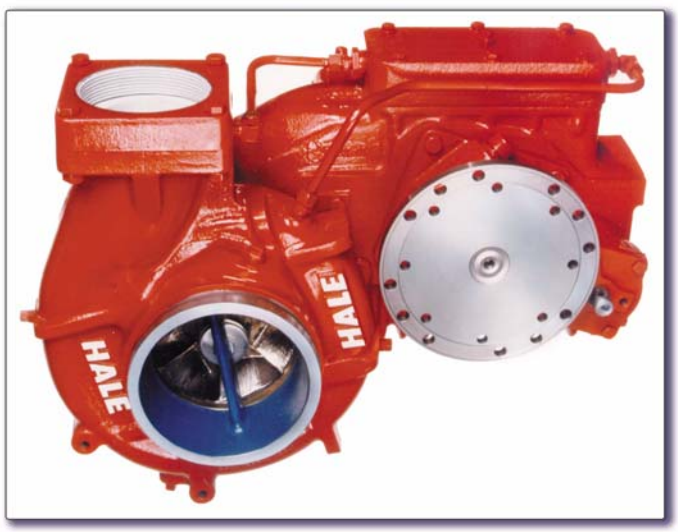
# MG / APMG Series
# Mid-Range Single Stage Pump
## Operation and Service
## Maintenance Manual





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# NOTICE !

Hale Products, Inc. cannot assume responsibility for product failure resulting from improper maintenance or operation. Hale is responsible only to the limits stated in the product warranty. Product specifications contained in this manual are subject to change without notice.

All Hale products are quality components -- ruggedly designed, accurately machined, precision inspected, carefully assembled and thoroughly tested. In order to maintain the high quality of your unit, and to keep it in a ready condition, it is important to follow the instructions on care and operation. Proper use and good preventive maintenance will lengthen the life of your unit.

**ALWAYS INCLUDE THE UNIT SERIAL NUMBER IN YOUR CORRESPONDENCE.**

| ECN No | REV | CHANGE FROM | BY | DATE | APVD |
| --- | --- | --- | --- | --- | --- |
| ???? | A | INITIAL RELEASE | | | MAL |
| | B | Complete System Update | LwH | 04/30/2006 | MAL |
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## Notes

# Hale MG Mid-Range, Single-Stage Pump

The Hale Midship line of **MG / APMG** Series Mid-Range, Single-Stage (Split-Shaft/ PTO) Pumps are built to fit the chassis of most commercially built fire trucks and tankers, attack pumpers, field and brush trucks and mid- or full-sized tankers. Covering a range of capacities from 500 Gallons Per Minute (GPM) (1,893 Liters Per Minute, LPM) up to 1,000 GPM (3,785 LPM), Hale pumps offer the versatility, dependability, reliability, and ease of operations necessary for effective fire fighting.

Hale MG series pumps are compact in size and lightweight for easy mounting and to fill the gap between Hale's full-range midship and standard attack pumps. The MG pumps have vertical or horizontal mounting capability and are configured to meet almost every space requirement, driveline or discharge arrangement. When applicable, the apparatus builder must supply the transmission PTO (power takeoff) and connecting shaft.

Hale offers various models of the MG pumps. The anticipated use and position on the apparatus determines the model selected as well as the drive unit. Flow capacities are shown in Figure A: MG / APMG Mid-Range, Single-Stage Pump Capacity.)

| Model | Type | Capacity |
|---|---|---|
| **MG Series** | Mid-Range, Single-Stage Split-Shaft / PTO Pump. | Up to 1,000 GPM (3,875 LPM). NFPA Rated at 500 to 1,000 GPM (1,893 to 3,875 LPM), per Standard 1901. |
| **MGA Series** | Mid-Range, Single-Stage Split-Shaft / PTO Pump. | Up to 1,000 GPM (4,732 LPM). NFPA Rated at 500 to 1,000 GPM (1,893 to 3,875 LPM), per Standard 1901. |
| **APMG Series** | Rear Mount, Single-Stage Split-Shaft / PTO Pump. | Up to 500 GPM (1,893 LPM). NFPA Rated at 300 to 500 GPM (1,136 to 1,893 LPM), per Standard 1901. |

**Figure A: MG / APMG Mid-Range, Single-Stage Pump Capacity**

For an illustrated pump assembly overview, see Figure B: "Typical MG / APMG Series Pump Assembly Overview" on page 12.

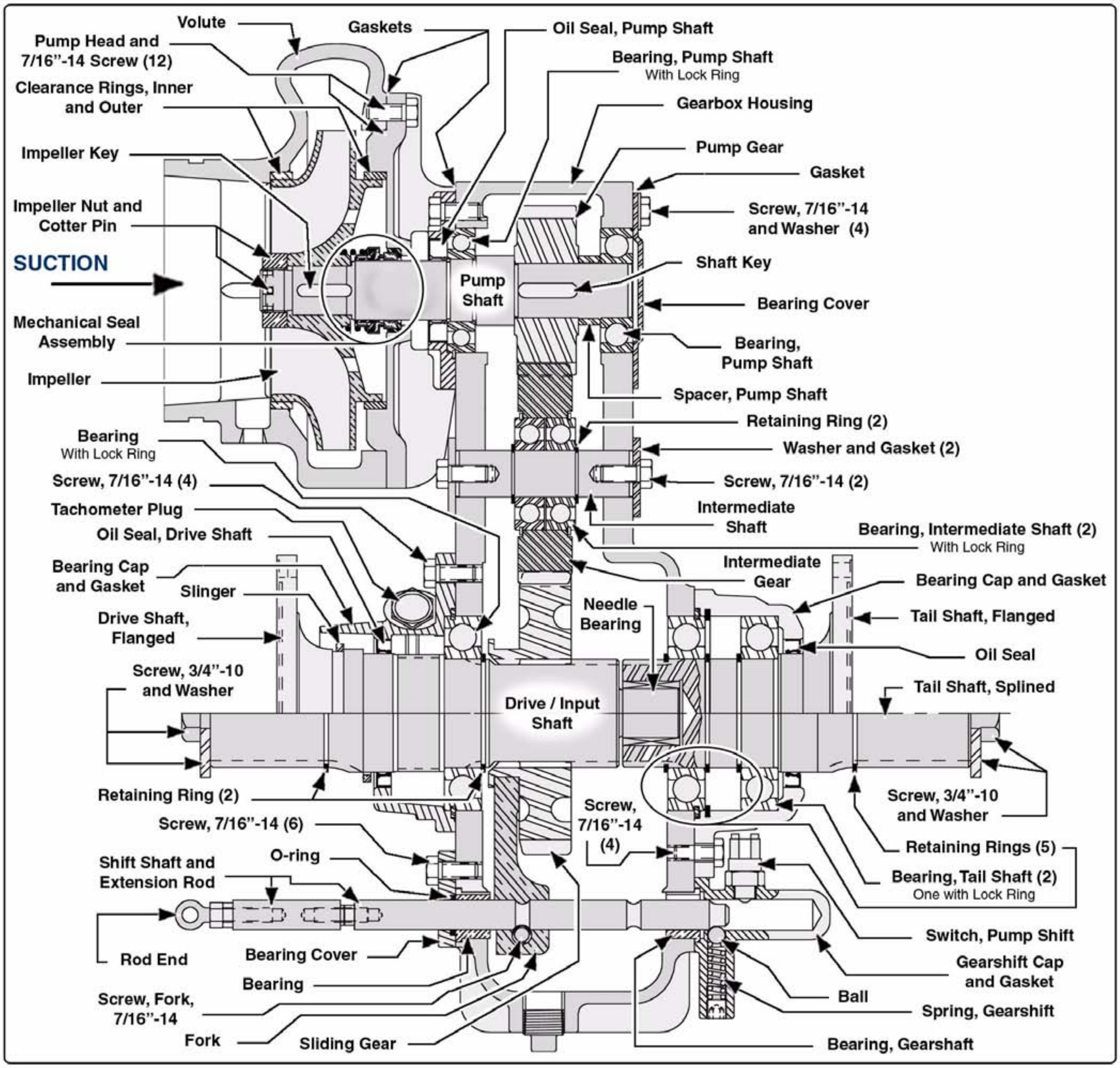


**Figure B: Typical MG / APMG Series Pump Assembly Overview**

# 1 Safety Precautions

**IMPORTANT !**

HALE SERIES PUMPS ARE DESIGNED FOR OPTIMUM SAFETY OF ITS OPERATORS. FOR ADDED PROTECTION, PLEASE FOLLOW THE SAFETY GUIDELINES LISTED IN THIS SECTION AND ADHERE TO ALL WARNING, DANGER, CAUTION AND IMPORTANT NOTES FOUND WITHIN THIS MANUAL.

ALL SUPPLIED DOCUMENTATION MUST BE CAREFULLY READ, UNDERSTOOD AND ADHERED TO STRICTLY BY ALL INSTALLERS AND OPERATORS BEFORE ATTEMPTING TO INSTALL OR OPERATE THE PUMP.

WHEN DEVELOPING DEPARTMENTAL APPARATUS OPERATING PROCEDURES, INCORPORATE THE WARNINGS AND CAUTIONS AS WRITTEN.

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## 1.1 GUIDELINES

**NOTICE !**

**THE PROCEDURES IN THIS MANUAL ARE GENERAL OPERATING PROCEDURES. THEY DO NOT REPLACE THE PROCEDURES, POLICIES OR GUIDELINES ESTABLISHED BY THE AUTHORITY HAVING JURISDICTION, NOR DO THEY REPLACE THE RECOMMENDATIONS AND PROCEDURES PROVIDED IN THE APPARATUS MANUFACTURER'S MANUAL.**

**REFER TO THE PROCEDURES PROVIDED BY THE AUTHORITY HAVING JURISDICTION ON SETTING WHEEL CHOCKS (TO PREVENT ANY MOVEMENT OF THE APPARATUS), AS WELL AS LAYOUT AND CONNECTION OF HOSES, VALVES AND DRAIN COCKS.**

- Use care when removing the pump assembly from its packaging to prevent personal injury and/or damage to the system.
- To fully support the pump assembly, use all mounting bolt holes provided on the gearbox and/or the pump. See the pump assembly plate drawing, located at the back of this manual, for additional installation information.

## CAUTION !

**ALL FASTENERS ON THE HALE PUMP AND GEARBOX ASSEMBLY HAVE BEEN SELECTED FOR THEIR APPLICATION. HALE PRODUCTS DOES NOT RECOMMEND REPLACING FASTENERS WITH ANYTHING OTHER THAN HALE PART NUMBERS PROVIDED. REPLACING WITH A WEAKER ALTERNATIVE POSES A SERIOUS SAFETY RISK.**

**ALL FASTENERS MUST BE INSTALLED WITH A LOCKING ANAEROBIC ADHESIVE/SEALANT, SUCH AS LOCTITE® #242 OR EQUIVALENT.**

- Installation should be performed by a trained and qualified installer, such as your authorized Hale representative. Be sure the installer has sufficient knowledge, experience and the proper tools before attempting any installation.

## WARNING !

**THE HALE PUMP AND GEARBOX ASSEMBLY CAN BE HEAVY AND BULKY. ADDING ACCESSORIES TO THE SYSTEM ALSO INCREASES THE WEIGHT. CHECK YOUR BILL OF LADING FOR THE APPROXIMATE WEIGHT.**

**BE CERTAIN TO USE PROPER LIFTING SUPPORT DEVICES (I.E., OVERHEAD CRANE, JACKS, CHAINS, STRAPS, ETC.) CAPABLE OF HANDLING THE LOAD WHEN REMOVING OR INSTALLING THE HALE PUMP AND GEARBOX ASSEMBLY.**

- The installer is responsible for observing all instructions and safety precautions in his or her daily routine as dictated by regional safety ordinances or departmental procedures.
- DO NOT permanently remove or alter any protective feature, guard or insulating devices, or attempt to operate the system when these guards are removed.

  Doing so voids the Hale pump warranty. Also see heading “Express Warranty” on page 129.
- Any of the above could affect system capacity and/or safe operation of the system and is a serious safety violation which could cause personal injury or could affect safe operation of the pump.

## WARNING!

**NO MODIFICATIONS MAY BE MADE TO THE HALE PUMP AND GEARBOX ASSEMBLY WITHOUT PRIOR WRITTEN PERMISSION FROM:**

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- ❑ Rotating drive line parts can cause injury. Be extremely careful that NO part of your body (head, feet, arms, legs, fingers, hair, etc.) is in an area of rotating parts where you could be subject to injury.
- ❑ Make sure everyone is clear of the apparatus before shifting to the PUMP position. Verify the parking brake is set and the wheels are chocked to prevent any movement of the apparatus.
- ❑ Make sure proper personal protective equipment is used when operating or servicing the apparatus.

## WARNING!

**BE SURE TO WEAR SAFETY GLASSES WHEN REMOVING AND/OR INSTALLING FORCE (PRESS) FITTED PARTS. WEAR PROTECTIVE, HEAT-RESISTANT GLOVES WHEN HANDLING PARTS THAT REQUIRE HEATING FOR INSTALLATION AND/OR REMOVAL. FAILURE TO COMPLY MAY RESULT IN SERIOUS EYE OR HAND INJURY.**

**DO NOT OVERHEAT PARTS CONSTRUCTED OF BRONZE (E.G. IMPELLER). OVERHEATING (PART TURNS RED OR BLUE) CAN WEAKEN THE PART AND IT MUST THEN BE REPLACED.**

- ❑ DO NOT operate the system at pressures higher than the maximum rated pressure. Always use the lowest possible relief valve settings to enhance operator and equipment safety. Also see Section 2 “Introduction” on page 17 for additional information.
- ❑ Relieve all system pressure, then drain all water from the system before servicing any of its component parts.
- ❑ Use only pipe, hose and fittings which are rated at or above the maximum pressure rating at which the water pump system operates.

- Per NFPA 1962 requirements, large diameter hose, marked “supply Hose 3-1/2” to 5” (89 - 127 mm) diameter” shall not be used at operating pressures exceeding 185 PSI (13 BAR). Large diameter hose, marked “Supply Hose 6” to 5” (152 mm) diameter” shall not be used at operating pressures exceeding 135 PSI (9 BAR).
- If leakage from the drain hole in the pump head is noticed or suspected, the impeller must be removed and the mechanical seal must be inspected and/or replaced.
- If a pump is operated without water for extended periods, or without discharging water, it could overheat. This can damage the mechanical seal, impeller or the drive mechanism.
- DO NOT attempt to pump until all the GREEN pump indicators in the cab and panel are ON. Also see Section 3 “Basic Operation” on page 31 for additional information.
- DO NOT advance the throttle unless the OK TO PUMP indicator is illuminated. Also see Section 3 “Basic Operation” on page 31 for additional information.
- DO NOT leave the cab, after selecting the PUMP mode, until all the GREEN pump indicators in the cab and panel are illuminated. Also see Section 3 “Basic Operation” on page 31 for additional information.
- DO NOT attempt emergency manual shift procedures while the engine is running. Also see Section 3 “Basic Operation” on page 31 for additional information.
- Never attempt to shift the pump (PUMP-to-ROAD, vise versa) while the truck transmission is in gear. Always shift the truck transmission to NEUTRAL (N) and verify the speedometer is ZERO (0) before shifting the pump. Also see Section 3 “Basic Operation” on page 31 for additional information.
- DO NOT reduce the pressure on the INTAKE gauge below zero (0). Serious damage to the water main could result.
- Some vehicles maintain air on the shift cylinder continuously regardless of transmission setting, and some only have air applied when the vehicle transmission is in NEUTRAL.

  Use caution when servicing.
- Use only PAC-EASE Rubber Lubricant Emulsion (or equal) on the rubber mechanical seal parts to ease installation. DO NOT use other lubricant types as damage to the mechanical seal and seat could occur.
- Before connecting any cord sets or wiring harnesses, inspect the seal washer in the connector.

  If the seal washer is missing or damaged, water can enter the connector causing corrosion. This could resulting in possible system failure.

# 2 Introduction

## 2.1 PRINCIPLES OF OPERATION

### Centrifugal Force

Hale pumps are centrifugal pumps that operate on the principle of centrifugal force created by a rapidly spinning disk. (See Figure 2-1: “Centrifugal Force - Rotating Disk.”)

As the disk rotates, it throws water from the center toward the outer circumference of the disk. The velocity at which the water travels from the center directly relates to the diameter of the disk and the speed of rotation.

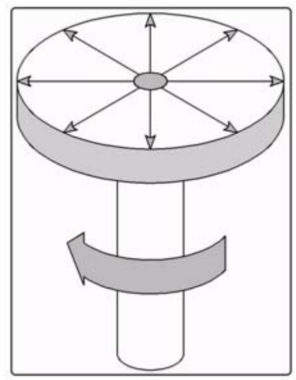


**Figure 2-1: Centrifugal Force - Rotating Disk**

When water is confined in a closed container, such as the volute (pump body), the velocity of the water is converted to pressure that rises to a level dependent on the speed of rotation.

There are three interrelated factors that regulate the performance of a centrifugal pump:

- ❑ **SPEED (RPM)** If the speed of rotation increases with flow held constant, fluid pressure increases.
- ❑ **PRESSURE** If pressure changes with speed held constant, the flow, measured in gallons or liters per minute (GPM/LPM), changes inversely; if pressure increases, flow decreases. Pressure is measured in pounds per square inch (PSI) or BAR.
- ❑ **FLOW** If the pressure is held constant, the flow increases with an increase in the speed of rotation. Flow is measured in the number of gallons of fluid per minute (GPM/LPM) that a pump can deliver when supplied from draft.

A centrifugal pump is preferred by the fire protection service due to its ability to fully utilize any positive suction inlet pressure, reducing the amount of work done by the pump.

For example, if the required discharge pressure is 120 PSI (8.3 BAR) and the inlet pressure is 45 PSI (3.1 BAR), the pump must only produce the difference in pressure or 75 PSI (5.2 BAR).

This contributes to improved performance with reduced maintenance. Decreased maintenance is aided by centrifugal pumps having few moving parts.

As the impeller rotates, the water moving outward in the impeller creates reduced pressure, or a vacuum in the suction eye, allowing atmospheric pressure to push water into the pump impeller replacing the water discharged. (See Figure 2-2: "Pump Water Flow, Cutwater.")

During operation, water enters the suction eye of the impeller. The rotating impeller vanes develop discharge pressure and via the "cutwater *," directs the water to the discharge opening.

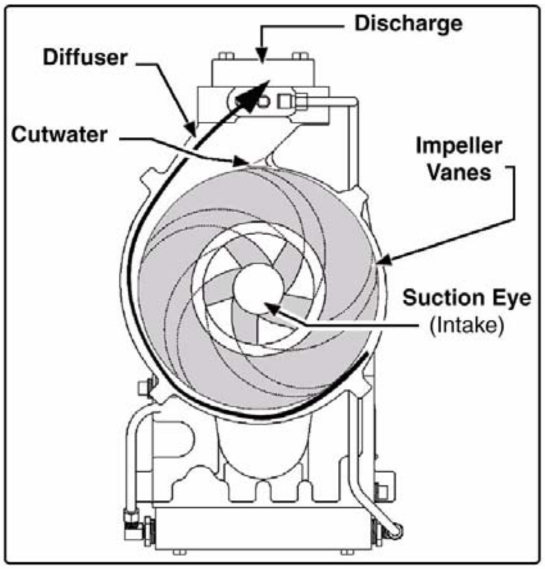



**Figure 2-2: Pump Water Flow, Cutwater**

** The "cutwater" is a wedge that divides the water between the volute (pump body) and the pump discharge.*

# 2.2 PUMP COMPONENTS

(See Figure 2-3: "Typical Pump and Gearbox Overview," on page 19.)

The Hale single-stage pump consist of:

- ❑ Volute (Pump Body)
- ❑ Impeller and Clearance Ring
- ❑ Mechanical Seal
- ❑ Gearbox

## Volute, Pump Body

(See Figure 2-3: "Typical Pump and Gearbox Overview," on page 19.)

As water discharges from the impeller, it enters the volute (pump body). The volute is constructed from fine-grain cast iron and shaped so that its area increases from the cutwater to its full capacity at the volute throat.

**Note:** Stainless Max pumps (volute and impeller) are construction of corrosion resistant stainless steel (Models SMM / SMD and SMR Series).

This gradual increase in size maintains a constant average velocity through the volute.

The volute is a single piece, and must be removed to service the impeller, clearance rings, and mechanical seal. Removal of the volute can often be accomplished without removing the pump and gearbox assembly from the apparatus.

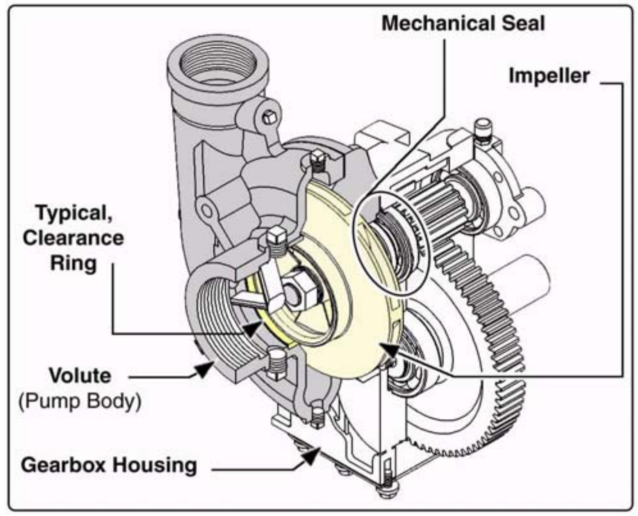



**Figure 2-3: Typical Pump and Gearbox Overview**

## Impeller

The impeller provides velocity to the water. Water enters the rotating impeller at the intake (or eye), and is confined by the shrouds and the vanes to build pressure. The vanes guide water from the inlet to the discharge and reduce the turbulence of the spinning water.

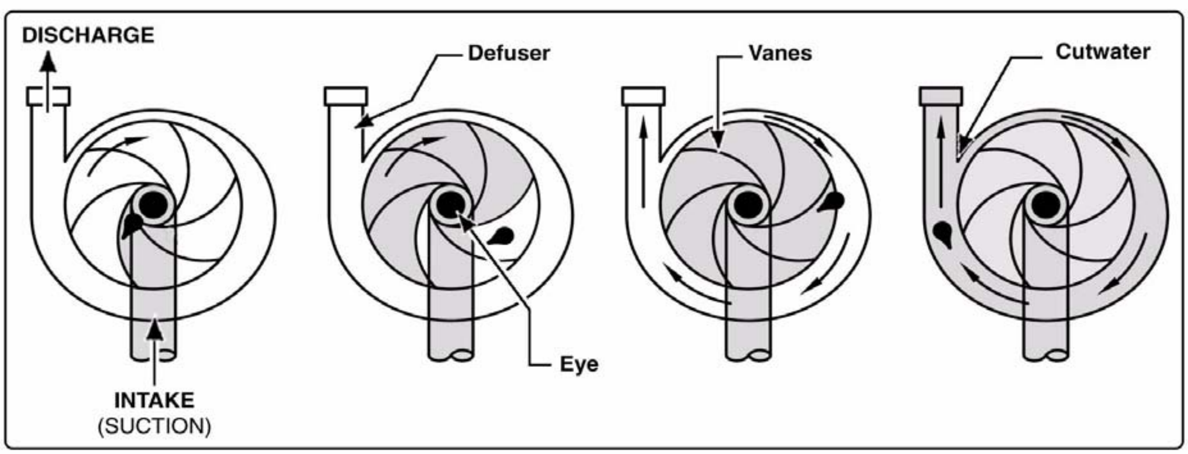



**Figure 2-4: Impeller Operation**

Figure 2-4: “Impeller Operation” traces a drop of water from the intake of the impeller to the discharge outlet.

## Clearance Rings

Clearance rings prevent pressurized water that is leaving the pump volute from returning to the intake of the impeller. Clearance rings at the impeller intake also prevent leakage, accomplished by limiting the radial clearance between the spinning impeller and the stationary clearance ring. Also see Figure 2-3: “Typical Pump and Gearbox Overview” on page 19.

Typically, a clearance ring has a radial clearance of about 0.0075” (0.191 mm) or between 0.015” to 0.020” (0.381-0.508 mm) per side. However, due to foreign material found in the water, this clearance increases over time as the pump is operated. Clearance rings are designed for replacement when wear limits cause the pump to exceed NFPA standards for satisfactory performance.

## Mechanical Seal

The “maintenance-free,” mechanical seal is common to Hale pumps. (See Figure 2-5: “Typical Mechanical Seal Overview.”)

The stationary seat is in constant contact with a rotating seal ring to prevent leakage. The sealing diaphragm is made of a rubber elastomer specifically designed for high-temperature operations.

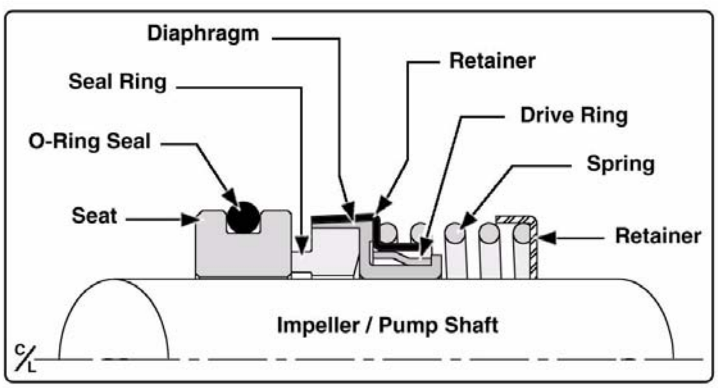



**Figure 2-5: Typical Mechanical Seal Overview**

**Note:** Mechanical seals do not drip like other pump packing. A Hale pump with a drip from the seal requires service.

**WARNING !**

**IF A PUMP IS OPERATED WITHOUT WATER FOR EXTENDED PERIODS, OR WITHOUT DISCHARGING WATER, IT COULD OVERHEAT. THIS CAN DAMAGE THE MECHANICAL SEAL OR THE DRIVE MECHANISM.**

### Ball and Tapered Bearings

Bearings support and align the impeller and input shafts for smooth operation. They are the most common anti-friction bearings used and offer a major contribution to the life of a fire pump. When replacing bearings, it is important that you do not interchange bearing manufacturer's components. The bearing race and cone must always be replaced in matching sets, as supplied by the manufacturer.

## 2.3 PUMP DRIVES

Hale pumps produce the volumes and pressures shown on their performance curves. However, maximum pump performance is sometimes limited by the power capacity and speed limits of the engine, transmission, and PTO, as applicable. (See Figure 2-6: "Pump / Engine Rotation.")

Three common pump drives are used on fire fighting apparatus:

- ❑ Split-shaft gearbox from the apparatus drive shaft - the most common pump drive
- ❑ Operation from a Power Take-Off (PTO) from the truck transmission or drive train
- ❑ A stand-alone drive with separate engine (auxiliary engine)

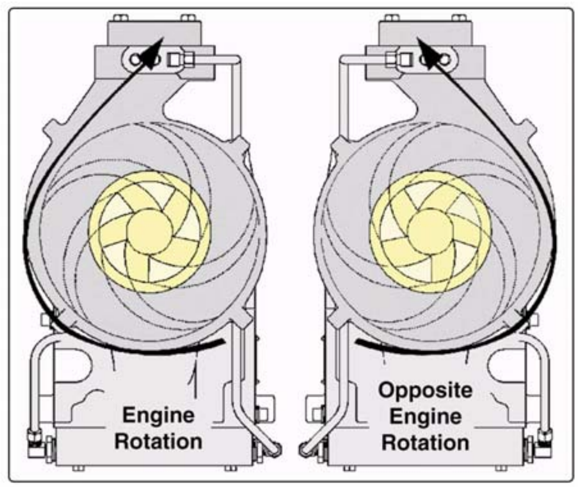



**Figure 2-6: Pump / Engine Rotation**

**Note:** Also see Plate #843A "Vehicle Mounted Pump Applications" located at the back of this manual. (See Section 8 "Drawing Package" on page 131.)

Certain Hale pumps are available for either engine rotation (clockwise), or opposite engine rotation (counterclockwise) PTO operation.

**WARNING!**

**NEVER OPERATE A HALE PUMP ABOVE THE CONTINUOUS TORQUE RATING FOR ITS TRANSMISSION OR PTO, OR ABOVE THE RECOMMENDED PTO OUTPUT SPEED AS RECOMMENDED BY THE PUMP / APPARATUS MANUFACTURER.**

## Gearbox

Hale pumps are equipped with an all ball bearing-type gearbox, utilizing helical gears to reduce operating noise. Hale gearboxes are available in a variety of ratios to accommodate a wide range of manufacturer requirements for engines, transmissions, and PTOs, (speed and available horsepower).

Gearboxes are also available in various mounting configurations (e.g., short (S), long (L), extra long (XL), split-shaft, PTO (top, left-hand, right-hand), rear mount, etc.) to accommodate the wide range of apparatus manufacturer requirements.

Hale pumps also feature, as standard equipment, a gearbox cooling tube to maintain proper operating temperatures.

## HALE Power Takeoff (PTO) Driven Pumps

Hale pumps feature a 1-1/2” (38 mm) input (drive) shaft for connection to a PTO driveline. Optional 1410, 1510 and 1610 companion flanges are also available.

## Hale Engine Mounted Pumps (-M Series)

Certain Hale pumps are available with an adapter to accept #2, #3 and #4 SAE bell housings. Elastomeric drive discs are also available for 10” (254 mm) and 11.5” (292 mm) clutch discs.

# 2a Accessories / Options

In addition to the basic Hale pump and gearbox, the following options and / or accessories are available to complete a system installation:

- ❑ Anodes
- ❑ Auxiliary Cooling, standard on some equipment
- ❑ Pressure Control Devices (Relief Valves or Governors)
- ❑ Thermal Relief Valve (TRV)
- ❑ Priming Systems
- ❑ Torrent Stainless Steel SVS Valves

## 2A.1 ANODES

The Hale Anode System helps prevent damage caused by galvanic corrosion in the pump. Galvanic corrosion occurs when different conducting materials are connected electrically and exposed to fluid. Galvanic corrosion, results in corrosion of the less resistant of the two metals, while the more resistant metal is protected. (See Figure 2a-1: "Hale 1-1/4" NPT Anode.")

Hale offers two types of anodes:

- ❑ Zinc anode - recommended for pumps where corrosion is an issue, including brackish or salt water exposure.
- ❑ Magnesium anode - available for use if the pump already uses zinc anodes and galvanic corrosion is still a concern. Magnesium anodes contain a notch in the hex head for identification.

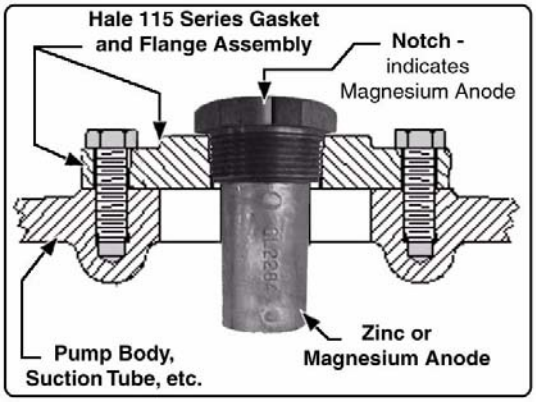



**Figure 2a-1: Hale 1-1/4" NPT Anode**

The Anode kit is designed for installation in the standard Hale 115 series flange opening. On fabricated manifolds and similar applications, the installer must provide 1-1/4" NPT openings and install anodes directly. It is recommended that one anode be installed on each suction manifold and one on the discharge side.

Typically, three (3) anodes are used andcan be mounted in any position, horizontal or vertical. Anodes should be inspected periodically * and replaced when over 75% of the metal has been consumed. Performance varies with water quality and PH.

