SEIZURE - The act of being held, bound; unable to function as usual.

SKIVE - To shave or cut off the surface of rubber.

SOLVENT - A liquid that can dissolve another substance.

SYMPTOM - The external sign or indication of a condition.

T

TIEDOWN - Strap or fastening device used to hold an object in position.

TORQUE Force around an axis. It produces a rotary or twisting motion, and is measured in foot pounds (ft lb) or newton-meters (N•m).

TRANSVERSE - Situated or lying across; crosswise.

V

VALVE - A device used to control the flow of a fluid.

VAPOR The gaseous form of any substance which is usually a liquid; vapors are present in the air around the substance.

VENTILATE - To provide with a source of fresh or uncontaminated air.

VISUAL - Visible; detected by the unaided eye.

VOLATILE - Evaporates rapidly at normal temperatures and pressures; unstable.

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
 1 decimeter = 10 centimeters = 3.94 inches
 1 meter = 10 decimeters = 39.37 inches
 1 dekameter = 10 meters = 32.8 feet
 1 hectometer = 10 dekameters = 328.08 feet
 1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
 1 decigram = 10 centigrams = 1.54 grains
 1 gram = 10 decigrams = .035 ounce
 1 dekagram = 10 grams = .35 ounce
 1 hectogram = 10 dekagrams = 3.52 ounces
 1 kilogram = 10 hectograms = 2.2 pounds
 1 quintal = 100 kilograms = 220.46 pounds
 1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
 1 deciliter = 10 centiliters = 3.38 fl. ounces
 1 liter = 10 deciliters = 33.81 fl. ounces
 1 dekaliter = 10 liters = 2.64 gallons
 1 hectoliter = 10 dekaliters = 26.42 gallons
 1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	To	Multiply by	To change	To	Multiply by
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
----	------------------------	----------------------------	---------------------	----

