



# APS / APS -M / MBP / MBP -M AP -M / MG -A / MG -M / TBP / TBP-M

## Installation, Operation and Service Maintenance Manual



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## NOTICE !

Hale Products, Inc. (Hale) 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.**

ECO NO	REV	CHANGE FROM	BY	DATE	APVD	 <b>HALE PRODUCTS, INC.</b> A Unit of IDEX Corporation Conshohocken, PA 19428 USA			
05-019	A	Initial Release	LwH	01/20/2005	MAL				
0336	B	Pump Shaft Bearings	LwH	03/15/2006	MAL				
0438	C	Model # Clarification	LwH	09/29/2006	MAL				
0534	D	Update Mechanical Seal +	LwH	03/08/2007	MAL				
0856	E	Add TBP	ZLW	08/04/2009	MAL	DRAWN BY	LwH	ISSUE DATE	03/08/2007
						CHECKED BY	PRW	<small>COPYRIGHT © NOT TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY.</small>	

# 1 Hale “Silencer” Booster Pump

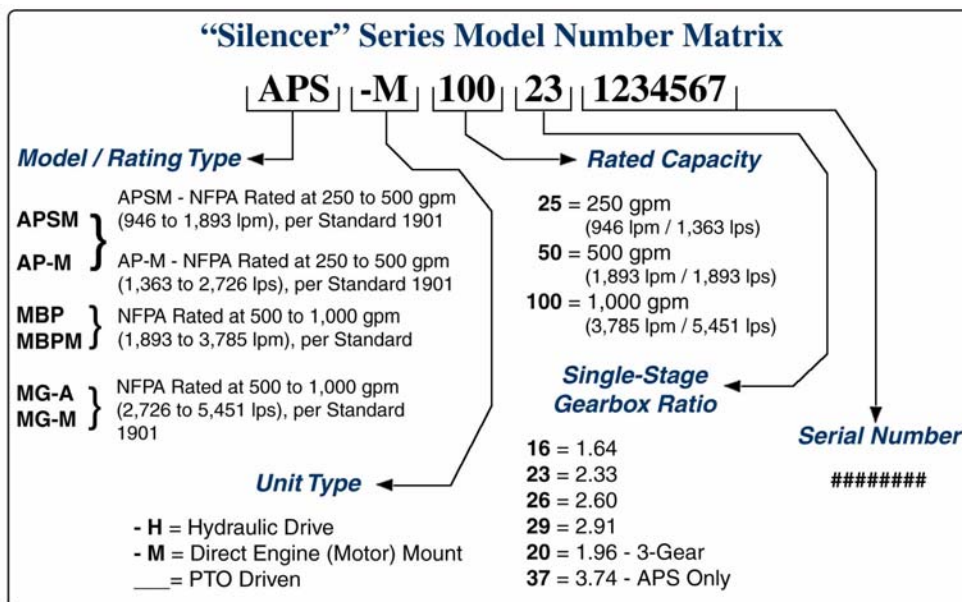
Hale Products, Inc. currently offers the “Silencer” Series Booster Pumps in various models. For a model number description, see Table A-1: Booster Pump Model Number Matrix.

-  **APS / AP-\* Series** – Single-Stage, Centrifugal Attack Pump (250-500 GPM / 1,000-2,000 LPM [1,363-2,726 LPS]) - three primary drive options: truck transmission PTO, hydraulic drive (-H) or direct engine mount (-M).
-  **MBP / MG -\* Series** – Single-Stage, Centrifugal, “High Volume” Attack Pump (500-1,000 GPM / 2,000-4,000 LPM [47.3-63.1 LPS]) - three primary drive options: truck transmission PTO, hydraulic drive (-H) or direct engine mount (-M).
-  **TBP - \* Series** – Two-Stage, Centrifugal, “High Volume / High Pressure” Attack Pump (500-750 GPM / 1,893-2,893 LPM [21.5-47.3 LPS]) -- three primary drive options: truck transmission PTO, hydraulic drive (-H) or direct engine mount (-M).

The Hale line of booster pumps are the favorites of fire fighters throughout the world. Booster pumps can be used as initial attack pumps or as auxiliary pumps in conjunction with the apparatus main pump. They offer the versatility, dependability, reliability, ease of operation and reduced maintenance that is so necessary to effective fire fighting. Hale booster pumps are compact in size and lightweight for easy mounting. The apparatus builder must supply the transmission PTO (power takeoff) and connecting shaft.

Hale offers various models of the silencer series booster pumps. The anticipated use and position on the apparatus determines the model selected as

well as the drive unit.



**Table A-1: Booster Pump Model Number Matrix**

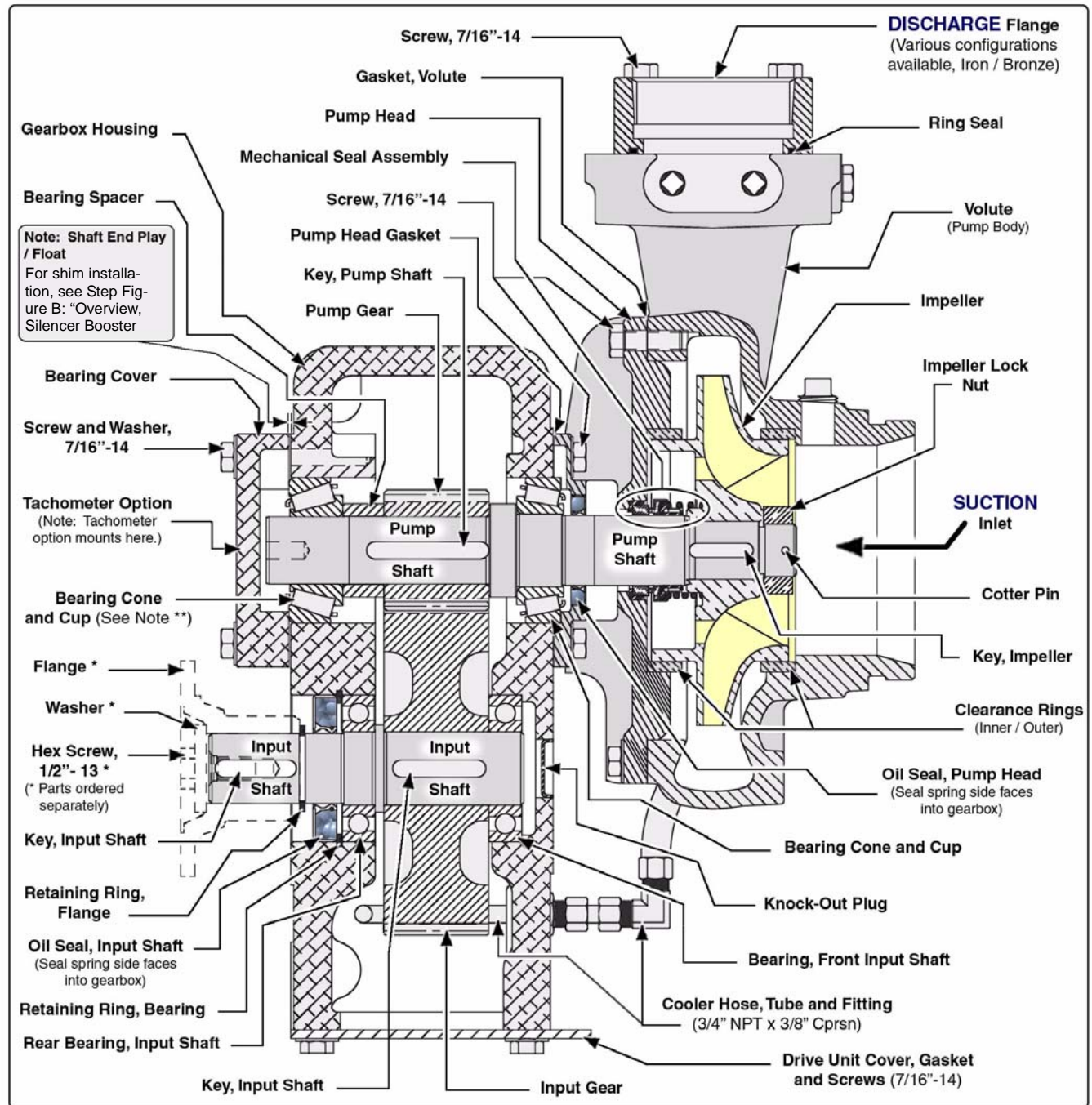


Figure B: Overview, Silencer Booster Pump



# 1 Safety Precautions



## IMPORTANT !

HALE 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.

*Hale is a registered trademark of Hale Products, Incorporated. All other brand and product names are the trademarks of their respective holders.*

## 1.1 DEFINITIONS



### DANGER !

**DANGER** - Immediate hazard which WILL result in severe personal injury or death if the warning is ignored.



### WARNING !

**WARNING** - Hazards or unsafe practices which COULD result in severe personal injury or death if the warning is ignored.



### CAUTION !

**CAUTION** - Hazards or unsafe practices which COULD result in minor or moderate personal injury if the warning is ignored.





### **NOTICE !**

**NOTICE** - Practices which could result in damage to the apparatus or other property.

## **1.2 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.**

**ALL FASTENERS ON THE HALE PUMP AND GEARBOX ASSEMBLY ARE 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.**

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



**WARNING - continued !**

**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.

- ☐ **Fluids** - To meet various shipping regulations, oil is drained from the gearbox reservoir prior to shipping from the factory.

At installation and before operation, oil must be added to the appropriate levels. (See Section 4, heading "Replace Gearbox Oil," on page 59.)

See separate documentation provided with the engine and pump and gearbox assemblies for proper fluids to use and quantities required.

- ☐ **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 145.

- ☐ 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:**

**Hale Products, Incorporated**

Fire Suppression Division

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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.

## □ Safety

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- 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 19 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 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 33 for additional information.
- DO NOT advance the throttle unless the OK TO PUMP indicator is ON. Also see Section 3 “Basic Operation” on page 33 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 ON. Also see Section 3 “Basic Operation” on page 33 for additional information.
- ☐ DO NOT attempt emergency manual shift procedures while the engine is running. Also see Section 3 “Basic Operation” on page 33 for additional information.
- ☐ Never attempt to shift the pump (PUMP-to-ROAD, vise versa) while the apparatus transmission is in gear. Always shift the transmission to NEUTRAL (N) and verify the speedometer is at ZERO (0) before shifting the pump. Also see Section 3 “Basic Operation” on page 33 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.

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## 2 Introduction

### 2.1 PRINCIPLES OF OPERATION

#### Centrifugal Force

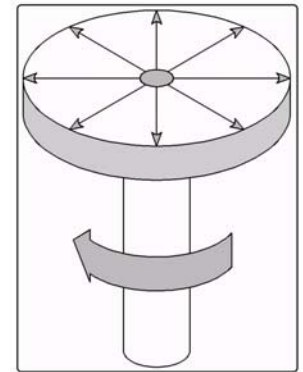
Hale pumps are centrifugal pumps that operate on the principle of centrifugal force created by a rapidly spinning disk. (See Figure 2-1: “Centrifugal Force - Rotating Disk.”)

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

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.

Three interrelated factors 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 / LPS), changes inversely; if pressure increases, flow decreases. Pressure is measured in pounds per square inch (PSI) or BAR (MPa).
- **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 / LPS) that a pump can deliver when supplied from draft.



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

A centrifugal pump has the ability to fully utilize any positive suction inlet pressure, thus reducing the amount of work done by the pump.

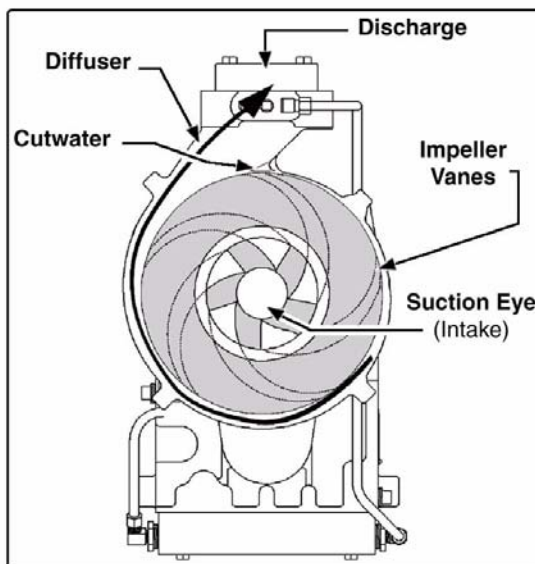
For example, if the required discharge pressure is 120 PSI (8.3 BAR / 0.8 MPa) and the inlet pressure is 45 PSI (3.1 BAR / 0.3 MPa), the pump must only produce the difference in pressure or 75 PSI (5.2 BAR / 0.5 MPa).

This contributes to improved performance with reduced maintenance. Additionally, 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.”)

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.

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



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

## Pump Stages

The number of pump stages is determined by the number of impellers on a common shaft. The Hale series of single and two-stage pumps provide the same normal operating and rating test pressures. The two-stage pump provides an additional level of operating pressures if required. See page \_\_\_\_ for single and two-stage pump ratings.

## 2.2 PUMP COMPONENTS

(See Figure 2-3: “Typical Pump and Gearbox Overview,” on page 15.)

**The Hale single-stage pump consists of:**

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

- Gearbox
- Bearings

**The Hale two-stage booster pump consists of the same major components as the single-stage pump, with the addition of a few more:**

- Impeller (2) and Clearance Ring (3)
- Transfer Valve
- Check Valve

## Volute, Pump Body

(See Figure 2-3: “Typical Pump and Gearbox Overview,” on page 15.)

Water discharging from the impeller 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.

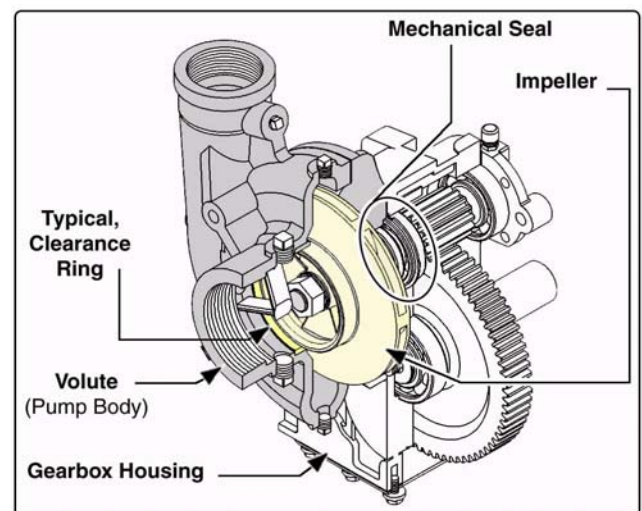
**Note:** Stainless Max pumps (volute and impeller) are constructed of corrosion resistant stainless steel (Models SMM / SMD and SMR Series).

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.

## 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” traces a drop of water from the intake of the impeller to the



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



discharge outlet.

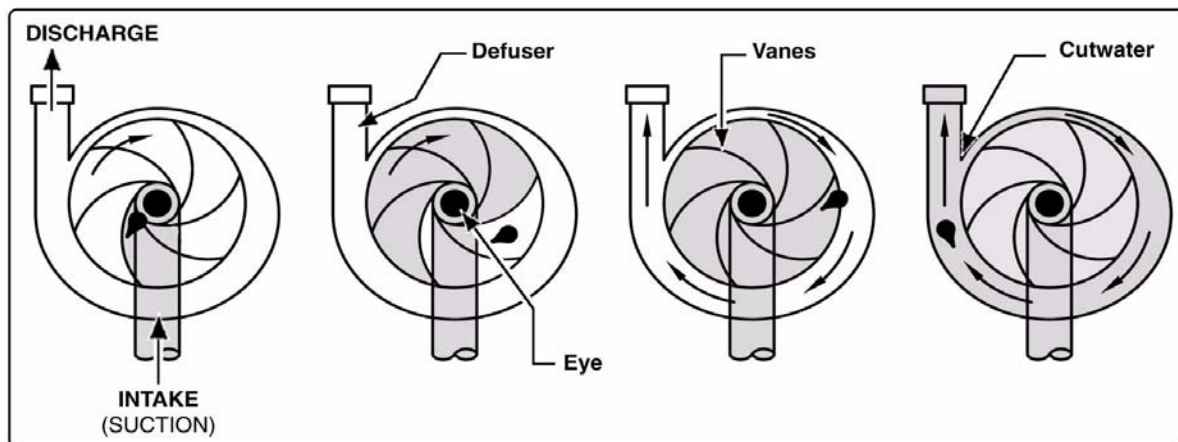


Figure 2-4: Impeller Operation

## Clearance Rings

Clearance rings prevent pressurized water that is leaving the pump volute from returning to the intake of the impeller.

They 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 15.

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. 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.

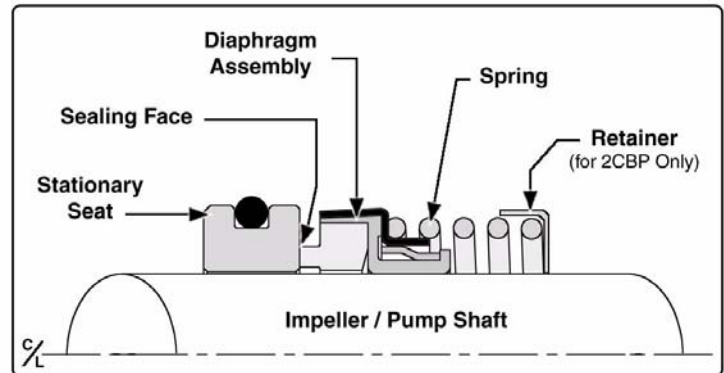


Figure 2-5: Typical Mechanical Seal Overview

**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. Anti-friction bearings are used and offer a major contribution to the life of a 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.

## Transfer Valve

A transfer valve allows the operator of a two-stage pump to select between volume and pressure operations, and is controlled from the apparatus pump control panel. This valve is an all-bronze waterway device that can transfer between pumping modes with a one-quarter turn of its control handle. The position of the valve is indicated on \_\_\_\_ by \_\_\_\_\_. An optional air actuated power transfer valve is also available.

## 2.3 TWO-STAGE BOOSTER PUMPS

The Hale series of two-stage booster pumps provide the same normal operating and rating test pressures as the Hale series of single-stage pumps, but the two-stage pump provides an additional level of operating pressures if required.

### Two-Stage Booster Pump Operation

The primary difference between a single-stage and a two-stage pump is that the former has only one impeller and no transfer valve to switch between volume and pressure operation. A transfer valve is a two-position valve that permits the impellers in a two-stage pump to be operated in parallel (volume) or series (pressure). Both types of operation are explained in the following paragraphs.

#### Volume (Parallel) Operation.

Volume operation (figure \_\_\_\_), results in the pressure at the pump intake being added to the pressure developed by both impellers and the amount of water delivered to the discharge. This is the sum of the flows of the two impellers. For example, if the inlet pressure is 30 PSI (2 BAR) and the flow of each impeller is 500 GPM (1,892 LPM) at 150 PSI (10 BAR), the pressure and volume at the discharge is:

Flow/Impeller x (# Impellers)

500 GPM per Impeller X 2 Impellers = 1,000 GPM (1,892 LPM per Impeller X 2 Impellers = 3,785 LPM)

30 PSI Inlet Pressure + 150 PSI Pump Pressure = 180 PSI (2 BAR)  
Inlet Pressure + 10 BAR Pump Pressure = 12 BAR)

#### Pressure (Series) Operation.

Pressure operation (figure \_\_\_\_), finds the impellers connected in series. That is, the output of the impeller supplied from the pump intake is supplied to the input of the next impeller. The pressure at the pump discharge is the sum of the pressure of the two impellers plus the pressure of the intake. The amount of water delivered to the discharge is the same amount that entered the first impeller. Using the example above when in series operation, the discharge pressure will

be 330 PSI (22 BAR), and the discharge volume will be 500 GPM (1,892 LPM).

### **Volume versus pressure operation:**

Selection of volume or pressure is determined by three factors.

Generally, the pump should be operated so that the pump gives the desired performance at the lowest engine speed.

Transfer volume (parallel) operation for higher flows (see figure \_\_\_\_).

Transfer to pressure (series) operation when higher water pressures are required (see figure \_\_\_\_).

## **Choosing Between Volume and Pressure Operation**

In deciding which range to pump (*pressure or volume*), choose the one that gives the desired flow and pressure at the lowest engine speed. When a change of range is desired, slow down to idle speed, and shift the transfer valve to the desired range. When shifting the transfer valve from *volume* to *pressure* operation, the pressure will be doubled. You may hear a metallic click or two clicks, which will be the check valves closing. If the clicks sound too harshly, you are changing the transfer valve while the pressure is too high. This happens when the truck engine is running at high speed.

Refer to your fire department policy for when to use volume operation and when to use pressure operations. If your fire department does not have a policy to follow, here are general guidelines:

1. Hale pumps are designed to pump up to 200 PSI (13 BAR) net pressure in volume operation at reasonable engine speeds.
2. Generally, volume operation should be used at any net pump pressure under 150 PSI (10 BAR), especially when pumping from a hydrant.
3. When pumping from draft or a water tank, pressure operation may be used when the volume is less than one-half the pump capacity and when the desired pressure is over 150 PSI (10 BAR).
4. Be certain to warn everyone involved before changing pump range.

## Transferring Between Volume and Pressure Operation

Transferring between volume and pressure operation is evidenced by a metallic click, which results from the check valves closing. If the click is too loud or, perhaps, somewhat violent, the pumping pressure is too high for switching. In this case, you should ease back on the engine throttle.

Switching between volume and pressure operation is generally governed by prevailing fire department policy. However, there are some general guidelines if your fire department does not have an established policy:

1. The pump should be operated so that engine speed is within its best operating range.
2. Transfer to volume (parallel) operation if the pump has to discharge more than 50 percent of its rated capacity. Be certain to warn everyone involved before switching between volume and pressure operation.
3. Reduce the pump pressure to 50-60 PSI (3-4 BAR) before switching. The engine speed should especially be reduced when switching from volume to pressure operation with hand held hoses in use.