** Zinc anodes should be inspected every twelve (12) months. Magnesium anodes, which are consumed at a faster rate, should be inspected ever three (3) or four (4) months.*

# 2A.2 AUXILIARY COOLING

## Gearbox Manifold Coolers

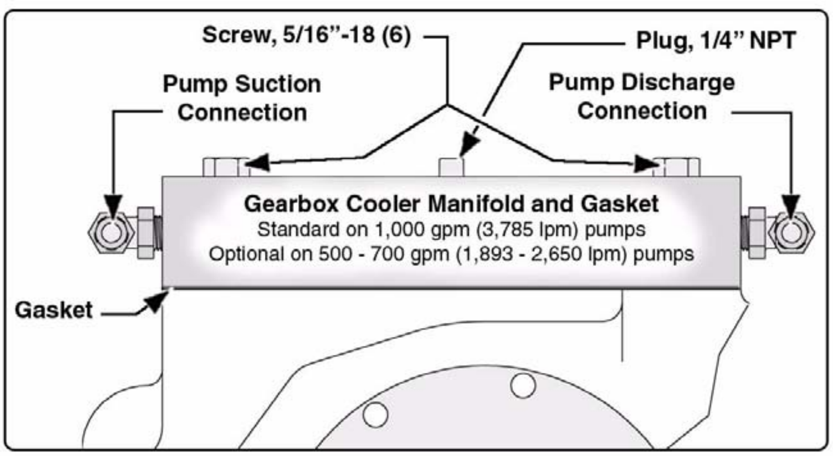



**Figure 2a-2: Typical Gearbox Manifold Coolers**

For pumps not equipped with standard gearbox cooling, a cooler option is available to protect the gearbox, the apparatus engine, and the pump. (See Figure 2a-2: “Typical Gearbox Manifold Coolers.”)

The gearbox cooler circulates pump water to transfer heat from the gearbox oil to the pump discharge, thus maintaining proper operating temperatures.

## Heat Exchanger, “K” Series

The Hale Model “K” heat exchangers, meet NFPA 1901 requirements. These units are used with any size radiator and use water from the pump to help maintain the proper temperature of the engine coolant during pumping. (See Figure 2a-3: “Model “K” Heat Exchanger,” on page 25.)

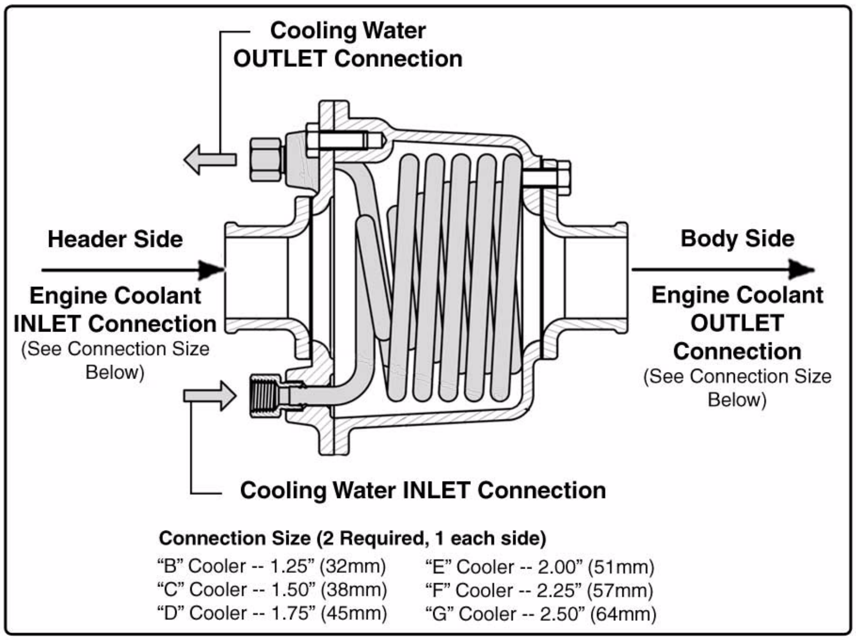



**Figure 2a-3: Model “K” Heat Exchanger**

The cast-iron housing and copper-tubing coil keeps the water and coolant from contaminating each other.

**Note:** A valve is normally added at the operator’s panel allowing the operator to control the amount of water supplied to the Model “K” heat exchanger.

# 2A.3 PRESSURE AND RELIEF VALVE CONTROL

**Note:** For additional information about the pressure and relief valves in your system, also see the separate manual provided with the valves.

## P Series Relief Valve System

The **P** Series relief valve system is a bronze, variable-pressure setting, relief valve that prevents undue pressure per the requirements of NFPA Standard 1901. An AMBER indicator light on the operator control panel signals when the valve is open. (See Figure 2a-4: “P Series Relief Valve System Arrangement,” on page 26.)

The **P** series relief valve system consists of a panel mounted control valve (PM) and a P25, P30 or P30V relief valve. The valve is mounted in the discharge piping and plumbed back to the pump suction. Valve connections are either flanged or Victaulic™.

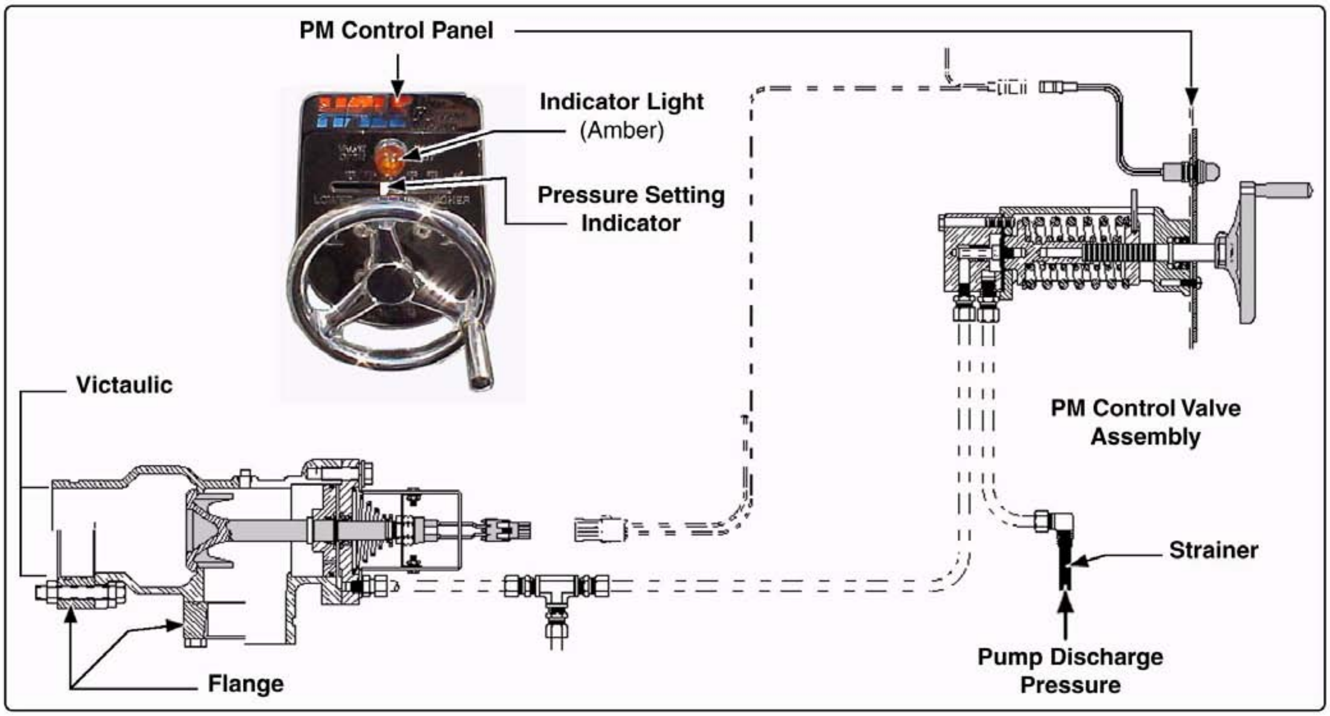



**Figure 2a-4: P Series Relief Valve System Arrangement**

## Thermal Relief Valves (TRV)

The optional TRV protects the pump from overheating. It is attached to the discharge piping either by flange mounting or 1-1/4" NPT threaded connection (38 mm for Model TRVM). (See Figure 2a-5: "Thermal Relief Valve, TRV," on page 27.)

The valve monitors the temperature of the water in the pump. When temperatures exceed 120° F (49° C), the valve automatically opens. Depending on the installation, a small amount of water either discharges to the ground or into the water tank allowing cooler water to enter. After the temperature returns to a safe level, the valve closes.

### TRV-L Kit

The TRV-L kit includes a chrome panel placard with a warning light, a light test button, and a pre-assembled wire harness. The RED light illuminates when the TRV is open and discharging water. (See Figure 2a-5: "Thermal Relief Valve, TRV," on page 27.)

An optional buzzer, mounted on the operator panel, provides an audible warning.

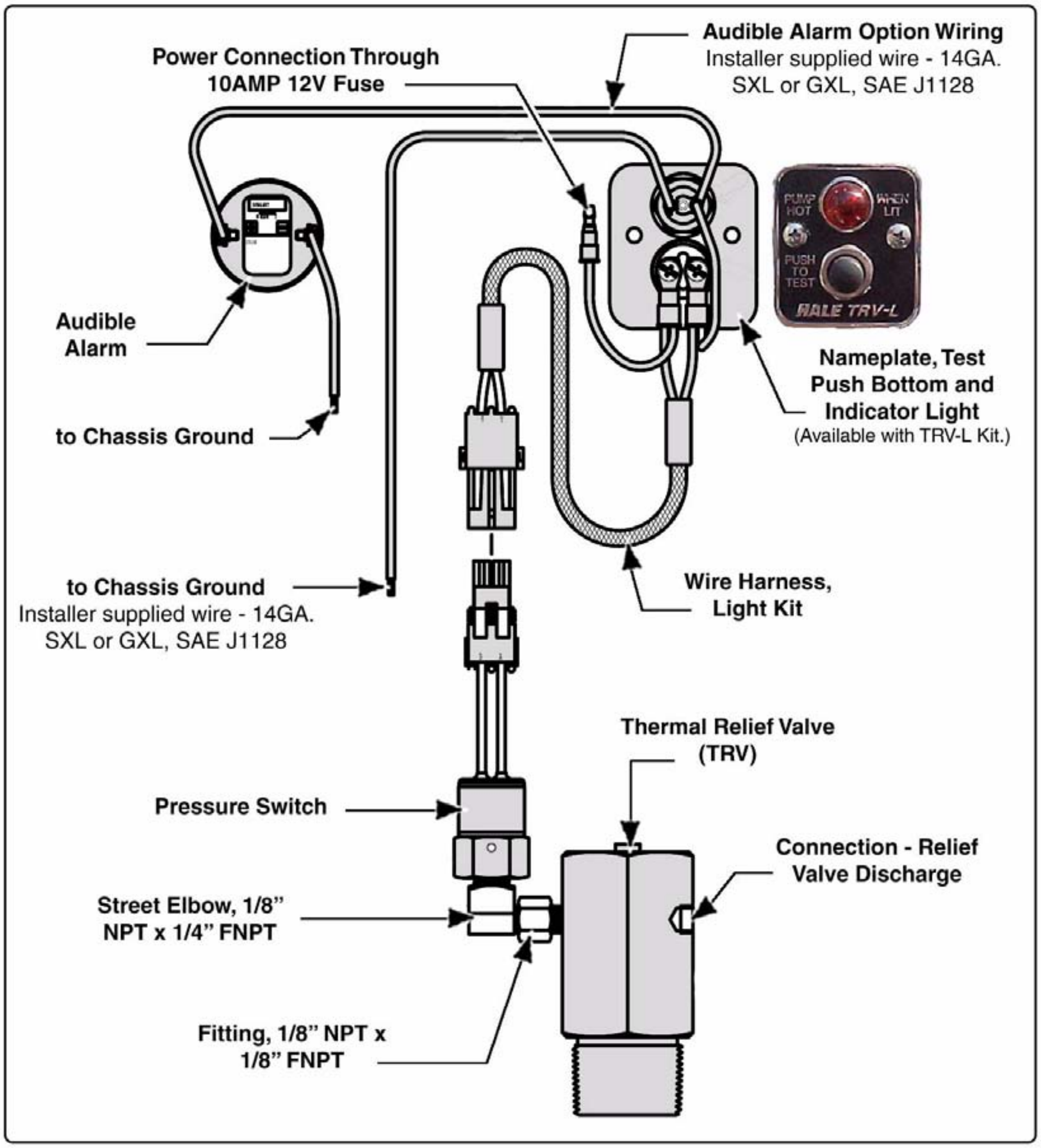



**Figure 2a-5: Thermal Relief Valve, TRV**

# 2A.4 PRIMING SYSTEMS

Hale pumps recommends **Rotary Vane Positive Displacement ESP** pumps for priming. (See Figure 2a-6: "Rotary Vane ESP Priming Pump," on page 28.)

Priming pumps are used to evacuate air in the suction hose and pump. The vacuum created allows atmospheric pressure to push water from the static source through the suction hose and into the pump.

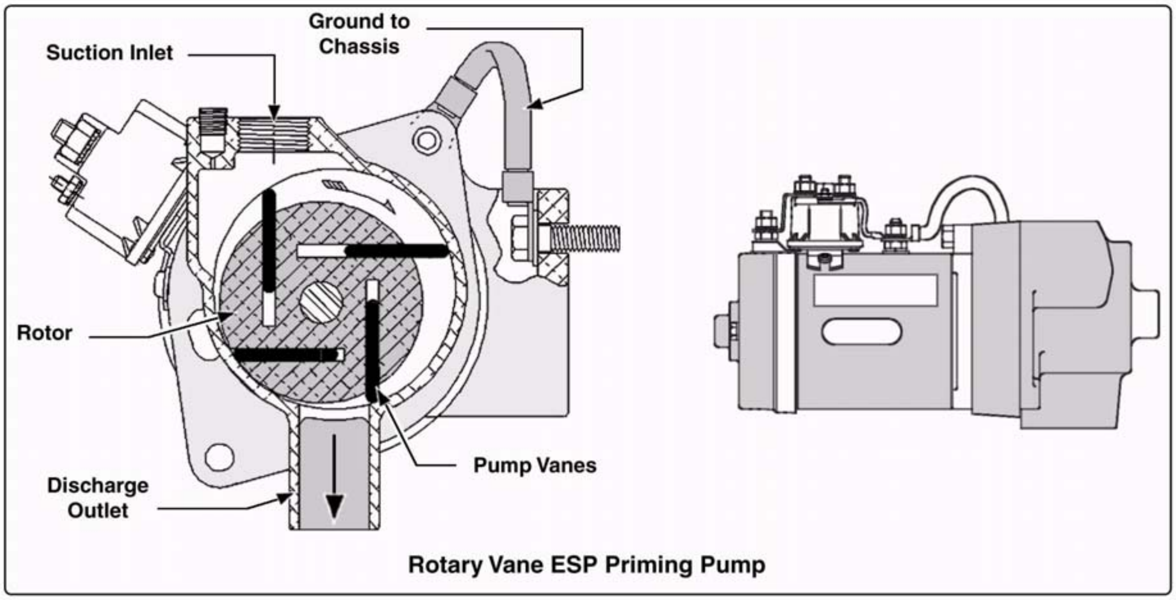



**Figure 2a-6: Rotary Vane ESP Priming Pump**

The Hale **ESP** series priming pump is an environmentally friendly primer that does not require a separate lubricant reservoir. The vanes and pump body are self-lubricating for maintenance free operation. An ESP priming pump also uses a single control to open the priming valve between the pump and the priming pumps, and start the priming motor.

## Priming Valves

Hale priming valves open when the priming pump is operated to allow the air to escape from the pump. Two priming valves are offered:

- **Hale Semi-Automatic Priming Valve (SPVR)**, for Remote Mounting

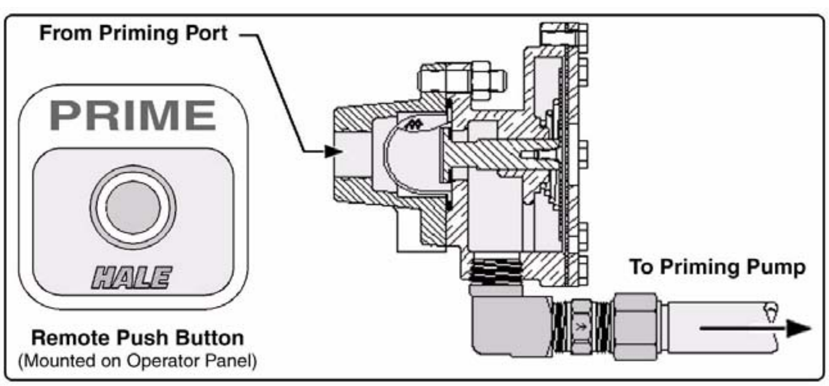



**Figure 2a-7: SPVR Priming Valves**

A hose is connected from the SPVR to the priming port on the pump body. A single push button on the operator's panel starts the priming pump motor. When a vacuum is created, the SPVR opens. (See Figure 2a-7: "SPVR Priming Valves," on page 28.)

Releasing the push button stops the priming pump and the SPVR closes.

- **The Hale PVG Priming Valve**

The PVG is mounted on the pump operator's panel. The PVG is a combination valve and switch. (See Figure 2a-8: "PVG Priming Valves.")

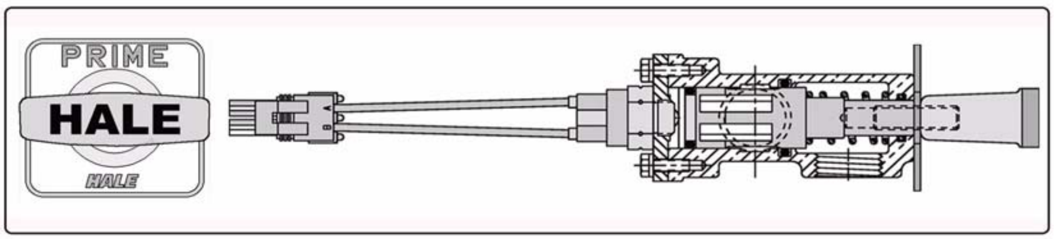



**Figure 2a-8: PVG Priming Valves**

When the handle on the PVG is pulled out, the valve opens and the switch energizes the primer motor. Pushing the handle in de-energizes the motor and closes the valve.

# 2A.5 PUMP SHIFT, AUTOMATIC (VPS / KPS)

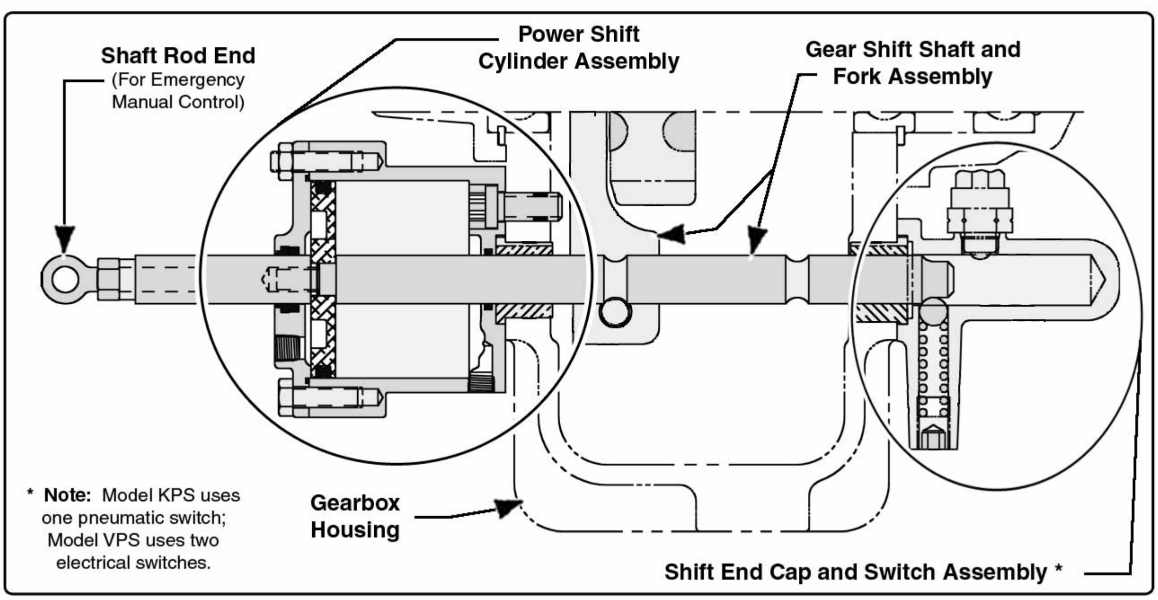



**Figure 2a-9: Automatic Pump Shift Overview**

The Hale Automatic Pump Shift, Models VPS or KPS, is a remote, pneumatically operated, shifting device to shift the pump transmission from ROAD-to-PUMP and back again. (See Figure 2a-9: “Automatic Pump Shift Overview,” on page 29.)

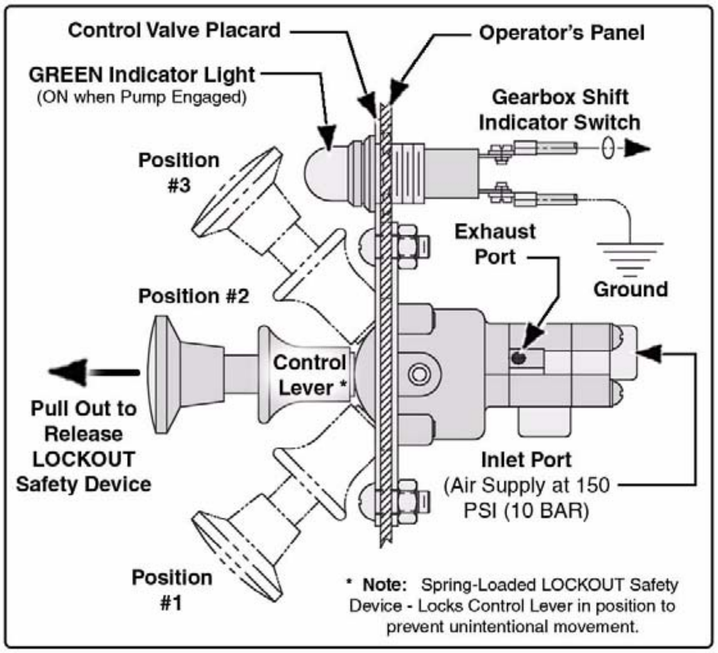



**Figure 2a-10: Pump Shift Control Valve**

It uses available apparatus vacuum or air pressure for power and is activated by an in-cab pump shift control valve. (See Figure 2a-10: “Pump Shift Control Valve.”) The system includes a three-position pump shift control valve assembly and indicator lights (GREEN), mounted in the operator’s cab and on the operator’s panel.

## Torrent SVS Valves

Torrent SVS valves control the flow to and from the full range of Hale pumps. SVS valves enable the operator to shut off flow completely, or throttle the flow rate from a trickle to full flow. (See Figure 2a-11: “Typical SVS Valve Primary Components.”)

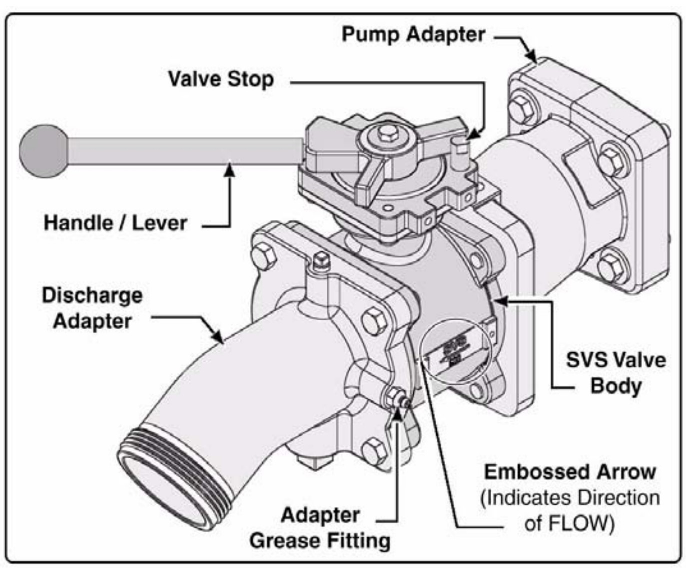



**Figure 2a-11: Typical SVS Valve Primary Components**

Numerous adapters tailor the valve to almost any installation requirement.

# 3 Basic Operation

**WARNING !**

**THE PROCEDURES IN THIS SECTION ARE GENERAL OPERATING PROCEDURES. NOT ALL PROCEDURES IN THIS SECTION MAY APPLY TO YOUR SPECIFIC OPERATIONAL REQUIREMENTS. REFER TO ONLY THOSE SECTIONS WHICH APPLY TO YOUR OPERATIONAL REQUIREMENTS.**

**THESE PROCEDURES DO NOT REPLACE THE PROCEDURES, POLICIES OR GUIDELINES ESTABLISHED BY THE AUTHORITY HAVING JURISDICTION, NOR DO THEY REPLACE THE RECOMMENDATIONS AND PROCEDURES PROVIDED IN THE APPARATUS MANUFACTURER'S MANUAL.**

**ALWAYS REFER TO THE PROCEDURES PROVIDED BY THE AUTHORITY HAVING JURISDICTION FOR OPERATING PROCEDURES, SETTING WHEEL CHOCKS, AS WELL AS LAYOUT AND CONNECTION OF HOSES, VALVES AND DRAIN COCKS. ALL VALVES, DRAIN COCKS AND CAPS SHOULD BE CLOSED.**

**NEVER ATTEMPT TO SHIFT THE PUMP TRANSMISSION WHILE THE TRUCK TRANSMISSION IS IN GEAR. ALWAYS SWITCH THE TRANSMISSION TO NEUTRAL (N) AND VERIFY THE SPEEDOMETER IS AT ZERO (0) BEFORE MAKING A PUMP TRANSMISSION SHIFT.**

## 3.1 OVERVIEW

The instructions provided are for “split-shaft” and “PTO” pump applications:

- **Pumping from a hydrant** - on page 32.
- **Pumping from draft** - on page 35.
- **Pumping from an onboard tank (Split-Shaft PTO)** - on page 38.
- **Pumping in relay** - on page 40.
- **Tandem (series) pumping** - on page 42.
- **Pump and Roll** - on page 43.
- **Post-operation procedures** - on page 47.

**Note:** Also refer to NFPA 1901 Regulations for additional information for apparatus split-shaft and PTO requirements.

# 3.2 STATIONARY PUMPING OPERATIONS

## Pumping From a Hydrant, General Operation

1. Position the apparatus for the best hydrant hookup and discharge hose layout.

2. Bring the truck to a complete stop, apply the truck parking brake, then shift the truck transmission to the NEUTRAL position. See **WARNING !** note on page 31.

3. Make sure the truck is at a complete stop before you attempt to shift from ROAD to PUMP. Also see heading "Pump-To-Road Shift Procedures" on page 43.

   Engage the PTO (power take-off) per the PTO manufacturer's instructions (move the in-cab pump shift control valve to the PUMP position). The GREEN shift warning lights illuminate, indicating a complete shift. (See Figure 3-1: "Driver's Compartment Indicator Lights.")

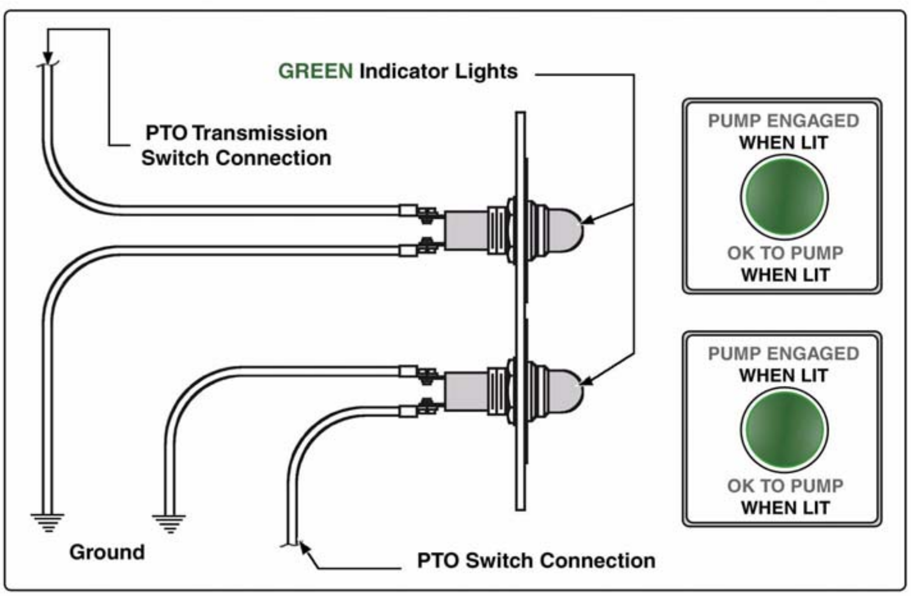



**Figure 3-1: Driver's Compartment Indicator Lights**

**Note:** If the truck manufacturer has used another in-cab valve to achieve pump shift or offers an electric switch, follow the instructions supplied with that valve.

**CAUTION !**

**DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB ARE ON.**

**DO NOT OPEN THE THROTTLE UNLESS THE GREEN INDICATOR LIGHT IS ON. (SEE FIGURE 3-2: “PUMP OPERATOR’S PANEL.”)**

4. Exit the driving compartment only after all the preceding steps are completed and you are sure the appropriate lights in the cab and panel are ON.

5. Verify that the pump panel GREEN shift indicator OK TO PUMP light illuminates and that all hose connections are complete.

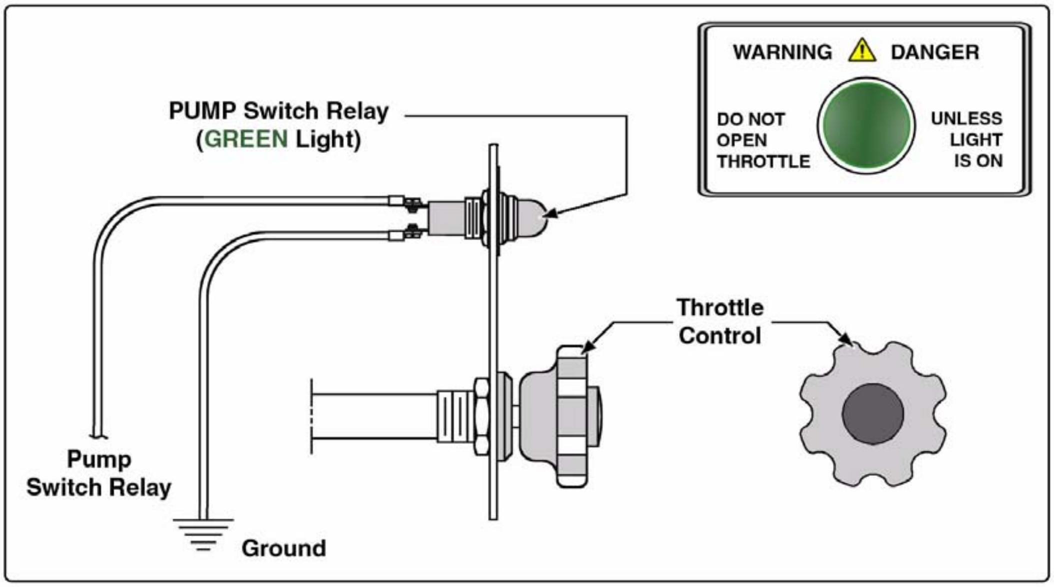



**Figure 3-2: Pump Operator’s Panel**

### For “Split-Shaft” operation

- ❑ Place the truck transmission in the proper pump operating range or gear. For most pumpers this is direct drive (1:1) ratio. In addition, the speedometer should register after the shift has been completed.
- ❑ If the shift does not complete, shift the transmission back to NEUTRAL (N) and repeat the entire procedure.
- ❑ Some vehicles drive the speedometer from the front wheel of the chassis. In this case, the speedometer will not register after shifting to the PUMP position. See the chassis manual for details.

