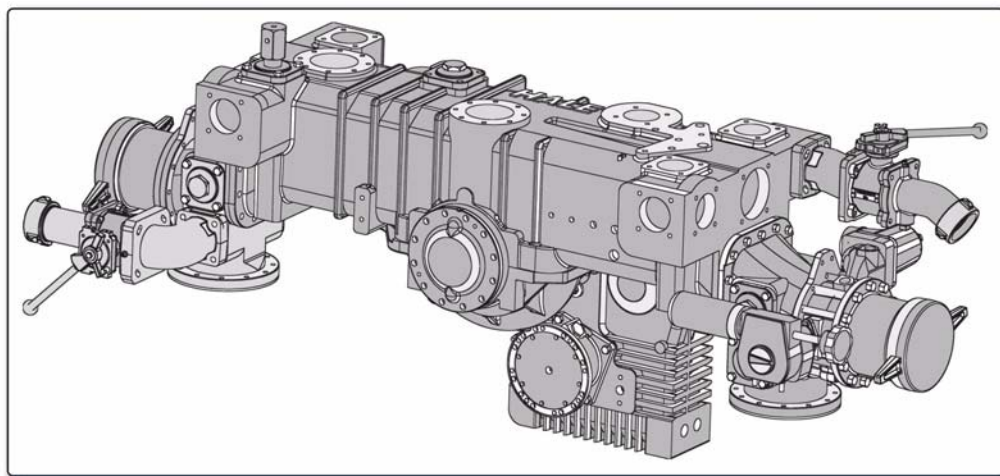




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# MUSCLE (Midship) Pumps ("Q" Series)

## Installation, Operation and Maintenance Manual Part 1



**Hale Products Inc.** „ A Unit of IDEX Corporation  
700 Spring Mill Avenue „ Conshohocken, PA 19428 U.S.A.  
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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.**

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# 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 STRICTLY ADHERED TO 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.



### **IMPORTANT!**

**IMPORTANT - PRACTICES WHICH COULD RESULT IN DAMAGE TO THE APPARATUS OR OTHER PROPERTY.**

## **1.2 GUIDELINES**



### **IMPORTANT!**

**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.

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 “Gearbox Lubrication,” on page 76.)  
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 201.
- 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  
700 Spring Mill Avenue  
Conshohocken, PA 19428 U.S.A.  
Telephone: 610-825-6300  
Fax: 610-825-6440  
Web: [www.haleproducts.com](http://www.haleproducts.com)

## ❑ Safety Precautions

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



### **WARNING!**

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

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

- ❑ DO NOT operate the system at pressures higher than the maximum rated pressure. Always use the lowest possible relief valve settings to enhance operator and equipment safety. Also see Section 2 “Introduction” on page 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 (1,276 kPa). Large diameter hose, marked “Supply Hose 6” (150 mm) diameter” shall not be used at operating pressures exceeding 135 PSI (931 kPa).
- ❑ 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 4 “Basic Operation” on page 53 for additional information.
- ❑ DO NOT advance the throttle unless the OK TO PUMP indicator is ON. Also see Section 4 “Basic Operation” on page 53 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 4 “Basic Operation” on page 53 for additional information.
- ☐ DO NOT attempt emergency manual shift procedures while the engine is running. Also see Section 4 “Basic Operation” on page 53 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 4 “Basic Operation” on page 53 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 DESCRIPTION

Hale single-stage and two-stage **Midship MUSCLE Pumps** cover a range of capacities from 750 Gallons Per Minute (GPM) (3,000 Liters Per Minute, LPM) up to 2,250 GPM (9,000 LPM). Hale single and two-stage pumps are designed to mount on the chassis rails of commercial and custom apparatus. The pump is driven from the truck's main driveline.

Various models of the single-stage muscle pumps and one model of the two-stage muscle pump are offered. The use and position on the apparatus determines the model selected as well as the drive unit. Flow capacities (or rates) are shown in Appendix H: "Midship Flow Rates" on page 199, located at the back of this manual.

### 2.2 PRINCIPLE OF OPERATION

#### Centrifugal Force

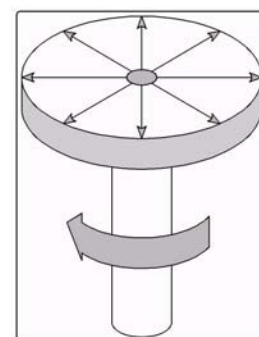
Hale pumps are centrifugal pumps that operate on the principle of centrifugal force created by a rapidly spinning disk. (See Figure 2-1: "Centrifugal Force - Rotating Disk.")

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

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

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

- **SPEED (RPM)** If the speed of rotation increases with flow held constant, fluid pressure increases.
- **PRESSURE** If pressure changes with speed held constant, the flow, measured in gallons or liters per minute (GPM/LPM), changes inversely; if pressure increases, flow decreases. Pressure is measured in pounds per square inch (PSI) or pascals (kPa).



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

- **FLOW** If the pressure (kPa) 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 or LPM) that a pump can deliver when supplied from draft.

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

For example, if the required discharge pressure is 120 PSI (827 kPa) and the inlet pressure is 45 PSI (310 kPa), the pump must only produce the difference in pressure or 75 PSI (517 kPa). This contributes to improved performance with reduced maintenance. Additionally, decreased maintenance is aided by a centrifugal pump having few moving parts.

## Pump Stages

The number of impellers on a common shaft determines the number of pump stages. The Hale single-stage pumps provide the same normal operating and rating test pressures as the Hale two-stage pumps. The two-stage pump provides an additional level of operating pressures if required.

### Single-Stage

Hale single-stage pumps use a one (1) impeller to develop the required volume and pressure. (See Figure 2-2: “Water Flow, Typical Hale Single-Stage Pump.”)

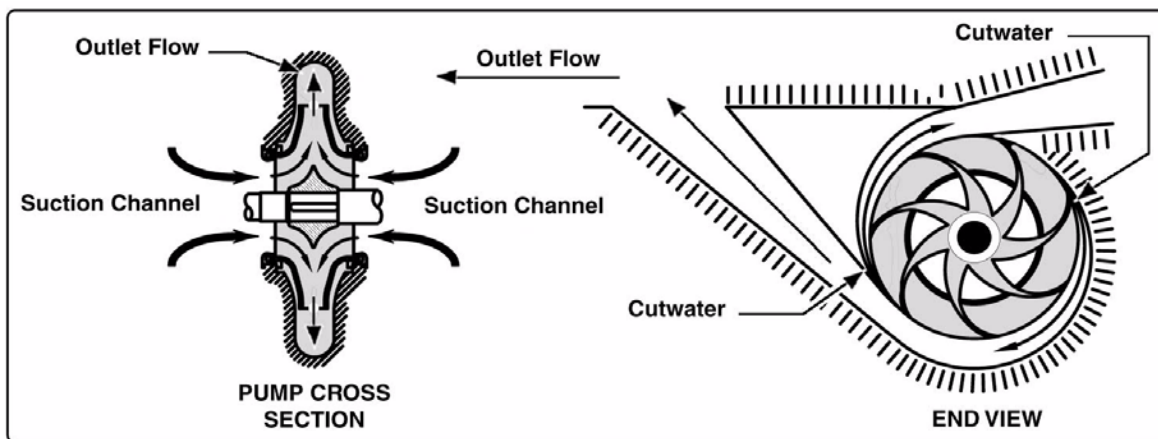


Figure 2-2: Water Flow, Typical Hale Single-Stage Pump



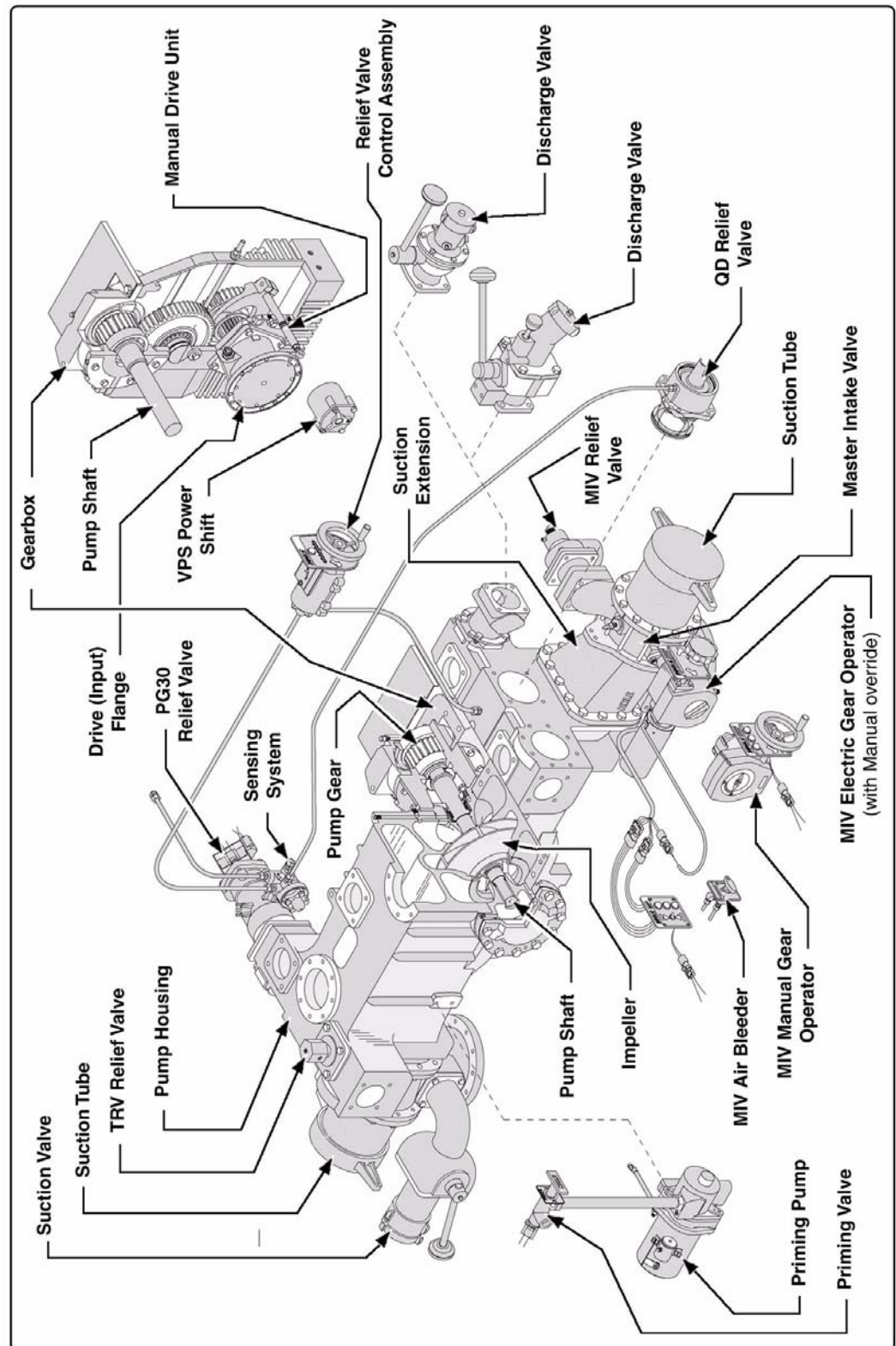


Figure 2-3: Single-Stage Pump Overview

Water enters the suction channels on both sides of the impeller, thereby maintaining axial balance. Dual cutwaters<sup>1</sup> on the Qmax and Qmid strip water from the rotating impeller and direct it to the discharge path. Radial hydraulic balance in the Qmax, Qmid, and Qtwo is maintained by the opposed discharge volute cutwaters.

The Qflo, Qflo Plus, and Qpak series pumps utilize an impeller with a single suction channel where water enters. The impeller develops discharge pressure and directs the water to a single cutwater\* and then to the discharge valves. The impellers are radially and axially balanced.

## Two-Stage

Hale two-stage pumps use two (2) impellers and a transfer valve / switch to develop the required volume and pressure. (See Figure 2-5: “Two-Stage Pump Overview” on page 23.)

**Note:** The transfer valve is a two-position valve that permits the impellers to be operated in parallel (volume) or series (pressure).

## Volume (Parallel) Operation

In Volume operation, the pressure at the pump intake is added to the pressure developed by both impellers, and the amount of water delivered to the discharge is the sum of the flows of the two impellers. (See Figure 2-4: “Two-Stage Pump VOLUME Operation.”)

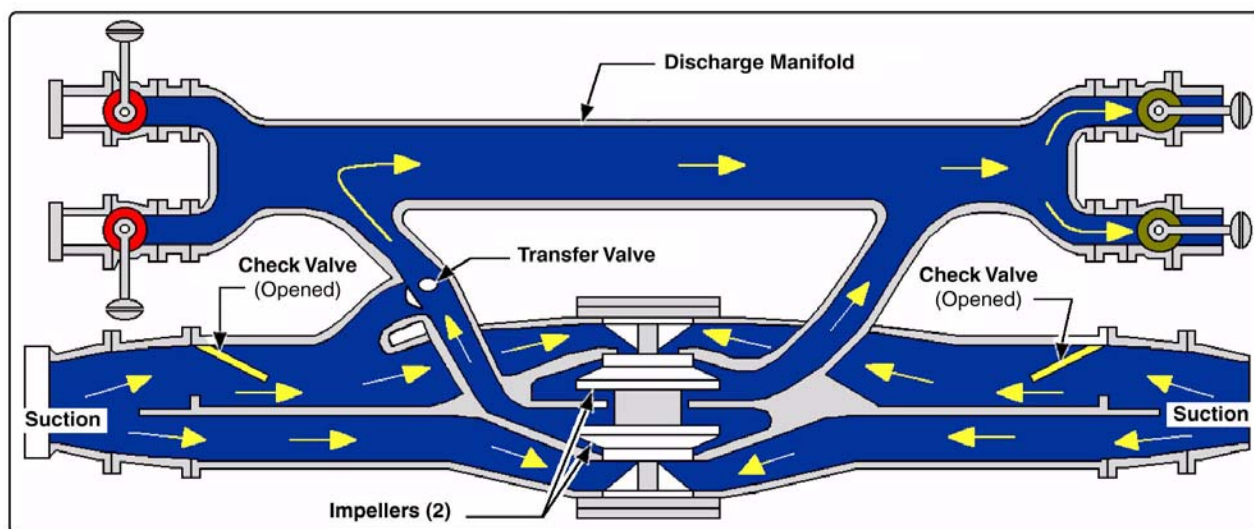


Figure 2-4: Two-Stage Pump VOLUME Operation

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

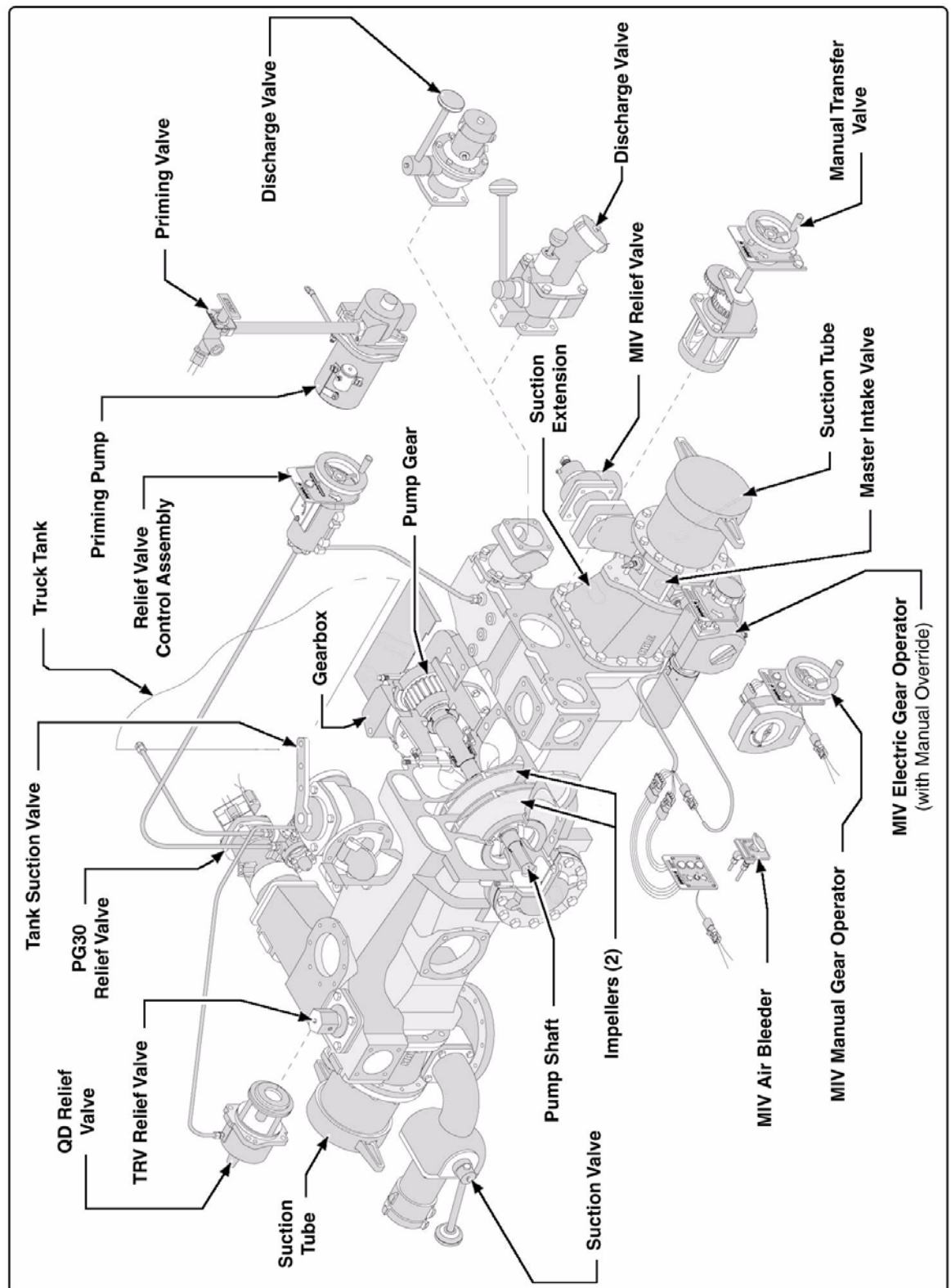
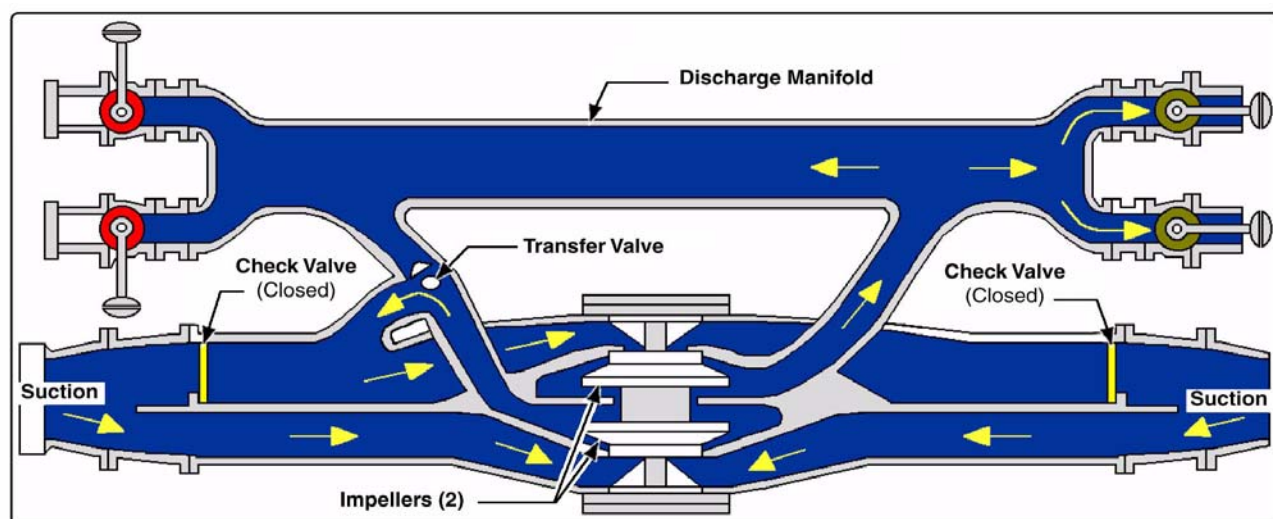


Figure 2-5: Two-Stage Pump Overview

For example, if the inlet pressure is 30 PSI (207 kPa) and the flow of each impeller is 500 GPM (1,892 LPM) at 150 PSI (1034 kPa), the pressure and volume at the discharge is: 180 PSI (1241 kPa).

### Pressure (Series) Operation

For Pressure operation the impellers are connected in series. The output of the impeller supplied from the pump intake is added to the input of the next impeller. (See Figure 2-6: “Two-Stage Pump PRESSURE Operation.”).



**Figure 2-6: Two-Stage Pump PRESSURE Operation**

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 preceding example, when in series operation, the discharge pressure is 330 PSI, (2275 kPa) and the discharge volume is 500 GPM (1,892 LPM)

### Volume vs. Pressure Operation

Selection of volume versus pressure operation is determined by three factors:

- Generally, the pump should be operated so that it provides the desired performance at the LOWEST engine speed.
- Set to VOLUME (parallel) operation for higher flows. (See Figure 2-4: “Two-Stage Pump VOLUME Operation” on page 22.)
- Set to PRESSURE (series) operation when higher water pressures are required. (See Figure 2-6: “Two-Stage Pump PRESSURE Operation” on page 24.)

## Transfer Valve

A transfer valve, controlled from the apparatus pump control panel, allows the operator to select VOLUME or PRESSURE operations.

The valve transfers between pumping modes with two and one-half turns of its control hand wheel. The position of the valve is indicated on the apparatus pump control panel via a positive mechanical indicator. As an option, Hale also offers a power transfer valve.

## Choosing Volume or Pressure Operation

In deciding which range to use (*pressure or volume*), choose the one that provides the desired flow and pressure at the LOWEST engine speed.



### IMPORTANT!

**REFER TO YOUR FIRE DEPARTMENT POLICY FOR WHEN TO USE “VOLUME” OR “PRESSURE” OPERATIONS. IF YOUR FIRE DEPARTMENT DOES NOT HAVE A POLICY, REFER TO THE FOLLOWING HEADING, “GENERAL GUIDELINES.”**

## General Guidelines

1. Hale pumps are designed to pump up to 200 PSI (1379 kPa) net pressure in volume operation and at reasonable engine speeds.
2. The pump should be operated so that engine speed is within its best operating range.
3. Generally, volume operation should be used at any net pump pressure under 150 PSI (1034 kPa), especially when pumping from a hydrant.
4. 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 (1034 kPa).
5. Set to VOLUME 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.**
6. Reduce the pump pressure to between 50 to 60 PSI (345 to 414 kPa) before switching. The engine speed should especially be reduced when switching from volume to pressure operation with hand held hoses in use.



**Note:** When shifting the transfer valve from *volume* to *pressure*, pressure (PSI / kPa) is doubled. You may hear a metallic click indicating as the check valve closes. If the clicking is too loud or somewhat violent, the pumping pressure is too HIGH for switching. Ease back on the engine throttle to reduce IDLE speed.

## **2.3 MUSCLE PUMP COMPONENTS**

Hale muscle pumps are manifolded-type pumps. The pump volute, suction manifold-ing, and discharge manifolding are cast as one piece to simplify installation. (See Figure 2-7: “Typical Midship Two-Stage Centrifugal Pump” on page 27.)

### **Pump Body**

The standard pump body and related parts are constructed from fine grain alloy cast iron, with a minimum tensile strength of 30,000 PSI (207 N/mm<sup>2</sup>). All moving parts subject to water contact.

A bronze body, for use with saltwater or harsh water applications, is also available.

### **Qmax, Qmid, and Qtwo Pumps**

The Qmax, Qmid, and Qtwo pump body is split horizontally on a single plane in two sections for easy removal of the impeller assembly, including clearance rings and bearings.

The impeller assembly is removed from the bottom of the pump to avoid interference with the surrounding piping and pump mounting on the apparatus chassis. (See Figure 2-7: “Typical Midship Two-Stage Centrifugal Pump” on page 27.)

Two tank suction valve locations are available to allow higher flows from the booster tank. Optional built-in check valves are available to prevent tank over-pressurization.

Both pumps include two large suction inlets on the left and right side. Optionally, additional front and rear inlets may be added as needed. Impeller inlets are on opposite sides of the pump to balance axial forces; discharges are on opposite sides to balance radial forces.

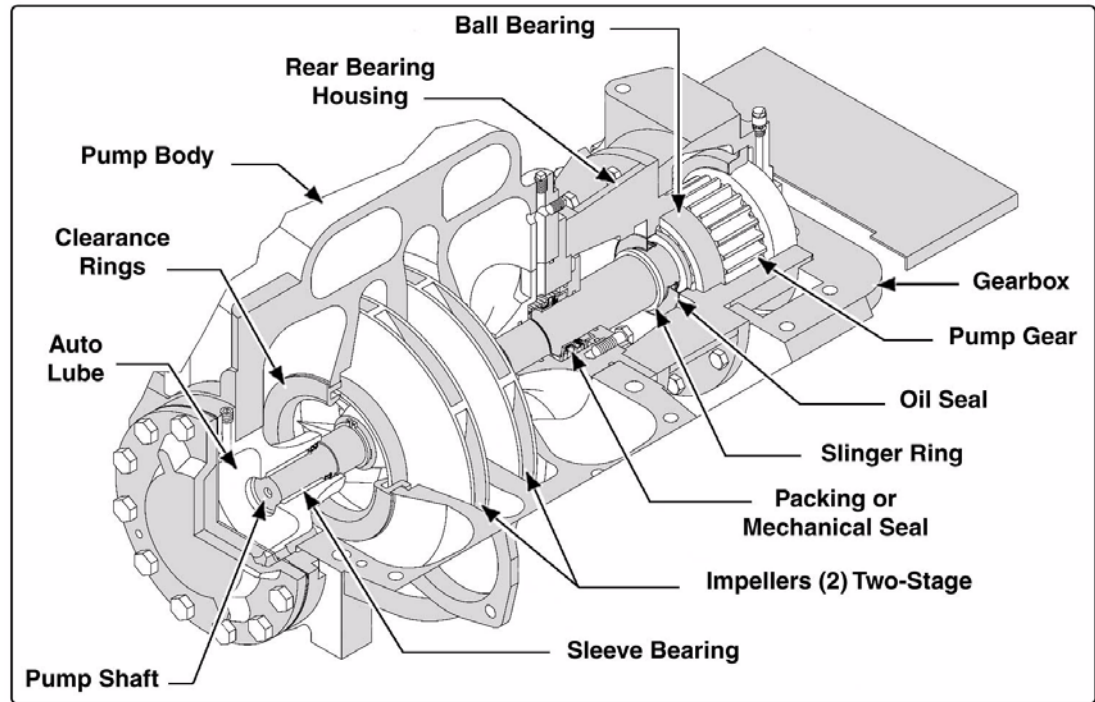


Figure 2-7: Typical Midship Two-Stage Centrifugal Pump

### Qpak, Qflo and Qflo-Plus Pumps

The pump bodies are a single piece construction. To avoid disturbing discharge or suction piping, the gearbox and rear pump head / bearing housing must be removed to service the impeller, clearance rings and mechanical seal.

The pumps include two large suction inlets on the left and right sides. The incoming water is directed to the impeller through the suction passages.

A tank suction valve opening, located on the rear of the pump, allows for high flows from the booster tank. An optional built-in check valve is available to prevent tank over-pressurization.

Discharge valves in the basic pump configuration are mounted at either side of the pump body. However, the manifolded pump body provides several additional discharge locations (facing front, back, or up) to accommodate additional discharge valves.

### 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. (See Figure 2-8: “Impeller Operation” on page 28.)

The vanes guide water from the inlet to the discharge and reduce the turbulence of the spinning water.

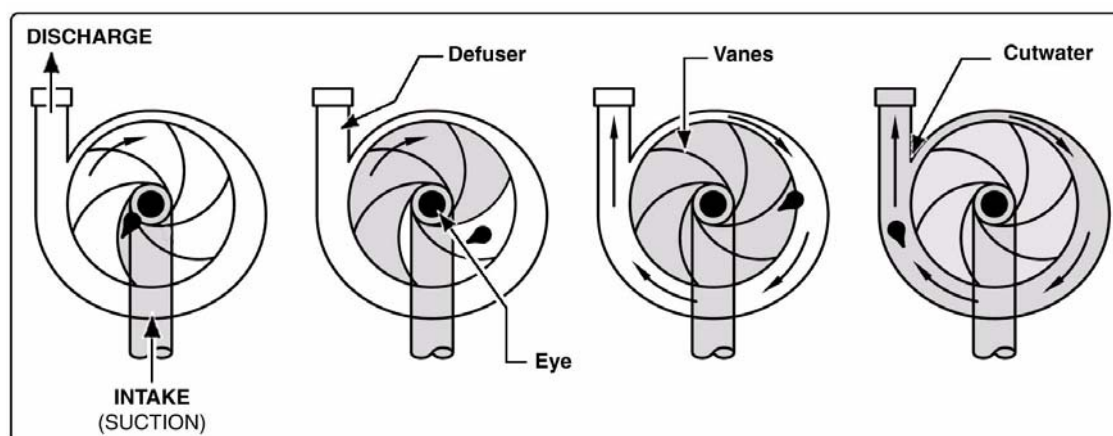


Figure 2-8: Impeller Operation

As water discharges from the impeller, it enters the volute (pump body). The volute increases in size from the cutwater to its full capacity at the volute throat.

This gradual increase maintains a constant average velocity through the volute. Figure 2-8: “Impeller Operation,” traces a drop of water from the intake of the impeller to the discharge outlet.

## Clearance Rings

Clearance rings prevent pressurized water that is leaving the pump volute from returning to the intake of the impeller. Clearance rings at the impeller intake also prevent leakage, accomplished by limiting the radial clearance between the spinning impeller and the stationary clearance ring. Also see Figure 2-7: “Typical Midship Two-Stage Centrifugal Pump” on page 27.

Typically, a new clearance ring has a radial clearance of about 0.005” (0.127 mm) or a 0.008” (0.203 mm) diameter. However, due to foreign material found in the water, this clearance increases over time as the pump is operated. Clearance rings are designed for replacement when wear limits exceed NFPA satisfactory performance.

## 2.4 PUMP SEALS

Two types of seals are used - a packing seal or a mechanical seal.



## Packing Seals

Packing, available on Qmax, Qmid, and Qtwo pumps, forms a watertight seal at the point where the shaft passes from the inside to the outside of the pump. The packing material is cooled with pump water. (See Figure 2-9: “Pump Packing Seal Assembly.”)

