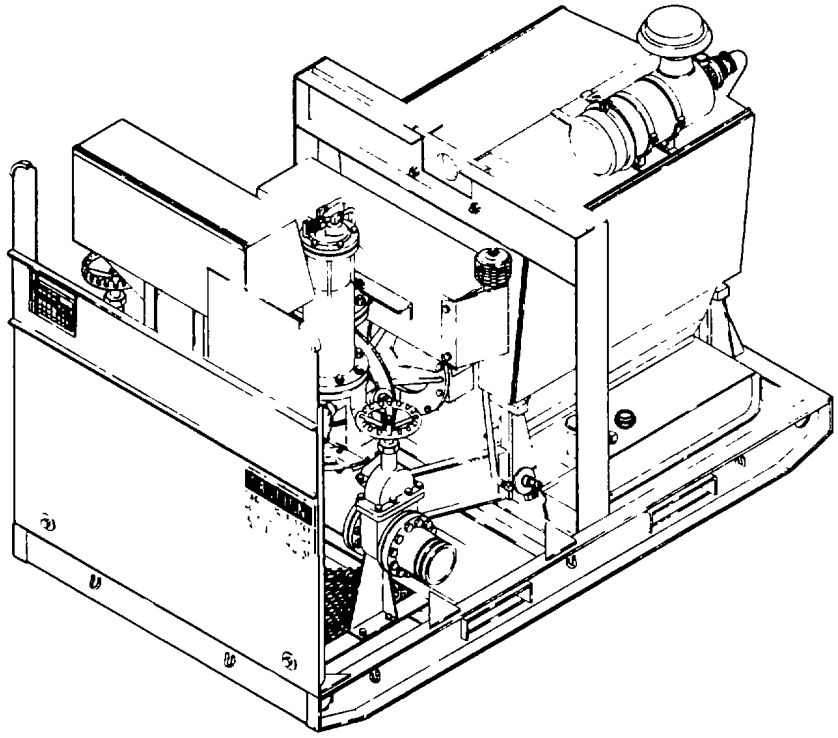
**OPERATOR'S MANUAL**





**This copy is a reprint which includes current pages from Change 1.**

**PUMP UNIT, CENTRIFIIGAL, FLOOD AND TRANSFER,**

**1250 GPM, DED, MODEL US612ACD**

**NSN 4320-01-194-5601**

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**HEADQUARTERS, DEPARTMENT OF THE ARMY**

**13 FEBRUARY 1987**

CHANGE

NO. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 31 October 1994

Operator's Manual

**PUMP UNIT, CENTRIFUGAL, FLOOD AND TRANSFER, 1250 GPM**
**DIESEL-ENGINE-DRIVEN, MODEL US612ACD**
**NSN 4320-01-194-5601**

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Operator's Manual

**PUMP UNIT, CENTRIFUGAL, FLOOD AND TRANSFER**
**1250 GPM, DED, MODEL US612ACD**
**NSN 4320-1-194-5601**

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CHANGE
NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 21 March 1988

Operator's Manual

**PUMP UNIT, CENTRIFUGAL, FLOOD AND TRANSFER,
1250 GPM, DED, MODEL US612ACD
NSN 4320-01-194-5601**

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| 2-37 and 2-38 | 2-37 and 2-38 |
| 2-47 through 2-50 | 2-47 through 2-50 |
| 2-55 through 2-58 | 2-55 through 2-58 |
| 2-61 and 2-62 | 2-61 and 2-62 |
| 3-1 and 3-2 | 3-1 and 3-2 |
| 3-7 and 3-8 | 3-7 and 3-8 |
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DISTRIBUTION:
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**WARNING**

**HEALTH HAZARD**
exists if pump is used to pump potable water after it has been used to pump fuel. Do not pump potable water after the pump has been contaminated by pumping fuel.

**SERIOUS INJURY**
may result if the engine is not turned off during service or maintenance.

**EXPLOSION HAZARD**
exists when smoking or using open flame or spark-producing equipment in the vicinity of battery.

**CAUSTIC CHEMICALS IN BATTERIES**
may cause serious injury if battery electrolyte (acid) or storage batteries are handled carelessly. If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.

**DEATH OR SERIOUS INJURY**
could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.

**SERIOUS INJURY**
may result if engine is not shut down when inspecting alternator.

**SEVERE BURNS**
can be caused by turbocharger and exhaust system heated during operation of the engine. If the engine has been running, do not touch the turbocharger or exhaust system components until they have cooled.

**WARNING**

**SERIOUS INJURY**
could occur if you attempt to pump any liquids for which this centrifugal pump unit has not been designed. The centrifugal pump unit has been designed to pump potable water or petroleum-based fuels with specific gravities between 0.85 and 1.0.

**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.

While running engine, be alert for fumes. 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.

**EXPLOSION HAZARD**
exists within 50 feet (15.2 m) of an operating pump unit. Smoking within this area creates a fire and explosion hazard.

**NOISE HAZARD**
exists for all personnel within 15 feet (4.57 m) of an operating centrifugal pump unit. Personnel must wear approved ear protection equipment. Failure to do so may result in impairment or loss of hearing.

**EXPLOSION HAZARD**
exists when handling ether cylinder. Ether is highly flammable. Do not use near sparks or open flames. Do not inhale fumes. Do not actuate ether start kit more than once. Overloading the engine air housing with this highly explosive fluid (ether) could result in an explosion.

**SEVERE INJURY**
may result from contact with the rotating cooling blower or V-belt. When it is necessary to make inspections in this area, be aware of the blower and V-belt position, or turn engine off.

TECHNICAL MANUAL

TM 5-4320-306-10

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 13 February 1987

# Operator's Manual
# PUMP UNIT, CENTRIFUGAL, FLOOD AND TRANSFER, 1250 GPM
# DIESEL-ENGINE-DRIVEN, MODEL US612ACD
# NSN 4320-01-194-5601

**REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this manual. If you find any mistakes, 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 directly to: Commander, U.S. Army Aviation and Troop Command, ATTN: AMSAT-I-MP, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

**Distribution Statement A: Approved for public release; distribution Is unlimited.**

# CHAPTER 1
# INTRODUCTION

## Section I. GENERAL INFORMATION

### 1-1. SCOPE

Type of Manual: Operator's

Model Number and Equipment Name: Pump Unit, Centrifugal, Flood and Transfer, 1250 GPM, Diesel Engine-Driven, Model US612ACD

Purpose of Equipment: Pumps petroleum products or potable water

### 1-2. MAINTENANCE FORMS AND RECORDS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 738-750, The Army Maintenance Management System (TAMMS).

### 1-3. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR's)

If your centrifugal pump unit 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 Aviation and Troop Command, ATTN: AMSAT-I-MDO, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. We'll send you a reply.

### 1-4. NOMENCLATURE CROSS-REFERENCE UST

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

| Common Name | Official Nomenclature |
|---|---|
| Centrifugal Pump Unit | Pump Unit, Centrifugal, Flood and Transfer, Diesel-Engine-Driven, 6-Inch, Skid-Mounted, 1250 gpm at 180 feet total head. |
| Engine | Diesel Engine |
| Pump | Centrifugal Pump |
| Starter | Starter Motor |

### 1-5. LIST OF ABBREVIATIONS

| | |
|---|---|
| °C | Degree Celsius |
| cm | Centimeter |
| cu ft | Cubic feet |
| cu m | Cubic meter |
| dc | Direct current |
| DED | Diesel-Engine-Driven |
| EIR | Equipment Improvement Recommendations |
| FT HD | Foot Head |

## 1-5. LIST OF ABBREVIATIONS (Continued)

| | |
|---|---|
| °F | Degree Fahrenheit |
| ft | Foot; feet |
| gal | Gallon |
| gpm | Gallons per minute |
| hp | Horsepower |
| in. | Inch |
| kg | Kilogram |
| kPa | Kilopascal |
| L/min | Liters per minute |
| lb | Pound |
| m | Meter |
| mm | Millimeter |
| NPT | National pipe thread |
| PMCS | Preventive maintenance checks and services |
| psi | Pounds per square inch |
| qt | Quart |
| rpm | Revolutions per minute |
| V | Volts |

## 1-6. GLOSSARY

| | |
|---|---|
| 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. |
| Acoustical | Sound deadening. |
| 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. |
| Aline | To arrange in a line vertically and/or horizontally. |
| Approved | Permitted to be used for a specific purpose by the person or group who is authorized to grant approval. |
| 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. |
| 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. |
| Cavitation | Condition caused when engine speed is increased beyond point of maximum suction vacuum. Cavitation is indicated by loud cracking noise in pump housing and is harmful to the pump unit. |
| 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. |

**1-6. GLOSSARY (Continued)**

| | |
|---|---|
| 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. |
| Deteriorate | A worsening of condition usually as a result of age or hostile environment, as opposed to mechanical damage. |
| Distortion | The bending, twisting, or any other dynamic change of a surface. |
| Dunnage | Padding or loose material placed in a shipping container to prevent damage to contents. |
| 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. |
| 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. |
| Frayed | Something which has been worn away or unravelled, usually by rubbing. |
| 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. |
| 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. |

**1-6. GLOSSARY (Continued)**

| | |
|---|---|
| Legible | Capable of being read. A legible nameplate can be read; an illegible plate cannot. |
| 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. |
| Obstruction | An obstacle. |
| 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. |
| Recommendations | Suggestions for change; advice given usually to make an improvement. |
| Require | To demand or need. |
| Respiration | The process of breathing; inhaling and exhaling. |
| Scope | The extent of an activity or concept; the amount of information covered as in a book. |
| Specific Gravity | Ratio of the weight of a liquid to the weight of an equal volume of water. Specific gravity of water is 1. |
| Symptom | The external sign or indication of a condition. |
| Tiedown | Strap or fastening device used to hold an object in position. |
| 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. |
| Volute | Housing into which impeller discharges water. |

## Section II. EQUIPMENT DESCRIPTION AND DATA

### 1-7. PURPOSE OF CENTRIFUGAL PUMP UNIT

**WARNING**

**Health hazard exists if pump is used to pump potable water after it has been used to pump fuel. Do not pump potable water after the pump has been contaminated by pumping fuel.**

Primary purpose is to pump potable (drinkable) water. Secondary purpose is to pump petroleum products.

### 1-8. CAPABILITIES AND FEATURES

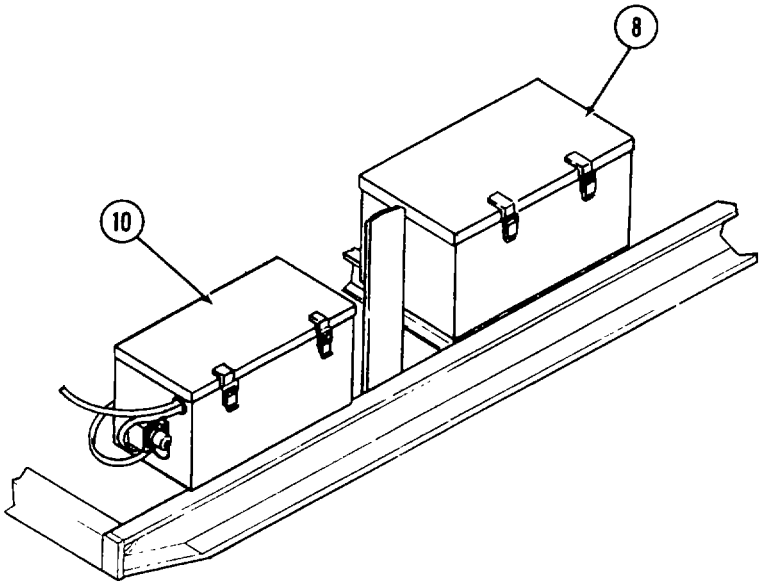
- Pumping rate of 1250 gpm at 180 feet total head
- Automatic shutdown for high temperature, low oil pressure, and overspeed
- Operates in surrounding temperature between + 155° and -65°F (+ 68.3° and -53.9°C)
- Operates at altitudes between sea level and 9000 feet (2743.2 m) above sea level
- Continuous operation during periods of blowing sand
- Operator station protected by noise shield
- Cold weather starting aid
- Skid mounted for transport

### 1-9. LOCATION AND DESCRIPTION OF EXTERNAL COMPONENTS

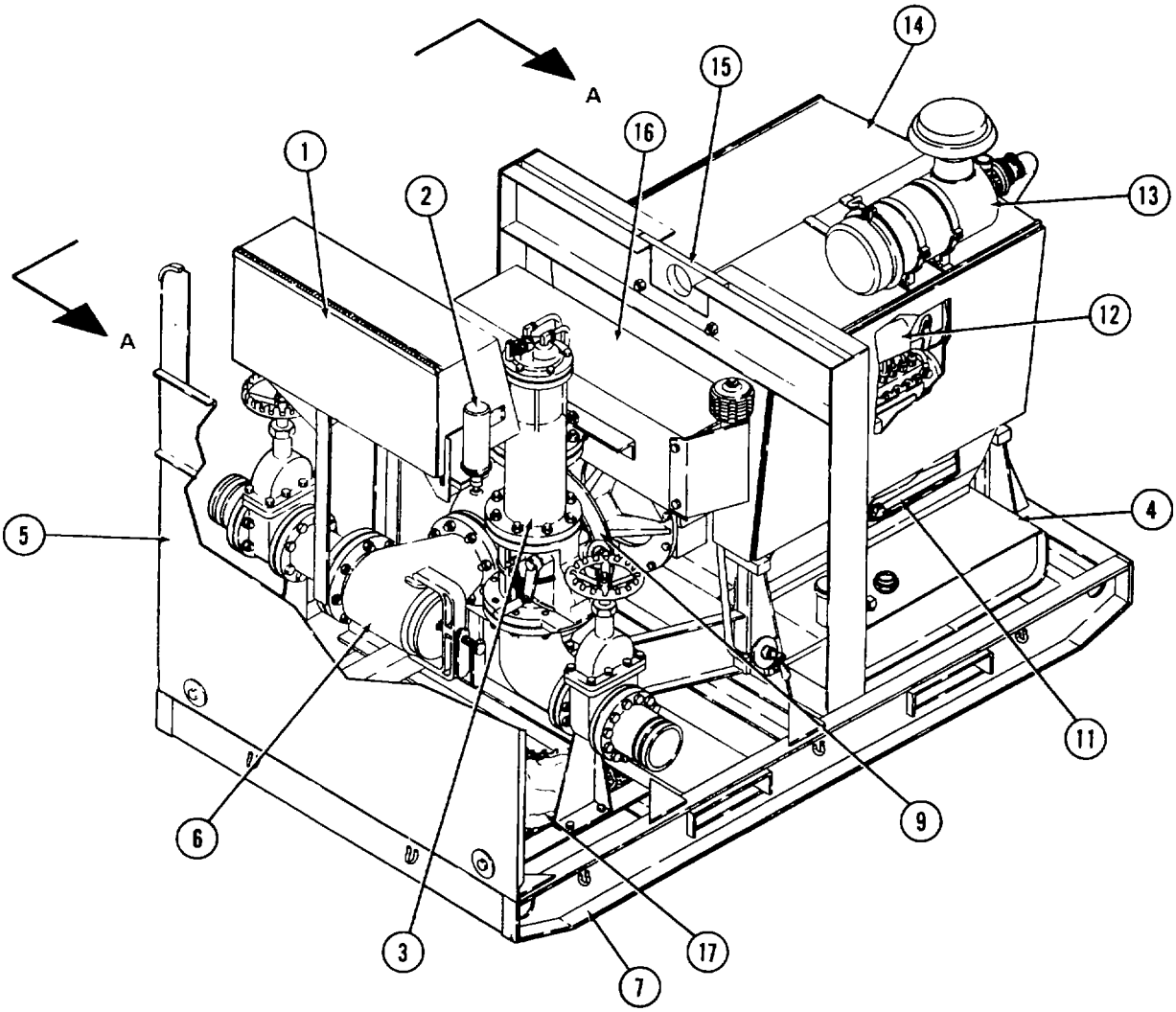
CONTROL PANEL AND ELECTRICAL SYSTEM (1). Used to operate and control the centrifugal pump unit. The control panel assembly is located at the front of the unit. It is supported by the suction assembly and noise shield. The control panel assembly contains the operating and instrument panels. The electrical system contains the wiring and hardware connecting the control panel components with the engine and pumping controls and sensors.

ETHER START KIT (2). Used when engine will not start normally in cold weather. Injects a mist of liquid ether into the engine air intake system to aid ignition. The kit components are the ether cylinder, control nozzle, and the hose between the nozzle and the air intake.

DISCHARGE MANIFOLD ASSEMBLY (3). This assembly controls the liquid pumped out of the pump body discharge port. The manifold is attached to the discharge port flange at the top of the pump body. It is supported by this connection and support brackets on the skid frame. The assembly consists of a gate valve, a check valve, an air valve, connective piping, and a victaulic coupling flange.




VIEW A-A



**1-9. LOCATION AND DESCRIPTION OF EXTERNAL COMPONENTS (Continued)**

FUEL TANK (4). The fuel tank contains a 20-gallon supply of diesel fuel for the engine. The tank is mounted to the rear third of the skid frame, just below the engine. The tank includes a filler cap, fuel gage, and various fittings for fuel lines.

NOISE SHIELD (5). The noise shield reduces pump and engine noise at the operator's position in front of the control panel. In addition, the shield reduces vibration of the control panel and supports the front portion of the fabric cover. The base of the shield is mounted to the front of the skid frame, and to the supports of the control panel.

SUCTION ASSEMBLY (6). This assembly controls the liquid supply to the pump body suction port. The assembly is secured to the suction port mounting studs at the front of the pump body. It is supported by this connection and support brackets on the skid frame. The suction assembly consists of a gate valve, a strainer assembly, connective piping, and a victaulic coupling flange.

SKID ASSEMBLY (7). The skid assembly is a movable mounting platform for the major components of the centrifugal pump unit. The skid is a welded frame with provisions for mounting the components, runners which incorporate enclosed forklift pockets, battery and tool boxes, and a 20-gallon engine fuel tank.

TOOL BOX (8). Centrifugal pump unit accessories are stored in the tool box. It is attached to the left side of the skid frame, in front of the battery box.

PUMP ASSEMBLY (9). The pump assembly uses the turning force of the engine to pump liquid from the suction port to the discharge port of the pump body. The pump assembly is a single-stage, centrifugal pump which is self priming after initial filling. The pump body portion of the assembly is mounted to the front portion of the skid frame. The bearing housing portion of the assembly attaches to the engine bell housing and flywheel.

BATTERY SYSTEM (10). The battery system components supply dc power to the starting motor, control panel, and electrical system. The components include a battery box, two 12-volt batteries, a charging receptacle, and connecting cables and wires.

OIL DRAIN ASSEMBLY (11). The oil drain assembly is an extension of the engine oil drain. It makes draining the engine oil easier. The drain assembly is located below the engine and projects from the rear of the pump assembly.

ENGINE (12). The engine provides turning force to the pump rotor. The engine is a turbocharged, six cylinder, in-line, diesel engine. It has a standard, continuous output rating of 102 hp at 2400 rpm. The engine is mounted to the rear portion of the skid frame. The engine flywheel is directly connected to the pump with a dry-type flexible coupling.

AIR INLET COMPONENTS (13). The air inlet components supply filtered air to the inlet of the engine through the turbocharger. The components include a dry-type air cleaner and air hoses between the air cleaner and turbocharger.

ENGINE COVER ASSEMBLY (14). The engine cover encloses and protects the engine from environmental conditions during operation. The cover consists of a metal frame; and side, top, and end panels. The frame is attached to the skid assembly. The cover panels are attached to the frame with hand operated fasteners. The rear panel includes an air intake duct and filter that provide filtered cooling air to the engine.

## 1-9. LOCATION AND DESCRIPTION OF EXTERNAL COMPONENTS (Continued)

LIFTING BAIL (15). The lifting bail provides a secure point of attachment for lifting the centrifugal pump unit. The bail is secured to the skid frame at the centrifugal pump unit center of gravity.

EXHAUST SYSTEM (16). The exhaust system components vent engine exhaust gases from the exhaust side of the turbocharger. The components include a spark arrestor, muffler, and the exhaust pipes between the muffler and turbocharger.

FABRIC COVER (17). The fabric cover fits over the centrifugal pump unit. It protects the components from environmental conditions when the unit is not in operation. The cover is made of a flame-resistant, vinyl-coated nylon material with rubber tiedowns that hold it in place.

## 1-10. DIFFERENCES BETWEEN MODELS

This technical manual covers only Centrifugal Pump Unit, Peabody Barnes Model US61 2ACD, part number 77000CA. No known differences exist for this model number.

## 1-11. EQUIPMENT DATA

a. *Pump*

| | |
|---|---|
| Manufacturer | Peabody Barnes, Inc. |
| Model number | US612ACD |
| Part number | 77000CA |
| Type | Self-priming centrifugal |
| Primary service | Potable water |
| Secondary service | Fuel |
| Output-primary service | 600 gpm (2271 Umin) |
| Output-secondary service | 1250 gpm (4730 Umin) |
| Rated driven speed | 2400 rpm |
| Suction (intake) port | 6-inch NPT |
| Discharge port | 6-inch NPT |
| Priming port | 1-1/2-inch NPT |
| Priming method | Self-priming |
| Drain port | 2-inch NPT |
| Rotation | Counterclockwise (facing pump inlet) |

b. *Engine*. (Refer to Appendix Al)

| | |
|---|---|
| Manufacturer | Klockner-Humbolt-Deutz AG |
| Model | F6L 912B |
| Type | Four-stroke-cycle diesel |
| Number of cylinders | 6 |
| Bore | 3.93 in. (100 mm) |
| Stroke | 4.72 in. (120 mm) |
| Total displacement | 344.84 cu in. (5652 cm3) |
| Compression ratio (nominal) | 15.5-1 |
| Direction of rotation (facing flywheel) | Counterclockwise |
| Firing order | 1-5-3-6-2-4 |
| Coolant | Air |

**1-11. EQUIPMENT DATA (Continued)**

c. *Engine accessories*.

Starter Motor
Manufacturer ..... Bosch
Part number ..... 1173241
Voltage ..... 24
Alternator
Manufacturer ..... Motorola
Model number ..... 8AR3080F
Voltage ..... 24
Air Cleaner
Manufacturer ..... Donaldson
Type .Dry
Element number
Primary ..... P11-9538
Secondary ..... P11-9539
Ether Start Kit
Manufacturer ..... KBI Dieselstart
Model ..... Economy Cable-Control

d. *Capacities.*

Engine oil capacity ..... 15 qt (14.2 liters)
Fuel tank capacity ..... 20 gal (75.7 liters)

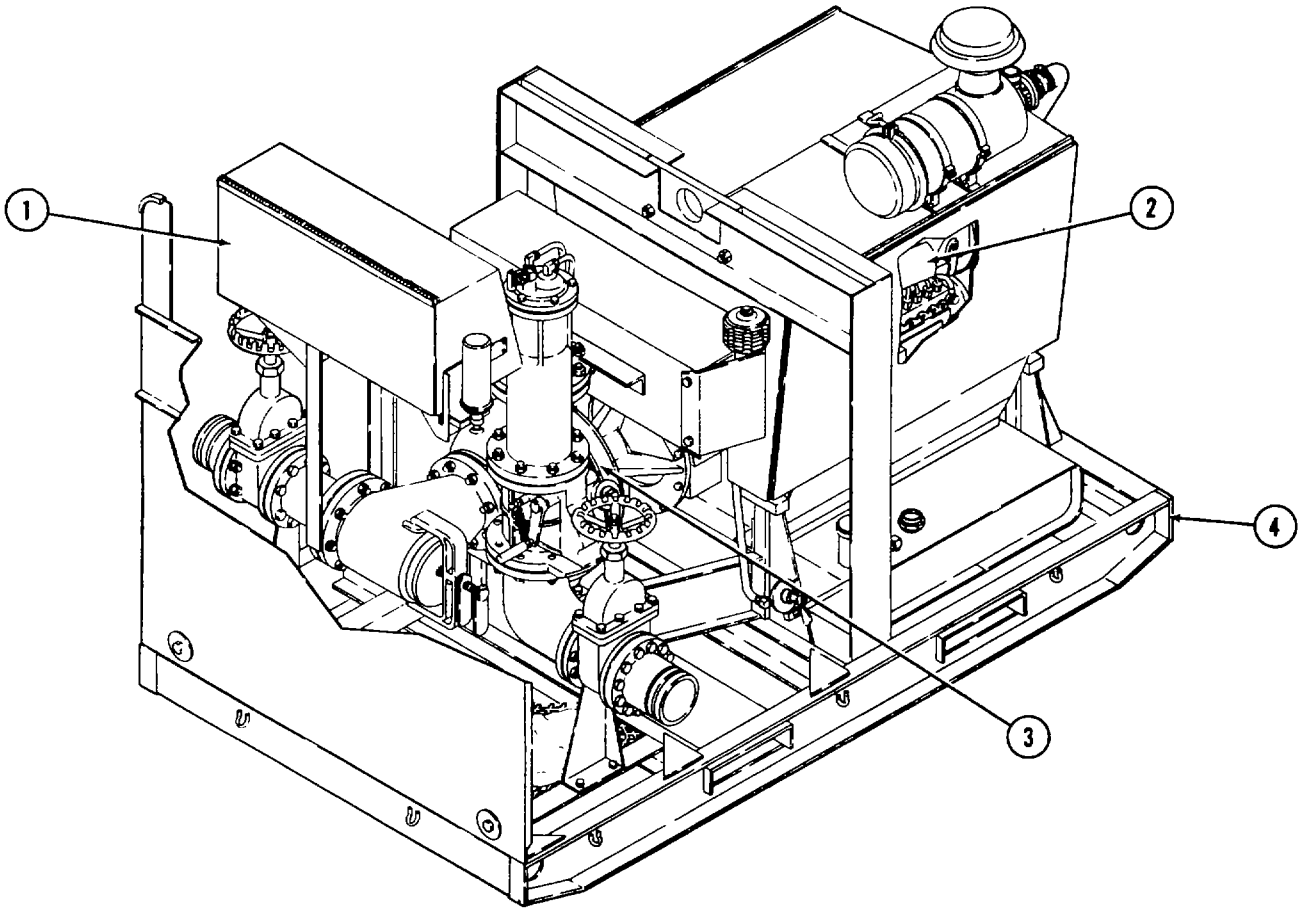
e. *Dimensions and weight.*

Overall length ..... 97.50 in. (2.48 meters)
Overall width ..... 58.50 in. (1.49 meters)
Overall height ..... 69.25 in. (1.76 meters)
Gross weight ..... 3000 lb (1360 kg)
Shipping volume ..... 229 cu ft (6.5 m3)

## Section III. 'TECHNICAL PRINCIPLES OF OPERATION

### 1-12. CENTRIFUGAL PUMP UNIT

The US612ACD six-inch flood and transfer pump unit is a skid-mounted, diesel-engine-driven, self-priming centriful pump. It is designed to pump petroleum products or potable water at a maximum operational output cf 1250 gpm (4730 L/min) at 180 FT HD for water and 212 FT HD for petroleum. Greater value of head for petroleum is due to it's lighter weight. The pumping assembly is ventilated and protected so it can operate continuously during periods of blowing sand. The self-priming centrifugal pump is directly coupled to a turbocharged diesel engine. Controls are contained in the control panel mounted at the front of the assembly. The pump and engine are mounted on a skid assembly.