6. Open the hydrant. Bleed off the air from the suction hose.

7. Open the suction valve to allow water flow into the pump.

8. Open the appropriate valve to expel air or prime the pump, if so equipped. Also see heading “Pumping From Draft” on page 35.

9. Note the discharge and intake pressures, then open the engine throttle gradually until the master discharge gauge indicates the desired pressure.

10. Set the automatic relief valve according to your fire department policy, if so equipped. If your fire department does not have a policy, see heading “TPM Operation from a Hydrant” on page 35.

**CAUTION !**

**DO NOT REDUCE THE PRESSURE ON THE INTAKE GAUGE BELOW DEPARTMENT LIMITS. SERIOUS DAMAGE TO THE WATER MAIN COULD RESULT.**

11. If the master intake gauge shows a vacuum before the desired discharge pressure or flow is achieved, it indicates that you are receiving all the water that the suction piping (hydrant) can supply.

12. If you need to increase pressure when this occurs, pump flow must be reduced or the water supply improved.

    To increase pressure, reduce the pump flow. However, the master intake gauge reading must be maintained at 5 PSI (0.34 BAR), minimum.

13. As the throttle (engine speed) is increased, the pressure gauge reading increases.

14. Close the throttle slowly until the pressure begins to stabilize and track with engine speed. If this does not correct the problem, you may be pumping more capacity than is available from the supply. Also check the inlet strainers for possible blockage.

15. Open the discharge valves.

**IMPORTANT !**

IF THE PUMP OVERHEATS AND IS NOT EQUIPPED WITH THE HALE TRV VALVE, OPEN THE VALVE TO ACCESS THE PUMP AUXILIARY COOLING SYSTEM, OR SLIGHTLY OPEN THE TANK FILL LINE TO CIRCULATE WATER.

16. When pumping operations are completed, gradually reduce the pump pressure until the engine returns to IDLE speed. See heading “Pumping From Draft” on page 35. Disengage the PTO per the PTO manufacturer’s instructions. Also see heading “Pump-To-Road Shift Procedures” on page 43.

## TPM Operation from a Hydrant

When operating from a positive inlet pressure, it may be necessary to adjust the TPM relief valve to a point where water is dumping to the ground.

The internal relief valve is always opened first, and if it cannot handle the pressure rise, the external relief valve dumps water on the ground. When the internal relief valve opens, the panel light illuminates, and when the external dump valve opens, the light on the panel FLASHES.

## Draft Limiting Factors

The effect of raised water temperatures when pumping from a positive pressure source (i.e., a hydrant) is negligible on fire pump performance. However, when pumping from draft (static source such as a pond, lake or basin), elevated water temperature does have a limiting effect.

Water temperatures above 95°F (35°C) cause a noticeable decrease in lift when drafting. Also see Figure F-2: “Lift Loss from Temperature” on page 127.

Barometric pressures below 29” Hg. can also limit lift when drafting. High elevations and storm conditions can affect maximum flow available from any pump. Also see Figure F-3a: “Lift Loss from Barometric Reading” on page 127.

## Pumping From Draft

1. Position the apparatus as close to the water source as practical. The pump can draw 100% of its rated capacity with less than a 10 foot (3.05 meters) vertical lift and 20 feet (6 meters) of suction hose.

   As the vertical lift increases to above 10 feet (3 meters), pump capacity is reduced. Also see Figure F-3: “Lift Loss from Elevation” on page 127.

2. Bring the truck to a complete stop, apply the truck parking brake, shift the truck transmission to the NEUTRAL position. See **WARNING !** note on page 31.

3. Make sure the truck is at a complete stop before you attempt to shift from ROAD to PUMP. Also see heading “Pump-To-Road Shift Procedures” on page 43.

   Engage the PTO (power take-off) per the PTO manufacturer’s instructions (move the in-cab pump shift control valve to the PUMP position). The GREEN shift warning lights illuminate, indicating a complete shift. (See Figure 3-1: “Driver’s Compartment Indicator Lights” on page 32.)

**Note:** If the truck manufacturer has used another in-cab valve to achieve pump shift or offers an electric switch, follow the instructions supplied with that valve.

**CAUTION !**

**DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB ARE ON.**

**DO NOT OPEN THE THROTTLE UNLESS THE GREEN INDICATOR LIGHT IS ON. (SEE FIGURE 3-2: “PUMP OPERATOR’S PANEL” ON PAGE 33.)**

4. Exit the driving compartment only after all the above steps are completed and you are sure that the appropriate lights in the cab and panel are ON.

5. Verify that the pump panel GREEN shift indicator OK TO PUMP light illuminates and that all hose connections are complete.

   **For “Split-Shaft” operation**

- Place the truck transmission in the proper pump operating range or gear. For most pumpers this is direct drive (1:1) ratio. In addition, the speedometer should register after the shift has been completed.
- If the shift does not complete, shift the transmission back to NEUTRAL (N) and repeat the entire procedure.
- Some vehicles drive the speedometer from the front wheel of the chassis. In this case, the speedometer will not register after shifting to the pump position. See the chassis manual for details.

6. Activate the priming pump - pull the control handle, or press the push button.

   Your departmental manual for pumping should specify the correct RPM for priming. However, in general, priming should be operated at IDLE.

   Running the engine at speeds higher than 1,200 RPM during priming is not recommended. It does not improve the priming operation but can cause damage to the pump.

### CAUTION !

**IF THE DISCHARGE GAUGE READING DOES NOT INCREASE, THE INTAKE GAUGE READING DOES NOT FALL BELOW ZERO (0), OR THE PRIMING PUMP DOES NOT DISCHARGE WATER TO THE GROUND WITHIN 30 TO 45 SECONDS, DO NOT CONTINUE TO RUN THE PRIMING PUMP.**

**STOP THE PUMP AND CHECK FOR AIR LEAKS OR POSSIBLE PROBLEMS. SEE SECTION 5 "TROUBLESHOOTING," ON PAGE 63.**

7. Monitor the intake and discharge master gauges. When the pump is primed, the intake reading falls below zero (0), and the discharge pressure starts to increase. You may also hear water splashing on the ground, indicating the pump is primed.

8. Gradually open the discharge valve until water emerges in a steady stream. Then open the other discharge valves to the desired setting.

9. Open the engine throttle gradually until the desired pressure or flow is achieved.

### CAUTION !

**DO NOT PUMP ENOUGH WATER TO CAUSE A WHIRLPOOL AT THE STRAINER. THIS ALLOWS AIR INTO THE PUMP, CAUSING ROUGH OPERATION AND PULSATION. REPOSITION THE STRAINER OR REDUCE FLOW TO CORRECT THE SITUATION.**

As the throttle is opened, the pressure gauge reading increases with the engine speed. If the engine speed increases without an increase in pressure, the pump may be cavitating.

10. If the pump is cavitating, warn personnel that the flow is being REDUCED. Close the throttle slowly until you operate without cavitation.

The following can also lead to cavitation:

- **Large nozzle tips** - use smaller nozzle to reduce flow.
- **Air enters with the water -** Air leaks can cause rough operation and an increase in engine speed without an increase in pressure or flow.

  If an air leak is suspected, discontinue pumping - see heading "Troubleshooting" on page 63.
- **Hot water -** see Figure F-2: "Lift Loss from Temperature" on page 127.

- ❑ **Low barometer -** see Figure F-3a: “Lift Loss from Barometric Reading” on page 127.
- ❑ **High lift -** see Figure F-3: “Lift Loss from Elevation” on page 127.

**Note:** Also see Section “Appendix F: Cavitation” on page 125.

11. If a pump shutdown is desired while pumping from draft, reduce the engine speed to IDLE and close the discharge valves.

    To resume pumping, open the throttle and discharge valves. If the pump overheats from continued churning without water flow, open the discharge valves periodically to release hot water.

12. Set the automatic relief valve according to your fire department policy. If your fire department does not have a policy, see heading “TPM Operation from a Hydrant” on page 35.

13. To avoid pump overheating, if not equipped with the Hale TRV valve, open the pump auxiliary cooling system valve, or slightly open the tank fill line.

14. After completion of pumping procedures, gradually reduce the engine RPM to IDLE speed. See heading “Pump-To-Road Shift Procedures” on page 43. Disengage the PTO per the PTO manufacturer’s instructions. Also see heading “Post Operation Procedures” on page 47.

## Pumping from On Board Water Tank (Split-Shaft PTO)

1. Position the truck for the best hydrant hookup and discharge hose layout.

2. Bring the truck to a complete stop, apply the truck parking brake, shift the truck transmission to the NEUTRAL position. See **WARNING !** note on page 31.

3. Make sure the truck is at a complete stop before you attempt to shift from ROAD to PUMP.

   Move the in-cab pump shift control valve to the PUMP position. The shift warning lights illuminate, indicating a complete shift. (See Figure 3-1: “Driver’s Compartment Indicator Lights” on page 32.)

**Notes:** If the truck manufacturer has used another in-cab valve to achieve pump shift or offers an electric switch, follow the instructions supplied with that valve.

4. Exit the driving compartment only after all the above steps are completed and you are sure that the shift completed lights in the cab and panel are ON.

**CAUTION !**

**DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB AND PANEL ARE ON.**

**DO NOT OPEN THROTTLE UNLESS ALL GREEN PUMP INDICATOR LIGHTS ARE ON. (SEE FIGURE 3-2: "PUMP OPERATOR'S PANEL" ON PAGE 33.)**

5. Verify that the pump panel shift indicator OK TO PUMP green light is ON and that all hose connections are complete.

6. Open the tank suction valve.

7. Check the master discharge gauge to see if priming is necessary. Start the priming pump - pull the control handle or press the prime push button.

**CAUTION !**

**IF DISCHARGE GAUGE READING DOES NOT INCREASE, THE INTAKE GAUGE READING DOES NOT FALL BELOW ZERO, OR THE PRIMING PUMP DOES NOT DISCHARGE WATER TO THE GROUND WITHIN 30 TO 45 SECONDS, DO NOT CONTINUE TO RUN THE PRIMING PUMP.**

**STOP THE PUMP AND CHECK FOR AIR LEAKS OR POSSIBLE PROBLEMS. SEE SECTION 5 "TROUBLESHOOTING," ON PAGE 63.**

8. Open the engine throttle gradually until the desired pressure or flow is achieved.

   As the throttle is opened, the pressure gauge reading increases with the engine speed. If the engine speed increases without an increase in pressure, the pump may be cavitating. Also see Section "Appendix F: Cavitation" on page 125.

9. If the pump is cavitating, warn personnel.

**WARNING !**

**DO NOT OPEN THROTTLE UNTIL ALL GREEN PUMP LIGHTS ARE ON. (SEE FIGURE 3-2: "PUMP OPERATOR'S PANEL" ON PAGE 33.)**

10. Gradually open the discharge valve until the water emerges as a steady stream. Then open the other discharge valves to the desired setting.

11. Set the automatic relief valve or governor according to your fire department policy (or the separate governor manual). If your fire department does not have a policy, see heading "TPM Operation from a Hydrant" on page 35.

12. To avoid pump overheating, if not equipped with the Hale TRV valve, open the pump auxiliary cooling system valve, or slightly open the tank fill line.

13. After completion of pumping procedures, gradually reduce the engine RPM until it is at an IDLE speed. See heading "Pump-To-Road Shift Procedures" on page 43. Disengage the PTO per the PTO manufacturer's instructions. Also see heading "Post Operation Procedures" on page 47.

# 3.3 PUMPING IN RELAY

Relay pumping is the movement of water through a number of consecutive pumpers, from suction to discharge. Relay operations are necessary when the water source is too far away from the fire to be pumped efficiently by one pumper. The number of pumpers is determined by how far the water source is from the fire.

In some cases, when you are on the receiving end of a relay, it may help to set the suction dump or TPM (if available) very low. This limits the incoming pump pressure by dumping water on the ground before the discharge hose lines are connected and are flowing water.

Then, as the incoming water is used the relief valve control can be increased to the desired operating pressure and set as instructed. This technique also helps to purge air from the incoming hose and the pump before it gets to a dangerously high pressure.

Use this procedure after the hose is positioned, the apparatus are in position, and the pumps are engaged. For setup and engagement instructions for apparatus receiving pressurized water, see heading "Pumping From a Hydrant, General Operation" on page 32.

## Relay Procedures

1. Open two discharge gates on all pumps, except on the pump at the source, to expel air from the hose lines and pumps.

2. On each pump, attach the hose lines to one of the discharges and leave the other discharge uncapped.

**Note:** Uncapping the second discharge gate is not necessary if a relay valve is installed. The valve, connected to the intake side of the pump, automatically opens and dumps water on the ground if too high a pressure is supplied, thus protecting the pump.

If no valve is present, the operator must watch the intake gauge for a high-pressure reading. If this is reached, open the gate controlling the uncapped discharge to dump excess water on the ground and reduce pressure.

3. Supply the pump at the water source with water; prime if necessary.

   The discharge pressure must not exceed 185 PSI (13 BAR) for 5” (127 mm) large diameter hose, or 135 PSI (9 BAR) for 6” (152mm) hose, per NFPA Standards 1962. See heading “Pumping From a Hydrant, General Operation” on page 32. Also see heading “Pumping From Draft” on page 35.

**IMPORTANT !**

FOR ADDITIONAL SUPPLY HOSE AND PRESSURE SETTING INFORMATION, SEE NFPA STANDARDS 1962.

4. When the water reaches the second pump, close the uncapped discharge gate. Repeat this step for all pumps until the water reaches the fire ground.

5. Adjust the throttle on the pump at the water source for the required operating pressure. Watch the gauges to avoid cavitation. Also see heading “Appendix F: Cavitation” on page 125.

   The pump operator at the fire scene must advise all other pump operators of the amount of water needed at the fire ground.

6. Adjust the discharge pressure or flow at the fire scene to supply the lines being used.

7. Observe the gauges carefully, and adjust the pressure or flow as needed.

8. Shutdown starts from the fire ground pump and works toward the water source. Gradually reduce pressure at the fire ground pump until you can disengage the pump.

   Follow this procedure for every pump in the relay until the pump at the water source is shut down.

**NOTICE !**

**LOCAL TRAINING PROCEDURES MAY VARY SLIGHTLY FROM ABOVE. ALWAYS FOLLOW LOCAL TRAINING PROCEDURES.**

# 3.4 TANDEM (SERIES) PUMPING

Tandem pumping operations may be used when higher pressures are required than a single engine is capable of supplying. This sometimes occurs when the pumper is attempting to supply high-rise sprinkler or standpipe systems or long hose layouts.

**Note:** Two 1,000 GPM (3,785 LPM) pumpers in a series from a hydrant can produce 500 GPM (1,893 LPM) at 500 PSI (35 BAR) if the relief valve systems allow 500 PSI.

**CAUTION !**

**WHEN SUPPLYING HOSE LINES IN A TANDEM PUMPING OPERATION IT IS POSSIBLE TO SUPPLY GREATER PRESSURE THAN THE HOSE CAN WITHSTAND. PRESSURE SUPPLIED TO THE HOSE SHOULD NOT EXCEED THE PRESSURE AT WHICH THE HOSE IS ANNUALLY TESTED BY THE DEPARTMENT.**

**CONSULT NFPA 1962, “STANDARD FOR THE CARE, USE AND SERVICE TESTING OF FIRE HOSE INCLUDING COUPLINGS AND NOZZLES,” FOR THE TEST PRESSURES RECOMMENDED FOR THE TYPE OF FIRE HOSE USED BY YOUR FIRE DEPARTMENT. DEPARTMENTS THAT ROUTINELY PERFORM HIGH-PRESSURE TANDEM PUMPING OPERATIONS MAY HAVE HOSE DESIGNATED FOR THAT SPECIFIC FUNCTION.**

In tandem pumping, the pumper directly attached to the water supply source pumps water through its discharge outlet(s) into the intake(s) of the second engine. This enables the second engine to discharge water at a much higher pressure than a single engine could have supplied. The higher pressure results from the pumps acting in series.

## Tandem Procedures

1. Using the large intake hose, connect the first pumper to the hydrant steamer. Open the hydrant until the pump is primed.
2. Position the second pumper “discharge-to-intake” with the first pumper.
3. Open a discharge to flow water.
4. Adjust the throttle on the first pumper until the intake gauge reads approximately 5 PSI (0.34 BAR)
5. Connect the second pumper to the unused streamer intake of the first pumper, using a large intake hose (approximately 2-1/2” / 64 mm).

6. Both pumpers pump water to the fire. Also see heading “Pumping From a Hydrant, General Operation” on page 32.

**NOTICE!**

**LOCAL TRAINING PROCEDURES MAY VARY SLIGHTLY FROM ABOVE. IN THIS CASE, ALWAYS FOLLOW LOCAL TRAINING PROCEDURES.**

## 3.5 PUMP-TO-ROAD SHIFT PROCEDURES

**(For Split-Shaft Gearboxes)**

1. Verify that the operator’s hand throttle or governor control has returned to IDLE speed.
2. Shift the truck transmission into the NEUTRAL, and wait about four (4) seconds. Check to make sure the speedometer reads ZERO (0).
3. Move the pump shift control valve lever to the ROAD position. The in-cab and panel pump indicator lights go out when the pump transmission starts to shift into the ROAD position.

**NOTICE !**

**REFER TO THE FIRE DEPARTMENT PROCEDURES FOR REMOVING WHEEL CHOCKS, AS WELL AS LAY OUT AND CONNECTION OF SUCTION AND DISCHARGE HOSES.**

## 3.6 PUMP AND ROLL

**IMPORTNAT !**

DURING PUMP AND ROLL OPERATION, IT IS NECESSARY TO SLOW THE FORWARD MOTION OF THE APPARATUS TO THE PTO MANUFACTURER'S RECOMMENDED ENGAGEMENT SPEED.

1. Slow the apparatus to a safe PTO engagement speed as recommended by the PTO manufacturer’s recommendations.

**Note:** Most PTOs must be engaged while the apparatus is stopped. Only a "Hot Shift" PTO can be engaged while the apparatus is rolling.

2. Engage the PTO.

3. Verify the PUMP ENGAGED light is ON. Also see Figure 3-1: “Driver’s Compartment Indicator Lights” on page 32.

4. Open the valve between the tank and pump suction.

5. Observe pump discharge pressure and verify that the pump pressure increases.

6. Prime the pump, if necessary.

7. Open the discharge valves and commence operations.

# 3.7 RELIEF VALVE PROCEDURES

Be sure to select the correct procedure based on how the truck is equipped. (See Figure 3-3: “TPM / PMD Relief Valve Control” on page 45.) Some trucks may utilize a governor in place of the relief valve.

## Standard Relief Valve Procedures

1. Increase the engine RPM to the desired pump operating pressure while reading the discharge pressure gauge.

2. Turn the handwheel slowly counterclockwise until the relief valve opens. The pilot light illuminates and the master pressure gauge drops a few PSI (BAR).

3. Turn the handwheel slowly clockwise until the master pressure gauge rises to the desired pressure and the pilot light goes out.

4. When the pump is not in operation, turn the handwheel clockwise to a position slightly above the normal operating pressure. When the pump is put into operation again, reset the valve to the desired operating pressure. More complete and detailed information is found in the relief valve manual.

## TPM Relief Valve Procedures

1. Set the pressure indicator on the PMD control valve to a position slightly above the normal operating pressure (even before water starts to flow).

2. After normal operating pressure is achieved (as indicated on the master pressure gauge while the pump is discharging water), slowly move the adjusting handwheel counterclockwise until the relief valve opens.

3. The AMBER indicator light illuminates. (See Figure 3-3: "TPM / PMD Relief Valve Control.")

4. Turn the handwheel slowly clockwise until the light goes out.

5. When the pump is not in operation, turn the handwheel clockwise to a position slightly above the normal operating pressure. More complete and detailed information is found in the relief valve manual.


**Figure 3-3: TPM / PMD Relief Valve Control**

**CAUTION !**

**THE PRESSURE INDICATOR ON THE PANEL IS ONLY A ROUGH INDICATION OF TPM SETTING. ALWAYS USE THE PRECEDING PROCEDURE TO PROPERLY SET THE TPM RELIEF VALVE SYSTEM.**

## TPM System with Engine Governor

1. Set the pressure indicator on the PMD control valve to a position slightly above the normal operating pressure (even before water starts to flow).

2. Power on the governor control per the manufacturer's manual.

3. Set the discharge pressure using the RPM mode of the pressure governor control.

4. Move the TPM handwheel counterclockwise until the relief valve opens and the AMBER pilot light illuminates.

5. Turn the handwheel slowly clockwise until the AMBER light just goes out. Then turn the handwheel one additional full turn clockwise.

**CAUTION !**

**THE TPM PRESSURE CONTROL VALVE MUST BE SET SLIGHTLY HIGHER THAN THE GOVERNOR CONTROL FOR PROPER OPERATION.**

6. Place the governor control in the PRESSURE GOVERNOR mode.

7. Use the following procedures to change the set pressure while running:

**Increasing Pressure**

- ❑ Set the TPM to a pressure (by the indicator) slightly higher than the desired new pressure.
- ❑ Place the governor control in the RPM mode, and increase the speed to the new pressure.
- ❑ Turn the TPM handwheel counterclockwise until the relief valve opens and the AMBER pilot light illuminates. (See Figure 3-3: “TPM / PMD Relief Valve Control” on page 45.)
- ❑ Turn the handwheel slowly clockwise, until the AMBER light just goes out. Then turn the handwheel one additional full turn clockwise for proper operation.

**CAUTION !**

**THE TPM PRESSURE CONTROL VALVE MUST BE SET SLIGHTLY HIGHER THAN THE GOVERNOR CONTROL FOR PROPER OPERATION.**

- ❑ Place the governor control in the pressure governor mode.

**Decreasing Pressure**

- ❑ Put the governor control in the RPM mode, and reduce the speed to the new pressure.
- ❑ Move the TPM handwheel counterclockwise until the relief valve opens and the AMBER pilot light illuminates.
- ❑ Turn the handwheel slowly clockwise until the AMBER light just goes out. Then turn the handwheel one additional full turn clockwise.

**CAUTION !**

**THE TPM PRESSURE CONTROL VALVE MUST BE SET SLIGHTLY HIGHER THAN THE GOVERNOR CONTROL FOR PROPER OPERATION.**

- ❑ Place the governor control in the PRESSURE GOVERNOR mode.

## 3.8 EMERGENCY PUMP SHIFT PROCEDURES

Before implementing manual override shift procedures, repeat recommended shift procedures. If the shift fails, proceed as follows:

1. Bring the truck to a complete stop.
2. Apply the truck parking brake, and chock the wheels.
3. Shift the truck transmission to the NEUTRAL.
4. For PUMP or ROAD position, place the in-cab shift control in the NEUTRAL (N) position.
5. Shut down the engine.

**WARNING !**

**DO NOT ATTEMPT EMERGENCY SHIFT PROCEDURES WHILE THE ENGINE IS RUNNING.**

6. Employ manual override procedure at the shift cylinder on the pump gear-box as follows:
   - ❑ An eyebolt is provided in the shift shaft to accept a drift punch or screwdriver.
   - ❑ Insert the tool into the hole provided, then pull or push the shaft manually.
   - ❑ Pull the shaft OUT for PUMP position (after in-cab control valve selection), or push shaft IN for ROAD position (after in-cab control valve selection).
   - ❑ If the shift stroke cannot be completed manually, turn the driveshaft slightly by hand to realign the internal gears and repeat the manual shift.

**Note:** Certain apparatus may offer a manual shift override handle or separate cable for activation.

## 3.9 POST OPERATION PROCEDURES

1. Return the engine to IDLE, then slowly close all valves.
2. Place the transmission in NEUTRAL, then slowly shift to ROAD to disengage the pump.
3. Drain the pump (especially important in freezing weather):

- ❑ Open the discharge valves, remove suction tube caps, and discharge valve caps.
- ❑ Open the pump body drain cocks or Hale multiple drain valve. If a multiple drain valve is used, all pump drain lines should be connected to this valve.
- ❑ On two-stage pumps, move the transfer valve back and fourth between the VOLUME and PRESSURE positions.

4. If sea water, dirty water, alkaline water or foam solution has been used, FLUSH THE PUMP WITH CLEAN WATER.

5. If installed, drain the gearbox cooler. After the pump is completely drained, replace all caps and close all valves.

6. Remove the wheel chocks only when preparing to leave the scene.

7. Fill out the Pump Run Log, indicating total pumping and out-of-station time.

8. Report all pump, vehicle and equipment malfunctions, and irregularities to the proper authority.

9. Know and follow all local procedures. See **WARNING !** note on page 31.

# 4 Preventive Maintenance

## 4.1 OVERVIEW

Hale **MG /APMG** series pumps require very little care and maintenance. Preventive maintenance tasks require very little time to accomplish and consist mainly of testing for leaks, lubrication, and cleaning.

The following procedures are for normal use and conditions. Extreme conditions may indicate a need for increased maintenance. The procedures in this section identify measures needed to ensure lengthened pump life and continuing dependability. Always follow local maintenance and test procedures.

## 4.2 POST OPERATION

1. Inspect the suction hose rubber washers and washers in the suction tube caps. Remove foreign matter from under these washers. Replace worn, damaged, or dry washers.

2. Verify that all discharge valves, booster line valves, drain valves, and cocks are closed.

3. Tighten suction caps.

## 4.3 EXTREME CONDITIONS

Extreme conditions occur when the pump has been operated during freezing weather and as a result of pumping from a water source that contains material that is harmful to the pump if not purged.

### During Freezing Weather

In freezing weather, drain the pump as follows:

1. Open all discharge and suction valves, remove suction tube caps, and discharge valve caps.

2. Open pump body drain cocks and/or Hale multiple drain valve.

3. After the pump is completely drained, replace all caps and close all valves.

**Pumping Salt Water, Contaminated Water, or Foam Solution**

1. Flush the pump and suction hoses by using water from a hydrant or other CLEAN water source.

2. After pumping foam through the pump, flush as above until all foam residue is flushed from the system.

3. Drain the gearbox cooler, if installed.

# 4.4 WEEKLY

Weekly maintenance consists of testing the relief valve system or governor, the priming system, and the pump shift warning indicator lights. If testing criteria is not met, refer to Section 5 “Troubleshooting” on page 63 for corrective maintenance procedures.

- ❑ Test the relief valve or governor system - see page 50
- ❑ Test the priming system - see page 51.

  Establish and HOLD prime control for about three (3) to five (5) seconds to flush fresh water through the priming pump.

  **Note:** DO NOT apply lubricant the primer pump vanes or vane slots. Lubricant and cold water produces a gummy residue that renders the unit defective.

- ❑ Test the pump shift warning indicator lights - see page 51
- ❑ Perform valve maintenance - see page 52
- ❑ Check and clean the intake strainers - see page 52
- ❑ Verify all gauges are in working order - see page 52
- ❑ Operate pump controls - see page 52
- ❑ Check auxiliary engine - see page 53

## Relief Valve Test

When the relief valve is not in operation, maintain a setting above the normal operating pressure. Also see Figure 3-3: “TPM / PMD Relief Valve Control” on page 45. Also refer to NFPA 1901 standard.

1. Prepare to pump from the onboard water tank with the discharge valve back to the water tank open less than 1/2 way. Also see Section 2a.3 “Pressure and Relief Valve Control” on page 25.

2. Increase pump pressure up to 150 PSI (10 BAR).

3. Turn the relief valve handwheel counterclockwise until the relief valve opens and the AMBER light illuminates. The master pressure gauge should drop at least 5 to 10 PSI (0.35 to 0.7 BAR). (See Figure 3-3: “TPM / PMD Relief Valve Control” on page 45.)

4. Turn the control valve handwheel clockwise then counterclockwise a few times to ensure that the handwheel turns freely. Observe the master pressure gauge and indicator light for proper valve operation.

5. Reset the relief valve to its normal operational setting.

## Governor Test

If your apparatus is equipped with an electronic governor, follow the manufacturer’s instructions for preventive maintenance.

## Priming System Test

1. Tighten all pump caps, and close all pump valves.

2. Pull the primer control while you watch for a below-zero (0) reading on the master intake gauge.

3. Continue operation for three (3) to five (5) seconds after the primer starts flushing water through the pump to clear any possible dirt or slug (gum) buildup.

4. Verify that the master intake gauge readings hold for approximately five (5) minutes after you release the primer control. A drop of 10” Hg. during this 5 minute period is anticipated per NFPA 1901 standards.

5. If air leaks are heard or the gauge bounces back to or above zero (0), the pump or valves require service.

## Pump Shift Warning Indicator Lights

1. Switch to non-pumping operations, and verify the warning indicators are OFF. See Section 3 “Basic Operation” on page 31.

**CAUTION !**

**MAKE SURE EVERYONE IS CLEAR OF THE APPARATUS BEFORE SHIFTING TO THE PUMP POSITION. VERIFY THE PARKING BRAKE IS SET AND THE WHEELS ARE CHOCKED TO PREVENT ANY MOVEMENT OF THE APPARATUS.**

2. Verify that the warning indicators in the cab and the pump control panel function properly.

3. Repair or replace any malfunctioning indicators.

## Valve Maintenance

Refer to the separate valve manual for proper valve maintenance procedures.

For example, lubricate all moving parts of the suction, discharge, hose drain, and multi-drain valves and valve linkage with a good grade, lithium base grease. For recommended grease, see “Appendix C1: Lube and Sealant Specifications” on page 119.

**Note:** The PMD valve should be lubricated every five (5) months.

## Intake Strainers

- ❑ Check and clean any debris from the intake.
- ❑ Flush the pump, if required, using departmental / company procedures.
- ❑ Repair or replace any damaged strainers.

## Verify All Gauges are in Working Order

Any gauge that is repeated in the cab or another panel, must agree with the gauge on the operator's panel. Gauges not reading within 10% of the calibrated test gauge must be removed from service and re-calibrated.

## Operate Pump Controls

Operate the pump drive controls to verify the pump engages. Verify the indicator lights work properly.

### Inspect Water and Foam Tanks

Visually inspect water and foam tanks for proper level and gauge readings. If any debris is present, flush the tanks to protect the pump from wear caused by dirty water or foam concentrate.

### Check Auxiliary Engine

See separate engine manufacturer's manual.

## 4.5 MONTHLY

Monthly maintenance includes the weekly maintenance procedures plus:

- ❑ Valve lubrication - see page 53
- ❑ Gearbox lubrication - see page 53
- ❑ Dry vacuum testing - see page 55
- ❑ Checking the pump and drive line bolts - see page 54

### Valve Lubrication

1. On handwheel-type valves, first remove old grease and paint, then use a dry lubricating spray on gears.

2. Lubricate suction threads with a light coat of a good grade, lithium base grease. For recommended grease, see "Appendix C1: Lube and Sealant Specifications" on page 119.

### Gearbox Lubrication

Incorrect oil types or amounts of oil result in unnecessary high oil temperature and possible wear or damage. Change the oil every twelve (12) months, depending on pump usage. All lubricants must meet service rating API GL-5 requirements.

**Note:** For domestic use, Hale recommends using an SAE EP-90, 80W90 Lubricant or "RoadRanger" Full Synthetic SAE 50 Transmission Lubricant, manufactured by the Eaton® Corporation, or equivalent. For International use, Hale recommends using an ISO68 lubricant, or equivalent.