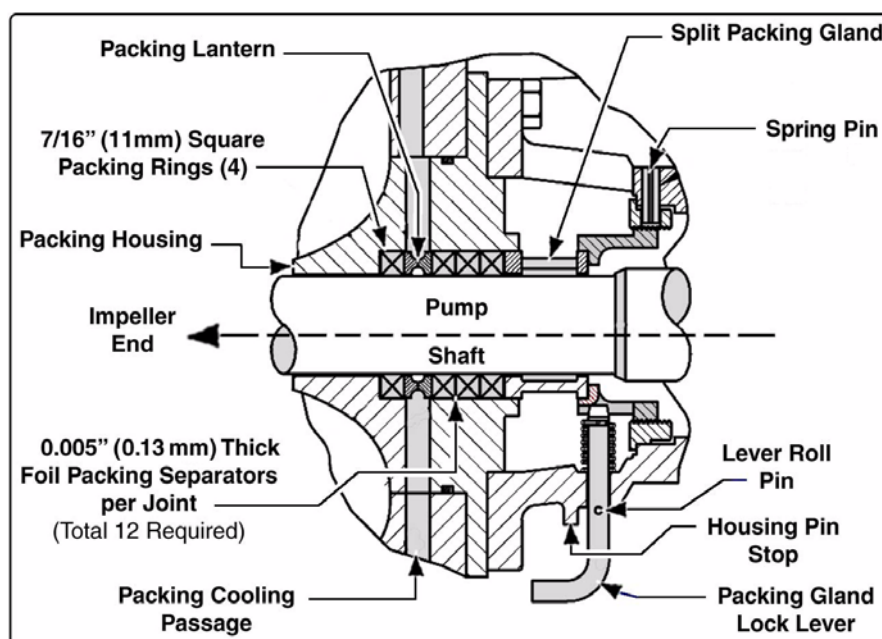


Figure 2-9: Pump Packing Seal Assembly

The single packing gland is located on the low-pressure side of the pump. The packing rings are made of a combination of unique materials and have sacrificial zinc separators to protect the pump shaft from galvanic corrosion.



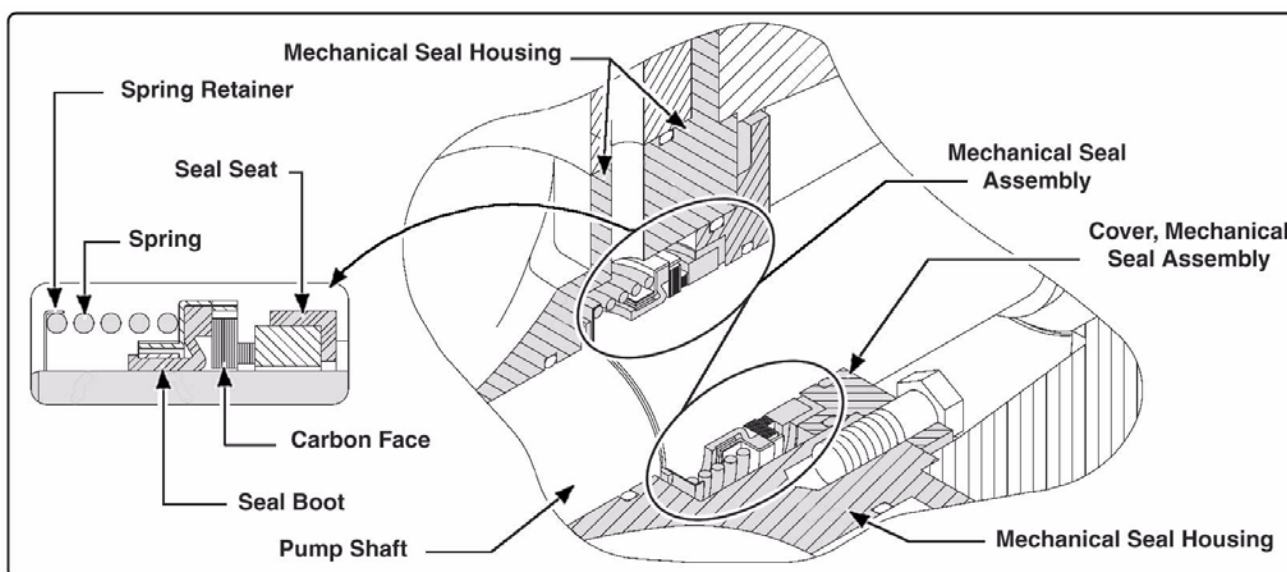
### IMPORTANT!

**THE PACKING GLAND SHOULD NOT BE OVER TIGHTENED, OR THE MATERIAL WILL LOSE ITS BUILT-IN LUBRICATION AND DRY OUT, WHICH MAY DAMAGE THE PUMP.**

**PACKING MATERIAL MAY ALSO DETERIORATE IF THE PUMP IS KEPT DRY FOR LONG PERIODS OF TIME (FOR EXAMPLE, TO PREVENT FREEZING). IN THIS CASE, CHARGING THE PUMP WITH WATER AT LEAST ONCE WEEKLY WILL PREVENT DETERIORATION. ALSO SEE SECTION 6 “TROUBLESHOOTING” ON PAGE 93.**

## Mechanical Seal

The mechanical seal is used on the Qpak, Qflo and Qflo-Plus pumps and is available as an option on the Qmax, Qmid, and Qtwo pumps. (See Figure 2-10: “Mechanical Seal Assembly.”)



**Figure 2-10: Mechanical Seal Assembly**

A stationary seal seat is in constant contact with a rotating carbon face to prevent leakage. The sealing diaphragm is made of a rubber elastomer specifically designed for high-temperature operations. Also see drawing Plate No. 757A, located at the back of this manual, for additional information and a detailed illustration.



### **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.**

## Auto Lube®

A patented centrifugal pump is built into the shaft of Qmax, Qmid, and Qtwo pumps. (See Figure 2-11: “AutoLube Feature.”)

This pump continuously forces oil from the reservoir, through the bearing, and back again. A balancing chamber, behind the oil reservoir, maintains the pressure in the oil reservoir equal to water pressure – whether you are pumping at high inlet pressure or pulling vacuum.

The pump adds enough extra pressure to maintain oil flow a few PSI higher than water pressure. Thus, oil pressure inside the double lip-type seal is always slightly higher than water pressure outside. Dirt and water are repelled by this higher pressure.

Auto-Lube also ensures continuous lubrication, even when you are pumping dry. A compact, double lip-type oil seal, and maintains a constant film of oil under this seal to prevent shaft wear. AutoLube completely eliminates the need for a second set of packing, or mechanical seals.

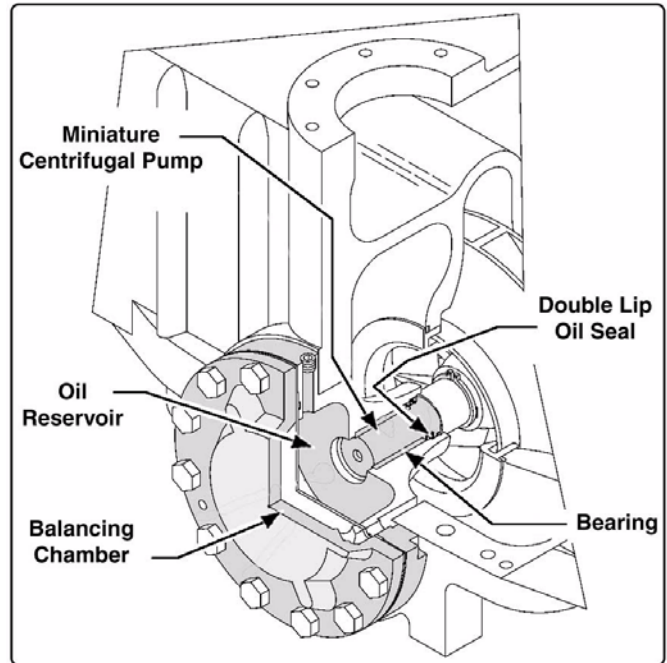


Figure 2-11: AutoLube Feature

## 2.5 PUMP DRIVES

Midship pumps are normally driven through an integral transmission that has a sliding gear shaft and sliding gear that selectively directs the engine power to the pump or the rear axle.

Four common centrifugal pump drives are used:

- Operation from the truck chassis drive shaft (split-shaft gearbox)

Also see Table 2-1: “Pump vs. Gearbox / Gear Ratio Comparison” on page 32.

Table 2-1: Pump vs. Gearbox / Gear Ratio Comparison

Pump Model	GPM (LPM) Range	Stage s	Integral Manifold	Hale Available Gearbox Selection and Ratio				
				“J”	“L”	“S”	“X”	“LK” & “XK”
<b>Qpak</b>	500–1,000 (2,000–3,000)	Single	Yes	1:1.64, 1.80, 2.08, 2.35, 2.57	1:1.58, 1.71, 1.86, 2.05, 2.28		1:1.96, 2.13, 2.32, 2.55, 2.83	
<b>Qflo</b>	750–1,250 (3,000–4,000)	Single	Yes		1:1.58, 1.71, 1.86, 2.05, 2.28		1:1.96, 2.13, 2.32, 2.55, 2.83	
<b>Qflo-Plus</b>	750–1,250 (3,000–5,000)	Single	Yes		1:1.58, 1.71, 1.86, 2.05, 2.28		1:1.96, 2.13, 2.32, 2.55, 2.83	
<b>Qmax</b>	1,000–2,250 (4,000–8,000)	Single	Yes		1:1.58, 1.71, 1.86, 2.05, 2.28	1:1.58, 1.71, 1.86, 2.05, 2.28	1:1.96, 2.13, 2.32, 2.55, 2.83	1:1.60, 1.71, 1.89, 2.04, 2.30, 2.52
<b>Qmid</b>	1,000–1,250 (4,000–5,000)	Single	Yes		1:1.58, 1.71, 1.86, 2.05, 2.28	1:1.58, 1.71, 1.86, 2.05, 2.28	1:1.96, 2.13, 2.32, 2.55, 2.83	
<b>Qtwo</b>	1,000–2,000 (4,000–7,000)	Two	Yes		1:1.58, 1.71, 1.86, 2.05, 2.28	1:1.58, 1.71, 1.86, 2.05, 2.28	1:1.96, 2.13, 2.32, 2.55, 2.83	1:1.60, 1.71, 1.89, 2.04, 2.30, 2.52

- Operation from a separate engine
- Operation from the front of the truck chassis engine (front engine PTO) crankshaft
- Operation from a PTO from the truck transmission, a PTO before the engine drive transmission or a PTO from the four-wheel drive transfer case.

**Note:** Also see plate No. 843 “Vehicle Mounted Pump Applications” located at the back of this manual (Section 8: Drawing Package).

The midship transmission is capable of handling full engine horsepower, enabling the pump to meet optimum performance levels as well as all torque requirements for over the road applications.

## 2.6 GEARBOX

The most common pump drive is the split-shaft gearbox. A variety of pump gear ratios is offered to accommodate a wide range of apparatus manufacturer requirements, based on engine speed and available horsepower. (See Figure 2-12: “Typical Gearbox Overview” on page 33.)

Typically, the gearbox is constructed of fine grain alloy cast iron, with a minimum tensile strength of 30,000 PSI (207 N/mm<sup>2</sup>). These units can withstand the full torque of the engine in ROAD operating conditions up to 16,000 pounds-feet (21,693 N-m).

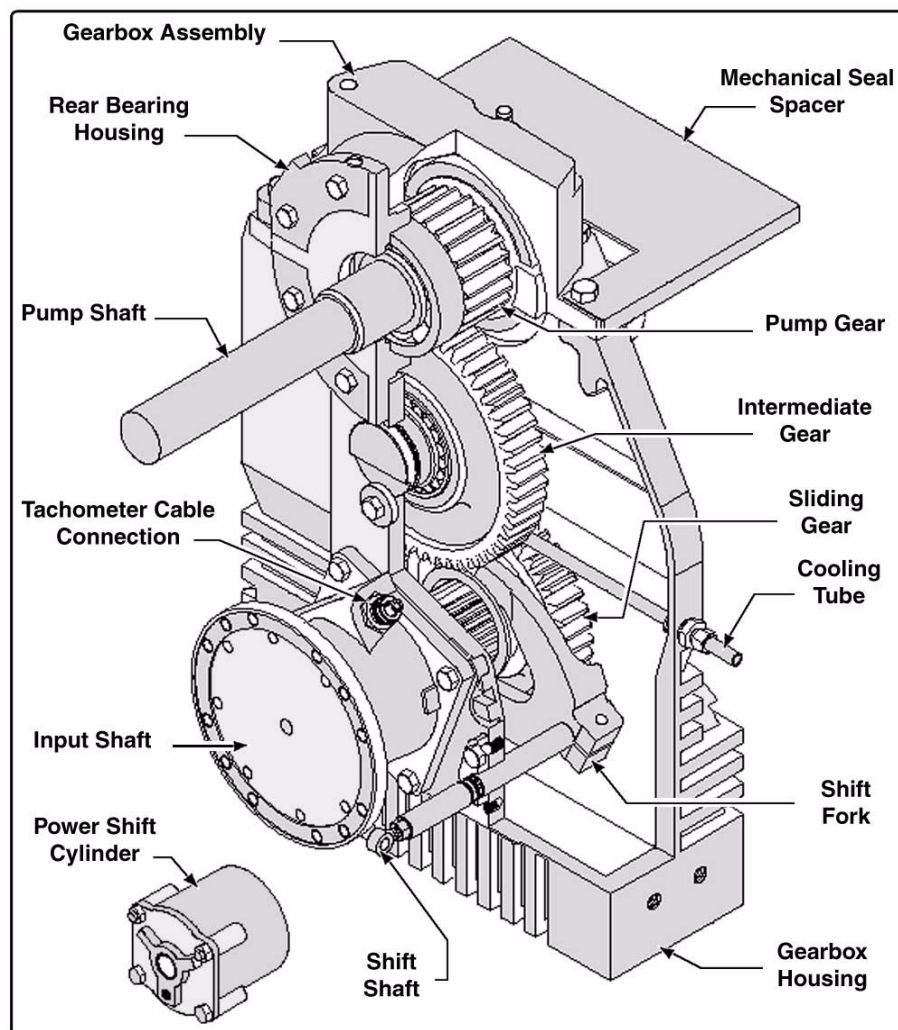


Figure 2-12: Typical Gearbox Overview

## A-Series

The Hale **A Series Gearbox** is a 2-gear unit driven by a PTO and designed for top or rear-mount pump applications. This gearbox has a wide range of ratios available to allow for use on different engine, transmission and PTO combinations. (See Figure 2-12: “Typical Gearbox Overview.”)

## G-Series

The Hale **G-Series Split-Shaft Gearbox** is available as a short (**S**), long (**L**), or extra long (**X**) model.

The **S**, **L**, or **X** designation indicates different distances from the pump center line / mount location to the center of the drive shaft for proper drive line angles. The location, pump, and drive line angle determine the optimum gearbox length selection.

## K-Series

The Hale **K-Series Gearbox**, is available as a long (LK) or extra long (XK) model. The gearbox is capable of handling the required engine horsepower, enabling the pump to meet optimum performance levels as well as torque requirements for over-the-road applications. The gearbox consists of the housing, helical gear set, and input and output shafts that are made of heat-treated nickel steel. This unit can withstand the full torque of the engine in ROAD operating conditions up to 18,500 pound-feet (25,083 N-m).

## J-Series

The Hale **J-Series Gearbox**, available for the Qpak pump, is an off-set gearbox that allows left-hand or right-hand side PTO hookup. The gearbox is heavy duty and driven from a transmission-mounted PTO allowing for pump and roll applications.

## R-Series

The Hale **R-Series Split-Shaft Gearbox** is similar to the G-Series long (L) model, having a rear-mounted output shaft.

## Power Shift - Optional

The power shift system includes an in-cab control valve for mode selection. This control locks in place for pump operation. Indicator lights are provided to alert the operator when the gearbox has fully shifted from ROAD to PUMP position. Additionally, manual shift is provided in the event of a power shift system failure.

## Engine Rotation Option - Qmax-U and Qtwo-U

Hale **Qmax-U** and **Qtwo-U** midship pumps are available for either engine rotation (clockwise), or opposite engine rotation (counterclockwise) operation. (See Figure 2-13: "Pump/Engine Rotation" on page 35.)

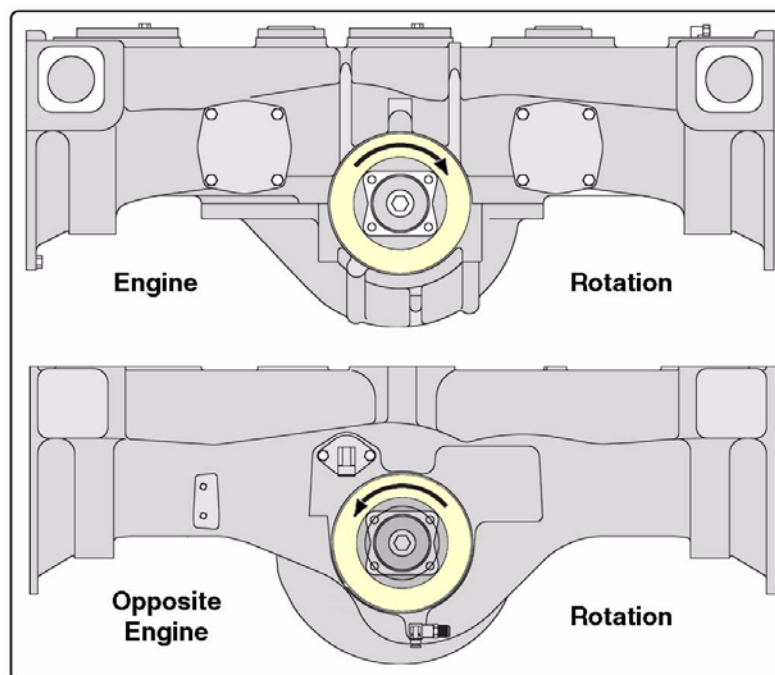


Figure 2-13: Pump/Engine Rotation

## HALE Power Takeoff (PTO) Driven Midship Pumps

Midship pumps feature a 1480 input flange for connection to a PTO driveline.

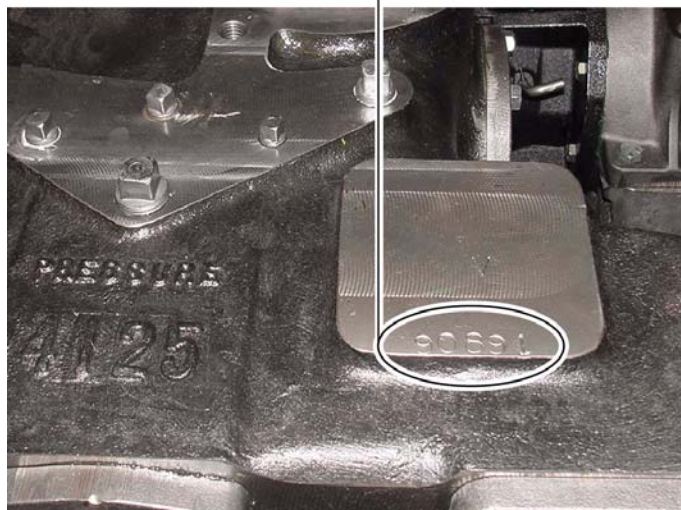
## 2.7 SERIAL NUMBER IDENTIFICATION

The midship pump assembly serial number is stamped in three locations on the assembly, dependent on system model. The serial number nameplate is always located on the gearbox, either on the very bottom of the housing or on one of the sides near the bottom. (See Figure 2-14: “Typical Midship Pump Serial Number Location” on page 36.)



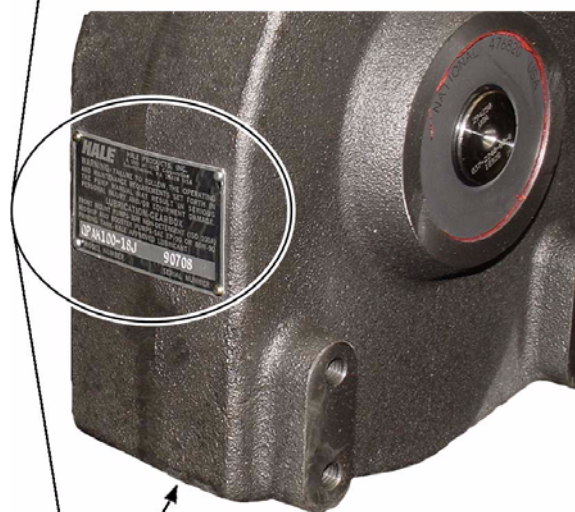
## □ Introduction

**Pump Main Housing  
Stamped Serial Number**  
(Stamped in machined surface  
on each side on housing)



**Gearbox Main Housing, Left Side  
Serial Number Nameplate**

(Serial number nameplate could be  
located directly on the bottom of the  
housing as well)



**Pump Rear Bearing Housing  
Stamped Serial Number**



**Figure 2-14: Typical Midship Pump Serial Number Location**



## 3 Accessories / Options

The following accessories and 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

### 3.1 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.

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.

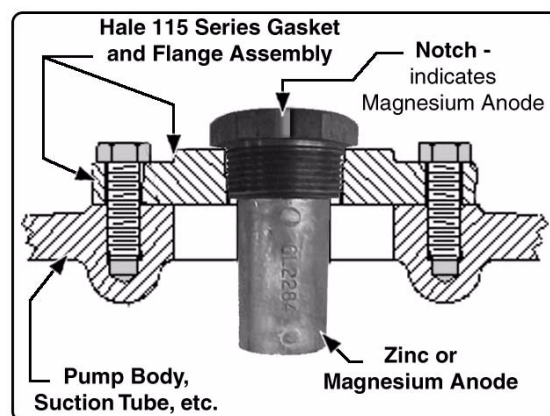


Figure 3-1: Hale 1-1/4" NPT Anode

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

## 3.2 AUXILIARY COOLING

### 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.

**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.

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

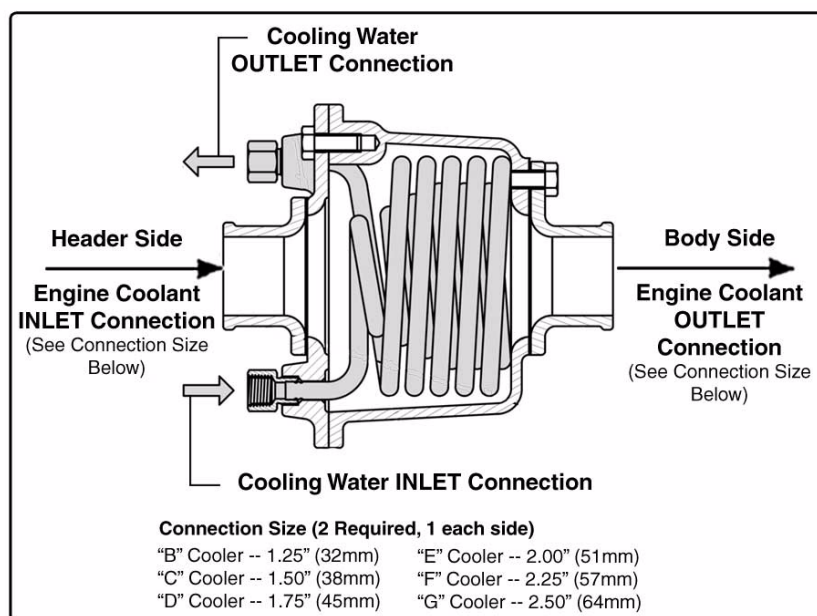


Figure 3-2: Model “K” Heat Exchanger

### 3.3 PRESSURE AND RELIEF VALVE CONTROL

#### Relief Valve System

The Hale Standard Relief Valve System consists of a panel mounted control valve (PM) and an internal relief valve, either a QG or a QD.

The relief valve system works as follows: The strainer mounted in the pump discharge pressure tap provides pressure to the diaphragm in the PM Control Valve. The handwheel on the PM control either increases or decreases spring tension on the diaphragm. The seat of the QD or QG relief valve is kept closed by pump discharge pressure.

As pump pressure increases, more pressure is applied to the diaphragm in the PM Control Valve. As the pressure on the diaphragm increases beyond the set point, the stem will move off its seat, allowing pump pressure to push on the piston in the relief valve. The pressure on the piston will cause the relief valve seat to lift, allowing excess discharge pressure to dump back to the pump suction.

The amber indicator light on the PM control illuminates when the relief valve is open.



**Figure 3-3: PMD Series Relief Valve Control (Shown)**

#### Thermal Relief Valves (TRV)

Thermal Relief Valves (TRV) protect the pump from overheating. (See Figure 3-4: "Thermal Relief Valve, TRV," on page 40.)

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 CLOSES.

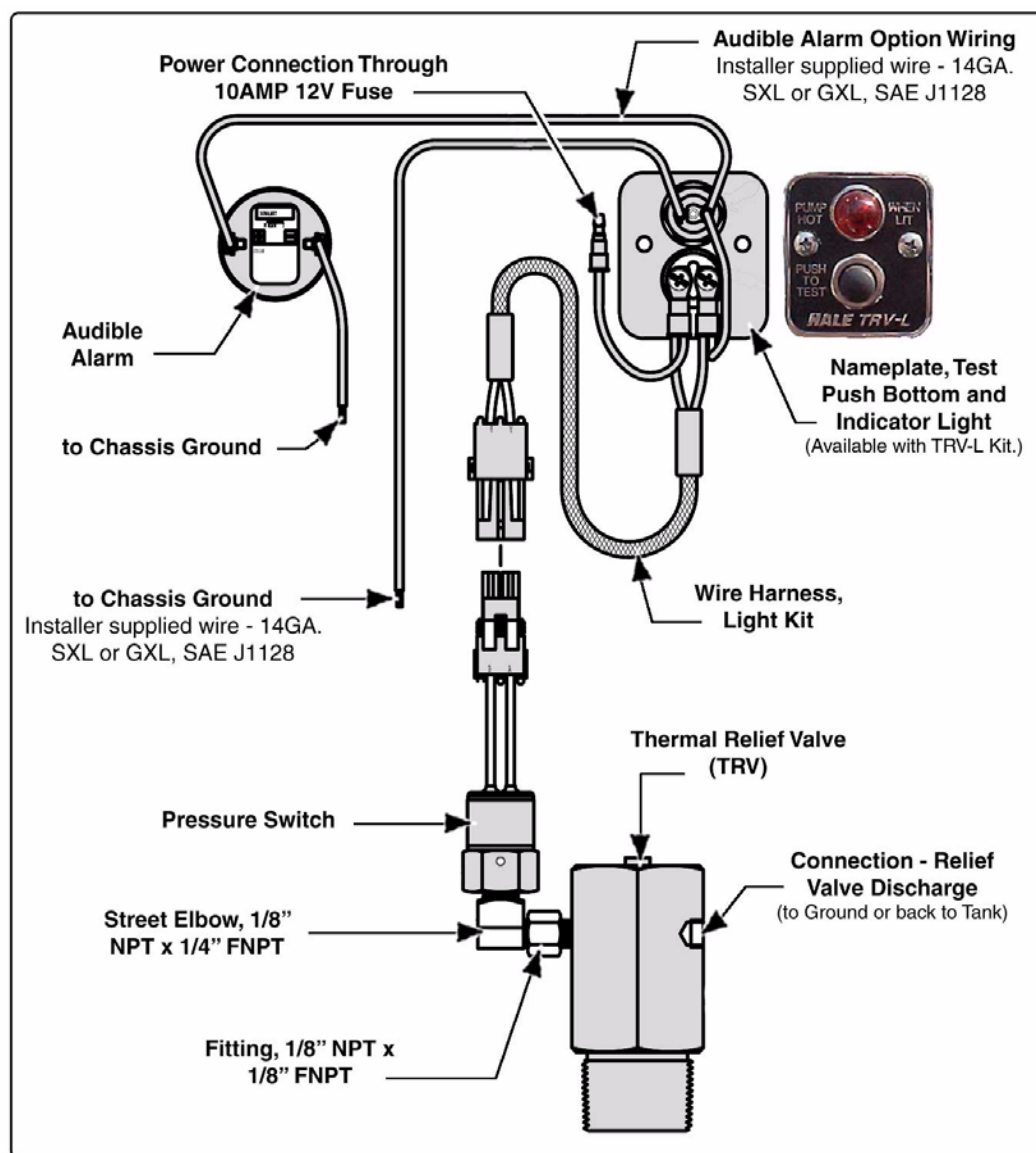


Figure 3-4: Thermal Relief Valve, TRV

### 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 3-4: "Thermal Relief Valve, TRV.") An optional buzzer, mounted on the operator panel, provides an audible warning.

### 3.4 PRIMING SYSTEMS

Hale uses **Rotary Vane Positive Displacement ESP** pumps for priming. Priming pumps are used to evacuate air in the suction hose and pump.

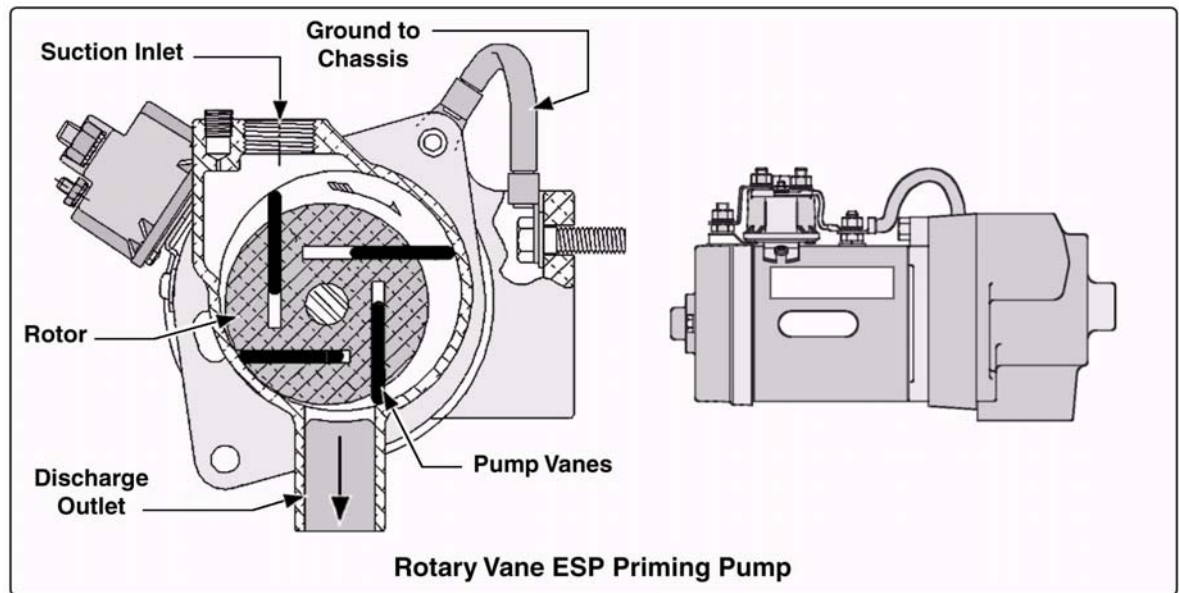


Figure 3-5: Rotary Vane ESP Priming Pump

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 (SPV)

A single push button on the operator's panel starts the priming pump motor. When a vacuum is created, the SPV **OPENS**. (See Figure 3-6: "SPVR Priming Valve (Shown)," on page 42.)

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

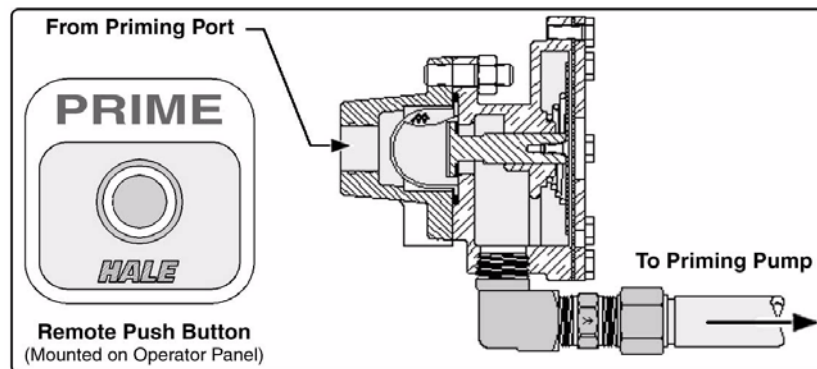


Figure 3-6: SPVR Priming Valve (Shown)

#### □ The Hale PVG Priming Valve

The PVG is a combination valve and switch and is mounted on the pump operator's panel. (See Figure 3-7: "PVG Priming Valves.")