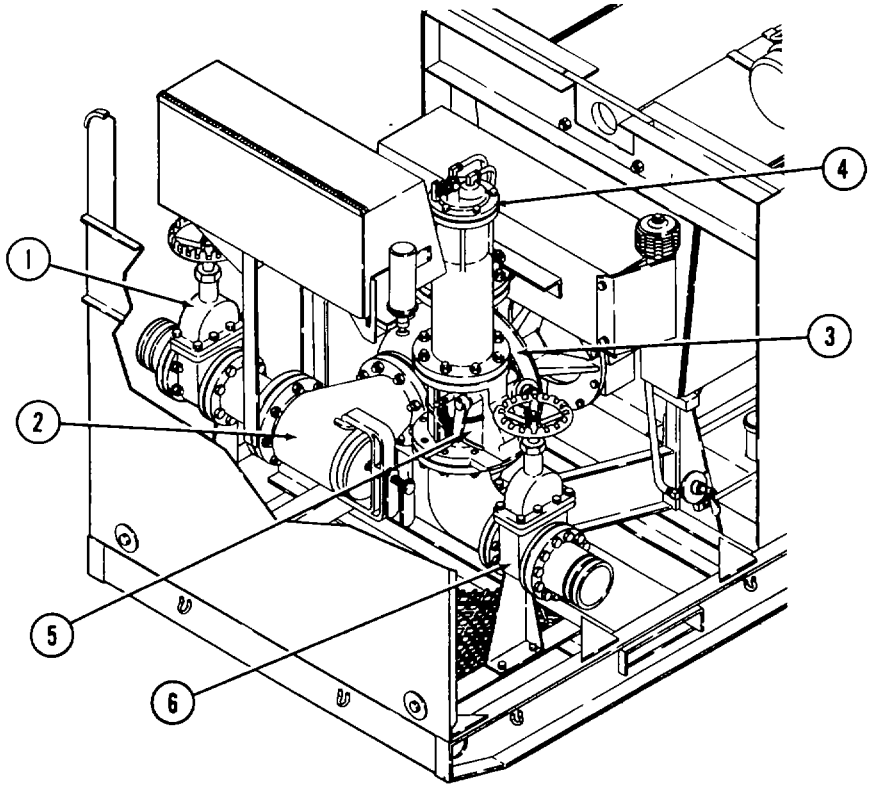

CONTROL SYSTEM (1). The control system is used to operate and control the centrifugal pump unit. Suction and discharge pressure is controlled by manually adjusting engine speed. There are three automatic safety controls. The unit automatically shuts down if the engine runs too fast, if oil pressure drops below 40 psi (276 kPa), or if lube oil temperature gets too hot. The system control panel is mounted at the front of the centrifugal pump unit.

ENGINE (2). The engine provides turning force to the pump rotor. The engine flywheel is coupled to the drive shaft of the pump impeller. The engine is bolted to the skid frame.

**1-12. CENTRIFUGAL PUMP UNIT (Continued)**

PUMP ASSEMBLY (3). The pump assembly uses the turning force of the engine to pump liquid from the suction port to the discharge port of the pump body. The pump body is mounted to the skid frame, and connects to the suction and discharge manifold assemblies. The bearing housing attaches to the engine, and contains the impeller drive shaft.

SKID ASSEMBLY (4). The skid assembly is a movable mounting platform for the components of the centrifugal pump unit.




SUCTION GATE VALVE (1). This gate valve regulates the flow of liquid from the supply hose into the pumping components.

SUCTION STRAINER (2). This in-line strainer filters large particles out of the liquid before it enters the pump body.

PUMP BODY (3). The pump body houses the impeller which pumps fluid from the inlet to the outlet of the pump body.

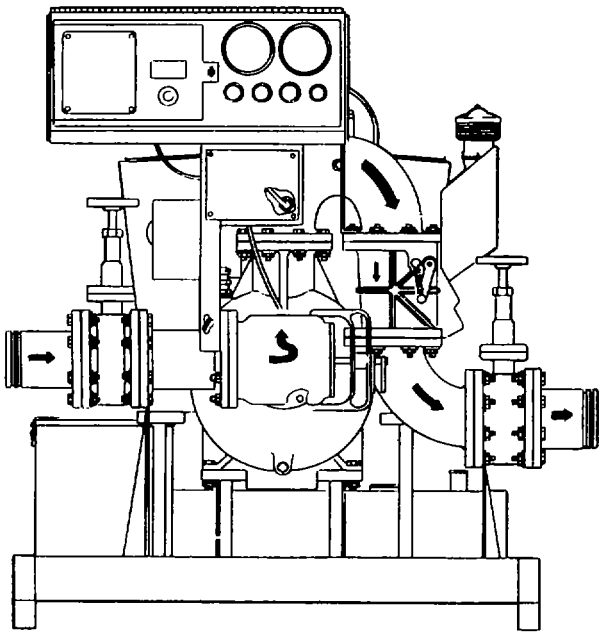
AIR VALVE COVER (4). The air valve cover is located at the top of the discharge elbow on top of the pump body. This assembly vents air from the pump body and discharge components during pumping and priming operations.

DISCHARGE CHECK VALVE (5). This flapper-type check valve is spring loaded. It allows liquid to flow in the discharge direction, and closes to stop liquid from flowing in the reverse direction.

DISCHARGE GATE VALVE (6). This gate valve regulates the liquid flow from the pump discharge components into the discharge hose.

## 1-13. PUMPING OPERATION

After the pump body is primed and pumping begins, liquid is pumped through the pumping components in the following sequence of operation.



1. Liquid in the supply hose enters the suction gate valve. If the gate valve is open, the liquid passes through the valve and enters the suction strainer.

2. As the liquid passes through the suction strainer, the strainer filters out large particles of debris.

3. From the strainer, the liquid enters the pump housing through the suction port. The impeller, rotating at high speed, forces the liquid at the suction port out of the pump body through the discharge port.

4. The liquid is forced out of the pump body into the discharge elbow, past the air valve, and into the check valve assembly. If air is in the liquid, the air valve vents it from the discharge elbow.

5. The discharge check valve permits the liquid to flow from the pump toward the discharge hose, and prevents it from flowing in reverse through the pump back to the storage container.

6. Liquid from the discharge check valve enters the discharge gate valve. The liquid passes through the open valve and enters the discharge hose.

7. As the sequence 1 through 6 continues, liquid is transferred from the supply through the pumping components, into the discharge hose.

## 1-14. PUMPING BALANCE

The suction and discharge gate valves can be used to limit and/or balance the amount of liquid being pumped in or out of the assembly. The gate valves can also be used to keep liquid in or out of the system when pumping action stops.

## 1-15. PUMP DRIVE OPERATION

The impeller rotates at engine speed. Adjusting engine speed changes the impeller speed, and results in changes to the suction and discharge pressures. Increasing or decreasing engine speed increases or decreases the speed of impeller rotation. By increasing or decreasing the speed of impeller rotation, the pumping rate and discharge head are increased or decreased.

## 1-16. ENGINE

Engine subsystems are: electrical system, lubrication system, cooling system, and fuel system. The components and functions of these subsystems are explained below.

a. *Electrical system*. The components of the engine electrical system are the batteries, starting motor, alternator, and wiring harness. The batteries provide electric power to run the starting motor and start the engine. The alternator recharges the batteries after the engine is started and provides power to all the electrical components through the wiring harness.

b. *Lubrication system*. The components of the engine lubrication system are the lube oil pump, lube oil cooler, and lube oil filter. The lube oil pump pumps oil to reduce friction between moving parts. The lube oil cooler reduces the temperature of the lube oil which cools the engine. The lube oil filter removes impurities from the oil.

c. *Cooling system*. The major components of the engine cooling system are the cooling air blower, the cooling air ducting, and the lube oil cooler. The primary coolant is the engine lube oil. The secondary coolant is forced air. The lube oil circulating through the engine removes heat from the engine. The cooling air blower forces air onto the cylinders and through the oil cooler. The forced air removes heat from the lube oil. The cooled lube oil again circulates through the engine to remove heat.

d. *Fuel system*. The major components of the engine fuel system are the fuel feed pump, fuel injection pump, fuel tank, fuel filter, and fuel lines. The fuel feed pump draws fuel from the fuel tank, through the filter, to the fuel injection pump. The injection pump injects fuel into the engine cylinders. The fuel lines connect these components.

# 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.**

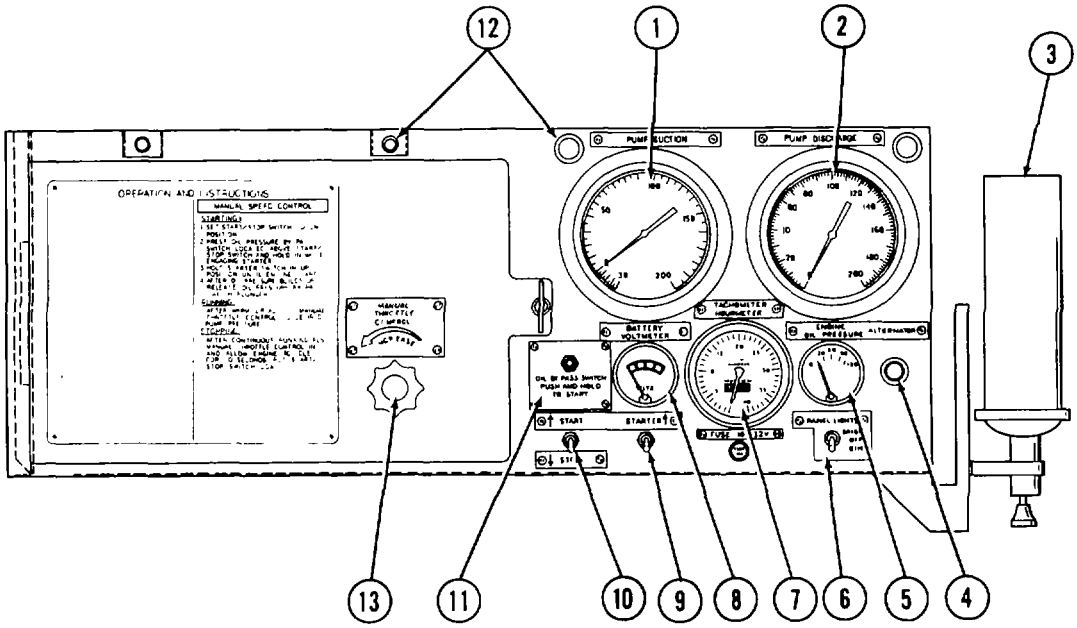



**Table 2-1. Operator's Controls and Indicators**

| Key | Control or Indicator | Function |
|---|---|---|
| 1 | PUMP SUCTION gage | Suction pressure gage displays pump suction conditions on a dial graduated from 0 to 30 inches (0 to 762 mm) of mercury, vacuum, and 0 to 200 pounds per square inch (psi) (0 to 1378 kPa) pressure. |
| 2 | PUMP DISCHARGE gage | Displays pump discharge pressure on a dial graduated from 0 to 200 psi (0 to 1378 kPa) pressure. |

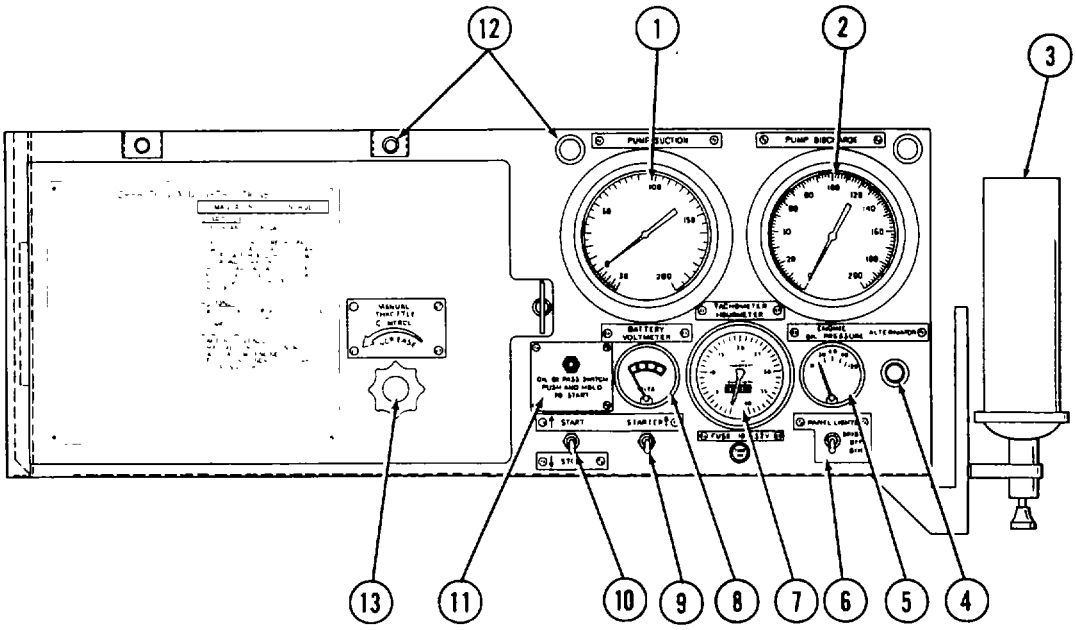



**Table 2-1. Operator's Controls and Indicators - Continued**

| Key | Control or Indicator | Function |
|---|---|---|
| 3 | Ether start kit | Used to help start engine when the air temperature is too cold for normal start. Operated by a control knob on bottom of ether cylinder. Mounted on right side of the control panel housing. |
| 4 | ALTERNATOR light | Lights when battery is charging. It may light briefly after starting the engine, and should go out with continued operation. |
| 5 | ENGINE OIL PRESSURE gage | Indicates engine oil pressure in psi. Electrically connected by a wire to the engine. Graduated in 30 psi (206.7 kPa) increments from 0 to 120 psi (0 to 826.8 kPa). |
| 6 | PANEL LIGHTS switch | Switch used to turn panel lights on and off. Push switch up for bright light, down for dim light. |
| 7 | TACHOMETER/HOURMETER | Indicates engine speed in revolutions per minute (rpm) gage and maintains a running total of engine operating hours to tenths of an hour. Graduated in 500 rpm increments from 0 to 4000 rpm. Time meter will record up to 9999.9 hours of operation. |
| 8 | BATTERY VOLTMETER | Indicates battery voltage. gage |

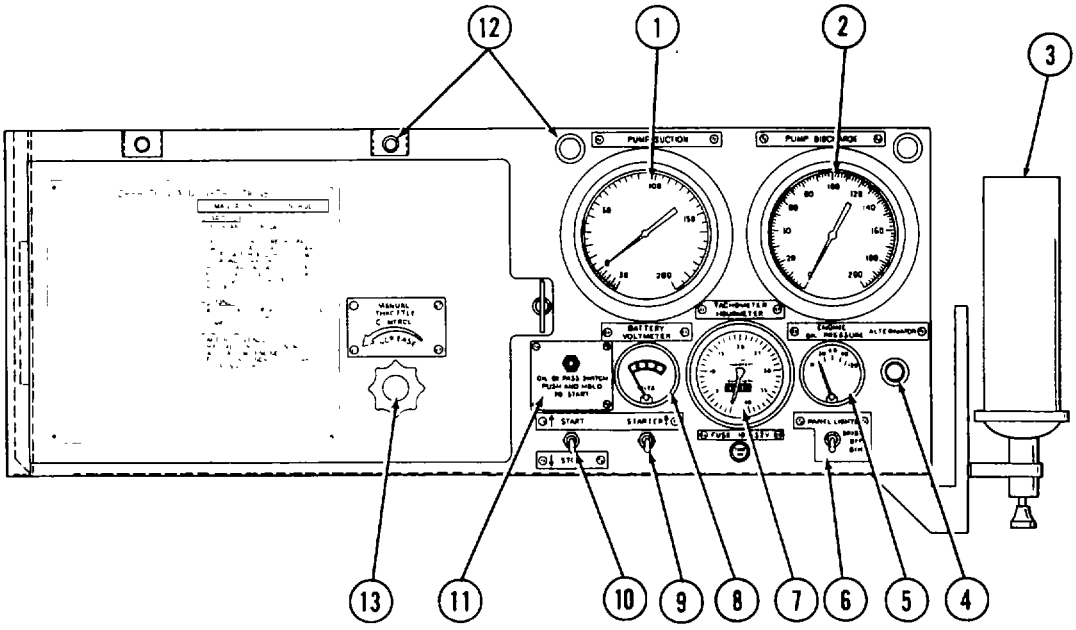



**Table 2-1. Operator's Controls and Indicators - Continued**

| Key | Control or Indicator | Function |
|---|---|---|
| 9 | STARTER switch | Starts engine. When pushed to the STARTER position, allows electric current to flow to the starter motor. This switch is spring loaded to return to the down position when released. |
| 10 | START/STOP switch | Energizes and deenergizes the pump and engine control and operating circuits. This switch must be in the START position before pressing the STARTER switch. |
| 11 | OIL BYPASS switch | Bypasses the low oil pressure switch. When starting the engine, there is no oil pressure in the lubrication system, and the low oil pressure switch would automatically shut down the engine. Pressing the OIL BYPASS switch allows the oil pressure to reach operating pressure during starting. This switch must be pressed before pressing the STARTER switch, and held in during starting. |
| 12 | Panel lights | Illuminate when turned on with PANEL LIGHTS switch (6). Can be set to bright or dim. |
| 13 | MANUAL THROTTLE CONTROL | Used to adjust engine speed and pump discharge pressure. |

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

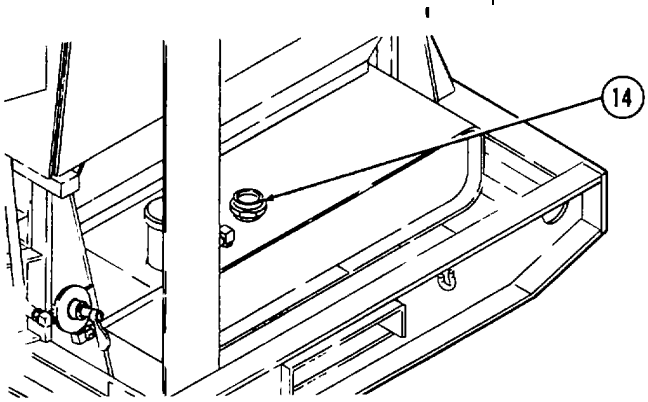
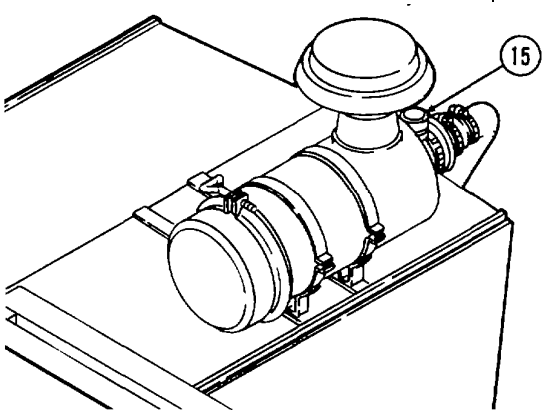
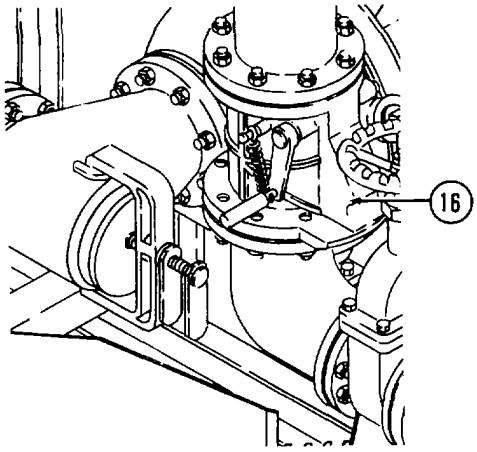
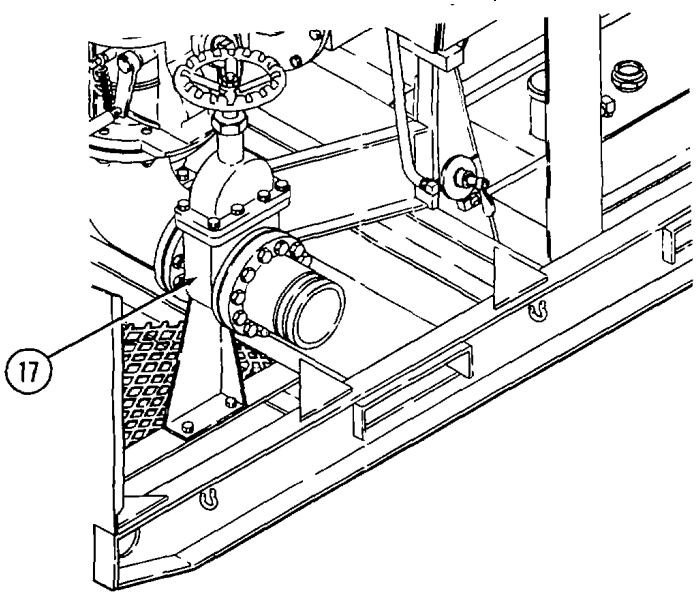
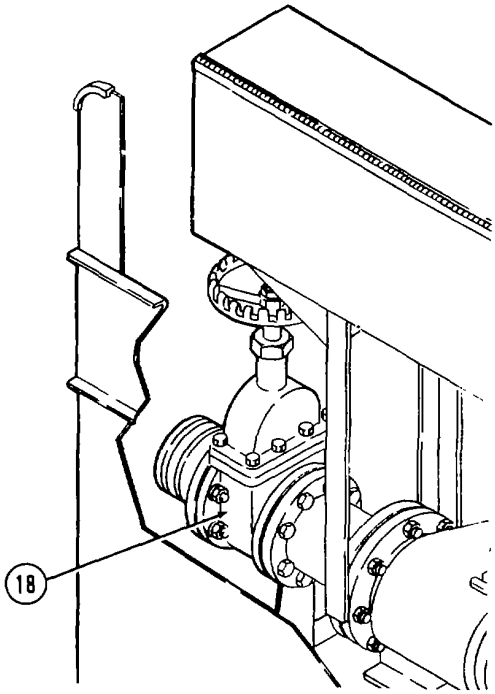
| Key | Control or Indicator | Function |
|---|---|---|
| 14 | Liquid level gage<br>  | Indicates fuel level in fuel tank. Mounted on the fuel tank near the fill cap. |
| 15 | Restriction indicator<br>  | Indicates blockage of air filter. A red indication appears in window to indicate the need for cleaning or replacement. Indicator is connected to air inlet housing by a flexible hose. It is actuated by high negative pressure. Indicator can be reset. |
| 16 | Discharge check valve<br>  | 6-inch check valve on discharge manifold. Opens automatically when discharge pressure is reached. If liquid being discharged backs up, the check valve closes to keep liquid from backing up into the pump. Can be opened manually for draining the pump. Can be closed manually to hold liquid in the pump for priming. |

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

| Key | Control or Indicator | Function |
|---|---|---|
| 17 | Discharge gate valve | Hand-operated, 6-inch gate valve located on the discharge manifold assembly. The suction and discharge gate valves are used to control the flow of liquid through the pump assembly. |
| 18 | Suction gate valve | Hand-operated, 6-inch gate valve located on the suction assembly. The suction and discharge valves are used to control the flow of liquid through the pump assembly. |

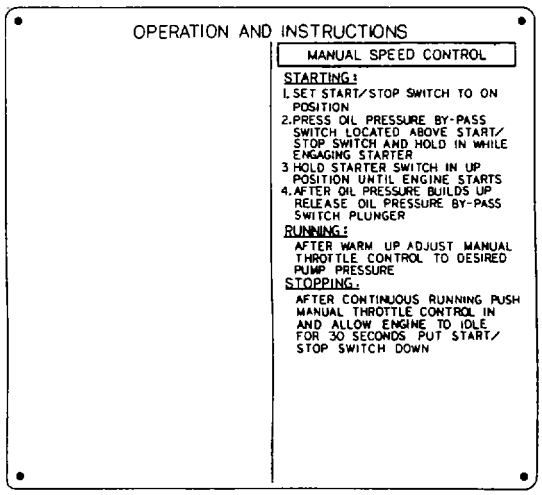


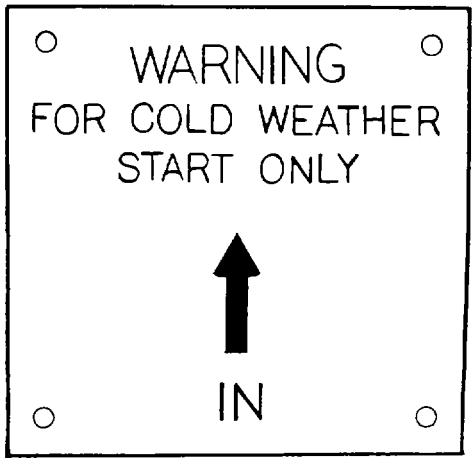
## 2-1. LOCATION AND DESCRIPTION OF INSTRUCTION AND WARNING PLATES

The pumping assembly has the following identification, instruction, and warning plates.