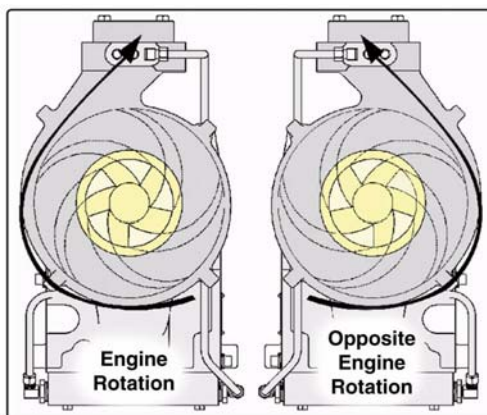
## 2.4 PUMP DRIVES

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:

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

**Note:** Also see Plate #843A "Vehicle Mounted Pump Applications" located at the back of this manual.



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

(See Section 9 "Drawing Package" on page 23.)

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, using helical gears to reduce operating noise. Gearboxes are available in a variety of ratios to accommodate most manufacturer requirements for engines, transmissions, and PTOs, (speed and available horsepower).

Gearboxes are also available with various mounting configurations (e.g., short (S), long (L), extra long (XL), split-shaft, PTO (top, left-hand, right-hand), rear mount, etc.).

Hale gearboxes also feature, as standard equipment, a 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 (-M series) accept, via adapter, #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

The following accessories and /or options 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
- Transfer 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. This 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.

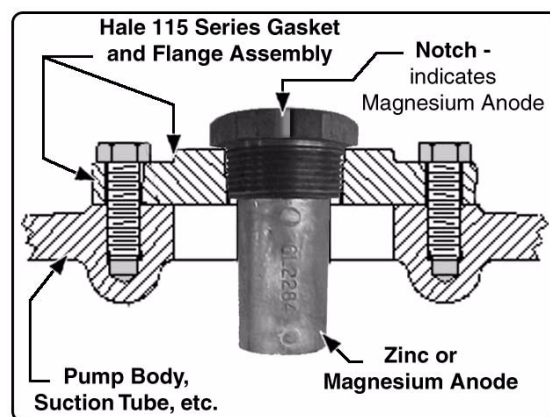


Figure 2a-1: Hale 1-1/4" NPT Anode

The Anode kit is designed for installation in the standard Hale 115 series flange opening. It is recommended that one anode be installed on each suc-

tion manifold and one on the discharge side. Performance varies with water quality and PH.

## 2A.2 AUXILIARY COOLING

### Gearbox Manifold Coolers

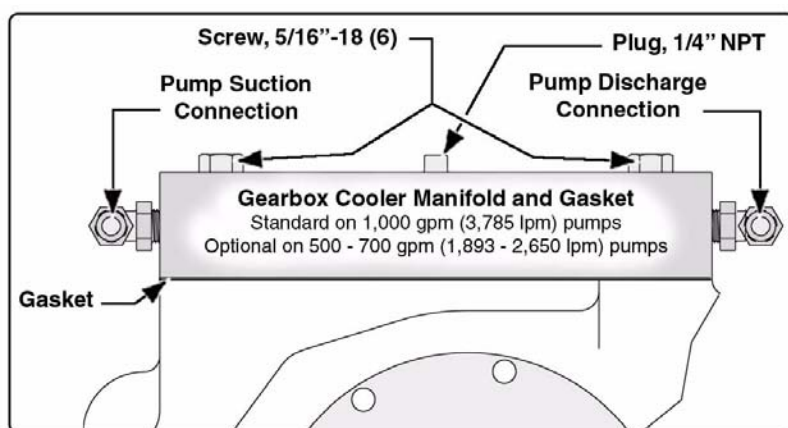


Figure 2a-2: Typical Gearbox Manifold Coolers

For pumps not equipped with standard gearbox cooling, a cooler option is available. (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.)

**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, see the separate manual provided with the valves. Also see Section 9, "Drawing Package" on page 23.

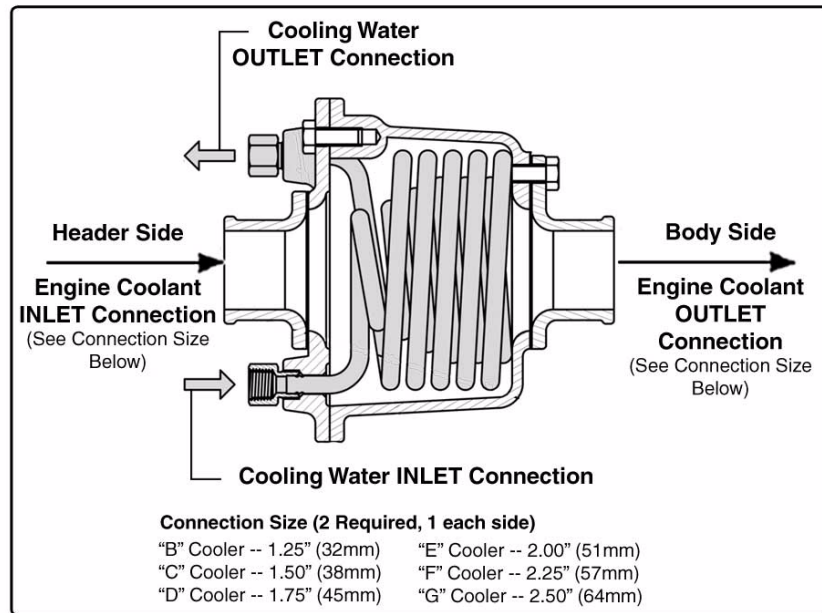


Figure 2a-3: Model "K" Heat Exchanger

## 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 Control.”)

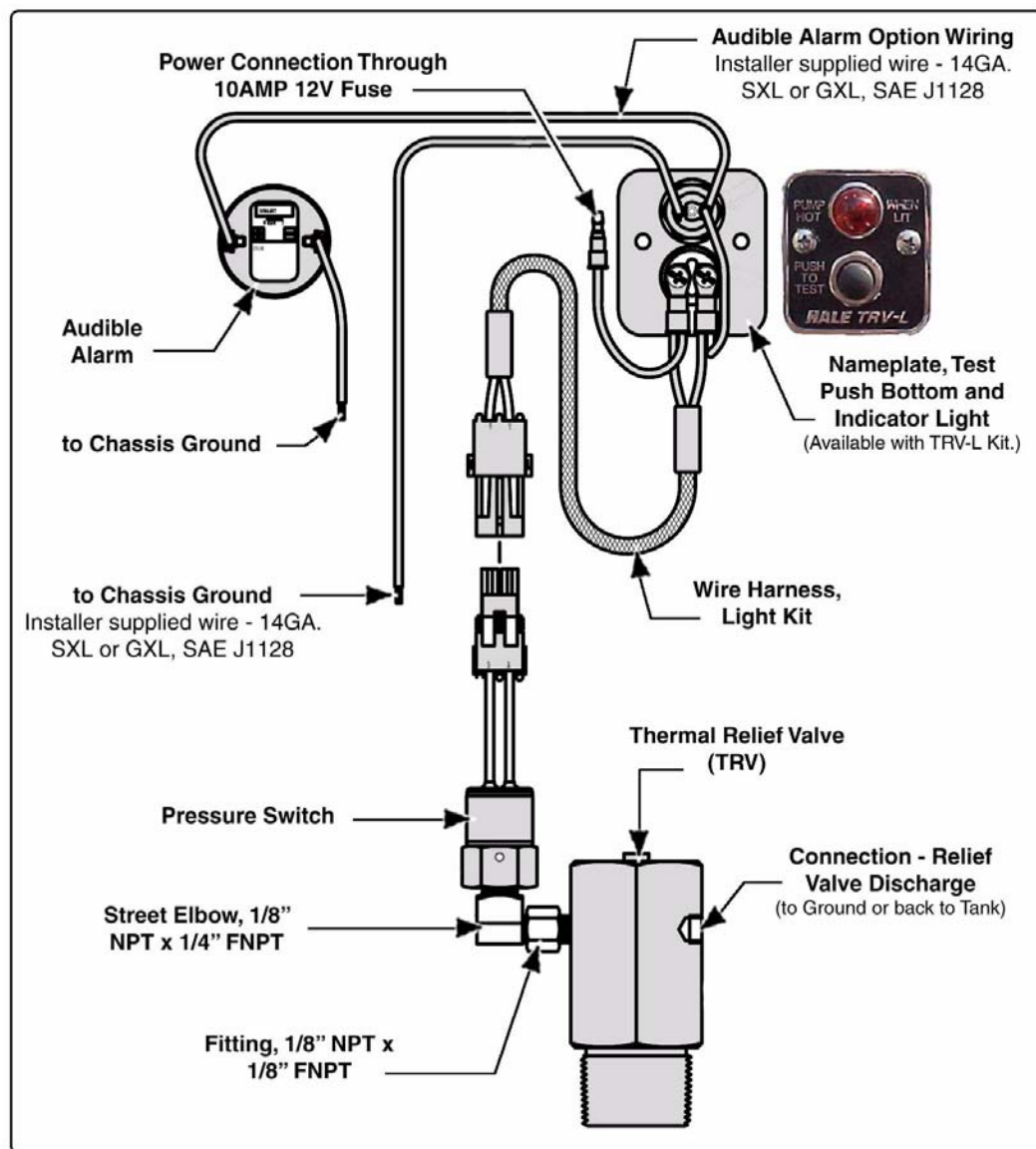
The **P** series relief valve system includes a panel mounted control valve (**PM**) and a relief valve (**P25, P30** or **P30V**). Also see Section 9, “Drawing Package” on page 23.

### Thermal Relief Valves (TRV)

Thermal Relief Valves (TRV) protect the pump from overheating. (See Figure 2a-5: “Thermal Relief Valve, TRV,” on page 27.)



**Figure 2a-4: P Series Relief Valve Control**



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

The valve monitors the water temperature in the pump. When temperatures exceed 120° F (49° C), the valve automatically OPENS. When the temperature returns to a safe level, the valve CLOSSES.

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

## 2A.4 PRIMING SYSTEMS

Hale recommends and uses **Rotary Vane Positive Displacement ESP** pumps for priming. Priming pumps are used to evacuate air in the suction hose and pump. (See Figure 2a-6: “Rotary Vane ESP Priming Pump.”)

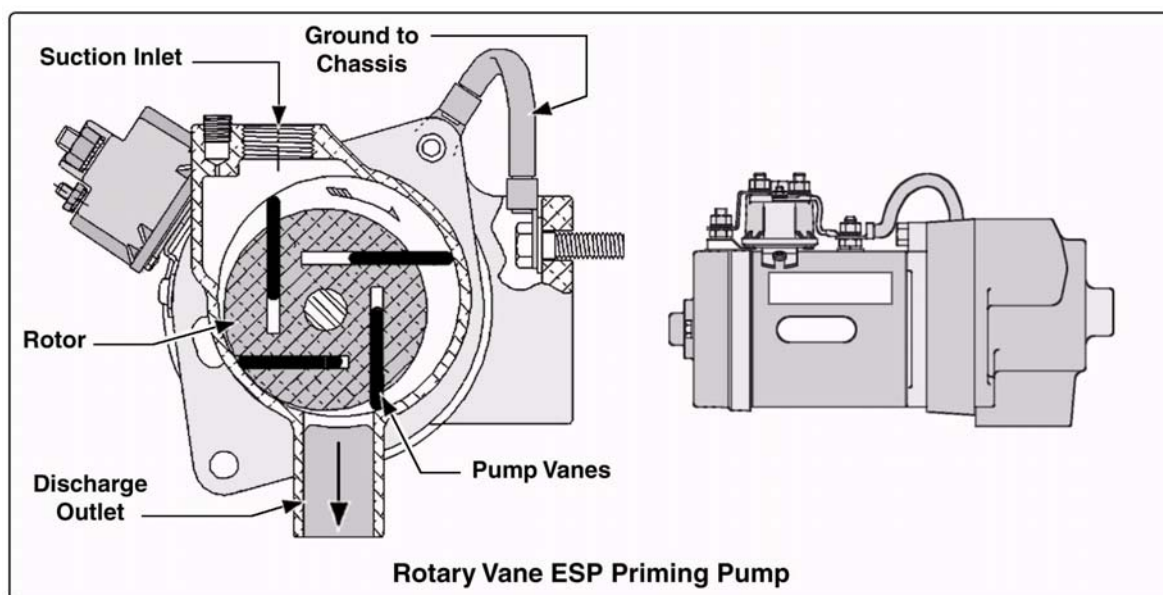


Figure 2a-6: Rotary Vane ESP Priming Pump

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 and start the priming motor. See separate manual, Hale p/n: 029-0810-01-0, for additional installation and operating instructions.

### 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

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 29.)

Releasing the push button stops the priming pump and the SPVR **CLOSES**.

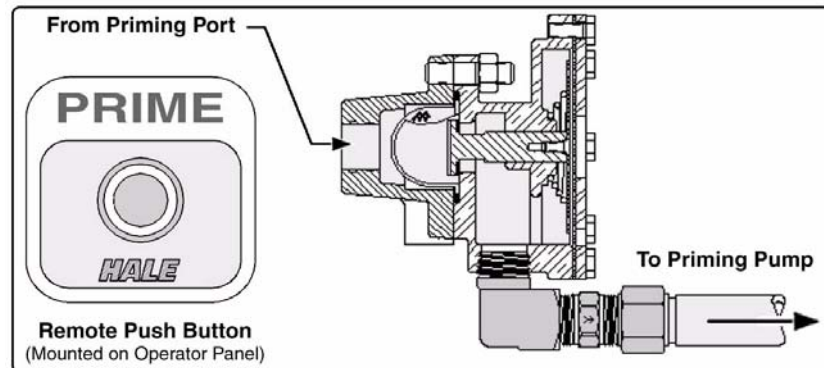


Figure 2a-7: SPVR Priming Valves

#### ☐ The Hale PVG Priming Valve

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

Pulling the handle out OPENS the valve and energizes the primer motor. Pushing the handle in de-energizes the motor and CLOSES the valve.

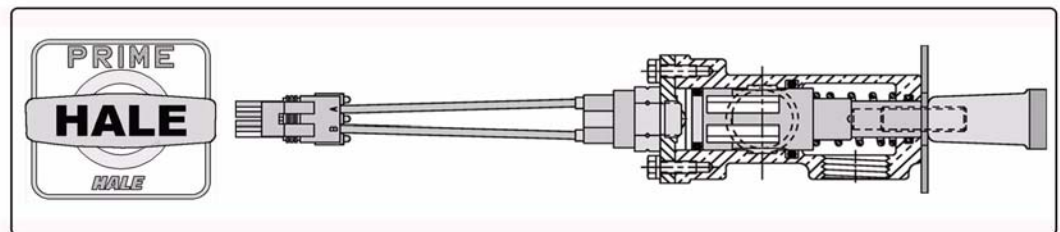
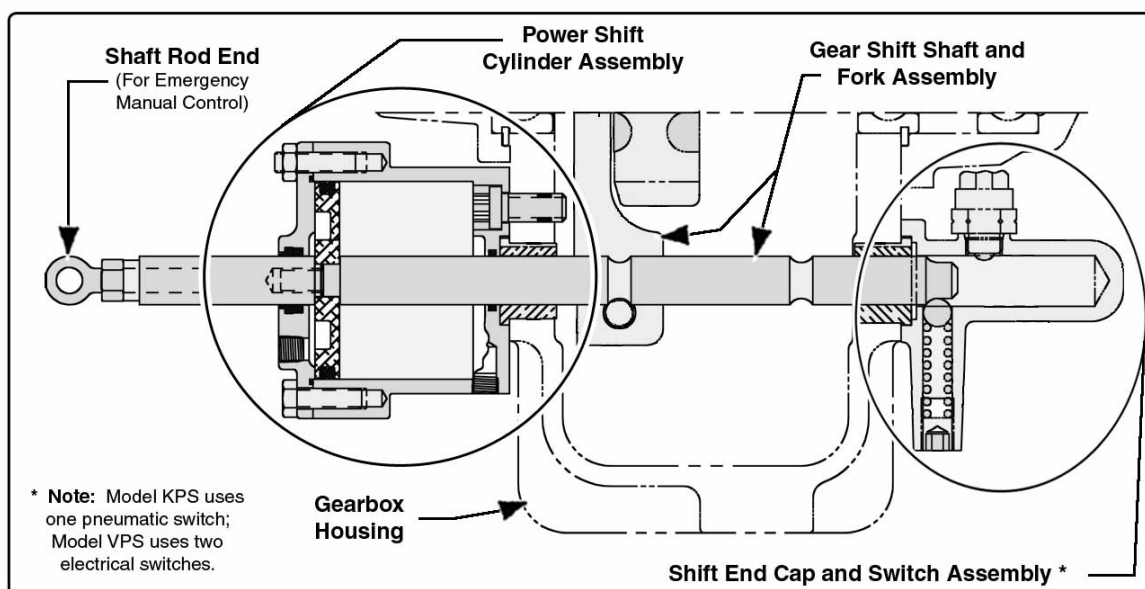


Figure 2a-8: PVG Priming Valves

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

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 30.)





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

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.

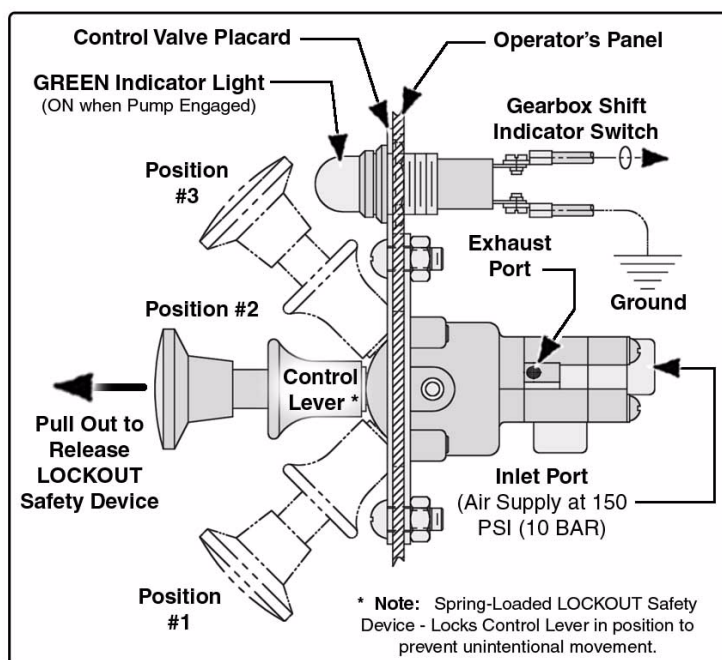


Figure 2a-10: Pump Shift Control Valve

## 2A.6 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.”)

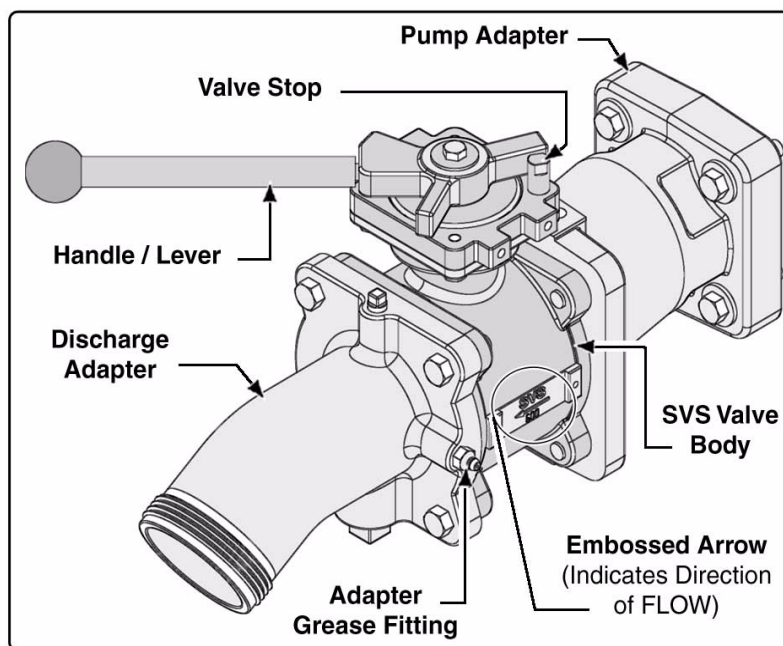


Figure 2a-11: Typical SVS Valve Primary Components

Numerous adapters tailor the valve to almost any installation requirement.

See separate manual (Hale p/n: 029-0020-90-0) provided for detailed operating and service instructions.



## 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:

- ☐ **Fluids** - on page 34.
- ☐ **Pumping from a hydrant** - on page 34.
- ☐ **Pumping from draft** - on page 38.
- ☐ **Pumping from an onboard tank (Split-Shaft PTO)** - on page 40.
- ☐ **Pumping in relay** - on page 42.
- ☐ **Tandem (series) pumping** - on page 44.
- ☐ **Pump and Roll** - on page 45.
- ☐ **Post-operation procedures** - on page 50.

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

## 3.2 FLUID LEVELS

To meet various shipping regulations, ALL fluids within the pump and gearbox assembly are drained prior to shipping from the factory.

### IMPORTANT !



AT INSTALLATION AND BEFORE OPERATING FOR THE FIRST TIME, OIL MUST BE ADDED TO THE GEARBOX TO THE APPROPRIATE LEVEL. FOR THE PROPER OIL TO USE AND QUANTITY REQUIRED, SEE SECTION 4, HEADING "REPLACE GEARBOX OIL" ON PAGE 59.

## 3.3 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 33.
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 45.



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 35.)

**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.

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.

### CAUTION !



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

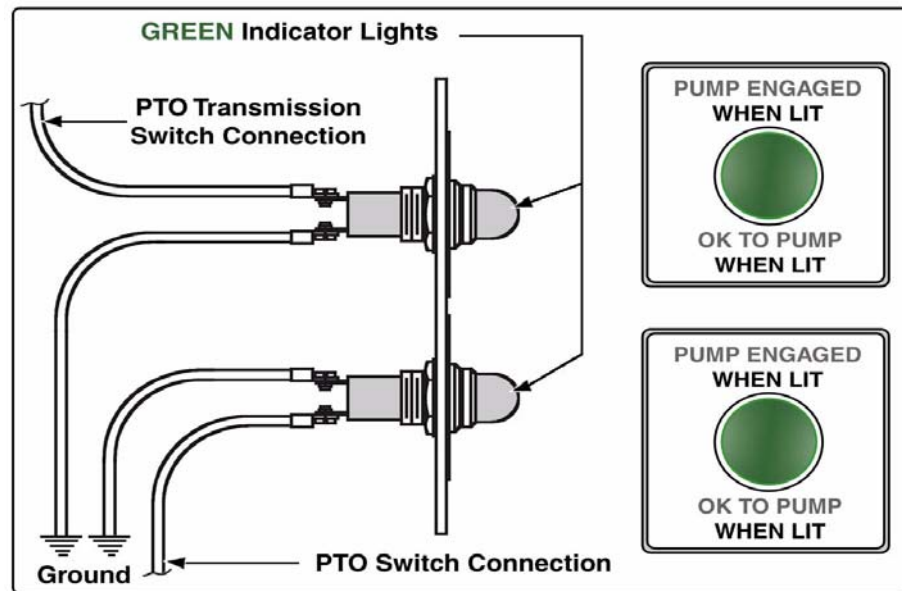


Figure 3-1: Driver's Compartment Indicator Lights



### CAUTION - continued !

**DO NOT OPEN THE THROTTLE UNLESS THE GREEN INDICATOR LIGHT IS ON.  
(SEE FIGURE 3-2: "PUMP OPERATOR'S PANEL" ON PAGE 36.)**

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. 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 38.