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

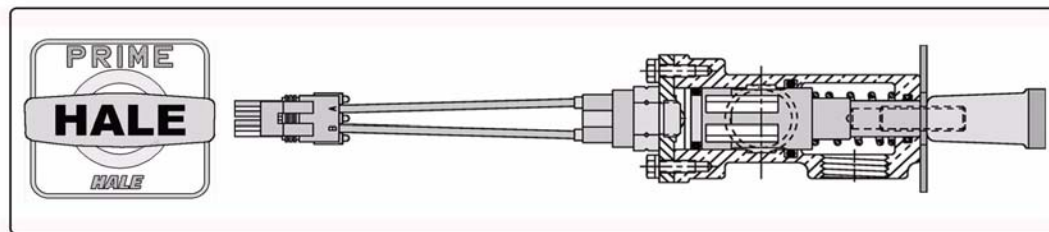
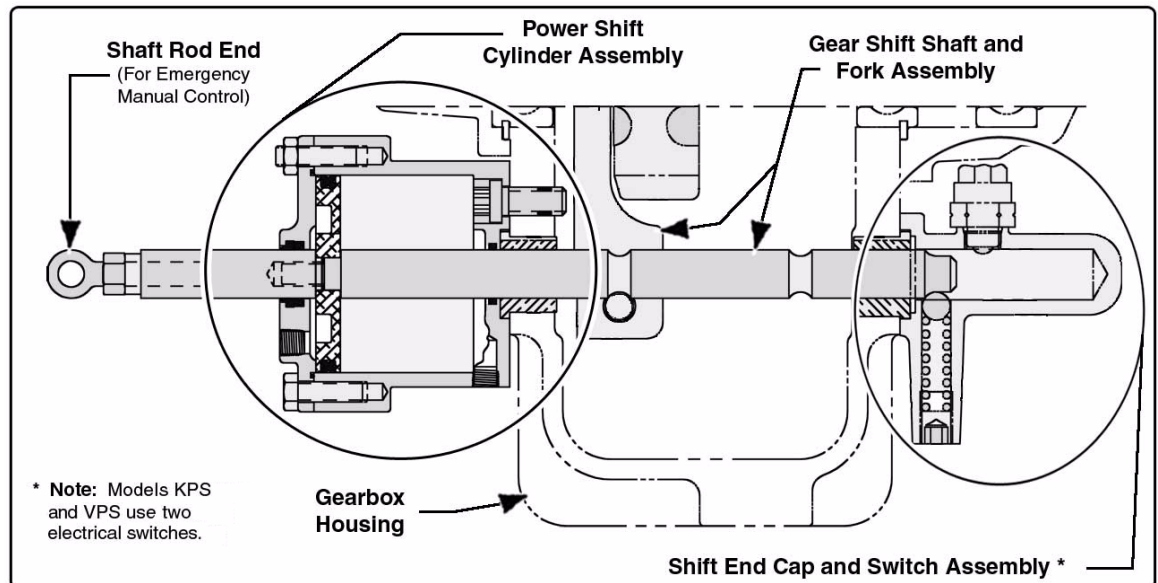


Figure 3-7: PVG Priming Valves

### 3.5 PUMP SHIFT, AUTOMATIC (VPS / KPS)

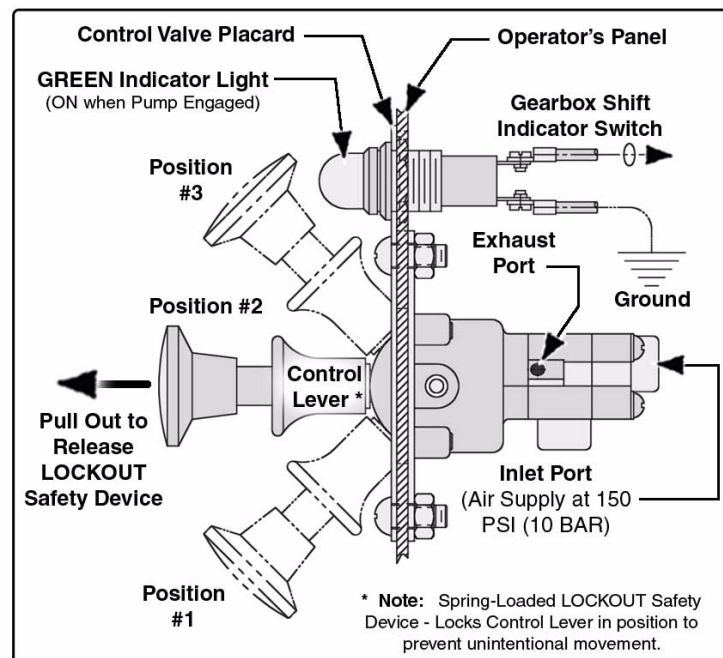
The Hale Automatic Pump Shift, Models VPS or KPS, is a remote, pneumatically-operated device to shift the pump transmission from ROAD-to-PUMP and back again.





**Figure 3-8: Automatic Pump Shift Overview**

It uses available apparatus air pressure for power and is activated by an in-cab pump shift control valve. (See Figure 3-9: “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 3-9: Pump Shift Control Valve**



### 3.6 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.

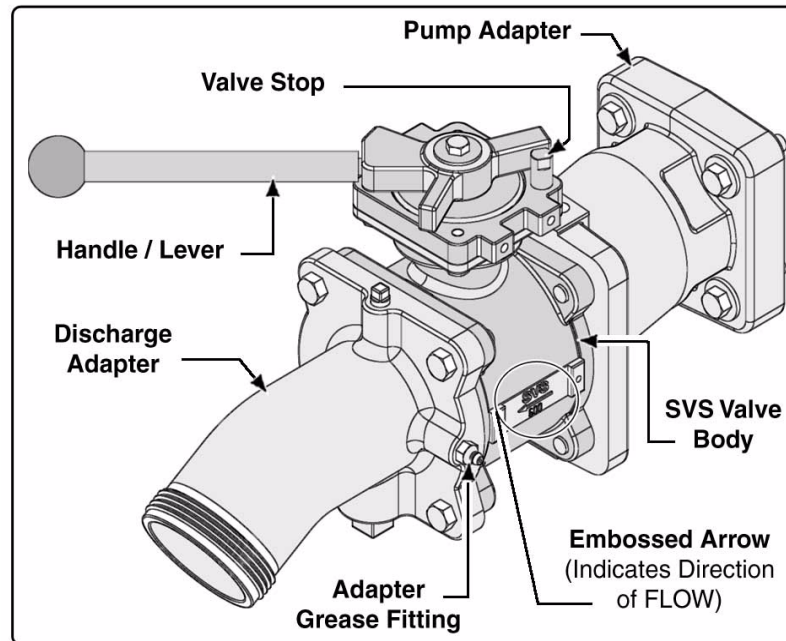


Figure 3-10: Typical SVS Valve Primary Components

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.

### 3.7 ADDITIONAL MIDSHIP ACCESSORIES

#### Auxiliary Heat Exchanger / Cooler, Model K

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.

**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.

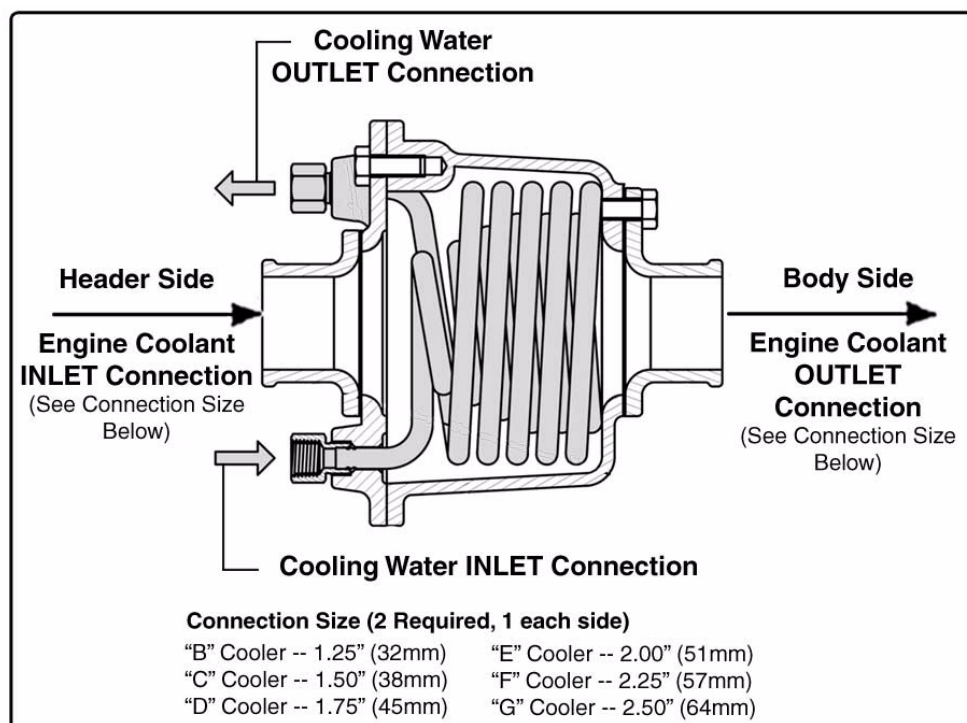


Figure 3-11: Model "K" Heat Exchanger

## Booster Pump Option, 2HP

Hale 2HP Booster Pumps offer low volume and high pressure for use with the midship pumps. The booster is ideal for high pressure, hose reel operation and is designed for direct mounting at the accessory port of the Hale "L" and "X" Series gearboxes.

The pump is driven by the gearbox intermediate gear to provide a positive drive. Water is directed to the booster pump through a pre-piped supply hose.

## In-Line / Discharge Valves

In-Line / discharge valves (Torrent SVS Valves) regulate the amount of water flowing through and leaving a pump. Each valve includes a locking device to permits opera-

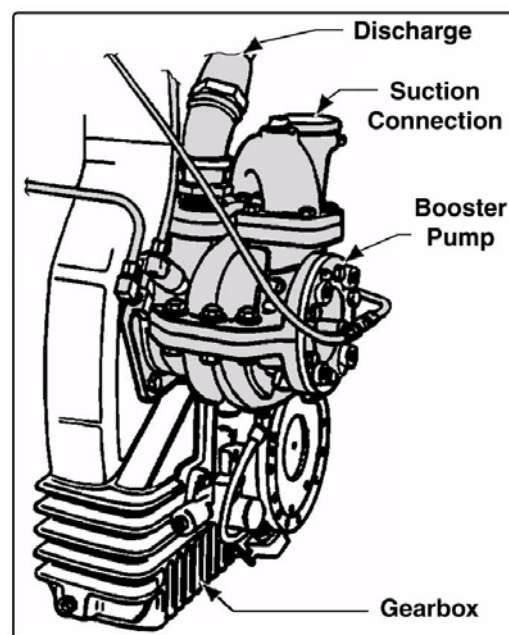


Figure 3-12: 2HP Booster Pump Option

tion in any position from fully opened to fully closed. Also see Section 3.6 “Torrent SVS Valves” on page 44.

Each discharge valve may be equipped with a drain. Opening the drain before uncoupling the hose relieves the pressure in the line and drains remaining water from the pump during freezing conditions.

## **Drain Valves**

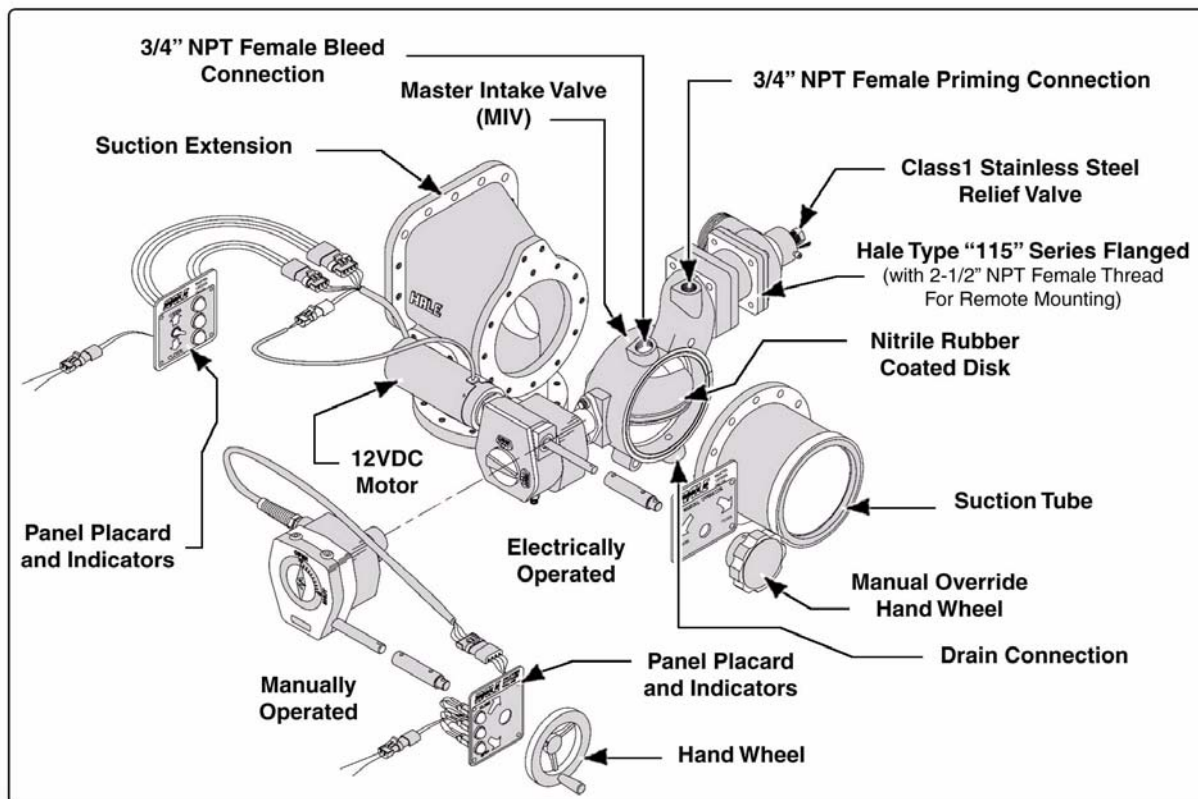
Various types and styles of manual and automatic drain valves are available, with both single and multiple ports opening.

The screw knob valve (MMD6) can connect up to six individual drain lines. The MMD12 can connect to 12 individual drain lines. Each connection is individual. The control knob is located on the operator’s panel. Turning the knob counterclockwise OPENS the drain valve.

## **Suction Valves**

Hale has valves that mount in the suction of the midship pump.

The Hale Master Intake Valve (MIV) becomes an integral part of the fire pump. When the valve is ordered as part of a Hale Midship fire pump, the pump will pass UL requirements up to 1,500 GPM (5,678 LPM) from the draft through a single 6” NST suction hose with the valve in place. When two valves are mounted to the fire pump, the pump can achieve NFPA Performance Point flows of 2,000 GPM (7,580 LPM) from draft with dual 6” NST suction hoses. NFPA Performance Point flows of 2,250 GPM (8,516 LPM) is achieved with two MIVs and three 6” NST suction hoses. The Hale MIV meets NFPA requirements for operations using a large diameter supply hose. (See Figure 3-13: “Master Intake Valve (MIV),” on page 47.) Further information on the MIV can be found in manual P/N 029-0020-35-0.



**Figure 3-13: Master Intake Valve (MIV)**

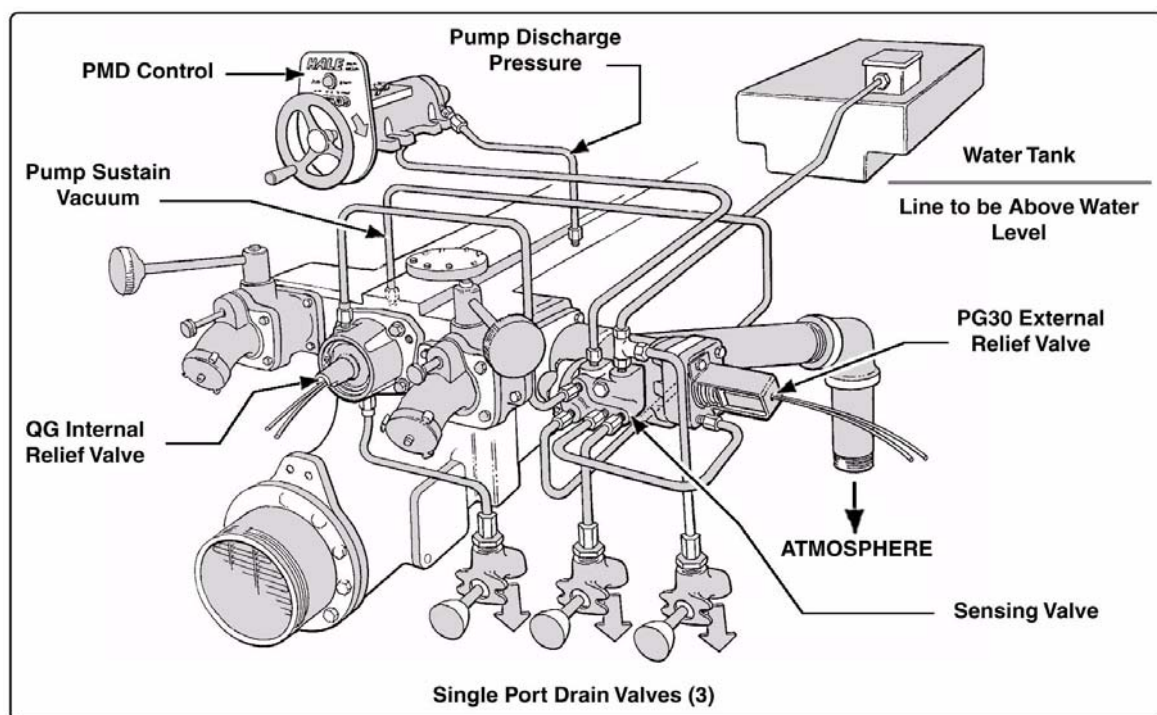
Additional information on the MIV can be found in manual P/N 029-0020-35-0, supplied with the unit.

## Tank Suction Valves

Hale offers the Torrent SVS Valve. Also see Section 3.6 “Torrent SVS Valves” on page 44.

## Total Pressure Master (TPM) Relief Valve System

The Hale TPM system is a mechanical system, consisting of an internal relief valve (QG) which by-passes water to the suction side of the pump; an external relief (dump) valve (PG30, with sensing valve attached), to discharge water to the atmosphere; and a single panel mounted control valve (PMD), to provide control of pump pressure, within NFPA required limits.



**Figure 3-14: Hale (TPM) Total Pressure Master Relief Valve System**

The TPM relief valve system automatically relieves excess pump pressure when operating from draft or positive incoming flows. The system self-restores to the non-relieving position when excessive pressure is no longer present. The PMD control permits the pump operator to “set” a desired pressure for both internal and external relief valves. The panel control has an easy-to-read and easy-to-set adjustment with an approximate pressure setting indication.

### How the TPM Works

The TPM system monitors and controls pump pressure and relieves excessive pressure by first utilizing the internal relief valve (QG), thus returning flow to the pump suction.

If excessive pressure remains and there is positive pressure on the suction, a secondary external relief valve (PG30) responds by discharging excessive pressure to the atmosphere.

The staging of the internal and external relief valves to operate in series ensures maximum protection against over pressure and eliminates the indiscriminate discharging of water to the ground.

The external relief valve (PG30) is mounted on the discharge side of the pump. Discharged water flowing through the valve provides a self-cleaning process and nearly

eliminates the possibility of the valve remaining in an open position due to contamination.

The amber indicator on the PMD control illuminates when the QG relief valve is open. The indicator flashes when both the QG and PG30 valves are open.

For sample TPM system overviews, see the following:

- ☐ Figure 3-15: “Typical TPM Relief Valve System, Condition 1” on page 50  
All Relief Valve CLOSED, Pump operating from Draft
- ☐ Figure 3-16: “Typical TPM Relief Valve System, Condition 2” on page 51  
QG Relief Valve OPEN, Pump operating from Draft
- ☐ Figure 3-17: “Typical TPM Relief Valve System, Condition 3” on page 52  
QG and PG30 Relief Valve OPEN, Pump operating with Positive Suction Pressure (Hydrant)



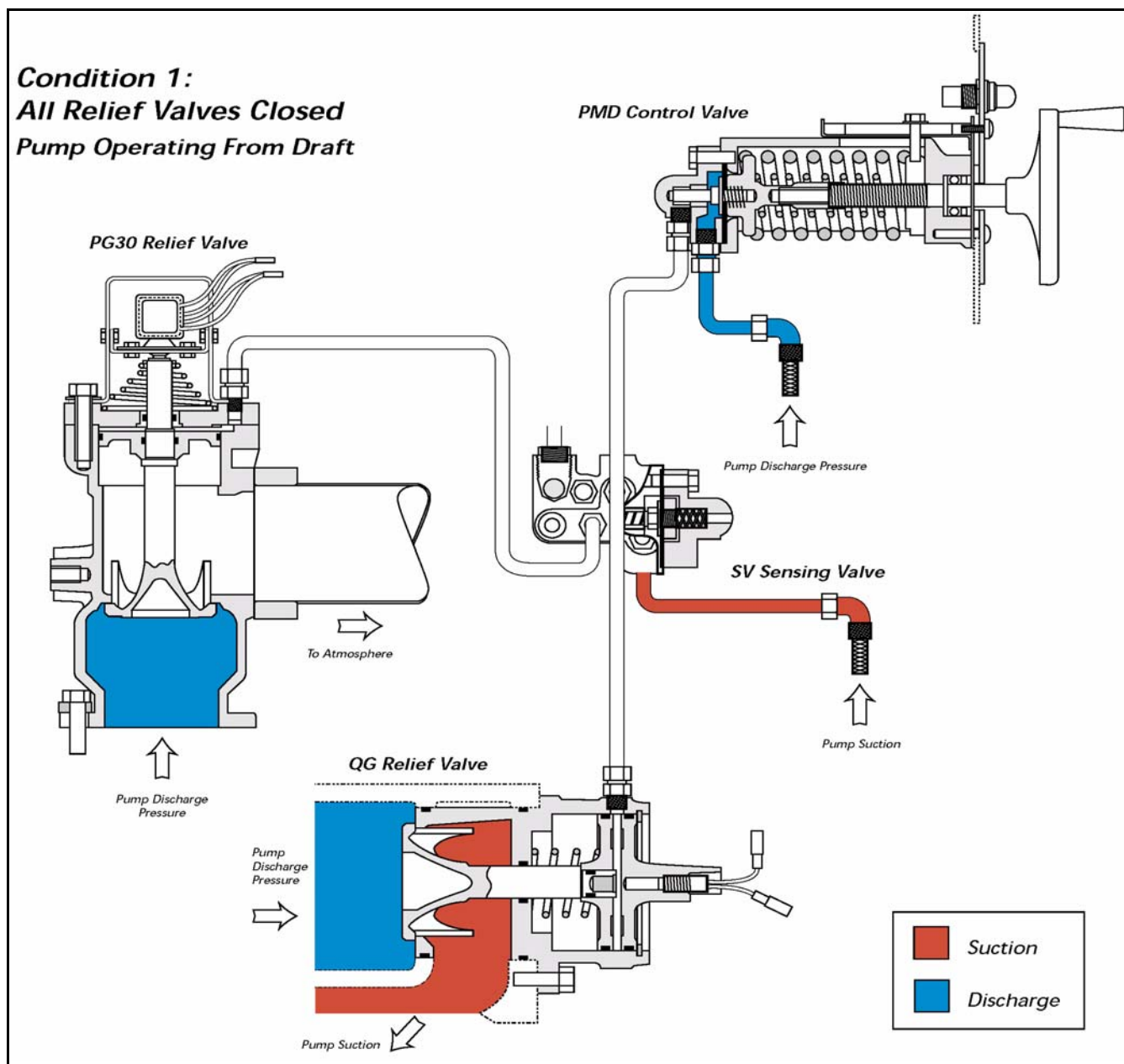
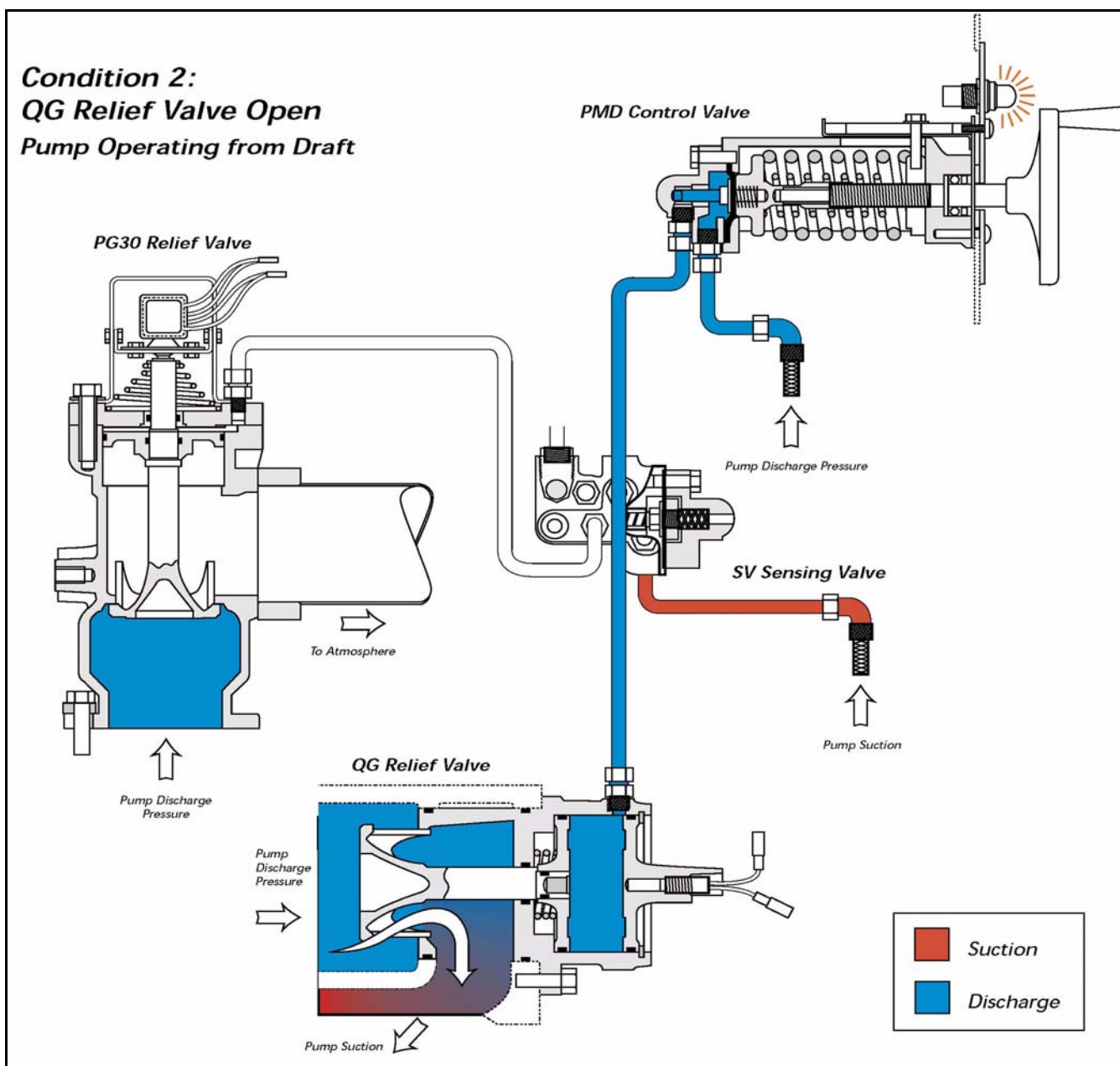


Figure 3-15: Typical TPM Relief Valve System, Condition 1



**Condition 2:  
QG Relief Valve Open  
Pump Operating from Draft**



**Figure 3-16: Typical TPM Relief Valve System, Condition 2**

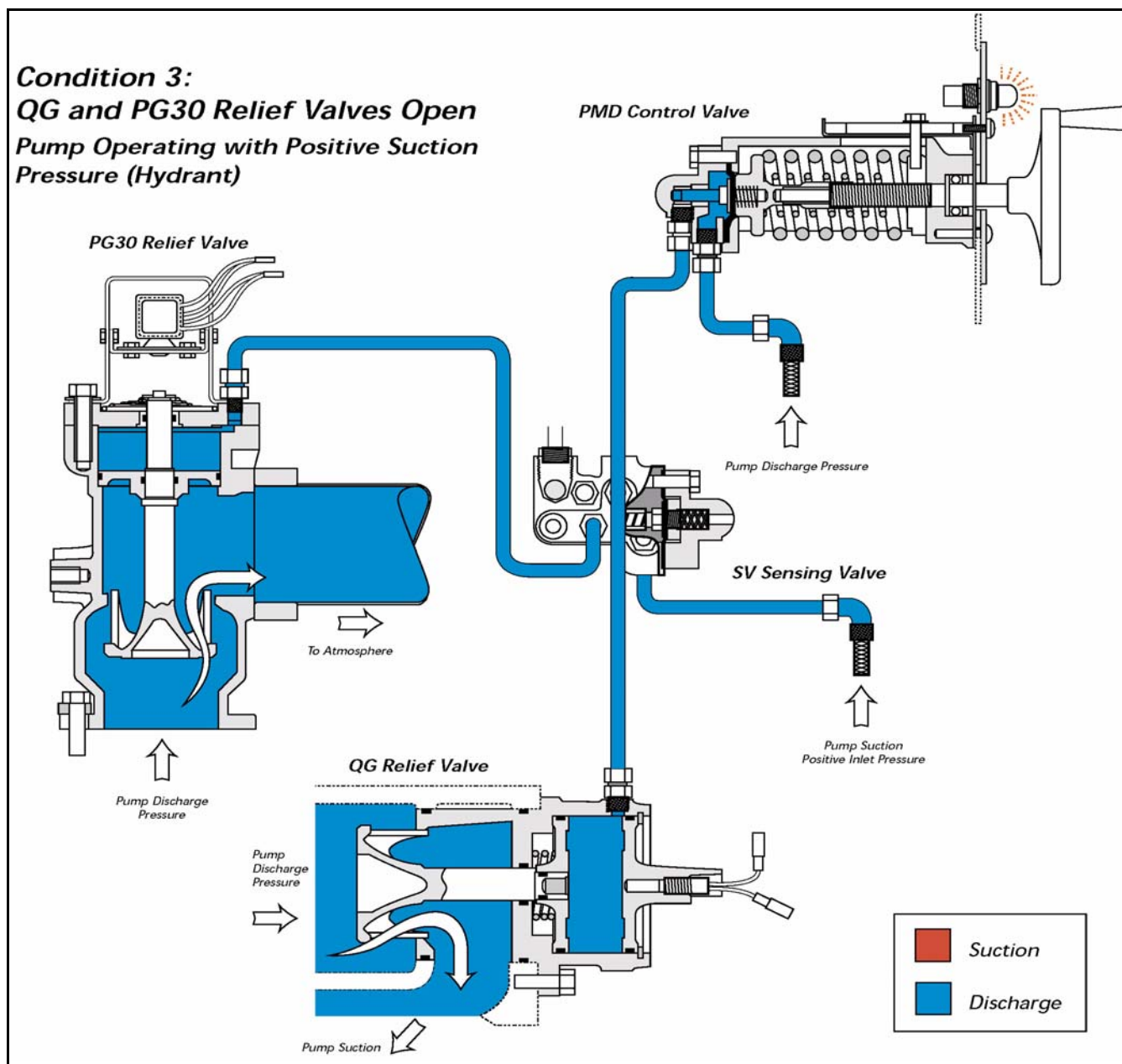


Figure 3-17: Typical TPM Relief Valve System, Condition 3

## 4 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.

### 4.1 OVERVIEW

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

- **Fluids** - on page 54.
- **Pumping from a hydrant** - on page 54.
- **Pumping from draft** - on page 58.
- **Pumping from an onboard tank (Split-Shaft PTO)** - on page 60.
- **Pumping in relay** - on page 62.
- **Tandem (series) pumping** - on page 64.
- **Pump and Roll** - on page 65.
- **Post-operation procedures** - on page 69.