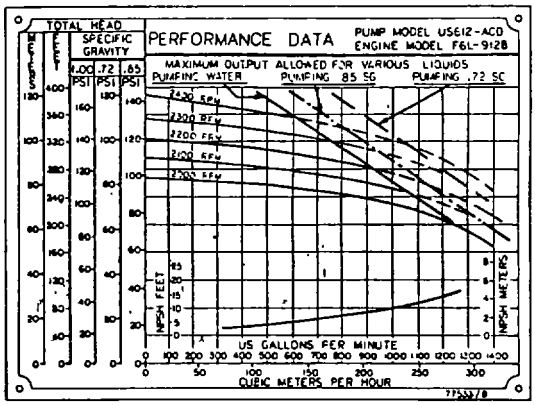
a. *Instruction plate*. Mounted on the throttle panel on the control panel assembly. It displays operating instructions for starting, running, and stopping the centrifugal pump unit.




b. *Cold start warning plate*. Located on the side of the control panel assembly next to the ether cylinder. Warns operator that ether release control knob is used only for starting engine in cold weather.



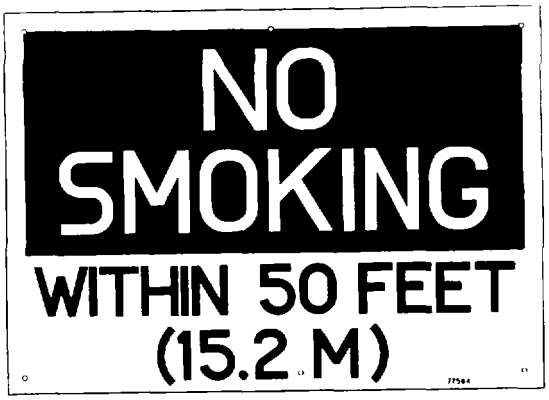

c. *Performance data information plate*. Located on the front face of the noise shield. It provides the performance range curve based on total head, revolutions per minute, and US gallons per minute. It also lists the psi for liquids with the specific gravities of 1.00, 0.72, and 0.85.



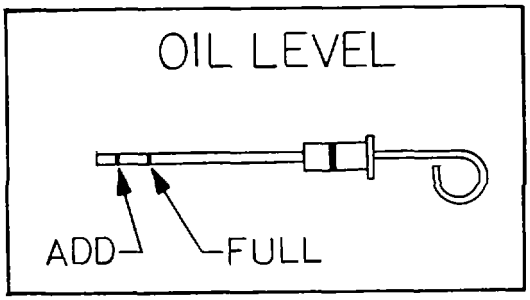
**2-1. LOCATION AND DESCRIPTION OF INSTRUCTION AND WARNING PLATES (Continued)**

d. *Ear protection warning plates*. Warning plates visible from both sides of the centrifugal pump unit. They warn of engine operating noise hazard.

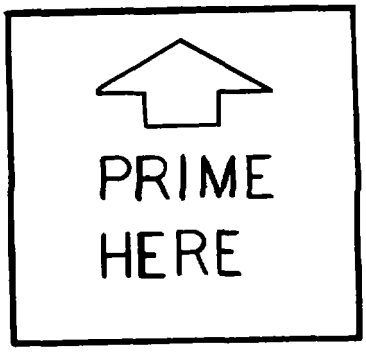

e. *No smoking warning plates*. Located on the engine housing.




f. *Oil level plate*. Located on the engine. Illustrates the oil dipstick markings ADD and FULL.

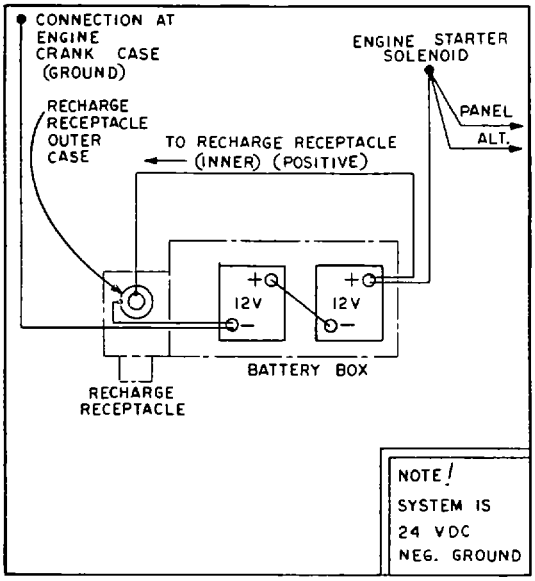



g. *Prime plate*. Located on pump body. Arrow points to priming port.

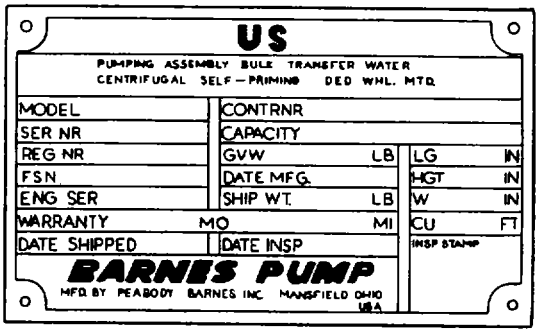


**2-1. LOCATION AND DESCRIPTION OF INSTRUCTION AND WARNING PLATES (Continued)**

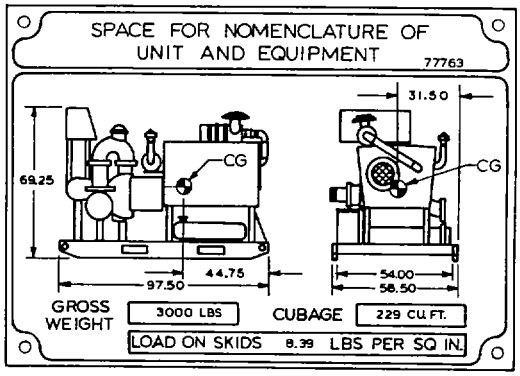
h. *Battery circuit plate*. Located inside the battery box. Shows battery circuit flow and connections.




i. *Pump identification plate*. Located on the front, left side of the skid. It provides the pump and engine identification numbers, pump dimensions, weight, and shipping information.




j. *Transportation plate*. Located on the front, right side of the skid. It provides shipping information: gross weight; loading cubic feet; overall width, length, and height; and the load on skids. It includes a diagram of the centrifugal pump unit that shows the overall dimensions and center of gravity.



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

### 2-2. 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 DA PAM 738-750.

### 2-3. 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 four categories: B Before Operation, D During Operation, A-After Operation, and W-Weekly. 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 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.

g. Leakage definitions for operator/crew PMCS shall be classified as follows:

Class I Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

**2-3. PREVENTIVE MAINTENANCE CHECKS AND SERVICES (Continued)**

Class II Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected.

Class III Leakage of fluid great enough to form drops that fall from the item being checked/ inspected.

**CAUTION**

**Equipment operation is allowable with minor leakages (Class I or II). Of course, you must consider the fluid capacity in the item/system being checked/inspected. When in doubt, notify your supervisor.**

**When operating with Class I or Class II leaks, continue to check fluid levels as required in your PMCS.**

**Class III leaks should be reported to your supervisor or organizational maintenance.**

h. 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.

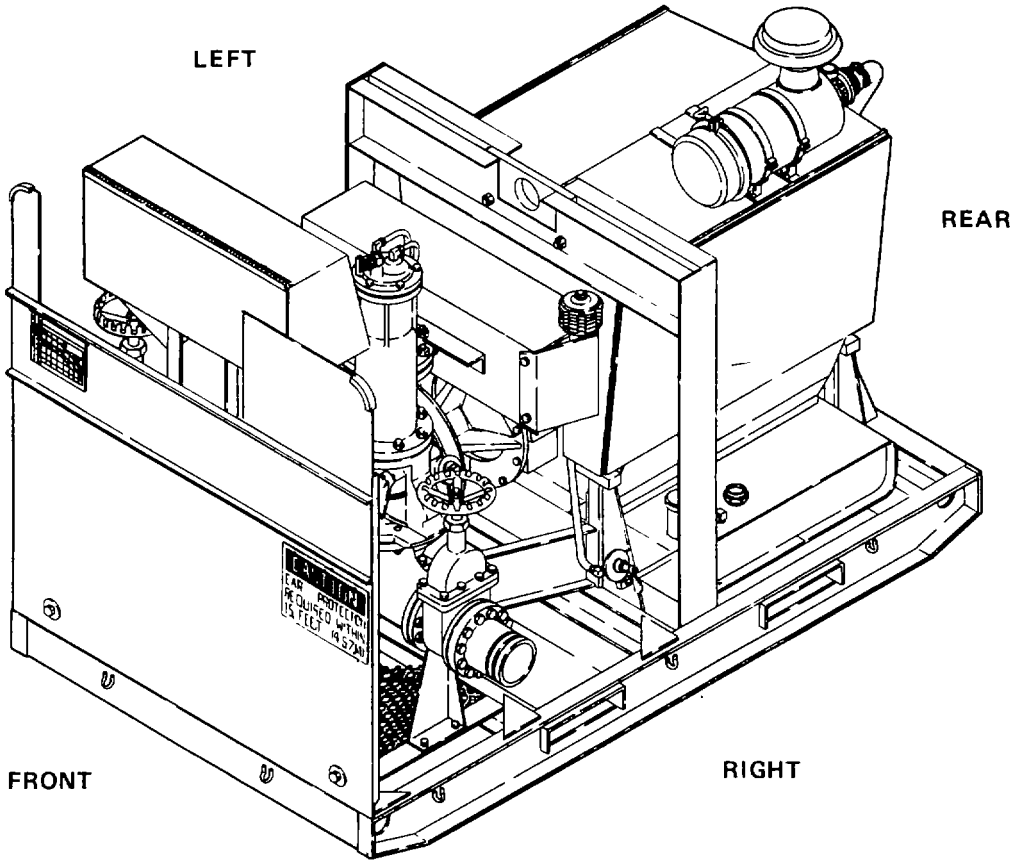


**Table 2-2. Preventive Maintenance Checks and Services**

**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
D - During Operation
A - After Operation
W - Weekly

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 1 | | | | • | *Skid* (1).<br><br>Check that the following components are securely mounted to the skid, and that attaching areas are free of corrosion and damage.<br><br>Transportation plate (2)<br>Pump identification plate (3)<br>Fuel tank strap (4)<br>Engine (5)<br>Battery box (6)<br>Tool box (7)<br><br>Visually inspect all skid welds for cracks. Inspect only those welds that can be seen without disassembly.<br><br>Check that plates can be read.<br><br>Pump identification plate (3)<br>Transportation plate (2)<br><br>Check that drain holes (8) are not blocked. | Cracks are de tected, or engine or pump and bearing housing assembly are loose. |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Skid (1) Continued.*<br><br>Check for indications of corrosion on skid around fuel tank assembly (9).<br><br>Check for indications of corrosion in areas between all mated parts.<br><br>Check condition of paint. Paint shall be in good condition with no bare metal or corrosion. | |

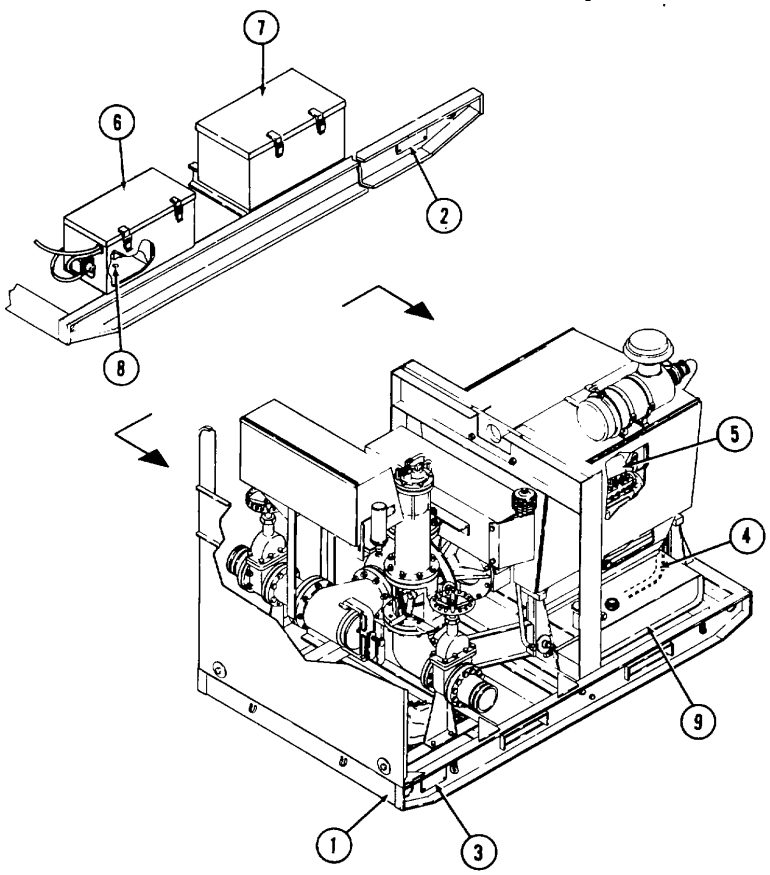


**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

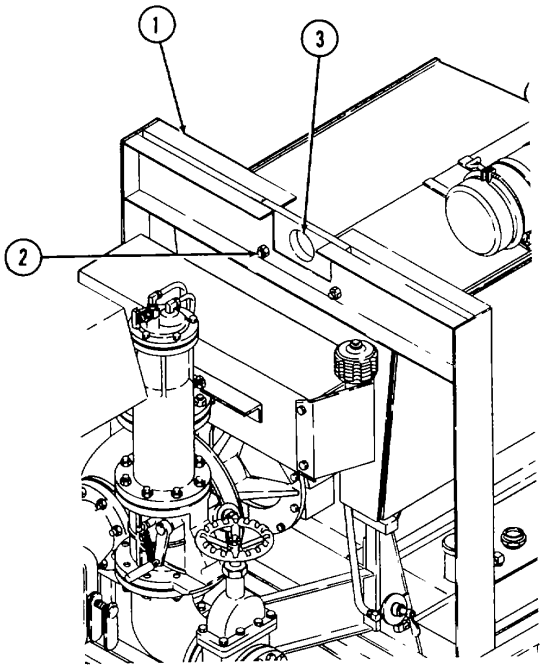
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 2 | | | | • | *Lifting Bail Assembly (1)*.<br><br>Check that screws (2) are not loose or corroded.<br><br>Check for cracks in base metal and/or welds.<br><br>Check 3-inch (7.6 cm) diameter hole (3) for wear and cracks.<br><br>Check for corrosion, especially at mating areas.<br><br>  <br> | Lifting bail assembly is cracked, broken, corroded and screws are loose or missing.<br><br>**NOTE**<br><br>**This applies only when centrifugal pump unit is lifted.** |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

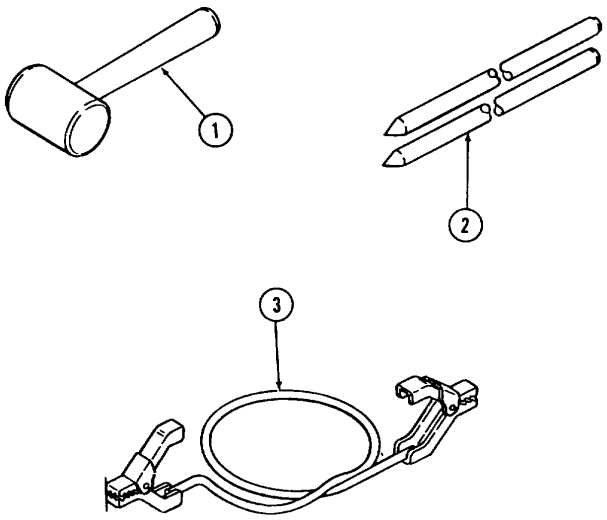
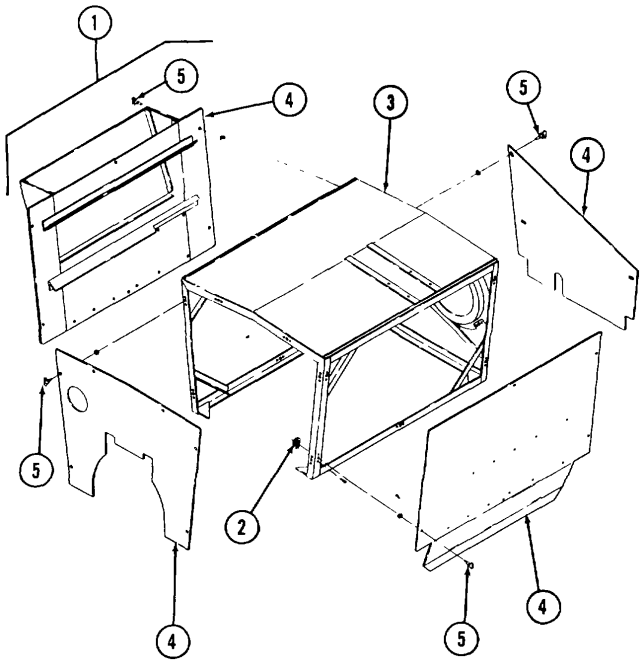
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 3 | | | | • | Accessory Items.<br><br>Inspect the contents of the tool box. The following items should be in the tool box or in use on or about the centrifugal pump unit.<br><br>1. Brass mallet, one<br>2. Ground rods, two<br>3. Ground cable assembly, one<br><br>  <br> | Ground cable is broken or missing or ground rod is not available. |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 4 | • | | | | *Engine Cover*.<br><br>Wipe all oily dirt, grease, and diesel fuel oil from engine cover (1).<br><br>Inspect engine cover frame for secure mounting to the skid. Check that all panel stud receptacles (2) are attached.<br><br>Inspect engine cover frame (3) for damaged holes.<br><br>Inspect panels (4) for distortion. Inspect the panels for proper number of mounting studs (5).<br><br>  <br> | The cover does not provide<br><br>for the engine compartment. The duct interferes<br><br>cooling air flow or V-belt. |

protection

with

**Table 2-2. Preventive Maintenance Checks and Services Continued**

B Before Operation After Operation D During Operation W Weekly

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

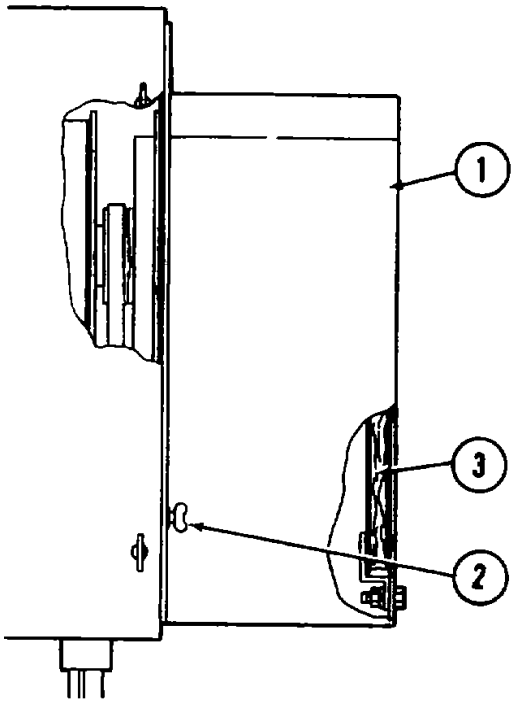
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Engine Cover - Continued*.<br><br>Inspect intake duct assembly (1) for distortion.<br><br>Inspect intake duct assembly for proper number of mounting studs (2).<br><br>Check that acoustical panel (3) is securely mounted and not blocking the blower intake ducting.<br><br>Check that the blower intake ducting is not distorted or interfering with V-belt operation.<br><br>  <br> | |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 5 | • | | | | Suction Gage Tap (1) and Hose (2).<br>Check for leaks. | Leaks are evident. |

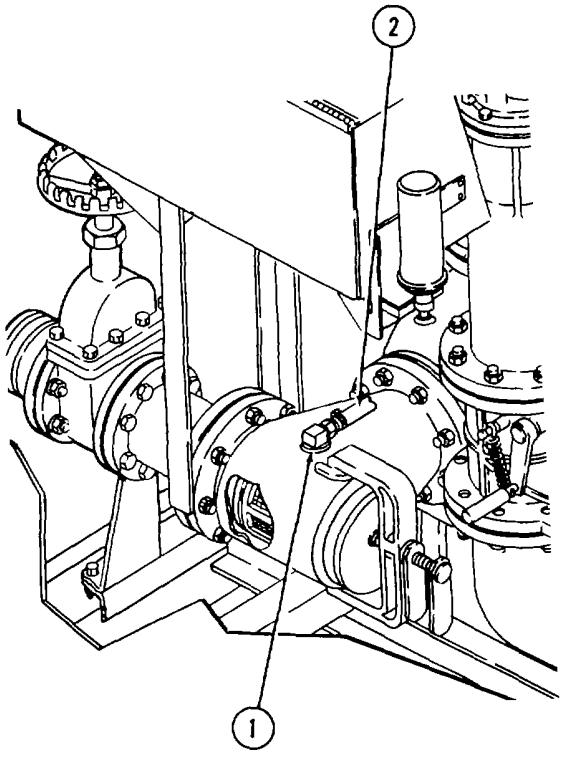


**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

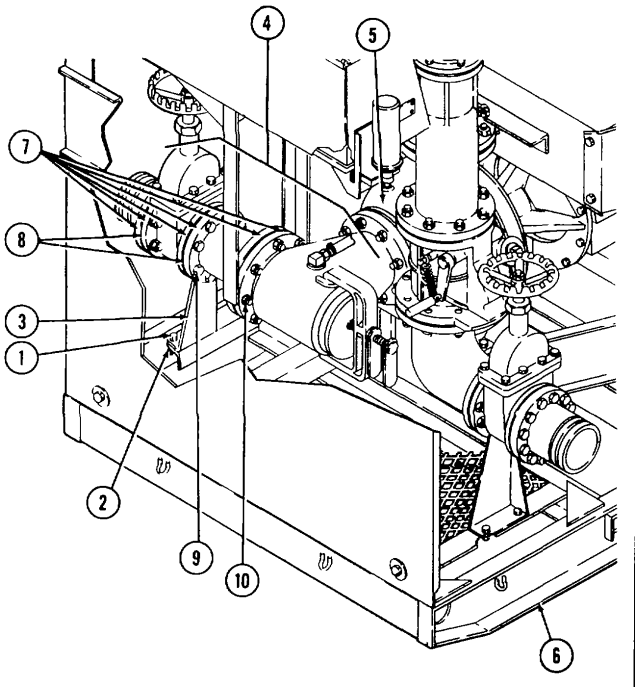
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 6 | • | | | • | *Suction Assembly.*<br><br>Check screws (1), nuts and lockwashers (2), and support brackets (3) that secure suction assembly (4) to pump body (5) and to skid (6). Check that support brackets are in place and all mounting screws, nuts, and lockwashers are tight. The support brackets, mounting screws, nuts, and lockwashers must be free of damage and corrosion.<br><br>Visually inspect flanges (7), gaskets (8), flange screws (9), and nuts and lockwashers (10) for misalinement or damage that would cause leaks.<br><br>  <br> | Components and supports are not securely mounted. Hoselines cannot be attached to victaulic coupling. There is evidence of Class III leaks. |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