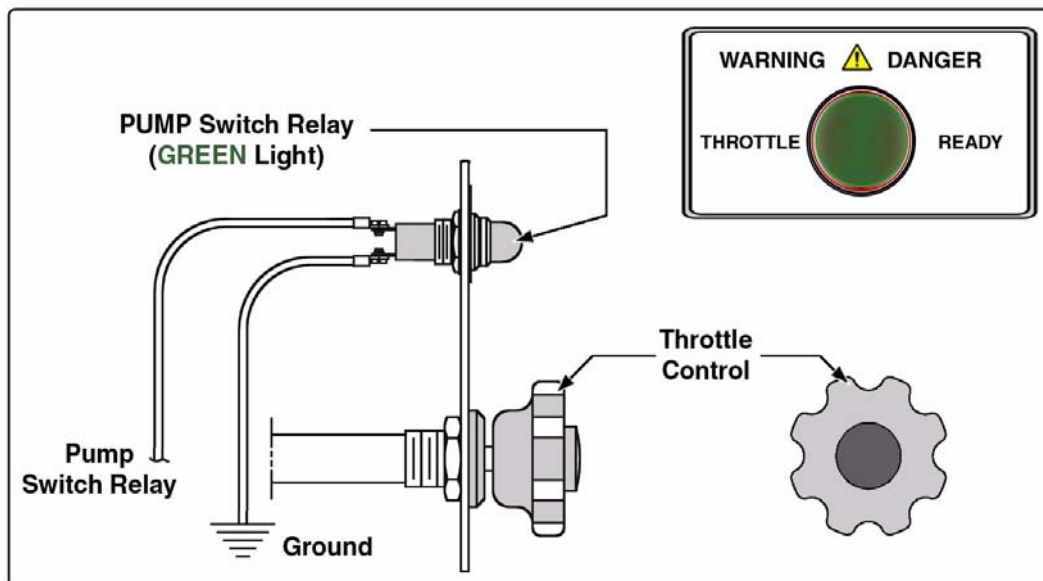


Figure 3-2: Pump Operator's Panel

9. Note the discharge and intake pressures, then gradually open the engine throttle 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 37.

### 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, 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 / 0.04 MPa), 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, 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 38. Disengage the PTO per the PTO manufacturer’s instructions. Also see heading “Pump-To-Road Shift Procedures” on page 45.

## **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-5: “Lift Loss from Temperature” on page 141.

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-6a: “Lift Loss from Barometric Reading” on page 141.

## 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-6: "Lift Loss from Elevation" on page 141.

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 33.
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 45.



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 35.)

**Note:** If the truck manufacturer uses 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 36.)**

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. 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 67.**

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. Gradually open the engine throttle until the desired pressure or flow is achieved.



### CAUTION !

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

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 “Trouble-shooting” on page 67.
- ❑ **Hot water** - see Figure F-5: “Lift Loss from Temperature” on page 141.
- ❑ **Low barometer** - see Figure F-6a: “Lift Loss from Barometric Reading” on page 141.
- ❑ **High lift** - see Figure F-6: “Lift Loss from Elevation” on page 141.

**Note:** Also see Section “Appendix F: Cavitation” on page 139.

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 37.
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 45. Disengage the PTO per the PTO manufacturer’s instructions. Also see heading “Post Operation Procedures” on page 50.

## 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 33.



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 35.)

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



### 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 36.)**

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 67.**

8. Gradually open the engine throttle 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 139.

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 36.)**

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 37.
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 45. Disengage the PTO per the PTO manufacturer's instructions. Also see heading "Post Operation Procedures" on page 50.

## 3.4 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. 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 34.

## 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, protecting the pump.

If no valve is present, you must watch the intake gauge for a high-pressure reading. If necessary, 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 / 1.3 MPa) for 5" (127 mm) large diameter hose, or 135 PSI (9 BAR / 0.9 MPa) for 6" (152 mm) hose, per NFPA Standards 1962. See heading "Pumping From a Hydrant, General Operation" on page 34. Also see heading "Pumping From Draft" on page 38.



### 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 139.

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.**

## 3.5 TANDEM (SERIES) PUMPING

Tandem pumping operations is used when higher pressures are required than a single engine is capable of supplying. This can occur when the pumper is attempting to supply high-rise sprinkler or standpipe systems or long hose lay-outs.

**Note:** Two 1,000 GPM (3,785 LPM / 5,451 LPS) pumpers in a series from a hydrant can produce 500 GPM (1,893 LPM / 2,726 LPS) at 500 PSI (35 BAR / 3.5 MPa) 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.**

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 / 0.03 MPa)
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 34.

**NOTICE!**

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

### **3.6 PUMP-TO-ROAD SHIFT PROCEDURES**

**(For Split-Shaft Gearboxes)**

1. Verify that the operator's hand throttle or governor control is at 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. Set the pump to the ROAD position. The in-cab and panel pump indicator lights go out as the pump transmission shifts 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.**

### **3.7 PUMP AND ROLL**

**IMPORTANT !**

**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 35.
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.

## 3.8 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 47.) 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 / MPa).
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. When 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.



### 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.**



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

## 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 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 47.)
- ❑ 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.

**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.

### 3.9 EMERGENCY PUMP SHIFT PROCEDURES

Before implementing manual override shift procedures, repeat the 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 gearbox 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.

### 3.10 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 33.



## 4 Preventive Maintenance

### 4.1 OVERVIEW

Hale Silencer Series Booster Pumps require minimal care and maintenance. Preventive maintenance tasks take little time to perform and consist primarily of leak testing, 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 some extreme conditions and the additional 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. Make sure the gearbox oil reservoir is full to correct level - see heading "Replace Gearbox Oil" on page 59.

### 4.3 EXTREME CONDITIONS

Extreme conditions occur when the pump has been operated during freezing weather or when 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 from Salt Water, Contaminated Water, or with Foam Solution**

Thoroughly flush the pump and suction hoses using fresh water from a hydrant or other clean water source.

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

## **4.4 WEEKLY**

Weekly maintenance consists of testing the relief valve system, the priming system, and the pump shift warning indicator lights. If testing criteria is not met, refer to Section 5 “Troubleshooting” on page 67 for corrective maintenance procedures. Always follow local maintenance and test procedures.

- ☐ Test the relief valve system - see page 52
- ☐ Test the priming system - see page 53

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 to the primer pump vanes or vane slots. Lubricant and cold water produce a gummy residue that renders the unit inoperative.

- ☐ Test the pump shift warning indicator lights - see page 53
- ☐ Perform valve maintenance - see page 54
- ☐ Perform transfer valve test (two-stage pumps only) - see page 54
- ☐ Check and clean the intake strainers - see page 55
- ☐ Check any auxiliary engines - see page 55
- ☐ Verify all gauges are in working order - see page 55
- ☐ Operate pump controls - see page 55
- ☐ Inspect water and foam tanks - see page 56
- ☐ Check roof and bumper turrets - see page 56

### **Relief Valve Test**

When the relief valve is not in operation, keep the hand wheel set above the



normal operating pressure. (See Figure 3-3: "TPM / PMD Relief Valve Control" on page 47.)

1. Prepare to pump from the onboard water tank, having the discharge flow directed back to the water tank.
2. Increase the pump pressure up to normal operating pressure as indicated on the master pressure gauge per normal operating procedures.
3. Turn the relief valve hand wheel counterclockwise until the valve opens. The relief valve is open when the AMBER indicator light is ON and the pressure begins to drop. (See Figure 3-3: "TPM / PMD Relief Valve Control" on page 47.)
4. Turn the relief valve hand wheel clockwise. The pressure should return. Cycle the relief valve a few times to ensure that the hand wheel turns freely. Observe the pressure gauge and indicator light for proper valve operation.
5. Return the relief valve hand wheel and the apparatus to normal operational condition.

### **Priming System**

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. in this 5 minute period is anticipated per NFPA 1901.
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 33.

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

**CAUTION !**



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

3. Repair or replace any malfunctioning indicators.

## Valve Maintenance

Properly functioning valves are integral to the operation of the pump. 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.

**Note:** The PMD valve should be lubricated every six (6) months.

## Transfer Valve Test (Two-Stage Pumps Only)

5. For manual transfer valves:
6. With the apparatus engine turned off, turn the handwheel between the volume and pressure positions a few times to verify that the valve operates freely.
7. Set the truck up for pumping per the procedure in Section 2, with the transfer valve in the volume position.
8. Leave the engine at idle speed and move the transfer valve to the pressure position.
9. Verify that the discharge pressure gauge readings have approximately doubled.
10. For power transfer valves:
11. With the apparatus engine turned off, use either a 3/8-inch socket on the indicator hex nut or a rod in the hole in the indicator hex nut to manually

transfer the valve to verify that the valve operates freely.

12. Set the truck up for pumping per the procedures in Section 2, with the transfer valve in volume position. Note the discharge gauge readings.
13. Leave the engine at idle speed and move the transfer valve to the pressure position.
14. Verify that the master intake gauge reading has approximately doubled.

### **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.

### **Auxiliary Engine**

See engine manufacturer's manual for wear and proper operation.

### **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 Roof and Bumper Turrets**

If the apparatus is so equipped, verify that the turrets function properly, and no leaks are present. Make repairs immediately.

Visually inspect all piping and valves on the pump and auxiliary equipment for corrosion or damage.

## **4.5 MONTHLY**

Monthly maintenance includes the weekly maintenance procedures plus:

- ☐ Valve lubrication - see page 56
- ☐ Gearbox lubrication - see page 56
- ☐ Checking the pump and drive line bolts - see page 57
- ☐ Relief valve system check - see page 60

### **Valve Lubrication**

1. On handwheel-type valves, including PM, PMD, and Transfer Valve Controls, if necessary, first remove old grease and paint, use a dry lubricating spray on gears.
2. Lubricate suction threads with a light coat of grease.

### **Gearbox Lubrication**

Incorrect oil types or amounts of oil result in unnecessary high oil temperature and possible wear or damage. Change the oil every 12 months, depending on pump usage. All lubricants must meet service rating API GL-5 requirements. Also see "Appendix C1: Lube and Sealant Specifications" on page 133.

To meet various shipping regulations, oil is drained from the gearbox reservoir prior to shipping from the factory. At installation and before operating the first time, oil must be added to the appropriate level.

**Note:** Hale recommends using an SAE EP-90, 80W90 Lubricant or “RoadRanger” Full Synthetic SAE 50 Transmission Lubricant, manufactured by the Eaton® Corporation, or equivalent.

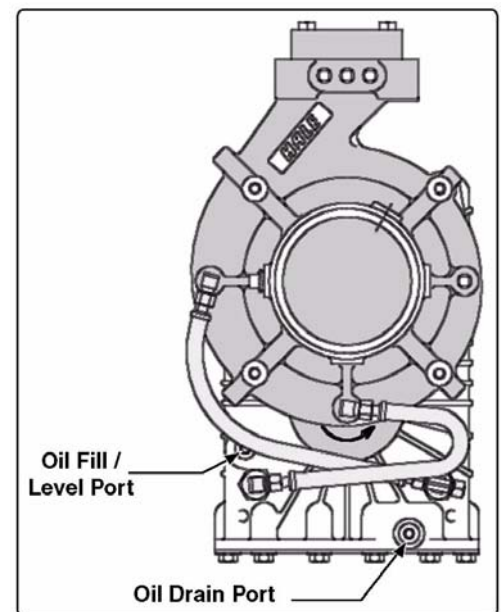
1. For gearbox capacity - see heading “Appendix C1: Lube and Sealant Specifications” on page 133.
2. Remove the gearbox oil fill plug, and check the level of the oil in the gearbox. (See Figure 4-1: “Typical Drain, Fill and Level Plugs.”)

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

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

**Note:** If water leak / contamination is suspected, see heading “Troubleshooting” on page 67.

5. Either of these conditions indicates maintenance is required on the unit. See Section 6 “Repair” on page 75.



**Figure 4-1: Typical Drain, Fill and Level Plugs**

## Pump, Drive Line and Flange Bolts

Check all pump, drive line and flange bolts to ensure:

- ☐ No bolts are missing.
- ☐ All bolts are tight. Use a torque wrench and torque bolts to the drive train manufacturer's recommended specifications.
- ☐ Bolts used are “Grade 5” strength minimum for mounting and “Grade 8” strength minimum for the 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 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 at least 22" Hg vacuum. (See Figure 4-2: "PVG Priming Valve Handle.")
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 than 10" Hg. in 5 minutes, it is an indication of at least one air leak.

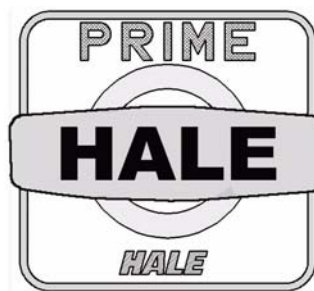


Figure 4-2: PVG Priming Valve Handle

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

6. Test the suction hose as follows:
  - ❑ Attach the suction hose to the pump.
  - ❑ Place a 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 calibrated 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 vacuum.
  - ❑ Watch the gauge. If the vacuum falls more than 10"Hg. in 5 minutes, it indicates at least one air leak.
  - ❑ Verify the test gauge and the apparatus gauge display the same readings. Repair or replace any 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
- ☐ INSPECT THE PUMP FOR LEAKS

## 4.6 ANNUALLY

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.

- ☐ Replace the pump gearbox oil - see page 59
- ☐ Check individual drain lines from the pump to the multi-drain to ensure proper drainage and protection from freezing temperatures - see page 61
- ☐ Clean Priming Pump, if installed - see page 61. (Also see separate manual provided.)
- ☐ Yearly pump test to check performance levels, including Tank-to-Pump Flow Rate - see page 62. (Also 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 133. Also see Figure 4-1: "Typical Drain, Fill and Level Plugs" on page 57.

Have clean disposable shop rags and oil dry handy.

**Note:** Assembly orientation determines which plugs are used for oil fill, drain and level detection. See installation plate drawings located at the back of this manual.

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 73.
3. Properly dispose of the used oil.

## ☐ Preventive Maintenance

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

Repair or replace components as necessary. See Section 6 “Repair” on page 75.

5. Replace the cooler or cover, if necessary. Remove the oil fill plug and the level detect plug. Clean the drain plug (magnetic).
6. Fill the gearbox with an approved gear oil until oil just begins seeping from the level plug opening - see “Appendix C1: Lube and Sealant Specifications” on page 133. Also see Figure 4-1: “Typical Drain, Fill and Level Plugs” on page 57.
7. Install all plugs.

### **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 52.
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 from respective tap.
  - ☐ Clean any debris from strainer and check strainer for damage.
  - ☐ Using a suitable thread sealant (Loctite PST or equivalent) reinstall strainer.
  - ☐ Reconnect tubing.
4. Test apparatus and check for leaks around strainer fittings.
  5. Place apparatus back in 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 of these drains 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 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 as needed. Reassemble the pump and test for proper operation. (See separate manual provided, Hale p/n: 101-2850-02-0.)

### IMPORTANT !



DO NOT 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 Figure 4-3: "Pump Ratings (GMP/LPM).")

Capacity	Pressure PSI (BAR)	Pump Rating in GPM (LPM)					
		250 (946)	350 (1,325)	450 (1,703)	500 (1,893)	750 (2,893)	1,000 (3,785)
<b>FULL</b>	150 (10)	250 (946)	350 (1,325)	450 (1,703)	500 (1,893)	750 (2,839)	1,000 (3,785)
<b>70%</b>	200 (14)	150 (568)	245 (927)	315 (1,192)	350 (1,325)	525 (1,987)	700 (2,650)
<b>50%</b>	250 (17)	125 (473)	175 (663)	225 (852)	250 (946)	375 (1,420)	500 (1,893)

Figure 4-3: Pump Ratings (GMP/LPM)

A pump must be able to pump FULL capacity at 150 PSI, 70% capacity at 200 PSI and 50% capacity at 250 PSI.

## 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.
3. Attach sufficient hose lines and nozzles to pump the desired discharge rate.
4. With the pump in gear, open the discharge to which the hose is attached 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 through the top fill opening or a direct tank line. 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 designed rate of the pump. If the flow rate is lower, a problem exists 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

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-foot 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 / 0.21 and 0.6 MPa). Also see “Appendix E: Nozzle Size vs. Pressure” on page 137.

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 than 35 ft./sec.

Also see “Appendix D: Hose Friction Loss” on page 135 at the back of this manual.

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 / 47 LPS) test, two 2-1/2” (64 mm) lines should be laid from the pumper to the nozzle
- For 1,000 GPM (3,785 LPM / 63 LPS) test, three lines are required

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 / 32 LPS). 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 / LPS).

Another alternative when a deluge gun is not available consists of a 1-1/4 inch (32 mm) nozzle on one and a 1-1/2 inch (38 mm) nozzle on the other to pass 1,000 GPM (3,785 LPM / 63 LPS). The sum of the flow from both nozzles is the GPM (LPM / LPS) 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 / 0.21 and 0.6 MPa).

## Performance Testing

**Note:** The NFPA standards require a 10% reserve in pressure at the capacity run when the apparatus is delivered.

1. Check the relief valve according to the Relief Valve Test procedure. See heading “Relief Valve Test” on page 52.
  - ☐ SLOWLY close the discharge valves. The rise in pressure shall not

exceed 30 PSI (2 BAR / 0.21 MPa), or approximately 180 PSI (12 BAR / 1.2 MPa) 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 procedures. Also see 3.10 "Post Operation Procedures" on page 50.
- 3. Run the standard pump test in accordance with NFPA standards to check pump performance.
- 4. "Silencer" Series Pumps rated below 750 GPM (2,839 LPM / 47 LPS) are tested fifty (50) minutes per NFPA 1901, 14-13.2.3.2.

Run the engine to stabilize engine temperature, then run the pump for:

- Thirty (30) minutes at FULL capacity and at 150 PSI (10 BAR / 0.4 MPa)
  - Ten (10) minutes at 70% capacity and at 200 PSI (14 BAR / 1.4 MPa)
  - Ten (10) minutes at 50% capacity and at 250 PSI (17 BAR / 1.7 MPa)
5. For Model "MBP / MG -\*" Series Pumps, rated at 750 GPM and 1,000 GPM (2,839 and 3,785 LPM / 47 and 63 LPS) a three (3) hour test is required:
- Two (2) hours at FULL capacity and at 150 PSI (10 BAR / 0.4 MPa)
  - Thirty (30) minutes at 70% capacity and at 200 PSI (14 BAR / 1.4 MPa)
  - Thirty (30) minutes at 50% capacity and at 250 PSI (17 BAR / 1.7 MPa)

Additionally, an engine overload test is required which consists of pumping at FULL capacity and at 165 PSI (11 BAR / 1.1 MPa) for ten (10) minutes.

- 6. If the apparatus does not reach performance levels, proceed to Section 5 "Troubleshooting" on page 67.
- 7. Compare the results of this test to those from when the apparatus was delivered. If the apparatus performance has dropped appreciably compared to its original performance, the unit needs servicing.

**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 or that clearance ring

replacement requires pump disassembly, 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.

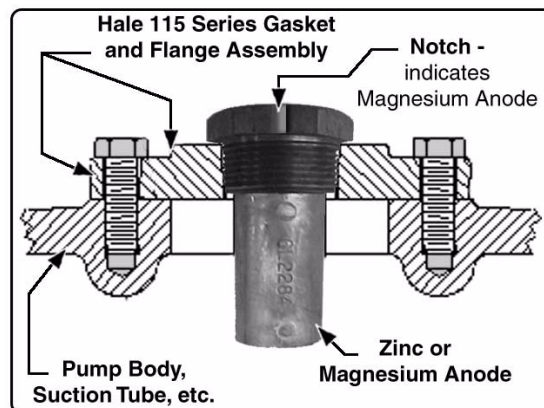
It should not be necessary to replace clearance rings until a loss in pump performance is noticed during the annual test – see heading “Performance Testing” on page 63. For clearance ring and impeller service, proceed to Section 6, heading “Impeller (Single-Stage Pumps)” on page 100.

Often, replacement of the clearance rings reduces the bypass and restores the pump to near original performance. A complete restoration requires that the impellers also be replaced. See Section 6 “Repair” on page 75 for maintenance and repair information if pump disassembly is required.

## Anode Check

Hale offers two types of anodes (consumables):

- 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.



**Figure 4-4: Hale Anode**

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.