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

## 4.2 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 “GEARBOX LUBRICATION” ON PAGE 76.**

## 4.3 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 53.
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 65.

**For PTO operation (Qmax-U, Qtwo-U, and Qpak-J pumps),** 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 4-1: “Driver’s Compartment Indicator Lights” on page 55.)

**For “Split-Shaft” operation,** move the in-cab shift control from ROAD to PUMP Position. The Green PUMP ENGAGED indicator light on the panel control will light.

- 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, then 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.

**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.**

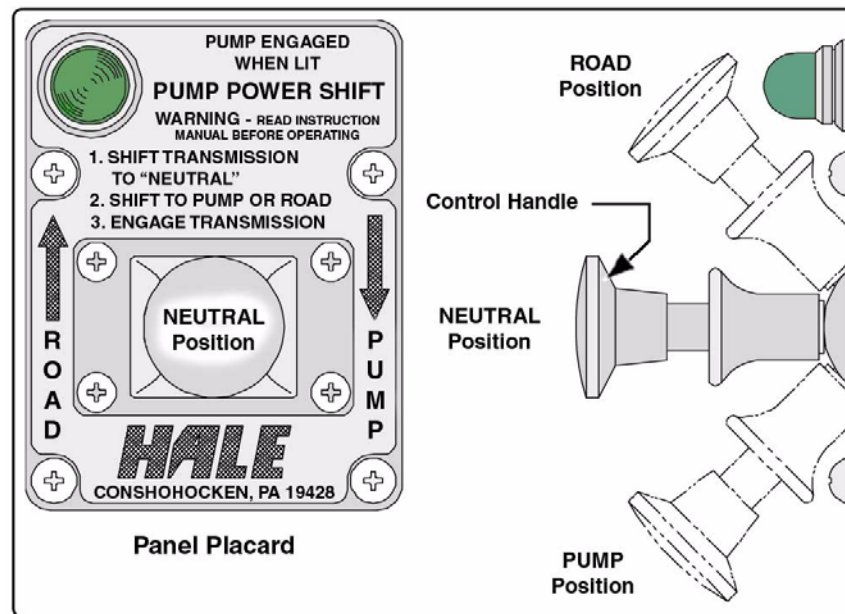


Figure 4-1: Driver's Compartment Indicator Lights



**CAUTION!**

**DO NOT OPEN THE THROTTLE UNLESS THE GREEN INDICATOR LIGHT IS ON. (SEE FIGURE 4-2: "PUMP OPERATOR'S PANEL" ON PAGE 56.)**

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 pumps 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 58.

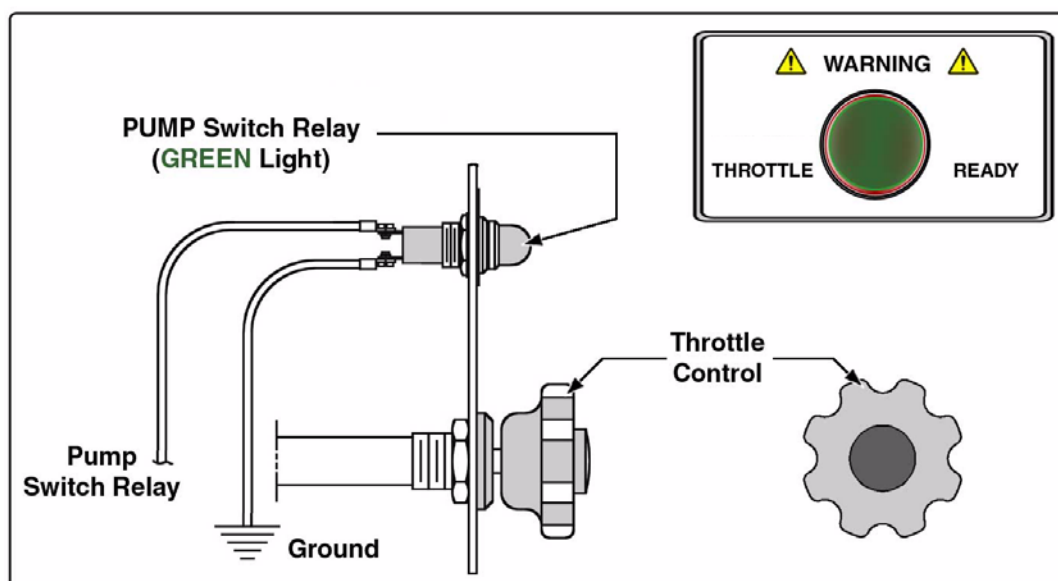


Figure 4-2: Pump Operator's Panel

- 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 57.



**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 (34 kPa), 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 58. Disengage the PTO per the PTO manufacturer’s instructions. Also see heading “Pump-To-Road Shift Procedures” on page 65.

## **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 Table G-2: “Lift Loss from Temperature” on page 195.



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 Table G-3: "Lift Loss from Barometric Reading" on page 196.

## 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 a 10 ft (3 m) vertical lift and 20 feet (6 meters) of suction hose.
2. As the vertical lift increases to above 10 ft (3 m), pump capacity is reduced. Also see Table G-1: "Lift Loss from Elevation" on page 195.



3. 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 53.
4. 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 65.
5. 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 4-1: "Driver's Compartment Indicator Lights" on page 55.)

**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 4-2: "PUMP OPERATOR'S PANEL" ON PAGE 56.)**

6. 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.
7. 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.
- 8. Activate the priming pump - pull the control handle, or press the push button.
- 9. Your departmental manual for pumping should specify the correct RPM for priming. However, in general, priming should be operated at IDLE.
- 10. 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 6 “TROUBLESHOOTING,” ON PAGE 93.**

- 11. 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.
- 12. Gradually open the discharge valve until water emerges in a steady stream. Then open the other discharge valves to the desired setting.
- 13. 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.**

- 14. 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.
- 15. 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 a smaller nozzle to reduce flow.

- ❑ **Air enters with the water** - Air leaks can cause rough operation and an increase in engine speed without an increase in pressure or flow. If an air leak is suspected, discontinue pumping. See heading “Troubleshooting” on page 93.
- ❑ **Hot water** - See heading “Lift Loss from Temperature” on page 195.
- ❑ **Low barometer** - See heading “Lift Loss from Barometric Reading” on page 196.
- ❑ **High lift** - see Table G-1: “Lift Loss from Elevation” on page 195.

**Note:** Also see Section Appendix G: “Cavitation” on page 193.

16. If a pump shutdown is desired while pumping from draft, reduce the engine speed to IDLE and close the discharge valves.
17. 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.
18. 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 57.
19. 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.
20. After completion of pumping procedures, gradually reduce the engine RPM to IDLE speed. See heading “Pump-To-Road Shift Procedures” on page 65. Disengage the PTO per the PTO manufacturer’s instructions. Also see heading “Post Operation Procedures” on page 69.

### **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 53.
3. Make sure the truck is at a complete stop before you attempt to shift from ROAD to PUMP.
4. Move the in-cab pump shift control valve to the PUMP position. The shift warning lights illuminate, indicating a complete shift. (See Figure 4-1: “Driver’s Compartment Indicator Lights” on page 55.)

**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.

5. 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.

6. 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 4-2: “PUMP OPERATOR’S PANEL” ON PAGE 56.)**

7. Open the tank suction valve.
8. 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 6 “TROUBLESHOOTING,” ON PAGE 93.**

9. Gradually open the engine throttle until the desired pressure or flow is achieved.
10. 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 G: “Cavitation” on page 193.
11. If the pump is cavitating, warn personnel.

**WARNING!**

**DO NOT OPEN THROTTLE UNTIL ALL GREEN PUMP LIGHTS ARE ON. (SEE FIGURE 4-2: “PUMP OPERATOR’S PANEL” ON PAGE 56.)**

12. Gradually open the discharge valve until the water emerges as a steady stream. Then open the other discharge valves to the desired setting.
13. 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 57.

14. 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.
15. 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 65. Disengage the PTO per the PTO manufacturer’s instructions. Also see heading “Post Operation Procedures” on page 69.

## 4.4 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 54.

### Relay Procedures

**Note:** When feeding through a pump, the pump must be in pump gear and the transmission in neutral in order to lubricate the pump and the intermediate gears.

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.

**Note:** 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.
4. The discharge pressure must not exceed 185 PSI (1,276 kPa) for 5" (125 mm) large diameter hose, or 135 PSI (931 kPa) for 6" (150 mm) hose, per NFPA Standards 1962. See heading "Pumping From a Hydrant, General Operation" on page 54. Also see heading "Pumping From Draft" on page 58.



### **IMPORTANT!**

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

5. 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.
6. Adjust the throttle on the pump at the water source for the required operating pressure. Watch the gauges to avoid cavitation. Also see heading "Cavitation" on page 193.
7. The pump operator at the fire scene must advise all other pump operators of the amount of water needed at the fire ground.
8. Adjust the discharge pressure or flow at the fire scene to supply the lines being used.
9. Observe the gauges carefully, and adjust the pressure or flow as needed.
10. 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.
11. Follow this procedure for every pump in the relay until the pump at the water source is shut down.



### **IMPORTANT!**

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

## 4.5 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 layouts.

**Note:** Two 1,000 GPM (3,785 LPM) pumpers in a series from a hydrant can produce 500 GPM (1,893 LPM) at 500 PSI (3,447 kPa) if the relief valve systems allow 500 PSI (3,447 kPa).



### 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 (34 kPa).
5. Connect the second pumper to the unused streamer intake of the first pumper, using a large intake hose (approximately 2-1/2” / 65 mm).
6. Both pumpers pump water to the fire. Also see heading “Pumping From a Hydrant, General Operation” on page 54.



**IMPORTANT!**

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

## 4.6 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.

**IMPORTANT!**

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

## 4.7 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 4-1: "Driver's Compartment Indicator Lights" on page 55.
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.

## **4.8 RELIEF VALVE PROCEDURES**

Be sure to select the correct procedure based on how the truck is equipped. (See Figure 4-3: “TPM / PMD Relief Valve Control” on page 67.) 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 (kPa).
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 4-3: "TPM / PMD Relief Valve Control.")
4. Turn the handwheel slowly clockwise until the light goes out.
5. When the pump is not in operation, turn the handwheel clockwise to a position slightly above the normal operating pressure. More complete and detailed information is found in the relief valve manual.



**Figure 4-3: TPM / PMD Relief Valve Control**



**CAUTION!**

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

### **TPM System with Engine Governor**

1. Set the pressure indicator on the PMD control valve to a position slightly above the normal operating pressure (even before water starts to flow).
2. Power on the governor control per the manufacturer's manual.
3. Set the discharge pressure using the RPM mode of the pressure governor control.
4. Move the TPM handwheel counterclockwise until the relief valve opens and the AMBER pilot light illuminates.
5. Turn the handwheel slowly clockwise until the AMBER light just goes out. Then turn the handwheel one additional full turn clockwise.



**CAUTION!**

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

6. Place the governor control in the PRESSURE GOVERNOR mode.
7. Use the following procedures to change the set pressure while running:

#### **Increasing Pressure**

- ❑ Set the TPM to a pressure 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 4-3: “TPM / PMD Relief Valve Control” on page 67.)
- ❑ 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.

## 4.9 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.

7. Once gearbox shift is complete, make sure all personnel are clear of the underside of that apparatus and start the engine to proceed with the desired operation.

## 4.10 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 53.



Truck Manufacturer \_\_\_\_\_  
Pump Model Number \_\_\_\_\_  
Pump Serial Number \_\_\_\_\_  
Year \_\_\_\_\_ Unit # \_\_\_\_\_

## Midship Pump Maintenance Check List

### RECOMMENDED “WEEKLY” PROCEDURES

- ☐ Test relief valve system or governor at 150, 200, 250 PSIG (1000, 1400, 1700 kPa) - see page 80.
- ☐ Test transfer valve (if applicable) - see page 73.
- ☐ Test the priming system. Flush the priming system - Also see Chapter 4, heading “Weekly” on page 72.
- ☐ Lubricate all valves, discharge, suction, hose, drain, and multi-drain - see page 74.
- ☐ Check pump shift warning indicator lights - see page 74.

Recommended MONTHLY Procedures	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Complete weekly checks.												
Lubricate threads on PM relief valve panel control and check lights.												
Lubricate remote valve controls.												
Check controlled packing leakage and adjust if necessary (8 to 10 drops per minute).												
Perform dry vacuum test. <sup>a</sup>												
Check drive flange bolts for tightness.												
Lubricate suction tube threads.												
Clean strainer.												
Inspect gaskets.												
Check oil level in pump gearbox; add oil if necessary.												
If necessary, replace oil.												

a. \*Per NFPA-1911, 22” Hg. minimum vacuum: loss not to exceed 10” Hg vacuum in five (5) minutes.



## RECOMMENDED “ANNUAL” PROCEDURES

- ☐ Complete all previous checks on all questions.
- ☐ Check gauge calibration - see page 75.
- ☐ Check oil level in AutoLube® assembly (SAE-EP 90 or 80W-90); see operation and maintenance manual for details.
- ☐ Lubricate power transfer cylinder, power shift cylinder, and shift control valve with vacuum cylinder oil, if applicable.
- ☐ Change pump gearbox oil and refill (SAE-EP 90 oil or 80W-90).
- ☐ Check individual drain lines from pump to multi-drain to ensure proper drainage and protection from freezing.
- ☐ Lubricate transfer valve mechanism on two stage pumps. Dry moly spray is preferred.
- ☐ Disassemble priming pump and clean vanes.
- ☐ Run yearly standard pump test (per NFPA-1911) to check pump performance levels – chart provided below.
- ☐ Repacking of pump is recommended every two or three years.

**Note:** The preceding general recommendations are provided for normal use and conditions. Extreme conditions or variables may indicate a need for increased maintenance. Good preventative maintenance lengthens pump life, ensures greater dependability, and minimizes downtime. See “Muscle Pump Service Chart, Part 1 of 3” on page 88.

Annual pump Test Results, in PSIG (kPa)			
Category	Capacity at 150 (1000)	Capacity at 200 (1400)	Capacity at 250 (1700)
Hose Layout			
Nozzle Size			
Nozzle Pressure			
Gallons (Liters) per Minute			
Pump Pressure, Current Engine Speed			
Engine Speed from Original Test Documents			
Lift and Suction Hose Size and Number.			

## 5 Preventive Maintenance

### 5.1 OVERVIEW

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.

### 5.2 POST OPERATION

1. On two-stage pumps, remove the suction tube strainers and ensure that check valves are free to swing. Verify that no foreign matter is caught between the valve and the seat.
2. 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.
3. Verify that all discharge valves, booster line valves, drain valves, and valve cocks are closed.
4. Tighten suction caps.
5. Make sure the gearbox oil reservoir is full to correct level - see heading "Replace Gearbox Oil" on page 80. Also see Figure 5-5: "Muscle Pump Service Chart, Part 2 of 3" on page 89.

**Note:** The auto-lube assembly is NOT drained at shipment but must be checked prior to operation. To check auto-lube oil, see Step 18. of Section 7.6 "QMID/QMAX/QTWO AutoLube® Service" on page 116. Also see Figure 5-4: "Muscle Pump Service Chart, Part 1 of 3" on page 88.

### 5.3 EXTREME CONDITIONS

Extreme conditions occur when operating in freezing weather or as a result of pumping from a water source that contains material that is harmful 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. On two-stage pumps, move the transfer valve back and forth between both the VOLUME and PRESSURE positions.
4. After the pump is completely drained, replace all caps and close all valves.

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

1. Flush the pump and suction hoses using fresh, clean water.
2. After pumping foam, flush as above until all foam residue is flushed from the system.
3. Drain the gearbox cooler, if installed

## **5.4 WEEKLY**

Weekly maintenance consists of the following:

- ❑ Test the relief valve or governor system - see page 73
- ❑ Test the priming system - see page 74.

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

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

- ❑ Test the transfer valve on two stage pumps - see page 73
- ❑ Test the pump shift warning indicator lights - see page 74
- ❑ Perform valve maintenance - see page 74
- ❑ Check and clean the intake strainers - see page 75
- ❑ Check any auxiliary engines - see page 75
- ❑ Verify all gauges are in working order - see page 75
- ❑ Operate pump controls - see page 75

If testing criteria is not met, refer to Section 6 “Troubleshooting” on page 93 for corrective maintenance procedures.

## Relief Valve and TPM Test

When the relief valve is not in operation, maintain a setting above the normal operating pressure. Also see Figure 4-3: “TPM / PMD Relief Valve Control” on page 67.

1. Open the discharge valve, back to the water tank, less than 1/2 way. Also see Section 3.3 “Pressure and Relief Valve Control” on page 39.
2. Increase pump pressure up to 150 PSI (1034 kPa).
3. Turn the relief valve handwheel counterclockwise until the relief valve opens and the AMBER light illuminates. The master pressure gauge should drop at least 5 to 10 PSI (35 to 69 kPa).
4. Turn the control valve handwheel clockwise then counterclockwise a few times to ensure that the handwheel turns freely. Observe the master pressure gauge and indicator light for proper valve operation.
5. Reset the relief valve to its normal operational setting.

## Governor Test

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

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

1. For MANUAL transfer valves:
  - ☐ With the engine turned OFF, turn the handwheel between VOLUME and PRESSURE a few times to verify that the valve operates freely.
  - ☐ Set the truck for pumping with the transfer valve set to VOLUME. See heading “Relief Valve Procedures” on page 66. Also see heading “TPM Relief Valve Procedures” on page 66.
  - ☐ With the engine at IDLE speed, set the transfer valve to PRESSURE.
  - ☐ Verify that the discharge pressure gauge readings have approximately doubled.
2. For POWER transfer valves:
  - ☐ With the engine turned OFF, use either a 3/8” socket on the indicator hex nut or insert a rod in the hole in the indicator hex nut and manually transfer the valve back-and-forth to verify that the valve operates freely.
  - ☐ Set the truck for pumping with the transfer valve set to VOLUME. Note the discharge gauge readings.

- ☐ With the engine at IDLE speed, set the transfer valve to PRESSURE.
- ☐ Verify that the master intake gauge readings have approximately doubled.

### Priming System Test

1. Tighten all pump caps, and close all pump valves.
2. Pull the primer control while you watch for a below-zero (0) reading on the master intake gauge.
3. Continue operation for three (3) to five (5) seconds after the primer starts flushing water through the pump to clear any possible dirt or slug (gum) buildup.
4. Verify that the master intake gauge readings hold for approximately five (5) minutes after you release the primer control. A drop of 10" Hg. 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 Lights

1. Switch to non-pumping operations and verify the warning indicators are OFF. See Section 4 "Basic Operation" on page 53.
2. Verify that the warning indicators in the cab and on the pump control panel function properly.



**CAUTION!**

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

3. Repair or replace any malfunctioning indicators.

### Valve Maintenance

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

Lubricate all moving parts of the suction, discharge, hose drain, and multi-drain valves and valve linkage with a good grade of grease. For recommended grease, see "Lube and Sealant Specifications" on page 187.

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

### **Intake Strainers**

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

### **Verify All Gauges are in Working Order**

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

### **Operate Pump Controls**

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

### **Inspect Water and Foam Tanks**

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

### **Check Auxiliary Engine**

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

## **5.5 MONTHLY**

Monthly maintenance includes the weekly maintenance procedures plus:

- ☐ Valve lubrication - see page 76
- ☐ Suction Check Valve testing - see page 76
- ☐ Gearbox lubrication - see page 76
- ☐ Dry vacuum testing - see page 78
- ☐ Checking the pump and drive line bolts - see page 77

- Relief valve system check - see page 81

## Valve Lubrication

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

## Suction Check Valve Testing, Two-Stage Pumps

On two-stage pumps, remove the suction tube strainers, and reach inside the pump to ensure that the check valves are free to swing. Also verify that no foreign matter is caught between the valve and the seat.

## 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. (See Figure 5-5: “Muscle Pump Service Chart, Part 2 of 3” on page 89.)

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

1. For gearbox capacity - see heading “Lube and Sealant Specifications” on page 187.
2. Remove the gearbox oil fill plug, and check the level of the oil in the gearbox. The oil level should be up to the bottom of the oil fill plug hole. Also see Figure 5-5: “Muscle Pump Service Chart, Part 2 of 3” on page 89.
3. Have clean disposable shop rags and oil dry handy and a suitable container to collect the fluid.
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 Section 5 Troubleshooting, heading 6 “Troubleshooting” on page 93.

5. Either of these conditions indicates maintenance is required to the unit. See Section 9.1 “G Series Gearbox Maintenance” on page 149. Also see Section 9.2 “J Series Gearbox Maintenance” on page 157.



## Packing Gland Adjustment

The packing gland is adjusted for a leakage rate of about 8 to 10 drops per minute at 150 PSI (1034 kPa). This slight leakage lubricates and cools the shaft and packing to prevent burning and scoring.

Check the leakage rate, and adjust the packing gland if necessary. If the leakage rate cannot be adjusted within satisfactory limits, replace packing. See Section 8.1 "Packing Seal Replacement" on page 131 for additional information.

Packing should be replaced every three (3) years.

### Adjustment

1. Connect the pump to a fresh water source of about 150 PSI (1034 kPa). If this is not possible, operate the pump at about 150 PSI from draft or from the booster tank discharging through the booster line, another small nozzle, or circulating back to the tank.
2. Count the drops (water leakage) per minute.
3. Shut down engine to make adjustments.



**WARNING!**

### DO NOT RUN THE ENGINE WHILE MAKING PACKING ADJUSTMENTS.

4. Loosen the packing nut lock. The lock is either a spring-loaded pin. The end of the lock fits into a slot in the gland. (See Figure 5-2: "Pump Packing Seal Assembly" on page 86.)
5. To loosen or tighten the packing gland:
  - ☐ Insert a screwdriver or rod into one of the slots. Refer to the Hale Service Chart.
  - ☐ To loosen the nut, turn it in the direction of engine rotation.
  - ☐ To tighten the nut, turn it in the opposite direction to engine rotation.
6. Repeat Steps 1 through 3 and verify that leakage is correct. Tighten to REDUCE leakage, loosen to INCREASE leakage.

## Pump, Drive Line and Flange Bolts

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

1. No bolts are missing.

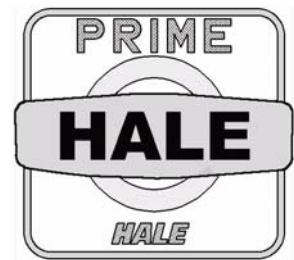
2. All bolts are tight. Use a torque wrench and torque bolts to the drive train manufacturer's recommended specifications.
3. Bolts used are "Grade 5" minimum for mounting and "Grade 8" minimum for the driveline.

### 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 so equipped).
2. Connect a test vacuum gauge or manometer to the intake test gauge connection on the pump panel.
3. Engage the priming pump until the gauge indicates 22" Hg.
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 five (5) minutes it is an indication of at least one air leak.
6. Vacuum leaks may often be detected by ear if the engine is turned OFF. Correct leaks immediately before returning the pump to service.
7. Test the suction hose as follows:

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



**Figure 5-1: Priming Valve Handle**

**IMPORTANT!**

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

**TO TEST:**

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

## 5.6 ANNUAL

Annual maintenance consists of post-operation, weekly, and monthly maintenance plus the following tasks:

- ☐ Replacing the pump gearbox oil - see page 80.
- ☐ Relief valve system, check and repair - see page 80.
- ☐ Checking individual drain lines from the pump to the multi-drain to ensure proper drainage and protection from freezing - see page 81.
- ☐ Disassembly of priming pump to clean vanes - see page 81. (Also see separate manual provided.)

**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.**

- ☐ MIV Relief Valve Test and Adjustment - see page 81.
- ☐ Relief Valve Test and Adjustment - see page 81.
- ☐ Yearly pump test to check performance levels, including Tank-to-Pump Flow Rate - see page 82. (Also see NFPA 1911 standard for more details.)
- ☐ Repacking the pump seal at three-year intervals - see page 85
- ☐ Autolube® assembly oil level check - fill or replace with SAE EP 90 or 80W90 weight oil.

- ❑ Lubricating the power transfer cylinder, power shift cylinder, and shift control valve with air cylinder oil.

## 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 “Lube and Sealant Specifications” on page 187. Also see Figure 5-5: “Muscle Pump Service Chart, Part 2 of 3” on page 89.
2. 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.
3. 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 101.
4. Properly dispose of the used oil.
5. Inspect the magnetic drain plug. If metal filings are present, visually inspect and clean the internal components.
6. Clean the drain plug (magnetic).
7. Repair or replace gearbox components as necessary. See appropriate Section for gearbox service.
8. Replace the cooler, if necessary.
9. Remove the oil fill plug and install the drain (magnetic) plug, using suitable thread sealant.
10. Fill the gearbox with an approved gear oil until oil just begins seeping from the oil level plug opening. For gearbox capacity, see “Lube and Sealant Specifications” on page 187. Also see Figure 5-5: “Muscle Pump Service Chart, Part 2 of 3” on page 89.
11. Install the oil fill plug using suitable thread sealant.

## 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 72.
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. Most drain lines are piped together to a multi-drain to allow the entire system to be drained by one valve.

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

## Clean Priming Pump

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



### IMPORTANT!

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

## MIV Relief Valve Test and Adjustment

See separate manual for additional information.

## Performance Testing Overview

The yearly standard performance test consists of checking the pumper, (according to rating) at three capacities and comparing the results to when the pump was first placed in service. This provides some measure of performance deterioration, if any. (See Table 5-1: "Pump Ratings (GPM / LPM)" on page 82.)

A pump must be able to pump FULL rated capacity at 150 PSI (1000 kPa), 70% capacity at 200 PSI (1400 kPa) and 50% capacity at 250 PSI (1700 kPa).

**Table 5-1: Pump Ratings (GPM / LPM)**

Capacity	Pressure PSI (kPa)	Pump Rating in GPM (LPM)								
		500 (2,000)	750 (3,000)	1,000 (4,000)	1,250 (5,000)	1,500 (6,000)	1,750 (7,000)	2,000 (8,000)	2,250 (9,000)	3,000 (12,000)
100%	150 (1000)	500 (2,000)	750 (3,000)	1,000 (4,000)	1,250 (5,000)	1,500 (6,000)	1,750 (7,000)	2,000 (8,000)	2,250 (9,000)	3,000 (12,000)
100%	165 (1100)	500 (2,000)	750 (3,000)	1,000 (4,000)	1,250 (5,000)	1,500 (6,000)	1,750 (7,000)	2,000 (8,000)	2,250 (9,000)	3,000 (12,000)
70%	200 (1400)	350 (1,400)	525 (2,100)	700 (2,800)	875 (3,500)	1,050 (4,200)	1,225 (4,900)	1,400 (5,600)	1,575 (6,300)	2,100 (8,400)
50%	250 (1700)	250 (1,000)	375 (1,500)	500 (2,000)	625 (2,500)	750 (3,000)	875 (3,500)	1,000 (4,000)	1,125 (4,500)	1,500 (6,000)

## 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 and begin pumping water.
5. Increase the engine throttle until the maximum consistent pressure is obtained on the discharge gauge.
6. Close the discharge valve without changing the throttle setting. Refill the tank. The bypass valve may be opened to prevent pump overheating.
7. Reopen the discharge valve and check the flow through the nozzle using a Pitot tube or flow meter. Adjust the engine throttle to bring the pressure to the amount previously determined.
8. Compare the flow rate measured to the NFPA minimum or the designated rate of the pump. If the flow rate is lower, a problem may exist in the tank-to-pump line.

The minimum flow rate should be continuously discharged until 80% of the tank is discharged.

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

## Performance Testing Equipment and Materials

Pumpers should be tested from draft at not over a 10' (3 m) lift with 20' (6 m) of suction hose. Pumpers rated at 1,500 GPM (6,000 LPM) and above often require two separate 20-foot (6-meter) 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 (207 and 586 kPa). Also see Appendix F: "Nozzle Size vs. Pressure" on page 191.

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 E: "Hose Friction Loss" on page 189.

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.

### Note:

- ☐ For 750 GPM (3,000 LPM) test, two 2-1/2" (64 mm) lines should be laid from the pumper to the nozzle
- ☐ For 1,000 GPM (4,000 LPM) test, three lines are required
- ☐ For the 1,250 GPM (5,000 LPM) and 1,500 GPM (6,000 LPM) tests, four or more lines are required between the pumper and the nozzle.
- ☐ For the 1,750 GPM (7,000 LPM), 2,000 GPM (8,000 LPM), and 2,250 GPM tests up to six hose lines into two separate nozzles should be used. Also see Appendix F: "Nozzle Size vs. Pressure" on page 191.

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



nozzle used on one, 2-1/2" line should not be larger than 1-1/2" (38 mm) for accuracy in measuring GPM (LPM).

Another alternative when a deluge gun is not available consists of a 1-1/4" (32 mm) nozzle on one and a 1-1/2" (38 mm) nozzle on the other to pass 1,000 GPM (3,785 LPM). The sum of the flow from both nozzles is the GPM (LPM) delivered by the pump. For good pitot gauge accuracy, the nozzle pressures should be between 30 and 85 PSIG (207 and 586 kPa).

## **Performance Testing**

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

1. Test the relief valve (per NFPA 1901 standards):
  - ☐ Set the relief valve flow rate capacity at 150 PSI (1034 kPa).
  - ☐ SLOWLY close the discharge valves. The rise in pressure shall not exceed 30 PSI (207 kPa), or approximately 180 PSI (1241 kPa) operating pressure.
  - ☐ SLOWLY open the discharge valves to re-establish the original pressure, 150 PSI (1,000 kPa).
2. Perform Steps 2 and 3 of the post operation maintenance procedures. Also see Section 4.10 "Post Operation Procedures" on page 69.
3. Run the standard pump test in accordance with NFPA standards to check pump performance.
4. Run the engine for 20 to 30 minutes to stabilize the engine temperature. Then run the pump for:
  - ☐ Two (2) hours at FULL capacity and at 150 PSI (1000 kPa)
  - ☐ Thirty (30) minutes at 70% capacity and at 200 PSI (1400 kPa)
  - ☐ Thirty (30) minutes at 50% capacity and at 250 PSI (1700 kPa)
  - ☐ Additionally, an engine overload test is required which consists of pumping at FULL capacity and at 165 PSI (1100 kPa) for ten (10) minutes.
5. If the apparatus does not reach performance levels, proceed to Section 6 "Troubleshooting" on page 93.
6. 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, it needs to be serviced.

**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).

## Thermal Relief Valve Test

The TRV requires testing every 12 months. Make sure a clear view to the TRV discharge exists. See separate manual for additional information.