1. For gearbox capacity - see “Appendix C1: Lube and Sealant Specifications” on page 119.

2. Remove the oil fill plug, and check the oil level in the gearbox. (See Figure 4-1: “Gearbox Oil Change Plugs.”)

3. The oil level should be up to the bottom of the plug hole.

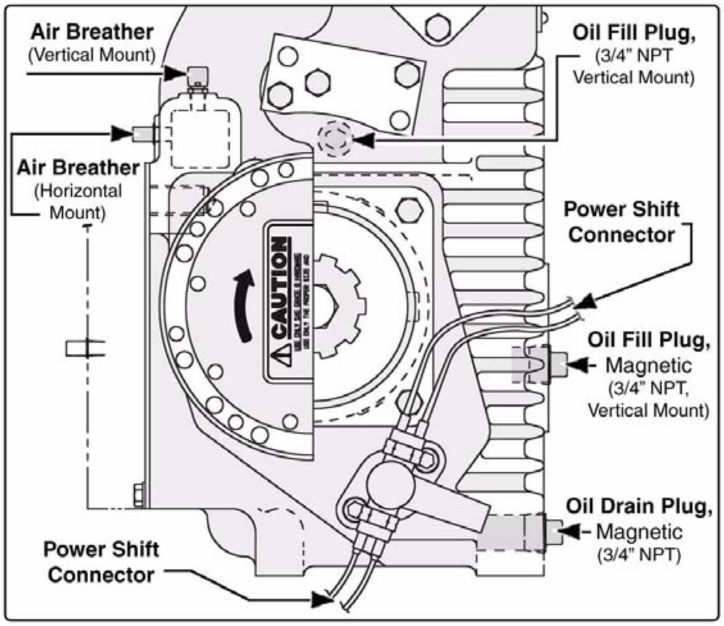



**Figure 4-1: Gearbox Oil Change Plugs**

4. If the oil appears white or “milky,” a water leak is indicated. Remove the drain plug and drain the oil into a suitable container. Examine the oil for metal flakes or other contamination.

   Have clean disposable shop rags and oil dry handy and a suitable container to collect the fluid.

**Note:** If water leak / contamination is suspected, see Section 5 Troubleshooting, heading “Water/Moisture in Pump Gearbox.” on page 69.

5. Either of these conditions indicates maintenance is required on the unit. See appropriate Section for gearbox service.

## Pump Mounting, Drive Line and Flange Bolts

Check all drive line and flange bolts to ensure:

- ❑ No bolts are missing
- ❑ All bolts are tight. Use a torque wrench to torque bolts to the drivetrain manufacturer's recommended specifications.
- ❑ Bolts used are “Grade 5” strength minimum for mounting and “Grade 8” minimum strength for driveline.

## Priming System Test (Dry Vacuum Test)

*(Refer to NFPA 1901 or NFPA 1911)*

1. Close all valves and drains. Cap all suction openings and the outlet of the suction side relief valve (if so equipped).

2. Connect a test vacuum gauge or manometer to the intake test gauge connection on the pump panel.

3. Engage the priming pump until the gauge indicates 22” Hg. vacuum.

4. Compare the readings of the test gauge and the apparatus gauge. Note any difference.

5. STOP the priming pump and observe the gauge. If the vacuum falls more then 10” Hg. in five (5) minutes, it is an indication of at least one air leak.

   Vacuum leaks may often be detected by ear if the apparatus engine is turned OFF. Correct leaks immediately before returning the pump to service.

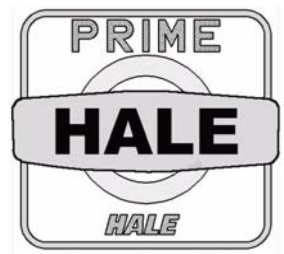



**Figure 4-2: Priming Valve Handle**

6. Test the suction hose as follows:
   - ❑ Attach the suction hose to the pump.
   - ❑ Place the suction tube cap on the end of the hose in place of a strainer.
   - ❑ Close all valves and drains. Cap all suction openings and the outlet of the suction side relief valve (if so equipped).
   - ❑ Connect a test vacuum gauge or manometer to the intake test gauge connection on the pump panel.
   - ❑ Engage the priming pump until the gauge indicates at least 22” Hg.
   - ❑ If the vacuum falls more then 10” in 5 minutes, it is an indication of at least one air leak.
   - ❑ Verify the test gauge and the apparatus gauge display the same readings. Repair and/or replace gauges that do not display the correct pressure.

**IMPORTANT !**

IF LEAKS CANNOT BE DETECTED BY FOLLOWING THE PROCEDURE, IT IS ADVISABLE TO TEST THE PUMP HYDROSTATICALLY. TO TEST:

- ❑ OPEN ALL VALVES

- ❑ PLACE CAPS ON ALL VALVES
- ❑ CONNECT A POSITIVE PRESSURE SOURCE (TYPICALLY 250 PSI / 17 BAR)
- ❑ INSPECT THE PUMP FOR LEAKS

# 4.6 ANNUAL

Annual maintenance consists of post-operation, weekly, and monthly maintenance. Maintenance for extreme conditions may also apply. In addition, the annual maintenance includes the following tasks:

- ❑ Replacing the pump gearbox oil - see page 56.
- ❑ Relief valve system, check and repair - see page 57.
- ❑ Checking individual drain lines from the pump to the multi-drain to ensure proper drainage and protection from freezing - see page 58.
- ❑ Test tank-to-pump flow rate - see page 58.
- ❑ Disassembly of priming pump to clean vanes - - see page 58. (Also see separate manual provided.)

**IMPORTANT !**

DO NO USE A LUBRICANT ON THE PUMP VANES AND VANE SLOTS. LUBRICANT AND COLD WATER FORM AN EVENTUAL GUMMY RESIDUE THAT RENDERS THE PRIMING SYSTEM INOPERATIVE. A COMPLETE AND THOROUGH DISASSEMBLY AND CLEANING IS THEN REQUIRED.

- ❑ Run a yearly pump test to check performance levels - see page 58. (See NFPA 1911 standard for more details.)

## Replace Gearbox Oil

1. Remove the drain plug (magnetic) and drain the gearbox oil into a suitable container. For container size based on gearbox capacity, see “Appendix C1: Lube and Sealant Specifications” on page 119. Also see Figure 4-1: “Gearbox Oil Change Plugs” on page 54.

   Have clean disposable shop rags and oil dry handy.

2. Examine the oil for contamination (e.g., water – turns the oil a milky color or settles to the bottom). Also see Section 5 Troubleshooting, heading “Water/Moisture in Pump Gearbox.” on page 69.

3. Properly dispose of the used oil.

4. Inspect the magnetic drain plug. If metal filings are present, remove the cover plate to visually inspect and clean the internal components.

   Clean the drain plug (magnetic).

5. Repair or replace components as necessary. See appropriate Section for gearbox service.

6. Replace the cooler or cover plate, if necessary.

7. Remove the oil fill plug and install the drain (magnetic) plug, using suitable thread sealant.

8. Fill the gearbox with an approved gear oil until oil just begins seeping from the oil level plug opening. For gearbox capacity, see “Appendix C1: Lube and Sealant Specifications” on page 119.

9. Install the oil fill plug using suitable thread sealent.

## Relief Valve System Check

1. Place apparatus out of service in accordance with departmental procedures.

2. Test relief valve system in accordance with weekly maintenance check. Also see heading “Weekly” on page 50.

3. If the relief valve is not working, clean the strainers as follows:

   - ❑ Open pump compartment panel and locate the relief valve system strainer(s).

     On all relief valve systems, the strainer is located in one of the pump pressure ports. On a TPM, an additional strainer is located in one of the pump vacuum ports.

   **Note:** An optional panel-mounted strainer is mounted on some apparatus.

   - ❑ Disconnect tubing then remove strainer.
   - ❑ Clean any debris from strainer and check strainer for damage.
   - ❑ Apply thread sealant (Loctite PST or equivalent) and reinstall the strainer.
   - ❑ Reconnect tubing.

4. Test apparatus and check for leaks around strainer fittings.

5. Place apparatus into service.

## Check Drain Lines to Multi-Drain

Drains are supplied on the pump and piping at the lowest points where water could collect and freeze, rendering the pump ineffective. Most drain lines are piped together to a multi-drain to allow the entire system to be drained by one valve.

It is necessary to inspect each line of the multi-drain to ensure the entire system is draining when the valve is operated. Inspect each connection and verify the individual lines to the multi-drain are free of debris. Repair and/or replace any lines that are damaged, kinked, or corroded.

## Clean Priming Pump

Disassemble the priming pump and clean the housing and vanes. Inspect the vanes for wear and replace if necessary. Reassemble the pump and test for proper operation. (See separate manual provided.)

**IMPORTANT !**

DO NO USE A LUBRICANT ON THE PUMP VANES AND VANE SLOTS. LUBRICANT AND COLD WATER FORM AN EVENTUAL GUMMY RESIDUE THAT RENDERS THE PRIMING SYSTEM INOPERATIVE. A COMPLETE AND THOROUGH DISASSEMBLY AND CLEANING IS THEN REQUIRED.

## Performance Testing Overview

The yearly standard performance test consists of checking the pumper, (according to rating) at three capacities and comparing the results to when the pump was first placed in service. This provides some measure of performance deterioration, if any. (See Table 4-3: “Pump Ratings (GMP/LPM)” on page 59.)

A pump must be able to pump FULL rated capacity at 150 PSI (10 BAR), 70% capacity at 200 PSI (14 BAR) and 50% capacity at 250 PSI (17 BAR).

### Tank-to-Pump Flow Rate Test

**Note:** This procedure is provided as a reference only. It does not supersede any local procedures.

1. Fill the water tank until it overflows.

2. Close the tank fill line, bypass the cooling line, and all the pump intakes.

| Capacity | Pressure PSI (BAR) | Pump Rating in GPM (LPM) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 500 (1,893) | 750 (2,839) | 1,000 (3,785) | 1,250 (4,732) | 1,500 (5,678) | 1,750 (6,625) | 2,000 (7,571) | 2,250 (8,517) | 3,000 (11,356) |
| FULL | 150 (10) | 500 (1,893) | 750 (2,839) | 1,000 (3,785) | 1,250 (4,732) | 1,500 (5,678) | 1,750 (6,625) | 2,000 (7,571) | 2,250 (8,517) | 3,000 (11,356) |
| FULL | 165 (11) | 500 (1,893) | 750 (2,839) | 1,000 (3,785) | 1,250 (4,732) | 1,500 (5,678) | 1,750 (6,625) | 2,000 (7,571) | 2,250 (8,517) | 3,000 (11,356) |
| 70% | 200 (14) | 350 (1,325) | 525 (1,987) | 700 (2,650) | 875 (3,312) | 1,050 (3,975) | 1,225 (4,637) | 1,400 (5,300) | 1,575 (5,692) | 2,250 (8,517) |
| 50% | 250 (17) | 250 (946) | 375 (1,420) | 500 (1,893) | 625 (2,366) | 750 (2,839) | 875 (3,312) | 1,000 (3,785) | 1,125 (4,259) | 1,500 (5,678) |

**Table 4-3: Pump Ratings (GMP/LPM)**

3. Attach hose lines and nozzles to pump the desired discharge rate.

4. With the pump in gear, open the discharge and begin pumping water.

5. Increase the engine throttle until the maximum consistent pressure is obtained on the discharge gauge.

6. Close the discharge valve without changing the throttle setting. Refill the tank. The bypass valve may be opened during this time to prevent pump overheating.

7. Reopen the discharge valve and check the flow through the nozzle using a Pitot tube or flow meter. Adjust the engine throttle to bring the pressure to the amount previously determined.

8. Compare the flow rate measured to the NFPA minimum or the designated rate of the pump. If the flow rate is lower, a problem may exist in the tank-to-pump line. The minimum flow rate should be continuously discharged until 80% of the tank is discharged.

9. The pump should not experience mechanical problems, power loss, or overheat during the test.

## Performance Testing Equipment and Materials

To accurately test pumper performance requires a Pitot Gauge, a calibrated pump master pressure gauge, and a master vacuum gauge or manometer. ALL gauges must be carefully tested for accuracy. Gauge testing is appropriately accomplished with a certified dead weight gauge tester.

Pumpers should be tested from draft at not over a 10’ (3 meters) lift with 20’ (6 meters) of suction hose. Pumpers rated at 1,500 GPM and above often require two separate 20’ lengths of suction hose and a lower lift height.

Use smooth bore test nozzles of accurate size with the Pitot gauge. The volume pumped is then determined by reference to discharge tables for smooth nozzles. Preferably, nozzles will be used on a Siamese deluge gun for greatest accuracy. A stream straightener, just upstream of the nozzle is advisable.

REFER TO LOCAL PROCEDURES FOR PUMP TESTING PROCEDURES AND PRACTICES AS WELL AS APPLICABLE NFPA STANDARDS.

For Pitot Gauge accuracy, the nozzle pressures should be between 30 and 85 PSIG (2.1 and 6.0 BAR). Also see “Appendix E: Nozzle Size vs. Pressure” on page 123 at the back of this manual.

The amount of discharge hose required for the service tests is dependent on the flow requirements and capacity test point. Provide adequate hose to discharge the rated capacity with a flow velocity less that 35 ft./sec. Also see “Appendix D: Hose Friction Loss” on page 121.

Since NFPA standards specify both GPM and pressure, it is usually necessary to restrict the flow somewhat to build up the pump pressure. In normal pumping, this restriction would be caused by the friction loss in the lines. It is common practice to gate the discharge valves as required to maintain pressure.

**Notes:**

- For 750 GPM (2,839 LPM) test, two 2-1/2” (64 mm) lines should be laid from the pumper to the nozzle
- For 1,000 GPM (3,785 LPM) test, three lines are required
- For the 1,250 (4,731 LPM) and 1,500 GPM (5,677 LPM) tests, four or more lines are required between the pumper and the nozzle.
- For 1,750 (6,624 LPM) and 2,000 For testing a 2,250 GPM (8,516 LPM) pumper up to six hose lines into two separate nozzles should be used. Also see “Appendix E: Nozzle Size vs. Pressure” on page 123.

Because deluge guns are not always available, other hose layouts may be used, such as one, 2-1/2” (64 mm) line to a 1-3/8” (35 mm) nozzle for 500 GPM (1,892 LPM). Generally, the nozzle used on one, 2-1/2” line should not be larger than 1-1/2” (38 mm) for accuracy in measuring GPM (LPM).

Another alternative when a deluge gun is not available consists of a 1-1/4” (32 mm) nozzle on one and a 1-1/2” (38 mm) nozzle on the other to pass 1,000 GPM (3,785 LPM). The sum of the flow from both nozzles is the GPM (LPM) delivered by the pump. For good pitot gauge accuracy, the nozzle pressures should be between 30 and 85 PSIG (2.1 and 5.8 BAR).

## Performance Testing

Note that the NFPA standards require a 10% reserve in pressure at the capacity run when the apparatus is delivered. Also see NFPA 1901 standards for testing procedures.

1. Test the relief valve (per NFPA 1901 standards):

    - ❑ Set the relief valve flow rate capacity at 150 PSI (10 BAR).
    - ❑ SLOWLY close the discharge valves. The rise in pressure shall not exceed 30 PSI (2 BAR), or approximately 180 PSI (12 BAR) operating pressure.
    - ❑ SLOWLY open the discharge valves to re-establish the original pressure (150 PSI).

2. Perform Steps 2 and 3 of the post operation maintenance procedures. Also see Section 3.9 “Post Operation Procedures” on page 47.

3. Run the standard pump test in accordance with NFPA 1901 standards to check pump performance.

4. Run the engine for 20 to 30 minutes to stabilize the engine temperature. Then run the pump for:
    - ❑ Two (2) hours at FULL capacity and at 150 PSI (10 BAR)
    - ❑ Thirty (30) minutes at 70% capacity and at 200 PSI (14 BAR)
    - ❑ Thirty (30) minutes at 50% capacity and at 250 PSI (17 BAR)
    - ❑ Additionally, an engine overload test is required which consists of pumping at FULL capacity and at 165 PSI (11 BAR) for ten (10) minutes.

5. If the apparatus does not reach performance levels, proceed to Section 5 “Troubleshooting” on page 63.

6. Compare results of this test to those when the apparatus was first delivered. If the apparatus performance has dropped appreciably compared to its original performance, service is needed.

**Note:** Apparatus test results should be on file with the delivery documents. If not, they may be obtained from the apparatus manufacturer or from the original certifying authority.

## Worn Clearance Rings and Impeller Hubs

Before assuming that clearance ring wear is at fault, it is advisable to thoroughly check other possible causes of low performance.

Clearance rings limit the internal bypass of water from the discharge side of the pump back to suction. The radial clearance between the impeller hub and the clearance rings is only a few thousandths of an inch when new. In clear water, the clearance rings continue to effectively seal for many hours of operation.

In dirty or sandy water, the impeller hub and clearance rings wear faster. The more wear, the greater the bypass and lower pump performance.

It should not be necessary to replace clearance rings until a loss in pump performance is noticed during the annual test – see "Performance Testing" on page 61. For clearance ring and impeller service, see heading "Impeller" on page 81.

Often, replacement of the clearance rings reduces the bypass and restores the pump to near original performance. A complete restoration requires that the impeller also be replaced. See Section 6a "Servicing the Pump" on page 79 for maintenance and repair information if pump disassembly is required.

## Anode Check

Hale offers two types of anodes (consumables):

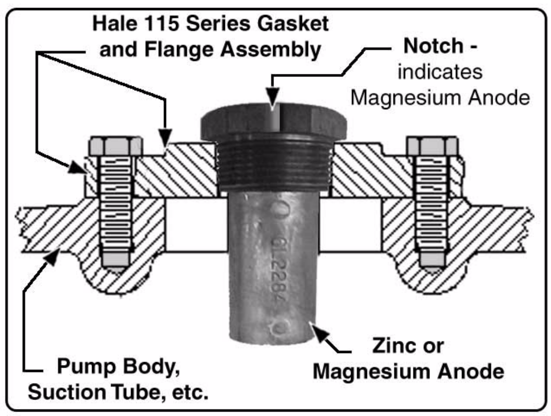



**Figure 4-4: Hale Anode**

- ❑ Zinc anode - recommended for all pumps where corrosion is an issue, including brackish or salt water exposure. Zinc anodes should be inspected every twelve (12) months.
- ❑ Magnesium anode - available if the pump already uses zinc anodes and galvanic corrosion is still a concern. Magnesium anodes, which are consumed at a faster rate, should be inspected ever three (3) or four (4) months. Magnesium anodes contain a notch in the hex head for identification.

Replace anodes when over 75% of the metal has been consumed. Performance of the anode life varies with water quality and pH. Anodes conform to MIL Spec. A180001.

# 5 Troubleshooting

Table 5-2 lists conditions, possible causes and suggested corrective action measures. Before calling Hale Products or your Hale authorized parts service center for assistance, eliminate problem causes using the following table.

If you cannot correct a problem, please have the following information prior to calling the Hale Customer Service for assistance. Contact Customer Service at telephone number **610-825-6300**.


**Figure 5-1: Sample, Serial Nameplate**

- ❑ Pump model and serial numbers - see Figure 5-1: “Sample, Serial Nameplate”
- ❑ Pump configuration information
- ❑ Observed symptoms and under what conditions the symptoms occur

**Note:** The serial number location varies depending on the pump model, but it is generally displayed on the pump operator's panel and/or the side of the gearbox.

| Condition | Possible Cause | Suggested Corrective Action |
|---|---|---|
| **PTO Will Not Engage.** | | • Consult the PTO manufacturer’s instructions. |
| **WARNING !**<br>**DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB AND PANEL ARE ILLUMINATED.** | | |
| **Pump Loses Prime or Will Not Prime.** | Electric priming system.<br><br>**Note:** Weekly priming is recommended to ensure proper operation. | • NO recommended engine speed is required to operate the electric primer. However, 1,000 engine RPM maintains the electrical system while providing enough speed for initial pumping operations.<br>• See Section 2a, heading “Priming Valves” on page 28. |
| *Chart continued on next page.* | Inoperative priming system or possible clogged priming pump. | **Note: Using lubricant on the vanes and vane slots during disassembly and cleaning eventually causes a gummy residue to develop, rendering the system inoperative.**<br><br>**DO NOT LUBRICATE VANES AND VANE SLOTS.** |

**Figure 5-2: Troubleshooting Chart**

| Condition | Possible Cause | Suggested Corrective Action |
|---|---|---|
| **Pump Loses Prime or Will Not Prime - continued.** | Inoperative priming system or possible clogged priming pump - continued. | • Check the priming system by performing a “Dry Vacuum Test” per NFPA standards. If the pump holds vacuum, but primer pulls less than 22” Hg., it could indicate excessive wear in the primmer.<br>• See Section 4 Preventive Maintenance, heading “Weekly” on page 50. Also see Section 4 Preventive Maintenance, heading “Annual” on page 56.<br>• See Section 2a, heading “Priming Valves” on page 28.<br>• Repair and/or replace accordingly.<br>**Note:** Using lubricant on the vanes and vane slots during disassembly and cleaning eventually causes a gummy residue to develop, rendering the system inoperative. |
| | Suction lifts too high. | • DO NOT attempt lifts exceeding 22’ (6.7 meters) except at low elevation. |
| | Blocked or restricted suction strainer. | • Remove obstruction from suction hose strainer.<br>• Thoroughly clean strainer screen. |
| | Suction connections. | • Clean and tighten all suction connections.<br>• Check suction hose and hose gaskets for possible defects - repair and/or replace. |
| | Air trapped in suction line. | • Avoid placing any part of the suction hose higher than the suction intake.<br>• Suction hose should be laid out with continuos decline to fluid supply.<br>• If trap in hose in unavoidable, repeated priming may be needed to eliminate air pockets in suction hose. |
| | Insufficient priming. | • Proper priming procedures should be followed.<br>• Do not release the primer control before assuring a complete prime.<br>• Open the discharge valve slowly during completion of prime to ensure complete prime. |
| | **NOTICE !**<br>**DO NOT RUN THE PRIMER OVER FORTY-FIVE (45) SECONDS. IF PRIME IS NOT ACHIEVED WITHIN 45 SECONDS, STOP AND LOOK FOR CAUSES (AIR LEAKS OR BLOCKED SUCTION HOSES).** | |
| *Chart continued on next page.* | Pump pressure too low when nozzle is opened. | • Prime pump again and maintain higher pump pressure while opening the discharge valve slowly. |

**Figure 5-2: Troubleshooting Chart**

| Condition | Possible Cause | Suggested Corrective Action |
|---|---|---|
| **Pump Loses Prime or Will Not Prime - continued.** | Air leaks. | • Attempt to located and correct air leaks using the following procedures:<br>  • Perform "Dry Vacuum Test" on pump per NFPA standards with 22" Hg. minimum vacuum required with loss not to exceed 10" Hg. in five (5) minutes.<br>  • If a minimum of 22" Hg. cannot be achieved, the priming device or system may be inoperative, or the leak is too big for the primer to overcome (such as an open valve). The loss of vacuum indicates leakage and could prevent priming or cause loss of prime.<br>  • After priming shut OFF the engine. Audible detection of a leak is often possible.<br>• Connect the suction hose from the hydrant or the discharge of another pumper to pressurize the pump with water and look for visible leakage and correct. A pressure of 100 PSI (6.9 BAR) should be sufficient. DO NOT exceed pressure limitations of pump, accessories or piping connections.<br>• The suction side relief valve can leak. Plug the valve outlet connection and retest |
| **Insufficient Pump Capacity.** | Insufficient engine power. | • Engine power check and tune up may be required for peak engine and pump performance.<br>• Also see Section "Rotation Symptoms." on page 69.<br>• Recheck pumping procedure for recommended transmission gear or range. Use mechanical speed counter on pump panel to check actual speed against possible clutch or transmission slippage or inaccurate tachometer.<br>• Check truck manual for proper speed counter ratio. |
| | Relief valve improperly set - if so equipped. | • If relief valve pressure is set too low it allows the valve to open and bypass water.<br>• Reset the relief valve pressure accordingly.<br>• Also see Section 4 Preventive Maintenance, heading "Relief Valve Test" on page 50. |
| | Suction hose diameter is too small for the volume being discharged. | • Use larger suction hose.<br>• Shorten total length by removing one length at a time.<br>• Reduce volume of discharge. |
| *Chart continued on next page.* | Restriction in suction line at strainer. | • Remove any debris restricting entrance of water at the strainer.<br>• Also see Section 4 Preventive Maintenance, heading "Intake Strainers" on page 52. |

**Figure 5-2: Troubleshooting Chart**

| Condition | Possible Cause | Suggested Corrective Action |
|---|---|---|
| **Insufficient Pump Capacity - continued.** | Air leaks. | • See heading “Air leaks.” under condition “ Pump Loses Prime or Will Not Prime” on page 65. |
| | Partial collapse of the lining in a suction hose. | • Damage to the outer lining may allow air between the outer and inner linings causing a partial collapse.<br>• Replace hose and retest. |
| | Engine governor set incorrectly. | • If the engine governor is set too LOW (pressure), when on automatic, engine speed decelerates before the desired pressure is achieved.<br>• Reset governor per manufacturer’s procedures. |
| | Truck transmission in wrong gear or clutch is slipping. | • Recheck the pumping procedures for the recommended transmission or gear range - review Section 3 “Basic Operation,” beginning on page 31.<br>• Use a mechanical speed counter on the pump panel to check speed against possible clutch or transmission slippage or inaccurate tachometer.<br>• Check truck manual for proper speed counter ratio. |
| **Insufficient Pressure.** | Insufficient engine power. | • See previous heading “Insufficient Pump Capacity.” on page 65. |
| **Remote Control Difficult to Operate.** | Lack of lubrication. | • Lubricate the remote control linkages and collar with oil. For lubricant recommendations, see “Appendix C1: Lube and Sealant Specifications” on page 119. |
| **Engine Speeds Too HIGH for Required Capacity or Pressure.** | Truck transmission in wrong gear or range. | • Recheck the pumping procedures for the recommended transmission or gear range - review Section 3 “Basic Operation,” beginning on page 31.<br>• Check truck manual for proper speed counter ratio. |
| | Lift too high, suction hose too small. | • Higher than normal lift (10 ft. / 3.1m) causes higher engine speeds, high vacuum and rough operation.<br>• Use larger suction hose.<br>• Move the pump closer to the water source. |
| | Faulty suction hose. | • Inner lining of suction hose may collapse when drafting and is usually undetectable.<br>• Try a different suction hose on the same pump.<br>• Test for comparison against original hose. |
| *Chart continued on next page.* | Blockage at suction hose entry. | • Clean suction hose strainer of obstruction. Also see Section 4 Preventive Maintenance, heading “Intake Strainers” on page 52.<br>• Follow recommended practices for laying suction hose.<br>• Keep off the bottom of the fluid supply by at least 2’ (0.6 meters) below the surface of the fluid. |

**Figure 5-2: Troubleshooting Chart**

| Condition | Possible Cause | Suggested Corrective Action |
|---|---|---|
| **Engine Speeds Too HIGH for Required Capacity or Pressure - continued.** | Pump is approaching "Cavitation." | • Gate the discharge valves to allow pressure to increase. This reduces the flow.<br>• Reduce the throttle opening to the original pressure setting.<br>• See "Appendix F: Cavitation" on page 125. |
| | Worn pump impeller(s) or clearance rings. | • Repair and/or replace as needed. See Section 6 "Repair" on page 71. |
| | Impeller blockage. | • A blocked impeller can prevent loss of both capacity and pressure.<br>• Back flushing the pump from discharge to suction may free the blockage.<br>• Removing half the pump body may be necessary - this is considered a major repair. |
| **Cavitation**<br><br>(Pump beginning to cavitate.)<br><br>**Note:** Also see "Appendix F: Cavitation" on page 125. | Discharging more water than the pump is taking in. | • Increase the flow into the pump with more and/or larger intake lines.<br>• Gate the discharge valves to reduce flow and maintain pressure. |
| | Air leak. | • Verify that the air bleeder on the suction tube is NOT open.<br>• Locate and eliminate all air leaks during maintenance. |
| | Drafting too high. | • Verify lift hose, hose friction, water temperature and other lift limiting factors are reduced or eliminated.<br>• Locate the pump closer to the water source. |
| | Water temperature too high. | • Reduce volume discharge by lowering the RPM or gating the discharge valves.<br>• Locate a source of cooler water. |
| | Suction hoes diameter is too small for the volume being discharged. | • Use a large suction hose.<br>• Shorten the total length by removing one length of hose.<br>• Reduce volume of discharge. |
| | Restriction in suction line at strainer. | • Remove any debris restricting entrance of water at the strainer.<br>• Also see Section 4 Preventive Maintenance, heading "Intake Strainers" on page 52. |
| **Relief Valve Does Not Relieve Pressure When Relief Valves are Closed.**<br><br>***Chart continued on next page.*** | Incorrect setting of control (PMD) Valve. | • Check and repeat proper procedures for setting relief valve system.<br>• See Section 3 Operation, heading 3.7 "Relief Valve Procedures" on page 44. |

**Figure 5-2: Troubleshooting Chart**

| Condition | Possible Cause | Suggested Corrective Action |
|---|---|---|
| **Relief Valve Does Not Relieve Pressure When Relief Valves are Closed - continued.** | Relief valve inoperative. | • Possibly in need of lubrication. Remove valve from pump, dismantle, clean and lubricate.<br>• Refer to relief valve manual and follow maintenance instructions for disassembly, cleaning and lubrication. |
| **Relief Valve Does Not Recover and Return to Original Pressure Setting After Opening Valves.** | Dirt in system causing sticky or slow reaction. | • Check and repeat proper procedures for setting the relief valve system.<br>• See Section 3 Operation, heading 3.7 “Relief Valve Procedures” on page 44. |
| | Relief valve inoperative. | • Blocked bleed orifice - clean the bleed orifice with a small wire or straightened paper clip.<br>• Refer to relief valve manual and follow maintenance instructions for disassembly, cleaning and lubrication. |
| **Relief Valve Opens When Control Valves are Locked Out.** | Drain hole in housing, piston or sensing valve is blocked. | • Clean the valve drain hole with a small wire or straightened paper clip.<br>• Refer to relief / sensing valve manual and follow maintenance instructions for disassembly, cleaning and lubrication. |
| **Unable to Obtain Proper Setting on Relief Valves.** | Using the wrong procedures. | • Check instructions for setting the relief valve and reset.<br>• See Section 3 Operation, heading 3.7 “Relief Valve Procedures” on page 44. |
| | Blocked strainer. | • Check and clean the strainer in the supply line from the pump discharge to the control valve. Check truck manual for location.<br>• Also see Section 4 Preventive Maintenance, heading “Intake Strainers” on page 52.<br>• Check and clean tubing lines related to the relief and control valves. |
| | Dirty control valve. | • Remove the control valve and clean. |
| | “Hunting” condition. | • Insufficient water supply from the pump to the control valve.<br>• Check the strainer and relief valve system for flow restrictions.<br>• Remove and clean the control valve. |
| **Discharge Valves Are Difficult to Operate.**<br><br>***Chart continued on next page.*** | Lack of lubrication. | • Recommended weekly lubrication of discharge and suction valve.<br>• Use a good grade, petroleum based, silicone grease.<br>  • For Hale Products, SVS Valves, etc., use Never-Seez® White Food Grade with PTFE.<br>  • Also see Section “Appendix C1: Lube and Sealant Specifications” on page 119.<br>• Refer to separate valve manual for additional information. |

**Figure 5-2: Troubleshooting Chart**

| Condition | Possible Cause | Suggested Corrective Action |
|---|---|---|
| **Discharge Valves Are Difficult to Operate - continued.** | Valve in need of more clearance for operation. | • Multi-gasket design allows additional gaskets for more clearance and free operation.<br>• **Note:** Adding too many gaskets to the valve eventually causes leakage. |
| **Water/Moisture in Pump Gearbox.** | Leak coming from above the pump. | • Check all piping connections and tank overflow for possible spillage falling directly onto the pump gearbox.<br>• Repair accordingly. |
| | Operating or a driving condition that submerges the gearbox in water. | • Visually inspect the unit for external signs of water leakage.<br>• Was the unit submerged in water? Does your unit include an air vent / breather where water can enter if submerged? If so, change oil. Also see Section 4 Preventive Maintenance, heading “Replace Gearbox Oil” on page 56. |
| | Normal condensation. | • Depending on area / region where unit is operated, normal condensation can develop over time.<br>• Periodic inspection and possibly more frequent oil changes are needed. |
| | Leaking oil seal or mechanical seal. | • Inspect the oil seals and replace as needed. If the oil seal checks OK, the mechanical seal may be leaking.<br>• There must be NO leaks at the mechanical seal. See Section 6b “Mechanical Seal Assembly” on page 85.<br>• Hydrostatic test the system to determine leakage. |
| **Rotation Symptoms.**<br><br>(Reduced pressure 60-100 PSI [4.1-6.9 BAR] and reduced flow.) | Wrong impeller installed. | • Verify the new impeller vanes are oriented the same as the old impeller before installing. (See Figure 2-6: “Pump / Engine Rotation,” on page 21.)<br>• Refer to relief / sensing valve manual and follow maintenance instructions for disassembly, cleaning and lubrication. |
| | Wrong application attempted. | • The pump was installed on an application for which it was not intended, i.e., front mount vs. rear mount. |
| | **NOTICE !**<br>**IT IS POSSIBLE TO REASSEMBLE THE PUMP INCORRECTLY OR WITH THE WRONG PARTS. ALWAYS COMPARE THE REPLACEMENT PARTS WITH THE ORIGINAL HARDWARE. CONTACT CUSTOMER SERVICE AT HALE PRODUCTS TO ANSWER QUESTIONS OR CONCERNS.** | |

**Figure 5-2: Troubleshooting Chart**

# Notes

# 6 Repair

## 6.1 OVERVIEW

This section describes the removal, inspection, and reinstallation (as required for maintenance and repair) of the Hale pump and gearbox components. Follow the disassembly instructions in the order in which they appear in this section. At any point in the disassembly process, the unit can be reassembled by following the instructions in the reverse.