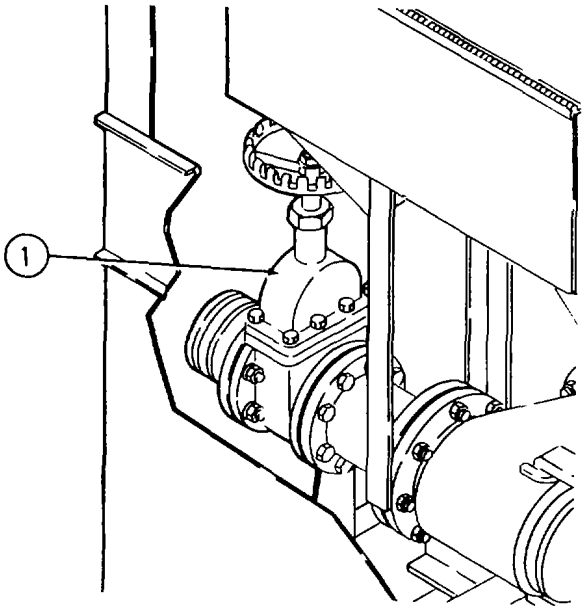
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 7 | • | | | | *Gate Valve (Suction)*.<br><br>Check that gate valve (1) operates freely from full open to full close and back.<br><br>  <br> | Gate valve cannot open or close. |
| 8 | • | | | • | *Discharge Manifold Assembly.*<br><br>Check bolts (1), nuts and lockwashers (2), and support brackets (3) that secure discharge manifold assembly (4) to pump body (5), and to skid (6). Check that support brackets are in place and securely mounted. The support brackets, bolts, nuts, and lockwashers must be free of damage and corrosion.<br><br>Visually inspect flanges (7), gaskets (8), or flange nuts and lockwashers (9) for misalinement or damage that would cause leaks. | Components and support brackets are not securely mounted. Check to valve spring is missing or does not allow pump to build prime. Hoselines cannot be attached to victaulic coupling. There is evidence of Class I II leaks. |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Discharge Manifold Assembly Continued.*<br><br>Inspect air cover hoses (10). They must be in place and long enough to prevent liquid from corroding the pump and skid components during venting.<br><br>Check that air cover valve (11 ) operates freely from full open to full close and back.<br><br>Inspect discharge check valve spring (12). It must be in place and under enough tension to hold check valve (13) closed during priming. | |

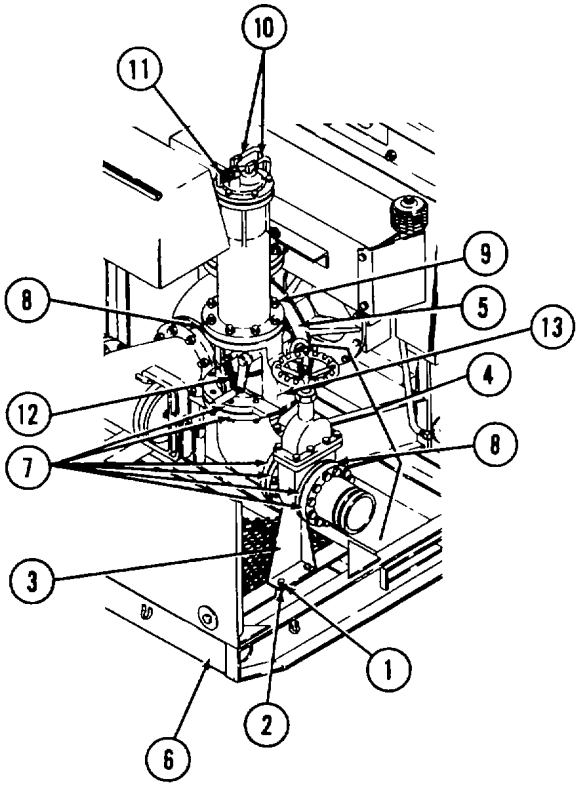


**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

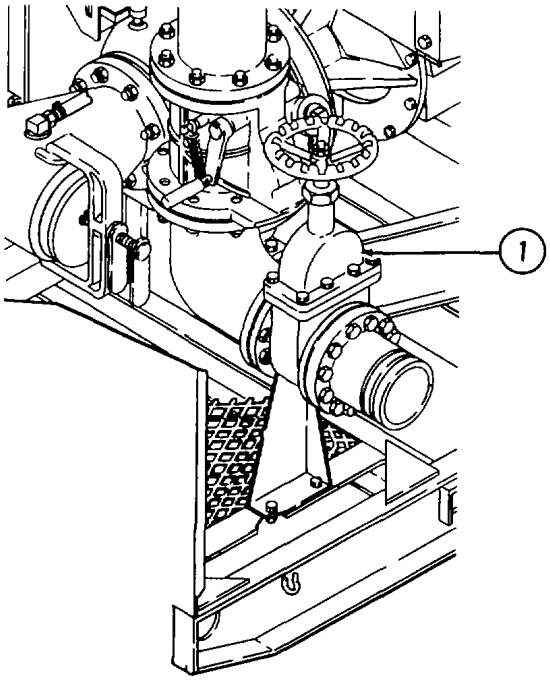
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 9 | • | | | | *Gate Valve (Discharge).*<br>Check that gate valve (1) operates freely from full open to full close and back.<br>  <br> | Gate valve cannot open or close. |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

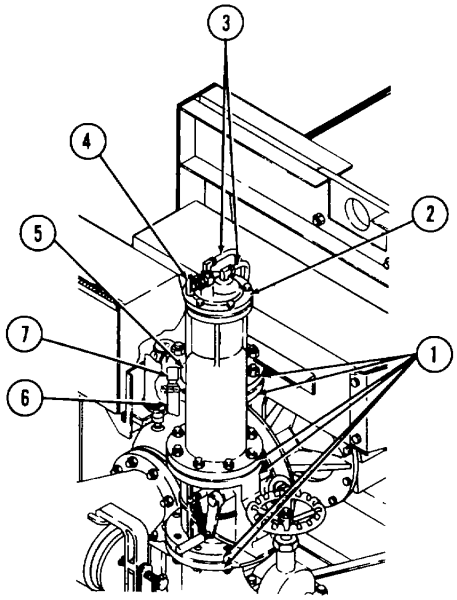
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 10 | | | • | | *Discharge Manifold Assembly.*<br><br>Inspect the discharge manifold for leaks at flanges (1), air cover gasket (2), hoses (3), valves (4), discharge gage tap (5), hose (6), and victaulic hoseline connection (7).<br><br>  <br> | There is evidence of Class III leaks. |
| 11 | • | | • | | *Pump Assembly.*<br><br>Check that pump assembly (1) is securely mounted to skid (2) and engine flywheel housing (3).<br><br>Check that pump body (4) and bearing housing (5) are securely fastened together.<br><br>Check that all nuts and lockwashers (6) are tight and free of damage and corrosion.<br><br>Check that plugs (7) are securely installed in the pump body. Check pump body (4) for cracks at mounting feet (8), suction and discharge flanges (9 and 10), priming check valve port (11), and bearing housing mounting bolts (12). | Pump assembly or bearing housing mounting hardware is loose or broken. There is evidence of Class III leaks or there are cracks. |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

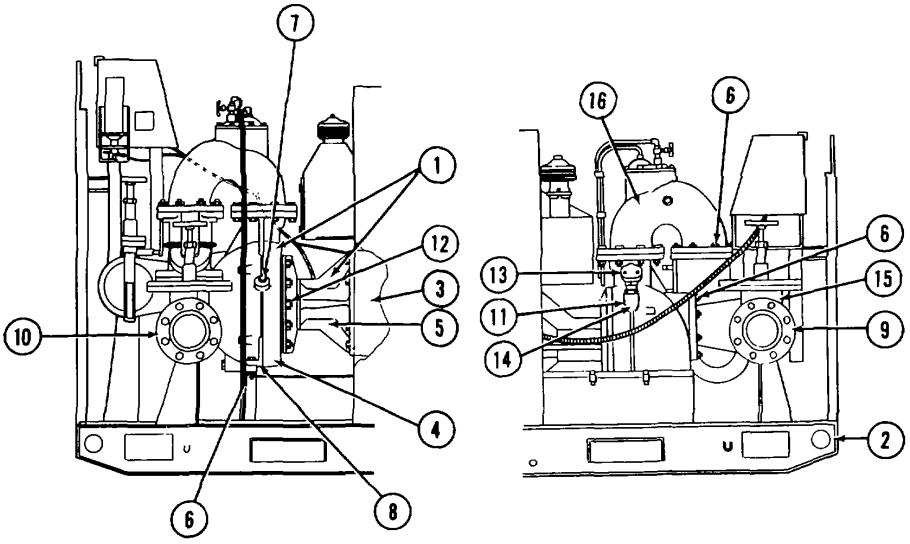
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Pump Assembly Continued.*<br><br>Check that priming check valve dust cap (13) is secured to check valve (14).<br><br>Check that suction assembly (15) and discharge manifold assembly (16) are securely attached to pump body (4).<br><br>  <br> | |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 12 | • | | | | *Pump Assembly*.<br><br>While unit is operating, listen to the pump assembly components.<br><br>Excessive noise in the pump body may indicate impeller binding or misalinement. A banging noise in the pump body may be impeller cavitation. This is corrected by reducing engine speed, opening the suction gate valve, or a combination of both. If cavitation occurs, consult the performance data plate for proper engine speed for the specific gravity liquid being pumped.<br><br>Noise behind the flywheel guard indicates a loose or faulty coupling. | Equipment damage is indicated by continuous, excessive noise. There is evidence of Class III leaks. |

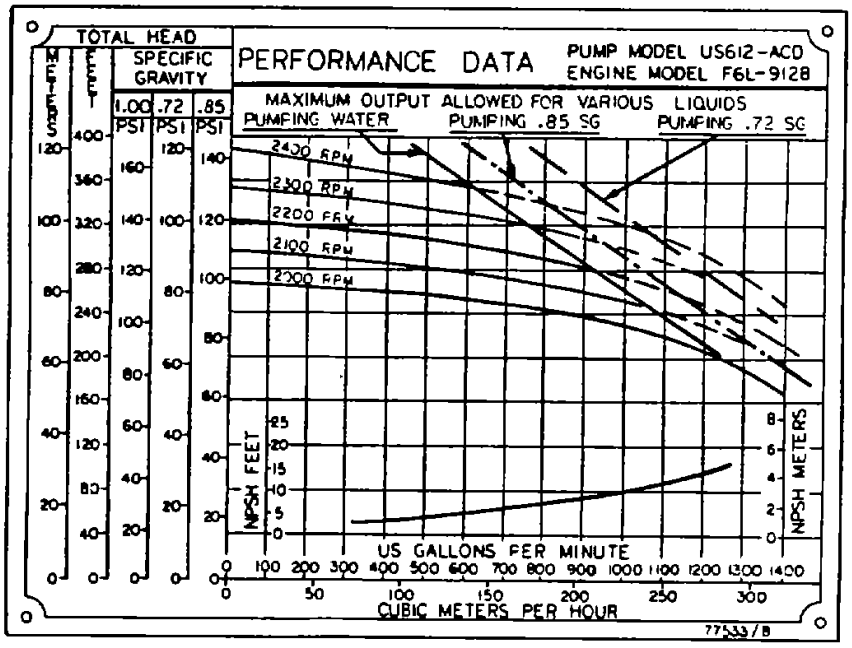
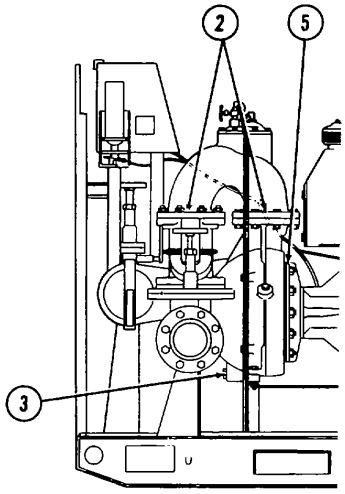
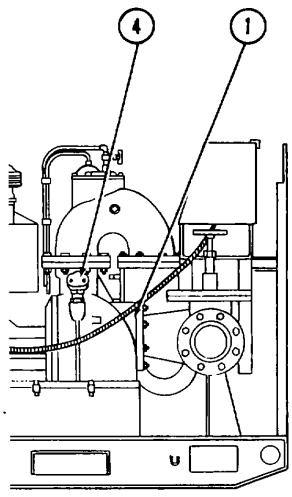


**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Pump Assembly Continued.*<br><br>Inspect the pump assembly for leaks at connection to suction assembly (1), connection to discharge manifold (2), plugs (3), priming check valve (4), or connection between pump body and bearing housing (5). | |
| 13 | | • | | • | *Flywheel Guards*.<br><br>Inspect for missing flywheel guards (1) and loose screws (2). | |



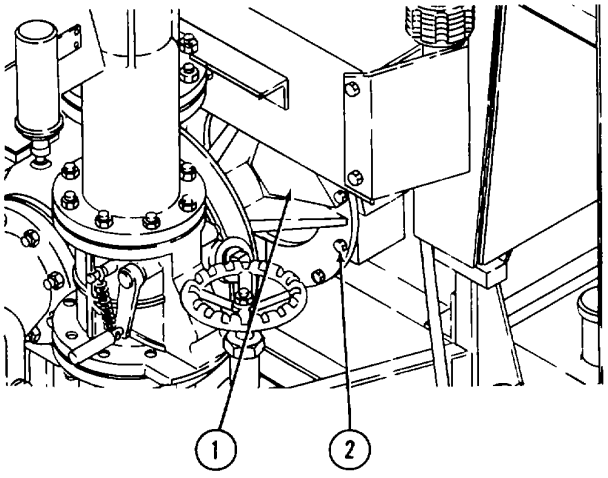



**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

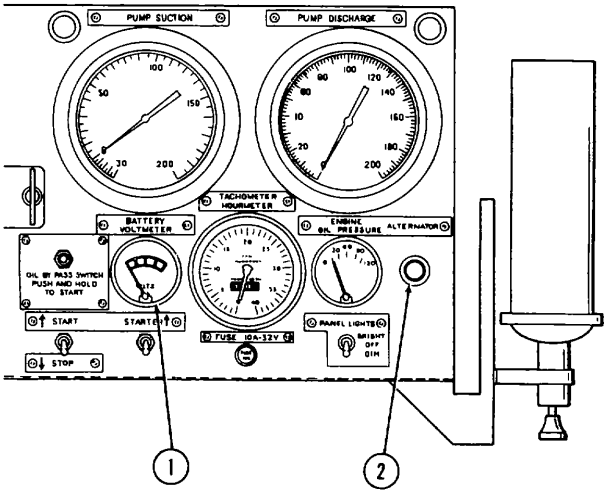
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 14 | • | • | • | | *Battery System*.<br><br>Check the overall operation of the battery system by observing the control panel during startup and operation.<br><br>Check the battery voltage. After switching on the control panel, observe BATTERY VOLTMETER (1) reading. The reading should be in the green.<br><br>Check the recharging rate during operation. Notice the amount of time ALTERNATOR light (2) remains lighted after the engine has started. If the light is on continuously or intermittently during operation, the battery system is not recharging or holding a charge properly.<br><br>  <br> | Voltmeter indicates other than green. |

**Table 2-2. Preventive Maintenance Checks and Services Continued B Before Operation**

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

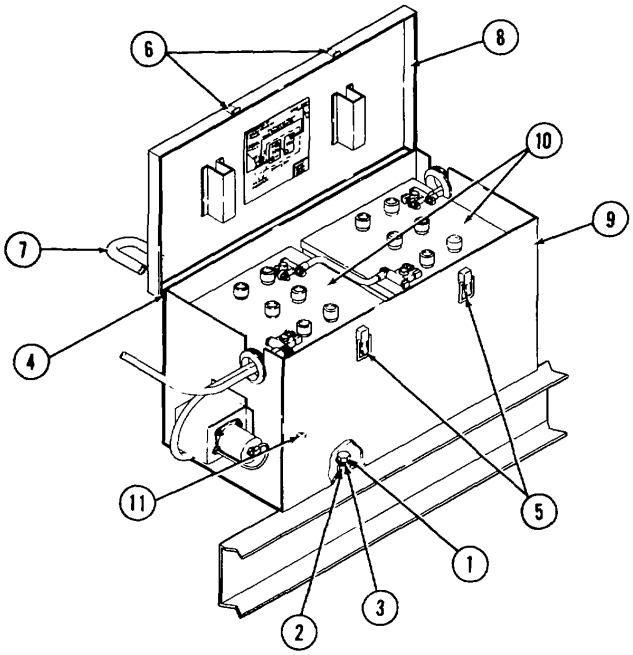
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 15 | | | | • | *Battery Box*.<br><br>Visually inspect for:<br><br>Loose, damaged, or corroded screws (1), washers (2), or lockwashers (3).<br><br>Damaged or corroded hinge (4), catches (5), or strikes (6).<br><br>Obstructed vent (7).<br><br>Physical damage to either battery box top (8) or battery box (9) that would indicate possible damage to enclosed batteries (10).<br><br>Corrosion or acid leakage at drain holes (11) in bottom of battery box.<br><br>  <br> | There are signs of battery acid leaks. |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

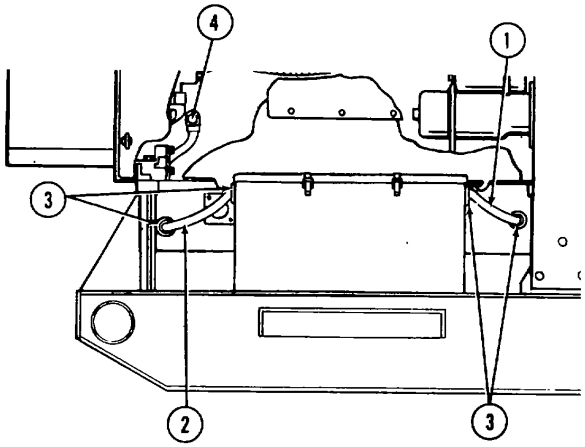
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 16 | | | | • | *Battery Cables*.<br><br>**WARNING**<br><br>**Do not smoke or use open flame or spark producing equipment in the vicinity of battery.**<br><br>**CAUSTIC CHEMICALS IN BATTERIES**<br><br>**Serious injury could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.**<br><br>**CAUTION**<br><br>**Avoid making contact across the two battery posts. This can result in severe arcing.**<br><br>**Damage to insulation of positive battery cable that would allow conductor to contact any metallic surface of the pump will cause battery charge to be drained.**<br><br>  <br> | There are signs of arcing, or potential grounding of positive side of battery. |

**Table 2-2. Preventive Maintenance Checks and Services Continued B Before Operation**

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

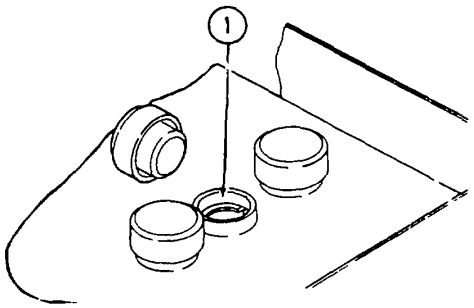
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Battery Cables Continued.*<br><br>Inspect for abraded or worn insulation of positive battery cable (1) and negative battery cable (2) and for worn or missing grommet (3).<br><br>Inspect for loose screw (4) attaching negative cable to pump. | |
| 17 | | | • | | *Batteries*<br><br>**WARNING**<br><br>**Do not smoke or use open flame or spark producing equipment In the vicinity of battery.**<br><br>**CAUSTIC CHEMICALS IN BATTERIES**<br><br>**Serious Injury could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid Is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash Immediately with plenty of clean water and get medical attention.**<br><br>**CAUTION**<br><br>**Avoid making contact across the two battery posts. This can result in severe arcing.**<br><br>**NOTE**<br><br>**Use distilled water or a good grade of drinking water (excluding mineral water).**<br><br>Check electrolyte level. If low, add water up to split rings (1).<br><br>  <br> | |

**Table 2-2. Preventive Maintenance Checks and Services Continued B Before Operation**

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

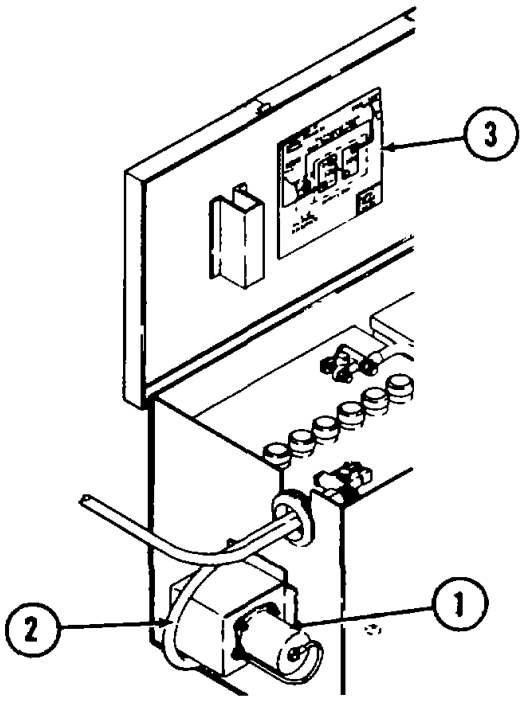
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 18 | | | | • | *Charging Receptacle*.<br><br>Check that charging receptacle (1) is securely mounted.<br><br>Check cables (2) between the receptacle and the batteries for corrosion, wear, and signs of shorts or improper grounding.<br><br>Check that the receptacle is connected and grounded, according to battery circuit plate (3) located on the inside top of the battery box.<br><br>Check the receptacle for damage that would prevent connection to the charging cable connector.<br><br>  <br> | The receptacle cannot accept the charging cable connector. The batteries cannot be charged through the receptacle. |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 19 | • | | | • | *Fuel Tank Assembly*.<br><br>**WARNING**<br><br>**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**<br><br>Check fuel tank strainer (1) for dirt.<br><br>**CAUTION**<br><br>**Condensed moisture in the fuel tank is harmful to engine operation. Keep fuel tank filled between periods of operation to reduce condensation.**<br><br>Inspect fuel tank (2) for loose screws (3) or nuts (4), and for dents, leaks, and other damage.<br><br>Visually check fuel tank (2) for physical damage that could cause leaks or contamination of fuel supply. | |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

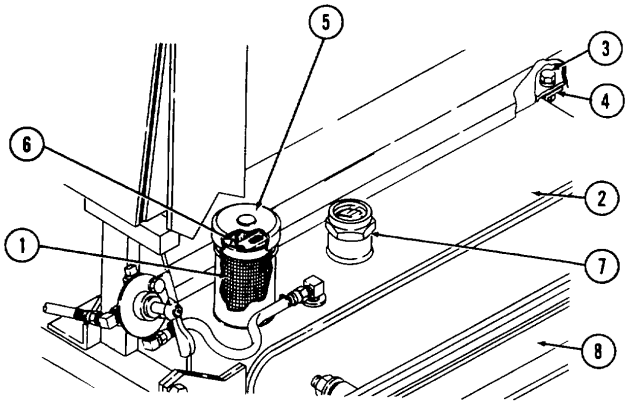
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Fuel Tank Assembly Continued.*<br><br>Remove fuel tank cap (5) and check operation of inside valve. Check that chain (6) and strainer (1) are present and in good condition. Clean strainer of foreign materials.<br><br>Check that liquid level gage (7) is legible and accurately registers level of fuel in tank.<br><br>Check fuel tank assembly (2) and surrounding area of skid frame (8) for corrosion.<br><br>  <br> | |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

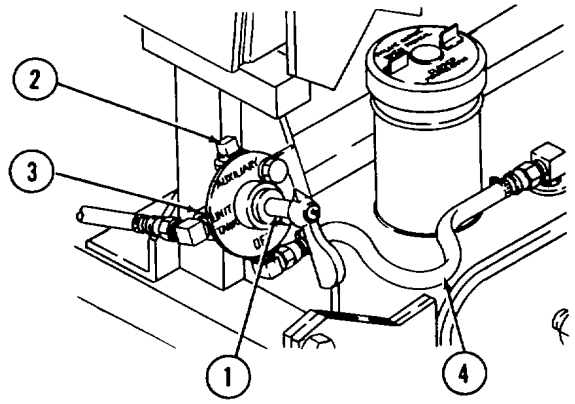
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 20 | | • | | | *3-Way Selector Valve and Fuel Line Assembly*.<br><br>**WARNING**<br><br>**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**<br><br>Visually check for fuel leaks at valve stem (1), cap plug or auxiliary line (2), male connectors (3), and fuel line assembly (4).<br><br>  <br> | Class III fuel leaks or fire hazard leakage are found. |
| 21 | | • | | • | *Electrical System Assembly.*<br><br>Check for frayed insulation, broken wires, and other damage. | Bare or broken wires are found. |