Table 5-2: Maximum Pump Run Time

Pressure PSIG (kPa)	Time in Minutes	
	TRV120 TRVM120	TRV170 TRVM170
200 (1378)	10	20
400 (2758)	4	8
600 (4137)	2	4



**CAUTION!**

**DO NOT RUN THE PUMP FOR LONGER THAN IS SHOWN IN TABLE 5-2: “MAXIMUM PUMP RUN TIME,” AS OVERHEATING COULD OCCUR CAUSING SERIOUS DAMAGE TO THE PUMP.**

## Repacking the Seal



**WARNING!**

**DO NOT ADJUST THE PACKING WITH THE ENGINE RUNNING.**

The three rings adjacent to the packing gland are replaced without disassembling the pump. The ring in front of the packing lantern does not need to be replaced. (See Figure 5-2: “Pump Packing Seal Assembly” on page 86.)

Repack the pump as follows:

1. Loosen the packing nut lock.
2. Loosen the packing gland. If necessary, soak the threads with penetrating oil and work the nut back and fourth to loosen.
3. Loosen the adjusting gland just enough to remove the split glands. If the front part of the gland is the split type, remove both halves.
4. Remove the old packing rings with a packing hook. The hook can be made from a bent piece of stiff wire or small pointed rod.

**Note:** Another type of packing hook is a corkscrew on the end of a flexible shaft. Be sure to remove all shreds of old packing, and clean out the packing housing.

5. Remove all old packing, dirt, and foreign matter from the bearing housing under the gland.

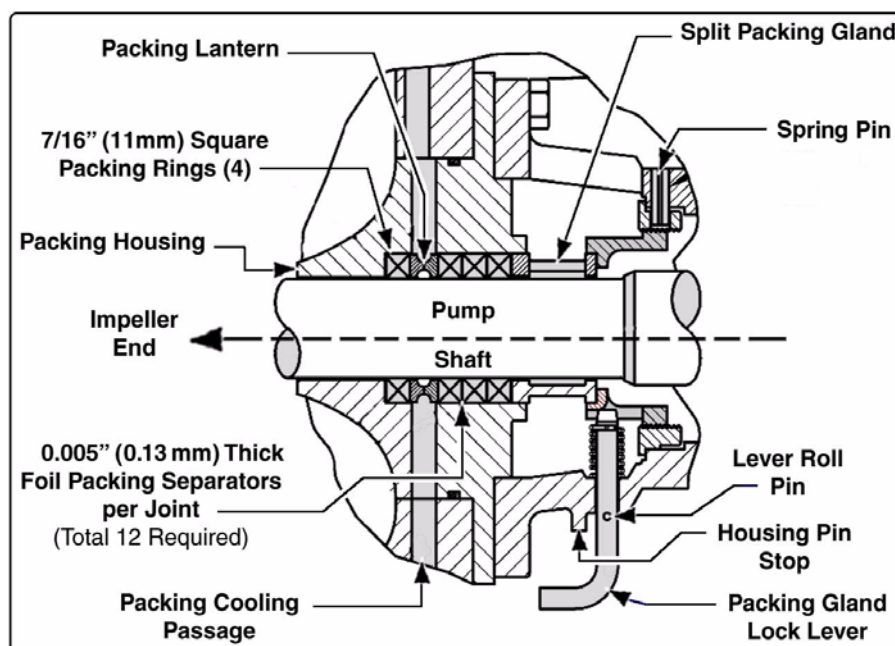


Figure 5-2: Pump Packing Seal Assembly

6. Repack using the Hale packing kit recommended for your particular pump. For most pumps, the packing is 7/16" (11 mm) square cut to the proper length.
7. Wrap one length of packing around the shaft to form a ring, and push the ring into the housing. Install the second ring the same way, but stagger the joint one-third of the way around from the first joint.
8. Insert a foil separator between each packing ring. The foil separator must be cut to fit.
9. Install the other rings, again staggering the joints.
10. Replace the gland and adjust accordingly. Also see heading "Packing Gland Adjustment" on page 77.
11. Operate the pump normally for about 15 minutes at 130 PSI (896 kPa), and check the packing gland. If necessary, adjust the packing nut again - see heading "Packing Gland Adjustment" on page 77.

## Worn Clearance Rings and Impeller Hubs

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

Clearance rings limit the internal bypass of water from the discharge side of the pump back to suction. The radial clearance between the impeller hub and the clearance

rings is only a few thousandths of an inch when new. In clear water, the clearance rings continue to effectively seal for many years of operation.

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

It should not be necessary to replace clearance rings until a loss in pump performance is noticed during the annual test – see “Performance Testing” on page 84.

Often, replacement of the clearance rings reduces the bypass and restores the pump to near original performance. A complete restoration requires that the impeller also be replaced. See Section 7 “Repair and Corrective Maintenance” on page 103 for maintenance and repair information if pump disassembly is required.

## Anode Check

(See Figure 5-3: “Hale 1-1/4” NPT Anode” on page 87.)

Anodes conform to MIL Spec. A180001. Performance of the anode life varies with water quality and pH.

Replace anodes when over 75% of the metal has been consumed.

### Zinc anodes -

Inspect every twelve (12) months and replace accordingly.

### Magnesium anodes -

Inspect every three (3) months and replace accordingly.

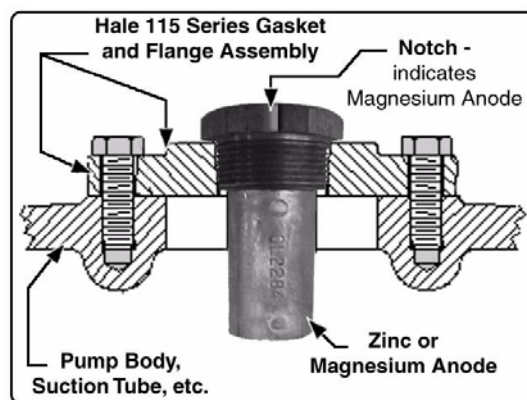


Figure 5-3: Hale 1-1/4” NPT Anode

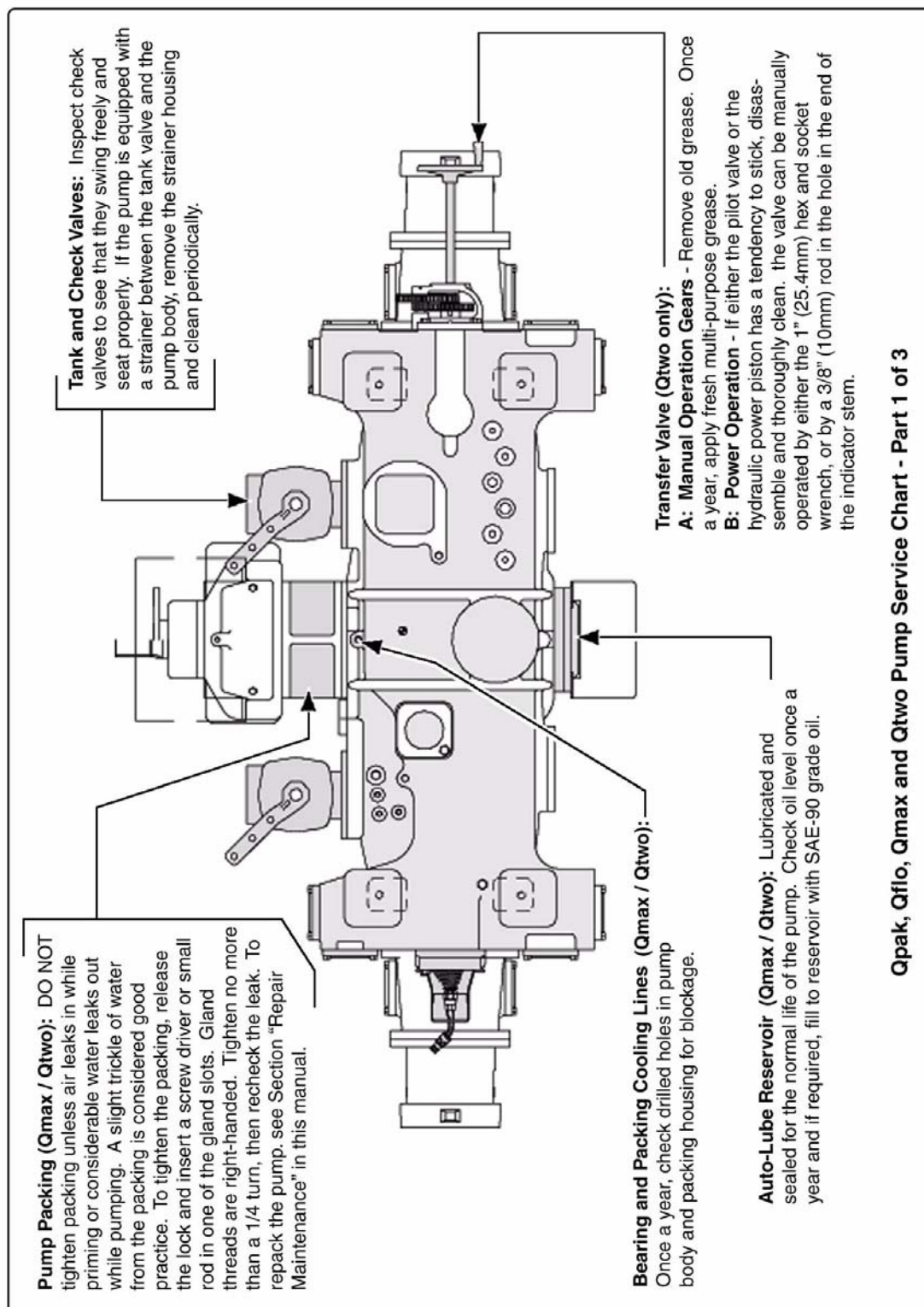


Figure 5-4: Muscle Pump Service Chart, Part 1 of 3

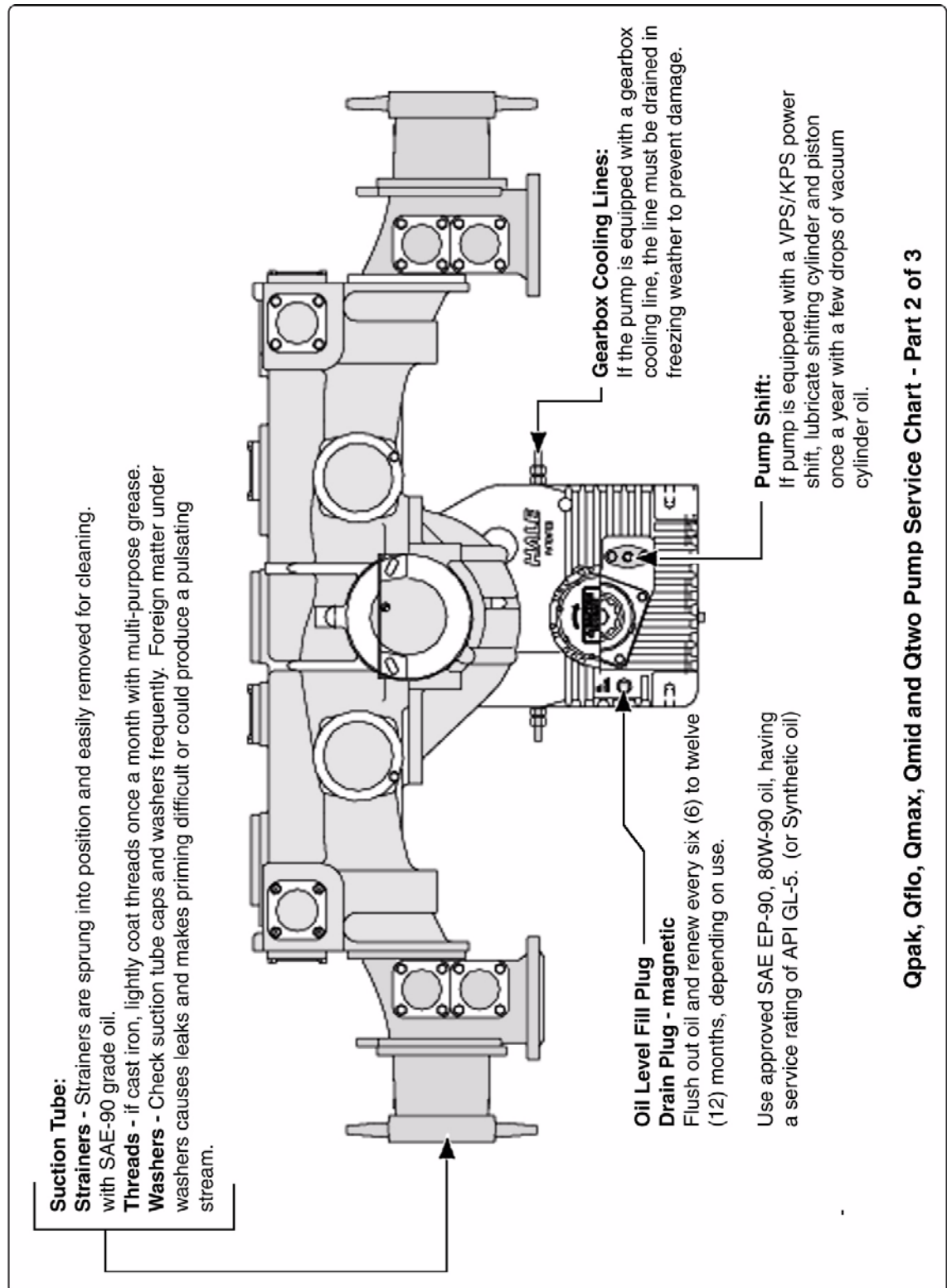


Figure 5-5: Muscle Pump Service Chart, Part 2 of 3



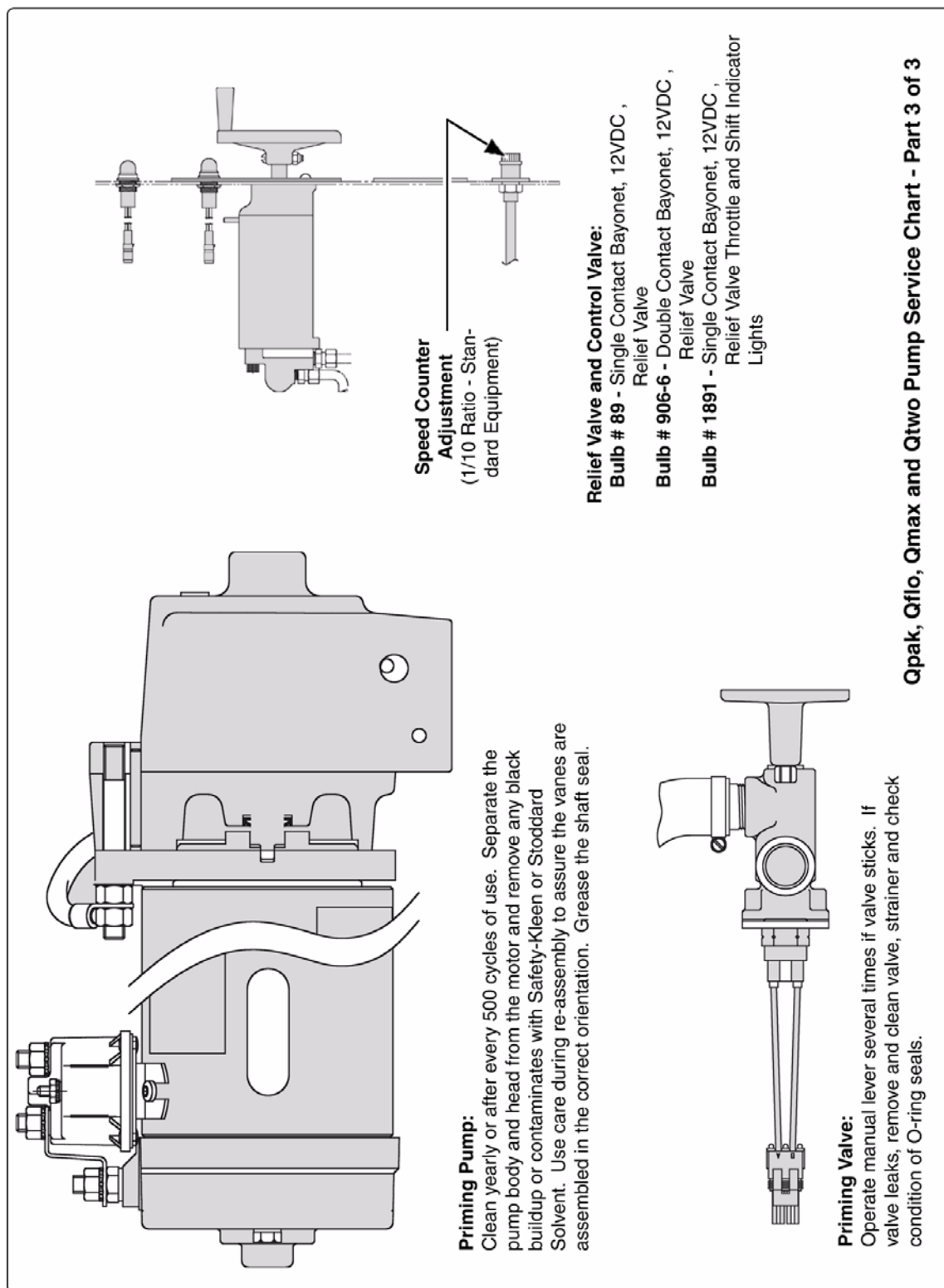


Figure 5-6: Muscle Pump Service Chart, Part 3 of 3





## 6 Troubleshooting

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

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

- ☐ Pump Model and Serial Numbers see Figure 2-14: “Typical Midship Pump Serial Number Location” on page 36.
- ☐ Pump Configuration Information
- ☐ Observed Symptoms and under what conditions the symptoms occur.

**Table 6-1: Muscle (Midship) Pump Troubleshooting (Sheet 1 of 9)**

Condition	Possible Cause	Suggested Corrective Action
PTO Will Not Engage.		<ul style="list-style-type: none"> <li>Consult the PTO Manufacturer’s Instructions.</li> </ul>
<div style="display: flex; justify-content: space-between; align-items: center;">  <div style="text-align: center;"> <b>WARNING!</b>  <b>DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB AND PANEL ARE ILLUMINATED.</b> </div>  </div>		
Pump Will Not Engage.  Standard transmission with Manual Pump Shift.	Clutch not fully disengaged or malfunction in shift linkage.	<ul style="list-style-type: none"> <li>Check clutch disengagement. Drive shaft must come to a complete STOP before attempting pump shift.</li> </ul>
Automatic transmission with Manual Pump Shift.	Automatic transmission not in NEUTRAL.	<ul style="list-style-type: none"> <li>Repeat recommended shift procedures with transmission in NEUTRAL position. Also see heading “Basic Operation” on page 53.</li> </ul>
Standard transmission with Power Pump Shift.	Insufficient air supply in shift system.  Clutch not fully engaged or malfunction in shift linkage.	<ul style="list-style-type: none"> <li>Repeat recommended shift procedures.</li> <li>Check system for loss of air supply (leaks).</li> <li>Check clutch disengagement. Drive shaft must come to a complete STOP before attempting pump shift.</li> <li>Turn engine OFF and employ shift override procedures as follows:</li> <li>Hole is provided in shift shaft to accomplish emergency shifting.</li> <li>Complete shift of control in cab to NEUTRAL and proceed to complete shift of lower control manually.</li> </ul>

**Table 6-1: Muscle (Midship) Pump Troubleshooting (Sheet 2 of 9)**





Condition	Possible Cause	Suggested Corrective Action
Pump Will Not Engage-continued.		<ul style="list-style-type: none"> <li>• Repeat recommended shift procedures with transmission in the NEUTRAL position.</li> <li>• Release brake system momentarily, then reset and repeat recommended shifting procedures.</li> </ul>
Automatic transmission with Power Pump Shift	Insufficient air in shift system.  Air leaks in shift system.	<ul style="list-style-type: none"> <li>• Repeat recommended shift procedures with transmission in the NEUTRAL position.</li> <li>• Check system for loss of air and possible air leaks. Use manual override procedures, if necessary.</li> <li>• Also see heading “Standard transmission with Power Pump Shift.” on page 93.</li> <li>• Attempt to locate and repair leak(s). Leakage, if external, may be detected audibly. Internal leakage is more difficult to detect and requires disassembly.</li> </ul>
<div style="display: flex; justify-content: space-between; align-items: center;">  <div style="text-align: center;"> <b>WARNING!</b>  <b>DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB AND PANEL ARE ILLUMINATED</b> </div>  </div>		
Pump Loses Prime or Will Not Prime.  <b>Note:</b> Weekly priming is recommended to ensure proper operation. See Section 4 Preventive Maintenance, heading “Priming System Test” on page 74.	Electric priming system.	<ul style="list-style-type: none"> <li>• NO recommended engine speed is required to operate the electric primer. However, 1,000 engine RPM maintains the electrical system while providing enough speed for initial pumping operations. Also see heading “Priming Valves” on page 41.</li> </ul>
	Inoperative priming system or possible clogged priming pump.	<b>Note:</b> Using lubricant on the vanes and vane slots during disassembly and cleaning eventually causes a gummy residue to develop, rendering the system inoperative. DO NOT lubricate vanes or vane slots.  <ul style="list-style-type: none"> <li>• Check the priming system by performing a “Dry Vacuum Test” per NFPA standards. If the pump holds vacuum but primer pulls less than 22” Hg, it could indicate excessive wear in the primer.</li> <li>• See Section 4 Preventive Maintenance, heading “Weekly” on page 72. Also see Section 4 Preventive Maintenance, heading “Annual” on page 79.</li> <li>• Also see heading “Priming Valves” on page 41.</li> <li>• Repair and/or replace accordingly.</li> </ul>
	Suction lifts too high.	<ul style="list-style-type: none"> <li>• DO NOT attempt lifts exceeding 22 feet (6.7 meters) except at low elevation.</li> </ul>
	Blocked suction strainer.	<ul style="list-style-type: none"> <li>• Remove obstruction from suction hose strainer.</li> <li>• Thoroughly clean strainer screen.</li> </ul>
	Suction connections.	<ul style="list-style-type: none"> <li>• Clean and tighten all suction connections.</li> <li>• Check suction hose and hose gaskets for possible defects - repair and/or replace accordingly.</li> </ul>

Table 6-1: Muscle (Midship) Pump Troubleshooting (Sheet 3 of 9)

Condition	Possible Cause	Suggested Corrective Action
<p>Pump Loses Prime or Will Not Prime - continued.</p> <p><b>Note:</b> Weekly priming is recommended to ensure proper operation. See Section 4 Preventive Maintenance, heading “Priming System Test” on page 74.</p>	Air trapped in suction line.	<ul style="list-style-type: none"><li>• Avoid placing any part of the suction hose higher than the suction intake.</li><li>• Suction hose should be laid out with continuous decline to fluid supply.</li><li>• If trap in hose is unavoidable, repeated priming may be needed to eliminate air pockets in suction hose.</li></ul>
	Insufficient priming	<ul style="list-style-type: none"><li>• Proper priming procedures should be followed.</li><li>• Do not release the primer control before assuring a complete prime.</li><li>• Open the discharge valve slowly during completion of prime to ensure complete prime.</li></ul>
	<div><div></div><div><b>NOTICE!</b> <b>DO NOT RUN THE PRIMER OVER FORTY-FIVE (45) SECONDS. IF PRIME IS NOT ACHIEVED WITHIN 45 SECONDS, STOP AND LOOK FOR CAUSES (AIR LEAKS OR BLOCKED SUCTION HOSES.)</b></div><div></div></div>	
	Pump pressure too low when nozzle is opened.	<ul style="list-style-type: none"><li>• Prime pump again and maintain higher pump pressure while opening the discharge valve slowly.</li></ul>
	Air leaks	<ul style="list-style-type: none"><li>• Attempt to located and correct air leaks using the following procedures:</li><li>• Perform “Dry Vacuum Test” on pump per NFPA standards with 22” minimum vacuum required with loss not to exceed 10” Hg. in five (5) minutes.</li><li>• If a minimum of 22” Hg. cannot be achieved, the priming device or system may be inoperative, or the leak is too big for the primer to overcome (such as an open valve). The loss of vacuum indicates leakage and could prevent priming or cause loss of prime.</li><li>• After priming shut OFF the engine. Audible detection of a leak is often possible.</li><li>• Connect the suction hose from the hydrant or the discharge of another pumper to pressurize the pump with water. Look for visible leakage and correct. A pressure of 100 PSI (689 kPa) should be sufficient. DO NOT exceed pressure limitations of pump, accessories or piping connections.</li><li>• Check pump packing during attempt to locate leakage. If leakage is in excess of recommendations, adjust accordingly. See Section 4 Preventive Maintenance, heading “Repacking the Seal” on page 85.</li><li>• The suction side relief valve can leak. Plug the valve outlet connection and retest</li></ul>

**Table 6-1: Muscle (Midship) Pump Troubleshooting (Sheet 4 of 9)**

Condition	Possible Cause	Suggested Corrective Action
Insufficient Pump Capacity, Single Stage.	Insufficient engine power.	<ul style="list-style-type: none"> <li>• Engine power check and tune up may be required for peak engine and pump performance.</li> <li>• Also see heading “Rotation Symptoms.” on page 101.</li> <li>• Recheck pumping procedure for recommended transmission gear or range. Use mechanical speed counter on pump panel to check actual speed against possible clutch or transmission slippage or inaccurate tachometer.</li> <li>• Check truck manual for proper speed counter ratio.</li> </ul>
	Relief valve improperly set - if so equipped.	<ul style="list-style-type: none"> <li>• If relief valve pressure is set too low it allows the valve to open and bypass water.</li> <li>• Reset the relief valve pressure accordingly.</li> <li>• See Section 4 Preventive Maintenance, heading “Relief Valve and TPM Test” on page 73.</li> </ul>
	Suction hose diameter is too small for the volume being discharged	<ul style="list-style-type: none"> <li>• Use larger sustain hose.</li> <li>• Shorten total length by remove one length at a time.</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>• See Section 4 Preventive Maintenance, heading “Intake Strainers” on page 75.</li> </ul>
	Air leaks	<ul style="list-style-type: none"> <li>• See heading “Air leaks” under condition “ Pump Loses Prime or Will Not Prime” on page 95.</li> </ul>
	Partial collapse of the lining in the 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 automatic, 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. Also see Section 3 Operation, heading “Basic Operation” on page 53.</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 ration.</li> </ul>

**Table 6-1: Muscle (Midship) Pump Troubleshooting (Sheet 5 of 9)**

Condition	Possible Cause	Suggested Corrective Action
Insufficient Pump Capacity, Dual-Stage.	Transfer valve not in proper position for operation, based on capacity rating and pressure.	<ul style="list-style-type: none"> <li>Place transfer valve in VOLUME position (parallel) when pumping more than 1/2 rated capacity.</li> <li>For pressure above 200 PSI (141379 kPa), pump should be placed in PRESSURE (series) position.</li> <li>For operating procedures, review Section 4 “Basic Operation,” beginning on page 53.</li> <li>For Transfer Valve test, review Section 4, heading “Transfer Valve Test (Two-Stage Pumps Only),” beginning on page 73.</li> </ul>
Insufficient Pressure.	Insufficient engine power.	<ul style="list-style-type: none"> <li>See previous heading “Insufficient Pump Capacity, Single Stage.” on page 96.</li> </ul>
	Two-Stage Pump Only -  Transfer valve not in proper position for operation, based on capacity rating and pressure.	<ul style="list-style-type: none"> <li>Two-Stage Pump Only -</li> <li>Place transfer valve in PRESSURE position (series) when pumping pressures above 200 PSI (1379 kPa).</li> <li>For operating procedures, review Section 4 “Basic Operation,” beginning on page 53.</li> <li>For Transfer Valve test, review Section 4, heading “Transfer Valve Test (Two-Stage Pumps Only),” beginning on page 73.</li> </ul>
Leak at Pump Packing.	Packing out of adjustment or worn.	<ul style="list-style-type: none"> <li>Readjust packing for 8 to 10 drops per minute leakage at 150 PSI (1000 kPa).</li> <li>Packing replacement is recommended every two to three years, depending on usage.</li> <li>See Section 4 Preventive Maintenance, heading “Packing Gland Adjustment” on page 77.</li> </ul>
Remote Control Difficult to Operate.	Lack of lubrication.	<ul style="list-style-type: none"> <li>Lubricate the remote control linkages and collar with oil.</li> </ul>

**Table 6-1: Muscle (Midship) Pump Troubleshooting (Sheet 6 of 9)**

Condition	Possible Cause	Suggested Corrective Action
Engine Speeds Too HIGH for Required Capacity or Pressure.	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 4 “Basic Operation,” beginning on page 53.</li> <li>• Check truck manual for proper speed counter ration.</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 line 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. See Section 4 Preventive Maintenance, heading “Intake Strainers” on page 75.</li> <li>• Follow recommended practices for laying suction hose.</li> <li>• Keep off the bottom of the fluid supply by at least 2 feet (0.6 meters) below the surface of the fluid.</li> </ul>
	Worn pump impeller(s) or clearance rings	<ul style="list-style-type: none"> <li>• Repair and/or replace as needed. See Section “Repair and Corrective Maintenance” on page 103.</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>
	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>• Also see “Cavitation” on page 193.</li> </ul>

Table 6-1: Muscle (Midship) Pump Troubleshooting (Sheet 7 of 9)



Condition	Possible Cause	Suggested Corrective Action
Cavitation  (Pump beginning to cavitate.)  <b>Note:</b> Also see “Cavitation” on page 193.	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>
Relief Valve Does Not Relieve Pressure When Relief Valves are Closed.	Incorrect setting of control (PM/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 “Relief Valve Procedures” on page 66.</li> <li>• See Section 3 Operation, heading “TPM Relief Valve Procedures” on page 66.</li> </ul>
	Relief valve inoperative.	<ul style="list-style-type: none"> <li>• Possibly in need of lubrication. Remove valve from pump, disassemble, clean and lubricate.</li> <li>• Refer to relief valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.</li> </ul>
Relief Valve Does Not Recover and Return to Original Pressure Setting After Opening Valves.	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 “Relief Valve Procedures” on page 66.</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>
Relief Valve Opens When Control Valves are Locked Out.	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>



**Table 6-1: Muscle (Midship) Pump Troubleshooting (Sheet 8 of 9)**

Condition	Possible Cause	Suggested Corrective Action
Unable to Obtain Proper Setting on Relief Valves.	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 “Relief Valve Procedures” on page 66.</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 the exact location.</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>
Discharge Valves Are Difficult to Operate.	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.</li> <li>• For Hale Products, SVS Valves, etc., use Never-Seez® White Food Grade with PTFE.</li> <li>• Refer to separate valve manual for additional information.</li> </ul>
	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> </ul> <p><b>Note:</b> Adding too many gaskets to the valve eventually causes leakage.</p>

Table 6-1: Muscle (Midship) Pump Troubleshooting (Sheet 9 of 9)

Condition	Possible Cause	Suggested Corrective Action
Water/Moisture in Pump Gearbox.	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. See Section 4 Preventive Maintenance, heading "Replace Gearbox Oil" on page 80.</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 packing seal or mechanical seal may be leaking.</li> <li>There must be NO leaks at the mechanical seal. See Section "Mechanical Seal Replacement" on page 133.</li> <li>Packing seals are designed to leak. For requirements, see "Packing Gland Adjustment" on page 77.</li> <li>Hydrostatic test the system to determine leakage.</li> </ul>
Rotation Symptoms.  (Reduced pressure 60–100 PSI [410–690 kPa] 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 2-13: "Pump/Engine Rotation" on page 35.</li> <li>Refer to relief / sensing valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.</li> </ul>
	Impellers installed backwards (two-stage pump).	<ul style="list-style-type: none"> <li>Verify the impellers are in the correct order - p/n: 016-0280-00-0 is installed closest to the gearbox in an "Engine Rotation" application and Closest to the front in a "Opposite Engine Rotation" application.</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>  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.  </div>	

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## 7 Repair and Corrective Maintenance

### 7.1 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.”

### 7.2 GENERAL REPAIR GUIDELINES

#### Before You Begin...



#### IMPORTANT!

**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.



**WARNING!**

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

**THE PUMP AND GEARBOX 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 OR INSTALLING FORCE (PRESS) FITTED PARTS. FAILURE TO COMPLY MAY RESULT IN SERIOUS EYE INJURY.**

**ALL FASTENERS ON THE PUMP AND GEARBOX 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 “Lube and Sealant Specifications” on page 187.
9. When replacing fasteners, use the proper nuts, bolts, and other hardware as specified in the manual or drawing. Unless otherwise specified, use minimum Grade 5 SAE fasteners.
10. Also ensure screws/bolts are properly torqued. (See Table 7-1: “Typical Torque Values Chart.”)
11. **Gearbox** - Apply Loctite #246 High Temperature Removable Threadlock (or equivalent) to all bolts on the gearbox.