Service should be performed by a trained and qualified service technician, or your authorized Hale Products service representative. Be sure you have sufficient knowledge, experience and the proper tools.

*Wherever there is a requirement for new parts, it is recommended to use only Hale authorized replacement parts for optimum safety of the equipment and its operators and to limit "downtime."*

## 6.2 GENERAL REPAIR GUIDELINES

### Before You Begin...

For a parts breakdown and identification, see Section 8, heading "Drawing Package" on page 131.

**READ ALL INSTRUCTIONS THOROUGHLY BEFORE BEGINNING ANY SERVICE REPAIR.**

1. Place apparatus out of service in accordance with your departmental procedures.

2. Park the vehicle on a level surface. Set the parking brake and chock the front and rear wheels.

3. Match mark, tag and/or note, or photograph the orientation of all mechanical and electrical components and connections to the pump and/or gearbox before disassembly. This aids in proper reassembly.

4. Determine best method for servicing, i.e., servicing while in the apparatus or removal from the top or bottom of the apparatus.

**WARNINGS !**

**BEFORE WORKING ON THE PUMP, DISCONNECT SUCTION AND DISCHARGE PIPING AND DRAIN THE PUMP BODIES.**

**THE PUMP AND GEARBOX ASSEMBLY CAN BE HEAVY AND BULKY. ADDING ACCESSORIES ALSO INCREASES THE WEIGHT. CHECK YOUR BILL OF LADING FOR THE APPROXIMATE WEIGHT. BE CERTAIN TO USE PROPER LIFTING SUPPORT DEVICES (I.E., OVERHEAD CRANE, JACK, CHAINS, STRAPS, ETC.) CAPABLE OF HANDLING THE LOAD WHEN REMOVING OR INSTALLING THE PUMP AND GEARBOX ASSEMBLIY. EXERCISE CARE WHEN USING CHAINS TO PROTECT THE FINISHED SURFACES FROM SCRATCHES.**

**BE SURE TO WEAR SAFETY GLASSES WHEN REMOVING AND/OR INSTALLING FORCE (PRESS) FITTED PARTS. FAILURE TO COMPLY MAY RESULT IN SERIOUS EYE INJURY.**

**ALL FASTENERS ON THE PUMP AND GEARBOX ASSEMBLY HAVE BEEN SELECTED FOR THEIR APPLICATION. HALE PRODUCTS DOES NOT RECOMMEND REPLACING FASTENERS WITH ANYTHING OTHER THAN HALE PART NUMBERS PROVIDED. REPLACING WITH A WEAKER ALTERNATIVE POSES A SERIOUS SAFETY RISK.**

**ALL FASTENERS MUST BE INSTALLED WITH A LOCKING ANAEROBIC ADHESIVE/SEALANT, SUCH AS LOCTITE® #246 FOR GEARBOX AND #242 FOR PUMP.**

5. Remove necessary body panels and framework to gain access to the pump compartment. Make sure there is sufficient clearance above the apparatus to lift the pump and gearbox assembly out of the apparatus.

6. Remove valve operators, discharge and suction piping and valves that would interfere with pump removal.

   Have clean disposable shop rags and oil dry handy.

7. Disconnect cooling tubes from the water manifold and pump, air lines, electrical switches and tachometer cable as required.

8. When required, use a Lithium-based grease with 1% to 3% Molybdenum Disulfate. For a listing, see “Appendix C1: Lube and Sealant Specifications” on page 119.

9. When replacing fasteners, use the proper nuts, bolts, and other hardware. Many are specifically rated; that is, SAE Grade 5 or higher. Unless otherwise specified, fasteners are Grade 5 SAE. Also ensure screws/bolts are properly torqued. (See Table 6-1: “Typical Torque Values Chart,” on page 73.)

| Bolt Size Lock Nut size | Material | Minimum Torque Ft.-Lb. (N-m) |
|---|---|---|
| 5/16”18 | Zinc-plated steel | 17 (23) |
| 5/16”18 | Zinc-plated steel, with 360° nylon lock | 19 (26) |
| 5/16”18 | Silicon bronze | 10.3 (14) |
| 3/8”16 | Zinc-plated steel | 30 (41) |
| 3/8”16 | Zinc-plated steel, with 360° nylon local | 33 (45) |
| 3/8”16 | Silicon bronze | 18 (24) |
| 7/16”14 | Zinc-plated steel | 50 (68) |
| 7/16”14 | Zinc-plated steel, with 360° nylon local | 53 (72) |
| 7/16”14 | Silicon bronze | 29 (39) |
| 5/8”-11 | Zinc-plated steel | 150 (203) |
| 5/8”-11 | Silicon bronze | 85 (115) |
| 3/4”-10 | Zinc-plated steel, Grade 5 | 260 (353) |
| 3/4”-10 | Zinc-plated steel, Grade 8 | 380 (515) |

**Table 6-1: Typical Torque Values Chart**

**Gearbox** - Apply Loctite #246 High Temperature Removable Threadlock (or equivalent) to all bolts on the gearbox.

**Hale Series Pump** - Apply Loctite #242 Medium Strength Threadlock (or equivalent) to all bolts on the Pump.

10. Before installing the mechanical seal, use alcohol swabs provided by Hale Products Inc. to clean all grease or oil from the pump shaft and mechanical seal running faces.

    Apply a generous coating of Pac-Ease Rubber Lubricant Emulsion (or equivalent) on the rubber seal parts to ease installation.

**WARNING !**

**DO NOT TOUCH THE CARBON SEAL WHILE INSTALLING THE MECHANICAL SEAL. USE OF ANY OTHER LUBRICANT CAN DAMAGE THE MECHANICAL SEAL AND SEAT.**

11. Use a pusher or bearing installation tool when installing bearings and seals to avoid cocking them or marking the their faces. Also review heading “Bearings” on page 74.

12. Before placing apparatus into operation, the pump assembly must be tested and checked for leaks. All leaks must be repaired immediately.

### Gearbox Assembly

1. Drain oil from the gearbox - remove the magnetic pipe plug. Also see Section 4 Preventive Maintenance, heading "Replace Gearbox Oil" on page 56.

2. Have clean disposable shop rags and oil dry handy and a suitable container to collect the fluid. For gearbox capacity, see "Appendix C1: Lube and Sealant Specifications" on page 119.

3. Disconnect drive shafts, air lines, electrical wiring / switches, tachometer cable and cooling lines, as necessary, from the gearbox.

## 6.3 CLEANING AND INSPECTION GUIDELINES

1. Inspect all components (such as, bearings, seals, gears, etc.) for excessive or abnormal wear, i.e., pitting, scroing / scratches, cracks, splits, etc.

**IMPORTANT !**

WHEN REASSEMBLING, ALL COMPONENTS MUST BE CLEAN AND FREE OF DEFECTS.

2. It is recommended to replace O-ring seals and gaskets whenever they are removed to avoid unnecessary downtime later.

3. Clean all gasket material from mating surfaces before installing a new gasket. Be careful not to score the finished surfaces.

4. Lightly oil or grease the shaft, O-ring seals and lip seals before reinstalling, especially when pressed-in.

5. For Hale recommended cleaners, see "Appendix C1: Lube and Sealant Specifications" on page 119.

6. Replace any hardware that shows signs of excessive wear.

### Bearings

Bearings must always be replaced in matching sets by manufacturer.

**IMPORTANT !**

WHEN REPLACING TAPPERED BEARINGS, IT IS IMPORTANT THAT YOU DO NOT INTERCHANGE BEARING MANUFACTURER'S COMPONENTS. THE BEARING RACE AND CONE MUST ALWAYS BE REPLACED IN MATCHING SETS, AS SUPPLIED BY THE MANUFACTURER.

- Bearings and other components should be cleaned using only recommended solvents.

## Tools Required

- Lifting gear-lever hoist or chain hoist, and short choker
- Ball peen hammer
- Center punch
- Drift punch
- Allen wrenches
- Strap wrench
- Snap ring pliers
- Pry bars (2)
- Ratchets and wrenches for disassembly
- Torque wrench capable of 40, 65, and 135 ft.-lbs. (54, 88, and 183 N-m)
- Pan (to collect drip oil)
- Disposable rags
- Oil dry
- Wedges
- Bearing puller
- Pusher tube (a small section of PVC tubing to fit over the shaft)
- N-06 or N-07 bearing nut socket or spanner wrench, available from:

  **Whittet-Higgins** at ***www.whittet-higgins.com*** or,
  35 Higginson Avenue
  P O Box 8
  Central Falls, RI 02863
  Phone.................(401) 728-0700

# Notes

# 6.4 REMOVING PUMP AND GEARBOX ASSEMBLY

## Removing Pump and Gearbox Assembly

Review **WARNING !** note on papge 72 before beginning any service operation.

1. First, review preceding Section “Before You Begin...” on page 71.
2. With the pump assembly properly supported and balanced, disconnect the mounting brackets (5/8”-11 screws) that secure the assembly to the apparatus chassis frame.

   See Section 8, heading “Drawing Package” on page 131 and review the appropriate Installation Drawing.
3. Carefully remove the assembly from the apparatus and place the pump assembly on a clean work area. Clamp into a suitable and stable holding device being careful not to damage any sealing surfaces.

## Installing the Assembly

Install the pump and gearbox assembly to the apparatus before filling with oil.

1. First, review preceding Section “Before You Begin...” on page 71.
2. Attach proper supporting devices and stabilize the assembly for transport to the apparatus. Also see **WARNING !** note found on page 72.
3. Place the pump assembly into position within the apparatus.
4. Apply Loctite and secure the pump assembly to the chassis frame (5/8”-11 screws). Torque the fasteners to proper values in accordance with manufacturer’s recommendations. Also see Table 6-1: “Typical Torque Values Chart” on page 73.
5. Remove the lifting device.
6. Connect the drive shaft to the gearbox. Apply a coating of Loctite to the fasteners and torque to the PTO manufacturer’s specifications.
7. Connect all components to the gearbox.

8. Fill the gearbox to the proper oil level. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 56.

9. Reassemble and connect all components removed to gain access to the pump assembly, paying particular attention to your sketch (photographs) and identification match markings/tags (e.g., valves, suction piping, discharge piping, valve operators, etc.)

10. Reinstall apparatus frame work and body panels previously removed.

11. Test the pump per your departmental requirements.

12. Recheck and top-off oil levels, then return the apparatus to operation.

# 6a Servicing the Pump

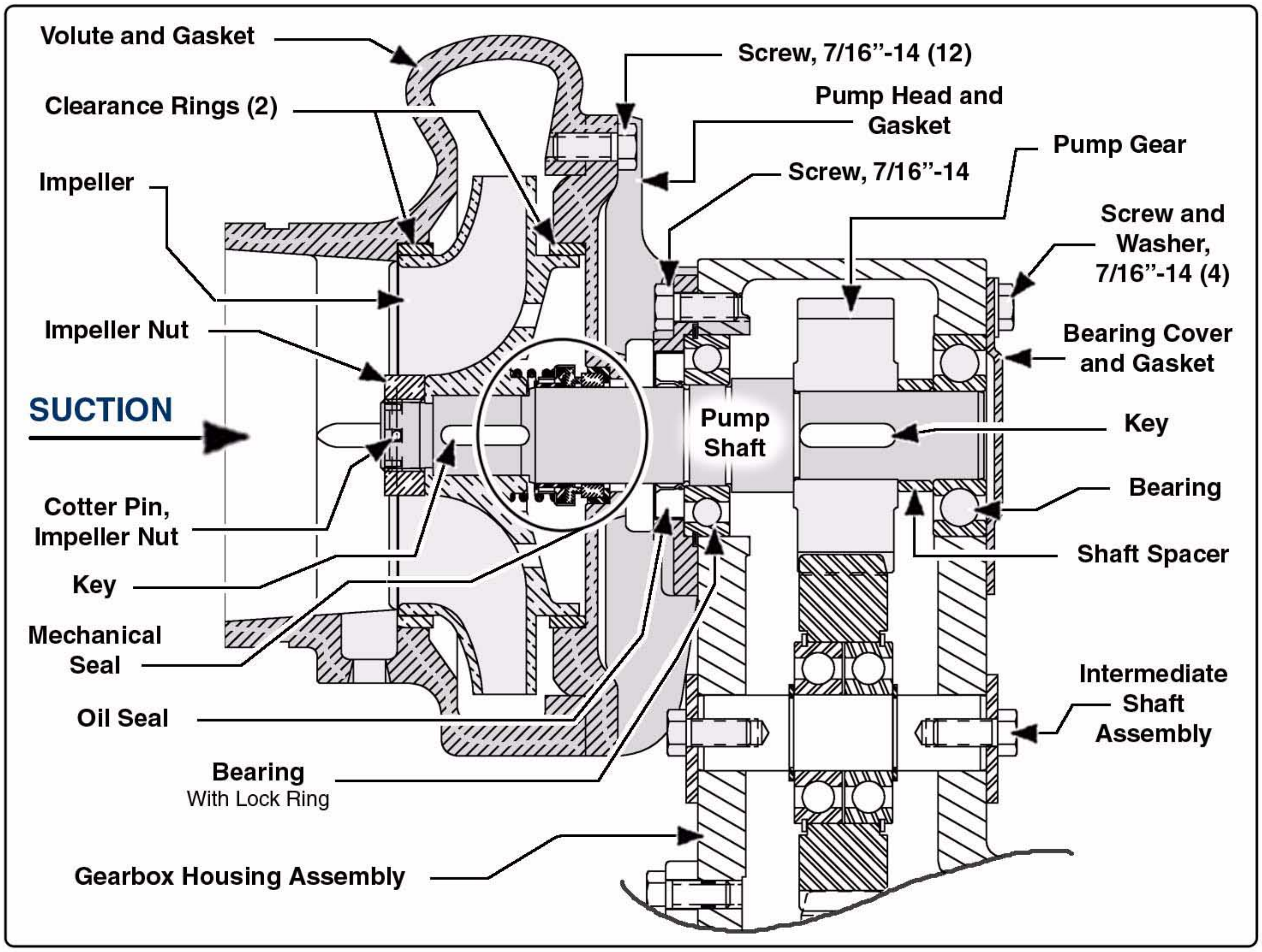



**Figure 6a-1: Typical MG Series Pump Overview**

## 6A.1 GENERAL

If room permits, the pump mechanical seal and pump shaft oil seal could be serviced within the apparatus. An "S" curved box wrench is required.

1. First, review preceding Section "Before You Begin..." on page 71.
2. To service the mechanical seal, see the following:
   - ❑ Heading 6a.2 "Volute" on page 80
   - ❑ Heading 6b "Mechanical Seal Assembly" on page 85

3. To service the pump shaft oil seal, see the following:

   ❑ Heading "Oil Seal, Pump Shaft" on page 82

# 6A.2 VOLUTE

(See Figure 6a-1: "Typical MG Series Pump Overview," on page 79.)

1. Disconnect water line compression fittings and the gearbox water cooling lines from the volute.

2. Match mark the volute and pump housing to ensure proper re-alignment during reassembly. Remove the twelve (12) 7/16"-14 screws. Support the weight of the volute as it is heavy and bulky.

**IMPORTANT !**

DO NOT DAMAGE THE BRASS CLEARANCE RINGS OR IMPELLER AS YOU SEPARATE THE VOLUTE (PUMP BODY) FROM THE PUMP HOUSING. THE IMPELLER, CLEARANCE RINGS AND MECHANICAL SEAL ASSEMBLY NEED NOT BE REMOVED.

3. Inspect the rear clearance ring, located in the volute, for wear and replace accordingly. See heading "Clearance Ring Measurement" on page 84.

4. To remove the clearance ring, use a hammer and chisel to collapse the ring in the housing. Do not mar the sealing surfaces of the housing.

**Note:** Removing the clearance ring renders it inoperative. It must be replaced. If one ring requires replacement the other should be replaced as well. Also verify the impeller clearance. (See Figure 6a-3: "Clearance Ring and Impeller ID / OD Measurement," on page 84.)

**Installation Notes – Volute**

Follow the preceding steps in the reverse order, paying attention to the following:

- ❑ Review preceding sections "Before You Begin...," on page 71 and "Cleaning and Inspection Guidelines," on page 74.
- ❑ If the clearance ring is removed, use a press to install it into the volute.
- ❑ When installing the volute, DO NOT damage the clearance ring or impeller.

- ❑ Reconnect all cooling lines, piping and tubing.
- ❑ Inspect system for proper operation, then return apparatus to service.

## 6A.3 IMPELLER

(See Figure 6a-1: “Typical MG Series Pump Overview,” on page 79.)

1. Remove the valute.
2. Remove the cotter pin from the impeller nut.
3. While holding the impeller with a strap wrench, remove the impeller nut.
4. Use wedges (3) or a bearing puller to remove the impeller from the pump shaft. Place the wedges or puller at the impeller vane area where the metal is the heaviest.

**Note:** Tap the pump shaft end, using a dead blow hammer, to free the impeller from the pump shaft. Use care to avoid damage to the shaft threads.

**CAUTION !**

**DO NOT STRIKE THE IMPELLER. IRREPARABLE DAMAGE COULD RESULT. MAKE CERTAIN THE WEDGES OR PULLER IS PLACED AT THE IMPELLER VANES TO AVOID IRREPARABLE DAMAGE.**

5. Remove the impeller and shaft key from the pump shaft.
6. Inspect the rear clearance ring for wear and replace accordingly. See heading “Clearance Ring Measurement” on page 84.

**Note:** Removing the rear clearance ring from the pump housing renders the ring inoperative. It must be replaced.

7. Removing the impeller may disturb the mechanical seal. A new seal may be required - see Section 6b “Mechanical Seal Assembly” on page 85.

**Installation Notes – Impeller**

Follow the preceding steps in the reverse order, paying attention to the following:

- ❑ Review preceding sections “Before You Begin...” on pape 71 and “Cleaning and Inspection Guidelines” on pape 74.

- ❑ Torque the impeller nut to 110 ft.-lbs. (149 N-m).
- ❑ Continue tightening the impeller nut until the cotter pin can be installed to lock the nut in place.
- ❑ Inspect the system for proper operation before returning the apparatus to service.

## OIL SEAL, PUMP SHAFT

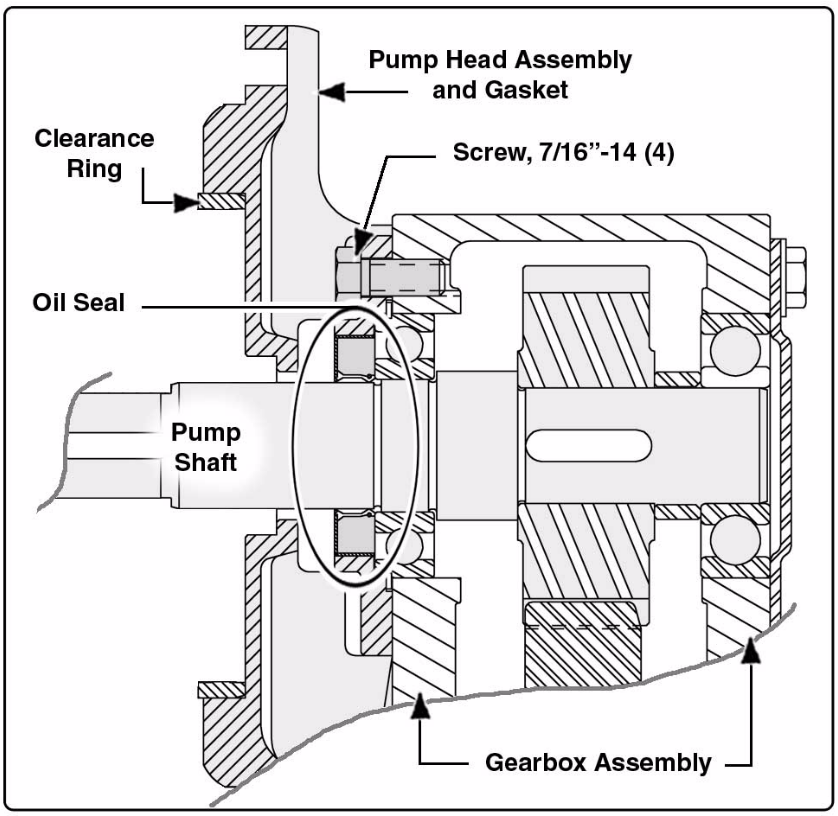



**Figure 6a-2: Pump Shaft Oil Seal Replacement**

Review heading "Before You Begin..." on page 71. Also review heading "Cleaning and Inspection Guidelines" on page 74.

1. Remove the volute, impeller and the mechanical seal:
   - ❑ Heading 6a.2 "Volute" on page 80
   - ❑ Heading 6a.3 "Impeller" on page 81
   - ❑ Heading 6b "Mechanical Seal Assembly" on page 85

2. Remove the four (4) 7/16”-14 screws securing the pump head to the gearbox. (See Figure 6a-2: “Pump Shaft Oil Seal Replacement,” on page 82.)

3. Use a soft faced (dead blow) hammer and tap around the pump head to loosen it. Slide the pump head assembly back EVENLY to remove it from the gearbox. Be careful not to damage or scratch the pump shaft.

4. Move the pump head to a clean work area and clamp into a suitable and stable holding device.

5. Remove the oil seal and discard. To replace, order Hale p/n: 296-2610-00-0.

6. Inspect the pump shaft, clearance ring and gearbox front bearing for excessive wear, chips, scoring or other damage. Repair and/or replace accordingly.

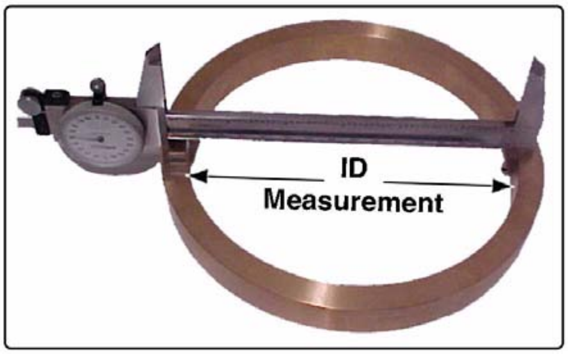
### Installation – Oil Seal

- ❑ Review heading “Before You Begin...” on page 71. Also review heading “Cleaning and Inspection Guidelines” on page 74.
- ❑ Lightly lubricate the pump shaft and insert (or press) a new oil seal into the bore of the pump head.

  Make sure to install the oil seal with the spring side of the seal facing into the gearbox. (See Figure 6a-2: “Pump Shaft Oil Seal Replacement,” on page 82.)
- ❑ Install the pump head being careful not to damage the oil seal.
- ❑ Insert the four (4) 7/16”14 screws. Tighten in a criss-cross fashion to ensure an EVEN seal and torque accordingly. (See Table 6-1: “Typical Torque Values Chart,” on page 73.) For Loctite specifications, see “Appendix C1: Lube and Sealant Specifications” on page 119.
- ❑ Re-install the:
  - Mechanical Seal - see heading “Installing Seal” on page 86
  - Impeller - see heading “Installation Notes – Impeller,” on page 81.
  - Volute - see heading “Installation Notes – Volute” on page 80.
- ❑ Reconnect drive shafts, electrical, and airlines to gearbox.
- ❑ Inspect the system for proper operation before returning the apparatus to service.

# 6A.4 CLEARANCE RING MEASUREMENT

With the clearance installed, inspect the front and back of both ring IDs and ODs in several places for signs of wear. Using a caliper, measure the diameters of each ring in several places. (See Figure 6a-3: “Clearance Ring and Impeller ID / OD Measurement.”)



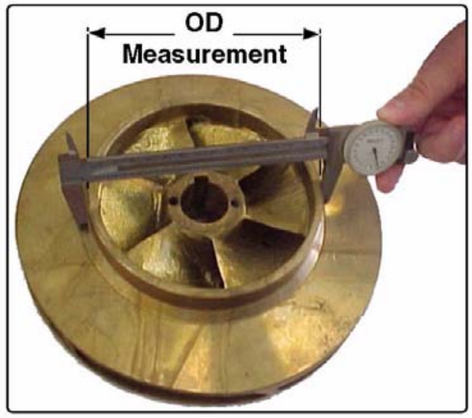




**Figure 6a-3: Clearance Ring and Impeller ID / OD Measurement**

The radial clearance between a new impeller hub and clearance rings is between 0.005” to 0.007” (0.127-0.78 mm) per side. Maximum acceptable radial clearance on used pumps is between 0.015” to 0.020” (0.381-0.508 mm) per side.

**500 - 1,000 GPM Pump**

If the gap is greater than 0.020” (0.508 mm) you must measure the impeller hub diameter. If the impeller hub diameter is greater than 5.58” (142 mm), you may be able to restore performance by installing new clearance rings. If the impeller hub diameter is less than 5.58” (142 mm), replacing just the clearance rings may not restore performance, in which case, both the impeller and clearance should be replaced.

Also, the impeller hub diameter can be cut (turned down) and “undersized” clearance rings can be ordered to compensate for the new impeller diameter. Contact Customer Service, Hale Products at **610-825-6300**.

**CAUTION !**

**WHEN TURNING IMPELLERS TO FIT UNDERSIZED RINGS, CAUTION MUST BE EXERCISED TO ENSURE THAT THE SEAL RING SURFACE RUNS TRUE WITH THE BORE TO WITHIN 0.002” (0.051 MM).**

# 6b Mechanical Seal Assembly

**IMPORTANT !**

IF WATER LEAKAGE FROM THE DRAIN HOLE IN THE VOLUTE IS NOTICED, THE IMPELLER MUST BE REMOVED AND THE MECHANICAL SEAL MUST BE INSPECTED. (SEE FIGURE 6B-1: “TYPICAL MECHANICAL SEAL.”)

## Removing the Seal

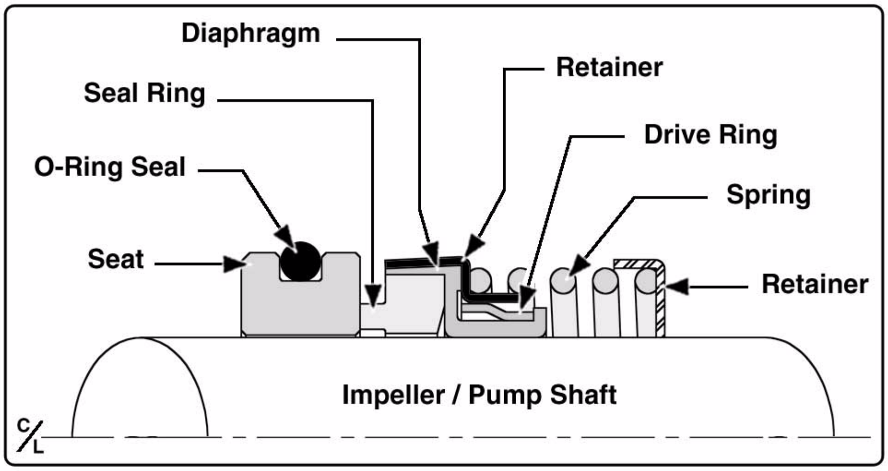



**Figure 6b-1: Typical Mechanical Seal**

4. To expose the mechanical seal, remove the:

   ❑ Suction head, if included

   ❑ Impeller - see heading “Impeller” on page 81.

**CAUTION !**

**MECHANICAL SEALS ARE PRECISION ENGINEERED DEVICE. EXTREME CARE MUST BE TAKEN TO ENSURE THAT NO DAMAGE OCCURS TO THE MATING FACES.**

**ENSURE THAT THE FACES ARE ABSOLUTELY CLEAN THROUGHOUT THE ENTIRE INSTALLATION. SOLID FACES MUST BE CLEANED WITH AN APPROPRIATE DEGREASER AND A SOFT CLOTH.**

5. From within the volute and/or pump head, and using a hook-type tool, reach in and remove the:

   - ❑ Mechanical seal spring
   - ❑ Seal diaphragm and retainer
   - ❑ Seal, stationary seat
     (See Figure 6b-1: “Typical Mechanical Seal” on page 85.)

   If the mechanical seal is removed, it must be replaced.

6. Carefully inspect clearance rings and other parts for excessive wear or damage. Replace accordingly.

   *It is recommended to always use Hale genuine replacement parts for optimum safety of the equipment and its operators and to avoid unnecessary downtime.*

## Installing Seal

(See Figure 6b-1: “Typical Mechanical Seal” on page 85.)

1. See **CAUTION !** warning beginning on pape 85.

2. Clean the bore of the pump head using alcohol swabs. Solid running faces must be cleaned with alcohol wipes, supplied with the Hale repair kit.

**WARNING !**

**OIL AND GREASE WILL DAMAGE THE MECHANICAL SEAL FACE. DO NOT TOUCH THE FACE OF THE MECHANICAL SEAL.**

**USE ONLY PAC-EASE RUBBER LUBRICANT EMULSION (OR EQUIVALENT) ON THE RUBBER MECHANICAL SEAL PARTS. USING ANY OTHER LUBRICANT CAN DAMAGE THE SEAL AND SEAT.**

**ENSURE THAT THE PUMP BODY AND IMPELLER BORES AND ALL MATING SURFACES OF THE MECHANICAL SEAL ASSEMBLY ARE ABSOLUTELY CLEAN THROUGHOUT THE ENTIRE INSTALLATION PROCESS.**

3. Apply a generous coating of Pac-Ease Rubber Lubricant Emulsion to the O-ring on the seal head assembly and the pump shaft and seal areas.

4. Without touching the carbon seal, slide the stationary seat into the pump head.

5. Push the stationary seat into the pump head bore using a soft, clean pusher tube. Verify the seat is firmly seated in the pump head.

6. Clean the pump shaft with alcohol swabs.

7. Apply a generous coating of Pac-Ease Lubricant to the seal diaphragm.

8. Without touching the face of the seal ring, slide the ring, diaphragm, and retainer onto the shaft with the pusher tube. (See Figure 6b-1: “Typical Mechanical Seal” on page 85.)

9. Verify the seal ring seats against the stationary seat. If binding occurs, apply additional Pac-Ease lubricant.

10. Slide the seal spring onto the shaft. The spring must seat on the seal retainer.

11. Install the impeller shaft key and impeller. Also see **CAUTION !** beginning on pape 85.

- ❑ Torque the impeller nut to 210 ft.-lbs. (285 N-m).
- ❑ Continue tightening the impeller nut until the cotter pin can be installed to lock the nut in place.
- ❑ Install cotter pin and bend over the ends.