**Table 2-2. Preventive Maintenance Checks and Services Continued**

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

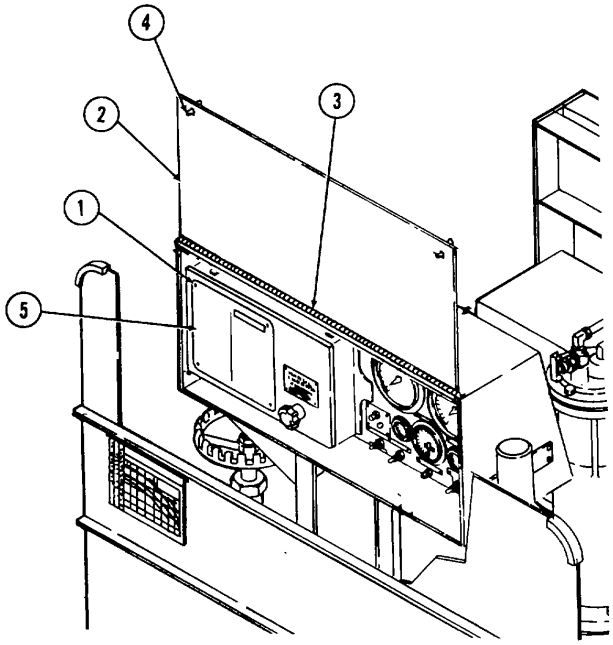
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 22 | | | | • | *Control Panel Assembly*.<br><br>Visually inspect for loose pop-type rivets (1), cracks in welds, damaged cover door (2) and hinge (3), broken pop-type rivets (1), stripped or damaged studs (4), and instruction or warning plates (5) that cannot be read.<br><br>  <br> | Damage to the assembly indicates internal components are damaged.<br>Switches are loose or damaged.<br>Gages cannot be read. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Control Panel Assembly - Continued.* | |
| | | | | | Inspect gages (1) for broken glass, legibility, or other damage. Clean gage faces by wiping with a damp cloth. | |
| | | | | | Inspect switches (2) for damage or loose mountings. Check switches for smooth operation. | |
| | | | | | Visually inspect for loose controls and indicators and damaged stud receptacles (3). | |

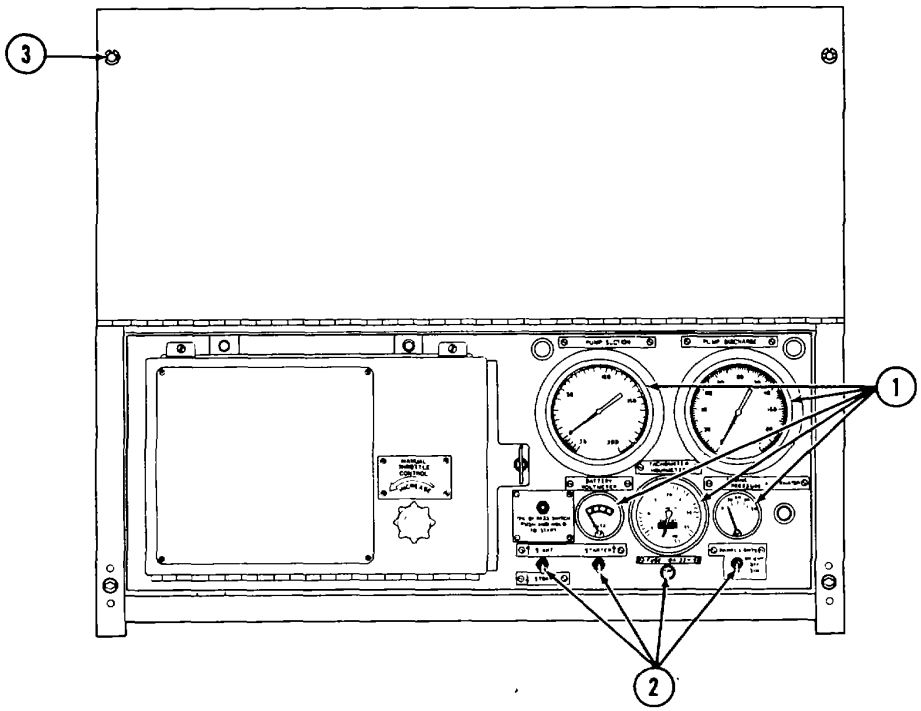


**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

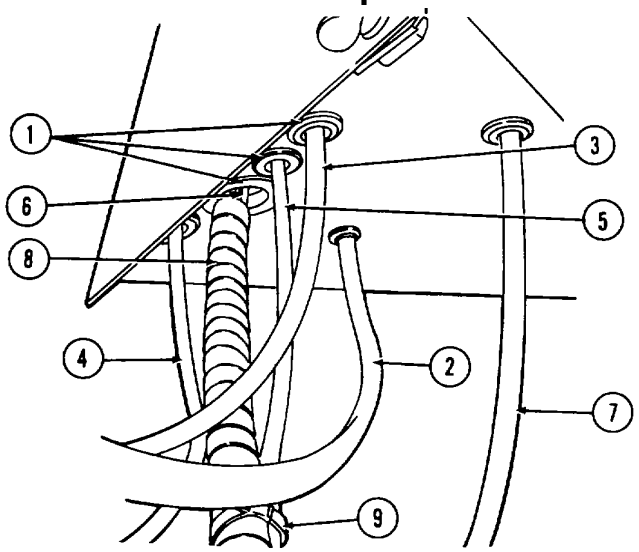
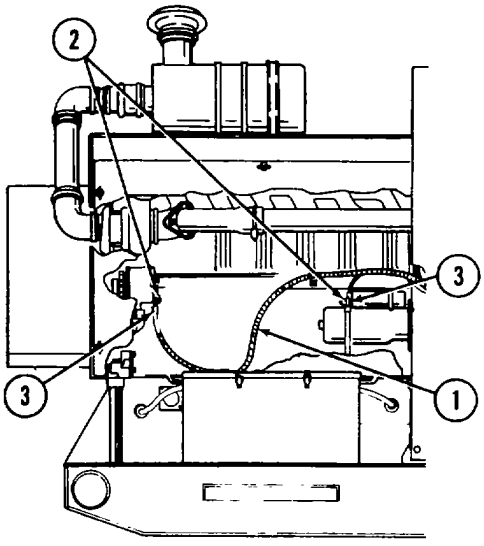
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 23 | · | | | • | *Wiring Control Panel and Instrument Hoses.*<br><br>Visually inspect for missing or worn grommets (1); frayed or worn oil pressure electrical wire (2); frayed, worn, or leaking suction hose assembly (3); frayed, worn, or leaking discharge hose assembly (4); frayed or worn tachometer cable (5); frayed or worn electrical system assembly (6); frayed, worn, or binding throttle cable assembly (7); frayed or worn spiral wrap tubing (8); and damaged or broken cable ties (9).<br><br>  <br><br><br>Inspect all main wiring harness (1) connections (2), and leads (3) for secure attachment. Check for frayed insulation, broken wires, and other damage.<br><br>  <br> | Class III leakage, arcing, or evidence of arcing is found. Bare or broken wires are found. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

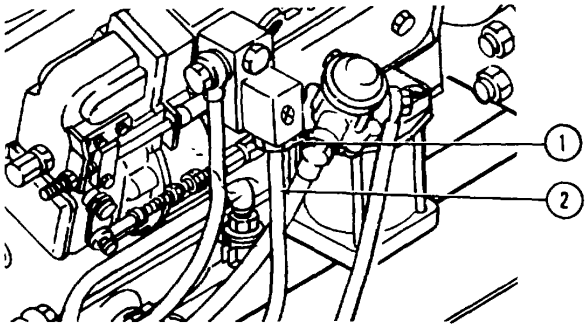
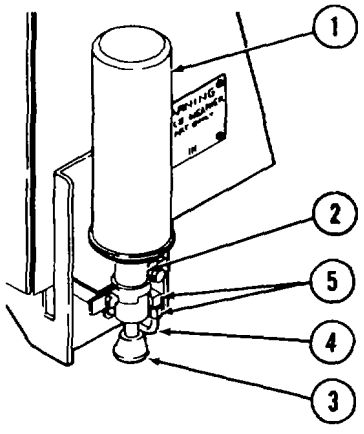
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 24 | • | | | • | *Engine Shutdown Valve (Electrical).*<br><br>Check for loose or missing electrical connector (1). Check for frayed insulation or other damage to wires (2) running to electrical connector.<br><br>  <br> | |
| 25 | | | | • | *Ether Start Kit*<br><br>Check that ether cylinder (1) is firmly in place. The cylinder should be finger tight in valve (2).<br><br>Inspect cylinder (1) and valve (2) for dents, corrosion, or other damage.<br><br>Inspect the valve assembly (2) for corrosion or other damage. Verify valve operation by pulling knob (3) for 3 seconds or less. If the valve operates freely but no ether is released, replace the cylinder (1) and test the valve again.<br><br>Inspect hose (4) for leaks or cracks. The hose should be secured to fitting (5) at both ends.<br><br>  <br> | During cold weather operation, The valve does not Release ether. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

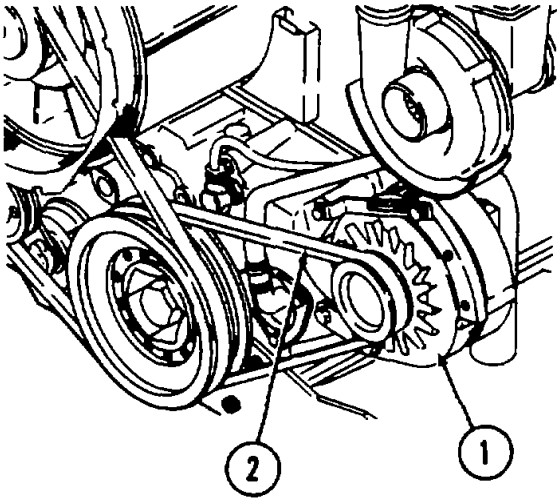
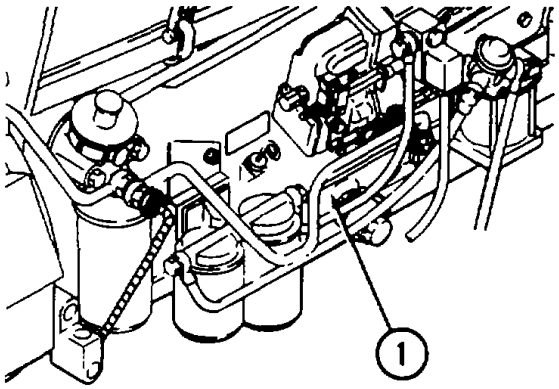
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 26 | • | | | • | *Alternator*<br><br>Inspect alternator (1) for looseness.<br><br>Check alternator (1) for evidence of binding or V-belt (2) slip.<br><br>  <br> | Alternator is loose or binds and if V-belt slips. |
| 27 | | | | • | *Oil Sump (1).*<br><br>Check for oil leaks.<br><br>  <br> | Oil leak is present. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 28 | | | | • | *Alternator*.<br><br>**WARNING**<br><br>**Engine must be shut down when inspecting alternator (1).**<br><br>**CAUTION**<br><br>**Avoid grounding or shorting the alternator. Never disconnect battery while alternator is operating.**<br><br>**Remove negative battery cable from battery before tightening connection on alternator.**<br><br>**Avoid making contact across the two battery posts. This can result in severe arcing**.<br><br>Visually inspect wire for loose ring terminals (2), loose connection at alternator post (3), corrosion at ring terminals (2) or alternator posts, burn marks at connections (arcing), damaged insulation (4), burned or melted insulation (overheating), and frayed or worn spiral wrap tubing (5).<br><br>Visually inspect alternator bearing support (6) for cracks or discoloration due to overheating.<br><br>Visually inspect voltage regulator (7) for looseness. | There is evidence of arcing, over-heating, binding, or cracking. |

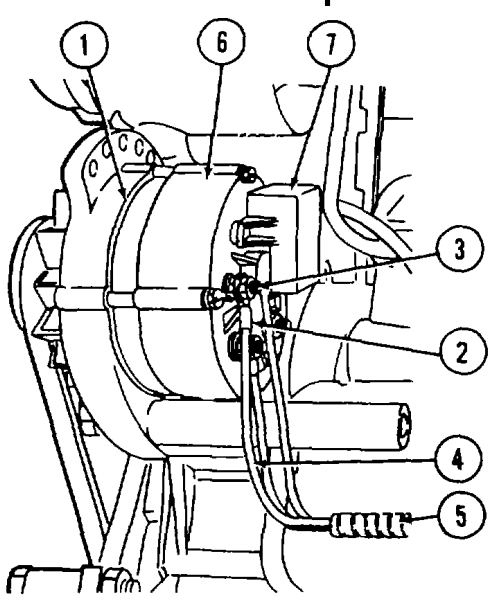


**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

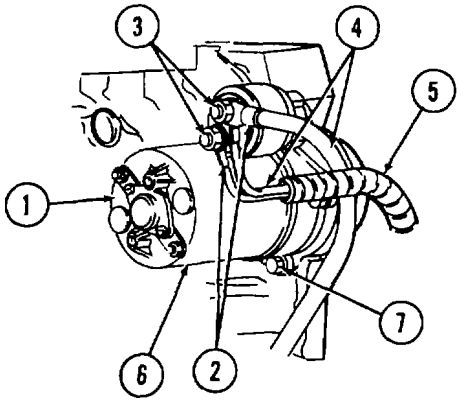
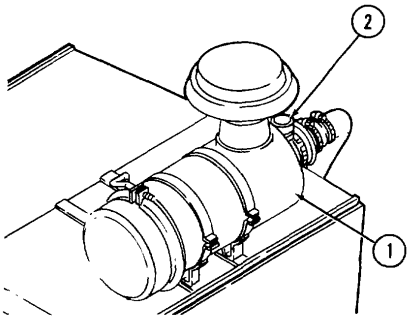
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 29 | | • | | • | *Starter Assembly (1).*<br><br>Visually inspect wires for loose ring terminals (2), loose connection at starter posts (3), burn marks at connections (arcing), corrosion of ring terminals (2) or starter posts (3), damaged wire insulation (4), burned or melted insulation (4) (overheating), and frayed or worn spiral wrap tubing (5).<br><br>Visually inspect starter (6) for goose mounting screws (7).<br><br>  <br> | Evidence of arcing, overheating, binding, or cracking. |
| 30 | | • | | | *Air Cleaner Assembly (1).*<br><br>Check air cleaner restriction indicator (2). If red band appears in window, press and release reset button. If red band reappears, refer to Table 3-1, Troubleshooting.<br><br>  <br> | |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

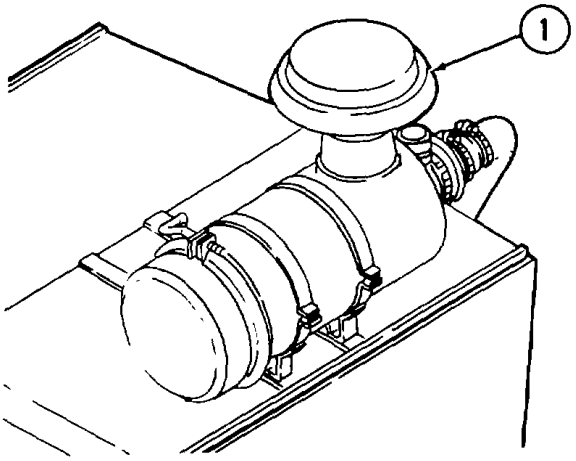
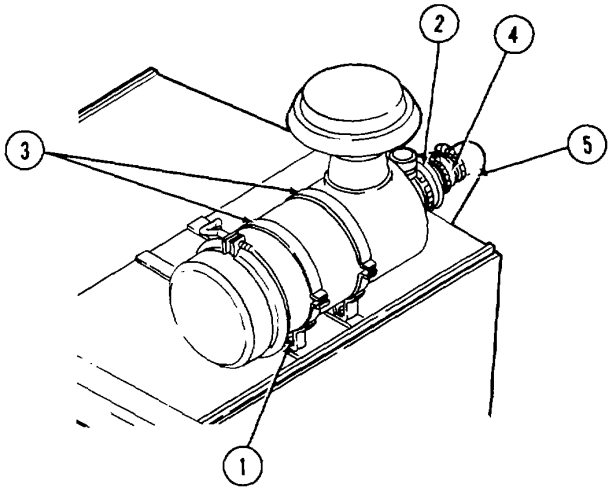
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 31 | • | | | | *Rain Cap*.<br><br>Check rain cap (1) for damage or blockage.<br><br>  <br> | Damage or blockage prevents air flow to engine. |
| 32 | | | | • | *Air Inlet System*.<br><br>Check mounting screw (1), hump reducer (2), clamps (3), reducer adapter (4), and air intake pipe (5) for damage, corrosion, or blockage.<br><br>  <br> | Damage or blockage prevents air flow to engine. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

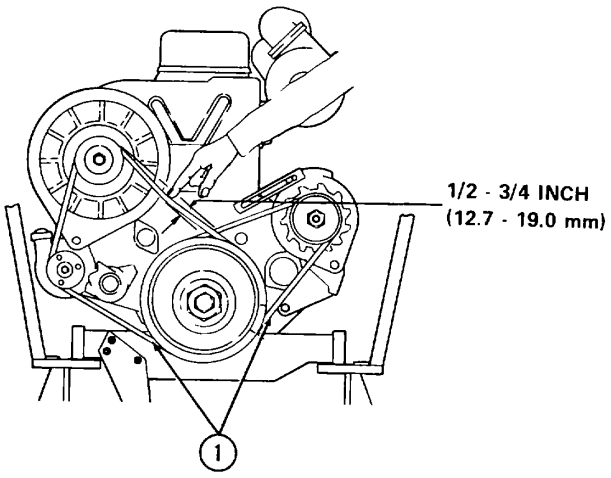
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 33 | • | | | • | *V-Belts*.<br><br>Visually inspect V-belts (1) for cuts, tears, and frayed edges, and for shiny surfaces of V portion of belt which indicate belt is slipping.<br><br>With unit shut down, check V-belt tension. When V-belt is pressed with forefinger at the midpoint between pulleys, it should deflect 1/2 to 3/4 inch (12.7 to 19.0 mm).<br><br>  <br> | V-belt is broken, excessively loose, or slipping. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

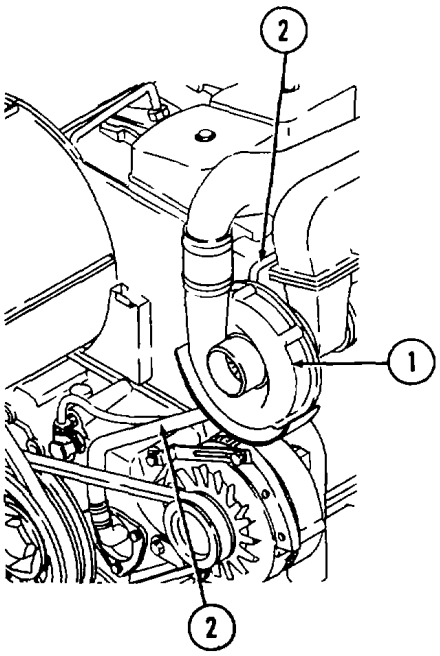
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 34 | | • | | | *Turbocharger (1).*<br><br>**WARNING**<br><br>**Severe burns can be caused by turbocharger and exhaust system heated during operation of the engine. If the engine has been running, do not touch the turbocharger or exhaust system components until they have cooled.**<br><br>Inspect turbocharger oil lines (2) for leaks, wear, and damage.<br><br>  <br> | Oil leak is present. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

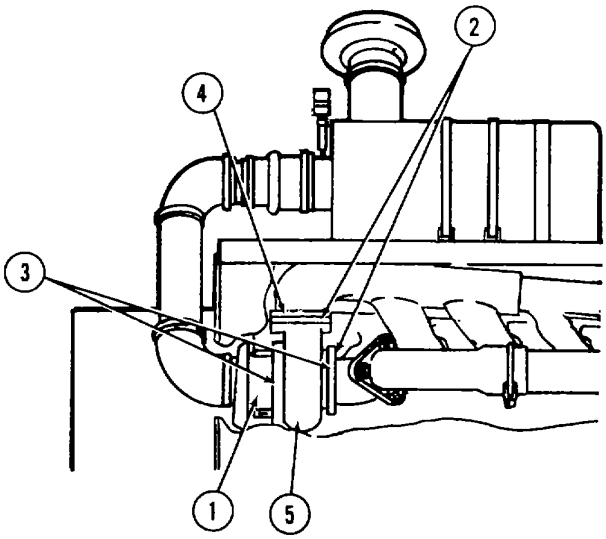
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Turbocharger (1) - Continued.*<br><br>Inspect turbocharger air and exhaust connections (1 and 2) for leaks.<br><br>Inspect turbocharger flanges (3) for cracking or looseness at the connections to suction pipe (1) and exhaust manifold (4).<br><br>Inspect exhaust manifold (4) and suction pipe (1) for secure mounting to the engine block. Turbocharger (5) is mounted on these manifolds. If they are loose, vibration will damage the turbocharger.<br><br>  <br> | |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

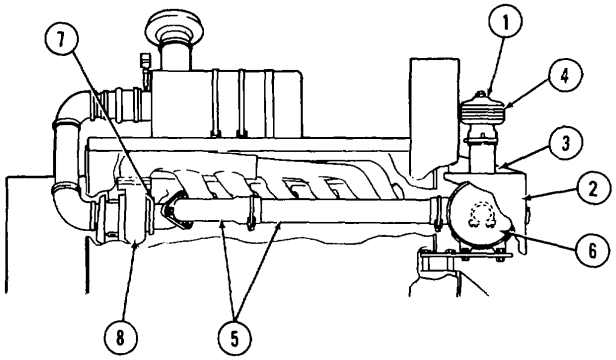
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 35 | • | | | • | *Exhaust System*.<br><br>**WARNING**<br><br>**Severe burns can be caused by exhaust system components heated during operation of the engine. If the engine has been running, do not touch any components of the exhaust system until they have cooled.**<br><br>Check that spark arrestor (1), muffler guard (2), and exhaust guard (3) are securely mounted.<br><br>Check that fins (4) of spark arrestor are not blocked by rust or dirt.<br><br>Inspect muffler pipes (5) between muffler (6) and turbocharger for loose connections, holes, or other damage.<br><br>Inspect flange (7) connection at turbocharger (8). The flange must be secured with all mounting bolts and show no indications of cracks or leaks.<br><br>  <br> | |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

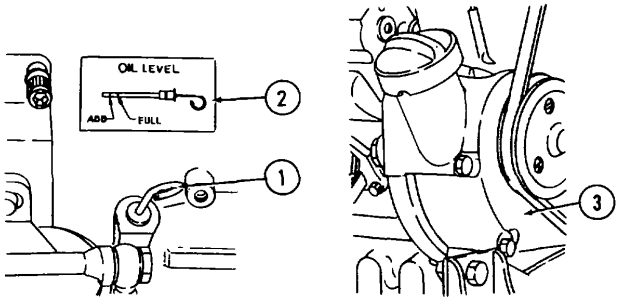
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 36 | • | | | • | *Lubrication System - Oil Level.*<br><br>With engine level, check oil level. Pull out oil dipstick (1) and wipe with clean, lint-free cloth.<br><br>Insert oil dipstick (1) as far as it will go into engine, then pull it out again.<br><br>Engine oil should coat oil dipstick (1) to the second mark (FULL) (2).<br><br>  <br><br>**CAUTION**<br><br>**Do not overfill crankcase with oil. Oil will be blown out through the crankcase breather if crankcase is overfilled.**<br><br>If oil coating is below second mark, immediately add oil to bring level up to second mark (FULL) on the oil dipstick. Again check oil level and be sure oil coats oil dipstick to second mark (FULL).<br><br>Check that oil cover (3) is tight. | Oil level is low or Class III oil leak is present. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