☐ Preventive Maintenance

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### Figure 5-2: Troubleshooting Chart





### Figure 5-2: Troubleshooting Chart

Condition	Possible Cause	Suggested Corrective Action
<b>Insufficient Pump Capacity - continued.</b>	Air leaks.	<ul style="list-style-type: none"> <li>• See heading “Air leaks.” under condition “ Pump Loses Prime or Will Not Prime” on page 69.</li> </ul>
	Partial collapse of the lining in a suction hose.	<ul style="list-style-type: none"> <li>• Damage to the outer lining may allow air between the outer and inner linings causing a partial collapse.</li> <li>• Replace hose and retest.</li> </ul>
	Engine governor set incorrectly.	<ul style="list-style-type: none"> <li>• If the engine governor is set too LOW (pressure), when on auto-matic, engine speed decelerates before the desired pressure is achieved.</li> <li>• Reset governor per manufacturer’s procedures.</li> </ul>
	Truck transmission in wrong gear or clutch is slipping.	<ul style="list-style-type: none"> <li>• Recheck the pumping procedures for the recommended transmission or gear range - review Section 3 “Basic Operation,” beginning on page 33.</li> <li>• Use a mechanical speed counter on the pump panel to check speed against possible clutch or transmission slippage or inaccurate tachometer.</li> <li>• Check truck manual for proper speed counter ratio.</li> </ul>
<b>Insufficient Pressure.</b>	Insufficient engine power.	<ul style="list-style-type: none"> <li>• See previous heading “Insufficient Pump Capacity.” on page 69.</li> </ul>
<b>Remote Control Difficult to Operate.</b>	Lack of lubrication.	<ul style="list-style-type: none"> <li>• Lubricate the remote control linkages and collar with oil. For lubricant recommendations, see “Appendix C1: Lube and Sealant Specifications” on page 133.</li> </ul>
<b>Engine Speeds Too HIGH for Required Capacity or Pressure.</b>	Truck transmission in wrong gear or range.	<ul style="list-style-type: none"> <li>• Recheck the pumping procedures for the recommended transmission or gear range - review Section 3 “Basic Operation,” beginning on page 33.</li> <li>• Check truck manual for proper speed counter ratio.</li> </ul>
	Lift too high, suction hose too small.	<ul style="list-style-type: none"> <li>• Higher than normal lift (10 ft. / 3.1m) causes higher engine speeds, high vacuum and rough operation.</li> <li>• Use larger suction hose.</li> <li>• Move the pump closer to the water source.</li> </ul>
	Faulty suction hose.	<ul style="list-style-type: none"> <li>• Inner lining of suction hose may collapse when drafting and is usually undetectable.</li> <li>• Try a different suction hose on the same pump.</li> <li>• Test for comparison against original hose.</li> </ul>
	Blockage at suction hose entry.	<ul style="list-style-type: none"> <li>• Clean suction hose strainer of obstruction. Also see Section 4 Preventive Maintenance, heading “Intake Strainers” on page 55.</li> <li>• Follow recommended practices for laying suction hose.</li> <li>• Keep off the bottom of the fluid supply by at least 2’ (0.6 meters) below the surface of the fluid.</li> </ul>
<i>Chart continued on next page.</i>		

Figure 5-2: Troubleshooting Chart

Condition	Possible Cause	Suggested Corrective Action
<b>Engine Speeds Too HIGH for Required Capacity or Pressure - continued.</b>	Pump is approaching "Cavitation."	<ul style="list-style-type: none"> <li>• Gate the discharge valves to allow pressure to increase. This reduces the flow.</li> <li>• Reduce the throttle opening to the original pressure setting.</li> <li>• See "Appendix F: Cavitation" on page 139.</li> </ul>
	Worn pump impeller(s) or clearance rings.	<ul style="list-style-type: none"> <li>• Repair and/or replace as needed. See Section 6 "Repair" on page 75.</li> </ul>
	Impeller blockage.	<ul style="list-style-type: none"> <li>• A blocked impeller can prevent loss of both capacity and pressure.</li> <li>• Back flushing the pump from discharge to suction may free the blockage.</li> <li>• Removing half the pump body may be necessary - this is considered a major repair.</li> </ul>
<b>Cavitation</b> (Pump beginning to cavitate.)  <b>Note:</b> Also see "Appendix F: Cavitation" on page 139.	Discharging more water than the pump is taking in.	<ul style="list-style-type: none"> <li>• Increase the flow into the pump with more and/or larger intake lines.</li> <li>• Gate the discharge valves to reduce flow and maintain pressure.</li> </ul>
	Air leak.	<ul style="list-style-type: none"> <li>• Verify that the air bleeder on the suction tube is NOT open.</li> <li>• Locate and eliminate all air leaks during maintenance.</li> </ul>
	Drafting too high.	<ul style="list-style-type: none"> <li>• Verify lift hose, hose friction, water temperature and other lift limiting factors are reduced or eliminated.</li> <li>• Locate the pump closer to the water source.</li> </ul>
	Water temperature too high.	<ul style="list-style-type: none"> <li>• Reduce volume discharge by lowering the RPM or gating the discharge valves.</li> <li>• Locate a source of cooler water.</li> </ul>
	Suction hoses diameter is too small for the volume being discharged.	<ul style="list-style-type: none"> <li>• Use a large suction hose.</li> <li>• Shorten the total length by removing one length of hose.</li> <li>• Reduce volume of discharge.</li> </ul>
	Restriction in suction line at strainer.	<ul style="list-style-type: none"> <li>• Remove any debris restricting entrance of water at the strainer.</li> <li>• Also see Section 4 Preventive Maintenance, heading "Intake Strainers" on page 55.</li> </ul>
<b>Relief Valve Does Not Relieve Pressure When Relief Valves are Closed.</b>  <i>Chart continued on next page.</i>	Incorrect setting of control (PMD) Valve.	<ul style="list-style-type: none"> <li>• Check and repeat proper procedures for setting relief valve system.</li> <li>• See Section 3 Operation, heading 3.8 "Relief Valve Procedures" on page 46.</li> </ul>

Figure 5-2: Troubleshooting Chart

Condition	Possible Cause	Suggested Corrective Action
<b>Relief Valve Does Not Relieve Pressure When Relief Valves are Closed - continued.</b>	Relief valve inoperative.	<ul style="list-style-type: none"> <li>• Possibly in need of lubrication. Remove valve from pump, dismantle, clean and lubricate.</li> <li>• Refer to relief valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.</li> </ul>
<b>Relief Valve Does Not Recover and Return to Original Pressure Setting After Opening Valves.</b>	Dirt in system causing sticky or slow reaction.	<ul style="list-style-type: none"> <li>• Check and repeat proper procedures for setting the relief valve system.</li> <li>• See Section 3 Operation, heading 3.8 "Relief Valve Procedures" on page 46.</li> </ul>
	Relief valve inoperative.	<ul style="list-style-type: none"> <li>• Blocked bleed orifice - clean the bleed orifice with a small wire or straightened paper clip.</li> <li>• Refer to relief valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.</li> </ul>
<b>Relief Valve Opens When Control Valves are Locked Out.</b>	Drain hole in housing, piston or sensing valve is blocked.	<ul style="list-style-type: none"> <li>• Clean the valve drain hole with a small wire or straightened paper clip.</li> <li>• Refer to relief / sensing valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.</li> </ul>
<b>Unable to Obtain Proper Setting on Relief Valves.</b>	Using the wrong procedures.	<ul style="list-style-type: none"> <li>• Check instructions for setting the relief valve and reset.</li> <li>• See Section 3 Operation, heading 3.8 "Relief Valve Procedures" on page 46.</li> </ul>
	Blocked strainer.	<ul style="list-style-type: none"> <li>• Check and clean the strainer in the supply line from the pump discharge to the control valve. Check truck manual for location.</li> <li>• Also see Section 4 Preventive Maintenance, heading "Intake Strainers" on page 55.</li> <li>• Check and clean tubing lines related to the relief and control valves.</li> </ul>
	Dirty control valve.	<ul style="list-style-type: none"> <li>• Remove the control valve and clean.</li> </ul>
	"Hunting" condition.	<ul style="list-style-type: none"> <li>• Insufficient water supply from the pump to the control valve.</li> <li>• Check the strainer and relief valve system for flow restrictions.</li> <li>• Remove and clean the control valve.</li> </ul>
<b>Discharge Valves Are Difficult to Operate.</b>  <i>Chart continued on next page.</i>	Lack of lubrication.	<ul style="list-style-type: none"> <li>• Recommended weekly lubrication of discharge and suction valve.</li> <li>• Use a good grade, petroleum based, silicone grease. <ul style="list-style-type: none"> <li>• For Hale Products, SVS Valves, etc., use Never-Seez® White Food Grade with PTFE.</li> </ul> </li> <li>• Also see Section "Appendix C1: Lube and Sealant Specifications" on page 133.</li> <li>• Refer to separate valve manual for additional information.</li> </ul>

**Figure 5-2: Troubleshooting Chart**



Condition	Possible Cause	Suggested Corrective Action
<b>Discharge Valves Are Difficult to Operate - continued.</b>	Valve in need of more clearance for operation.	<ul style="list-style-type: none"> <li>Multi-gasket design allows additional gaskets for more clearance and free operation.</li> <li><b>Note:</b> Adding too many gaskets to the valve eventually causes leakage.</li> </ul>
<b>Water/Moisture in Pump Gearbox.</b>	Leak coming from above the pump.	<ul style="list-style-type: none"> <li>Check all piping connections and tank overflow for possible spillage falling directly onto the pump gearbox.</li> <li>Repair accordingly.</li> </ul>
	Operating or a driving condition that submerges the gearbox in water.	<ul style="list-style-type: none"> <li>Visually inspect the unit for external signs of water leakage.</li> <li>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 "Replace Gearbox Oil" on page 59.</li> </ul>
	Normal condensation.	<ul style="list-style-type: none"> <li>Depending on area / region where unit is operated, normal condensation can develop over time.</li> <li>Periodic inspection and possibly more frequent oil changes are needed.</li> </ul>
	Leaking oil seal or mechanical seal.	<ul style="list-style-type: none"> <li>Inspect the oil seals and replace as needed. If the oil seal checks OK, the mechanical seal may be leaking.</li> <li>There must be NO leaks at the mechanical seal. See Section 6a "Mechanical Seal Assembly" on page 93.</li> <li>Hydrostatic test the system to determine leakage.</li> </ul>
<b>Rotation Symptoms.</b>  (Reduced pressure 60-100 PSI [4.1-6.9 BAR / 0.4-0.7 MPa] and reduced flow.)	Wrong impeller installed.	<ul style="list-style-type: none"> <li>Verify the new impeller vanes are oriented the same as the old impeller before installing. (See Figure 2-6: "Pump / Engine Rotation," on page 23.)</li> <li>Refer to relief / sensing valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.</li> </ul>
	Wrong application attempted.	<ul style="list-style-type: none"> <li>The pump was installed on an application for which it was not intended, i.e., front mount vs. rear mount.</li> </ul>
	<div style="text-align: center;">  <b>NOTICE !</b>  </div> <p>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.</p>	

Figure 5-2: Troubleshooting Chart

## This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

## 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 9, heading "Drawing Package" on page 151.



#### **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 in accordance with your departmental procedures.
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.**

**THE PUMP, GEARBOX AND PEDESTAL ASSEMBLIES 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 THESE ASSEMBLIES. 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, GEARBOX AND PEDESTAL ASSEMBLIES ARE 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 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 133.
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.")

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 79.

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

### **Gearbox Assembly**

1. Drain oil from the gearbox. Also see Section 4 Preventive Maintenance, heading “Intake Strainers” on page 55.
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 133.
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 (bearings, seals, gears, etc.) for excessive or abnormal wear, i.e., pitting, scoring / scratches, cracks, splits, etc.

### **IMPORTANT !**



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

2. 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 machined surfaces.

Install new gaskets and apply a light coat of grease to the gasket to hold it on place. Where applicable, trim gaskets to match the contour of the matching part.

4. Lightly oil or grease the shaft, O-ring seals and lip seals with a coating of general-purpose grease before reinstalling, especially when pressed-in.
5. For Hale recommended cleaners, see “Appendix C1: Lube and Sealant Specifications” on page 133.
6. Replace any hardware that shows signs of excessive wear.

## Bearings

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

Bearings must always be replaced in matching sets by manufacturer.



### IMPORTANT !

WHEN REPLACING TAPERED 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.

## 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)

☐ **Corrective Maintenance**

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- ☐ N-06 or N-07 bearing nut socket or spanner wrench, available from:

**Whittet-Higgins** at [www.whittet-higgins.com](http://www.whittet-higgins.com) or,

35 Higginson Avenue

P O Box 8

Central Falls, RI 02863

Phone ..... (401) 728-0700

## 6.4 SILENCER BOOSTER PUMP OVERVIEW

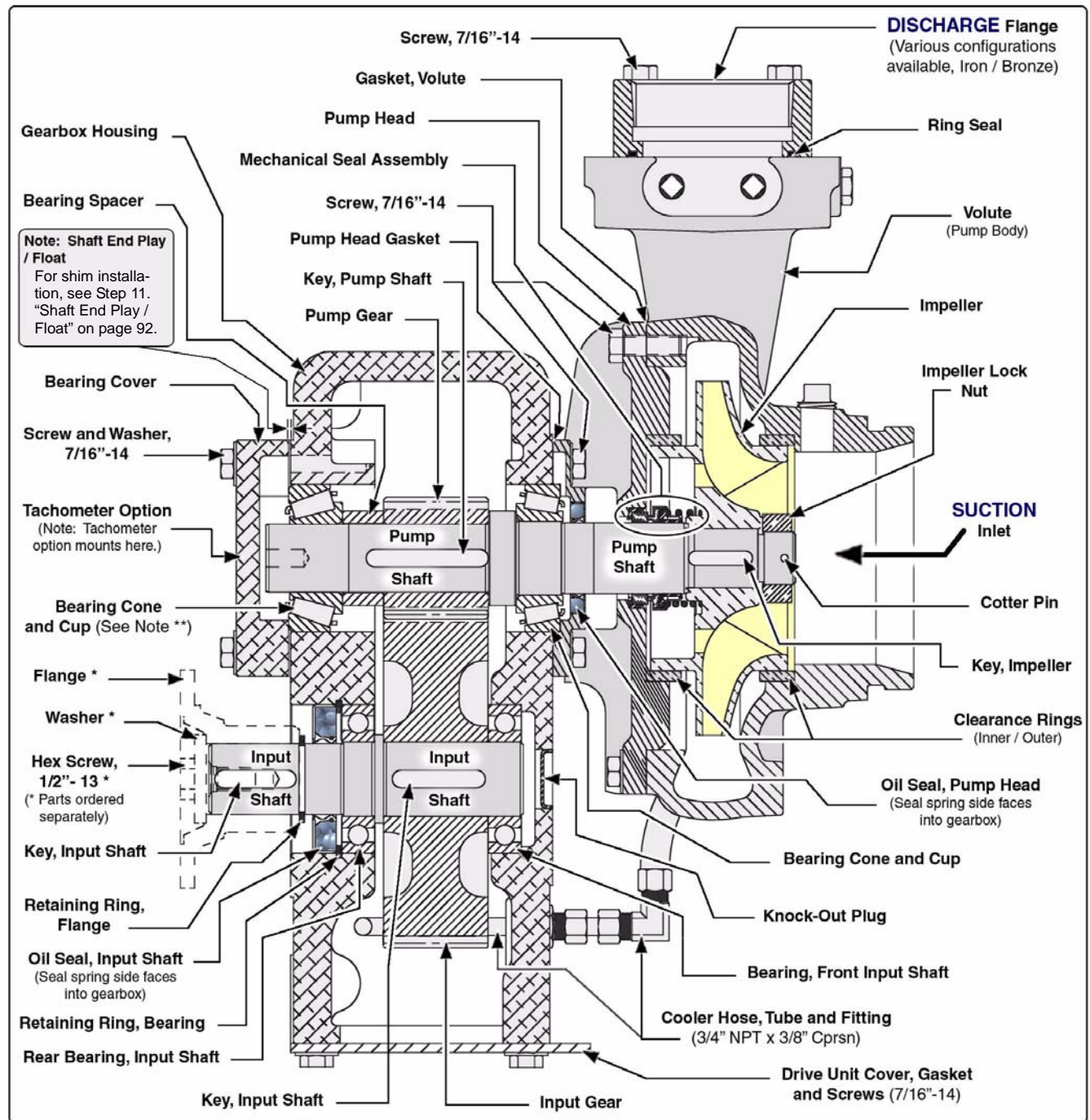


Figure 6-2: Silencer Series Booster Pump

## 6.5 REMOVING THE ASSEMBLY

### Removing the Assembly

1. First, review preceding Section “Before You Begin...” on page 81.

**Note:** Before beginning the removal process, you may want to make a sketch (or photograph) the plumbing and component configuration to aid in re-assembly.

2. Remove the pump and any piping drain plugs to drain the inlet (suction) side of the pump body per your required procedures.
3. Disconnect the suction and discharge piping.

Have clean disposable shop rags and oil dry handy. Also disconnect cooling tubes from the water manifold and pump, air lines, electrical switches and tachometer cable as required.

4. Drain oil from the gearbox - remove the magnetic pipe plug. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 58.

Have a suitable container available to collect excess fluid, approximately two (2) quarts (2 liters).

5. Disconnect the drive shaft from the gearbox.

**Note:** If your pump assembly includes the optional Hydraulic Drive Assembly it must be removed from the assembly. (See Figure 6c-1: “Hydraulic Drive Option, \* -H,” on page 1-112.)

6. With the pump assembly properly supported and balanced, disconnect the mounting brackets that secure the assembly to the apparatus. See **WARNINGS !** note on page 82. Also see Section 9 “Drawing Package” on page 23 and review the appropriate Installation Drawing.



Always use proper lifting and support apparatus (jacks, hoists, straps, etc.) when servicing the unit. Exercise care when using chains to protect finished surfaces from scratches.

7. Carefully remove the assembly from the apparatus.
8. Place and support the pump assembly on a stable work stand/bench of suitable capacity (see **WARNINGS !** note on page 82).



## Installing the Assembly



1. First, review preceding Section “Before You Begin...” on page 81.
2. Attach proper supporting devices and stabilize the assembly for transport to the apparatus. Also see **WARNINGS !** note on page 82.
3. Place the pump assembly into position within the apparatus.
4. Apply Loctite™ #242 (removable medium strength thread lock) and insert and tighten mounting hardware that secures the pump assembly to the chassis frame. For sealant recommendations, see “Appendix C1: Lube and Sealant Specifications” on page 133.

Torque the fasteners to proper values in accordance with PTO manufacturer’s recommendations. Also see Table 6-1: “Typical Torque Values Chart” on page 83.

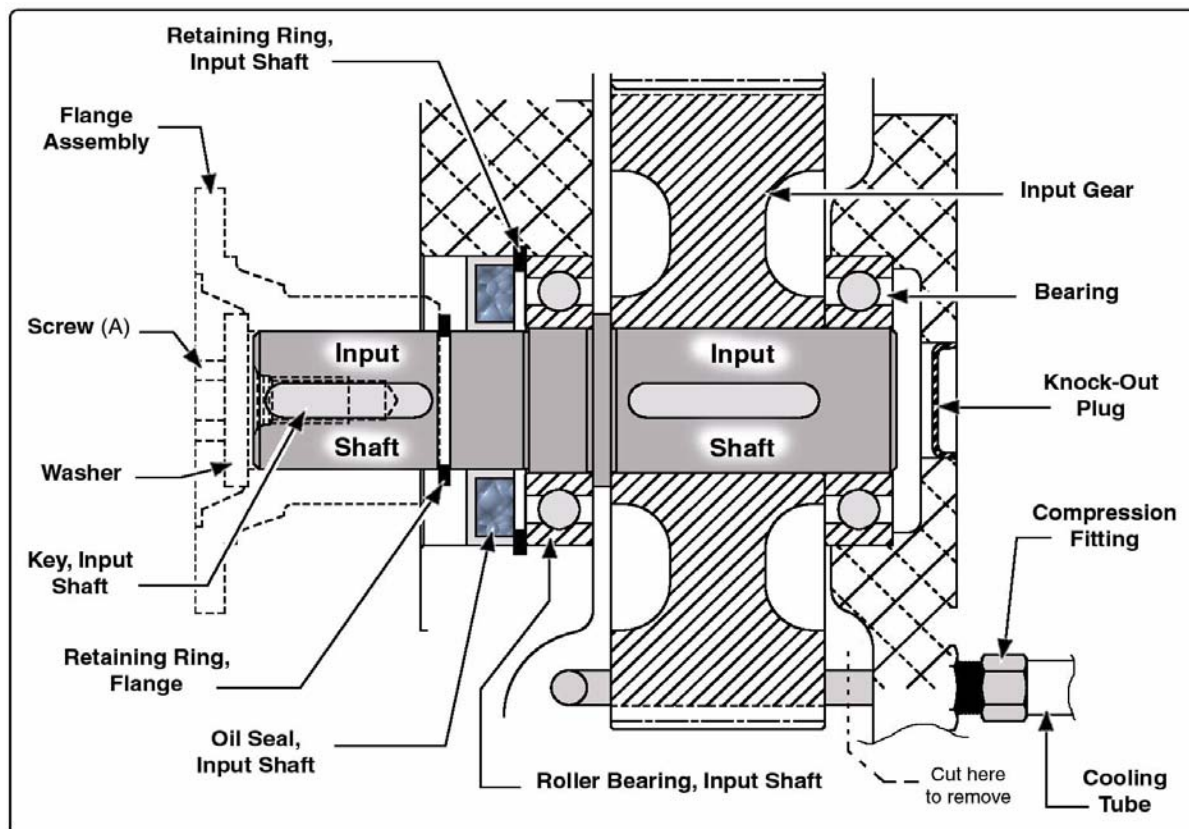
5. Connect the drive shaft to the gearbox. Apply a coating of Loctite to the fasteners and torque to PTO manufacturer’s specifications.
6. Connect all components to the gearbox, then fill the gearbox with oil to the proper oil level. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 58.
7. Reassemble and reconnect all components removed to gain access to the pump assembly, paying particular attention to your sketch and identification match markings/tags.
8. Reinstall apparatus frame work and body panels previously removed to gain access to the pump compartment. For sealant recommendations, also see “Appendix C1: Lube and Sealant Specifications” on page 133.
9. Test the pump for proper operation per your departmental requirements. Note and repair any leaks.
10. Recheck and top off oil levels, then return the apparatus to operation.

## 6.6 REPLACE OIL SEAL – INPUT SHAFT

See Figure 6-3: “Oil Seal, Input Shaft” on page 84

1. Drain gearbox oil into an appropriate container. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 58.





**Figure 6-3: Oil Seal, Input Shaft**

**Note:** If your system is engine mounted, by means of a flywheel housing adapter, see heading “ENGINE DRIVE, \* -M SERIES (FLYWHEEL MOUNT)” on page 114.

2. Remove the flange assembly screw (A) and washer securing the flange assembly to the input shaft. See Figure 6-3: “Oil Seal, Input Shaft”
3. Remove the shaft key and the flange retaining ring.
4. Carefully remove (pry out) the oil seal making sure not to damage the bore, shaft or roller bearing. Removing the seal renders it defective. Replace with Hale, p/n: 296-2650-00-0.