# Notes

# 6c MG Series Gearbox

## 6C.1 SYSTEM OVERVIEW

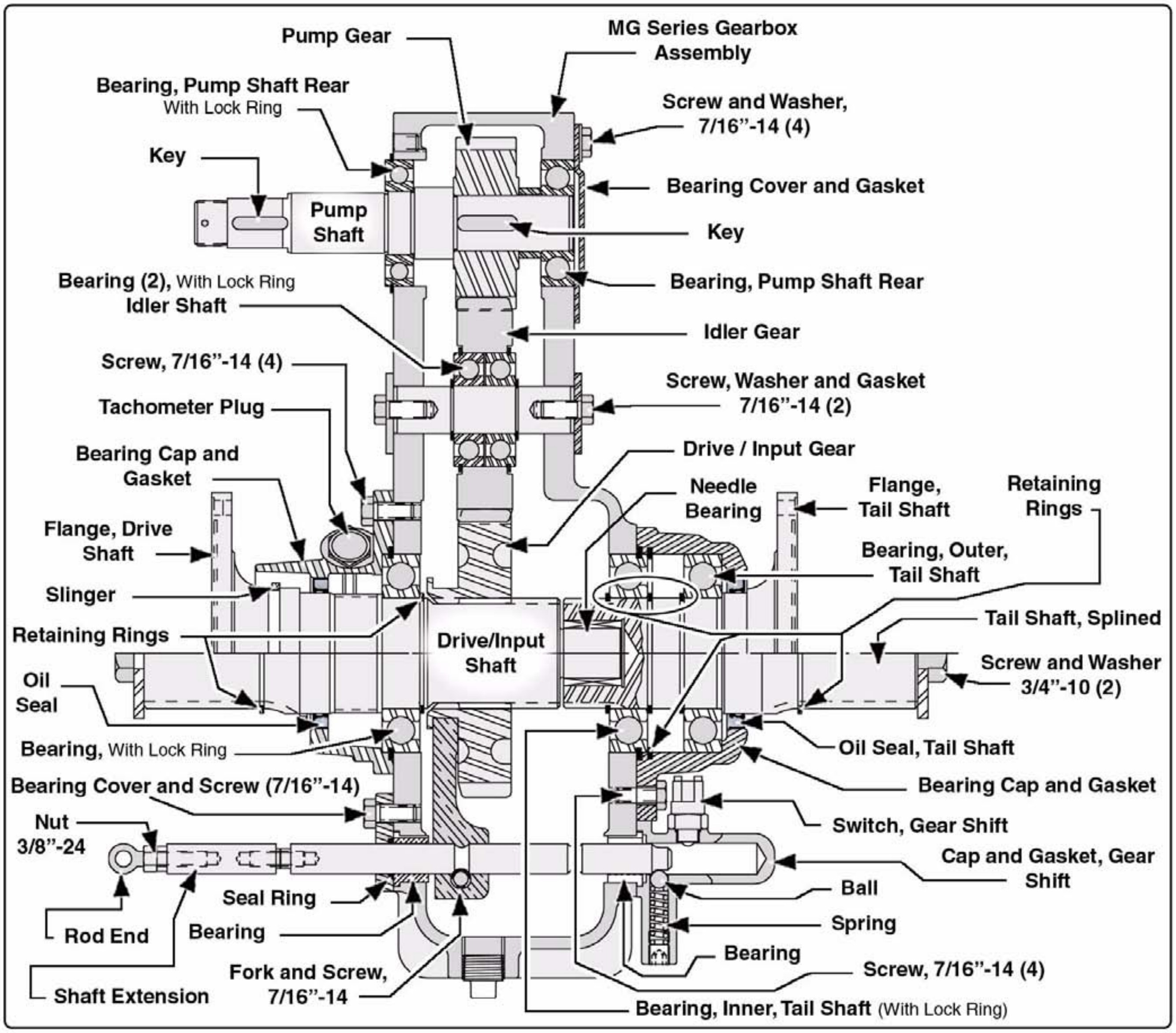



Figure 6c-1: MG Gearbox Assembly Overview

Review **WARNING !** note on page 72.

# 6C.2 OIL SEALS, DRIVE AND TAIL SHAFTS

**Splined Shafts** - Oil seals are replaced by removing the yoke and can be accomplished with the gearbox installed in the apparatus - see Section 6c.4 “Gearbox Disassembly” on page 91.

**Flanged Shafts** - Oil seals are replaced by removing the gearbox from the apparatus then disassembling the shaft assembly - see Section 6c.4 “Gearbox Disassembly” on page 91.

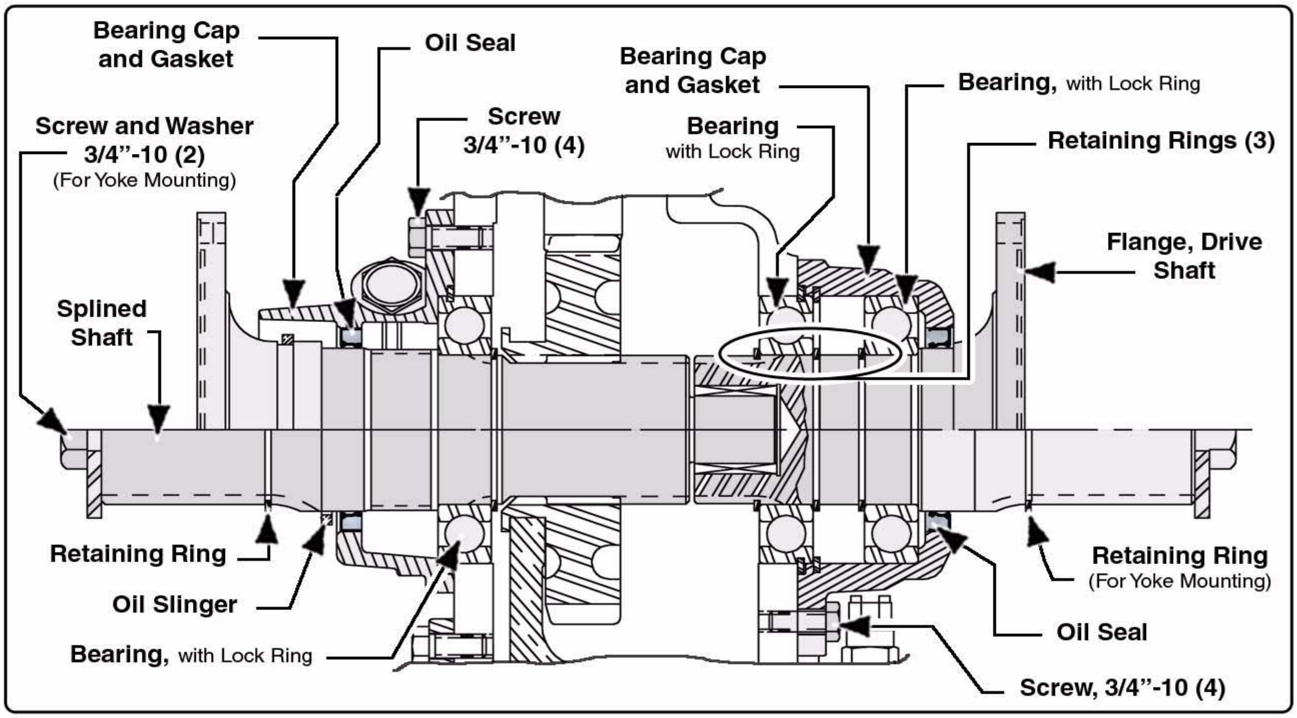



**Figure 6c-2: Oil Seal Replacement**

## Oil Seal - Splined Shaft

1. First, review preceding Section “Before You Begin...” on page 71. Also review heading “Cleaning and Inspection Guidelines” on page 74.
2. Set the gear shift to the PUMP.
3. Remove the 3/4”-10 screw and washer, then remove the yoke. (See Figure 6c-2: “Oil Seal Replacement.”)
4. Replace the oil seal. Clean and lightly lubricate the shaft. Insert a new oil seal “flush” into the bearing cap.

5. Install the yoke. Secure with the 3/4”-10 screw and washer. Torque screw to 260 ft.-lb. (352 N-m). DO NOT overtighten. The yoke must spin freely.

### Oil Seal - Flanged Shaft

See heading “Gearbox Disassembly” on page 91.

## 6C.3 OIL SEAL, PUMP SHAFT

See Section 6a: Servicing the Pump, heading “Oil Seal, Pump Shaft” on page 82.

## 6C.4 GEARBOX DISASSEMBLY

The pump and gearbox assembly must be removed from the apparatus for internal servicing and must be disassembled in the order stated in this Section. See Section 6.4 “Removing Pump and Gearbox Assembly” on page 77. Also see 6a “Servicing the Pump” on page 79 for pump disassembly.

### Gearbox Cover

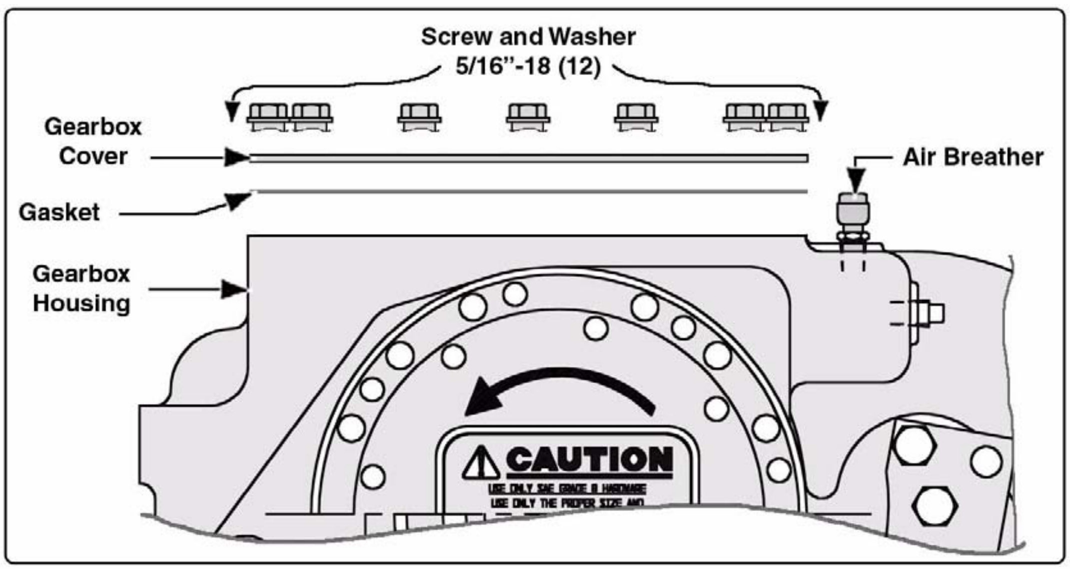



**Figure 6c-3: Remove the Gearbox Cover**

1. Remove the twelve (12) 5/16”-18 screws, washers and gasket. (See Figure 6c-3: “Remove the Gearbox Cover.”)

2. When installing, tighten screws in a criss-cross pattern to ensure an even seal and torque accordingly. (See Table 6-1: "Typical Torque Values Chart" on page 73.)

### Gearbox Cooler

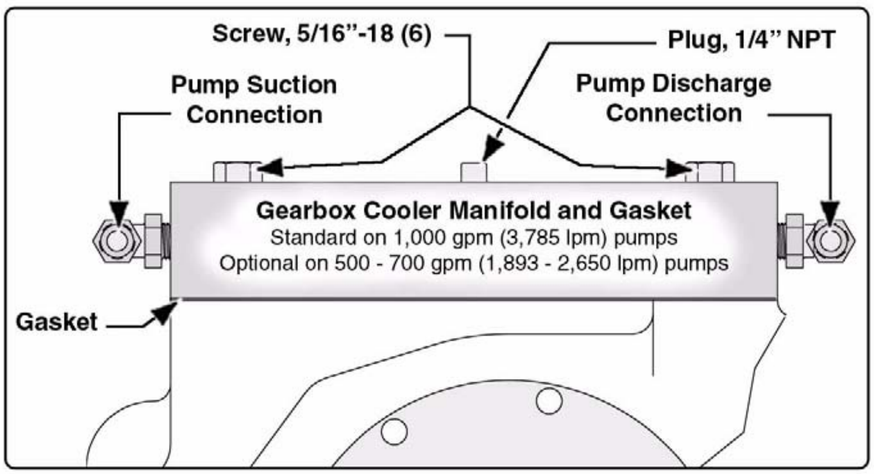



**Figure 6c-4: Gearbox Water Cooler**

1. Turn OFF water supply and OPEN the drain valve to drain water from the manifold and lines.

2. Disconnect the water lines at the manifold fittings. (See Figure 6c-4: "Gearbox Water Cooler.")

3. Remove six (6) 5/16"-18 screws, the water manifold and gasket.

4. When installing, tighten screws in a criss-cross pattern to ensure an even seal and torque accordingly. (See Table 6-1: "Typical Torque Values Chart" on page 73.)

5. Reconnect water cooler lines.

## Tail Shaft

**Note:** It may not be necessary to remove the gearbox from the apparatus if there is easy access to the tail shaft assembly.

1. First, review preceding Section "Before You Begin..." on page 71. Also review heading "Cleaning and Inspection Guidelines" on page 74.

2. Set the gear shift to the PUMP position to place the drive (sliding) gear under the idler gear.

3. For splined tail shaft with yoke (See Figure 6c-5: "Tail Shaft Assembly."),

- ❑ Remove the 3/4"-10 screw and washer.
- ❑ Remove the yoke and the yoke retaining ring.

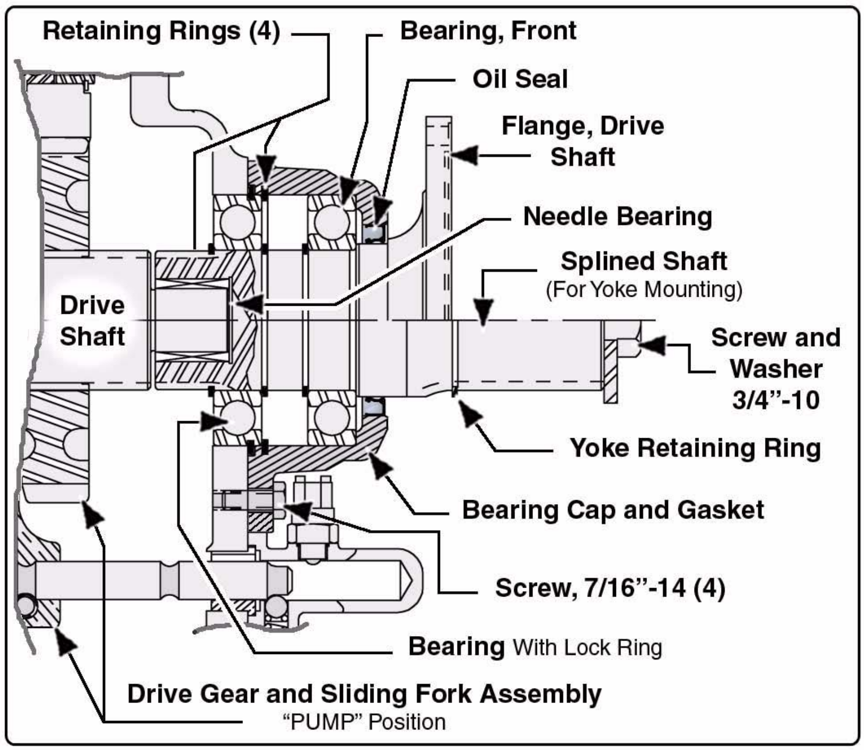



**Figure 6c-5: Tail Shaft Assembly**

4. Remove four (4) 7/16"-14 screws and the rear bearing cap and tail shaft assembly. Be careful not to damage this needle bearing.

5. Disassemble the tail shaft as follows:

**Note:** A press is required to remove and install shaft bearings.

- ❑ Inner bearing retaining ring (1)
- ❑ Inner bearing with lock ring
- ❑ Inner retaining rings (2)
- ❑ Outer bearing
- ❑ Tail shaft from the rear bearing cap

- ❑ Tail shaft oil seal. To replace, order Hale p/n: 296-2540-00-0.
- ❑ Needle bearing

6. Replace all components that are worn, damaged, or pitted.

### Installation Notes - Tail Shaft

(See Figure 6c-5: “Tail Shaft Assembly” on page 93.)

- ❑ A press is required to install the tail shaft bearings.
- ❑ Install shaft components by reversing the steps in the preceding section making sure the proper bearing is in its correct position and all retaining rings are installed.
- ❑ Be careful not to damage the oil seal or needle bearing.
- ❑ Install, tighten and torque the four (4) bearing cap 7/16”-14 screws. (See Table 6-1: “Typical Torque Values Chart” on page 73.)
- ❑ If required, install the splined shaft and yoke retaining ring. Secure the yoke to the shaft using the 3/4”-10 screw and washer. (See Table 6-1: “Typical Torque Values Chart” on page 73.)

  Rotate the yoke to ensure free spin. If too tight, back-off slightly (1/4 turn) on the 3/4”-10 screw.
- ❑ Install the gearbox cover and gasket, fill with proper fluid and test system before returning to operation.

## Drive (Sliding Gear) Shaft

1. First, review preceding Section “Before You Begin...” on page 71. Also review heading “Cleaning and Inspection Guidelines” on page 74.

**Note:** It may not be necessary to remove the gearbox from the apparatus if there is easy access to the drive shaft assembly.

2. Set the gear shift to the ROAD position to place the drive gear partially onto the tail shaft assembly. If the tail shaft has been removed, the gearbox cover must also be removed - see heading “Gearbox Cover” on page 91.

3. If the optional speed counter (tachometer) is included, disconnect the electrical connector and unscrew the sensor from the front bearing cap. Also see Section 6d “Available Options - Repair” on page 103.

4. For the splined drive shaft with yoke (See Figure 6c-6: “Drive (Sliding Gear) Shaft Assembly” on page 95.):

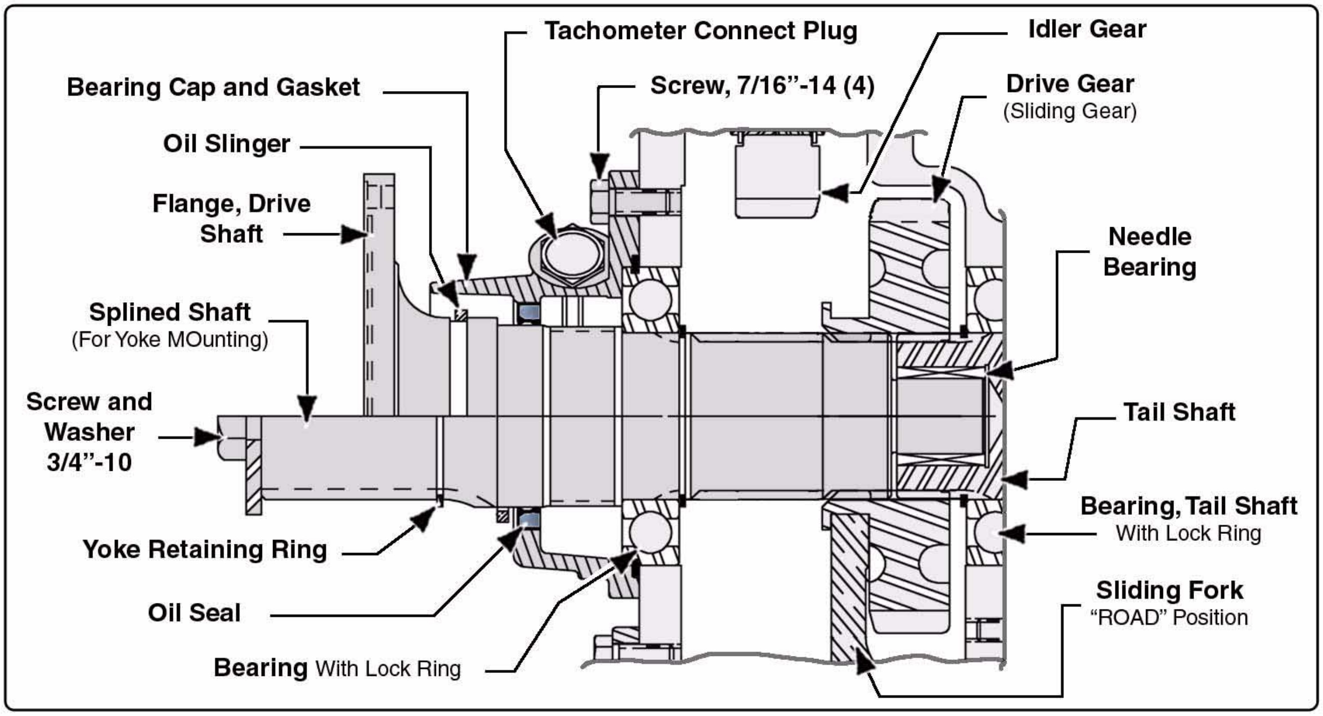



**Figure 6c-6: Drive (Sliding Gear) Shaft Assembly**

- ❑ Remove the 3/4"-10 screw and washer, then remove the yoke and the yoke retaining ring.

5. Remove the four (4) 7/16"-14 screws and the front bearing cap and drive shaft assembly. Be careful not to damage the needle bearing.

6. Disassemble the drive (sliding gear) shaft as follows:
(See Figure 6c-6: "Drive (Sliding Gear) Shaft Assembly.")

**Note:** A press is required to remove and install the drive shaft bearings.

- ❑ Inner retaining ring
- ❑ Inner bearing with lock ring
- ❑ Drive shaft from the front bearing cap
- ❑ Slinger
- ❑ Drive shaft oil seal. To replace, order Hale p/n: 296-2540-00-0.
- ❑ Needle bearing

7. Replace all components that are worn, damaged, or pitted.

### Installation Notes - Drive (Sliding Gear) Shaft

- ❑ A press is required to install the tail shaft bearings.
- ❑ Install shaft components by reversing the steps in the preceding section making sure the proper bearing is in its correct position and all retaining rings are installed. Also see Figure 6c-6: “Drive (Sliding Gear) Shaft Assembly” on page 95.
- ❑ Install a new oil seal - order Hale p/n: 296-2540-00-0.
- ❑ Be careful not to damage the oil seal or needle bearing during installation
- ❑ Install, tighten and torque the four (4) 7/16”-14 screws. (See Table 6-1: “Typical Torque Values Chart” on page 73.).
- ❑ If required, install the splined shaft and yoke retaining ring. Secure the yoke to the tail shaft using the 3/4”-10 screw and washer. Torque screw to 260 ft.-lb. (352 N-m).

  Rotate the yoke to ensure free spin. If too tight, back-off slightly (1/4 turn) on the 3/4”-10 screw.
- ❑ Install the gearbox cover and gasket, fill with proper fluid and test system before returning to operation.

## Gear Shift Shaft and Fork Assembly

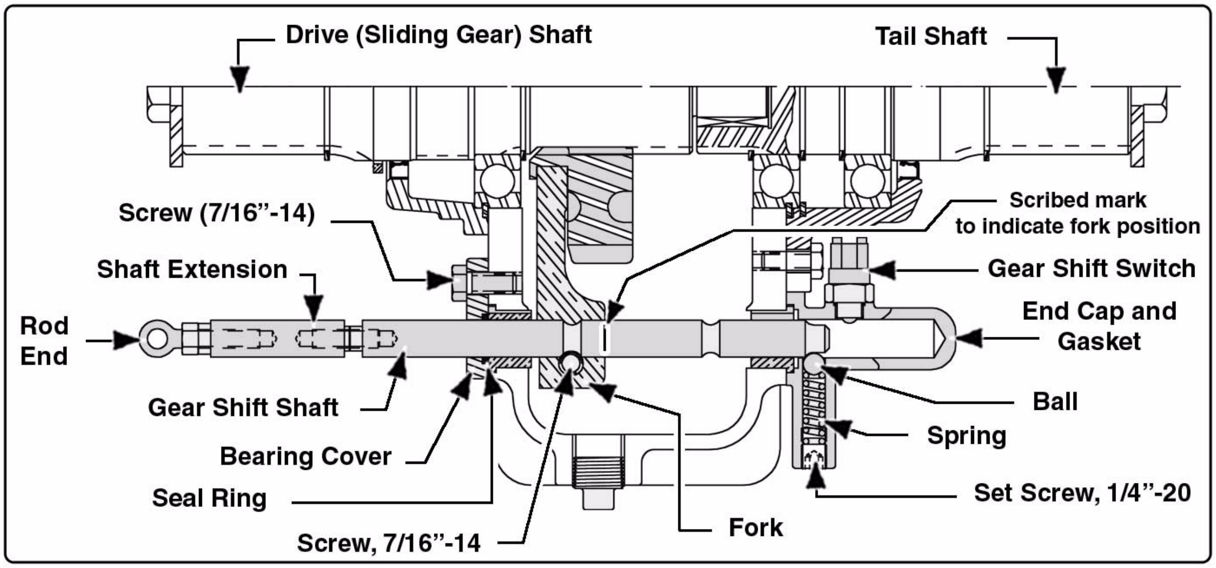
(See Figure 6c-7: “Gear Shift Shaft Assembly, Standard” on page 97.)

**Notes:** If your assembly includes the PTO drive option the gear shift shaft assembly is not included and is sealed by two blank-off plates, gaskets and 7/16”-14 screws. If your assembly includes a Hale optional power shift system, for service instructions see ?

1. First, review preceding Section “Before You Begin...” on page 71. Also review heading “Cleaning and Inspection Guidelines” on page 74.

**Note:** It is not necessary to remove the gearbox from the apparatus if there is easy access to the gear shift shaft assembly.

2. Set the gear shift to the ROAD position to place the drive gear partially onto the tail shaft assembly. If the tail shaft has been removed, place the gear-shift in the PUMP position.
3. Score (mark) the location of the fork on the shaft.
4. Loosen the fork 7/16”-14 locking screw, then remove the gear shift bearing cover (7/16”-14 screw) and seal ring.



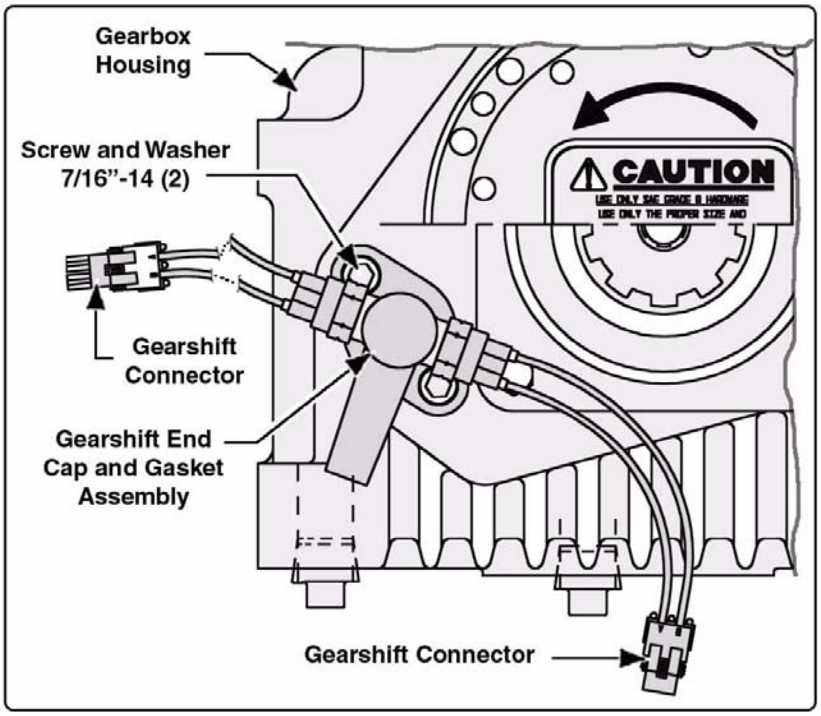




**Figure 6c-7: Gear Shift Shaft Assembly, Standard**

5. Remove the gear shift end cap set screw (1/2"-20), spring and ball.

6. Disconnect the switch connectors (2). Remove the end cap (7/16"-14 screws - 2), gasket and electrical switch.

7. Hold the fork and remove the gear shift shaft, then the fork.

8. Examine the shaft bearings on both sides of the gearbox housing. If required, press bushings from the housing and replace. If one requires replacement, it is always best to replace both bushings.

9. Replace components that are worn or damaged.

**Installation Notes - Gear Shift Shaft**

(See Figure 6c-7: “Gear Shift Shaft Assembly, Standard” on page 97.)

- ❑ Install shaft components by reversing the steps in the preceding section.
- ❑ If removed, press shift shaft bushings into the gearbox housing.
- ❑ Align the fork to your scribe mark on the shift and engage with the drive gear. Tighten and torque the locking screw. Also see Table 6-1: “Typical Torque Values Chart” on page 73.
- ❑ Operate the gear shift shaft assembly to ensure a smooth in and out movement. Ensure that the gears align properly when in the PUMP position and that they are fully disengaged when in the ROAD position.
- ❑ Install the gearbox cover and gasket, fill with proper fluid and test system before returning to operation.

## Idler Gear Shaft

1. Remove in the following order:

   - ❑ Gearbox cover - see heading “Gearbox Cover” on page 91.
   - ❑ Gear shift and fork assembly - see heading “Gear Shift Shaft and Fork Assembly” on page 96.
   - ❑ Drive shaft assembly- see heading “Drive (Sliding Gear) Shaft” on page 94.
   - ❑ Tail shaft assembly - see heading “Tail Shaft” on page 92.

2. Remove the 7/16”-14 screw, washer and gasket. (See Figure 6c-8: “Idler Shaft Assembly” on page 99.)

3. Remove the idler gear retaining rings (2).

4. Use a brass drift or similar object and tap the idler shaft out of the gearbox housing while holding the gear.

5. Remove idler gear with bearing assembly.

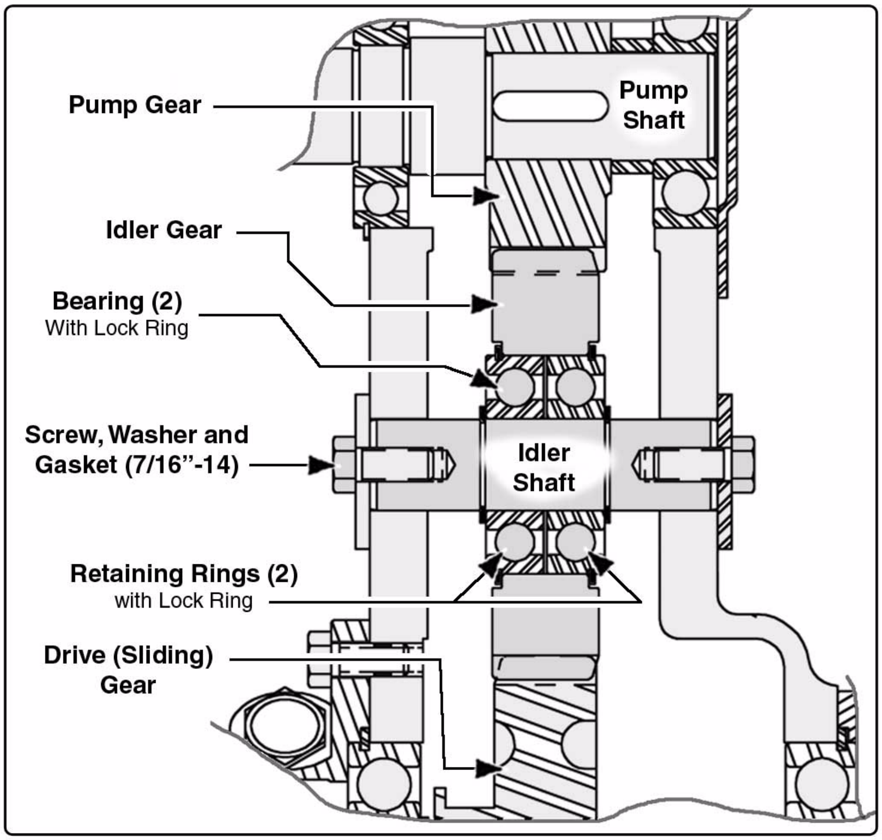



**Figure 6c-8: Idler Shaft Assembly**

6. Replace components that are worn or damaged.

### Installation Notes - Idler Shaft

- ❑ Press the bearings (2) into the idler gear making sure the lock ring is seated “flush” against the gear.
- ❑ Insert the shaft into the gearbox while assembling as follows:
  - one retaining ring
  - the gear and bearing assembly
  - remaining retaining ring
- ❑ Slide the shaft into the other side of the gearbox housing. (See Figure 6c-8: “Idler Shaft Assembly” on page 99.)
- ❑ Install, tighten and torque both the 7/16”-14 screws, gaskets and washers to pull the shaft evenly into the housing. (See Table 6-1: “Typical Torque Values Chart” on page 73.)