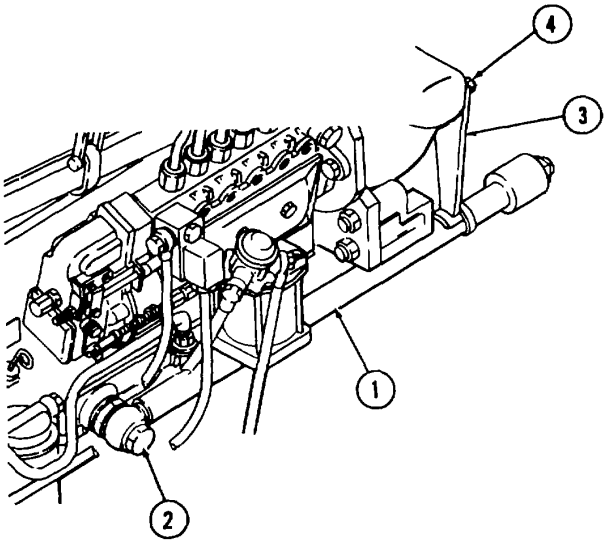
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 37 | | | | • | *Oil Drain Assembly*.<br><br>Inspect oil drain tube (1) and fittings (2) for leaks and damage.<br><br>Inspect oil drain tube support bracket (3) and mounting screws (4) for damage or corrosion.<br><br>  <br> | Class III oil leakage is present. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

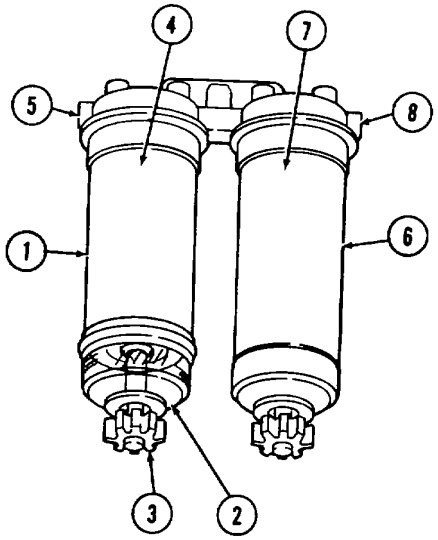
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 38 | • | | • | | *Fuel Lines and Fittings.*<br><br>**WARNING**<br><br>**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**<br><br>While the engine is running, inspect the fuel system components for leaks, damage, corrosion, and loose line fittings. Inspect that fuel system components are secure.<br><br>Check for the following:<br>Water separator (1) has clear bowl (2) with no cracks, functional knurled screw (3), undamaged cartridge (4), and secure and undamaged fuel line connections (5).<br><br>Fuel filter (6) has secure and undamaged cartridge (7) and fuel line connections (8).<br><br>  <br> | Fuel leaks. |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

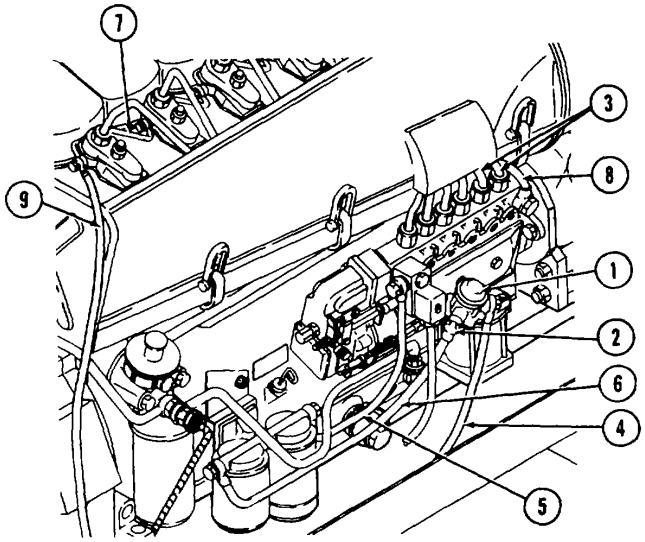
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Fuel Lines and Fittings-Continued.*<br><br>Fuel pump (1) has secure and undamaged cover, upper chamber, pump body, banjo bolts (2) and banjo fittings.<br><br>  <br><br><br>Injector lines (3) are securely mounted.<br><br>Inspect the following fuel lines for leaks along the length of each line for holes, cracks, worn spots, kinks or looseness, and other damage that would cause deterioration during operation resulting in fuel leaks or restricted fuel flow. Check that each line is securely mounted and during operation would be free of vibration that would cause wear or abrasion.<br><br>Fuel supply line (4)<br>Separator-to-pump line (5)<br>Pump-to-filter line (6)<br>Injector lines (2)<br>Backleakage line (7)<br>Overflow line (8)<br>Fuel return line (9) | |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

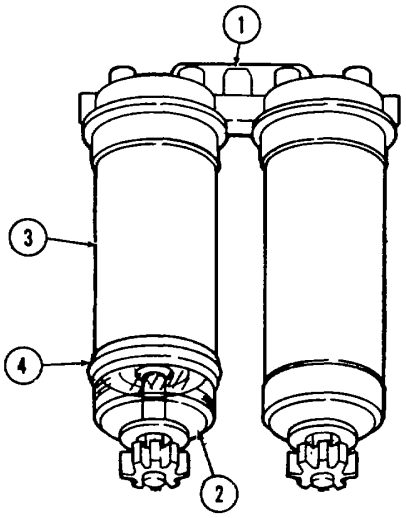
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 39 | • | | | | *Fuel Filters (1).*<br><br>**WARNING**<br><br>**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**<br><br>Check fuel filters for leaks.<br><br>Check clear bowl (2) at the bottom of water separator (3). Water in the bowl must be drained. Water at the bottom of the bowl is a lighter color than the fuel above. The water level in the bowl must never exceed the lower rim of bed (4).<br><br>  <br> | |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

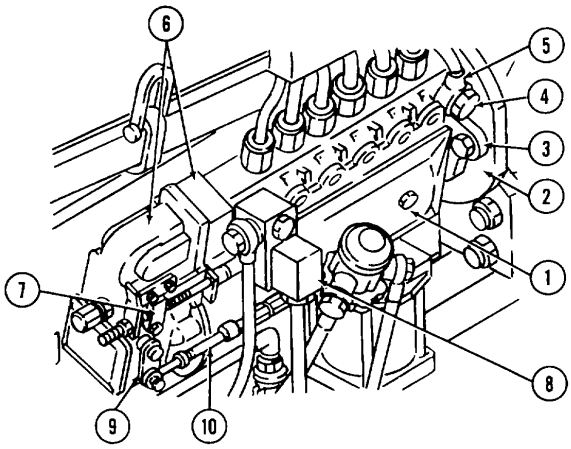
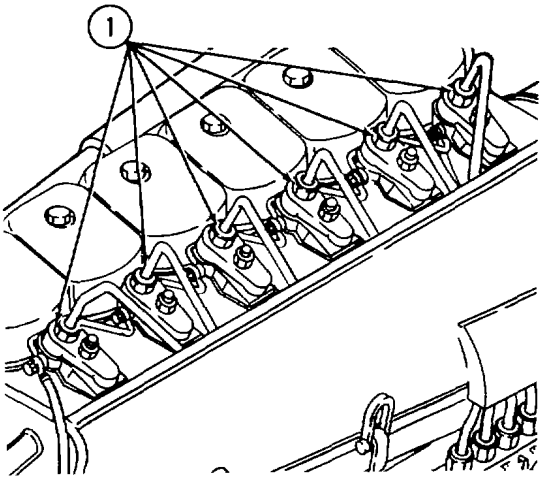
| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| 40 | • | | | • | *Injection Pump*.<br><br>**WARNING**<br><br>**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**<br><br>Check that injection pump (1) is securely mounted to crankcase (2).<br><br>Check for oil leaks between the pump housing and crankcase.<br><br>Inspect injection pump mounting flange (3) for cracks.<br><br>  <br> | |

**Table 2-2. Preventive Maintenance Checks and Services - Continued**

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

| ITEM NO. | INTERVAL | | | | ITEM TO BE INSPECTED PROCEDURE | Equipment is Not Ready/ Available |
|---|---|---|---|---|---|---|
| | B | D | A | W | | |
| | | | | | *Injection Pump - Continued*.<br><br>Check that there are no leaks at banjo bolts (4) and fittings (5). Check that governor assembly (6) is securely mounted to the pump body.<br><br>Check that stop lever (7) is securely attached to the shaft of shutdown solenoid (8).<br><br>Check that speed lever (9) is securely attached to throttle extension lever (10). | |
| 41 | | | | • | *Injectors*.<br><br>Check that injectors (1) are securely mounted.<br><br>  <br> | |
| 42 | | | | • | *Data and Warning Plates.*<br><br>Inspect that data and warning plates are securely mounted in place and all information is readable. | |

## Section III. OPERATION UNDER USUAL CONDITIONS

### 2-4. ASSEMBLY AND PREPARATION FOR USE

a. The pumping assembly comes fully assembled, ready for use after attaching the suction and discharge hoses.

b. 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, operation of the pump assembly, and 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 an individual job.

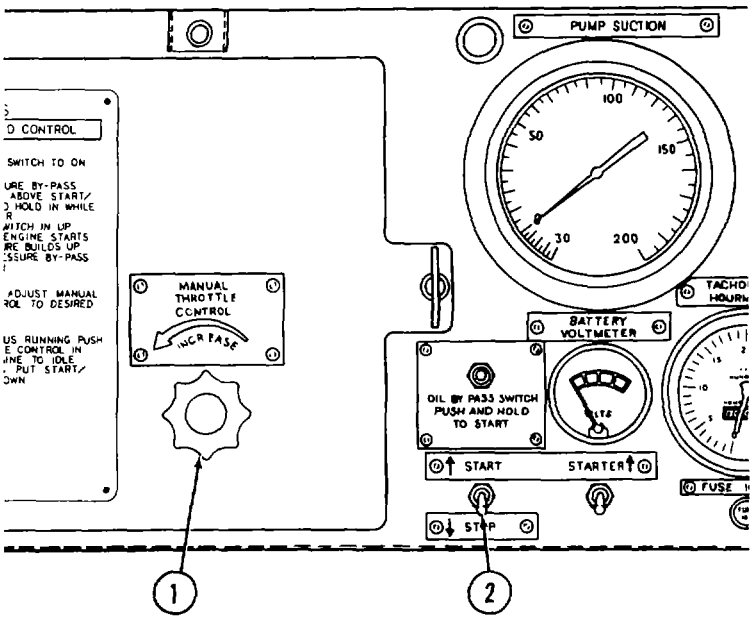
### 2-5. INITIAL ADJUSTMENTS AND DAILY CHECKS

a. Loosen studs on control panel cover door. Lift door.

b. Position controls as follows:

(1) MANUAL THROTTLE CONTROL (1) pushed in.

(2) Engine START/STOP switch (2) down at STOP position.




c. Perform all category B preventive maintenance checks and services (PMCS) listed in Table 2-2. Report any problems to organizational maintenance.

d. If pumping assembly has not been operated for one week, perform all category B and W PMCS listed in Table 2-2. Report any problems to organizational maintenance.

e. If pumping assembly has not been operated for more than a month, perform all PMCS listed in Table 2-2. Report any problems to organizational maintenance.

## 2-6. OPERATING PROCEDURE

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

(1) Locate unit as close as possible to the liquid to be pumped with the suction (inlet) side toward the source. Keep both the length of the suction hose and the height of the suction 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. *Grounding*. Ground the centrifugal pump unit as follows.

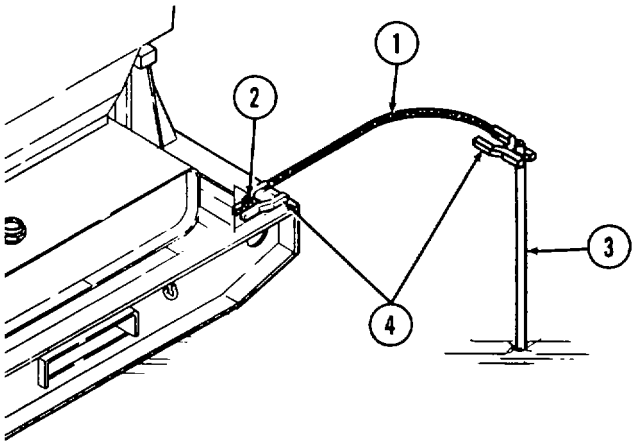
(1) Connect ground cable assemblies (1) to ground connection (2). Be sure that electrical connection is tight.

**NOTE**

**The earth surrounding ground rods must be moist to make a good electrical connection. In dry or sandy areas, pour water around the rods to improve the connection.**

(2) Drive ground rods (3) a minimum of 2-1/2 feet (0. 762 m) into the ground. Use nonsparking mallet stowed in tool box.

(3) Connect ground cable assemblies (1) to ground rods (3). Be sure that connector (4) has made a tight electrical connection.



**2-6. OPERATING PROCEDURES (Continued)**

**WARNING**

**Do not attempt to pump any liquids for which this centrifugal pump unit has not been designed. The centrifugal pump unit has been designed to pump potable water or petroleum based fuels with specific gravities between 0.85 and 1.0.**

**Do not pump potable water after the pump has been contaminated by pumping fuel.**

c. *Preparation for starting.* Although the centrifugal pump unit is self-priming, it should never be operated unless the pump body is filled with liquid to the bottom of the suction port.

(1) Open gate valve (1) of the pump suction assembly.

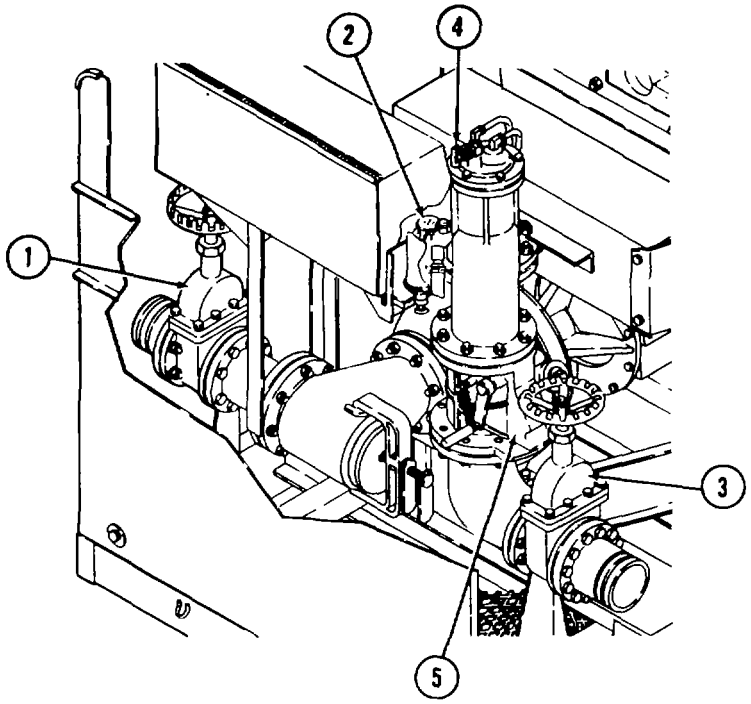
(2) Remove dust cap from priming port (2) on pump body. Fill the pump volute with the liquid that will be pumped until it reaches the bottom of the suction port. Replace dust cap. When the centrifugal pump unit is started, the pump will reprime and reprime as necessary as long as the pump body is full to the bottom of the suction port.

(3) Open gate valve (3) of the pump discharge manifold assembly.

(4) Open needle valve (4) of the air valve cover assembly on the discharge manifold assembly elbow.

(5) Be certain discharge check valve (5) is closed.

(6) Remove control panel cover assembly and turn four brass valves to the open position.



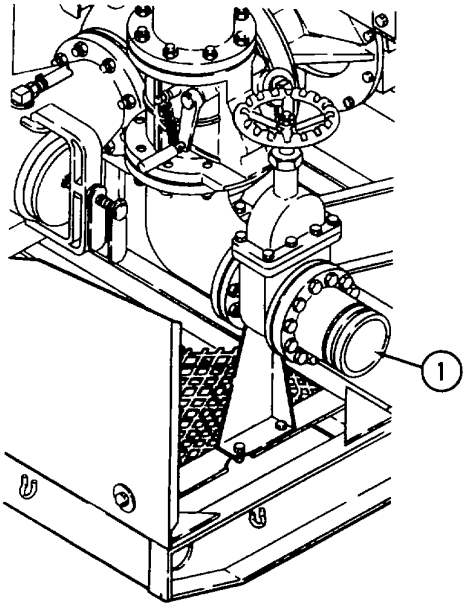
**2-6. OPERATING PROCEDURE (Continued)**

d. *Discharge hose installation.* Aline the discharge hose exactly with the piping of the discharge manifold assembly before connecting it to the pump. Never try to pull the hose into place by tightening the coupling.

(1) Connect the discharge hose to victaulic coupling flange (outlet) (1) of the discharge manifold assembly.

(2) Be sure that discharge hose is free of twists and pinch points after installation. Support and secure discharge hose to avoid strain and vibration during operation.

(3) Make certain that all connections are tight.

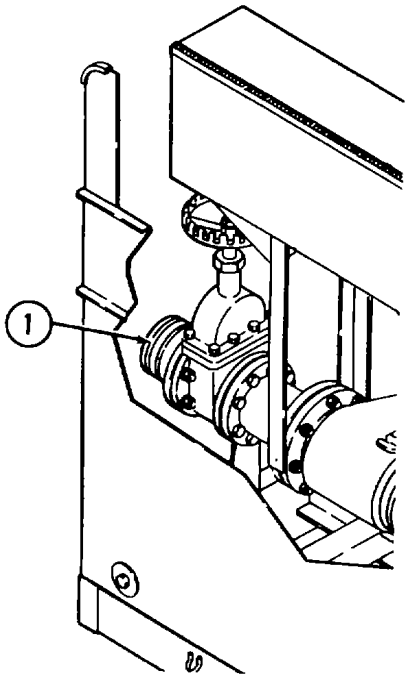



e. *Suction hose installation*. Aline the suction hose exactly with the piping of the suction assembly before connecting it to the pump. Never try to pull the hose into place by tightening the coupling.

(1) Connect the suction hose to the victaulic coupling flange (inlet) (1) of the suction assembly.

(2) Be sure that the suction hose is free of twists and pinch points after installation. Support and secure suction hose to avoid strain and vibration during operation. Highest point in the suction hose should be at the pump.

(3) Make certain that all connections are tight. Even a slight leak in the suction line will affect priming, head, and capacity.



**2-6. OPERATING PROCEDURE (Continued)**

**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. While running engine, be alert for fumes. 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.**

**Do not smoke within 50 feet (15.2 m) of an operating pump unit. Smoking within this area creates a fire and explosion hazard. All personnel within 15 feet (4.57 m) of an operating centrifugal pump unit must wear approved ear protection equipment. Failure to do so may result in impairment or loss of hearing.**

CAUTION

**Be sure the pump volute is filled with liquid to the bottom of the suction port before starting the engine. The pump will not prime when dry. Extended operation of a dry pump will destroy the seal assembly and cause overheating which could seriously damage the pump. Do not use ether start kit except in extremely cold weather when engine will not start. See paragraph 2-8. To prevent starter from overheating, do not crank engine with starter for more than 10 seconds. Battery life will be lengthened if 60 seconds is allowed to elapse between starting attempts. Under any condition, if engine does not start on initial attempt, allow engine rotation to stop completely before again engaging starter.**

**NOTE**

**Be sure priming port dust cap is securely in place on the pump body.**

f. *Starting.* Instructions (1) for starting, running, and stopping the engine are located on throttle panel assembly (2).

(1) Set PANEL LIGHTS switch (3) to the BRIGHT or DIM position to turn on panel lights.

(2) Set START/STOP switch (4) to START position.

(3) Press OIL BYPASS switch (5) located above START/STOP switch (4) and hold in while engaging starter (6). This switch bypasses the low oil pressure circuit. When oil pressure is below normal, the low oil pressure circuit stops the engine. Oil pressure is normally low when starting the engine. This switch bypasses the circuit until the oil pressure reaches approximately 40 psi (276 kPa).

**CAUTION**

**If engine fails to start within 10 seconds, release STARTER switch; do not attempt starting again until starter motor stops turning. Failure to comply with this rule may result in serious damage to the starter motor.**

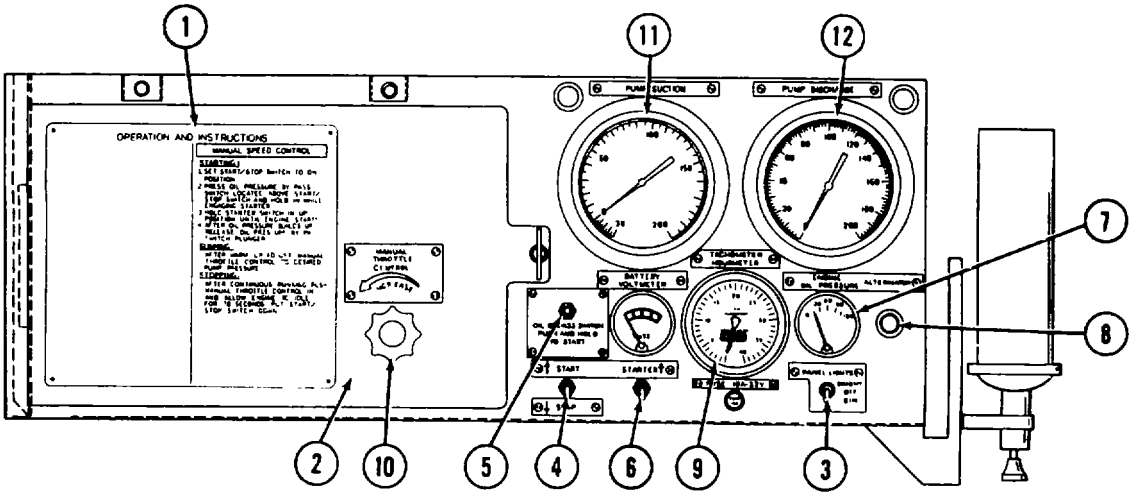
(4) Hold STARTER switch (6) in UP position until engine starts. If the engine fails to start after four periods of cranking, see troubleshooting procedures in Chapter 3.

(5) Continue pressing OIL BYPASS switch (5) and observe oil pressure gage (7). After oil pressure builds up over 40 psi (276 kPa), release the OIL BYPASS switch (5).

(6) Check that ALTERNATOR light (8) has gone out. This means batteries are being adequately charged by alternator.

(7) After starting the engine, observe TACHOMETER (9). Use MANUAL THROTTLE CONTROL knob (10) to adjust engine speed (approximately 800 to 900 rpm).

(8) Observe PUMP SUCTION GAGE (11); the gage should show a vacuum. The pump may not prime immediately because the suction hose must first fill with liquid. If the pump fails to prime within 5 minutes, stop the engine and check for leaks. If there are no leaks, and the pump fails to prime, refer to Table 3-1, Troubleshooting.



**2-6. OPERATING PROCEDURE (Continued)**

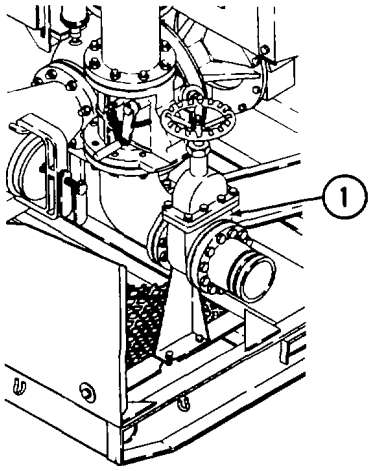
(9) The check valve on the discharge manifold assembly is forced open when discharge pressure indicated on PUMP DISCHARGE GAGE (12) is high enough to initiate flow.

**CAUTION**

**After centrifugal pump unit is primed and pumping, maintain engine idle speed until engine warmup cycle is complete.**

(10) Run the centrifugal pump unit with engine at idle speed for a few minutes. Adjust MANUAL THROTTLE CONTROL knob (10) until desired operating speed is reached. Refer to paragraph g.

(11) Partially close the discharge gate valve (1) to fill the hose slowly and guard against excessive shock pressure to fittings. As the discharge hose fills, open the discharge gate valve until it is adjusted to the required discharge flow rate.




**CAUTION**

**Impeller cavitation occurs when engine speed is increased beyond the point of maximum suction vacuum. Cavitation is harmful to the pump unit and should be avoided at all times. Cavitation is indicated by a very loud cracking noise in the pump housing.**

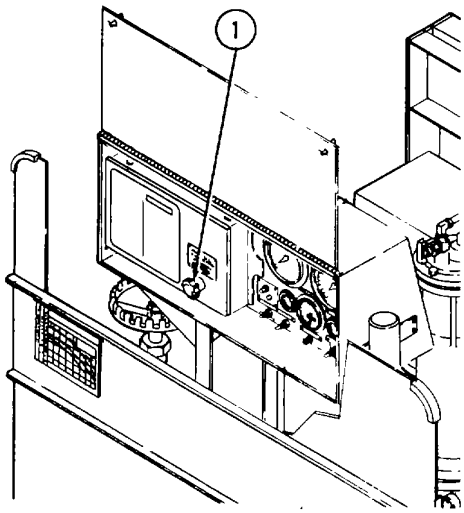
**NOTE**

**Engine speed and pump discharge will vary in accordance with the output demand. When there is no increase in vacuum (suction) as indicated on the suction gage, maximum pumping capacity has been reached.**

*g. Adjustments.* Engine speed and pump discharge pressure are controlled with MANUAL THROTTLE CONTROL knob (1). Pull MANUAL THROTTLE CONTROL knob out to increase engine speed and pump discharge pressure; push in to decrease engine speed and pump discharge pressure. Adjust the MANUAL THROTTLE CONTROL until the required speed and discharge pressure are

**2-6. OPERATING PROCEDURE (Continued)**

reached. Engine speed and pump discharge pressure vary with the weight of the liquid being pumped and the demands of the pumping application. See the pump performance data plate, located on the noise shield, to determine the correct flow rate for the liquid being pumped. Pump capacities are shown in US gallons per minute (cubic meters per hour). Discharge pressures are shown in psi and feet of head for 1.00, 0.72, and 0.85 specific gravity liquids. Engine speed is shown in 100 rpm increments from 2000 to 2400 rpm (maximum governed speed). Pump and engine assembly will give satisfactory life and performance when operated in accordance with the pump performance data.