### Installation Notes - Oil Seal

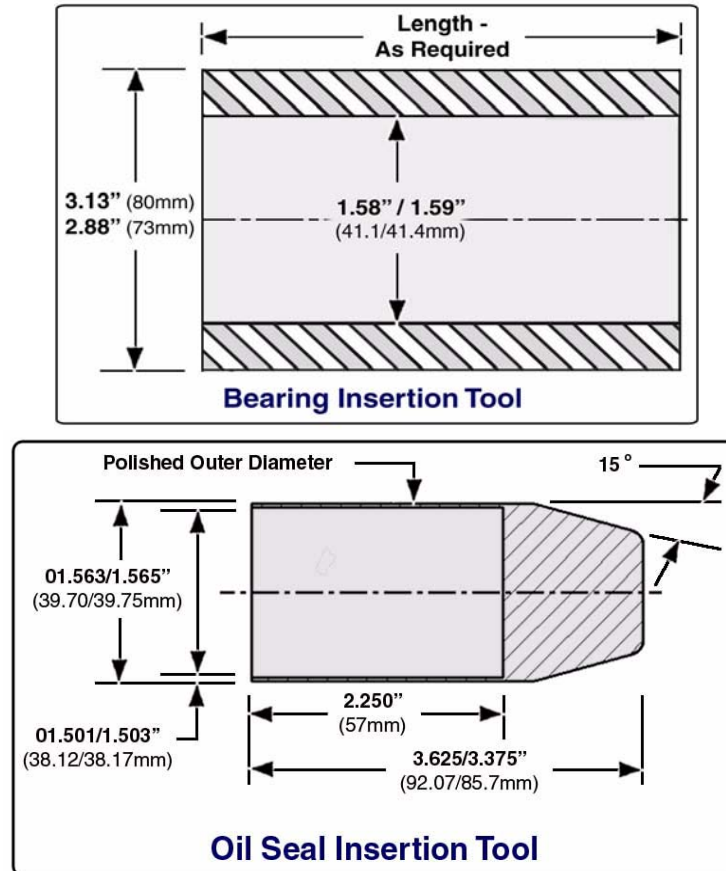
To install, follow the preceding steps in the reverse order, paying attention to the following:

- ❑ Review preceding sections “Before You Begin...,” on page 81 and “Cleaning and Inspection Guidelines,” on page 84.
- ❑ Evenly press-in a new oil seal (Hale, p/n: 296-2650-00-0) in the gearbox housing until flush against the roller bearing.



Lightly tap the seal around the edges to ensure an “even” seat.

**Note:** It is recommended to manufacture insertion tools to assure a correct installation of the input shaft bearing and oil seal. See Figure 6-4: “Typical Bearing and Seal Insertion Tool Drawings’ These drawings are provided to assist in the manufacture of these tools.



**Figure 6-4: Typical Bearing and Seal Insertion Tool Drawings**

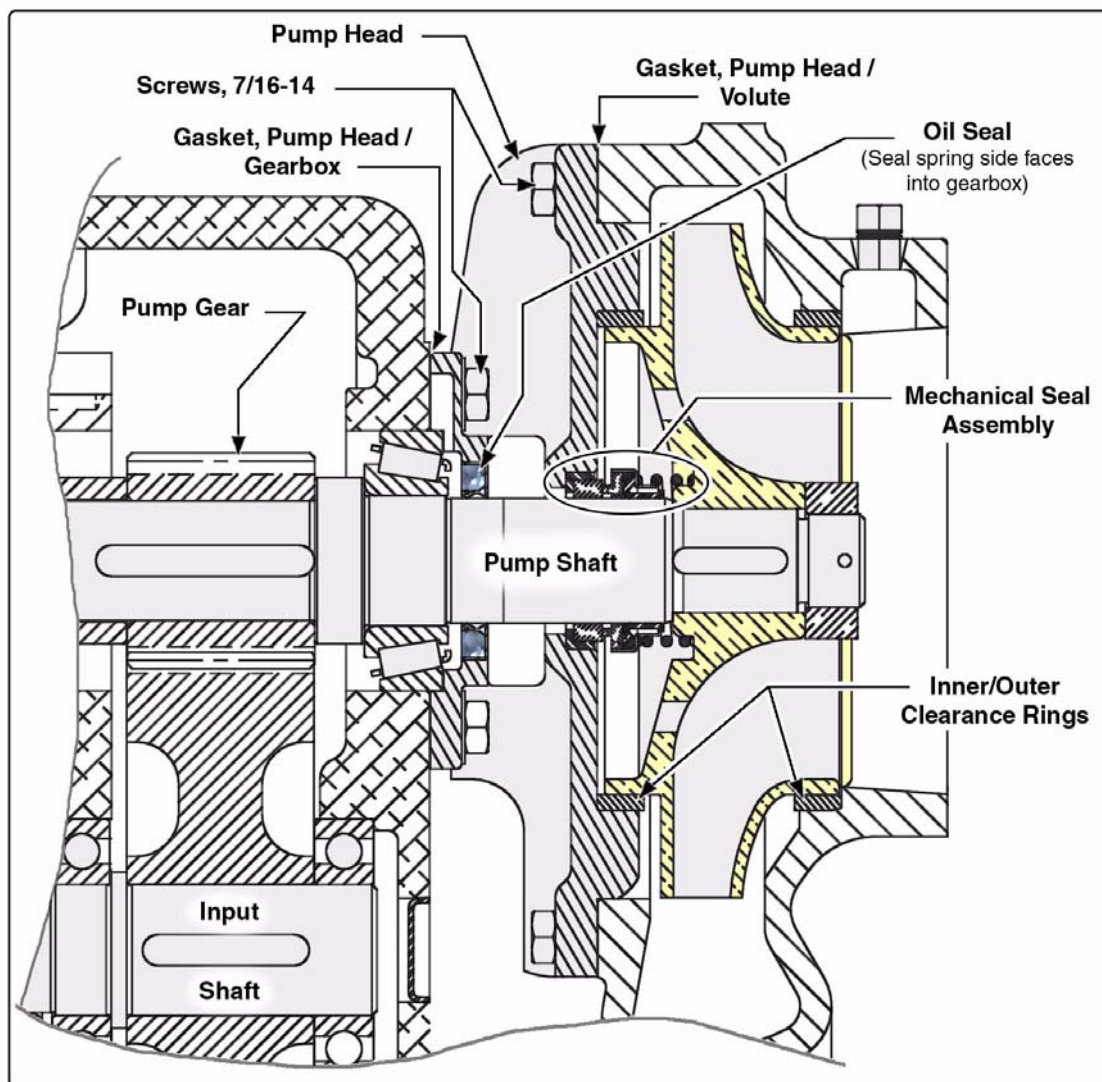
If the seal / bearing tool is not available, cover the flange retaining ring groove with thin electrical tape to avoid cutting the oil seal as it is inserted.

- ☐ Replace the gearbox cover and add fresh oil. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 58.

## 6.7 REPLACE OIL SEAL – PUMP HEAD

See Figure 6-5: “Oil Seal Replacement / Pump Head” on page 86

To service the oil seal between the pump head and gearbox you must dismantle the pump head from both units. Also, please review section *General Repair Guidelines*, on page 81, before beginning these procedures.



**Figure 6-5: Oil Seal Replacement / Pump Head**

1. Remove the following to replace the pump head oil seal -
  - ❑ Volute (All Except TBP) on page 93 and Impeller (All Except TBP) on page 95.
  - ❑ Volute and Impeller (TBP Only) on page 99.
  - ❑ Mechanical seal on page 103.
2. Remove the four (4) 7/16"-14 screws securing the pump head to the gearbox housing.
3. Using a soft faced (dead blow) hammer, carefully tap around the pump head until it is separated from the gearbox. Be careful not to damage the pump

shaft.

4. Scrape any gasket material between the mating surfaces of the pump head, pump body and gearbox housing.
5. Remove the oil seal from the pump side of the pump head. See Figure 6-5: "Oil Seal Replacement / Pump Head" on page 86. Oil seals cannot be reused. Replace with Hale p/n: 296-2850-00-0.

### Installation Notes – Oil Seal

To install, follow the preceding instructions in the reverse order, paying attention to the following:

- ☐ Review preceding sections "Before You Begin..." beginning on page 81 and "Cleaning and Inspection Guidelines" beginning on page 84.
- ☐ Install a new oil seal (Hale p/n: 296-2850-00-0) and clearance ring into the pump head. See Figure 6-5: "Oil Seal Replacement / Pump Head" on page 86.

Make sure to install the oil seal with the spring side of the seal facing into the gearbox.

- ☐ Replace all gaskets where applicable. Apply a coating of general-purpose grease to the gasket and align to the pump head.
- ☐ Install the pump head on the gearbox being careful not to damage the oil seal or pump shaft.
- ☐ Apply Loctite #242 and install the 7/16-14 hex screws and hardware to secure the pump head to the gearbox. Torque screws to 50 ft.-lb. (68 N-m). See Section "Appendix C1: Lube and Sealant Specifications" on page 133. Also see Table 6-1: "Typical Torque Values Chart" on page 83.

## 6.8 "B" SERIES GEARBOX

The most efficient method for servicing the gearbox is to remove it and the pump assembly as complete unit from the apparatus. See heading "Removing the Assembly" on page 82.

### Removing the Pump Assembly

See Figure 6-6: "B Gearbox Parts Identification" on page 88

1. With the B series gearbox and pump assembly removed from the apparatus, place and support the assembly on a suitable stand or work bench.

See heading “Removing the Assembly” on page 82.

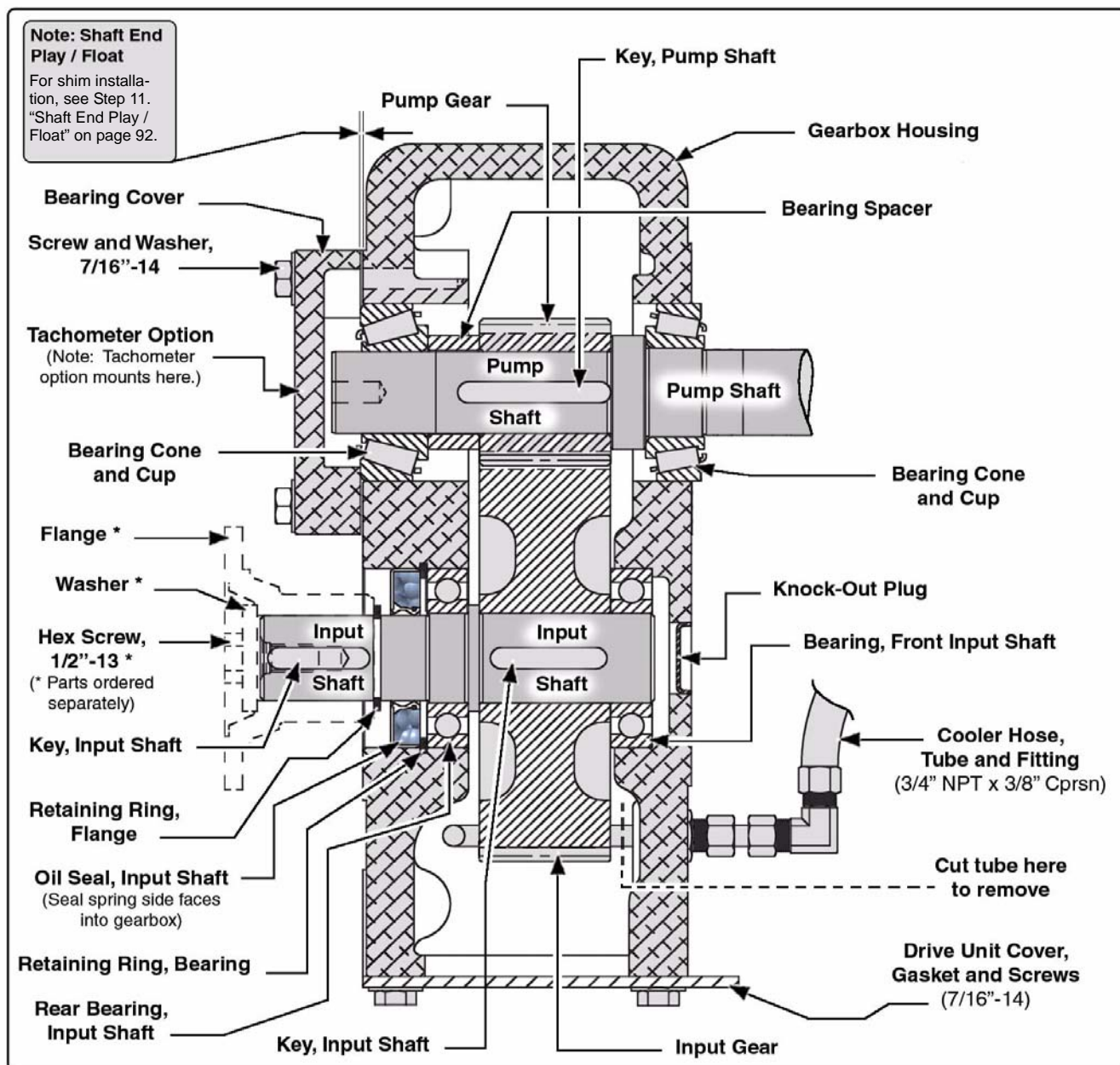


Figure 6-6: B Gearbox Parts Identification

2. Remove the volute, impeller, mechanical seal, pump head and pump shaft oil seal. These must be removed to enable the gearbox to be separated from the pump. For removal instructions, see heading “Servicing the Booster Pump (All Except TBP)” on page 93, or see heading “Servicing the Twin Booster Pump (TBP)” on page 99.

Scrape all gasket material from mating surfaces taking care not to scratch the machined finishes. All gaskets must be replaced.

## Removing the Input Shaft

See Figure 6-6: "B Gearbox Parts Identification" on page 88

1. Remove the twelve (12) 7/16"-14 screws and hardware securing the gear-box cover to the gearbox housing to expose the internal parts.
2. Remove the two 3/4" NPT x 3/8" compression fittings that secure the brass U-shaped cooling tube to the braided cooling hoses. To remove the cooling tube, it must be cut using a hacksaw or similar tool. Cut the tube on the outside of the gearbox. See Figure 6-6: "B Gearbox Parts Identification" on page 88.
3. Remove the flange assembly screw (**A**) and washer securing the flange assembly to the input shaft. See Figure 6-3: "Oil Seal, Input Shaft" on page 84.
4. Remove the input shaft key and the flange retaining ring.
5. Remove (pry out) the oil seal making sure not to damage the bore, shaft or bearing. Removing the oil seal renders it defective. Replace with Hale P/N: 296-2650-00-0.
6. Using a brass drift punch, remove the knock-out plug and push the input shaft out of the gear box while protecting the input gear from falling out of the housing. A new plug is required for installation. The rear input shaft bearing is removed with the shaft due to the shaft shoulder. Once the input shaft is clear of the gearbox housing remove the gear and key.

**Note:** The front input shaft bearing remains in the housing. The bearing must be cleaned and inspected for excessive wear and replaced accordingly. A puller may be required or lightly tap the bearing out via the knock-out plug access hole.

7. If necessary, remove the rear input shaft bearing from the shaft using an appropriate puller or press. It is not required to remove the bearing from the shaft to clean and inspect it.
8. Inspect and clean all components according to the Cleaning and Inspection Guidelines on page 84.



### **Installation Notes - Input Shaft**

See Figure 6-6: “B Gearbox Parts Identification” on page 88. Also see Figure 6-3: “Oil Seal, Input Shaft” on page 84.

To install, follow the preceding steps in the reverse order, paying attention to the following:

- ❑ Review preceding sections “Before You Begin...,” on page 81 and “Cleaning and Inspection Guidelines,” on page 84.
- ❑ Install the front bearing in the gearbox housing and the rear bearing to the input shaft.  
A press and bearing insertion tools may be needed to insure an even, flush installation.
- ❑ Install the input shaft, shaft key and gear and you slide the shaft into the housing.
- ❑ Install the snap ring against the roller bearing. See Figure 6-3: “Oil Seal, Input Shaft” on page 84.
- ❑ Evenly press-in a new oil seal (Hale p/n: 296-2560-00-0) until flush against the snap ring. Lightly tap the seal around the edges to ensure an “even, flush” seat.  
Make sure to install the oil seal with the spring side of the seal facing into the gearbox. See Figure 6-5: “Oil Seal Replacement / Pump Head” on page 92.  
If a seal / bearing tool is not available, cover the flange retaining ring groove with thin electrical tape to avoid cutting the oil seal as it is inserted.
- ❑ Install the outer snap ring, shaft key and drive unit flange.
- ❑ Replace the gearbox cover and add fresh oil. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 58.

### **Removing the Pump Shaft**

See Figure 6-6: “B Gearbox Parts Identification” on page 88

**Note:** If your pump assembly includes the optional Tachometer Drive Assembly, it must be removed. See heading “TACHOMETER DRIVE OPTION” on page 113.

1. If not already done, remove the input shaft assembly to gain access to the pump shaft internal components. See heading “Removing the Input Shaft” on page 89.
2. Remove the four 7/16”-14 screws and hardware that secure the bearing

cover to the gearbox. Remove the bearing cover and shim spacers.

3. Strike the pump shaft on the bearing cover end with a rubber mallet to push the pump shaft assembly out of the pump head side of the gearbox housing, while protecting the pump gear, spacer and shaft key from falling out of the housing.

**Always protect these parts from being marred, scratched, etc. as they are removed.**

4. If necessary, remove (tap out) the opposite-side bearing cup (race) from the housing. However, it is not required to remove it to clean and inspect the cup.
5. Using a press or puller, remove both bearings from the pump shaft.
6. Inspect and clean all components, especially the bearing cup (race) and cone, according to the Cleaning and Inspection Guidelines on page 84.

## Installation - Pump Shaft

See Figure 6-6: "B Gearbox Parts Identification" on page 88

1. Review preceding sections "Before You Begin..." on page 81 and "Cleaning and Inspection Guidelines," on page 84.
2. Using a press, install the pump-side bearing cone onto the pump shaft, making sure it is properly aligned - see Figure 6-6: "B Gearbox Parts Identification" on page 88. Also review heading "Bearings" on page 85. The bearing and race / cone must always be replaced in matching sets, by manufacturer.
3. Insert the pump shaft key into the pump shaft.
4. Slide the pump gear into the gearbox housing in its approximate assembled position. Then slide the pump shaft through the front face of the gearbox housing and the pump gear. See Figure 6-6: "B Gearbox Parts Identification" on page 88
5. Install the pump-side bearing cup into the gearbox housing using a soft faced hammer. Leave the cup protruding from the housing about 3/16" (5 mm). Also review heading "Bearings" on page 85. The bearing cup and cone must always be replaced in matched sets. Do not interchange cups and cones from different manufacturers.
6. Install the pump head and gasket onto the gearbox housing. Apply a small amount of grease to help hold the gasket in place.

The pump head is secured to the gearbox housing using four (4) 7/16"-14 hex screws with Loctite (#242).

**Note:** On applications with aluminum heads, such as the 4DB, washers must be used underneath the screws.

7. Lay the gearbox flat on the face of the pump head. Use wood blocks or similar supports to stabilize the gearbox.
8. Slide the pump shaft spacer over the bearing cover end of the pump shaft.
9. Using a pusher tool with a press or soft faced hammer, install the remaining bearing cone making sure to properly align the bearing - see Figure 6-6: "B Gearbox Parts Identification" on page 88. Also review heading "Bearings" on page 85. The bearing and race / cone must always be replaced in matching sets, by manufacturer.
10. Tap the remaining bearing cup into the gearbox housing using a soft faced hammer.

#### **11. Shaft End Play / Float**

- Temporarily install the bearing cover and gasket and tighten the four 7/16"-14 screws in a cross pattern to insure a proper seal. Tighten until the shaft barely spins.
  - Using feeler gauges, or dial indicator gauge, measure the gap between the bearing cover and the gearbox housing. See Figure 6-6: "B Gearbox Parts Identification" on page 88
  - Record this measurement, then remove the bearing cover.
  - To establish the proper shaft end-play, or "float," ADD an additional 0.003" to 0.005" (0.08 mm - 0.13 mm) to the recorded gap measurement and install the appropriate shims. This establishes the required shaft "float."
12. Reinstall the bearing cover and tighten the four (4) 7/16"-14 screws (apply Loctite #242) in a staggered pattern to insure a proper seal.  
  
Also see "Appendix C1: Lube and Sealant Specifications" on page 133.  
For torque specs, see Table 6-1: "Typical Torque Values Chart" on page 83.
  13. Install the input shaft - see heading "Installation Notes - Input Shaft" on page 90
  14. Using Loctite PST or equivalent thread-sealing compound, install the cooler compression fittings. Install new cooler lines.
  15. Install the mechanical seal - see heading "Mechanical Seal" on page 103.



## 6.9 SERVICING THE BOOSTER PUMP (ALL EXCEPT TBP)

APS series volutes are mounted for either engine rotation (clockwise), as viewed from the suction inlet, or opposite engine rotation (counterclockwise). MBP series pumps are available in the engine rotation (clockwise) only.

Note the direction of flow of the impeller for proper mounting of the volute. Also see Figure 2-6: "Pump / Engine Rotation" on page 20.

### Volute (All Except TBP)

See Figure 6-8: "Booster Pump Parts Breakdown" on page 94

The volute is secured by hex screws (quantity dependent on pump model). Replace the volute gasket whenever the volute is removed.

1. Remove the suction manifold (if still installed).
2. Unthread the compression fittings and disconnect gearbox cooler hoses from the volute. See See Figure 6-7: "Typical Water Cooling Lines"
3. Remove the 7/16"-14 screws and hardware securing the volute to the pump head. Remove the volute being careful not to damage the impeller or scratch the sealing surfaces of the volute.

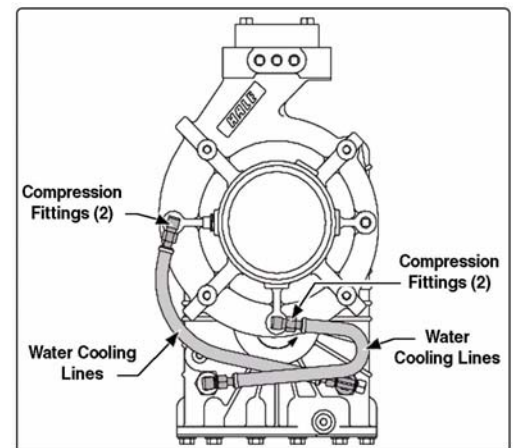


Figure 6-7: Typical Water Cooling Lines

**Note:** A dead blow hammer could be needed. Tap, in a crisscross pattern, around the volute until it is separated from the coverplate. Support the weight of the volute as it weighs approximately 45lbs (17 kgs).