❑ Reinstall in the following order:

- Tail shaft assembly - see heading “Installation Notes - Tail Shaft” on page 94.
- Drive shaft assembly- see heading “Installation Notes - Drive (Sliding Gear) Shaft” on page 96.
- Gear shift and fork assembly - see heading “Installation Notes - Gear Shift Shaft” on page 98.
- Gearbox cover - see heading “Gearbox Cover” on page 91.

## Pump Shaft Assembly .

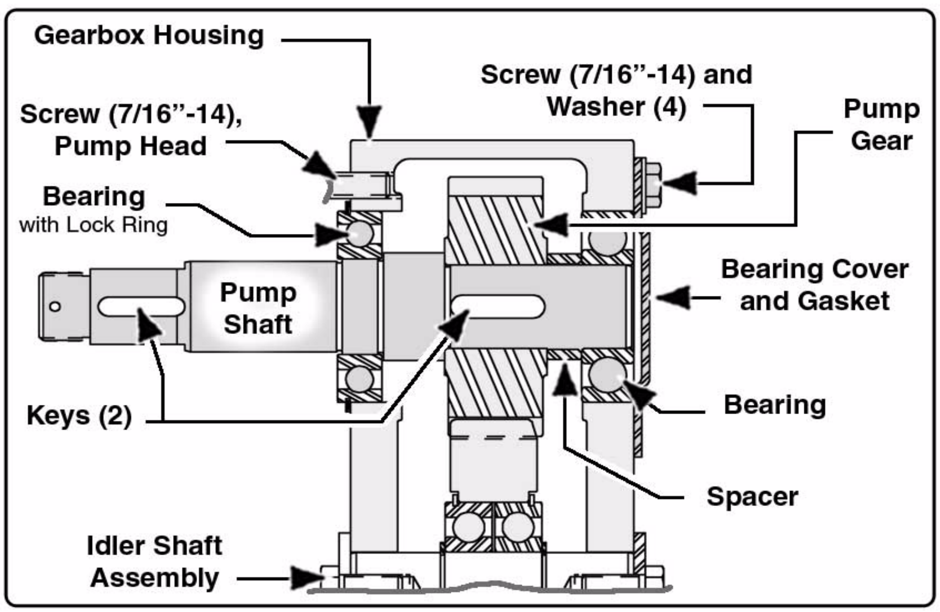



**Figure 6c-9: Pump Shaft Assembly**

1. Remove in the following order:

❑ Pump assembly (volute, impeller and pump head) - see Section 6a “Servicing the Pump” on page 79.

❑ Gearbox cover - see heading “Gearbox Cover” on page 91.

❑ Gear shift and fork assembly - see heading “Gear Shift Shaft and Fork Assembly” on page 96.

❑ Drive shaft assembly- see heading “Drive (Sliding Gear) Shaft” on page 94.

- ❑ Tail shaft assembly - see heading “Tail Shaft” on page 92.
- ❑ Idler shaft assembly - see heading “Idler Gear Shaft” on page 98.

2. Remove 7/16”-14 screw, washer and gasket from the bearing cover.

**Note:** If the pump gear diameter is smaller than the bore in the gearbox housing, the pump shaft assembly is removed from the housing as a complete assembly.

If the pump gear diameter is larger than the gearbox housing bore, the pump gear, shaft key and bearing must be disassembled within the housing as the shaft is being removed. (See Figure 6c-10: “Gear vs. Bore Diameter.”)

3. **If the gear fits through the gearbox bore**, use a brass drift or similar object and tap out the pump shaft assembly, including the rear bearing. (See Figure 6c-9: “Pump Shaft Assembly” on page 100.)

   **If the gear is larger than the gearbox bore (does not fit through the bore)**, place brass bar stock, or similar non-marking type object, between the pump gear and the front face of the gear-box housing to support the shaft and act as a wedge. (See Figure 6c-10: “Gear vs. Bore Diameter.”)

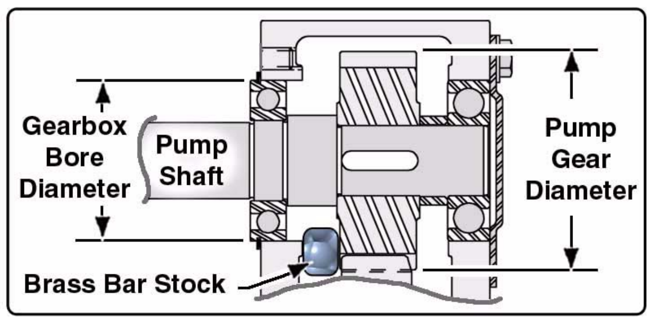



Figure 6c-10: Gear vs. Bore Diameter

   Tap the pump shaft out the front of the gearbox while removing the pump gear, shaft key and shaft spacer.

4. Remove the rear bearing from the gearbox housing.

5. Using a press, remove the front bearing (with lock ring) from the pump shaft.

6. Replace components that are worn or damaged.

### Installation Notes - Pump Shaft

(See Figure 6c-9: “Pump Shaft Assembly” on page 100.)

- ❑ Install shaft components by reversing the steps in the preceding section.
- ❑ A press is required to install the shaft bearing with lock ring.

- ❑ Insert and assemble the pump shaft by installing:
  - shaft key
  - pump gear
  - shaft spacer
- ❑ Install the bearing cover, gasket and tighten and torque the four (4) 7/16"-14 screws. (See Table 6-1: "Typical Torque Values Chart" on page 73.)
- ❑ Use a brass drift or similar object and tap the shaft into the gearbox housing until the bearing lock ring seats in the housing groove.
- ❑ Reinstall in the following order:
  - Idler shaft assembly - see heading "Idler Gear Shaft" on page 98.
  - Tail shaft assembly - see heading "Installation Notes - Tail Shaft" on page 94.
  - Drive shaft assembly- see heading "Installation Notes - Drive (Sliding Gear) Shaft" on page 96.
  - Gear shift and fork assembly - see heading "Installation Notes - Gear Shift Shaft" on page 98.
  - Gearbox cover - see heading "Gearbox Cover" on page 91.

## Final Assembly

1. Rotate the drive (sliding gear) shaft and manually shift the gearshift to check for proper operation.
2. Reinstall the pump assembly - see Section 6a "Servicing the Pump" on page 79.
3. Install the gearbox - see heading "Installing the Assembly" on page 77.

# 6d Available Options - Repair

## 6D.1 TACHOMETER / SPEED COUNTER

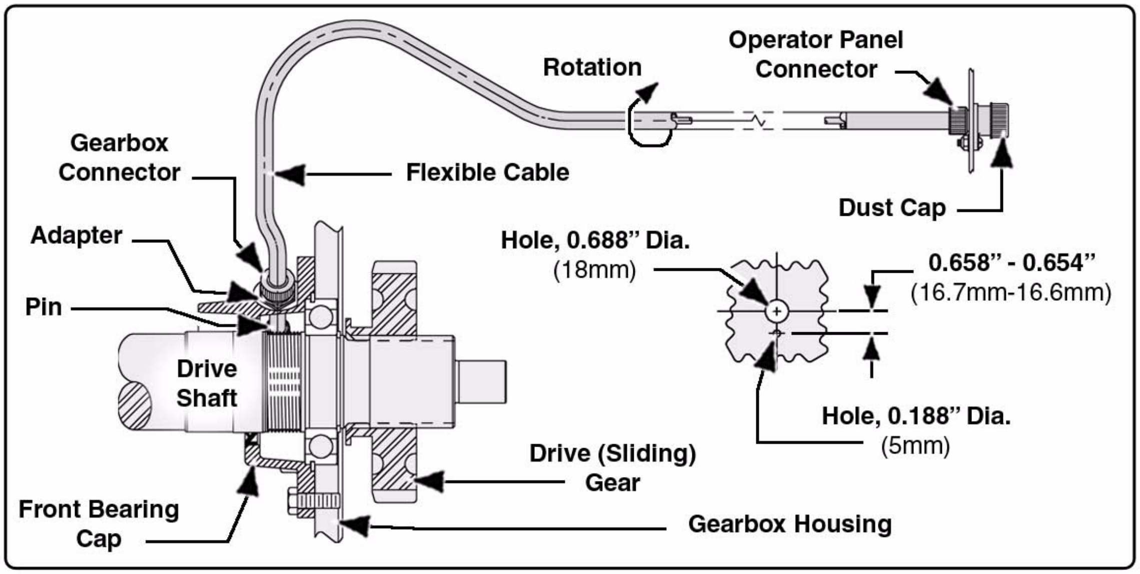



**Figure 6d-1: Tachometer / Speed Counter Option**

1. Disconnect the flexible cable at the front bearing cap adapter and the operator panel. (See Figure 6d-1: “Tachometer / Speed Counter Option.”)

2. Unthread the adapter fitting from the front bearing cap and remove the tachometer drive assembly.

**Installation Notes**

To install, follow the preceding steps in the reverse order. (See Figure 6d-1: “Tachometer / Speed Counter Option.”)

## 6D.2 AUTOMATIC PUMP SHIFT

1. Set the gear shift rod to the PUMP position.

2. Loosen 3/8”-24 nut and remove rod end and nut. (See Figure 6d-2: “Automatic Power Shift Overview,” on page 104.)

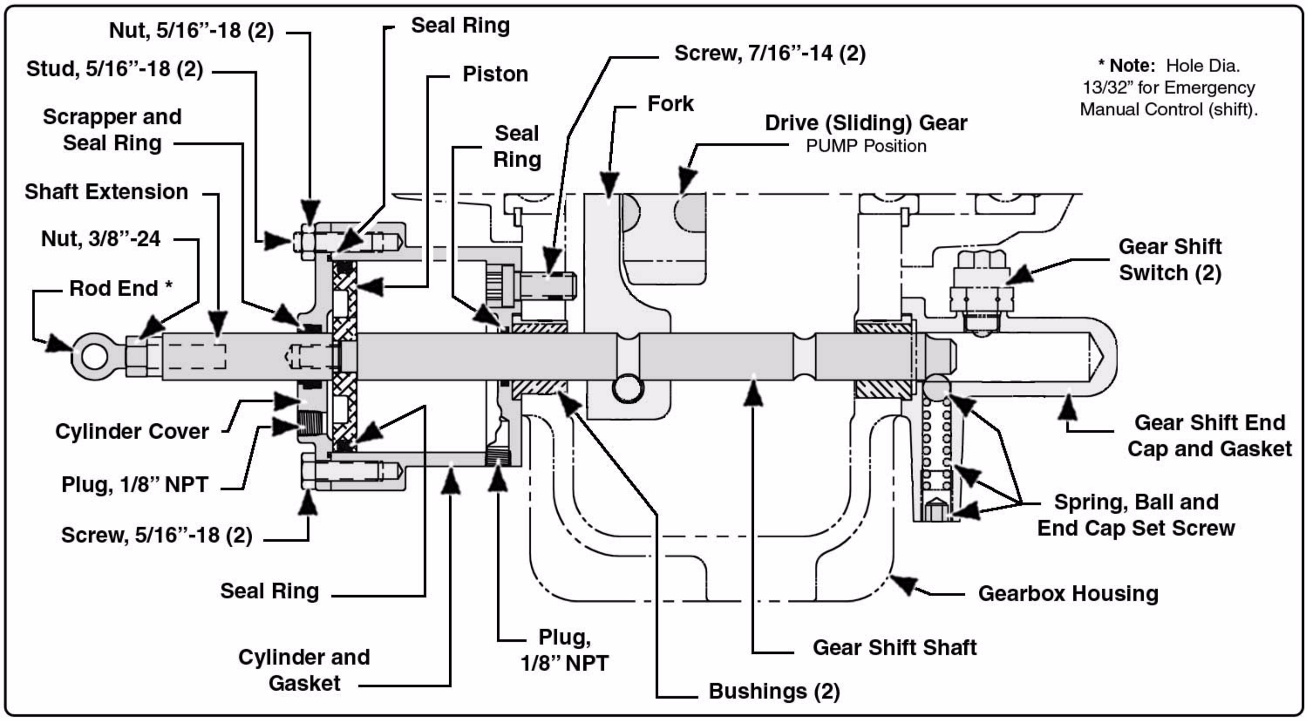



**Figure 6d-2: Automatic Power Shift Overview**

3. Shut-off air or vacuum supply to the shift cylinder and carefully open lines to evacuate. Disconnect lines at the cylinder.

4. Remove cylinder cap and seal ring, two 5/16”-18 screws and nuts. (See Figure 6d-2: “Automatic Power Shift Overview.”)

5. Remove cylinder cap scraper and seal ring.

6. Unscrew shaft extension and remove piston and seal ring.

7. Unscrew two 7/16”-14 screws and remove the cylinder, gasket and seal ring.

8. Remove internal seal ring from shift cylinder.

9. To remove the shaft, see heading “Gear Shift Shaft and Fork Assembly” on page 96.

10. Remove and check the shaft bushings. To replace, order Hale p/n: 140-1169-03-0.

**Installation Notes - Power Shift**

(See Figure 6d-2: “Automatic Power Shift Overview,” on page 104.)

- ❑ Make sure the flat side of the piston is facing towards the inside of the cylinder.
- ❑ Make sure the piston and shaft move freely in the cylinder.
- ❑ Apply a light coating of general-purpose grease to install the scraper and seal rings.

## Pump Shift Switch

(See Figure 6d-2: “Automatic Power Shift Overview,” on page 104.)

1. Disconnect the electrical control connections at the operator’s panel.
2. Set the gear shift rod to the PUMP position.
3. Unthread the switch from the gear shift end cap.
4. To install, apply a Loctite #246 and tighten.
5. Reconnect electrical control and pneumatic / vacuum connections.

## Pump Shift Maintenance

(See Figure 6d-2: “Automatic Power Shift Overview,” on page 104.)

Lubricate the shift cylinder once a year by applying a few drops of light vacuum cylinder oil into the cylinder through the compression fittings in the front side of the cylinder.

# Notes

# 7 Installation

## 7.1 OVERVIEW

This section provides general guidelines and recommendations for installing the pump and gearbox assembly into your truck chassis.

## 7.2 FRAME MOUNTING

See Section 8, heading “Drawing Package” on page 131, located at the back of this manual, for the required mounting specifications. The installation drawing provides mounting configurations with bolt down specifications.

**IMPORTANT!**

TO FULLY SUPPORT THE PUMP AND GEARBOX ASSEMBLY, USE ALL MOUNTING BOLT HOLES PROVIDED IN THE GEARBOX, AS ILLUSTRATED ON THE INSTALLATION DRAWING. SEE SECTION 8, HEADING “DRAWING PACKAGE” ON PAGE 131.

**WARNINGS !**

**THE HALE PUMP AND GEARBOX ASSEMBLY ARE HEAVY AND BULKY. ADDING ACCESSORIES INCREASES THE WEIGHT. CHECK YOUR BILL OF LADING FOR THE APPROXIMATE WEIGHT. BE CERTAIN TO USE PROPER LIFTING SUPPORT DEVICES (I.E., OVERHEAD CRANE, JACK, CHAINS, STRAPS, ETC.) CAPABLE OF HANDLING THE LOAD WHEN REMOVING OR INSTALLING THE PUMP AND GEARBOX ASSEMBLIES.**

**BE SURE TO WEAR SAFETY GLASSES WHEN REMOVING AND/OR INSTALLING FORCE (PRESS) FITTED PARTS. FAILURE TO COMPLY MAY RESULT IN SERIOUS EYE INJURY.**

### General Mounting

Tapped holes of various sizes and depths are provided, dependent on pump model and layout requirements.

Mounting also varies depending on assembly configuration, i.e.,

- ❑ Horizontal

- ❑ Vertical
- ❑ Inverted mount
- ❑ Standard engine rotation (clockwise)
- ❑ Opposite engine rotation (counterclockwise)

# 7.3 DRIVELINE ISSUES

## Drive Line and Flange Bolts

Ensure that:

- ❑ All bolts are tight. Use a torque wrench to torque bolts to the drive train manufacturer's recommended specifications.
- ❑ Bolts used are “Grade 8” strength.

**CAUTION !**

**ALL FASTENERS ON THE HALE PUMP AND GEARBOX ASSEMBLY HAVE BEEN SELECTED FOR THEIR APPLICATION. HALE PRODUCTS DOES NOT RECOMMEND REPLACING FASTENERS WITH ANYTHING OTHER THAN HALE PART NUMBERS PROVIDED. REPLACING WITH A WEAKER ALTERNATIVE POSES A SERIOUS SAFETY RISK.**

**ALL FASTENERS MUST BE INSTALLED WITH A LOCKING ANAEROBIC ADHESIVE/SEALANT, SUCH AS LOCTITE® #246 FOR GEARBOX AND #242 FOR PUMP.**

*Wherever there is a requirement for new parts, it is recommended to use only Hale authorized replacement parts for optimum safety of the equipment and its operators and to reduce unnecessary “downtime.”*

## Issues

It is critical to use computer driveline analysis software, such as Dana’s “The Expert,” during driveline layout. Dana’s software is available free on the World Wide Web at: ***http://www2.dana.com/expert***

When performing calculations, strive to achieve the lowest driveline torsional and inertial vibrations, making sure to avoid severe driveline angles.

Be conservative and always err on the side of SAFETY. Always measure the drive shaft after construction to make sure it matches the computer design.

Remember the following points while designing a driveline:

- ❑ Problems can occur with or without noticeable vibration.
- ❑ Do not measure driveline angles using a bubble protractor. Instead, use a digital inclinometer. Remember to zero the inclinometer on the truck frame, not the ground.
- ❑ Center the sliders.

Long drivelines can lead to component vibration or failure. As the driveline approaches half critical speed, a vibration will occur that can damage driveline components.

Table 7-1: Maximum Recommended Driveline Lengths below lists the maximum driveline length using a safety factor of 42% of critical speed.

| Recommended Drive Lengths, Inches (Millimeters) | | | | | | |
|---|---|---|---|---|---|---|
| Shaft RPM | Tube Diameter, Inches (Millimeters) | | | | | |
| | 2.0 (51) | 2.5 (64) | 3.0 (76) | 3.5 (89) | 4.0 (102) | 4.5 (114) |
| **2,400** | 47 (1,194) | 53 (1,346) | 58 (1,473) | 63 (1,600) | 67 (1,702) | 71 (1,803) |
| **2,600** | 45 (1,143) | 51 (1,295) | 55 (1,397) | 60 (1,524) | 64 (1,626) | 68 (1,727) |
| **2,800** | 44 (1,118) | 49 (1,245) | 53 (1,346) | 58 (1,473) | 62 (1,575) | 65 (1,651) |
| **3,000** | 42 (1,067) | 47 (1,194) | 52 (1,321) | 56 (1,422) | 60 (1,524) | 63 (1,600) |
| **3,200** | 41 (1,-41) | 46 (1,168) | 50 (1,270) | 54 (1,372) | 58 (1,473) | 61 (1,549) |
| **3,400** | 39 (991) | 44 (1,118) | 48 (1,219) | 53 (1,346) | 56 (1,422) | 59 (1,499) |
| **3,600** | 38 (965) | 43 (1,092) | 47 (1,194) | 51 (1,295) | 55 (1,397) | 58 (1,473) |
| **3,800** | 37 (940) | 42 (1,067) | 46 (1,168) | 50 (1,270) | 53 (1,346) | 56 (1,422) |
| **4,000** | 36 (914) | 41 (1,041) | 45 (1,143) | 48 (1,219) | 52 (1,321) | 55 (1,397) |

**Table 7-1: Maximum Recommended Driveline Lengths**

This table is based on a 0.134” (3.4 mm) wall thickness. Although wall thickness does not have a significant effect on drive shaft length for this calculation, it does have some effect.

Extremely short drive lengths can also cause problems from excessive operating angles. Use caution and conservative design values when utilizing air ride suspension and short rear drivelines.

More information on fire apparatus drivelines can be found in Hale OEM Technical Bulletin # 957. For application assistance and approval, contact a driveline equipment manufacturer, such as Spicer/Dana or Merritor.

**Note:** Hale assumes no liability for any information provided under this heading "Driveline Issues." Driveline design and truck system integration is the responsibility of the apparatus manufacturer. Failure to comply with the driveline parameters set forth can result in termination of Hale's warranty on driveline related issues.

## 7.4 PLUMBING CONNECTIONS

See Section 8, heading "Drawing Package" on page 131, located at the back of this manual, for the required plumbing specifications. The appropriate plate drawing provides available plumbing specifications, both standard and optional.

For example:

- ❑ Suction, victaulic and/or flange-type
- ❑ Discharge, typically flange-type

Various flanges and manifolding are also available. Contact Hale Products at **610-825-6300** for additional information.

# Appendix A: Glossary

***Atmospheric*** .......Pressure caused by the elevation of air above the earth. Air pressure is 14 pounds. Atmospheric pressure effects a pumps ability to pump from draft. Higher pressures increase a pump performance, while lower pressures cause a noticeable decrease in lift.

***Pressure*** .............per square inch at sea level. Pressure increases below sea level and decreases above sea level. The weather also effects air pressure. Atmospheric pressure effects a pumps ability to pump from draft. Higher pressures increases a pumps performance, while lower pressures can cause a noticeable decrease in lift.

***Auxiliary Cooling Valve*** .............Permits water from a pump to cool the radiator water through a heat exchange.

***Capacity*** .............Pump flow rating.

***Cavitation*** ...........Occurs when the pump attempts to deliver more fluid than is being supplied. This causes the formation of bubbles in the pump. When the bubbles collapse, the liquid, under pressure, rushes in to fill the empty space. This damages the pump and must be corrected immediately.

***Centrifugal Force*** .........Force that tends to make rotating bodies move away from the center of rotation.

***Centrifugal Pump*** .........A pump that uses a rapidly spinning disk or impeller to create the pressure for fluid movement.

***Certification*** ........Pumper test in accordance with NFPA standards to determine if a pump can deliver its rated volume and pressure.

***Check Valve*** ........A one-way valve or non-return valve that allows flow in one direction, but shifts to prevent flow in the reverse direction.

In two stage pumps, there are two swing check or flap valves in the suction passage of the second stage. They are located in each side of the pump between the suction tube and the pump body. These valves swing open when pumping in parallel for volume. They are closed by first stage pressure when pumping in series for pressure.

***Clearance Rings*** ...........Prevents discharge fluid from returning to the eye of the impeller.

***Compound Gauge*** .........A compound gauge is graduated to read pressure in "pounds per square inch" and "vacuum in inches of mercury."

**Cut Water** ............Cut water is a wedge-shaped point between the volute (pump body) and the pump discharge where the volume of fluid is directed to the victaulic discharge connection.

***Dead Heading*** .....Operating a pump without any discharge. The lack of flow causes temperatures to rise inside the pump.

**WARNING !**

***IF A PUMP IS OPERATED WITHOUT WATER FOR EXTENDED PERIODS, OR WITHOUT DISCHARGING WATER, IT MAY OVERHEAT. THIS COULD DAMAGE THE MECHANICAL SEAL OR THE DRIVE MECHANISM.***

***Double Suction Impeller*** ..Fluid enters on both sides of the impeller.

***Dry Prime Test*** ...Provides information on the ability of a priming pump to evacuate air from the main pump. If the vacuum does not hold, it is an indication there is a leak in the system.

***Eye, Impeller*** .......Point where fluid enters the impeller.

***Flow Meter*** ..........Measures the volume of fluid that is flowing.

***Friction Loss*** ......Loss of pressure in hose, fittings, standpipes, and other appliances because of the resistance between the fluid molecules and the inside surfaces of the hoses, fittings, standpipes, piping, and other appliances.

***Front-Mount Pump*** .......Pump mounted ahead of the vehicle's engine – usually on the front of the radiator.

***Gauge Pressure*** .................Pressure read from a gauge (PSIG).

***Governor*** .............Minimizes pressure changes by controlling engine speed to maintain pump discharge pressure.

***Horsepower*** ........A measure of mechanical work.

***Impeller*** ...............The working part of a centrifugal pump that, when rotating, imparts energy to fluid. Essentially, an impeller consists of two disks separated by vanes. The vanes force the fluid to move outward between the disks so that it is thrown outward at high velocity by centrifugal force. The water from the impeller discharges into a diverging passage known as a volute, converting the high velocity energy of the water into pressure.

***Net Pump Pressure*** ............The difference in pressure between discharge and suction pressure.

***Packing*** ...............Material that maintains an airtight seal at the point where the impeller shaft enters and exits the pump body.

***Parallel*** ................Capacity position in which each impeller on a two-stage pump works independently into the discharge – often termed "Volume Mode."

***Pitot Gauge***.........Measures velocity head at the discharge of a nozzle and can be converted to flow using a chart or simple calculation.

***Positive Displacement Pump***...............A pump with a fixed flow delivered to the discharge with each revolution.

***Positive Pressure***..............Pressure above atmospheric.

***Power Valve***........A valve that uses hydraulic pressure to transfer two-stage pump operation from volume mode to pressure mode, and vice versa.

***Pressure***.............Force per unit area.

***Pressure Gauge***............The pressure gauge is usually graduated in pounds per square inch (PSI) only. It is connected to the pump discharge manifold, thus indicating pump discharge ressure.

***Priming***...............Priming evacuates the air from the main pump and suction hose, thus creating a vacuum. This allows atmospheric pressure on the source of the fluid to push the fluid up into the suction hose and pump.

***Priming Pump***....An auxiliary positive displacement pump which pumps air out of the booster pump that creates a vacuum to prime the main pump. The priming pump is a rotary vane type, electric motor driven. Once the main pump is primed and pumping, the priming pump is shut off.

***Priming Pump Valve***...A valve located in the priming line between the priming pump and the main pump. It remains closed at all times except when priming. The control is normally located on the pump panel.

***Pump Shift***..........A midship pump is usually mounted with a split gearbox installed in the drive shaft.The pump shift moves a sliding gear in the gearbox that transmits power either to the pump or the rear axle. In ROAD position, power is shifted to the rear axle for driving; in PUMP position, the rear axle is disconnected, and power is shifted to the pump shaft.

***Relay***...................Movement of water from an apparatus at a water source to additional apparatus until water reaches the fire ground.

***Relief Valve***.........An automatic valve which, when activated by the relief valve control, holds pump pressure steady when discharge valves or shut-off nozzles are closed. The valve maintains its given pressure by dumping the pump discharge flow into the pump suction.

***Relief Valve Control (PM)***........A handwheel adjustment valve which controls and/or adjusts the relief valve to maintain the working pressure (i.e., set to control the desired pressure).

***Series***..................Pressure position in which the first impeller's discharge is fed to the eye of the second impeller in a two-stage pump which then discharges the fluid from the pump.

***Service Test*** ........ Pump test performed to determine if the apparatus can deliver its rated volume and pressure.

***Shrouds*** .............. Sides of an impeller that confine the fluid.

***Slinger Ring*** ........ Prevents fluid from continuing to travel down a shaft to the gears and ball bearings.

***Stages*** ................ The number of impellers in a pump that are used in series; that is, one following another in terms of flow. Each impeller develops part of the total pump pressure.

***Tachometer*** ........ Indicates the speed of the engine crankshaft in revolutions per minute.

***Torque*** ................ The force that acts to produce rotation.

***Transfer Valve*** ... A two-position valve in a pump that changes the operation from parallel (volume) to series (pressure) operation and vice versa (not used on single stage pumps).

***Vanes*** .................. Guides inside an impeller that direct fluid to the volute (pump body).

***Volute*** .................. A gradually increasing discharge waterway. Its function is to collect the water from the impeller and, depending on its design, it either increases pressure and decreases velocity or increases velocity and decreases pressure.