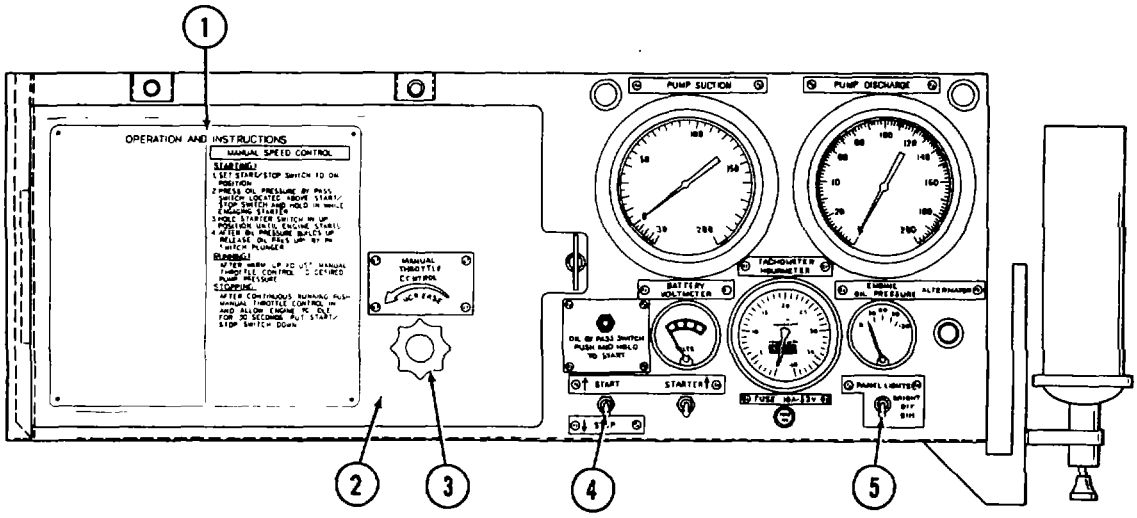

h. Stopping. Instructions (1) for stopping operation are on the throttle panel assembly (2) on the control panel. Follow these stopping procedures.

(1) Slowly push in MANUAL THROTTLE CONTROL knob (3) until engine is at idle speed.

(2) Allow engine to idle for 30 seconds.

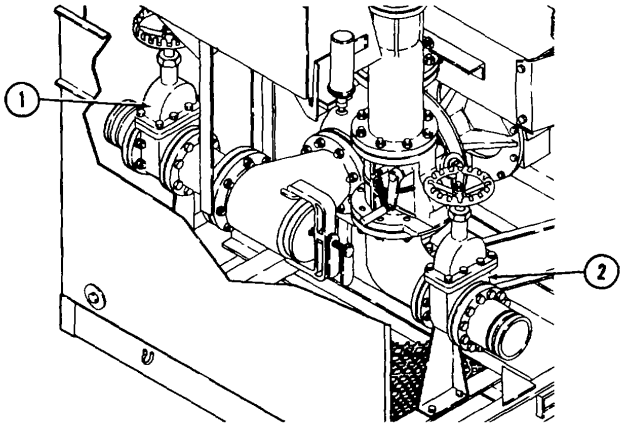
(3) Set START/STOP switch (4) to STOP position. The engine and pumping action will stop.

(4) Turn PANEL LIGHTS switch (5) to OFF position.



**2-6. OPERATING PROCEDURE (Continued)**

(5) Close suction assembly gate valve (1) and discharge manifold assembly gate valve (2) to retain the liquid in the pump.




**2-7. PREPARATION FOR MOVEMENT**

a. Shut down the centrifugal pump unit according to paragraph 2-6.h.

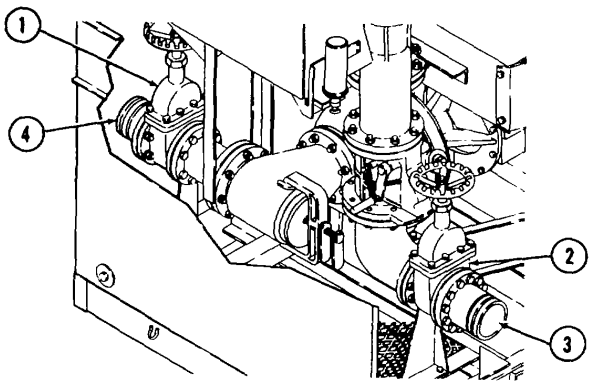
b. Be sure suction assembly and discharge manifold assembly gate valves (1 and 2) are closed.

c. Drain the discharge hose before disconnecting it from the discharge manifold assembly victaulic coupling flange (3) (outlet). If the centrifugal pump unit has been used to pump fuel, drain the discharge hose into a suitable container.

d. Remove suction hose from the suction assembly victaulic coupling flange (4) (inlet).

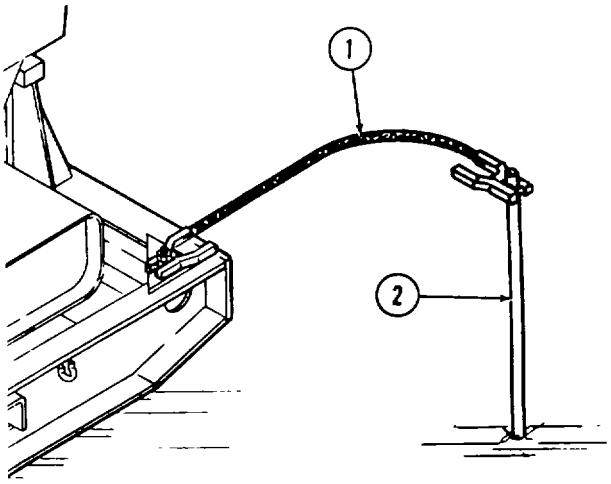
e. Remove discharge hose from the discharge manifold assembly victaulic coupling flange (3) (outlet).

f. Cover the victaulic coupling flanges (outlet and inlet) (3 and 4) to keep debris from entering the pump.

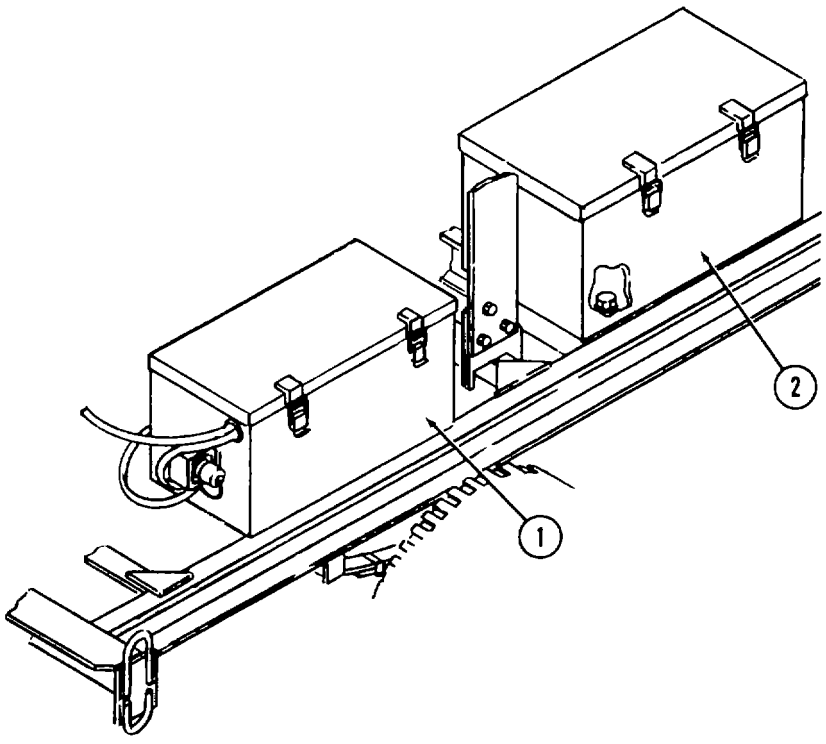


**2-7. PREPARATION FOR MOVEMENT (Continued)**

g. Disconnect ground rod cable assemblies (1). Remove ground rods (2) from the earth. Stow cable assemblies in tool box. Stow ground rods.




h. Be sure that battery box assembly (1) and tool box (2) are closed securely.



## Section IV. OPERATION UNDER UNUSUAL CONDITIONS

### 2-8. OPERATION IN EXTREME COLD

a. Use proper engine oil for cold weather. Refer to paragraph 3-1.

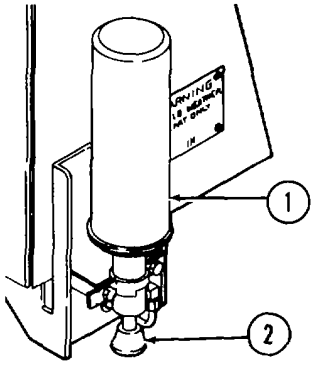
**WARNING**

**Ether is highly flammable. Do not use near sparks or open flames. Do not inhale fumes. Do not actuate ether start kit more than once. Overloading the engine air housing with this highly explosive fluid (ether) could result in an explosion.**

b. Use ether start kit to help start the engine in extremely cold temperatures. The ether cylinder (1) is located on the right side of the control panel assembly. The control knob (2) is located at the neck of the cylinder.

(1) Just before starting engine, push in and release cylinder control knob. This will inject a small amount of ether into the engine air intake.

(2) If engine does not start, do not use the ether start kit again until all fumes have evaporated; wait at least 5 minutes.




**WARNING**

**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**

c. Keep fuel tank full to prevent condensation. Condensation can freeze and clog lines, filters, and injectors.

d. Before filling the fuel tank, clear any snow, ice, or moisture from the area around the fuel tank cap and the drive plate area at the engine flywheel.

e. Keep fuel tank filler cap tight to prevent foreign matter from entering the engine fuel tank.

**2-8. OPERATION IN EXTREME COLD (Continued)**

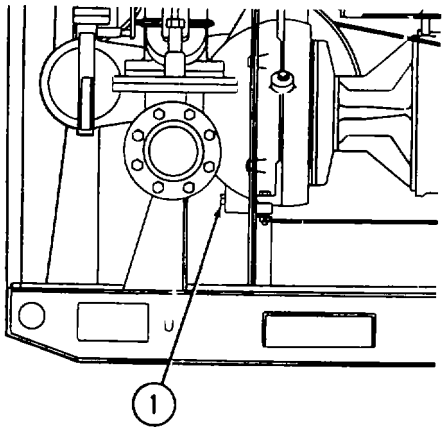
**CAUTION**

**Drain the pump volute after operation to prevent freezing.**

f. Drain pump after use to prevent water in pump from freezing. Remove pump body drain plug (1). Remove all fluid from pump body. Crank engine briefly to complete draining. Replace drain plug.

**NOTE**

**The drain plug has a 1-5/16 inch square head and can be removed with a standard tool.**




g. Cover centrifugal pump unit with weather cover when not in use and shelter from weather, if possible.

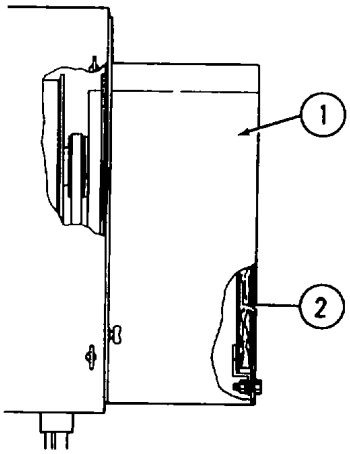
**2-9. OPERATION IN EXTREME HEAT**

**CAUTION**

**Poor air filtering and restrictions to air and exhaust flows are harmful to engine.**

The engine of the centrifugal pump is air cooled. Heat is removed from the engine through engine exhaust, engine oil, and the passage of air across and through the cylinder cooling fins. When operating in high temperatures, observe the following.

a. *Intake duct*. Inspect engine intake duct (1). Check that acoustical panel (2) is securely mounted and not blocking the blower intake ducting. Check that the blower intake ducting is not distorted or interfering with V-belt operation.

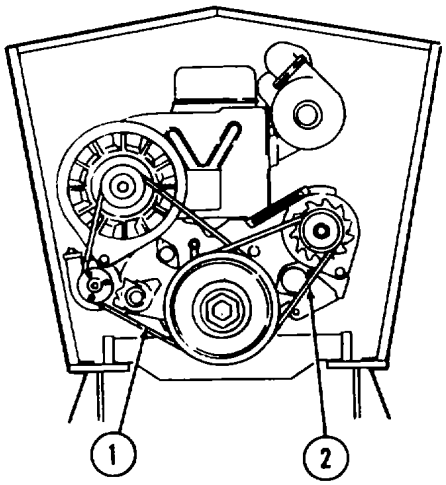


## 2-9. OPERATION IN EXTREME HEAT (Continued)

**WARNING**

**Severe injury may result from contact with the rotating cooling blower or V-belt. When it is necessary to make inspections in this area, be aware of the blower and V-belt position, or turn engine off.**

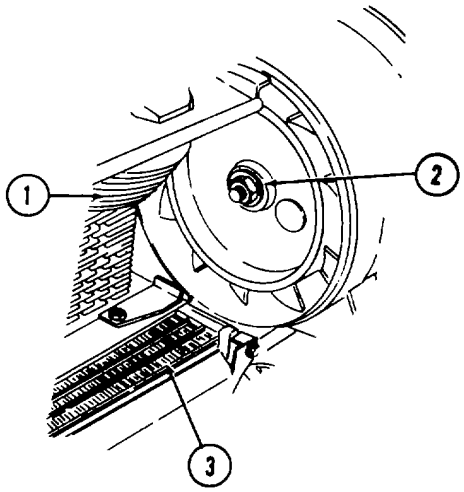
b. *V-Belts.* Check that V-belt (1) driving air blower assembly is properly adjusted and drives air blower without slipping. During operation of the engine, observe the alternator light. If the alternator light goes on or occasionally blinks, the alternator V-belt (2) may be slipping. Contact organizational maintenance if V-belts need to be serviced.




c. Cylinder cooling fins (1). Cylinder cooling fins should be free of dirt.

d. Bottom roller (2). Bottom roller should be free of dirt.

e. Lube oil cooler cooling fins (3). Lube oil cooler cooling fins should be free of dirt.



**2-9. OPERATION IN EXTREME HEAT (Continued)**

f. *Air Cleaner.* High am bent temperatures change density of air used by the engine in combustion. Monitor engine's ability to breathe using the air cleaner intake restriction indicator. Air filter elements should be changed at first indication of unacceptable restriction of air flow.

**WARNING**

**Death or serious Injury could occur if diesel fuel oil Is not handled carefully. Use In a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not Inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before fueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**

g. Fuel. Fill the fuel tank at the end of each day of operation in order to prevent an accumulation of vapor in the fuel tank. However, do not overfill. Allow room for fuel expansion.

h. Batteries. Increase battery PMCS frequency. Use distilled water or a good grade of drinking water I (excluding mineral water) to bring electrolyte to proper level.

**2-10. OPERATION IN RAINY OR HUMID CONDITIONS**

**WARNING I**

**Death or serious Injury could occur if diesel fuel oil Is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, Ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not Inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**

a. Check that fuel 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. Coat machined surfaces with oil. Contact organizational maintenance to remove any rust or corrosion, and cover the exposed surfaces with paint.

**2-11. OPERATION IN HIGH ALTITUDES**

The centrifugal pump unit will operate normally at elevations up to 9000 feet (2743. 2 ml above sea level. Above 9000 feet (2743. 2 ml, the operating efficiency of the engine is reduced. Make sure that engine is operating at peak efficiency.

**2-12. OPERATION IN SANDY OR DUSTY AREAS**

The engine cover of the pump unit is designed to protect the engine during periods of blowing sand. When operating the pump unit in this type of environment, observe the following precautions.

a. Protect the unit from blowing sand and dust as much as possible.

**2-12. OPERATION IN SANDY OR DUSTY AREAS (Continued)**

**CAUTION**

**Closely monitor air cleaner intake restriction indicator in sandy or dusty locations. At first sign of restriction, change filter elements.**

b. Frequently check the air cleaner restriction indicator. If red band appears in window of air cleaner restriction indicator and no damage to system components is found, service the air cleaner and replace primary and secondary elements as described in paragraph 3-8.

c. Frequently check oil to be sure it is not contaminated. Contact organizational maintenance if oil is contaminated.

d. Cylinder cooling fins should be free of dirt.

e. Bottom roller should be free of dirt.

f. Lube oil cooler cooling fins should be free of dirt.

**WARNING**

**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**

g. During fueling and PMCS, do not allow sand or dust to enter fuel or lubrication system.

h. Check that fuel tank filler cap is tight and gasket is not torn. Keep cap tight to prevent foreign matter from entering the engine fuel tank.

i. Keep stores of fuel and oil tightly sealed to prevent contamination.

j. Close control panel cover whenever possible to limit damage to gage faces from blowing sand or grit.

k. When centrifugal pump unit is not in use and suction or discharge hoses are not installed, cover the suction flange (intake) and check valve assembly body port (discharge).

## 2-13. OPERATION IN SALT WATER AREAS

When the centrifugal pump unit is operated near salt water, the salt air will quickly cause corrosion of unpainted surfaces.

a. Coat machined surfaces with oil.

b. Use fresh water to wash off any salt water that comes in contact with the equipment.

c. Contact organizational maintenance to remove any rust or corrosion, and cover the exposed surfaces with paint.

CHAPTER 3
OPERATOR MAINTENANCE INSTRUCTIONS

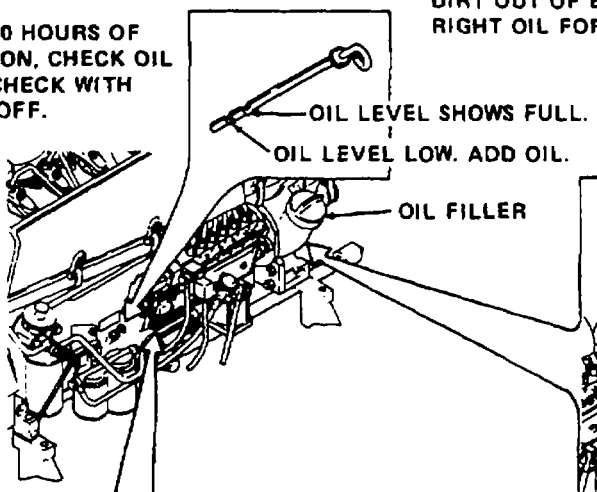
## Section I. LUBRICATION INSTRUCTIONS

NOTE: THESE LUBRICATION INSTRUCTIONS ARE MANDATORY.

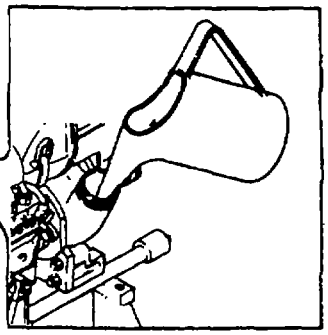
### CHECK IT!

1. EVERY 10 HOURS OF OPERATION, CHECK OIL LEVEL. CHECK WITH ENGINE OFF.

DON'T FORGET: KEEP OIL CLEAN, KEEP DIRT OUT OF ENGINE, AND SELECT THE RIGHT OIL FOR EXPECTED TEMPERATURES.

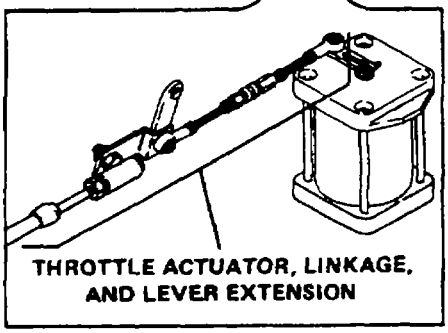



### ADD IT!



2. REMOVE OIL FILLER. ADD OIL AS NEEDED TO RAISE OIL LEVEL TO FULL MARK ON DIPSTICK. REPLACE OIL FILLER.

### LUBE IT!




3. EVERY 200 HOURS OF OPERATION, WIPE OFF ALL PIVOT POINTS AND ADJUSTING THREADS, THEN APPLY A LIGHT COAT OF ENGINE OIL.

THE TEMPERATURE WILL DETERMINE WHICH OIL TO USE

| °F | <-50 | -40 | -30 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °C | <-46 | -40 | -34 | -29 | -23 | -18 | -12 | -7 | -1 | 4 | 10 | 16 | 21 | 27 | 32 | 38 | 44 | 49 |

OE/HDO-30 (0-238)
OE/HDO-40 (NONE)
OE/HDO-15/40 (0-1236)
OEA (0183)

Note: For Arctic Operation Refer to TM 9-207

## Section II. TROUBLESHOOTING PROCEDURES

### 3-2. TROUBLESHOOTING

a. Table 3-1 lists common malfunctions which you may find during operation or maintenance of the centrifugal pump unit 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 and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

**Table 3-1. Operator/Crew Troubleshooting**

| MALFUNCTION<br>TEST OR INSPECTION<br>CORRECTIVE ACTION |
|---|

**1. ENGINE FAILS TO CRANK OR CRANKS AT LOW SPEED**

**WARNING**

**Overfilling will cause battery electrolyte to surface. Serious Injury or blindness could occur from careless handling of batteries or battery electrolyte (acid). If acid Is splashed on the skin, wash the affected area Immediately with plenty of clean water. If acid is splashed in the eyes, wash Immediately with plenty of clean water and get medical attention.**

Step I. Read the BATTERY VOLTMETER gage.

If no reading, check fuse in control panel.

If the reading is in the green, notify organizational maintenance of the engine malfunction.

If the reading is not in the green, proceed to step 2.

Step 2. Remove filler caps and check fluid level in battery.

**NOTE**

**Use only distilled water or a good grade drinking water (excluding mineral water)**

If fluid level is low, add water up to split ring. Replace filler caps and wipe excess fluid from battery.

If the battery fluid level is not low, or the battery voltage fails to increase within an hour of adding water, notify organizational maintenance of the engine malfunction.

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**Table 3-1. Operator/Crew Troubleshooting - Continued**

**MALFUNCTION**
**TEST OR INSPECTION**
**CORRECTIVE ACTION**

**2. ENGINE CRANKS BUT FAILS TO START**

**WARNING**

**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**

Step 1. Check for insufficient fuel supply.

Refill low tank. Perform the checks and services of table 2-2, item 19. If tank is empty, notify organizational maintenance.

Step 2. Check starting procedures for prevailing conditions.

If procedures have been performed as described, notify organizational maintenance.

Step 3. Check for malfunctioning engine shutdown valve.

Perform the checks and services of table 2-2, Item 24.

Step 4. Check for loose connections or restricted or damaged fuel lines.

Perform the checks and services of table 2-2, item 20. Report damaged lines or loose connections to organizational maintenance.

Step 5. Inspect water separator for water in collection bowl.

Perform the checks and services of table 2-2, item 39.

Step 6. Inspect for leakage around the fuel filter gasket.

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

Step 7. Check engine air cleaner restriction indicator.

If indicator shows red and no damage to system components is found, replace primary and secondary elements (para 3-8).

**Table 3-1. Operator/Crew Troubleshooting - Continued**

| MALFUNCTION<br>TEST OR INSPECTION<br>CORRECTIVE ACTION |
|---|

**3. UNEVEN RUNNING OR FREQUENT STALLING**

**WARNING**

**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**

**CAUTION**

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

Step 1. Check for insufficient fuel supply.

Refill low tank. Perform the checks and services of table 2-2, item 19. If tank is empty, notify organizational maintenance.

Step 2. Check for malfunctioning engine shutdown valve.

Perform the checks and services of table 2-2, item 24.

Step 3. Check for loose connections or restricted or damaged fuel lines.

Perform the checks and services of table 2-2, item 20. Report damaged lines or loose connections to organizational maintenance.

Step 4. Inspect water separator for water in collection bowl.

Perform the checks and services of table 2-2, item 39.

Step 5. Check engine air cleaner restriction indicator. If indicator shows red with engine shut off, and no damage to system components is found, replace primary and secondary elements (para 3-8).

**Table 3-1. Operator/Crew Troubleshooting - Continued**

| MALFUNCTION<br>TEST OR INSPECTION<br>CORRECTIVE ACTION |
|---|

**4. LACK OF POWER**

**WARNING**

**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**

**CAUTION**

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

Step 1. Check for insufficient fuel supply.