Table 7-1: 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)

12. **Hale Series Pump** - Apply Loctite #242 Medium Strength Threadlock (or equivalent) to all bolts on the Pump.
13. 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.
14. 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.**

15. 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 106.
16. Before placing apparatus into operation, the pump assembly must be tested and checked for leaks.

## Remove the Gearbox Assembly

1. Drain oil from the gearbox. Also see Section 4 Preventive Maintenance, heading "Gearbox Lubrication" on page 76.

2. Have clean disposable shop rags and oil dry handy and a suitable container to collect the fluid. For gearbox capacity, see “Lube and Sealant Specifications” on page 187.
3. Disconnect drive shafts, air lines, electrical wiring / switches, tachometer cable and cooling lines, as necessary, from the gearbox.

## 7.3 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.
4. 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.
5. 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.
6. For Hale recommended cleaners, see “Lube and Sealant Specifications” on page 187.
7. Replace any hardware that shows signs of excessive wear.

### Bearings

Clean bearings and other components using only recommended solvents.



### IMPORTANT!

**WHEN REPLACING TAPERED BEARINGS, 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)
- ☐ 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

## 7.4 REMOVING THE PUMP ASSEMBLY

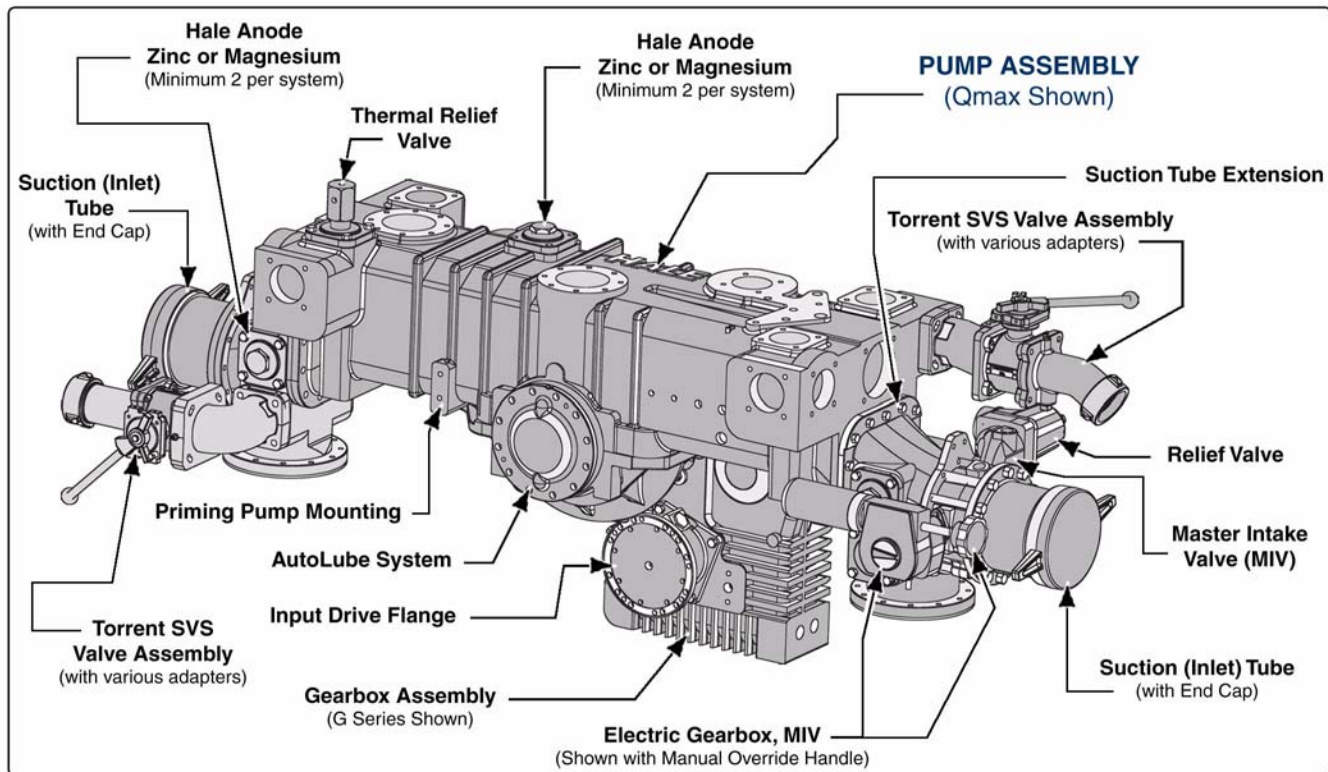


Figure 7-1: Typical Muscle (Midship) Pump Overview

1. First, review preceding Section “Before You Begin...” on page 103.  
See Section “Drawing Package” on page 203. and review the appropriate Installation Drawing.
2. Install 5/8”-11 UNC eyebolts into the lifting holes on the midship pump body. (See Figure 7-2: “Lifting Eyebolt Attachment Layout,” on page 109.)



**CAUTION!**

**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. ALSO SEE WARNINGS! NOTE ON PAGE 104.**

3. With the pump assembly properly supported and balanced, disconnect the mounting brackets that secure the assembly to the apparatus chassis frame.

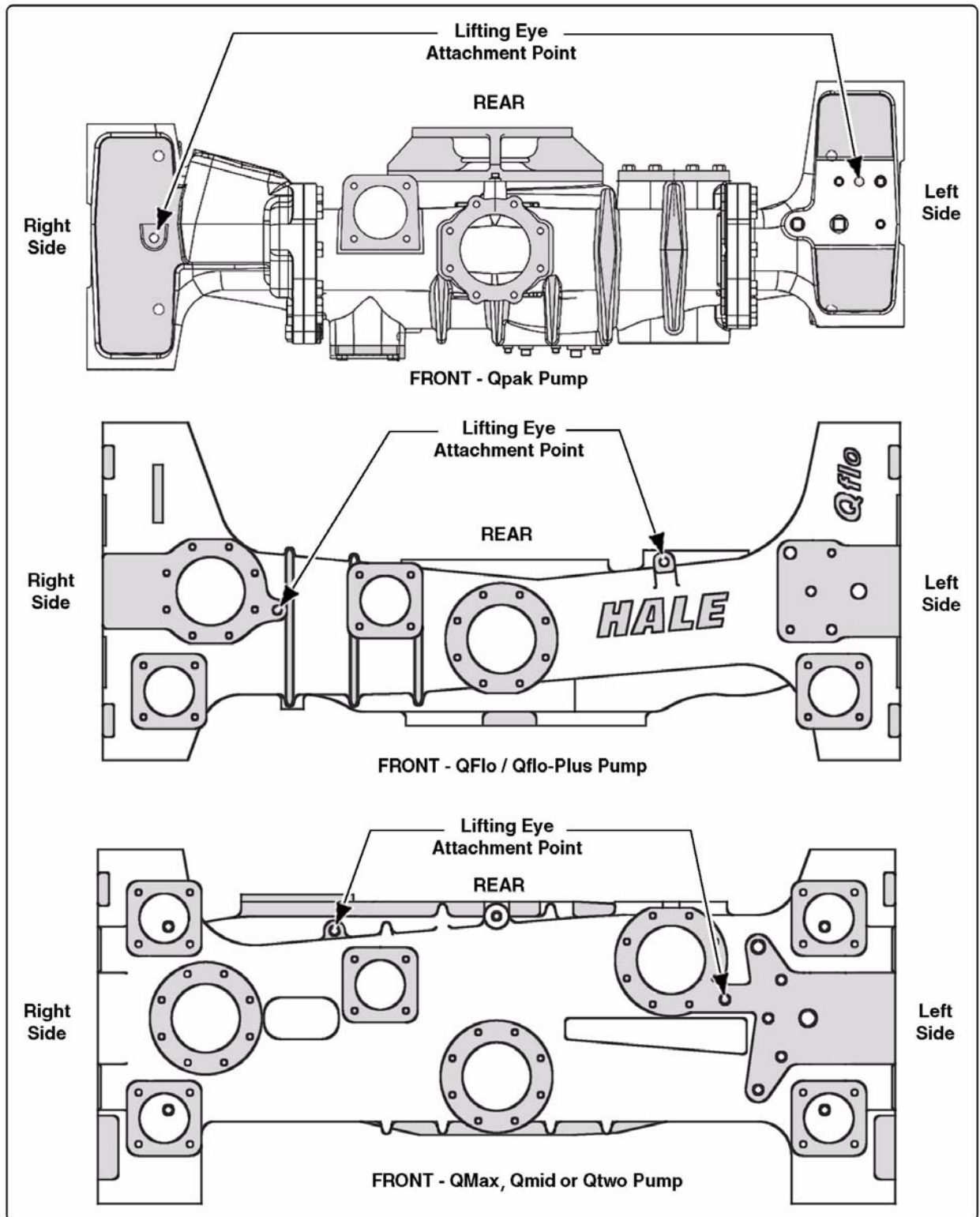


Figure 7-2: Lifting Eyebolt Attachment Layout

4. Carefully remove the assembly from the apparatus and place on a clean work area. Clamp into a suitable and stable holding device being careful not to damage any machined surfaces.

## **Installing the Assembly to the Apparatus**

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

1. First, review “Before You Begin...,” on page 103
2. Attach proper supporting devices and stabilize the assembly for transport to the apparatus. (See Figure 7-2: “Lifting Eyebolt Attachment Layout,” on page 109.)
3. Place the pump assembly into position within the apparatus.
4. Apply Loctite and secure the midship pump assembly to chassis frame. Torque the fasteners to proper values in accordance with manufacturer’s recommendations. Also see Table 7-1: “Typical Torque Values Chart” on page 105.
5. Remove the lifting device and 5/8”-11 UNC eyebolts.
6. Connect the drive shaft to the gearbox. Apply a coating of Loctite #246 to the fasteners and torque to the manufacturer’s specifications.
7. Connect all components to the gearbox.
8. Fill the gearbox to the proper oil level. See “Replace Gearbox Oil,” on page 80.
9. Reassemble and connect all components removed to gain access to the pump assembly, paying particular attention to your sketch (photographs) and identification match markings/tags (e.g., valves, suction piping, discharge piping, valve operators, etc.)
10. Reinstall apparatus frame work and body panels previously removed.
11. Test the pump per your departmental requirements.
12. Recheck and top-off oil levels, then return the apparatus to operation.

## **7.5 REMOVING THE GEARBOX**

### **G Series Gearbox**

Review “Before You Begin...,” on page 103. Also see Figure 7-3: “Typical G Series Gearbox Removal” on page 111.

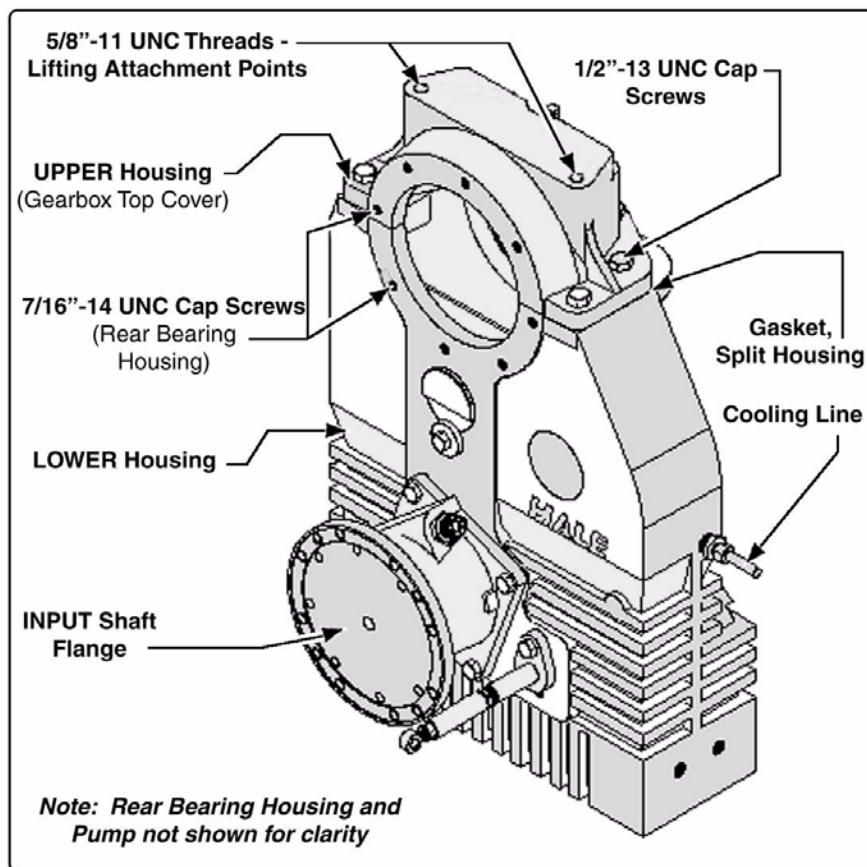


Figure 7-3: Typical G Series Gearbox Removal

### Removal - G Series

1. Position a supporting device, such as a jack, under the gearbox.
 

**Note:** The number of screws that secure the rear bearing housing to the gearbox depends on the model, e.g., the short gearbox uses seven (7) screws; the long gearbox uses eight (8).
2. Remove the 7/16"-14 screws securing the rear bearing housing to the lower gearbox housing.
3. Remove the gearbox from the apparatus. Move the assembly to a clean work area and clamp into a suitable and stable holding device.
4. Place a temporary cover over the exposed pump assembly to prevent dirt and debris contamination.
5. Inspect bearings and internal parts for signs of excessive wear, pitting or damage. Repair and/or replace accordingly. For gearbox disassembly, see "Disassembly," on page 149.
6. Also see heading "Cleaning and Inspection Guidelines" on page 106.

### **Installation - G Series**

Review preceding sections “Before You Begin...,” on page 103.

1. Install a new gasket between the gearbox seating surface of the rear bearing housing.
2. Install a new gasket between the gearbox and gearbox cover. Check the fit and trim the gasket to match the contour of the gearbox, if necessary.
3. Lift the gearbox into place around the rear bearing housing. Apply Loctite #246 and insert two or three 7/16"-14 screws through the rear bearing housing. Tighten screws hand tight.
4. Position the gearbox cover, apply Loctite #246 and insert six 1/2"-13 screws. Tighten screws hand tight.
5. Apply Loctite #246 and insert the remaining 7/16"-14 and 1/2"-13 screws through the rear bearing housing and gearbox cover and gaskets. Tighten all screws in a criss-cross fashion to ensure an EVEN seal, then torque to:
  - ❑ 40 ft.-lbs. (54 Nm) for 7/16"
  - ❑ 65 ft.-lbs. (88 Nm) for 1/2"
6. Connect drive shafts, cooling lines, air hoses, and electrical connections to the gearbox.
7. Fill the gearbox with oil as shown in “Replace Gearbox Oil,” on page 80.
8. Test the pump for proper operation per your departmental requirements.
9. Recheck and top off oil levels before returning the apparatus to operation.

### **J Series Gearbox**

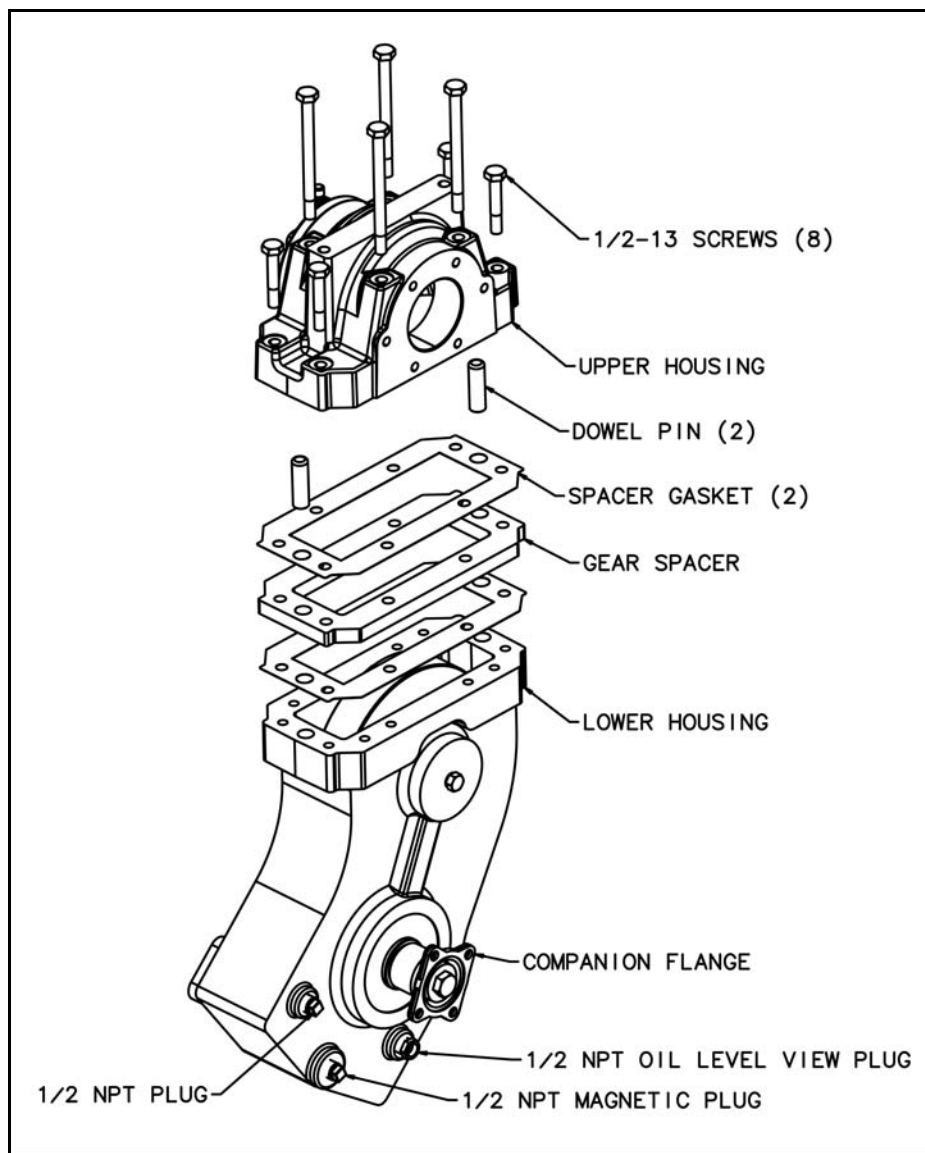
Review preceding sections “Before You Begin...,” on page 103.

#### **Removal - J Series**

1. Connect or position the gearbox to your supporting device and assure that it is adequately supported.
2. Remove the 1/2"-13 screws to separate the upper and lower housings and remove the service spacer plate, if installed.
3. Remove the gearbox from the apparatus. Move the assembly to a clean work area and clamp into a suitable and stable holding device.
4. Place a temporary cover over the exposed pump assembly to prevent dirt and debris contamination.



5. Inspect bearings and internal parts for signs of excessive wear, pitting or damage. Repair and/or replace accordingly. For gearbox disassembly, see “J Series Gearbox Maintenance,” on page 157 and “Cleaning and Inspection Guidelines,” on page 106.



**Figure 7-4: Typical J Series Gearbox Removal**

### Installation - J Series

Review preceding sections “Before You Begin...,” on page 103.

1. Make sure the dowel pins are properly seated in the gearbox housing. If they are scored or damaged, install new dowel pins.



2. Install new gaskets onto the seating surface of the lower gearbox housing.
3. Reinstall the spacer plate, and install a new gasket.
4. Lift the gearbox into place aligning the dowel pins with the holes in the upper gearbox housing.
5. Apply Loctite #246 and insert the eight 1/2"-13 cap screws. Tighten the screws in a criss-cross fashion to ensure an even seal and torque screws to 65 ft.-lbs. (88 N-m).
6. Connect the drive shafts, cooling lines, air hoses, and electrical connections to the gearbox.
7. Fill gearbox with oil. See Section 4: Preventive Maintenance, heading "Replace Gearbox Oil" on page 80.

**Note:** Proper oil level is when oil fills 1/2 to 3/4 of the oil level sight gauge.

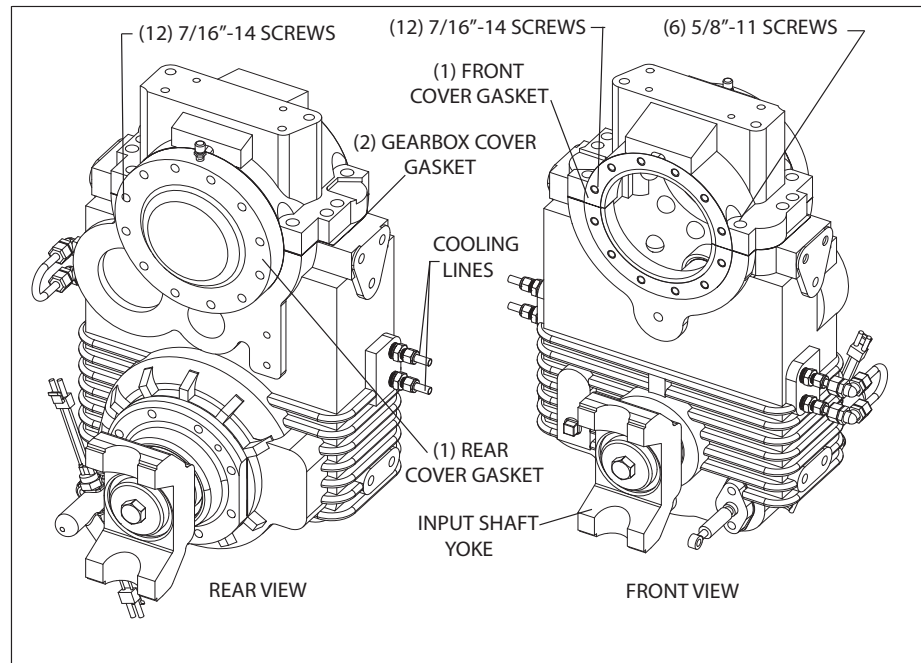
8. Test the pump for proper operation per your departmental requirements. Note and repair any leaks.
9. Recheck and top off oil levels before returning the apparatus to operation.

## **K Series Gearbox**

Review preceding sections "Before You Begin..." on page 103.

### **Removal - K Series**

1. Position a supporting device such as a jack under the gearbox.
2. Remove twelve (12) 7/16"-14 x 1-1/2" screws in the rear cover, then remove cover and gasket. (See Figure 7-5: "K Gearbox Removal," on page 115.) Remove the spacer plate if installed.
3. Remove six (6) 5/8"-11 x 2-1/4" screws on the cover of the gearbox. (See Figure 7-5: "K Gearbox Removal," on page 115.)
4. Remove 7/16"-14 x 1-1/4" screws securing the rear bearing housing to the lower gearbox housing and cover. Remove the gearbox cover.
5. Remove the gearbox from the apparatus. Move the assembly to a clean work area and clamp into a suitable and stable holding device.
6. Place a temporary cover over the exposed pump assembly to prevent dirt and debris contamination.
7. Inspect bearings and internal parts for signs of excessive wear, pitting or damage. Repair and/or replace accordingly. For "K" series gearbox disassembly, see heading "9.3 K Series Gearbox Maintenance," beginning on page 161.
8. Also see heading "Cleaning and Inspection Guidelines" on page 106.



**Figure 7-5: K Gearbox Removal**

### Installation - K Series

Review preceding sections “Before You Begin...,” on page 103.

1. Install a new gasket between the gearbox seating surface of the rear bearing housing.
2. Install a new gasket between the gearbox and gearbox cover. Check the fit and trim the gasket to match the contour of the gearbox, if necessary.
3. Lift the gearbox into place around the rear bearing housing. Apply Loctite #246 and insert two or three 7/16\"-14 screws through the rear bearing housing. Tighten screws hand tight.
4. Position the gearbox cover, apply Loctite #246 and insert six 5/8\"-11 screws. Tighten screws hand tight.
5. Apply Loctite #246 and insert the remaining 7/16\"-14 and 5/8\"-11 screws through the rear bearing housing and gearbox cover and gaskets. Tighten all screws in a criss-cross fashion to ensure an EVEN seal, then torque to:
  - 40 ft.-lbs. (54 Nm) for 7/16\"-14
  - 140 ft.-lbs. (190 Nm) for 5/8\"-11
6. Install the rear cover using its twelve (12) 7/16\"-14 screws.

7. Connect drive shafts, cooling lines, air hoses, and electrical connections to gear-box.
8. Fill gearbox with oil. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 80.
9. Test the pump for proper operation per your departmental requirements.
10. Recheck and top off oil levels before returning the apparatus to operation.

## 7.6 QMID/QMAX/QTWO AUTOLUBE® SERVICE

Review preceding sections “Before You Begin...,” on page 103.

1. Drain water from the pump.
2. Remove the fill and drain plugs from the AutoLube reservoir and drain oil. (See Figure 7-6: “AutoLube Assembly Overview,” on page 117.)
3. Have clean disposable shop rags and oil dry handy and a suitable container to collect the fluid - approximately one (1) quart (0.9 liters).
4. Use a center punch to mark the AutoLube front bearing housing cover and the front bearing cover housing for proper alignment during re-assembly.
5. Remove the 1/2”-13 UNC screws attaching the AutoLube to the pump body. At the “notches” in the front bearing housing, gently and evenly pry the AutoLube assembly from the pump body and impeller shaft.



**CAUTION!**

**THE AUTOLUBE IS MANUFACTURED FROM CAST METAL. DO NOT USE A CHISEL TO SEPARATE THE AUTOLUBE HOUSING FROM THE PUMP BODY.**

**THE MATING SURFACES COULD BE SCRATCHED OR GOUGED, WHICH COULD CAUSE A LEAK. ALWAYS PRY BETWEEN THE “NOTCHES” IN THE AUTOLUBE HOUSING AND THE PUMP BODY TO SEPARATE THE ASSEMBLY FROM THE PUMP HOUSING.**

6. Place the AutoLube face down on a work bench and remove the two 3/8”-16 UNC allen-head screws from the impeller side.
7. Remove the diaphragm.
8. Remove the oil seal retaining ring, then remove and discard the oil seal.
9. Check the impeller shaft front sleeve bearing for wear - replace accordingly.

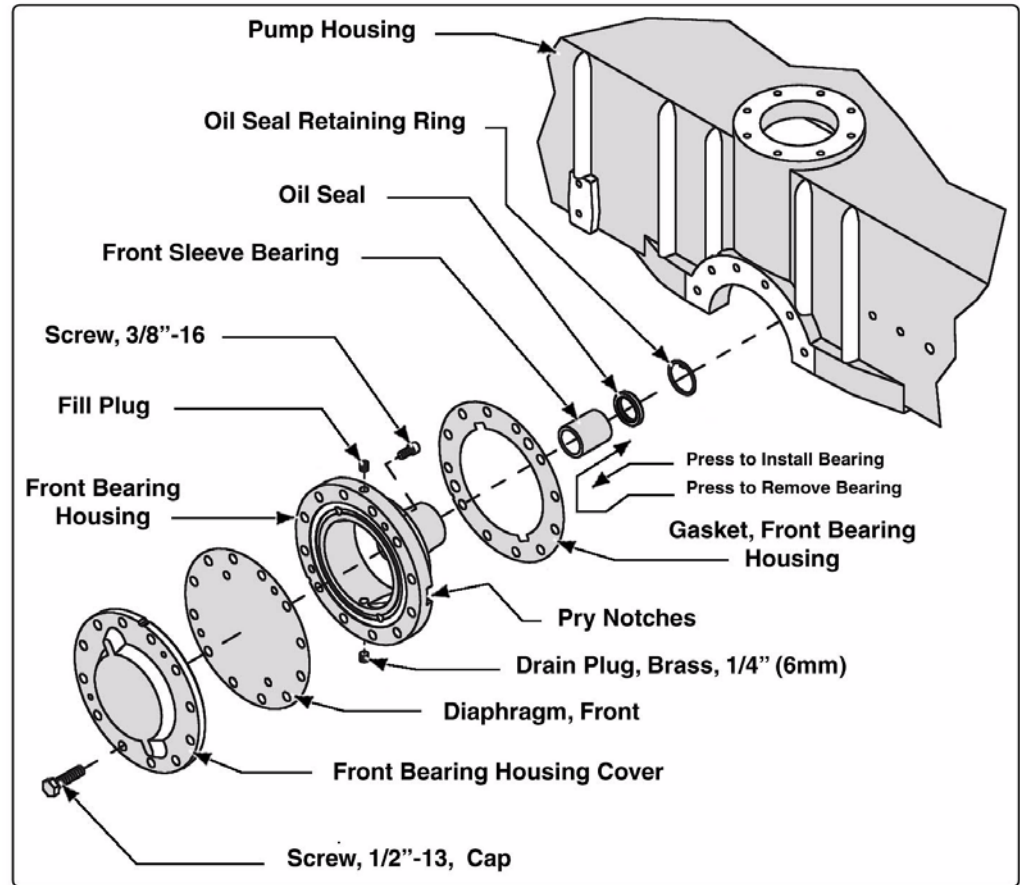


Figure 7-6: AutoLube Assembly Overview



### CAUTION!

**THE FRONT SLEEVE BEARING / BUSHING SEATS AGAINST A SHOULDER IN THE AUTOLUBE BEARING HOUSING AND CAN ONLY BE REMOVED AND INSTALLED AS DIRECTED OR SERIOUS DAMAGED COULD RESULT.**

10. To replace the front sleeve bearing, a press must be used. Also see Figure 7-6: "AutoLube Assembly Overview."
11. Clean the inner and outer halves of the AutoLube.
12. Check for restrictions in the water passages in the bearing housing, leading to the area between the front bearing cover and the front diaphragm. Clean as required.
13. Install a new oil seal, then install the seal retaining ring. (See Figure 7-6: "AutoLube Assembly Overview," on page 117.)
14. Align and install the diaphragm.

15. Line up the center-punch marks and install the housing cover. Apply Loctite #242 to the two (2) 3/8-16 UNC screws. Tighten and torque to 26 ft.-lbs. (35 N-m).
16. Install a new gasket onto the bearing housing.
17. Slide the AutoLube assembly onto the pump shaft. Apply Loctite #242 and secure the assembly with 1/2"-13 UNC screws. Tighten the screws in a criss-cross fashion ensuring an EVEN seal, then torque to 64 ft.-lbs (87 N-m).



**CAUTION!**

**DO NOT DAMAGE THE OIL SEAL. A DAMAGED OIL SEAL COULD RESULT IN DAMAGE TO THE AUTOLUBE ASSEMBLY, AS WELL AS THE PUMP.**

18. To eliminate air pockets and false readings, fill the AutoLube with 90W oil, if possible, by pumping new oil in from the bottom plug opening until the oil spills from the top plug opening.