***Water Horsepower*** ................... Amount of energy in the water stream.

***Wear Rings*** ......... See Clearance rings.

# Appendix A-1: Measurements

Water Horsepower ........ (GPM x PSI)/1,714
One Gallon of Water Weighs ........ 8.33 Pounds
One Gallon ........ 231 Cubic Inches
One Cubic Foot ........ 7.48 Gallons
One Pound per Square Inch of Head ........ 2.31 Feet of Water
One Inch of Mercury ........ 1.132 Feet of Water
One Pound per Square Inch ........ 2.0178 Inches of Mercury
equals 27.68 inches of Water
One Cubic Meter ........ 1,000 Liters
One Imperial Gallon ........ 1.2 Gallons

## CONVERSION CHART

| To Convert | To | Multiply By |
|---|---|---|
| BAR | PSI | 4.504 |
| Feet Head | Pounds Pressure | 2.31 |
| FT-LB (Torque) | N-m | 1.3558 |
| Gallons | Liters | 3.785 |
| HP (Horsepower) | KW (Kilowatts) | 0.7457 |
| One Pound per Square Inch | One Bar | 0.0690 |
| One Pound per Square Inch | KPA | 0.001 |
| PSI | BAR | 0.06895 |
| Pounds per Square Inch | Feed Head | 0.433 |

**Hale Products Inc.**
A Unit of IDEX Corporation
700 Spring Mill Avenue
Conshohocken, PA 19428 U.S.A.
Telephone..............1-610-825-6300
Fax ........................1-610-825-6440
Web........ www.haleproducts.com

# Appendix C: Alternate Lubricant Manufacturers

In addition to the Hale recommended lubricants:

- ❑ FULL SYNTHETIC SAE 50 Transmission Lubricant (Cognis 2924/2833)
- ❑ DEXRON III SYNTHETIC (Cognis 2803) for temperatures below 32°F (0°C)

the following list of alternate oils and suppliers is provided .

| Oil / Lubricant | Manufacturer |
|---|---|
| **Alternate STANDARD-Temperature Lubricant (Cognis 2923/2833)<br>See Service Manual for additional information.** | |
| **Brad Penn Full Synthetic Transmission Lube SAE-50** | American Refining Group<br>77 N Kendall Avenue<br>Bradford, PA 16701 |
| **Bulldog Synthetic Transmission Lube SAE-50 Trans.** | Mack Truck Company<br>2100 Mack Boulevard<br>Allentown, PA 18105 |
| **D-A SynSure Synthetic Lube SAE-50 Trans.** | D.A. Lubricant Company, Incorporated<br>1340 West 29th Street<br>Indianapolis, IN 46208 |
| **Dyna-Plex 21C Synzol SAE-50 Trans.** | Universal Lubricants<br>P O Box 2920<br>2824 North Ohio<br>Wichita, KS 67219 |
| **Emgard SAE-50 Synthetic Transmission Lubricant** | Cognis Corporation<br>5051 Estecreek Drive<br>Cincinnati, OH 45232 |
| **Fleetrite Synthetic SAE-50 Transmission Oil Trans.** | International Truck & Engine Corporation<br>5 Westbrook Corporate Center<br>Westchester, IL 60154 |
| **Hi-Tek Synthetic SAE-50 Trans.** | Industrial Oils Unlimited<br>P O Box 3066<br>Tulsa, OK 74101 |
| **Kenworth SAE-50 Original Factory Fill Fluid Trans.** | Paccar Parts<br>750 Houser Way N<br>Renton WA 98055 |
| **Maxtro MT SAE-50 Trans.** | Country Energy LLC<br>5500 Cenex Drive<br>Inver Grove Heights, MN 55077 |

**Table C-1: Alternate Lubricant Manufacturers**

| Oil / Lubricant | Manufacturer |
|---|---|
| **Alternate STANDARD-Temperature Lubricant (Cognis 2923/2833)**<br>**See Service Manual for additional information.** | |
| **Monarch Syntran Plus**<br>**SAE-50 Trans.** | Royal Manufacturing Company, Inc.<br>P O Box 3308<br>516 South 25th West Avenue<br>Tulsa, OK 75127 |
| **Mystik Synguard SX-7000**<br>**SAE-50 Trans.** | Cato Oil and Grease Company<br>P O Box 26868<br>1808 NE 9th Street<br>Oklahoma City, OK 73126 |
| **Peterbilt SAE-50 Original**<br>**Factory Fill Fluid, Trans.** | Paccar Parts<br>750 Houser Way N<br>Renton, WA 98055 |
| **SYN-CD Gear Lubricant**<br>**SAE-50 Trans.** | Black Bear Company, Incorporated<br>27-10 Hunters Point Avenue<br>Long Island City, NY 11101 |
| **Valvoline HD Synthetic Trans.**<br>**Oil SAE-50 Trans.** | Valvoline, Incorporated<br>A Subsidiary of Ashland Oil, Inc.<br>3499 Blazer Parkway<br>Lexington, KY 40512 |
| | |
| **Alternate LOW-Temperature Lubricant (Cognis 2803)**<br>**See Service Manual for additional information.**<br><br>**CAUTION !**<br>**USE ONLY FOR EXTREME LOW TERPERTAURES, BELOW FREEZING (32° F / 0° C)** | |
| **Motorcraft Synthetic ATF** | Local Ford Dealership |

**Table C-1: Alternate Lubricant Manufacturers**

## Hale Products Inc.

A Unit of IDEX Corporation
700 Spring Mill Avenue
Conshohocken, PA 19428 U.S.A.
Telephone ............. 1-610-825-6300
Fax ........................ 1-610-825-6440
Web........ www.haleproducts.com

# Appendix C1: Lube and Sealant Specifications

| Gearbox Model | Approximate Capacity | | Recommended Oil |
|---|---|---|---|
| | Quarts | Liters | |
| **4DK** | 5 | 4.7 | SAE 50 - above 0° F (above -18° C)<br>Dextron III or Cognis 2803 -<br>Between -40° F to 0° F (-40° to -18° C) |
| **A** | 1 | 0.95 | SAE 20<br>SAE30 Non-Detergent Oil |
| **AP** | 1.75 | 1.7 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.) |
| **AP (Inverted)** | 1.25 | 1.2 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.) |
| **B (Vertical)** | 2 | 1.9 | SAE 50<br>80W-90 Synthetic + |
| **B (Horizontal)** | 1.5 | 1.4 | SAE 50<br>80W-90 Synthetic + |
| **B (Inverted)** | 1.75 | 1.7 | SAE 50<br>80W-90 Synthetic + |
| **CBP / CBP2 / CBP3 / 2CBP / 2CBP2 / 2CBP3** | 1.75 | 1.7 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.) |
| **CBP4 / CBP5 / 2CBP4 / 2CBP5** | 1 | 0.95 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.) |
| **G (L and X)** | 4 | 3.8 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.)<br>75W-80 Synthetic * |
| **G (S)** | 3 | 2.8 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.)<br>75W-80 Synthetic + |
| **HG / PSM / RSD** | 1.4 | 1.3 | SAE 50, or ISO 68 Grade (where applicable)<br>80W-90 Synthetic *<br>75W-80 Synthetic * |
| **HP Pumps** | 1.5 | 1.3 | SAE 30 |
| **J** | 2 | 1.9 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.) |
| **MG (Horiz. or Vert.)** | 3 | 2.8 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.) |
| **P** | 4 | 3.8 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.)<br>**Table continued on next page.** |

**Table C1-2: Oil Capacity and Recommendation**

| Gearbox Model | Approximate Capacity | | Recommended Oil |
|---|---|---|---|
| | Quarts | Liters | |
| **PSD / CSD / HFM** | 2.5 | 2.4 | SAE 20 Non-Detergent Oil<br>SAE 30 |
| **PSD (Vertical)** | 2.5 | 2.4 | SAE 20 Non-Detergent Oil<br>SAE 30 |
| **RG** | 4 | 3.8 | SAE EP 90<br>80W-90 (Lubricants must meet service rating API GL-5 requirements.) |

**Table C1-2: Oil Capacity and Recommendation**

* For domestic use, Hale recommends using an SAE EP-90, 80W-90 Lubricant or “Roadrunner” Full Synthetic SAE 50 Transmission Lubricant, manufactured by the Eaten® Corporation, or equivalent.

## Grease

Use a Lithium-based grease with 1% to 3% Molybdenum Dissolved, i.e.,

- ❑ Do Corning BR2-PLUS
- ❑ Shell Super Duty Grease
- ❑ Mobile Grease Special
- ❑ Lubricate-Fiske #3000
- ❑ Imperial #777
- ❑ Sunoco Moly #2EP

**Note:** For Hale SVS Torrent Stainless Valves see separate manual for additional lubrication information.

## Loctite Sealant

- ❑ #246 High Temperature Removable Threadlock (or equivalent) - for gear-box assembly
- ❑ #246 Medium Strength Threadlock (or equivalent) - primarily for pump assembly

## Oil

Also see Section “Appendix C: Alternate Lubricant Manufacturers” on page 117.

## Recommended Cleaners

- ❑ Safety Keen
- ❑ Stockyard Solvent

# Appendix D: Hose Friction Loss

| GPM (LPM | 3/4" (19mm | 1.0" (25.4mm | 1-1/2" (38mm | GPM (LPM | 1-3/4" (44mm) Hose Width | 2.0" (38) Hose Width | 2-1/2" (64mm) Hose | 3.0" (76mm) Hose Width | 3.0" (76mm) Hose | GPM (LPM | 3-1/2" (89mm) Hose | 4.0" (102mm) Hose | 5.0" (217mm) Hose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10 (38)** | 13.5 (0.9) | 3.5 (0.24) | | **95 (38)** | 14 (0.96) | 8 (0.6) | | | | **500 (1,893)** | 9.5 (0.7) | 3 (0.2) | |
| **20 (38)** | 44 (3.0) | 6 (0.4) | | **125 (38)** | 24 (1.7) | 13 (0.9) | | | | **750 (2,839)** | 20 (1.4) | 11 (0.8) | 5 (0.4) |
| **30 (38)** | 99 (6.8) | 14 (0.96) | | **150 (38)** | 35 (2.4) | 18 (1.2) | | | | **1,000 (3,785)** | 34 (2.4) | 20 (1.4) | 8 (0.6) |
| **40 (38)** | 176 (12.0) | 24 (1.7) | 4 (0.3) | **175 (38)** | 47 (3.2) | 25 (1.7) | 6 (0.4) | | | **1,250 (4,732)** | 53 (3.7) | 31 (2.1) | 13 (0.9) |
| **50 (38)** | | 38 (2.6) | 7 (0.5) | **200 (38)** | 62 (4.3) | 32 (2.2) | 8 (0.6) | | | **1,500 (5,678)** | 74 (5.1) | 45 (3.1) | 18 (1.2) |
| **60 (38)** | | 54 (3.7) | 9 (0.6) | **225 (38)** | | | 10 (0.7) | | | **1,750 (6,625)** | | 61 (4.2) | 25 (1.7) |
| **70 (38)** | | | 12 (0.8) | **250 (38)** | | | 13 (0.9) | 5 (0.4) | 4 (0.3) | **2,000 (7,571)** | | | 32 (2.2) |
| **80 (38)** | | | 15 (1.03) | **275 (38)** | | | 15 (1.03) | | | | | | |
| **95 (38)** | | | 22 (1.5) | **300 (38)** | | | 18 (1.2) | | | | | | |
| **125 (38)** | | | 38 (2.6) | **325 (38)** | | | 22 (1.5) | 8 (0.6) | | | | | |
| **150 (38)** | | | 54 (3.7) | **350 (38)** | | | 25 (1.7) | | 8 (0.6) | | | | |
| | | | | **500 (38)** | | | | 20 (1.4) | 17 (1.2) | | | | |
| | | | | **750 (38)** | | | | 45 (3.1) | 36 (2.5) | | | | |
| | | | | **1,000 (38)** | | | | 80 (5.5) | 68 (4.7) | | | | |

**Table D-11: Hose Friction Loss (PSI / BAR 100 Feet)**

**Hale Products Inc.**
A Unit of IDEX Corporation
700 Spring Mill Avenue
Conshohocken, PA 19428 U.S.A.
Telephone..............1-610-825-6300
Fax.........................1-610-825-6440
Web ........ www.haleproducts.com

# Appendix E: Nozzle Size vs. Pressure

| GPM (LPM) at Various Nozzle Sizes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Nozzle Pressure** | **Nozzle Size in Inches (millimeters)** | | | | | | | |
| **PSI (BAR)** | **1/2" (13)** | **5/8" (16)** | **3/4" (19)** | **7/8" (22)** | **1.0" (25.4)** | **1-1/8" (29)** | **1-1/4" (32)** | **1-3/8" (35)** |
| **30 (2.1)** | 41 (155) | 64 (242) | 92 (348) | 125 (473) | 163 (617) | 206 (780) | 254 (962) | 308 (1,166) |
| **35 (2.4)** | 44 (167) | 69 (261) | 99 (375) | 135 (511) | 176 (666) | 222 (840) | 275 (1,041) | 332 (1,257) |
| **40 (2.7)** | 47 (178) | 73 (296) | 106 (401) | 144 (545) | 188 (711) | 238 (901) | 294 (1,113) | 355 (1,334) |
| **45 (3.1)** | 50 (189) | 78 (295) | 112 (424) | 153 (579) | 199 (753) | 252 (954) | 311 (1,177) | 377 (1,437) |
| **50 (3.5)** | 53 (201) | 82 (310) | 118 (447) | 161 (610) | 210 (795) | 266 (1,007) | 328 (1,242) | 397 (1,503) |
| **55 (3.8)** | 55 (208) | 86 (326) | 124 (469) | 169 (640) | 220 (833) | 279 (1,056) | 344 (1,302) | 417 (1,647) |
| **60 (4.1)** | 58 (220) | 90 (341) | 130 (492) | 176 (666) | 230 (871) | 291 (1,102) | 360 (1,363) | 435 (1,363) |
| **62 (4.3)** | 58 (220) | 91 (345) | 132 (500) | 179 (678) | 234 (886) | 296 (1,121) | 366 (1,385) | 442 (1,673) |
| **64 (4.4)** | 59 (223) | 93 (352) | 134 (507) | 182 (689) | 238 (901) | 301 (1,139) | 371 (1,404) | 449 (1,700) |
| **66 (4.6)** | 60 (227) | 94 (356) | 136 (515) | 185 (700) | 241 (912) | 305 (1,155) | 377 (1,427) | 456 (1,726) |
| **68 (4.7)** | 61 (231) | 96 (363) | 138 (522) | 188 (711) | 245 (927) | 310 (1,174) | 383 (1,450) | 463 (1,753) |
| **70 (4.8)** | 62 (235) | 97 (367) | 140 (530) | 190 (719) | 248 (939) | 315 (1,192) | 388 (1,469) | 470 (1,779) |
| **72 (5.0)** | 63 (238) | 99 (375) | 142 (538) | 193 (731) | 252 (954) | 319 (1,208) | 394 (1,492) | 477 (1,806) |
| **74 (5.1)** | 64 (242) | 100 (379) | 144 (545) | 196 (742) | 255 (965) | 323 (1,223) | 399 (1,510) | 483 (1,828) |
| **76 (5.2)** | 65 (246) | 101 (382) | 146 (553) | 198 (750) | 259 (980) | 328 (1,242) | 405 (1,553) | 490 (1,855) |
| **78 (5.4)** | 66 (250) | 103 (390) | 148 (560) | 201 (761) | 262 (992) | 332 (1,257) | 410 (1,552) | 496 (1,878) |
| **80 (5.5)** | 66 (250) | 104 (394) | 150 (568) | 203 (768) | 266 (1,007) | 336 (1,272) | 415 (1,571) | 502 (1,900) |
| **85 (5.9)** | 68 (257) | 107 (405) | 154 (583) | 210 (795) | 274 (1,037) | 347 (1,314) | 428 (1,620) | 518 (1,961) |
| **90 (6.2)** | 70 (265) | 110 (416) | 159 (602) | 216 (818) | 282 (1,067) | 357 (1,351) | 440 (1,666) | 533 (2,018) |
| **95 (6.6)** | 72 (273) | 113 (428) | 163 (617) | 222 (840) | 289 (1,094) | 366 (1,386) | 452 (1,711) | 547 (2,071) |
| **100 (6.9)** | 74 (280) | 116 (439) | 167 (362) | 228 (863) | 297 (1,124) | 376 (1,423) | 464 (1,756) | 562 (2,127) |
| **105 (7.2)** | 76 (288) | 119 (451) | 171 (647) | 233 (882) | 304 (1,151) | 385 (1,457) | 476 (1,802) | 575 (2,177) |
| **110 (7.6)** | 78 (295) | 122 (462) | 175 (663) | 239 (905) | 311 (1,117) | 394 (1,492) | 487 (1,844) | 589 (2,230) |
| **115 (7.9)** | 80 (303) | 125 (473) | 179 (678) | 244 (924) | 319 (1,208) | 403 (1,526) | 498 (1,885) | 602 (2,279) |
| **120 (8.3)** | 81 (307) | 127 (481) | 183 (712) | 249 (943) | 325 (1,203) | 412 (1,560) | 509 (1,927) | 615 (2,328) |

**Chart E-1: Nozzle Flow and Pressure Ratings, Part 1**

| GPM (LPM) at Various Nozzle Sizes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Nozzle Pressure | Nozzle Size in Inches (millimeters) | | | | | | | |
| PSI (BAR) | 1-1/2” (13) | 1-5/8” (16) | 1-3/4” (19) | 1-7/8” (22) | 2.0” (25.4) | 2-1/4” (57) | 2-1/2” (64) | 3.0” (76) |
| **30 (2.1)** | 366 (1,386) | 430 (1,628) | 498 (1,885) | 572 (2,065) | 651 (2,464) | 824 (3,119) | 1,017 (3,850) | 1,464 (5,542) |
| **35 (2.4)** | 395 (1,495) | 464 (1,756) | 538 (2,037) | 618 (2,339) | 703 (2,661) | 890 (3,369) | 1,098 (4,156) | 1,581 (5,985) |
| **40 (2.7)** | 423 (1,601) | 496 (1,878) | 575 (2,177) | 660 (2,498) | 751 (2,843) | 951 (3,600) | 1,174 (4,444) | 1,691 (6,401) |
| **45 (3.1)** | 448 (1,696) | 525 (1,987) | 610 (2,309) | 700 (2,650) | 797 (3,017) | 1,009 (3,820) | 1,245 (4,713) | 1,793 (6,787) |
| **50 (3.5)** | 473 (1,791) | 555 (2,101) | 643 (2,434) | 738 (2,794) | 840 (3,180) | 1,063 (4,024) | 1,313 (4,970) | 1,890 (7,154) |
| **55 (3.8)** | 496 (1,878) | 582 (2,203) | 675 (2,555) | 774 (2,930) | 881 (3,335) | 1,115 (4,221) | 1,377 (5,213) | 1,982 (7,503) |
| **60 (4.1)** | 518 (1,961) | 608 (2,302) | 705 (2,669) | 809 (3,062) | 920 (3,483) | 1,165 (4,410) | 1,438 (5,444) | 2,071 (7,840) |
| **62 (4.3)** | 526 (1,991) | 618 (2,339) | 716 (2,710) | 822 (3,112) | 935 (3,540) | 1,184 (4,482) | 1,462 (5,534) | 2,105 (7,968) |
| **64 (4.4)** | 535 (1,025) | 628 (2,377) | 728 (2,756) | 835 (3,161) | 950 (3,596) | 1,203 (4,554) | 1,485 (5,621) | 2,138 (8,093) |
| **66 (4.6)** | 543 (1,056) | 637 (2,411) | 739 (2,797) | 848 (3,210) | 965 (3,653) | 1,222 (4,626) | 1,508 (5,708) | 2,172 (8,222) |
| **68 (4.7)** | 551 (1,086) | 647 (2,449) | 750 (2,839) | 861 (3,259) | 980 (3,710) | 1,240 (4,694) | 1,531 (5,796) | 2,204 (8,343) |
| **70 (4.8)** | 559 (1,116) | 656 (2,483) | 761 (2,886) | 874 (3,309) | 994 (3,763) | 1,258 (4,762) | 1,553 (5,879) | 2,236 (8,464) |
| **72 (5.0)** | 567 (1,146) | 666 (2,521) | 772 (2,922) | 886 (3,354) | 1,008 (3,816) | 1,276 (4,830) | 1,575 (5,962) | 2,268 (8,585) |
| **74 (5.1)** | 575 (1,177) | 675 (2,555) | 783 (2,964) | 898 (3,390) | 1,022 (3,869) | 1,293 (4,895) | 1,597 (6,045) | 2,299 (8,703) |
| **76 (5.2)** | 583 (1,207) | 684 (2,589) | 793 (3,002) | 910 (3,445) | 1,036 (3,922) | 1,311 (4,963) | 1,618 (6,125) | 2,330 (8,820) |
| **78 (5.4)** | 590 (1,233) | 693 (2,623) | 803 (3,040) | 922 (3,490) | 1,049 (3,971) | 1,328 (5,027) | 1,639 (6,204) | 2,361 (8,937) |
| **80 (5.5)** | 598 (1,264) | 707 (2,657) | 814 (3,081) | 934 (3,536) | 1,063 (4,024) | 1,345 (5,091) | 1,660 (6,284) | 2,391 (9,051) |
| **85 (5.9)** | 616 (1,332) | 723 (2,737) | 839 (3,176) | 963 (3,645) | 1,095 (4,145) | 1,386 (5,247) | 1,711 (6,477) | 2,465 (9,331) |
| **90 (6.2)** | 634 (2,400) | 744 (2,816) | 863 (3,266) | 991 (3,751) | 1,127 (4,266) | 1,427 (5,402) | 1,761 (6,666) | 2,536 (9,600) |
| **95 (6.6)** | 651 (2,464) | 765 (2,896) | 887 (3,358) | 1,018 (3,858) | 1,158 (4,384) | 1,466 (5,549) | 1,809 (6,848) | 2,605 (9,861) |
| **100 (6.9)** | 668 (2,529) | 784 (2,968) | 910 (3,445) | 1,044 (3,952) | 1,188 (4,497) | 1,504 (5,693) | 1,856 (7,027) | 2,673 (10,118) |
| **105 (7.2)** | 685 (2,593) | 804 (3,044) | 932 (3,529) | 1,070 (4,050) | 1,217 (4,607) | 1,541 (5,833) | 1,902 (7,200) | 2,739 (10,368) |
| **110 (7.6)** | 701 (2,654) | 823 (3,115) | 954 (3,611) | 1,095 (4,145) | 1,246 (4,717) | 1,577 (5,970) | 1,947 (7,370) | 2,803 (10,611) |
| **115 (7.9)** | 717 (2,714) | 841 (3,184) | 976 (3,695) | 1,120 (4,240) | 1,274 (4,823) | 1,613 (6,106) | 1,991 (7,537) | 2,867 (10,853) |
| **120 (8.3)** | 732 (2,771) | 859 (3,252) | 997 (3,774) | 1,144 (4,331) | 1,301 (4,925) | 1,647 (6,235) | 2,034 (7,700) | 2,928 (11,084) |

**Chart E-2: Nozzle Flow and Pressure Ratings, Part 2**

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# Appendix F: Cavitation

(See Figure F-1: “Sample, Cavitation Regions.”)

Cavitation can occur while pumping from draft, in relay, or from a hydrant (although it is more likely from draft conditions). The operator must be aware of the warning signs and immediately correct the situation.

Cavitation can damage the impeller and other sensitive components, impair pump performance, and reduce flow capacity. The damage done during any one period of cavitation is not great, but the effects are cumulative. Implosions occurring during cavitation break away or erode tiny pieces of metal from the internal parts and the pump casing. When enough metal has been chipped away, the impeller becomes unbalanced causing a strain and vibration on bearings, bushings and shafts.

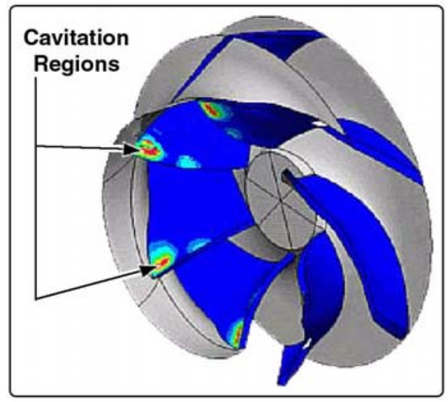


**Figure F-1: Sample, Cavitation Regions**

## Process of Cavitation

Cavitation occurs when a centrifugal pump attempts to discharge more water than it is receiving. When cavitation occurs, bubbles are created under the vacuum, formed near the eye of the impeller. Cavitation is often referred to as “the pump running away from the fluid supply.” This means the operator is trying to pump more water out of the pump than is going into the pump.

The formation of bubbles in the low pressure regions of the impeller cause the impeller to “slip” in the water, since the impeller is designed to move liquid not the air in the bubbles. (See Figure F-1: “Sample, Cavitation Regions.”)

When increased discharge flow exceeds the intake, bubbles form in the low-pressure region at the eye of the impeller. The pressure of the water in the pump drops as it flows from the suction flange through the suction nozzle and into the impeller.

As flow from the pump increases, the vacuum at the impeller increases. As vacuum increases, water near the impeller eye begins to boil and vaporizes.

Once the vapor pockets (bubbles) enter the impeller, the process begins to reverse itself. As the vapor reaches the discharge side of the pump, it is subjected to a high positive pressure and condenses back to a liquid.

This sudden change from vapor to liquid generates a shock effect that damages the impeller and pump housing. Usually there are thousands of tiny vapor pockets (or bubbles).

It is the collapsing (or implosion) of these bubbles that causes the characteristic sound of cavitation that has been described as rocks tumbling in the pump.

## Warning Signs of Cavitation (Discharge and Gauges)

### Discharge Pressure

In a properly functioning pump, an increase in RPM increases the discharge pressure and volume. An increase in engine RPM that does not cause an increase in the pump discharge pressure is the most reliable indication that a pump is approaching cavitation.

### Vacuum Compound Gauge

Do not depend entirely on the vacuum (compound) gauge to indicate when a pump is nearing cavitation.

The vacuum gauge is usually tapped into the intake chamber several inches away from the leading edge of the impeller eye where the greatest amount of vacuum occurs. The vacuum gauge does not take into account ambient temperature nor atmospheric pressure and is not accurate near zero (0) on the vacuum scale.

## To Eliminate Cavitation

To eliminate cavitation, the operator must be aware of the warning signs listed above. Low barometer, high elevation, and elevated water temperature also contributes to cavitation.

Pumps are rated at standard temperatures and barometric pressures. When conditions vary from standard, the maximum capacity of the pump from draft can be affected.

The most common way to eliminate cavitation is to decrease the amount of water being discharged by decreasing engine speed or closing discharge valves. However, this also results in a reduction of flow.

Cavitation is also eliminated by increasing the pump inlet pressure. This is accomplished with reduced vertical lift, reduced inlet losses, or running from positive pressure supplies.

## During Operations

| Water Temperature F° | (C°) | Lift Losses Head Ft. | (Meters) |
|---|---|---|---|
| **60°** | (16°) | **NFPA Base Line - 2.38 (0.73mm)** | |
| **70°** | (21°) | **0.3** | (0.09) |
| **80°** | (27°) | **0.6** | (0.18) |
| **90°** | (32°) | **1.1** | (0.34) |
| **100°** | (38°) | **1.7** | (0.52) |
| **110°** | (43°) | **2.5** | (0.76) |

**Figure F-2: Lift Loss from Temperature**

- Do not increase pump speed beyond the speed at which the pressure ceases to rise. The higher the elevation above sea level, the lower the atmospheric pressure and less lift. *Lift loss is in addition to NFPA Baseline of 2.38 ft. (0.73 meters) at 2,000 (610 meters) of elevation - see Figure F-3: "Lift Loss from Elevation" on page 127.*
- Open the throttle gradually and watch the pressure gauge and the tachometer, if equipped. An increase in engine RPM without a corresponding increase in pressure indicates cavitation.
- Monitor the water temperature. Figure F-2: "Lift Loss from Temperature" shows the amount of lift loss as temperatures rise.
- Monitor barometric pressure. NFPA standard sets a baseline of 29.9" Hg. (See Figure F-3a: "Lift Loss from Barometric Reading.")

| Elevation, Feet | (Meters) | Lift Loss, Feet | (Meters) |
|---|---|---|---|
| **2,000** | (610) | **NFPA Base Line - 2.38 (0.73mm)** | |
| **3,000** | (914) | 1.1 | (0.33) |
| **4,000** | (1,219) | 2.2 | (0.67) |
| **5,000** | (1,524) | 3.3 | (1.00) |
| **6,000** | (1,829) | 4.4 | (1.34) |
| **7,000** | (2,134) | 5.5 | (1.67) |
| **8,000** | (2,438) | 6.6 | (2.01) |
| **9,000** | (2,743) | 7.7 | (2.35) |
| **10,000** | (3,048) | 8.8 | (2.68) |

**Figure F-3: Lift Loss from Elevation**

| Barometric Reading in. | (mb) | Lift Loss, Head Ft. | (Meters) |
|---|---|---|---|
| **29.9** | (1,012.5) | **NFPA Base Line - 2.38 (0.73mm)** | |
| **29.7** | (1,005.8) | 0.2 | (0.6) |
| **29.5** | (999) | 0.5 | (0.15) |
| **29.3** | (999.2) | 0.7 | (0.21) |
| **29.1** | (985.4) | 0.9 | (0.27) |
| **28.9** | (987.7) | 1.1 | (0.33) |
| **28.7** | (971.9) | 1.4 | (0.43) |

**Figure F-3a: Lift Loss from Barometric Reading**

- Regularly inspect suction hoses to check for air leaks. Air leaks can also cause cavitation.
- Check suction strainer for blockage or effectiveness. See heading "Strainers:" on page 128.

## Preventive Measures

- Consider the size of the suction hose. Figure F-4: "Hose Size vs. Pump Rating Capacity" on page 128, lists the NFPA pre-selected hose sizes for each pump-rating capacity. Using the appropriately sized hose minimizes the occurrence of cavitation. An undersized suction hose can lead to cavitation.

❑ Consider the piping within the truck. Suction losses can result from additional suction piping added to the fire pump during assembly.

| Hose Diameter in. (mm) | 3" (76) | 4" (102) | 4.5" (127) | 5" (127) | 6" (152) | Dual 6" (152) |
|---|---|---|---|---|---|---|
| **Flow - gpm (lpm)** | **Lift Loss (gpm (lpm)** | | | | | |
| **250 (946)** | 5.2 (20) | | | | | |
| **350 (1,325)** | | 2.5 (9.5) | | | | |
| **500 (1,893)** | | 5.0 (19) | 3.6 (13.6) | | | |
| **750 2,839)** | | 11.4 (43) | 8.0 (30) | 4.7 (18 | 1.9 (7.2) | |
| **1,000 (3,785)** | | | 14.5 (55) | 8.5 (32) | 3.4 (13) | |
| **1,250 (4,732)** | | | | 13 (49) | 5.2 (20) | |
| **1,500 (5,678)** | | | | | 7.6 (29) | 1.9 (7.2) |
| **1,750 (6,625)** | | | | | 10.4 (39) | 2.6 (10) |
| **2,000 (7,571)** | | | | | | 3.4 (13) |
| **2,500 (9,464)** | | | | | | 5.2 (20) |

**Figure F-4: Hose Size vs. Pump Rating Capacity**

❑ Follow the maintenance and inspection procedures.

❑ Cavitation can also occur when air enters the pump. The pump could be primed; however, air leaks can cause rough operation and an increase of engine speed without an increase in pressure or flow. If an air leak is suspected, refer to Section 5 "Troubleshooting."

❑ Using "soft sleeve" vs. "hard sleeve." The soft sleeve has an advantage as the sleeve collapses under a partial vacuum (visual indication of cavitation), even though the intake gauge might still indicate a positive pressure. With a hard sleeve, the only indicator would be the intake gauge, which is inaccurate at close to the ZERO (0) reading.

**Strainers:**

Clogged strainers or suction strainer selection, restricting flow. Verify the hose strainers and suction strainer are clear (unobstructed) and located deep enough in the water source to insure constant, uninterrupted water flow.

**Note:** Strainer type, basket vs. barrel, also has an affect on water flow which can contribute to flow restrictions, thus causing cavitation and reduced pump performance, especially during high drafting conditions. Basket strainers are preferred by Hale due to their overall suction and straining area.

❑ Turbulence or whirlpools in the hose line can be caused by excessive operating pressures from the intake source. Carefully monitor and reduce pressures as needed.

# Express Warranty

**EXPRESS WARRANTY:** Hale Products, Inc. (HALE) hereby warrants to the original Buyer that products manufactured by Hale are free of defects in material and workmanship for two (2) years or 2,000 hours usage, whichever shall first occur. The "Warranty Period" commences on the date the original Buyer takes delivery of the product from the manufacturer.

**LIMITATIONS:** Hale's obligation is expressly conditioned on the Product being:

- Subjected to normal use and service.
- Properly maintained in accordance with Hale's Instruction Manual as to recommended services and procedures.
- Not damaged due to abuse, misuse, negligence, or accidental causes.
- Not altered, modified, serviced (non-routine) or repaired other than by an Authorized Service Facility.
- Manufactured per design and specifications submitted by the original Buyer.

**THE ABOVE EXPRESS LIMITED WARRANTY IS EXCLUSIVE. NO OTHER EXPRESS WARRANTIES ARE MADE. SPECIFICALLY EXCLUDED ARE ANY IMPLIED WARRANTIES INCLUDING, WITHOUT LIMITATIONS, THE IMPLIED WARRANTIES OF MERCHANTABILITY OF FITNESS FOR A PARTICULAR PURPOSE OR USE; QUALITY; COURSE OF DEALING; USAGE OF TRADE; OR PATENT INFRINGEMENT FOR A PRODUCT MANUFACTURED TO ORIGINAL BUYER'S DESIGN AND SPECIFICATIONS.**

**EXCLUSIVE REMEDIES:** If Buyer promptly notifies HALE upon discovery of any such defect (within the Warranty Period), the following terms shall apply:

- Any notice to HALE must be in writing, identifying the Product (or component) claimed defected and circumstances surrounding its failure.
- HALE reserves the right to physically inspect the Product and require Buyer to return same to HALE's plant or other Authorized Service Facility.
- In such event, Buyer must notify HALE for a Returned Goods Authorization Number and Buyer must return the product F.O.B. within thirty (30) days thereof.
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- Absent proper notice *within* the Warranty Period, HALE shall have no further liability or obligation to Buyer therefore.

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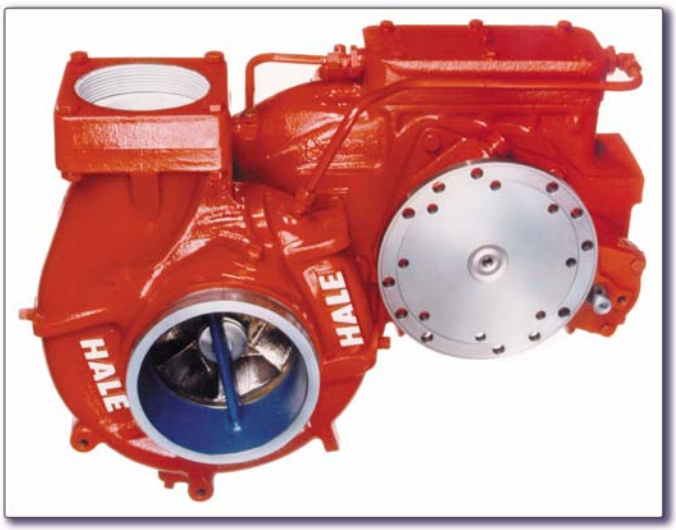


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