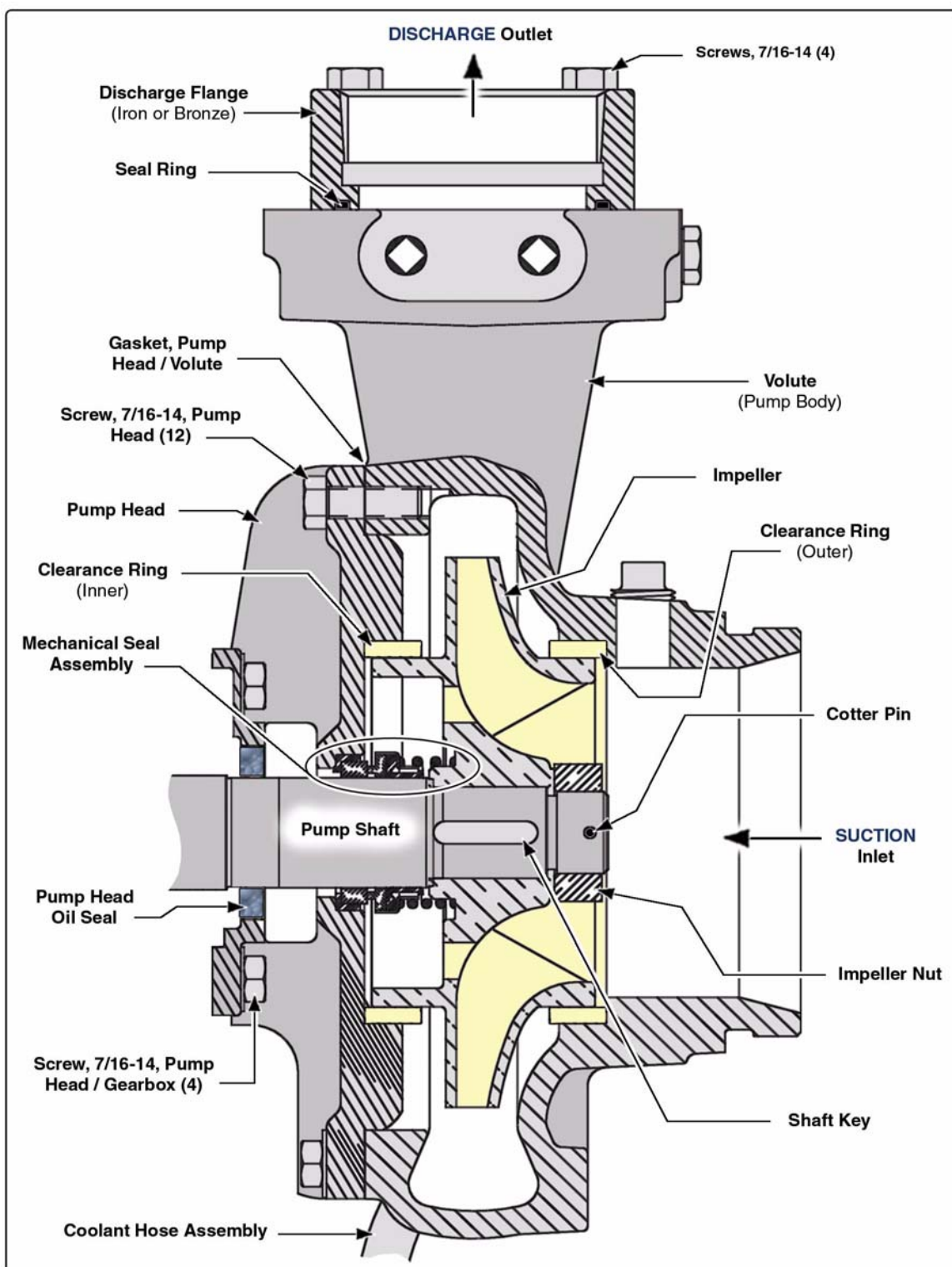


Figure 6-8: Booster Pump Parts Breakdown

## Installation Notes - Volute (All Except TBP)

To install, follow the preceeding steps in reverse order, paying attention to the following:

- ☐ Review preceeding sections “Before you Begin...” on page 73 and “Cleaning and Inspection Guidelines,” on page 76.
- ☐ Replace all gaskets. Apply a small amount of grease to the gasket(s) and align on the pump body.
- ☐ When installing the pump body to the pump head, DO NOT damage the clearance rings or impeller.
- ☐ Reconnect all cooling lines, piping and tubing.
- ☐ Inspect the system for proper operation.
- ☐ Return the apparatus to service.

## Impeller (All Except TBP)

(See Figure 6-8: “Booster Pump Parts Breakdown” on page 94.)

1. Remove the volute (pump body) to expose the impeller, clearance rings and mechanical seal.
2. Remove the cotter pin from the impeller nut and set safely aside.
3. While holding the impeller with a strap wrench, remove the impeller nut.
4. To avoid damaging the impeller, use a bearing puller to remove the impeller from the pump shaft. Place the puller at the impeller vane area where the metal is 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 PULLER IS PLACED AT THE IMPELLER VANES TO AVOID IRREPARABLE DAMAGE.**

5. Slide the impeller from the pump shaft, then remove the impeller shaft key and set safely aside.

6. Inspect the rear clearance ring for wear and replace accordingly. See heading "Clearance Rings, Impeller Measurement" on page 97.

**Note:** Removing the rear clearance ring from the pump head renders the ring defective and it must be replaced.

7. Removing the impeller may disturb the mechanical seal. For mechanical seal replacement instructions, See heading "6a Mechanical Seal Assembly" - on page 103.

## Installation Notes - Impeller

To install, follow the preceeding instructions in the reverse order, paying attention to the following:

- ❑ Review preceeding sections "Before You Begin..." on page 73 and "Cleaning and Inspection Guidelines" on page 76.
- ❑ Install the impeller shaft key into the slot on the pump shaft.

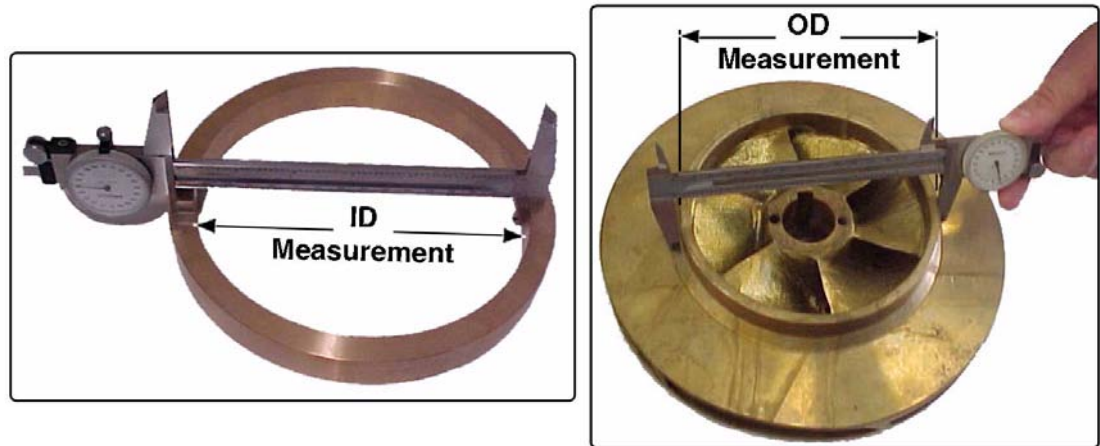


### CAUTION !

#### DO NOT STRIKE THE IMPELLER. IRREPARABLE DAMAGE MAY RESULT.

- ❑ Carefully slide the impeller over the pump shaft, aligning the keyway with impeller key.
- ❑ Torque the impeller nut to 110 ft.-lbs. (148 N-m).
- ❑ Continue tightening the impeller nut until the cotter pin can be installed to lock the nut in place.
- ❑ Install cotter pin.
- ❑ Replace all gaskets. Apply a small amount of grease to the gasket(s) and align on the pump body.
- ❑ When installing the pump body (volute) to the pump head, DO NOT damage the clearance rings or impeller.
- ❑ Reconnect all cooling lines, piping and tubing.
- ❑ Inspect the system for proper operation.
- ❑ Return the apparatus to service.

## Clearance Rings, Impeller Measurement



**Figure 6-9: Clearance Ring ID and Impeller ID / OD Measurement**

Inspect both clearance ring IDs for signs of wear. Using a caliper, measure the inside diameter of each ring in several places. If the nominal dimension does not fall within the acceptable range specified below, the clearance ring must be replaced. (See Figure 6-9: "Clearance Ring ID and Impeller ID / OD Measurement".)

**Note:** Clearance rings should be measure while pressed into the body.

When new, the radial clearance between the impeller hubs and the clearance rings are 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.

### ☐ Maximum Inside Diameter - Clearance Rings

APS / AP - .....4.777" (121.3 mm)

MBP / MG - ..... 5.638" (143.2 mm)

TBP (outer)- .....4.777" (121.3 mm)

TBP (center)- ..... 4.776" (121.3 mm)

### ☐ Minimum Outside Diameter - Impeller

APS / AP- .....4.760" (120.9 mm)

MBP / MG- .....5.620" (142.7 mm)

TBP (outer)- .....4.758" (120.9 mm)

**TBP (center)-..... 4.758" (120.9 mm)**

If the nominal dimension does not fall within the specified acceptable range the clearance ring must be replaced. If the diameter is equal to or less than the maximum outside wear limit a new impeller must be installed.

If the clearance rings on the booster pump show significant wear but the impeller itself is within the size tolerance, "undersized" clearance rings can be installed to delay a complete rebuild. Contact Customer Service at 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).**

## 6.10 SERVICING THE TWIN BOOSTER PUMP (TBP)

Before servicing the TBP, it is important to note the orientation of the volute and the direction of rotation of each impeller. During reassembly, it is possible to install the volute and impellers backwards. Careful notes, pictures, and match-marks will ensure that the pump is reassembled correctly.

### Volute and Impeller (TBP Only)

See Figure 6-12: "TBP Parts Breakdown" on page 100

1. Remove the suction manifold (if still installed).
2. Unthread the compression fittings and disconnect gearbox cooler hoses from the volute. See Figure 6-10: "Typical Water Cooling Lines Left Side" and See Figure 6-11: "Typical Water Cooling Lines Right Side".
3. Remove the 7/16"-14 screws and hardware securing the discharge manifold to the volute and remove the manifold with the transfer valve still installed.
4. Remove the Victaulic coupling securing the suction elbow to the outboard pump head.
5. Remove the 7/16"-14 screws and hardware securing the opposite end of the suction elbow to the check valve housing and remove the elbow.
6. Remove the 7/16"-14 screws and hardware securing the outboard pump head to the volute. Remove the outboard pump head from the volute.

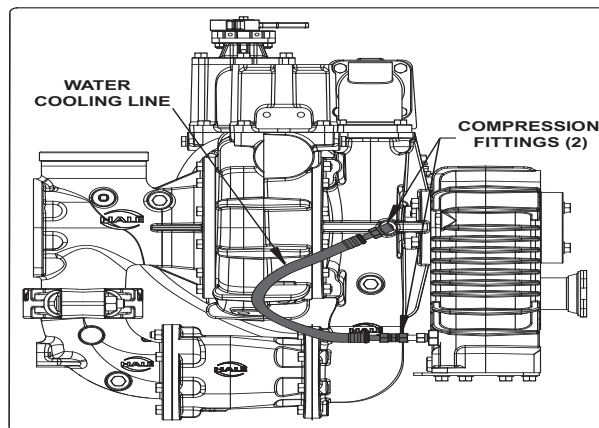


Figure 6-10: Typical Water Cooling Lines Left Side

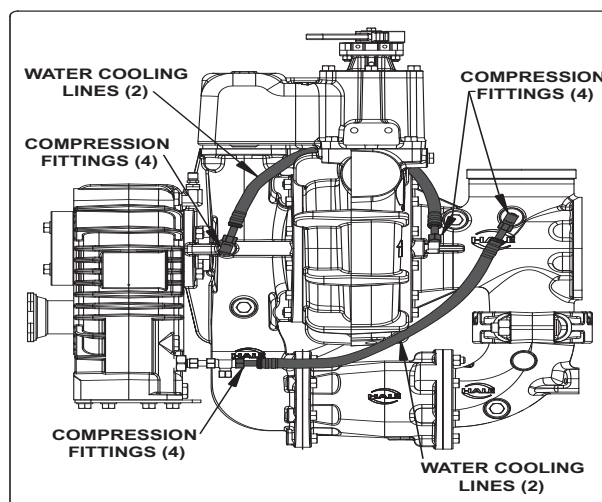
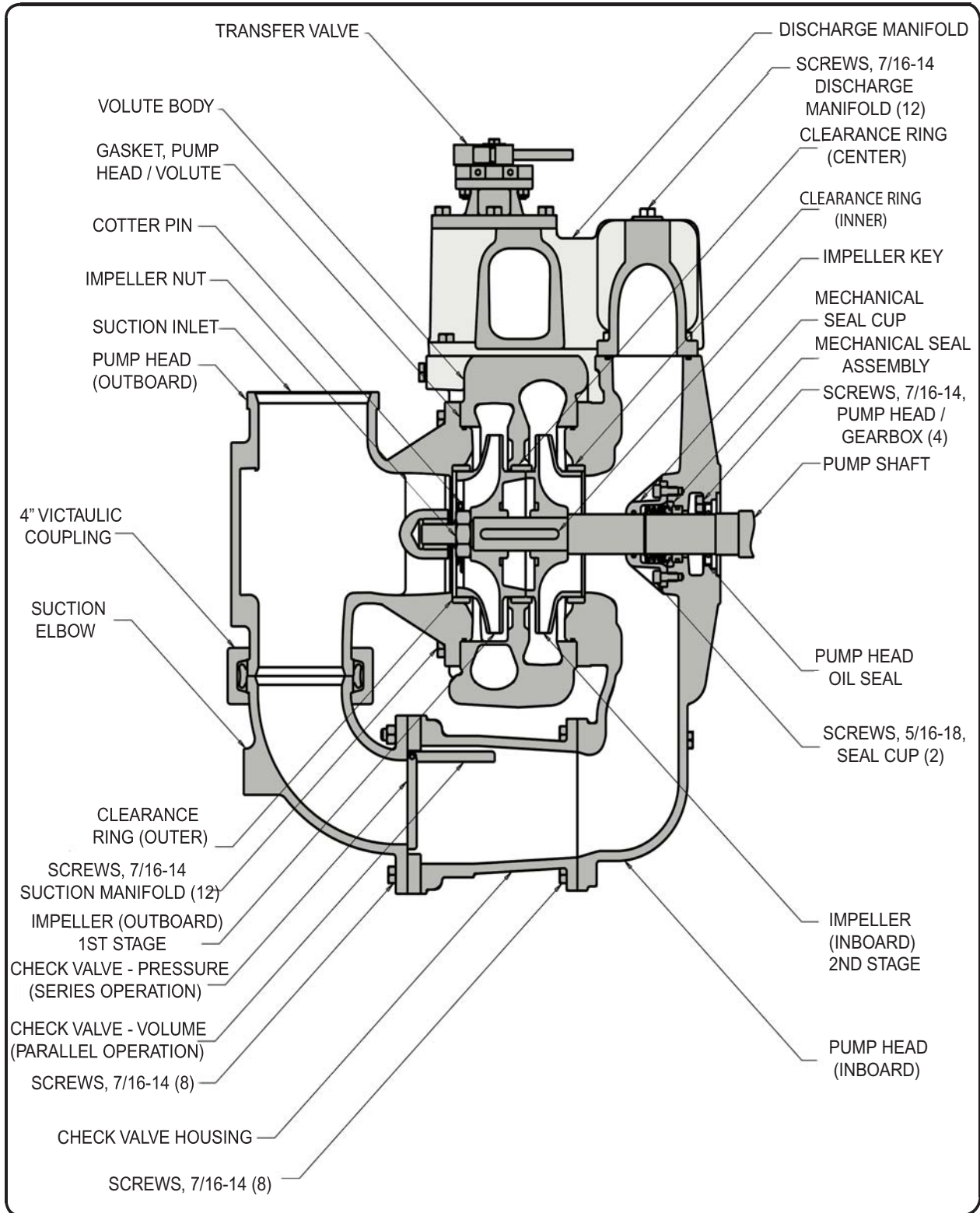


Figure 6-11: Typical Water Cooling Lines Right Side





**Figure 6-12: TBP Parts Breakdown**



Inspect outer clearance rings for wear and replace accordingly.  
See "Clearance Rings, Impeller Measurement" on page 97.

7. Remove cotter pin and impeller nut, and set aside.
8. Remove the outboard impeller from the pump shaft by using a bearing puller. To avoid causing damage place the puller at the impeller vane area where the metal is the heaviest.
9. Remove the 7/16"-14 screws and hardware securing the volute to the inboard pump head. Remove the volute being careful not to damage the inboard impeller or scratch the sealing surfaces of the volute. A dead blow hammer could be needed. Tap, in a crisscross pattern, around the volute until it is separated from the cover plate. Support the weight of the volute as it weighs approximately 45 lbs. (17 kgs.).

### 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.**

**Notes:** 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.

10. Without removing from the volute, inspect the center clearance ring for wear and replace accordingly. See heading "Clearance Rings, Impeller Measurement" on page 97.
11. Slide the inboard impeller from the pump shaft, then remove the impeller shaft key and set safely aside.
12. Inspect the rear clearance ring for wear and replace accordingly. See heading "Clearance Rings, Impeller Measurement" on page 97.

**Note:** Removing the rear clearance ring from the pump head renders the ring defective and it must be replaced.

13. For Mechanical Seal Replacement Instructions, see headingsee heading "Mechanical Seal Assembly" on page 103.

## Installation Notes – Volute and Impeller (TBP)

- ☐ Review preceding sections "Before You Begin...", on page 81 and "Cleaning and Inspection Guidelines," on page 84.
- ☐ Replace all gaskets. Apply a small amount of grease to the gasket(s) and align on the pump body.

1. If necessary, replace the mechanical seal using instructions beginning on page 103.
2. If necessary, install new clearance rings. See heading “Clearance Rings, Impeller Measurement” on page 97.
3. Reinstall the impeller shaft key and slide the inboard impeller back on the pump shaft. For engine rotation pumps, the short hub, seven vein impeller is the inboard impeller. The long hub, five vein impeller is the inboard impeller for opposite engine rotation pumps.

**CAUTION !**



**DO NOT STRIKE THE IMPELLER. IRREPARABLE DAMAGE MAY RESULT.**

4. Reinstall volute taking care not to damage the impeller or clearance rings. For engine rotation pumps, the cast arrow on the volute will be on the left side and will be pointing in a clockwise direction. For opposite engine pumps, the cast arrow on the volute will be on the right side and will be pointing in a counter-clockwise direction.
5. Put the outboard impeller back on the pump shaft. Use care to avoid damaging the shaft threads. For engine rotation pumps, the long hub, five vein impeller is the outboard impeller. The short hub, seven vein impeller is the outboard impeller for opposite engine rotation pumps.
6. To reinstall the impeller nut and cotter pin, first torque the impeller nut to 110 ft.-lbs. (148 N-m). Then continue tightening the impeller nut until the cotter pin can be installed to lock the nut in place.
7. Inspect the pump shaft bearing in the outboard head and replace if necessary.
8. Reinstall the outboard pump head to cover the outboard impeller and clearance ring. Make sure to align the cooling line port in the volute with the mating hole in the gasket and outboard pump head.
9. Reconnect all cooling lines, piping, and tubing.
10. Inspect the system for proper operation.

## 6a 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.

WHENEVER A MECHANICAL SEAL IS REMOVED, IT MUST BE REPLACED WITH A NEW SEAL.

### 6A.1 MECHANICAL SEAL (ALL EXCEPT TBP)

#### Mechanical Seal Removal (All Except TBP)

To expose the mechanical seal, first remove the:

- Pump suction head, if included.
  - Impeller - see heading "Impeller (All Except TBP)" on page 95.
1. From within the pump head, and using two jaw-type puller tools (hook-type), spaced 180° apart, reach in and pry (pull) the seal ring from the pump shaft.

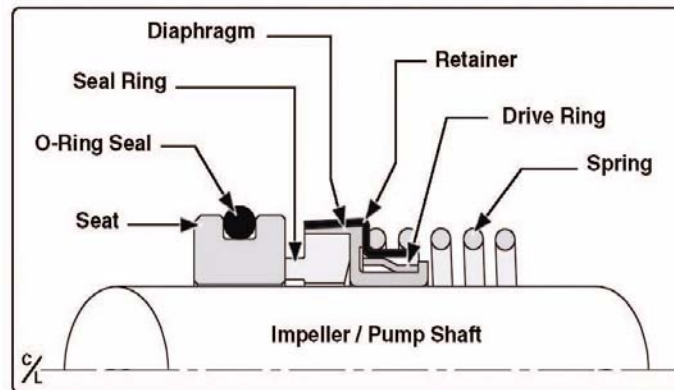


Figure 6a-1: Typical Mechanical Seal Assembly

**Note:** On pump models CBP and 2CBP first remove the spring retainer. See Figure 6a-3: "Typical TBP Mechanical Seal Assembly" on page 106.

2. Place two hook-type tools or two small screw drivers, 180° apart, between the diaphragm assembly and the stationary sealing face. Using steady, gentle pressure, pry the diaphragm assembly from the shaft.
3. Slide the short end of a 3/32" or 7/64" (2.5 mm - 3.0 mm) hex key between the back side of the pump head and the pump shaft.