**CAUTION!**

**PURGE THE AIR FROM THE AUTOLUBE WHILE FILLING WITH OIL OR A “FALSE-FILL” SITUATION COULD DEVELOP, WHICH COULD CAUSE DAMAGE TO THE AUTOLUBE AND OTHER INTERNAL COMPONENTS.**

19. Add water to the pump.
20. Operate the fire pump and check the AutoLube for water or oil leaks per your departmental requirements.
21. Recheck and top off oil levels before returning the apparatus to operation.

## **7.7 IMPELLER ASSEMBLY**

Review preceding section “Before You Begin...,” on page 103.

### **QMID/QMAX/QTWO Removing Impeller and Clearance Rings**

1. Drain the water from the pump, then remove the gearbox.
  - For G Series Gearbox, see heading “Removal - G Series” on page 111
  - For K Series Gearbox, see heading “Removal - K Series” on page 114
2. Remove the drain lines from the lower pump body.

**WARNING!**

**THE LOWER PUMP BODY WEIGHS APPROXIMATELY 100 LBS (46 KGS). (SEE FIGURE 7-7: "QMAX / QTWO ASSEMBLY OVERVIEW," ON PAGE 120.) SUPPORT THE LOWER PUMP BODY AND IMPELLER ASSEMBLY WITH THE PROPER LIFTING DEVICE. FAILURE TO DO SO COULD RESULT IN THE LOWER PUMP BODY AND IMPELLER ASSEMBLY FALLING, WHICH COULD RESULT IN SERIOUS PERSONAL INJURY, OR PROPERTY DAMAGE.**

3. Match mark the lower pump body, Autolube housing, and rear bearing housing for easy and accurate reassembly. (See Figure 7-6: "AutoLube Assembly Overview," on page 117.)
4. Drain the oil from the AutoLube - see heading "QMID/QMAX/QTWO AutoLube® Service" on page 116
5. Remove the:
  - ☐ 1/2"-13 UNC x 2" screws from the "top half" of the AutoLube bearing housing and the pump body. (See Figure 7-7: "Qmax / Qtwo Assembly Overview," on page 120.)
  - ☐ 1/2"-13 UNC x 1-3/4" screws from the upper half of the rear bearing housing and pump body.
  - ☐ 1/2"-13 UNC x 1-1/4" screws, from the lower pump body.

**WARNING!**

**DO NOT REMOVE THE FOUR CAP SCREWS, ONE IN EACH CORNER OF THE LOWER PUMP BODY, UNTIL THE LIFTING DEVICE IS IN POSITION. FAILURE TO DO SO COULD RESULT IN THE LOWER PUMP BODY AND IMPELLER ASSEMBLY FALLING, WHICH COULD RESULT IN SERIOUS PERSONNEL INJURY OR PROPERTY DAMAGE.**

6. Position the lifting device to support the lower pump body, then remove the 5/8"-11 UNC x 5" screws in each of the four corners of the lower pump body. (See Figure 7-7: "Qmax / Qtwo Assembly Overview," on page 120.)
7. Lower the lower pump body and impeller assembly being careful that it does not tip from the lifting device.

Move the assembly to a clean work area and clamp into a suitable and stable holding device.
8. Remove the remaining screws from the lower half of the AutoLube, the rear bearing housing, and the lower pump body.
9. Lift the impeller assembly from the lower pump housing and set aside.



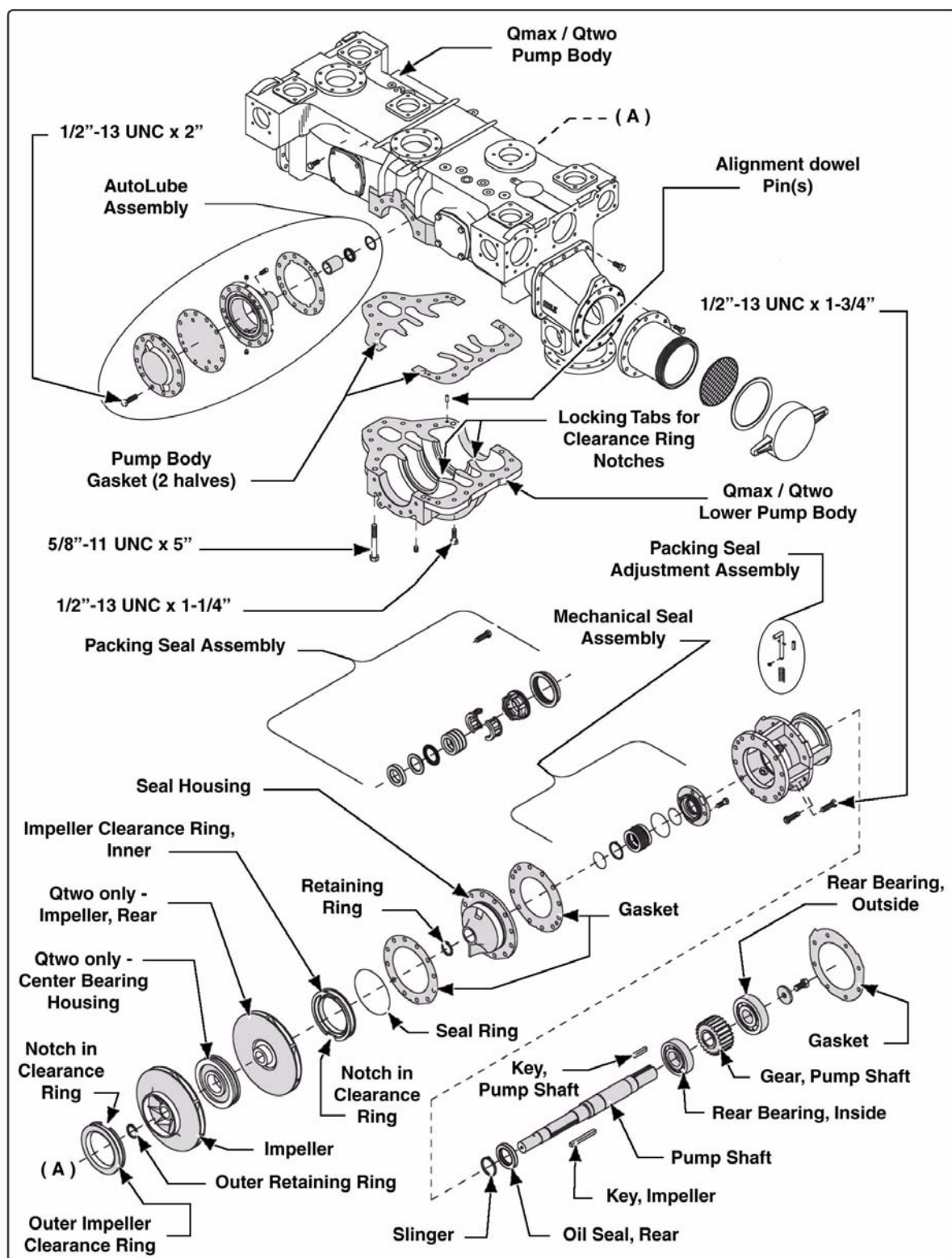


Figure 7-7: Qmax / Qtwo Assembly Overview



**WARNING!**

**THE IMPELLER ASSEMBLY IS HEAVY. DO NOT ATTEMPT TO LIFT THE ASSEMBLY WITHOUT THE AID OF PROPER LIFTING APPARATUS CAPABLE OF HANDLING THE LOAD. FAILURE TO DO SO COULD RESULT IN PERSONNEL INJURY OR PROPERTY DAMAGE.**

10. See heading “Cleaning and Inspection Guidelines” on page 106.
  - ☐ Clean the gasket sealing surfaces of the upper and lower pump bodies, as well as those on the AutoLube and the rear bearing housing face. Whenever gaskets are removed, they must be replaced.
  - ☐ Clean the clearance ring and clearance ring seats in both the upper and lower pump body halves to so that the new clearance rings seat properly.

**Note:** Pitting of the clearance rings may occur from the build-up of material and the effects of corrosion. Once the seats are cleaned, any pitting on the clearance rings is considered normal.

### **Disassembly - QMAX/QMID Single-Stage Pump**

1. Place the impeller shaft assembly on a suitable workbench, capable of handling the load.
2. Carefully remove the AutoLube assembly from pump shaft end. Also see heading “QMID/QMAX/QTWO AutoLube ® Service” on page 116.
3. Remove the outer retaining ring and clearance ring. (See Figure 7-7: “Qmax / Qtwo Assembly Overview,” on page 120.)

Before removing the impeller, note the orientation of the vanes for proper reassembly. The vanes turn in a clockwise manner when viewed from the front.

4. Using an acetylene torch, carefully heat the “eye” and hub of the impeller **EVENLY** for approximately two minutes.

When heated properly, the impeller is removed from the pump shaft using a gear puller. If the impeller moves but does not slide freely, do not immediately reheat. Allow the assembly to cool to room temperature, then reheat again and continue removing the impeller.



**WARNING!**

WEAR PROTECTIVE, HEAT-RESISTANT GLOVES WHILE HEATING THE IMPELLER TO REMOVE OR INSTALL IT ONTO THE IMPELLER SHAFT. HEATED METAL CAN CAUSE SERIOUS INJURY TO YOUR HANDS.

DO NOT OVER HEAT THE IMPELLER. THE IMPELLER IS CONSTRUCTED OF BRONZE. IF THE IMPELLER IS OVERHEATED (AND TURNS RED OR BLUE DURING REMOVAL FROM THE SHAFT), IT HAS BEEN WEAKENED AND MUST BE REPLACED.

ALLOW ALL COMPONENTS TO COOL TO ROOM TEMPERATURE BEFORE CONTINUING.

5. Remove the inner clearance ring, then remove the impeller key.

### Assembly - QMAX/QMID Single-Stage Pump

Also see Figure 7-7: “Qmax / Qtwo Assembly Overview” on page 120.



1. Clean the impeller shaft and the keyway. Also see heading “Cleaning and Inspection Guidelines” on page 106. See **WARNING!** note on page 122.
2. Check the water way in the seal housing for restrictions - clean as needed.
3. Install the inner retaining ring.
4. Install a new gasket on the seal housing face. (See Figure 7-7: “Qmax / Qtwo Assembly Overview,” on page 120.)
5. Verify the key is free to slide in the impeller keyway, then install the key.



**CAUTION!**

IF THE IMPELLER OR CLEARANCE RINGS ARE DROPPED, DAMAGED OR DEFORMED, THEY MUST BE REPLACED.

6. Install the inner clearance ring over the impeller shaft checking for proper orientation.
7. Using the torch, heat the “eye” and hub of the new impeller in an EVEN fashion for approximately two minutes. Then, slide the impeller onto the shaft making sure the vanes are in the proper orientation.

**Note:** The vanes turn in the clockwise direction when viewed from the front of the impeller assembly. If the impeller does not fully slide onto the shaft allow the assembly to cool to room temperature before re-heating.

8. Install the outer retaining ring and the outer clearance ring ensuring proper orientation.
9. Slide the AutoLube assembly over pump shaft. Also see heading “QMID/QMAX/QTWO AutoLube ® Service” on page 116.
10. Install the impeller shaft assembly to the pump.

## Disassembly - QTWO Two-Stage Pump

Also see Figure 7-7: “Qmax / Qtwo Assembly Overview” on page 120.

1. Place the impeller shaft assembly on a suitable workbench, capable of handling the load.
2. Remove the AutoLube assembly from pump shaft end. Also see heading “QMID/QMAX/QTWO AutoLube ® Service” on page 116.



### IMPORTANT!

**MARK THE PRIMARY OR SECONDARY IMPELLERS IN RELATION TO THE AUTOLUBE. IMPROPER OR BACKWARD INSTALLATION OF THE IMPELLERS AFFECTS PUMP PERFORMANCE.**

3. Remove impeller retaining rings.
4. With an acetylene torch **EVENLY** heat the “eye” and hub of the first impeller for approximately two minutes.
5. When heated properly the impeller is removed from the pump shaft using a gear puller. If the impeller moves but does not slide freely, do not immediately reheat. Allow the complete assembly to cool to room temperature, then reheat again and continue removing the impeller.
6. Allow the components to cool to room temperature before continuing.
7. Remove the center support bearing. Then rotate the impeller shaft assembly end for end and heat and remove the second impeller.
8. Remove the impeller key.

## Assembly - QTWO Two-Stage Pump

Also see Figure 7-7: “Qmax / Qtwo Assembly Overview” on page 120.



1. Clean the impeller shaft, the keyway, and the seal housing and face. Also see heading “Cleaning and Inspection Guidelines” on page 106. See **WARNING!** note on page 122.
2. Check the waterway in the seal housing for restrictions - clean as needed.
3. Install a new gasket on the seal housing face.
4. Install the key into the keyway.



### CAUTION!

**IF THE IMPELLER OR CLEARANCE RINGS ARE DROPPED, DAMAGED OR WARPED, THEY MUST BE REPLACED.**

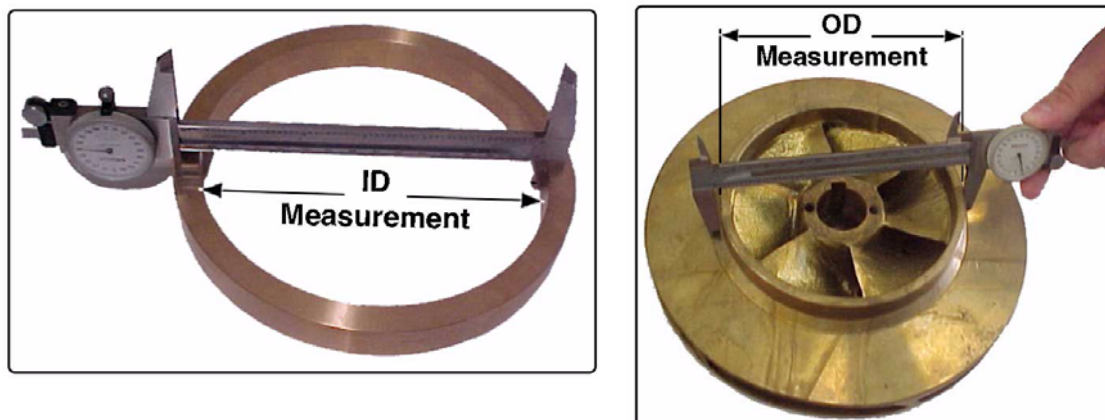
5. Install the inner clearance ring over the impeller shaft checking for proper orientation.
6. With an acetylene torch **EVENLY** heat the “eye” and hub of each impeller for approximately two minutes.
7. Slide the individual impellers onto the shaft making sure they are in the correct orientation. Make sure the center support bearing is installed between impellers.

**Note:** The vanes turn in a clockwise direction when viewed from the front of the impeller assembly. If the impeller does not fully slide onto the shaft allow the assembly to cool to room temperature before re-heating and continue installing the impeller.

8. Allow the components to cool to room temperature before continuing.
9. Install the outer retaining ring and the outer clearance ring ensuring proper orientation.
10. Slide the AutoLube assembly over pump shaft. Also see heading “QMID/QMAX/QTWO AutoLube ® Service” on page 116.
11. Install the impeller shaft assembly to the pump.

## Inspection – Clearance Rings

(See Figure 7-8: “Clearance Ring and Impeller ID / OD Measurement.”)



**Figure 7-8: Clearance Ring and Impeller ID / OD Measurement**

Inspect the front and back of both clearance ring IDs and ODs in several places for signs of wear. Using a caliper, measure the inside diameter of each ring in several places.

When new, the radial clearance between the impeller hub and the clearance rings is between 0.005" to 0.007" (0.127-0.177mm) per side. Maximum acceptable radial clearance on used pumps is between 0.015" to 0.020" (0.381-0.508mm) per side.

If the gap between the impeller and the clearance ring is greater than 0.020" (0.508 mm) you must measure the impeller hub diameter. (See Figure 7-8: "Clearance Ring and Impeller ID / OD Measurement.") If the impeller diameter is greater than 8.480" (215 mm), the clearance ring must be replaced.

If the impeller diameter is less than 8.480" (215 mm) but more than 8.437"

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



**CAUTION!**

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

If the impeller diameter is less than 8.437" (214 mm) and you are not meeting pump performance, you may need to replace both the clearance rings and the impeller.

## Installing the Impeller and Clearance Rings

Also see Figure 7-7: “Qmax / Qtwo Assembly Overview” on page 120.

1. Install the pump body gaskets to the lower pump body, trimming as necessary.
2. Install the impeller assembly into the lower pump housing, carefully aligning the clearance ring lock notches with the clearance ring lock tabs in the lower pump body.

Rotate the clearance rings to one side to align the lock notches with the lock tabs in the upper pump body.



### CAUTION!

**FAILURE TO LINE UP THE CLEARANCE RING LOCK NOTCHES WITH THE PUMP BODY TABS MAY RESULT IN PUMP DAMAGE AND PUMP FAILURE.**

3. Install the 1/2”-13 UNC x 1-3/4” screws through the rear bearing housing and the seal housing. Do not tighten at this time.
4. Install the 1/2”-13 UNC x 2” screws into the AutoLube housing and lower pump body.
5. Make sure the dowel pins are in the upper pump body to assist with alignment to the lower pump body.
6. Using proper lifting device, slowly raise the lower pump body and the impeller assembly into place. Align the lower pump body aligns with the dowel pins and the clearance ring notches with the clearance ring lock tabs in upper pump body. (See Figure 7-7: “Qmax / Qtwo Assembly Overview,” on page 120.)
7. Rotate the impeller shaft and check for free movement when the lower pump body and the impeller assembly is in place.
8. Apply Loctite and install the four 5/8”-11 UNC x 5” screws (one in each corner of the lower pump body). Tighten snugly but do not fully torque.
9. Apply Loctite and install the remaining 1/2”-13 UNC x 1-3/4” screws in the rear bearing housing and mechanical seal housing, and the 1/2”-13 UNC x 2” screws into the AutoLube. Tighten to 53 ft.-lbs. (72 N-m).
10. Remove the lifting device.
11. Torque the 5/8”-11 UNC x 5” screws to 150 ft.-lbs. (203 N-m), then, starting from the center and moving outward, tighten and torque the lower pump body screws to 65 ft.-lbs. (88 N-m).
12. Install the gearbox.

□ For G Series Gearbox, see heading “Installation - G Series” on page 112



- ☐ For K Series Gearbox, see heading “Installation - K Series” on page 115
  - ☐ Also see **WARNINGS!** note on page 104.
13. Test the pump for proper operation per your departmental requirements. Note and repair any leaks. Recheck and top off oil levels before returning the apparatus to operation.



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## ☐ Repair and Corrective Maintenance

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## 8 Packing and Mechanical Seal Maintenance

### 8.1 PACKING SEAL REPLACEMENT

When the packing adjustment has reached its limit, a single ring of packing can be added. However, it is usually more efficient to repack the pump. (See Figure 8-1: "Pump Packing Seal Overview.") Also see Figure 8-2: "Packing / Mechanical Seal Assembly Overview" on page 132.

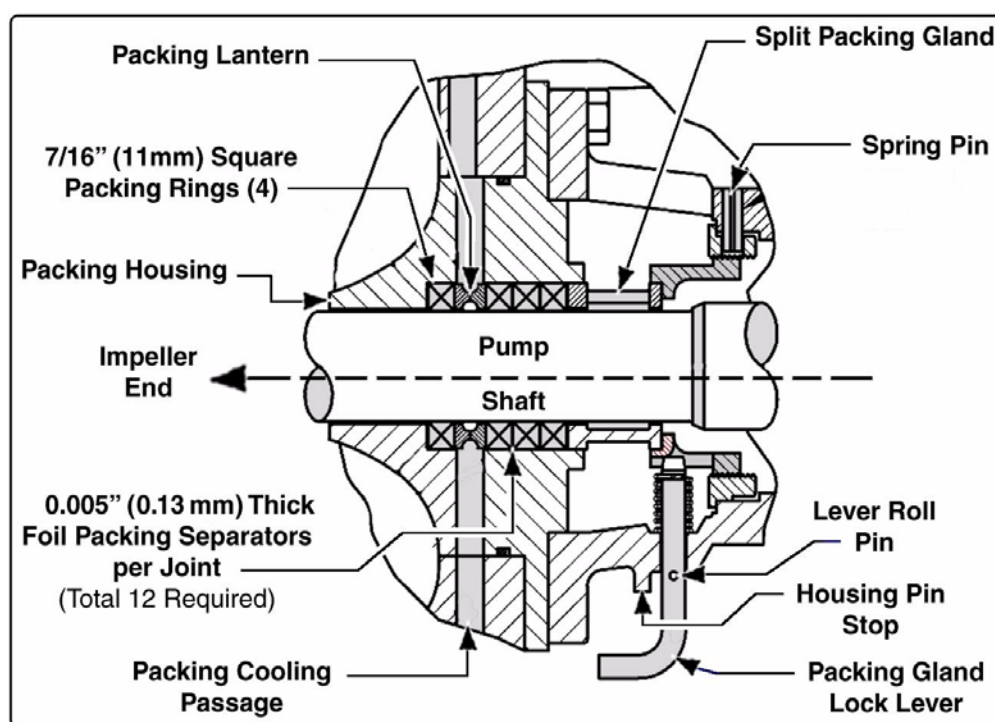


Figure 8-1: Pump Packing Seal Overview

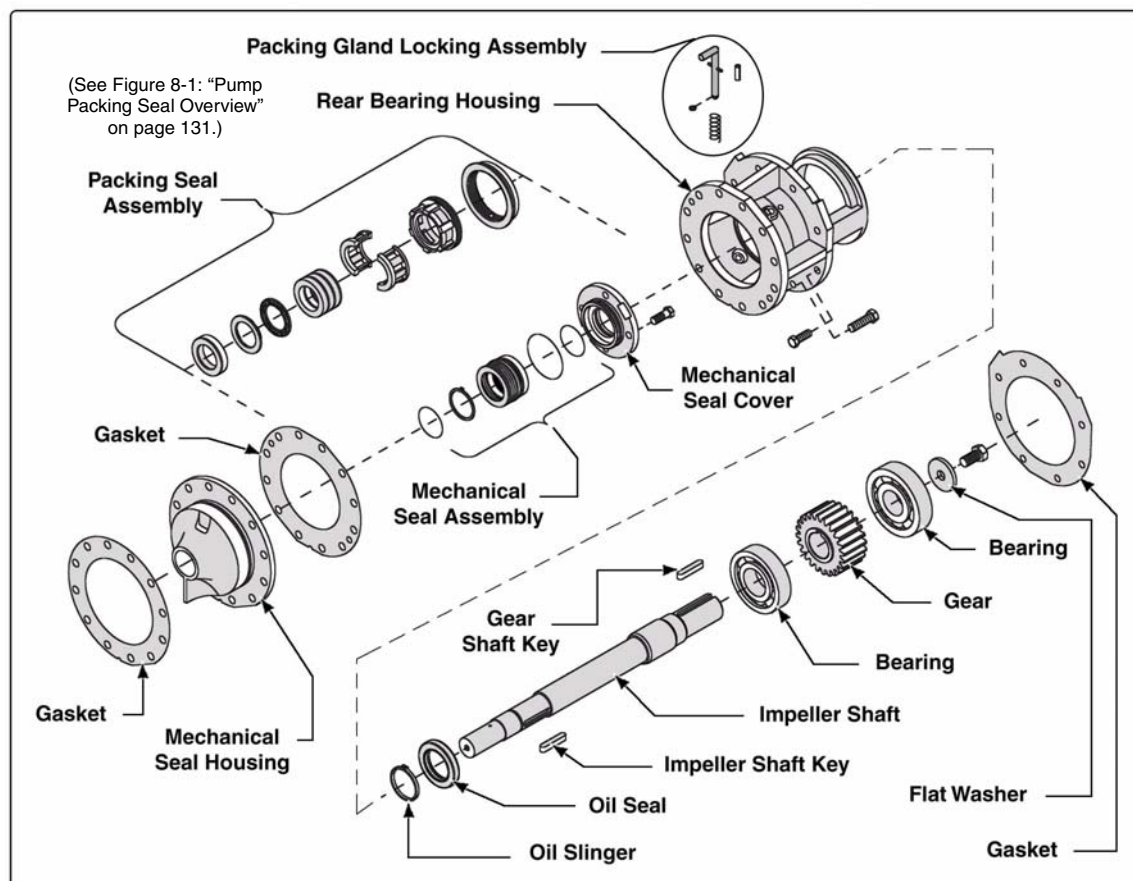
Review preceding sections "Before You Begin..." on page 103 and "Cleaning and Inspection Guidelines," on page 106.

The three rings adjacent to the packing gland can be replaced without disassembling the pump. The ring in front of the lantern does not need to be replaced. (See Figure 8-1: "Pump Packing Seal Overview.")



**WARNING!**

**DO NOT RUN THE ENGINE WHILE PERFORMING ANY SERVICING TO THE PACKING, I.E., PACKING SEAL ADJUSTMENT OR REPLACEMENT.**



**Figure 8-2: Packing / Mechanical Seal Assembly Overview**

1. Loosen the slotted packing nut. (See Figure 8-1: “Pump Packing Seal Overview” on page 131.)
2. Release the packing gland locking lever and set the lever roll pin on the housing pin stop.
3. Loosen the split packing nut just enough to remove the split glands. If necessary, soak the threads with penetrating oil and work the nut back and fourth to loosen. If the front part of the gland is the split type, remove both halves.
4. Remove the old packing rings with a packing hook. The hook can be made from a bent piece of stiff wire or small pointed rod. Another type of packing hook consists of a corkscrew on the end of a flexible shaft.
5. Be sure to remove all shreds of old packing, and clean out the packing housing as best as possible.

**Note:** Forced air can also be used to remove the packing. Use appropriate safety measures if forced air is being used.

6. Remove all old packing, dirt and foreign matter from the bearing housing, especially under the packing gland.

7. Repack using the Hale packing kit recommended for your particular pump. For most pumps, the packing is 7/16" (11 mm) square cut to the proper length.
8. Wrap one length of packing around the shaft to form a ring, and push the ring into the packing housing. Install the second ring the same way, but stagger the joint one-third of the way around from the first joint. (See 8.1 "Packing Seal Replacement" on page 131.)
9. Insert foil separators between each packing ring. The foil separators must be cut to fit the shaft.
10. Install the other rings, again staggering the joints.
11. Replace the gland and adjust accordingly. See Section 4: Preventive Maintenance, heading "Packing Gland Adjustment" on page 77.
12. Operate the pump normally for about 15 minutes, and check the packing gland. If necessary, re-adjust the packing nut accordingly.

## **8.2 MECHANICAL SEAL REPLACEMENT**

**Note:** Before starting disassembly, use a center punch to match-mark the rear bearing housing, mechanical seal housing, and pump body. This assists with proper alignment during reassembly. If the mechanical seal requires replacement, order Hale Mechanical Seal Replacement Parts Kit, p/n: 296-5210-50-0.



**CAUTION!**

**MECHANICAL SEALS ARE PRECISION-ENGINEERED DEVICES. EXTREME CARE MUST BE TAKEN TO ENSURE THAT NO DAMAGE OCCURS TO ALL MATING FACES. ENSURE THAT THE FACES ARE ABSOLUTELY CLEAN THROUGHOUT THE ENTIRE INSTALLATION. SOLID FACES MUST BE CLEANED WITH AN APPROPRIATE DEGREASER AND A SOFT CLOTH.**

### **Qmax and Qtwo Pumps with G Series Gearbox**

Review preceding sections "Before You Begin..." on page 103 and "Cleaning and Inspection Guidelines," on page 106.

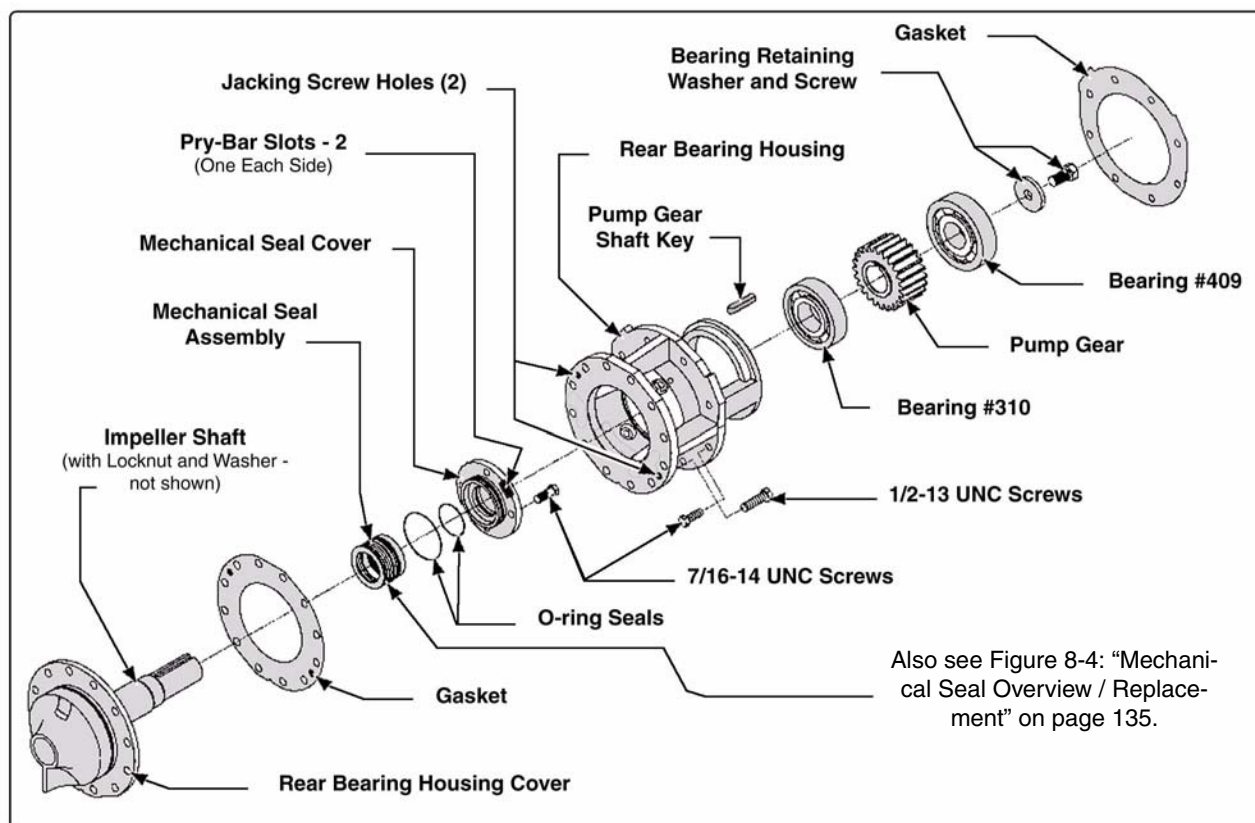


Figure 8-3: Qmax, Qmid, and Qtwo Mechanical Seal Assembly Overview

### Removing the Seal

(See Figure 8-3: “Qmax, Qmid, and Qtwo Mechanical Seal Assembly Overview.”) Also see Figure 8-4: “Mechanical Seal Overview / Replacement” on page 135.