Refill low tank. Perform the checks and services of table 2-2, item 19. If tank is empty, notify organizational maintenance.

Step 2. Check engine air cleaner restriction indicator.

If indicator shows red with engine shut off, and no damage to system components is found, replace primary and secondary elements (para 3-8).

Step 3. Check for malfunctioning turbocharger and leaking turbocharger oil lines.

Perform the checks and services of table 2-2, item 34.

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

Report damaged lines or loose connections to organizational maintenance.

Step 5. Check for restrictions in suction and discharge assemblies and hoses or hose end.

Perform the checks and services of table 2-2, item 8, and clean away debris. Replace severely damaged or restricted hoses.

Be sure that suction and discharge gate valves are open correctly to balance flow.

**Table 3-1. Operator/Crew Troubleshooting - Continued**

**MALFUNCTION**
**TEST OR INSPECTION**
**CORRECTIVE ACTION**

**5. ENGINE STOPS RUNNING**

**WARNING**

**Death or serious injury could occur if diesel fuel oil is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Be certain that fuel lines and connections are secure. Do not inhale vapor. Do not overfill fuel tank. Engines must be turned off and cooled before refueling. Use proper refueling procedures and equipment to avoid spillage. Do not run engines near open fuel containers. DO NOT SMOKE.**

Step 1. Check for insufficient fuel supply.

Refill low tank. Perform the checks and services of table 2-2, item 19. If fuel tank is empty, notify organizational maintenance.

Step 2. Check for malfunctioning engine shutdown valve.

Perform the checks and services of table 2-2, item 24.

Step 3. Check engine air cleaner restriction indicator.

If indicator shows red, and neither rain cap nor cup assembly are damaged, replace primary and secondary elements (para 3-8).

Step 4. Check that crankcase is filled with oil to the correct level.

**CAUTION**

**Do not overfill. Oil will be blown out through crankcase breather if crankcase is overfilled.**

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

b. Start engine and observe oil pressure gage. If no oil pressure shows on gage, notify organizational maintenance.

**Table 3-1. Operator/Crew Troubleshooting-Continued**

| MALFUNCTION<br>TEST OR INSPECTION<br>CORRECTIVE ACTION |
|---|

Step 5. Check for broken or damaged V-belts.

Perform the checks and services of table 2-2, item 33.

If V-belts are damaged or broken, contact organizational maintenance.

Step 6. Inspect intake duct assembly.

Perform the checks and services of table 2-2, item 4.

Step 7. Check fuse in control panel.

**6. EXCESSIVE LUBRICATING OIL CONSUMPTION**

Step 1. Check that engine speed is correct for the specific gravity of liquid being pumped. Refer to pump performance data plate.

Adjust MANUAL THROTTLE CONTROL until engine is running at correct speed (para 2-6.g.).

Step 2. Check exhaust. If exhaust discharge contains oil, excessive oil is being burned in engine cylinders or around cylinder valve stems.

Notify organizational maintenance.

Step 3. With engine not running, check oil cartridge, oil sump, drain tube fitting, drain tube, oil cooler, oil pump cover, turbocharger feed line, and turbocharger return line for oil leaks.

If leaking, notify organizational maintenance.

**7. LOW OIL PRESSURE**

Step 1. Check the oil pressure sensing line for leaks. Leaks will cause false gage reading.

If leaking, notify organizational maintenance.

Step 2. Check that crankcase is filled to the correct level.

**CAUTION**

**Do not overfill. Oil will be blown out through crankcase breather if crankcase is overfilled.**

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

b. Start engine and observe oil pressure gage. If oil pressure is still low, notify organizational maintenance.

**Table 3-1. Operator/Crew Troubleshooting - Continued**

| MALFUNCTION<br>TEST OR INSPECTION<br>CORRECTIVE ACTION |
|---|

**8. PUMP FAILS TO PRIME**

Step 1. Check that pump volute is filled with liquid to bottom of suction port.

Remove dust cap from priming port on pump body and fill pump volute (para 2-6. c. ). Replace dust cap.

Step 2. Check that engine speed is correct for the specific gravity of liquid being pumped. Refer to pump performance data plate.

Adjust MANUAL THROTTLE CONTROL until engine is running at correct speed (para 2-6. g. ).

Step 3. Check for restrictions in flow through suction and discharge assemblies and hoses.

Perform the checks and services of table 2-2, item 8, and clean away debris. Replace severely damaged or restricted hoses.

Step 4. Check the suction assembly components and connections for leaks. Check suction hose connection, gate valve, spool, strainer, gaskets, and the connection between the strainer and pump assemblies (para 2-6.e.). Check that locking lever securely holds strainer in place.

a. Tighten hose connection.

b. Tighten strainer locking lever.

c. For any other leaks found, notify organizational maintenance.

Step 5. Check for clogged suction strainer or suction hose.

Perform the checks and services of table 2-2, item 6, and clean away debris from suction strainer and hose. Replace severely damaged or restricted hoses.

Step 6. Check for excessive suction lift.

Move centrifugal pump unit closer to source of liquid.

Step 7. Check the discharge check valve for a defective valve spring.

If the valve spring does not hold the valve closed long enough to establish prime, hold the valve closed until the prime is established.

**Table 3-1. Operator/Crew Troubleshooting - Continued**

| MALFUNCTION<br>TEST OR INSPECTION<br>CORRECTIVE ACTION |
|---|

**9. PUMP FAILS TO DELIVER CAPACITY**

Step 1. Check that engine speed is correct for the specific gravity of liquid being pumped. Refer to pump performance data plate.

Adjust MANUAL THROTTLE CONTROL until engine is running at correct speed (para 2-6.g.).

Step 2. Check that suction and discharge gate valves are fully open.

Open gate valves.

Step 3. Check that suction hose (intake) is properly submerged or connected to liquid supply.

a. Submerge intake of suction hose.

b. If connection to liquid supply is leaking, notify organizational maintenance.

Step 4. Check for collapsed or damaged suction hose.

If suction hose is collapsed or damaged, notify organizational maintenance.

Step 5. Check the suction assembly components and connections for leaks. Check suction hose connection, gate valve, spool, strainer, gaskets, and the connection between the strainer and pump assemblies. Check that locking lever securely holds strainer in place.

a. Tighten hose connection.

b. Tighten strainer locking lever.

c. If any other leaks are found, notify organizational maintenance.

Step 6. Check for clogged suction strainer or suction hoses. Perform the checks and services of table 2-2, item 8, and clean away debris. Replace severely damaged or restricted hoses.

Clean debris from suction strainer and hose.

Step 7. Check for excessive suction lift.

Move centrifugal pump unit closer to source of liquid.

**Table 3-1. Operator/Crew Troubleshooting - Continued**

| MALFUNCTION<br>TEST OR INSPECTION<br>CORRECTIVE ACTION |
|---|

**10. NOISY PUMP OPERATION**

Step 1. Check for clogged suction strainer or suction hoses.

Perform the checks and services of table 2-2, item 8, and clean away debris. Replace severely damaged or restricted hoses.

Clean debris from suction strainer and hose.

Step 2. Check that engine speed is correct for the specific gravity of liquid being pumped. Refer to pump performance data plate.

Adjust MANUAL THROTTLE CONTROL until engine is running at correct speed (para 2-6.g.).

**11. LOW DISCHARGE PRESSURE**

Step 1. Check that engine speed is correct for the specific gravity of liquid being pumped. Refer to pump performance data plate.

Adjust MANUAL THROTTLE CONTROL until engine is running at correct speed (para 2-6.g.).

Step 2. Check that suction and discharge gate valves are fully open.

Open gate valves.

Step 3. Check the suction components and connections for leaks. Check suction hose connection, gate valve, spool, strainer, gaskets, and the connection between the strainer and pump assemblies. Check that locking lever securely holds strainer in place.

a. Tighten hose connection.

b. Tighten strainer locking lever.

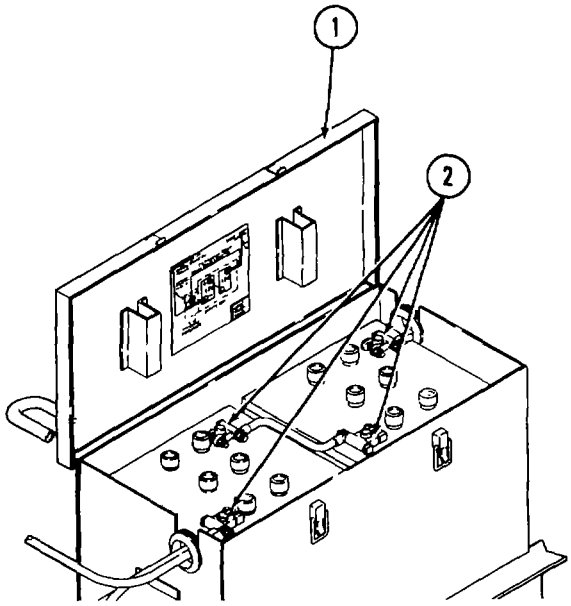
c. If any other leaks are found, notify organizational maintenance.

## Section III. MAINTENANCE PROCEDURES

### 3-3. INTRODUCTION

This section contains maintenance procedures which are the responsibility of the operator.

### 3-4. CLEANING BATTERY CABLES




**WARNING**

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

**CAUSTIC CHEMICALS IN BATTERIES**

**Serious injury could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.**

**CAUTION**

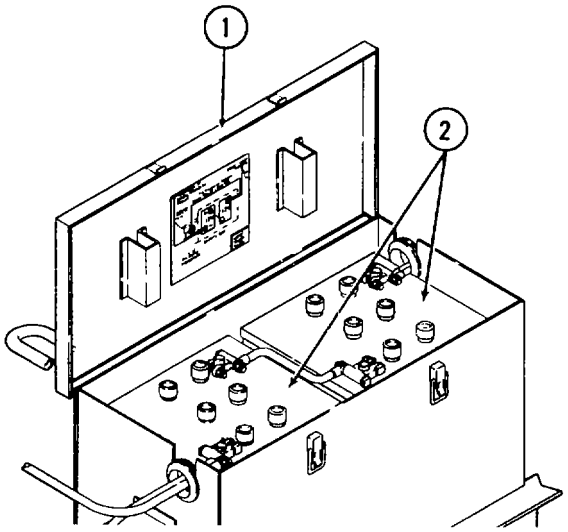
**Avoid making contact across the two battery posts. This can result in severe arcing.**

1 Open battery box top (1).

2 Use a wire brush to gently remove visible corrosion on outside of cable terminal lugs (2).

3 Close battery box top.

## 3-5. CLEANING BATTERY




**WARNING**

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

**CAUSTIC CHEMICALS IN BATTERIES**

**Serious injury could occur from the careless handling of storage batteries or battery electrolyte (acid). If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.**

**CAUTION**

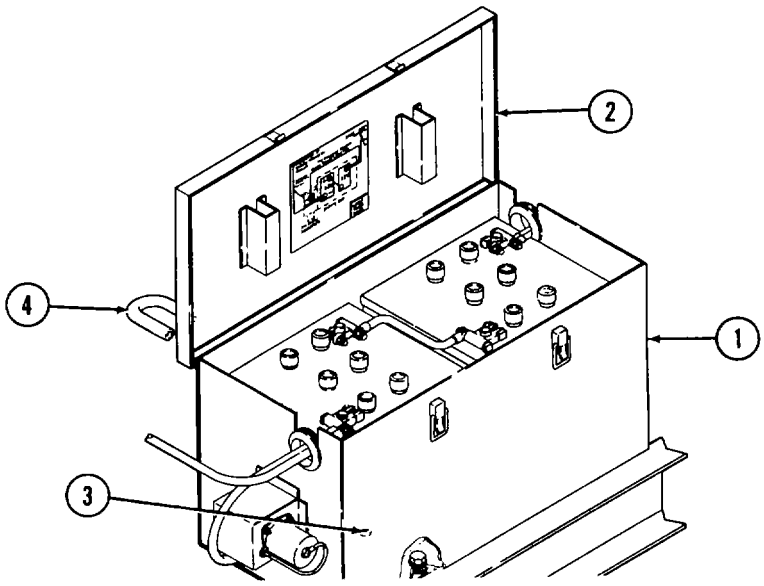
**Avoid making contact across the two battery posts. This can result in severe arcing.**

1 Open battery box top (1).

2 Use a clean, dry cloth to wipe dirt or excess fluid from the top surface of batteries (2).

3 Close battery box top.

### 3-6. SERVICING/CLEANING BATTERY BOX



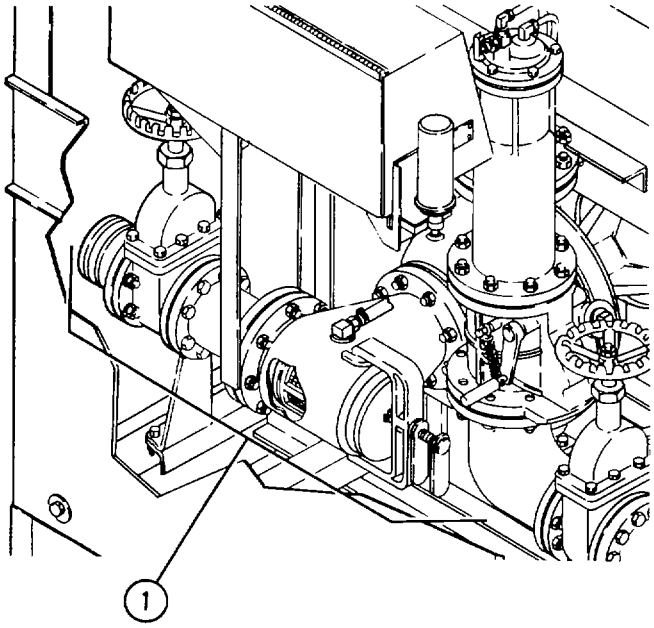

1 Wipe dirt from exterior of battery box (1) and battery box top (2) with a clean, dry cloth.

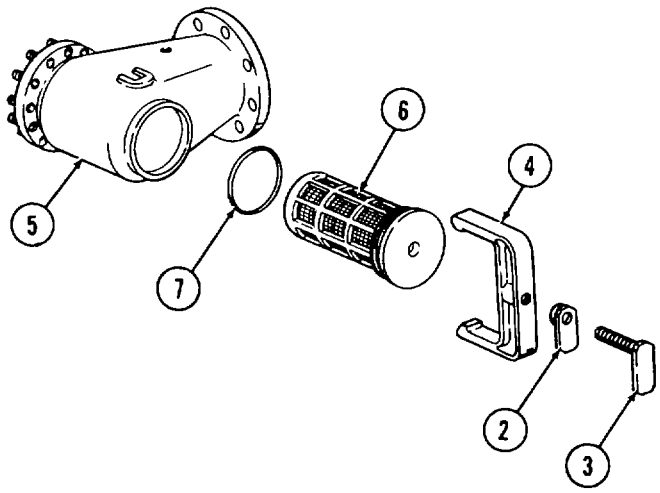
2 Examine the exterior bottom of the battery box to be sure that drain holes (3) are open.

3 If drain holes are obstructed, gently brush them clean with a wire brush.

4 Remove dirt or debris in or around battery box vent (4).

## 3-7. CLEANING/INSPECTING/REPLACING SUCTION ASSEMBLY




1 Clean dirt from exterior of suction assembly (1) using a clean, dry cloth.

2 Unlock locking lever (2) and remove lever bolt (3).

3 Remove strainer clamp (4) from strainer body (5).

4 Remove strainer assembly (6) from strainer body and examine strainer assembly for debris and tears.

5 Remove any debris found in strainer assembly.

6 Discard damaged strainer assembly and replace with new strainer assembly.

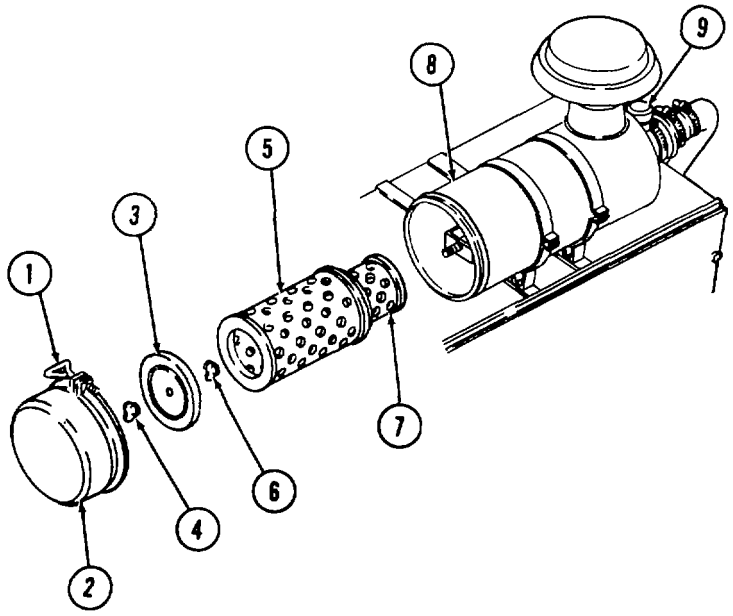
7 Place strainer assembly in strainer body.

8 Check that preformed packing (7) and sealing surfaces of strainer body seat properly to prevent leaks.

9 Install strainer clamp (4) on strainer body (5) with locking lever (2) and lever bolt (3).

10 Tighten lever bolt and locking lever.

## 3-8. REPLACING AIR CLEANER PRIMARY AND SECONDARY ELEMENTS




1 Loosen clamp assembly (1).

2 Remove cup assembly (2).

3 Remove baffle assembly (3).

4 Wipe off cup and baffle assemblies with a clean, dry cloth.

5 Remove nut assembly (4) from threaded rod.

6 Remove and discard primary element (5).

7 Remove nut assembly (6) from threaded rod.

8 Remove and discard secondary element (7).

9 Wipe out interior of body assembly (8) with a clean, dry cloth.

10 Install secondary element (7) into body assembly. Aline hole in element with threaded rod.

**CAUTION**

**Hand tighten nut assembly as necessary to make a tight, vibration-free installation.**

**Overtightening the nut will deform the element.**

11 Install nut assembly (6) and hand tighten.

12 Install primary element (5) over secondary element (7). Aline hole in element with threaded rod.

**3-8. REPLACING AIR CLEANER PRIMARY AND SECONDARY ELEMENTS (Continued)**

**CAUTION**

**Hand tighten nut assembly as necessary to make a tight, vibration-free installation.**

**Overtightening the nut will deform the element.**

13 Install nut assembly (4) and hand tighten.

14 Install baffle assembly (3).

15 Install cup assembly (2).

**NOTE**

**Install cup assembly with arrows pointing up.**

16 Seat cup assembly against body assembly (8).

**CAUTION**

**Hand tighten clamp assembly as necessary to make a tight, vibration-free installation.**

**Overtightening the clamp assembly will deform the cup assembly or the body assembly.**

17 Hand tighten clamp assembly (1).

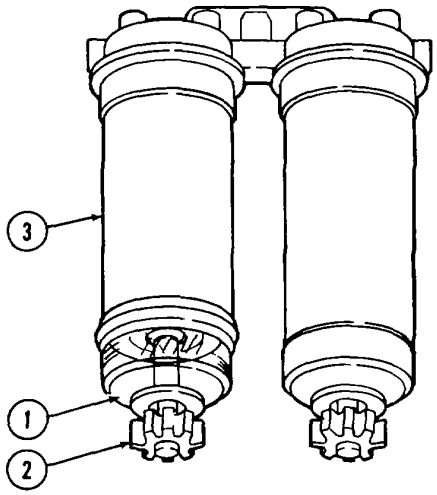
18 Reset air cleaner intake restriction indicator (9).

### 3-9. SERVICING FUEL FILTER

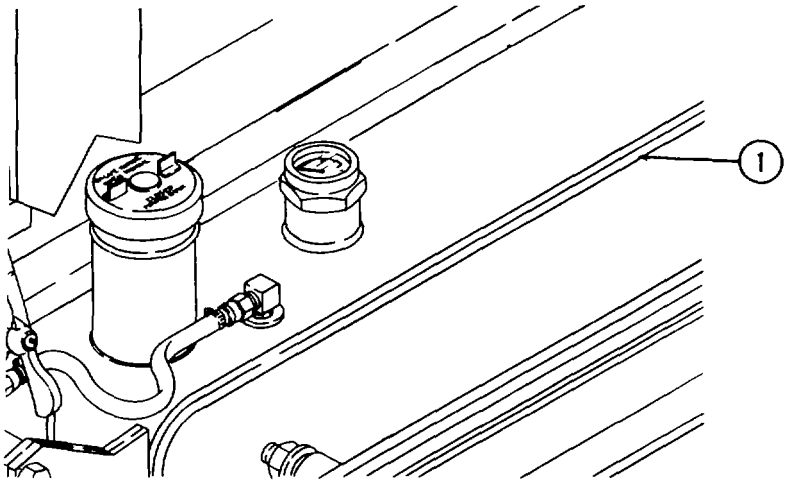
1 Place receptacle under clear bowl (1).

2 Loosen knurled screw (2) at bottom of clear bowl one or two turns. Drain water from separator (3).

3 Watch flow of fluid from clear bowl. When all water has emptied, and fuel begins to flow from the clear bowl, tighten knurled screw. Do not overtighten.




### 3-10. CLEANING FUEL TANK ASSEMBLY




1 Wipe dirt from exterior of fuel tank (1) and fuel lines with a clean, dry cloth.

# 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 Worksheet ..... DA Form 2404
Quality Deficiency Report ..... SF 368
Recommended Changes to Publications and Blank Forms ..... DA 2028-2

## A-3. FIELD MANUALS

Operation and Maintenance of Ordnance Materiel in Cold Weather (0° to -65°F) ..... FM 9-207

## A-4. TECHNICAL MANUALS

Hand Portable Fire Extinguishers for Army Users ..... TB 5-4200-200-10
Organizational, Direct Support and General Support
Maintenance Manual, Centrifugal Pump Unit, Model US612ACD ..... TM 5-4320-306-24
Organizational, Direct Support and General Support
Maintenance Repair Parts and Special Tools List,
Centrifugal Pump Unit, Model US612ACD ..... TM 5-4320-306-24P
The Army Maintenance Management System (TAMMS) ..... DA Pam 738-750

# APPENDIX B
# COMPONENTS OF END ITEMS AND BASIC ISSUE ITEMS LISTS

## Section I. INTRODUCTION

### B-1. SCOPE

This appendix lists components of end item and basic issue items for the centrifugal pump unit to help you inventory items required for safe and efficient operation.

### B-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/MTOE authorization of the end item.

### B-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 Federal 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

| (1) Illus Number | (2) National Stock Number | (3) Description FSCM and Part Number | (4) U/M | (5) Qty Rqr |
|---|---|---|---|---|
| N/A | N/A | Technical Manual TM 54320-306-10 | ea | 1 |

# APPENDIX C
# ADDITIONAL AUTHORIZATION LIST

## Section I. INTRODUCTION

### C-1. SCOPE

This appendix lists additional items you are authorized for the support of the centrifugal pump unit.

### C-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.

### C-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.

## Section II. ADDITIONAL AUTHORIZATION LIST

| (1) National Stock Number | (2) Description FSCM and Part Number | (3) U/M | (4) Qty Rqr |
|---|---|---|---|
| | ( ) AUTHORIZED ITEMS | | |
| 4240-00-022-2946 | Protector, Aural | Pr | 1 |

# APPENDIX D
# EXPENDABLE SUPPLIES AND MATERIALS LIST

## Section I. INTRODUCTION

### D-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).

### D-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., Fuel Oil Diesel, Item 1, Appendix D).

b. *Column (2) Level.* This column identifies the lowest level of maintenance that requires the listed item.

C Operator/Crew

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 Federal Supply Code for Manufacturer (FSCM) in parentheses followed by the part number.

e. *Column (5) Unit of Measure (U/M)*. Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (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 MATERIALS LIST

| (1) Illus Number | (2) Level | (3) National Stock Number | (4) Description | (5) U/M |
|---|---|---|---|---|
| 1 | C | | Fuel Oil, Diesel, V V-F-800 | gl |
| 2 | C | 9150-00-186-6681 | Oil, Lubricating, Internal Combustion Engine, MI L-L-2104 | gl |

## APPENDIX E
## ALPHABETICAL INDEX

**Subject** **Page**

**A**



**B**



**C**



D

**Subject** **Page**

**E**



**F**



**G**



**I**



L

**Subject** **Page**

**M**



**N**



**0**



**P**



**R**

**Subject** **Page**

**S**



**T**



**V**



**W**

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

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U.S. GOVERNMENT PRINTING OFFICE : 1994 0 - 300-421 (83094)

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| PUBLICATION NUMBER | PUBLICATION DATE | PUBLICATION TITLE |
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| | | |

BE EXACT PIN-POINT WHERE IT IS

| PAGE NO. | PARA-GRAPH | FIGURE NO. | TABLE NO. |
|---|---|---|---|
| | | | |

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PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

## 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 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
acres
1 hectogram = 10 decagrams = 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 milliters = .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

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 |
|---|---|---|---|---|

**PIN: 061095-000**