Then, using steady gentle pressure, pull on the hex key with a screw driver to push the stationary seat out of the pump head. **Removing the mechanical seal renders it inoperative and it must be replaced.**

4. Carefully inspect clearance rings and other internal 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.*

## Mechanical Seal Installation (All Except TBP)

### 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 PUMP BODY, IMPELLER BORES AND ALL MATING SURFACES OF THE SEAL ASSEMBLY ARE ABSOLUTELY CLEAN THROUGHOUT THE ENTIRE INSTALLATION PROCESS. SOLID FACES MUST BE CLEANED WITH AN APPROPRIATE DEGREASER AND A SOFT CLOTH, E.G., ALCOHOL WIPES SUPPLIED WITH THE HALE SEAL INSTALLATION KIT.**

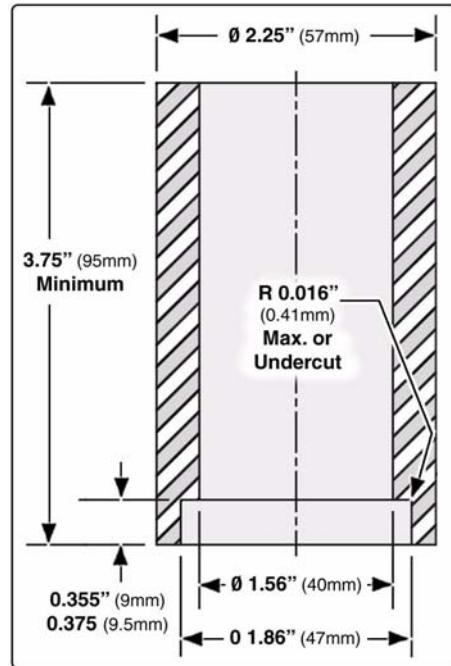
**OIL AND GREASE, INCLUDING SKIN OILS, WILL DAMAGE THE MECHANICAL SEAL FACE. NEVER TOUCH THE FACE OF THE MECHANICAL SEAL. WEAR PROTECTIVE GLOVES, I.E., RUBBER, ACRYLIC, LATEX, ETC., NOT CLOTH OR LEATHER, TO PREVENT TOUCHING THE SEAL FACES WITH YOUR BARE HANDS.**

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

1. Clean the pump head mechanical seal bore and pump shaft using alcohol wipes supplied with the Hale repair installation kit.
2. Apply a generous coating of Pac-Ease Rubber Lubricant Emulsion to the O-ring portion of the stationary seat and to the pump head mechanical seal bore. Also see Figure 6a-1: "Typical Mechanical Seal Assembly" on page 103.
3. Without touching the polished seal face, slide the stationary seat into the pump head bore until the seat is firmly placed in the pump head.
4. Apply a generous coating of Pac-Ease lubricant to the rubber diaphragm

portion of the diaphragm assembly. Without touching the seal faces, slide the diaphragm assembly over the pump shaft, with the polished face toward the stationary seat.

5. Using a mechanical seal insertion tool, push the diaphragm assembly in until the two running faces contact.
6. The seal insertion tool is available from Hale (order P/N: 029-0760-00-0). If necessary, the seal insertion tool can be made of plastic or brass to the dimensions in Figure 6a-2: "Typical Mechanical Seal Insertion Tool" on page 105.
7. Place the spring on the diaphragm assembly, making sure to locate the spring on the diaphragm assembly's pilot.
8. Install impeller per page 96.
9. Install volute per page 95.



**Figure 6a-2: Typical Mechanical Seal Insertion Tool**

## 6A.2 MECHANICAL SEAL (TBP ONLY)

### Mechanical Seal Removal (TBP Only)

#### Two-Stage Pumps

1. Remove volute and impeller per instructions on page 99.
2. Remove the 5/16"-18 screws and hardware from the mechanical seal housing.

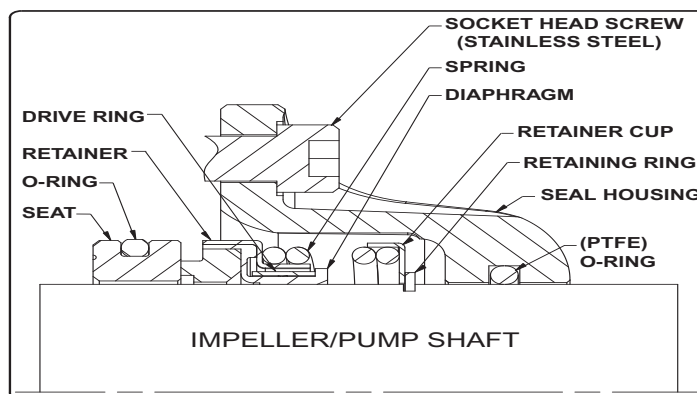


Figure 6a-3: Typical TBP Mechanical Seal Assembly

3. Screw 3/8-24 UNF screws into the jacking holes and turn until the mechanical seal housing has broken away from the mechanical seal assembly.
4. Once the mechanical seal housing has broken away, slide the housing off of the shaft to expose the remaining mechanical seal assembly. Remove PTFE seal ring from seal cup.
5. From within the inboard pump head, remove retaining ring from groove in pump shaft. Remove the spring retainer (See Figure 6a-3: "Typical TBP Mechanical Seal Assembly" on page 106) and spring.
6. Place two hook-type tools or two small screw drivers, 180° apart, between the diaphragm assembly and the stationary sealing face. Using steady, gentle pressure, pry the spring and diaphragm assembly from the shaft.
7. Slide the short end of a 3/32" or 7/64" (2.5 mm - 3.0 mm) Allen wrench between the back side of the pump head and the pump shaft through the inspection opening.

Then, using steady gentle pressure, pry Allen wrench with a screw driver to push the stationary seat out of the pump head. **Removing the mechanical seal renders it inoperative and it must be replaced.**

8. Carefully inspect clearance rings and other internal 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.*

## Mechanical Seal Installation (TBP Only)

### 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 PUMP BODY, IMPELLER BORES AND ALL MATING SURFACES OF THE SEAL ASSEMBLY ARE ABSOLUTELY CLEAN THROUGHOUT THE ENTIRE INSTALLATION PROCESS. SOLID FACES MUST BE CLEANED WITH AN APPROPRIATE DEGREASER AND A SOFT CLOTH, E.G., ALCOHOL WIPES SUPPLIED WITH THE HALE SEAL INSTALLATION KIT.**

**OIL AND GREASE, INCLUDING SKIN OILS, WILL DAMAGE THE MECHANICAL SEAL FACE. NEVER TOUCH THE FACE OF THE MECHANICAL SEAL. WEAR PROTECTIVE GLOVES, I.E., RUBBER, ACRYLIC, LATEX, ETC., NOT CLOTH OR LEATHER, TO PREVENT TOUCHING THE SEAL FACES WITH YOUR BARE HANDS.**

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

1. Clean the bore of the pump head and pump shaft using alcohol wipes supplied with the Hale repair installation kit.
2. Apply a generous coating of Pac-Ease Rubber Lubricant Emulsion to the stationary seat assembly, the pump head and shaft and seal areas.
3. Without touching the seal face, slide the stationary seat into the pump head bore until the seat is firmly seated in the pump head. Also see Figure 6a-3: "Typical TBP Mechanical Seal Assembly" on page 106.
4. Apply a generous coating of Pac-Ease lubricant to the seal diaphragm assembly. Without touching the seal faces, slide the diaphragm assembly over the pump shaft, with the polished face toward the stationary seat.
5. Using a mechanical seal insertion tool, in Figure 6a-2: "Typical Mechanical Seal Insertion Tool" on page 105. Push the diaphragm assembly in until the two running faces contact.
6. The seal insertion tool is available from Hale - order p/n: 029-0760-00-0.

**Note;** If necessary, the seal insertion tool can be made of plastic or brass to the

dimensions in Figure 6a-2: "Typical Mechanical Seal Insertion Tool" on page 105.

7. Keep the seal well lubricated and verify that the seal seats against the stationary seat. If binding occurs, apply additional Pac-Ease lubricant.
8. Place the spring on the diaphragm assembly, making sure to locate the spring on the diaphragm assembly's pilot.
9. Slide the spring retainer onto the pump shaft and secure in place with the retaining ring. See Figure 6a-3: "Typical TBP Mechanical Seal Assembly" on page 106.
10. If still attached, remove 3/8-24 UNF jacking screws from the seal housing. Make sure PTFE seal ring is in groove of seal housing. Then slide the seal housing onto the shaft. Make sure housing is seated properly in head.
11. Secure the seal housing in place using the 5/16-18 screws.
12. Install volute and impellers per instructions on page 101.



## 6b Transfer Valve (TBP Only)

### 6B.1 TRANSFER VALVE REMOVAL

1. Refer to Figure 6b-1 on page 115 for an exploded view.
2. Disconnect any extensions or air cylinders from cam handle. The handle can then be removed.
3. Remove the bolt and washer securing the handle. Note the orientation of the handle with respect to the "V" groove in the stem of the transfer drum. It may be useful to make a mark on the handle corresponding to the "V" groove in the end of the transfer drum stem.
4. Remove the (4) screws securing the cover retainer, and then lift off the stop and cover retainer.
5. Remove the (4) bolts from the transfer valve cover. Pull up on the transfer drum cover to remove the transfer drum and components as an assembly.
6. Remove the square seal ring.
7. Remove the 2 1/2 non-locking cover.
8. Remove the retaining ring from the transfer valve drum and remove the transfer drum.
9. If necessary, remove the locating pin from the transfer valve cover.
10. If required, remove the two bronze bushings from the transfer valve cover.
11. If required, remove the O-ring from the transfer valve cover.
12. Remove the transfer drum sleeve from the bore of the discharge manifold.

### 6B.2 TRANSFER VALVE INSTALLATION

1. Refer to Figure 6b-1 on page 115 for an exploded view.
2. Before reassembly of parts, clean and inspect any worn or damaged components. Always use a new retaining ring and seals.
3. If removed, apply grease and install the O-ring into the underside of the transfer valve

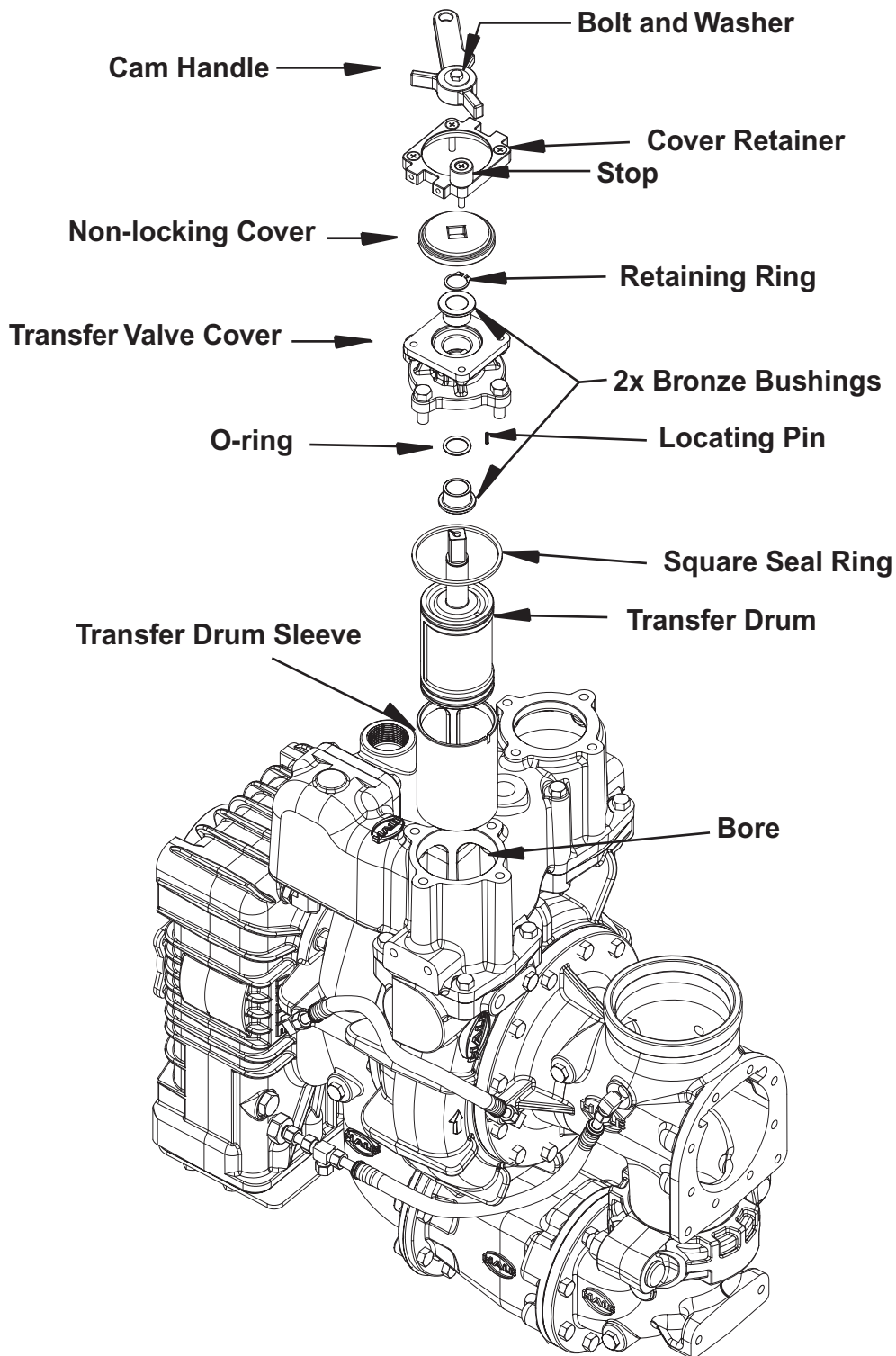


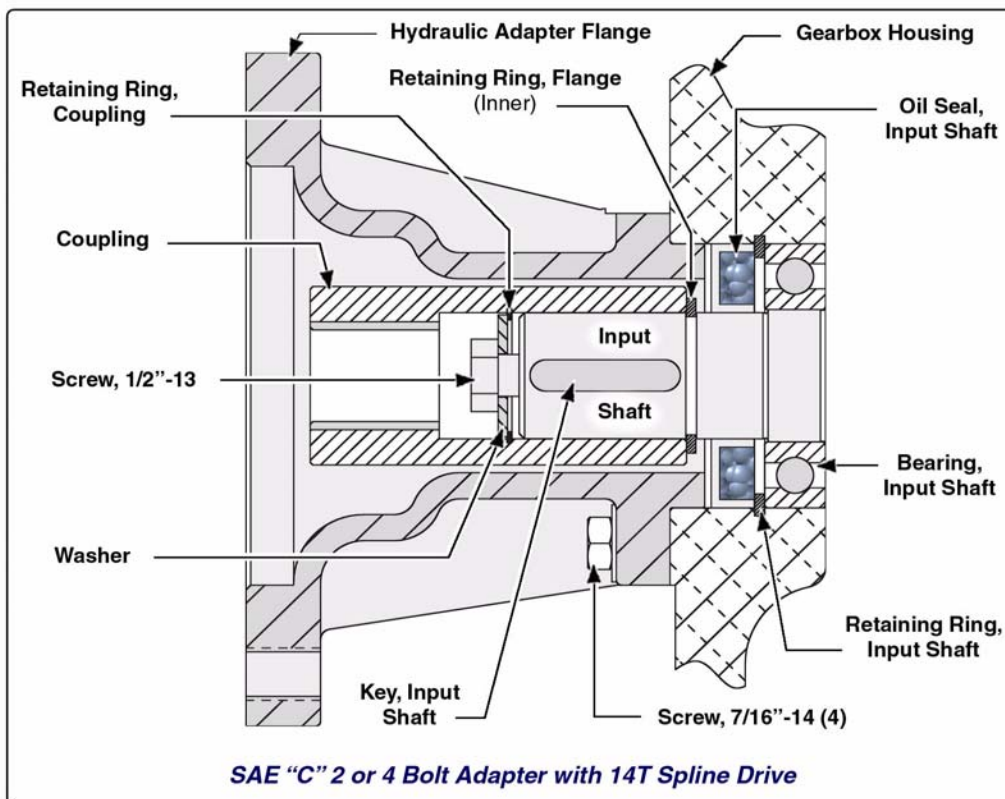
Figure 6b-1: Exploded TBP Transfer Valve and Parts

cover.

4. If removed, install the bronze bushings in the top and bottom of the transfer valve cover.
5. If removed, install the locating pin into the bottom of the transfer valve cover.
6. Apply grease to bores of bronze bushings and insert the stem of the transfer drum up through the center of the transfer valve cover bushings.
7. Insert a new retaining ring into the groove of the transfer drum stem.
8. Apply grease to the outside of the transfer drum sleeve and insert it into the bore. Align the two openings of the sleeve with the two openings of the bore.
9. Apply grease to seal ring groove in transfer valve cover and install square seal ring in the groove and the bore of the transfer valve sleeve.
10. Apply grease to top of discharge manifold and install the transfer drum assembly into the transfer drum sleeve making sure to align the locating pin with the notch in the sleeve.
11. Tighten the four (4) mounting screws to 50 ft.-lbs.
12. Install the nylon non-locking cover on the stem of the transfer drum.
13. Install the cover retainer, mounting screws, valve stop and lock nuts to the transfer valve cover. The "V" groove in the top of the stem of the transfer drum indicates the opening side of the transfer drum.
14. Install the handle on the transfer drum. The orientation of the handle depends on how it is connected to an air cylinder or a pre-existing handle extension.
15. Secure the handle in place with washer and bolt.
16. Connect the handle to an air cylinder or extension handle.

## 6c Available Options

### 6C.1 HYDRAULIC DRIVE OPTION ( -H SERIES)



**Figure 6c-1: Hydraulic Drive Option, \* -H**

1. Review preceeding sections "Before You Begin..." on page 73 and "Cleaning and Inspection Guidelines" on page 76.
2. Remove the hydraulic motor from the hydraulic adapter flange. Unbolt motor and pull back to slide motor shaft (splined) from the input shaft coupling.
3. Remove the four (4) 7/16"-14 hex screws and hardware securing the hydraulic adapter flange to the gearbox housing. (See Figure 6c-1: "Hydraulic Drive Option, \* -H".)
4. Remove the 1/2"-13 screw and washer securing the coupling to the input shaft.
5. Slide (Pull back) the coupling from the shaft and remove the shaft key and set safely aside. (See Figure 6c-1: "Hydraulic Drive Option, \* -H".)

6. Inspect and clean all components according to the Cleaning and Inspection Guidelines on page 76.

## Installation Notes

(See Figure 6c-1: "Hydraulic Drive Option, \* -H" on page 112.) To install, follow the preceding steps in the reverse order.

- ☐ Using Loctite #242 (removable medium strength thread lock) install the 1/2"-13 and 7/16"-14 mounting screws and hardware. For sealant specifications, also see "Appendix C1: Lube and Sealant Specifications" on page 121.
- ☐ Torque screws accordingly - see Table 6-1: "Typical Torque Values Chart" on page 75.

## 6C.2 TACHOMETER DRIVE OPTION

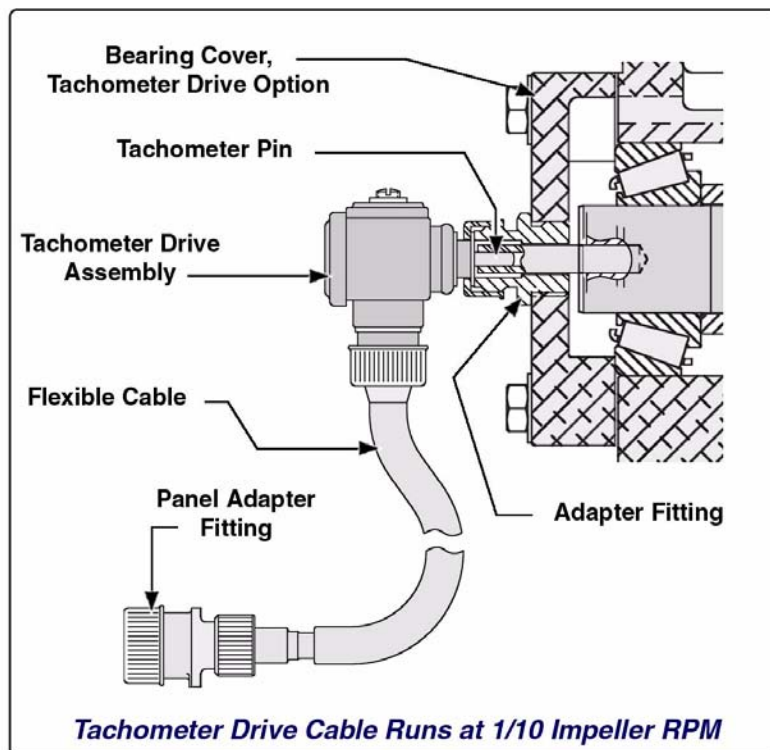


Figure 6c-2: Tachometer Drive Option

1. Disconnect the tachometer cable from the tachometer drive assembly.
2. Remove the tachometer drive assembly from the adapter fitting.

3. Unthread the adapter fitting from the bearing cover.

## **Installation Notes**

(See Figure 6c-2: “Tachometer Drive Option” on page 113.)

To install, follow the preceeding steps in reverse order.

### **6C.3 ENGINE DRIVE, \* -M SERIES (FLYWHEEL MOUNT)**

(See Figure 6c-3: “Engine Drive Option, \* -M” on page 115)

To service the input shaft oil seal, elastomeric drive disk and/or pump input shaft assembly you must disassemble the flywheel housing adapter from the engine. This service repair involves removing of the pump and gearbox assembly and interconnecting manifolding, valving, etc.

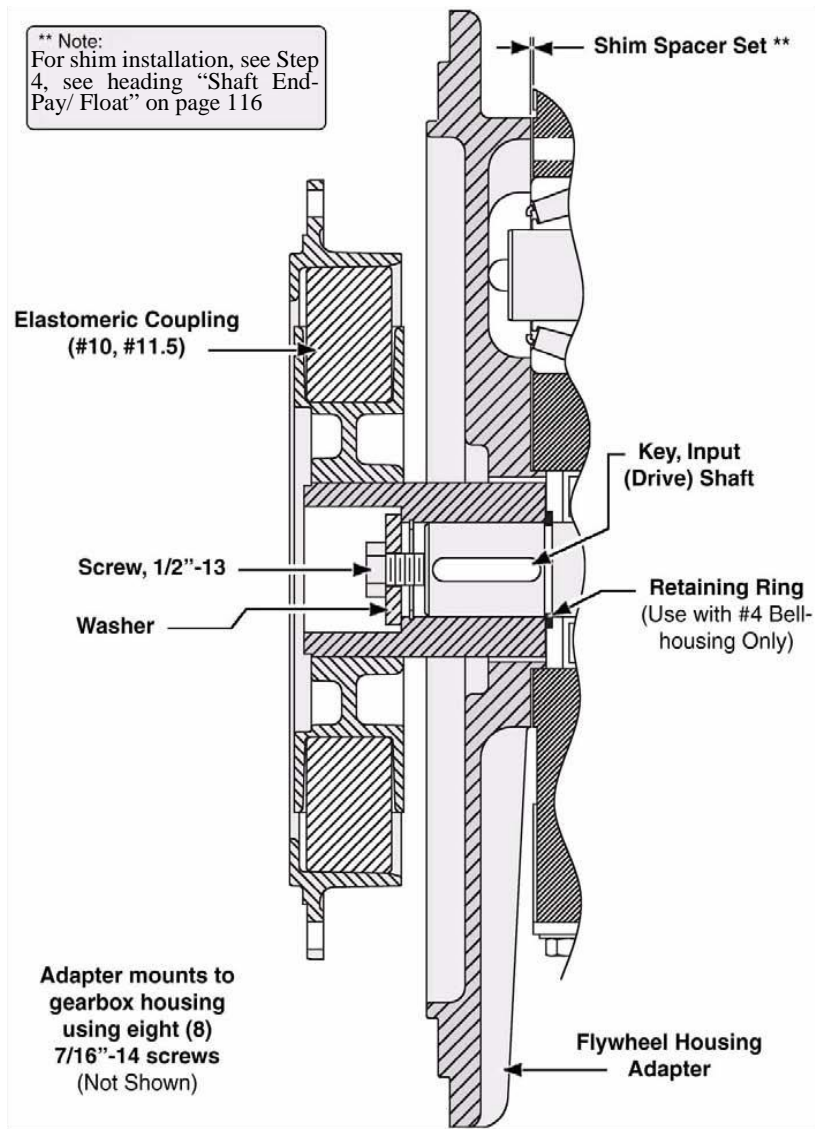
1. Review sections “Before You Begin...,” on page 73 and “Cleaning and Inspection Guidelines,” on page 76. Also review **WARNINGS !** not on page 74.

**Note:** Before beginning the removal process, you may want to make a sketch of the plumbing and component configuration to aid in re-assembly.

2. If not already done, remove the necessary enclosures to gain access to the Silencer Series booster pump assembly.
3. Make sure there is sufficient clearance above and around the apparatus to perform your service requirements. Obtain access to the pump and gearbox assembly by removing or disconnecting other equipment as needed, e.g., valve operators, discharge and suction piping and valves that would interfere with pump removal.

Have clean disposable shop rags and oil dry handy. Also disconnect cooling tubes to the pump, air lines, electrical switches and tachometer cable as required.

4. If you are servicing the oil seal only, it is not necessary to drain oil from the gearbox. However, if your service is internal, i.e., input shaft assembly components, you must drain oil from the gearbox - remove the magnetic pipe plug. See Section 4: Preventative Maintenance, heading “Replace Gearbox Oil” on page 58.



**Figure 6c-3: Engine Drive Option, \* -M**

5. With the pump and gearbox assembly properly supported and balanced, remove the screws and hardware that secure the flywheel housing adapter to the engine bell housing. (See Figure 6c-3: "Engine Drive Option, \* -M".)

Always use proper lifting and support apparatus (jacks, hoists, straps, chain, etc.) when servicing the unit. Exercise care when using chains to protect finished surfaces from scratches.

6. Move the assembly to a clean work area and clamp into a suitable and stable holding device. It is recommended to maintain the lifting device connected to the pump assembly.



7. Remove the input shaft center screw (1/2"13) and washer to separate the elastomeric drive disc assembly from the input shaft. (See Figure 6c-3: "Engine Drive Option, \* -M" on page 115.)
8. Remove the eight (8) 7/16"-14 screws securing the flywheel housing to the gearbox housing.



### **IMPORTANT !**

**THE ADAPTER HOUSING IS BULKY AND HEVY. ALTHOUGH A PILOT SECURES THE ADAPTER TO THE HOUSING, EXERCISE CAUTION WHEN THE SCREWS ARE REMOVED. CONNECT THE ADAPTER HOUSING TO A LIFTING/SUPPORTING DEVICE OR REQUEST AN ADDITIONAL PERSON FOR ASSISTANCE TO PREVENT INJURY.**

9. Remove the shims used to create shaft and play (float).
10. Inspect and clean all components, including the four (4) elastomeric elements in the coupling, according to the Cleaning and Inspection Guidelines on page 76.

### **Installation Notes - Engine Mounting**

1. Review sections "Before You Begin..." on page 73 and "Cleaning and Inspection Guidelines," on page 76. Also review WARNINGS ! note on page 74.
2. Insert the input shaft key.
3. Temporarily install the flywheel housing adapter and gasket to the gearbox housing tighten the eight (8) 7/16"-14 screws in a cross pattern until the shaft barely spins.

### **Shaft End-Pay/ Float**

1. Using feeler gauges, measure the gap between the flywheel housing adapter and the gearbox housing to establish the proper shaft end play, or "float." (See Figure 6c-3: "Engine Drive Option, \* -M" on page 115.)
2. Record this gap measurement, then remove the flywheel housing adapter.
3. Add an additional 0.003"-0.005" (0.0762-0.127 mm), rounding up where necessary, to the established gap in preceeding step 4 and install appropriate thickness of shims to generate the needed float.



4. Reinstall the flywheel housing adapter and gasket and tighten the eight (8) 7/16-14 screws (apply Loctite #242) in a staggered pattern to insure a proper seal. Apply a small amount of grease to the gasket to help hold it in place. Refer to Table 6-1: "Typical Torque Values Chart" on page 75 for recommended torque value.
5. The elastomeric drive disk assembly includes only four (4) rubber couplings. Insure they are properly inserted before installing the disk assembly to the input shaft. Apply two-sided tape to hold the disks in place as you slide the assembly onto the input shaft.



### **IMPORTANT !**

**IF YOU ARE USING A #3 BELL HOUSING, THE RETAINING RING IS NOT USED.**

**HOWEVER, IF YOU ARE INSTALLING A #4 BELL HOUSING, THE RETAINING RING MUST BE INSTALLED TO THE INPUT SHAFT BEFORE INSTALLING THE ELASTOMERIC DISK ASSEMBLY. (SEE FIGURE 6B-3: "ENGINE DRIVE OPTION, \* -M" ON PGE 104.)**

6. Install the washer and 1/2"-13 screw (apply Loctite #242) and torque accordingly. refer to Table 6-1: "Typical Torque Values Chart" on page 75 for recommended torque value.
7. Install the entire assembly to the engine mount. Make sure screw contain Loctite and are torqued according to manufacturer's specifications.
8. Inspect the system for proper operation before returning the apparatus to service.

## 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 separate Section, “Drawing Package” on page 133, 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 SEPARATE SECTION, “DRAWING PACKAGE” ON PAGE 133, LOCATED AT THE BACK OF THIS MANUAL.



#### **WARNING!**

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)

Move TBP pump with lifting locations in Figure 7-1: "TBP Pump Side View." and Figure 7-2: "TBP Pump Front View." Refer to installation plate PL1180AA for weight and center of gravity.

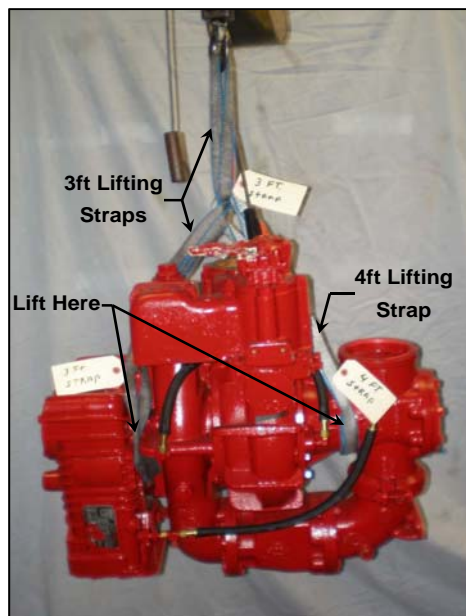


Figure 7-1: TBP Pump Side View



Figure 7-2: TBP Pump Front View

## 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 ARE 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 drive-line 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 (1,041)	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



### WARNINGS!

**THE TBP PUMP CAN OPERATE AT PRESSURES IN EXCESS OF 600PSI. MAKE SURE TRUCK PLUMBING IS CAPABLE OF WITHSTANDING THIS PRESSURE.**

See separate Section, "Drawing Package" on page 133, 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.

## 7.5 FLUID LEVELS

To meet various shipping regulations, ALL fluids within the pump and gear-box assemblies are drained prior to shipping from the factory.

### IMPORTANT !



AT INSTALLATION AND BEFORE OPERATING FOR THE FIRST TIME, OIL MUST BE ADDED TO THE GEARBOX TO THE APPROPRIATE LEVELS. FOR THE PROPER OIL TO USE AND QUANTITY REQUIRED, SEE SECTION 4: PREVENTIVE MAINTENANCE, HEADING "REPLACE GEARBOX OIL" ON PAGE 58.

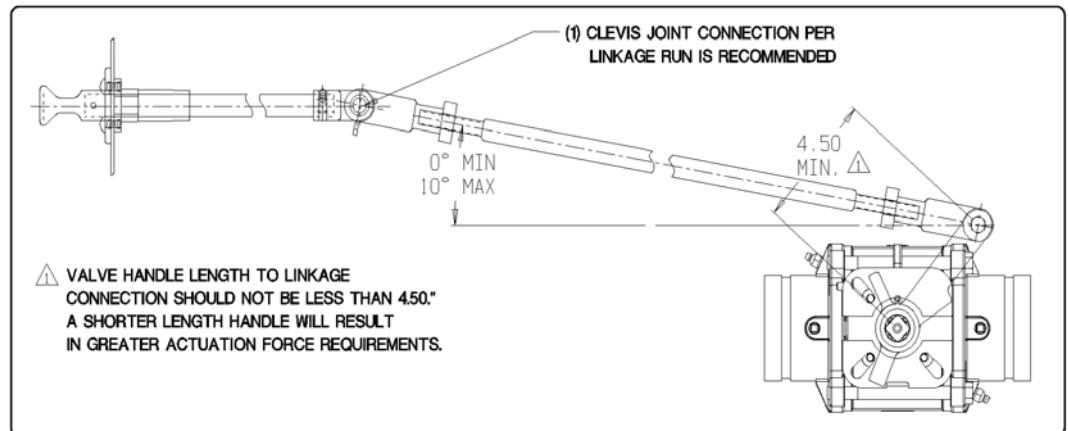
## 7.6 LINKAGE DESIGN FOR TRANSFER VALVE

Proper linkage design and installation is critical to valve actuation. To maximize the available actuation force on a remote valve, the linkage lines should be as straight as possible.

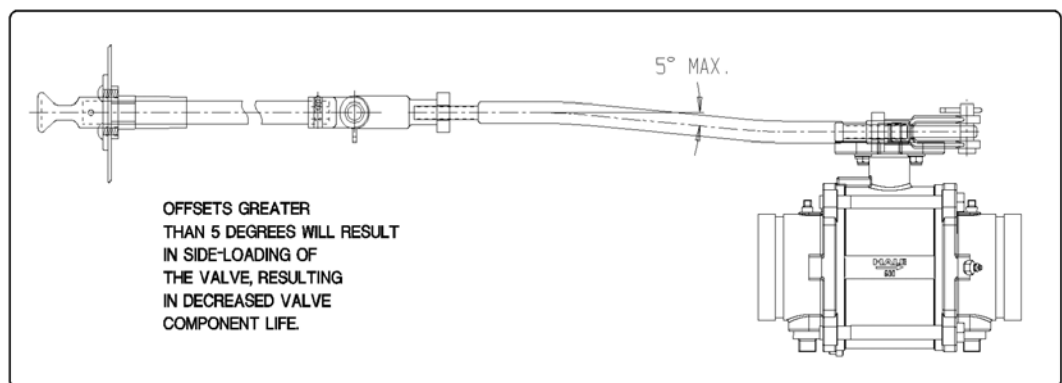
It is recommended that the pull rod lines do not exceed a 10° line of travel (see Figure 7-3: "Adjustable Valve Linkage Guidelines-- Top View" on 123). Also, limit the number of bends to minimize flexing of the remote control rod(s) (see Figure 7-4: "Adjustable Valve Linkage Guidelines-- Side View" on 123).

Actual installed actuation force is dependent upon many factors:

- **Pump pressure** - Valves are harder to operate at higher pressures.
- **Condition of linkage** - The remote pull rods, linkages and hardware should be kept clean and well lubricated. Linkage joints should be lubricated regularly.
- **Plumbing interferences** - When running remote linkage lines, be careful that they DO NOT come in contact with the pump, plumbing, or other linkage rods. This contact causes friction which increase the forces required to operate the valve handle.



**Figure 7-3: Adjustable Valve Linkage Guidelines-- Top View**



**Figure 7-4: Adjustable Valve Linkage Guidelines-- Side View**





## Appendix A: Glossary

**Atmospheric Pressure** ..... Pressure caused by the elevation of air above the earth. Atmospheric pressure is 14 pounds per square inch at sea level. Pressure increases below sea level and decreases above sea level. The weather also effects atmospheric pressure. Atmospheric pressure effects a pumps ability to pump from draft. Higher pressures increase 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 Ring** ..... 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 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** ..Fluid enters on both sides of the impeller.  
**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.

**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.

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

**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 pressure.

**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 pump body 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 (often termed "Pressure Mode").

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

**Horsepower**

**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 (PSI)	One BAR	0.0690
One Pound per Square Inch (PSI)	KPA	0.001
Pounds per Square Inch (PSI)	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](http://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
<b>Alternate STANDARD-Temperature Lubricant (Cognis 2923/2833) See Service Manual for additional information.</b>	
<b>Brad Penn Full Synthetic Transmission Lube SAE-50</b>	American Refining Group 77 N Kendall Avenue Bradford, PA 16701
<b>Bulldog Synthetic Transmission Lube SAE-50 Trans.</b>	Mack Truck Company 2100 Mack Boulevard Allentown, PA 18105
<b>D-A SynSure Synthetic Lube SAE-50 Trans.</b>	D.A. Lubricant Company, Incorporated 1340 West 29th Street Indianapolis, IN 46208
<b>Dyna-Plex 21C Synzol SAE-50 Trans.</b>	Universal Lubricants P O Box 2920 2824 North Ohio Wichita, KS 67219
<b>Emgard SAE-50 Synthetic Transmission Lubricant</b>	Cognis Corporation 5051 Estecreek Drive Cincinnati, OH 45232
<b>Fleetrite Synthetic SAE-50 Transmission Oil Trans.</b>	International Truck & Engine Corporation 5 Westbrook Corporate Center Westchester, IL 60154
<b>Hi-Tek Synthetic SAE-50 Trans.</b>	Industrial Oils Unlimited P O Box 3066 Tulsa, OK 74101
<b>Kenworth SAE-50 Original Factory Fill Fluid Trans.</b>	Paccar Parts 750 Houser Way N Renton WA 98055
<b>Maxtro MT SAE-50 Trans.</b>	Country Energy LLC 5500 Cenex Drive Inver Grove Heights, MN 55077

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

□ Alternate Lubricant Manufacturers



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

Table C-1: Alternate Lubricant Manufacturers



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## Appendix C1: Lube and Sealant Specifications

Pump	Gearbox or Pedestal	Approximate Capacity		Recommended Oil
		Quarts	Liters	
4DK		5	4.7	SAE 50 - above 0° F (above -18° C); Dextron III or Cognis 2803 - between -40°F to 0°F (-40° to -18°C)
APS APSM MBP MBPM 4DB SBP	B (Vertical)	2	1.9	SAE 50 80W-90; 75W-80 Synthetic
	B (Horizontal)	1.5	1.4	SAE 50 80W-90; 75W-80 Synthetic
	B (Inverted)	1.75	1.7	SAE 50 80W-90; 75W-80 Synthetic
QTWO / QMAX QPAK / QFLO QFLOPLUS DSD / SMD	G X, L and R Series	4	3.8	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.)
SMM / QSMG / QG 8FGF / 8FGR / RGA / QMID / LGA	G S Series	3	2.8	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.)
QPAK-J	J	2	1.9	SAE EP 90 80W-90 (Lubricants must meet service rating API GL-5.)
RSD-M / RSD PSM / SMR-A	HG *	1.4	1.3	ISO 68 Grade; SAE 50W 80W-90; 75W-80 Synthetic (Lubricants must meet service rating API GL-5.)
SMR-A / SMR-U SMR-AC	Pedestal - Long / Short	0.75 (1.5 pints)	0.71	10W-40 to 15W-40 Multi-Grade Engine Oil (Lubricants must meet service rating API GL-5.)
50FB-U / 50FB-U-U 8FC-U	Pedestal			SAE EP90; 80W-90; 75W-80 Synthetic (Lubricants must meet service rating API GL-5.)
QFLO-A QPAK-A HFM / CSD / PSD	A	1	0.95	SAE 20W Non-Detergent Oil SAE 30W
PSD (Inverted)		2.5	2.4	SAE 20W Non-Detergent Oil SAE 30W
HP Portables		1.5	1.4	SAE 30W
	P	4	3.8	SAE EP 90 80W-90 (Lubricants must meet service rating API GL-5.)
A		4	3.8	SAE EP 90 80W-90 (Lubricants must meet service rating API GL-5.)
APM / AP (Inverted)		1.25	1.2	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.)
APMG MG	MGA (Horizontal or Vertical)	3	2.8	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.)
	I (Special)	4	3.8	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.)
CBP4 / CBP5 2CBP4 / 2CBP5		1	0.95	SAE EP90; 80W-90 (Lubricants must meet service rating API GL-5.) Table continued on next page

Table C1-2: Oil Capacity and Recommendation

## ☐ Lubricant Specifications

Pump	Gearbox or Pedestal	Approximate Capacity		Recommended Oil
		Quarts	Liters	
APM / AP CBP / 2CBP CBP2 / CBP3 2CBP2 / 2CBP3		1.75	1.7	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.)
20FS 30FS		1.75	1.7	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.)
50FBG / 80FBG 609FBG	G	3	2.8	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.)

**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.,

- ☐ Dow 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) - primarily for gearbox assembly
- ☐ #242 Medium Strength Threadlock (or equivalent) - primarily for pump assembly

## Oil

See “Appendix C: Alternate Lubricant Manufacturers” on page 131.

## Recommended Cleaners

- ☐ Safety Kleen®
- ☐ Stoddard Solvent

**IMPORTANT !** The use and disposal of solvents / cleaners must be in accordance with your local environmental regulations.



## Appendix D: Hose Friction Loss

GPM (LPM)	3/4" (19mm) Booster	1.0" (25.4mm) Booster	1-1/2" (38mm) Hose	GPM (LPM)	1-3/4" (44mm) Hose with 1-1/2" (38mm) Coupling	2.0" (38) Hose with 1-1/2" (38mm) Coupling	2-1/2" (64mm) Hose	3.0" (76mm) Hose with 2-1/2" (38mm) Coupling	3.0" (76mm) Hose	GPM (LPM)	3-1/2" (89mm) Hose	4.0" (102mm) Hose	5.0" (127mm) Hose
<b>10 (38)</b>	13.5 (0.9)	3.5 (0.24)		<b>95 (360)</b>	14 (0.96)	8 (0.6)				<b>500 (1,893)</b>	9.5 (0.7)	3 (0.2)	
<b>20 (76)</b>	44 (3.0)	6 (0.4)		<b>125 (473)</b>	24 (1.7)	13 (0.9)				<b>750 (2,839)</b>	20 (1.4)	11 (0.8)	5 (0.4)
<b>30 (114)</b>	99 (6.8)	14 (0.96)		<b>150 (568)</b>	35 (2.4)	18 (1.2)				<b>1,000 (3,785)</b>	34 (2.4)	20 (1.4)	8 (0.6)
<b>40 (151)</b>	176 (12.0)	24 (1.7)	4 (0.3)	<b>175 (662)</b>	47 (3.2)	25 (1.7)	6 (0.4)			<b>1,250 (4,732)</b>	53 (3.7)	31 (2.1)	13 (0.9)
<b>50 (189)</b>		38 (2.6)	7 (0.5)	<b>200 (757)</b>	62 (4.3)	32 (2.2)	8 (0.6)			<b>1,500 (5,678)</b>	74 (5.1)	45 (3.1)	18 (1.2)
<b>60 (227)</b>		54 (3.7)	9 (0.6)	<b>225 (852)</b>			10 (0.7)			<b>1,750 (6,625)</b>		61 (4.2)	25 (1.7)
<b>70 (265)</b>			12 (0.8)	<b>250 (946)</b>			13 (0.9)	5 (0.4)	4 (0.3)	<b>2,000 (7,571)</b>			32 (2.2)
<b>80 (303)</b>			15 (1.03)	<b>275 (1,041)</b>			15 (1.03)						
<b>95 (360)</b>			22 (1.5)	<b>300 (1,136)</b>			18 (1.2)						
<b>125 (473)</b>			38 (2.6)	<b>325 (1,230)</b>			22 (1.5)	8 (0.6)					
<b>150 (568)</b>			54 (3.7)	<b>350 (1,325)</b>			25 (1.7)		8 (0.6)				
				<b>500 (1,893)</b>				20 (1.4)	17 (1.2)				
				<b>750 (2,839)</b>				45 (3.1)	36 (2.5)				
				<b>1,000 (3,785)</b>				80 (5.5)	68 (4.7)				

Table D-1: Hose Friction Loss (PSI / BAR 100 Feet)



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## 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

□ Nozzle vs. Pressure Rating

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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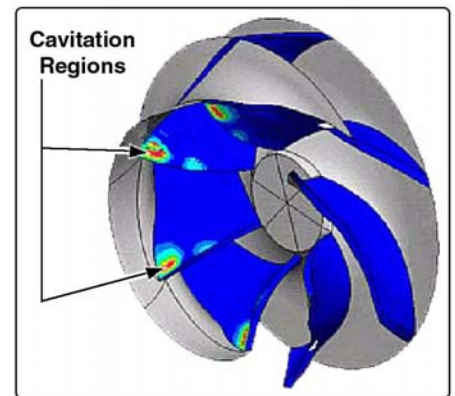


## Appendix F: Cavitation

(See Figure F-4: “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-4: Sample, Cavitation Regions**

### Process of Cavitation

Cavitation occurs when a centrifugal pump attempts to discharge more water than it is receiving. 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 you are 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-4: “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 installed 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 contribute to cavitation.

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

- 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-6: "Lift Loss from Elevation" on page 141.*

- 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-5: "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-6a: "Lift Loss from Barometric Reading.")

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-5: Lift Loss from Temperature

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-6: 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-6a: 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 142.

## Preventive Measures

- Consider the size of the suction hose. Figure F-7: "Hose Size vs. Pump Rating Capacity" on page 142, 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.

## □ 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-7: 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" on page 67.
- 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.
- If determined defective, HALE shall, at its option, repair or replace the Product, or refund the purchase price (less allowance for depreciation).
- Absent proper notice *within* the Warranty Period, HALE shall have no further liability or obligation to Buyer therefore.

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