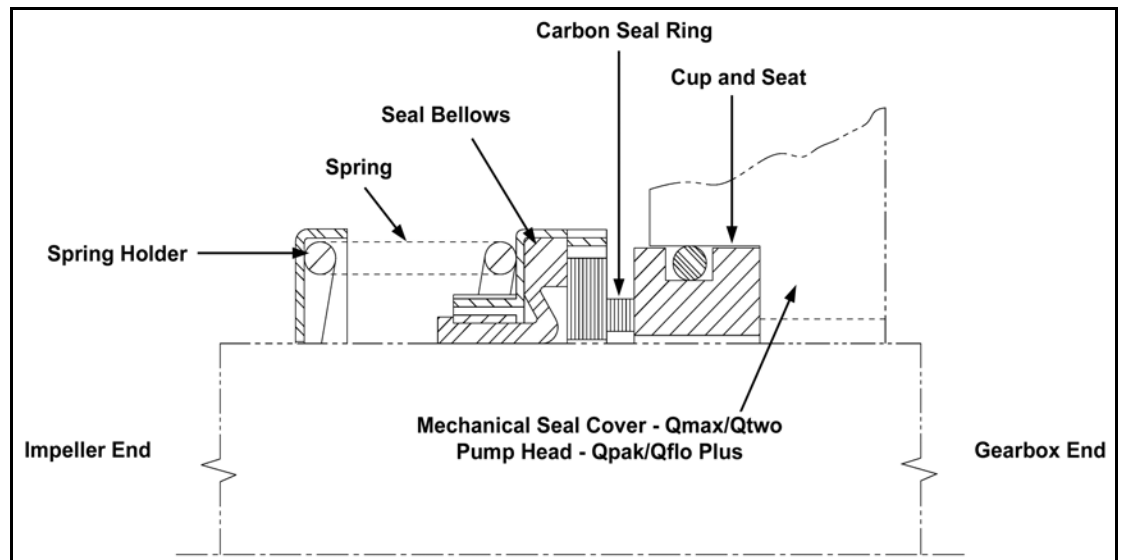


### IMPORTANT!

**IF WATER LEAKAGE FROM THE DRAIN HOLE IN THE PUMP HEAD IS NOTICED, THE MECHANICAL SEAL MUST BE INSPECTED.**

1. Remove the gearbox - see heading “G Series Gearbox” on page 110.
2. Remove the 5/8”-11 screw and bearing retainer washer from the end of the impeller shaft.
3. Remove twelve 1/2”-13 screws securing the rear bearing housing to the pump body.





**Figure 8-4: Mechanical Seal Overview / Replacement**

4. Install two 1/2"-13 x 2-1/2" cap screws into the 1/2"-13 UNC threaded holes on the rear bearing housing to use as jacking screws.
5. Install a 1/2"-13 x 2-1/2" screw into one of the holes on the rear bearing housing into the pump body to keep the mechanical seal housing from rotating while removing the rear bearing housing.

**Note:** It may be necessary to use pry bars to loosen the back bearing and gear before attempting to remove the rear bearing housing.

6. Evenly turn the jacking screws clockwise to separate the rear bearing housing away from the pump body.
7. Remove the gear and gear key from the impeller shaft.



### IMPORTANT!

**DO NOT ALLOW THE WEIGHT OF THE REAR BEARING HOUSING TO REST ON THE OIL SEAL AS DAMAGE MAY RESULT RENDERING THE SEAL INOPERATIVE.**

8. Remove the rear bearing housing being careful not to damage the oil seal.
9. Remove the slinger from the impeller shaft.
10. Match-mark the mechanical seal cover and mechanical seal housing. Remove four 7/16"-14 screws securing the mechanical seal cover.

11. If necessary, use pry bars in the slots provided to loosen the mechanical seal cover from the mechanical seal housing. (See Figure 8-3: “Qmax, Qmid, and Qtwo Mechanical Seal Assembly Overview” on page 134.)
12. Remove the old mechanical seal from the housing and impeller shaft. Two small hooks aid in the removal. (See Figure 8-4: “Mechanical Seal Overview / Replacement” on page 135.)

**Note:** Removing the mechanical seal renders it inoperative; it must be replaced.

13. Inspect bearings and other internal parts for excessive wear, pitting or damage. Repair and/or replace accordingly.

### Installing the Seal



1. See **CAUTION!** warning on page 133.
2. Clean the bore of the pump head using alcohol swabs supplied with the Hale repair kit (p/n: 296-5210-50-0). Also clean solid running faces with alcohol wipes.
3. Ensure that the pump body, mechanical seal housing, impeller bores and all mating surfaces of the mechanical seal assembly are absolutely clean throughout the entire installation process.
4. Make sure the impeller shaft is smooth and free of burrs at the gear key slot and bearing journals.
5. Clean the pump shaft with alcohol swabs.
6. Apply a generous coating of Pac-Ease Rubber Lubricant Emulsion (or equivalent) to the mechanical seal bellows, the pump shaft and seal.



### **WARNING!**

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

**USE ONLY PAC-EASE RUBBER LUBRICANT EMULSION (OR EQUAL) ON THE RUBBER MECHANICAL SEAL TO EASE INSTALLATION. USING AN OTHER LUBRICANT CAN DAMAGE THE SEAL AND SEAT. MAKE SURE ALL SHAFT SURFACES AND THE INSIDE OF THE SEALING BOOT ARE WELL LUBRICATED.**

7. Without touching the carbon seal, slide the new mechanical seal bellows end over the impeller shaft making sure the spring is oriented towards the impeller. (See Figure 8-4: “Mechanical Seal Overview / Replacement” on page 135.)
8. Using a soft pusher tube (2” / 51 mm PVC pipe) and keeping fingers away from carbon seal ring, push the mechanical seal assembly into the mechanical seal housing. If binding occurs apply more lubricant to the impeller shaft and bellows. Verify the stationary seat is firmly seated in the housing.

9. Without touching the face of the seat, install the cup and seat into the mechanical seal cover. Lubricate the cup and mechanical seal cover with Pac-Ease Rubber Lubricant Emulsion. Also apply a generous coating of the lubricant to the seal diaphragm.
10. Replace the seal rings in the mechanical seal cover. Apply a light coat of grease to the rings being careful not to get grease on the impeller shaft.
11. Slide the mechanical seal cover over the impeller shaft making sure the seal remains seated in the bore of the cover. Make sure there is no oil or grease on the faces of the mechanical seal. (See Figure 8-3: "Qmax, Qmid, and Qtwo Mechanical Seal Assembly Overview" on page 134.)
12. If binding occurs, apply additional PAC-EASE lubricant.
13. Screw a 7/16"-14 UNC stud into one of the holes in the mechanical seal housing to aid in bolt hole alignment.
14. Insert the mechanical seal cover in the mechanical seal housing making sure to line up your center punch marks.
15. Apply Loctite and install four 7/16-14" screws. Tighten the screws evenly in a staggering (or criss-cross) fashion. Torque screws to 40 ft.-lbs. (54 N-m).  
**Note:** If the screws are being replaced, they must be replaced with Grade 5, zinc plated steel, nylon locking type screws.
16. Slide the slinger onto the impeller shaft.
17. Install new oil seal.
18. Place a new gasket over the mating surface of the mechanical seal housing and rear bearing housing.
19. Install two 1/2"-13 UNC studs into the mechanical seal housing. Slide the rear bearing housing over the impeller shaft making sure the oil seal aligns properly. Align the bolt holes and your center punch marks.

**IMPORTANT!**

**DO NOT ALLOW THE WEIGHT OF THE REAR BEARING HOUSING TO REST ON THE OIL SEAL AS DAMAGE MAY RESULT RENDERING THE SEAL INOPERATIVE.**

20. Apply Loctite and insert twelve 1/2"-13 screws to secure the rear bearing housing to the seal housing. Evenly tighten the screws in a staggering (or criss-cross) fashion and torque to 65 ft.-lbs. (88 N-m). (See Figure 8-3: "Qmax, Qmid, and Qtwo Mechanical Seal Assembly Overview" on page 134.)
21. Install the 250-0310-00-0 (310S) bearing onto the impeller shaft and properly seat into the bearing housing.
22. Insert the gear key into the slot on the impeller shaft, then install the gear.

23. Install #409 bearing and properly seat in the bearing housing.
24. Install the bearing retainer washer on impeller shaft end and secure using 5/8-11 (16 mm) screw. Tighten the screw and torque to 135 ft.-lbs. (183 N-m).
25. Re-install the gearbox - see heading "Installation - G Series" on page 112.
26. Operate the pump for about 15 minutes, and check the seal for leakage.

## **Qmax and Qtwo Pumps with K Series Gearbox**

Review preceding sections "Before You Begin..." on page 103 and "Cleaning and Inspection Guidelines," on page 106.

### **Removing the Seal**

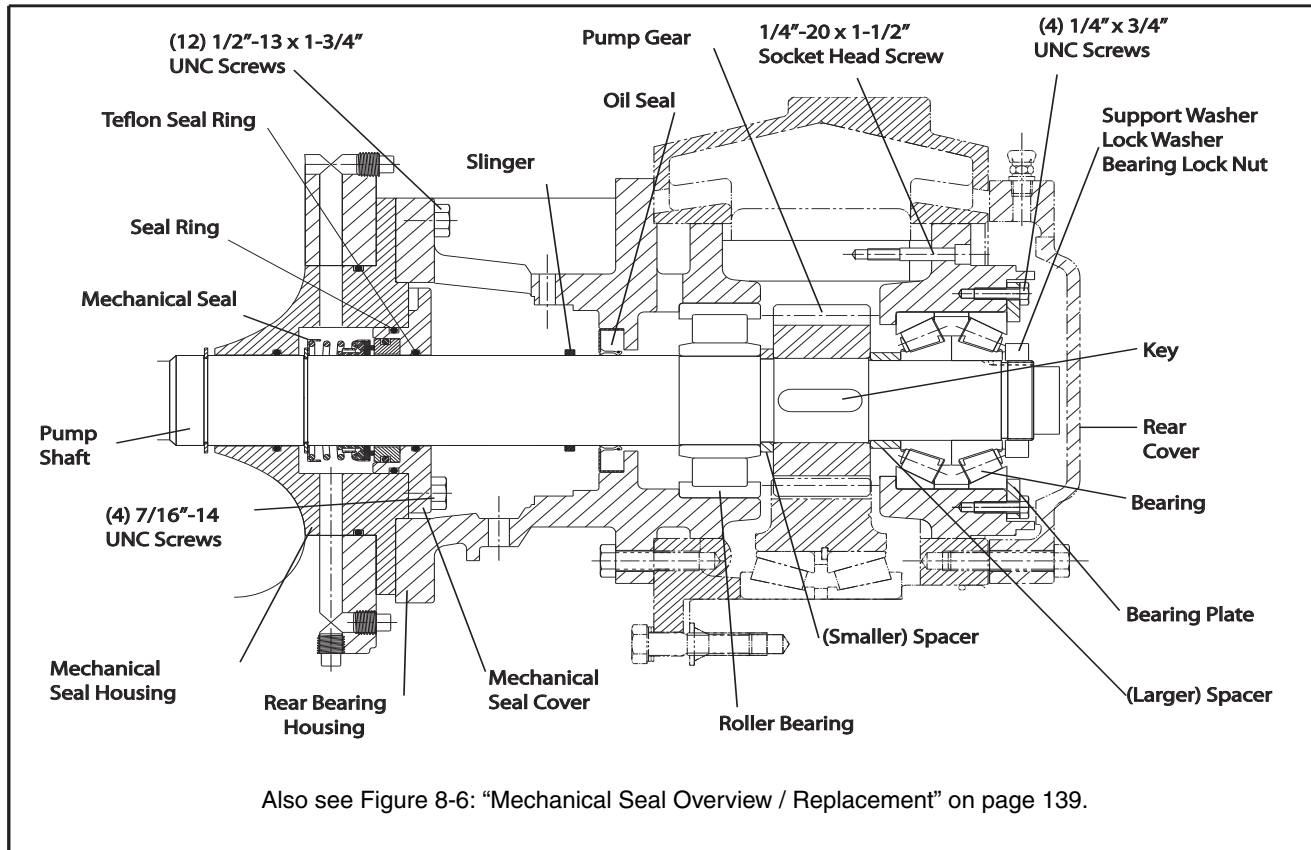
(See Figure 8-5: "QmaxK and QtwoK Mechanical Seal Assembly Overview.") Also see Figure 8-6: "Mechanical Seal Overview / Replacement" on page 139.



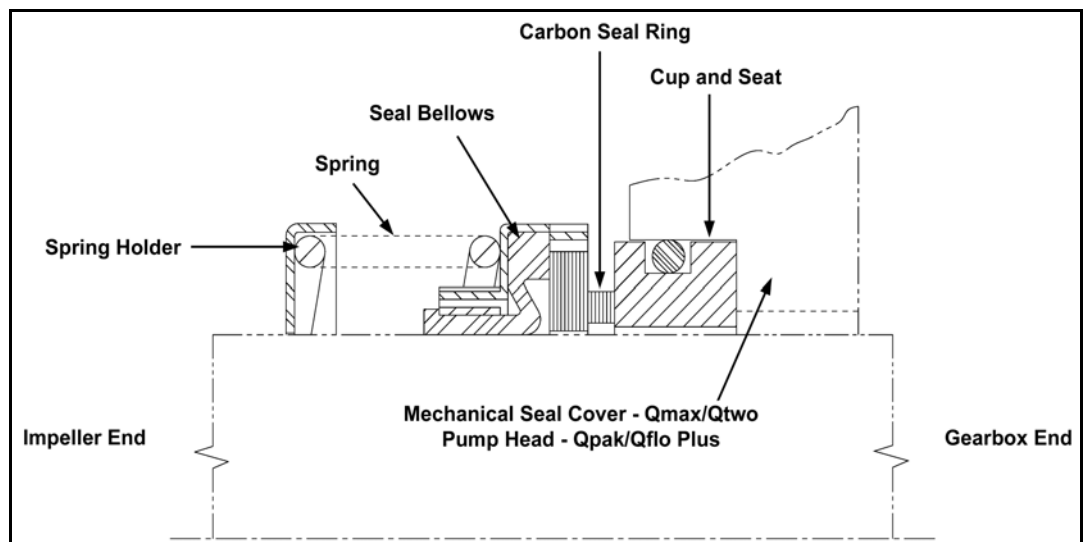
### **IMPORTANT!**

**IF WATER LEAKAGE FROM THE DRAIN HOLE IN THE PUMP HEAD IS NOTICED, THE MECHANICAL SEAL MUST BE INSPECTED.**

1. Remove the gearbox - see heading "K Series Gearbox" on page 114.
2. Remove bearing lock nut, lock washer, and support washer from impeller shaft. (See Figure 8-5: "QmaxK and QtwoK Mechanical Seal Assembly Overview" on page 139.)
3. Remove 1/4"-20 x 1-1/2" socket head screw on thick leg of rear bearing housing.
4. Remove the smaller portion of the rear bearing housing (facing gearbox). It may be necessary to remove the four 1/4" x 3/4" screws, bearing plate and bearing before removing the smaller portion of the rear bearing housing.
5. Remove the larger spacer.
6. Remove gear and gear key.
7. Remove the smaller spacer.
8. Remove twelve 1/2"-13 screws securing the rear bearing housing to the pump body.
9. Install two 1/2"-13 x 2-1/2" cap screws into the 1/2"-13 UNC threaded holes on the rear bearing housing to use as jacking screws.



**Figure 8-5: QmaxK and QtwoK Mechanical Seal Assembly Overview**



**Figure 8-6: Mechanical Seal Overview / Replacement**

10. Install a 1/2"-13 x 2-1/2" screw into one of the holes on the rear bearing housing into the pump body to keep the mechanical seal housing from rotating while removing the rear bearing housing.

**Note:** It may be necessary to use pry bars to loosen the roller bearing before attempting to remove the rear bearing housing.

11. Evenly turn the jacking screws clockwise to separate the rear bearing housing away from the pump body.



### **IMPORTANT!**

**DO NOT ALLOW THE WEIGHT OF THE REAR BEARING HOUSING TO REST ON THE OIL SEAL AS DAMAGE MAY RESULT RENDERING THE SEAL INOPERATIVE.**

12. Remove the rear bearing housing being careful not to damage the oil seal.
13. Remove the slinger from the impeller shaft.
14. Match-mark the mechanical seal cover and mechanical seal housing. Remove four 7/16"-14 screws securing the mechanical seal cover.
15. If necessary, use pry bars in the slots provided to loosen the mechanical seal cover from the mechanical seal housing. (See Figure 8-3: "Qmax, Qmid, and Qtwo Mechanical Seal Assembly Overview" on page 134.)
16. Remove the old mechanical seal from the housing and impeller shaft. Two small hooks aid in the removal. (See Figure 8-6: "Mechanical Seal Overview / Replacement" on page 139.)

**Note:** Removing the mechanical seal renders it inoperative; it must be replaced.

17. Inspect bearings and other internal parts for excessive wear, pitting or damage. Repair and/or replace accordingly.

### **Installing the Seal**



1. See **CAUTION!** warning on page 133.
2. Clean the bore of the pump head using alcohol swabs supplied with the Hale repair kit (p/n: 296-5210-50-0). Also clean solid running faces with alcohol wipes.
3. Ensure that the pump body, mechanical seal housing, impeller bores and all mating surfaces of the mechanical seal assembly are absolutely clean throughout the entire installation process.
4. Make sure the impeller shaft is smooth and free of burrs at the gear key slot and bearing journals.
5. Clean the pump shaft with alcohol swabs.

6. Apply a generous coating of Pac-Ease Rubber Lubricant Emulsion (or equivalent) to the mechanical seal bellows, the pump shaft and seal.

**WARNING!**

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

**USE ONLY PAC-EASE RUBBER LUBRICANT EMULSION (OR EQUAL) ON THE RUBBER MECHANICAL SEAL TO EASE INSTALLATION. USING AN OTHER LUBRICANT CAN DAMAGE THE SEAL AND SEAT. MAKE SURE ALL SHAFT SURFACES AND THE INSIDE OF THE SEALING BOOT ARE WELL LUBRICATED.**

7. Without touching the carbon seal, slide the new mechanical seal bellows end over the impeller shaft making sure the spring is oriented towards the impeller. (See Figure 8-4: "Mechanical Seal Overview / Replacement" on page 135.)
8. Using a soft pusher tube (2" / 51 mm PVC pipe) and keeping fingers away from carbon seal ring, push the mechanical seal assembly into the mechanical seal housing. If binding occurs apply more lubricant to the impeller shaft and bellows. Verify the stationary seat is firmly seated in the housing.
9. Without touching the face of the seat, install the cup and seat into the mechanical seal cover. Lubricate the cup and mechanical seal cover with Pac-Ease Rubber Lubricant Emulsion. Also apply a generous coating of the lubricant to the seal diaphragm.
10. Replace the seal rings in the mechanical seal cover. Apply a light coat of grease to the rings being careful not to get grease on the impeller shaft.
11. Slide the mechanical seal cover over the impeller shaft making sure the seal remains seated in the bore of the cover. Make sure there is no oil or grease on the faces of the mechanical seal. (See Figure 8-3: "Qmax, Qmid, and Qtwo Mechanical Seal Assembly Overview" on page 134.)
12. If binding occurs, apply additional PAC-EASE lubricant.
13. Screw a 7/16"-14 UNC stud into one of the holes in the mechanical seal housing to aid in bolt hole alignment.
14. Insert the mechanical seal cover in the mechanical seal housing making sure to line up your center punch marks.
15. Apply Loctite and install four 7/16-14" screws. Tighten the screws evenly in a staggering (or criss-cross) fashion. Torque screws to 40 ft.-lbs. (54 N-m).  
**Note:** If the screws are being replaced, they must be replaced with Grade 5, zinc plated steel screws.
16. Slide the slinger onto the impeller shaft.



17. Install new oil seal in rear bearing housing.
18. Place a new gasket over the mating surface of the mechanical seal housing and rear bearing housing.
19. Properly seat 250-8240-00-0 roller bearing into rear bearing housing. Do not install roller bearing race yet.
20. Install two 1/2"-13 UNC studs into the mechanical seal housing. Slide the rear bearing housing over the impeller shaft making sure the oil seal aligns properly. Align the bolt holes and your center punch marks.



**IMPORTANT!**

**DO NOT ALLOW THE WEIGHT OF THE REAR BEARING HOUSING TO REST ON THE OIL SEAL AS DAMAGE MAY RESULT RENDERING THE SEAL INOPERATIVE.**

21. Apply Loctite and insert twelve 1/2"-13 screws to secure the rear bearing housing to the seal housing. Evenly tighten the screws in a staggering (or criss-cross) fashion and torque to 65 ft.-lbs. (88 N-m). (See Figure 8-3: "Qmax, Qmid, and Qtwo Mechanical Seal Assembly Overview" on page 134.)
22. Install race of the 250-8240-00-0 roller bearing onto the impeller shaft between shaft and bearing.
23. Insert small spacer against race.
24. Insert the gear key into the slot on the impeller shaft, then install the gear.
25. Insert large spacer on shaft.
26. Install the 250-8340-00-0 bearing and properly seat in the bearing housing.
27. Secure bearing plate to rear bearing housing with four 1/4" x 3/4" screws.
28. Place support washer on shaft and insert lock washer with outer teeth pointing toward gearbox and inner tooth in small groove of shaft.
29. Apply Loctite to shaft threads and tighten lock nut on impeller shaft. Torque nut to 135 ft.-lbs. (183 N-m). Using a punch, bend one tooth on lock washer into one groove on lock nut.
30. Re-install the gearbox - see heading "Installation - G Series" on page 112.
31. Operate the pump for about 15 minutes, and check the seal for leakage.

## Impeller Assembly and Mechanical Seal Qflo, Qflo-Plus and Qpak Pump

Review preceding sections “Before You Begin...,” on page 103 and “Cleaning and Inspection Guidelines,” on page 106. Also see Figure 8-7: “Qflo / Qflo-Plus / Qpak Mechanical Seal Assembly Overview” on page 144.

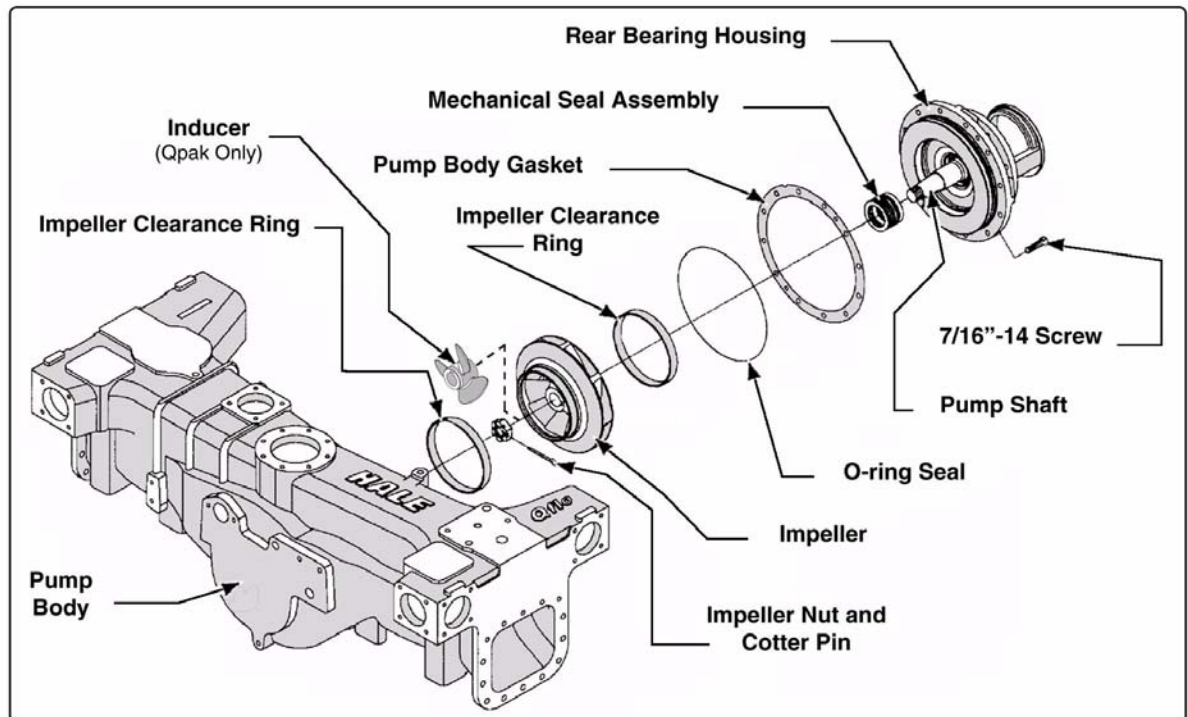
### Removing the Mechanical Seal



#### IMPORTANT!

**IF WATER LEAKAGE FROM THE DRAIN HOLE IN THE PUMP HEAD IS NOTICED, THE IMPELLER MUST BE REMOVED AND THE MECHANICAL SEAL MUST BE INSPECTED.**

1. Remove the gearbox - see heading “G Series Gearbox” on page 110. For J Series Gearbox, see heading “J Series Gearbox” on page 112.
2. Remove the twelve 7/16-14 UNC screws and remove the bearing housing from the pump body. (See Figure 8-7: “Qflo / Qflo-Plus / Qpak Mechanical Seal Assembly Overview” on page 144.)
3. Install 7/16”-14 UNC screws into the threaded holes on bearing housing to use as jacking screws.

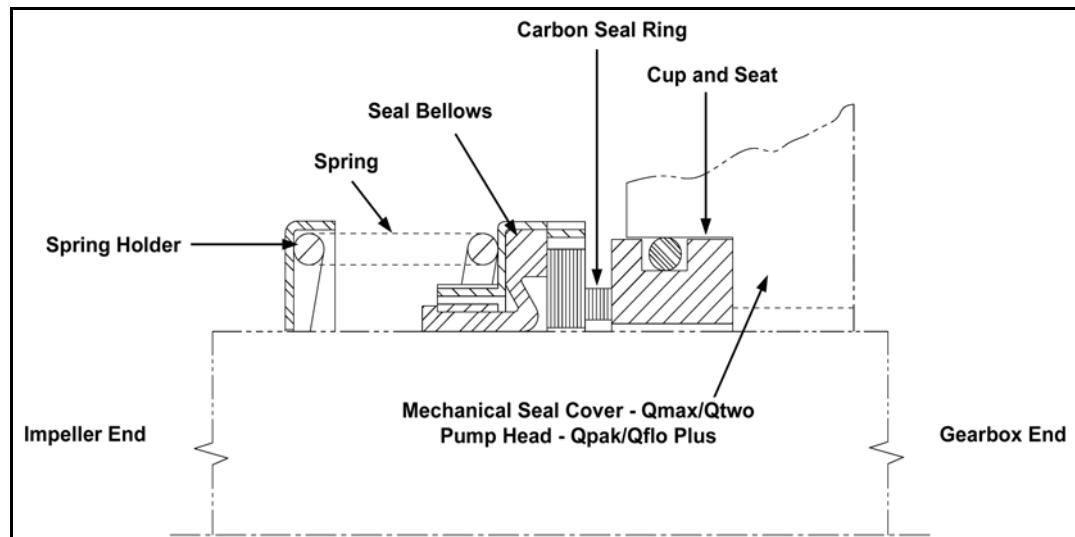


**Figure 8-7: Qflo / Qflo-Plus / Qpak Mechanical Seal Assembly Overview**

4. EVENLY turn the jacking screws clockwise to back the bearing housing out of the pump body. Make sure the assembly is properly supported.
5. Remove the gearbox and impeller assembly to a suitable work area.
6. Be careful NOT to damage the brass clearance rings or impeller as you separate the gearbox assembly from the pump head.
7. Remove cotter pin and nut from impeller shaft.

**Note:** On Qpak pumps an inducer is installed directly in front of the impeller. First remove the inducer, then the impeller.

8. Using a suitable puller, remove the impeller and impeller key from the shaft and set safely aside.
9. Use hooks that fit around the shaft and seal, then remove the mechanical seal assembly. (See Figure 8-8: “Mechanical Seal Overview / Replacement” on page 144.)
10. Remove the cup and seat from the bearing housing.



**Figure 8-8: Mechanical Seal Overview / Replacement**

11. Clean the impeller shaft and all components - proceed to Section 6, heading 7.3 “Cleaning and Inspection Guidelines” on page 106.
12. Measure the impeller wear surfaces and the clearance rings for excessive wear - see heading “Inspection – Clearance Rings” on page 124.
13. If necessary, remove and replace the clearance rings in the pump body and rear bearing housing.

**Note:** Removing the clearance ring renders it inoperative. It must be replaced. A usual good practice, if one ring requires replacement, the other should be replaced as well. Also verify the impeller clearance.

14. Inspect the rear clearance ring for wear and replace accordingly.
15. Removing the impeller may disturb the mechanical seal. A new seal must be installed.
16. Inspect the oil seal in the rear bearing housing and replace if necessary.

### **Installing the Seal**



1. See **CAUTION!** warning on page 133.
2. Clean the bore of the pump head using alcohol swabs. Solid running faces must be cleaned with alcohol wipes, supplied with the Hale repair kit (p/n: 296-5210-50-0).
3. Ensure that the pump body, mechanical seal housing, impeller bores and all mating surfaces of the mechanical seal assembly are absolutely clean throughout the entire installation process.
4. Make sure the impeller shaft is smooth and free of burrs at the gear key slot and bearing journals.
5. Clean the pump shaft with alcohol swabs.
6. Apply a generous coating of Pac-Ease Rubber Lubricant Emulsion (or equal) to the mechanical seal bellows and the pump shaft and seal areas.



### **WARNING!**

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

**USE ONLY PAC-EASE RUBBER LUBRICANT EMULSION (OR EQUAL) ON THE RUBBER MECHANICAL SEAL PARTS TO EASE INSTALLATION. USING AN OTHER LUBRICANT CAN DAMAGE THE SEAL AND SEAT. MAKE SURE ALL SHAFT SURFACES AND THE INSIDE OF THE SEALING BOOT ARE WELL LUBRICATED.**

7. Lubricate the carbon seal, cup and seat assembly with Pac-Ease Rubber Lubricant Emulsion. Without touching the carbon seal, slide the cup and seat assembly over the impeller shaft. (See Figure 8-4: “Mechanical Seal Overview / Replacement” on page 135.)
8. Using a soft pusher tube (2” / 51 mm PVC pipe) and keeping fingers away from carbon seal ring, carefully push the cup and seat assembly in until they are

- seated squarely in the rear bearing housing. If binding occurs apply more lubricant.
9. Orient the carbon seal ring towards the seal and slide the bellows and spring over the impeller shaft. Use the pusher tube to make sure the assembly is pushed all the way in. If binding occurs apply more lubricant to the impeller shaft and bellows.
  10. Insert impeller key in the impeller shaft and install the impeller on the shaft. Also insert the inducer. See heading “Qflo / Qflo-Plus / Qpak Mechanical Seal Assembly Overview” on page 144.
  11. Install impeller nut - tighten and torque to 135 ft.-lbs. (183 N-m). Lock the impeller nut in place using a cotter pin.
  12. Apply a light coating of grease to the seal ring groove and install a new seal ring on the rear bearing housing.
  13. Install a new gasket on the rear bearing housing, holding it in place with a light coating of grease.
  14. Thread two 7/16”-14 UNC studs in the pump body to help guide the rear bearing housing onto the pump body.
  15. Using proper lifting device lift gearbox and impeller assembly into place. Use studs to guide the rear bearing housing into the pump body.
  16. Insert the 7/16”-14 UNC cap screws into the rear bearing housing. Tighten and torque screws to 40 ft.-lbs. (58 N-m).
  17. Reconnect drive shafts, electrical, and air lines to gearbox.
  18. Fill the gearbox with oil. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 80.
  19. Operate the pump for about 15 minutes, and check the seal for leakage.

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## 9 Gearbox Maintenance

### 9.1 G SERIES GEARBOX MAINTENANCE

Review heading “Before You Begin...” on page 103. Also review heading “Cleaning and Inspection Guidelines” on page 106.

#### Disassembly

##### Intermediate and Sliding Gear Shaft Assemblies

Remove and disassemble the intermediate shaft assembly. (See Figure 9-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox.”)

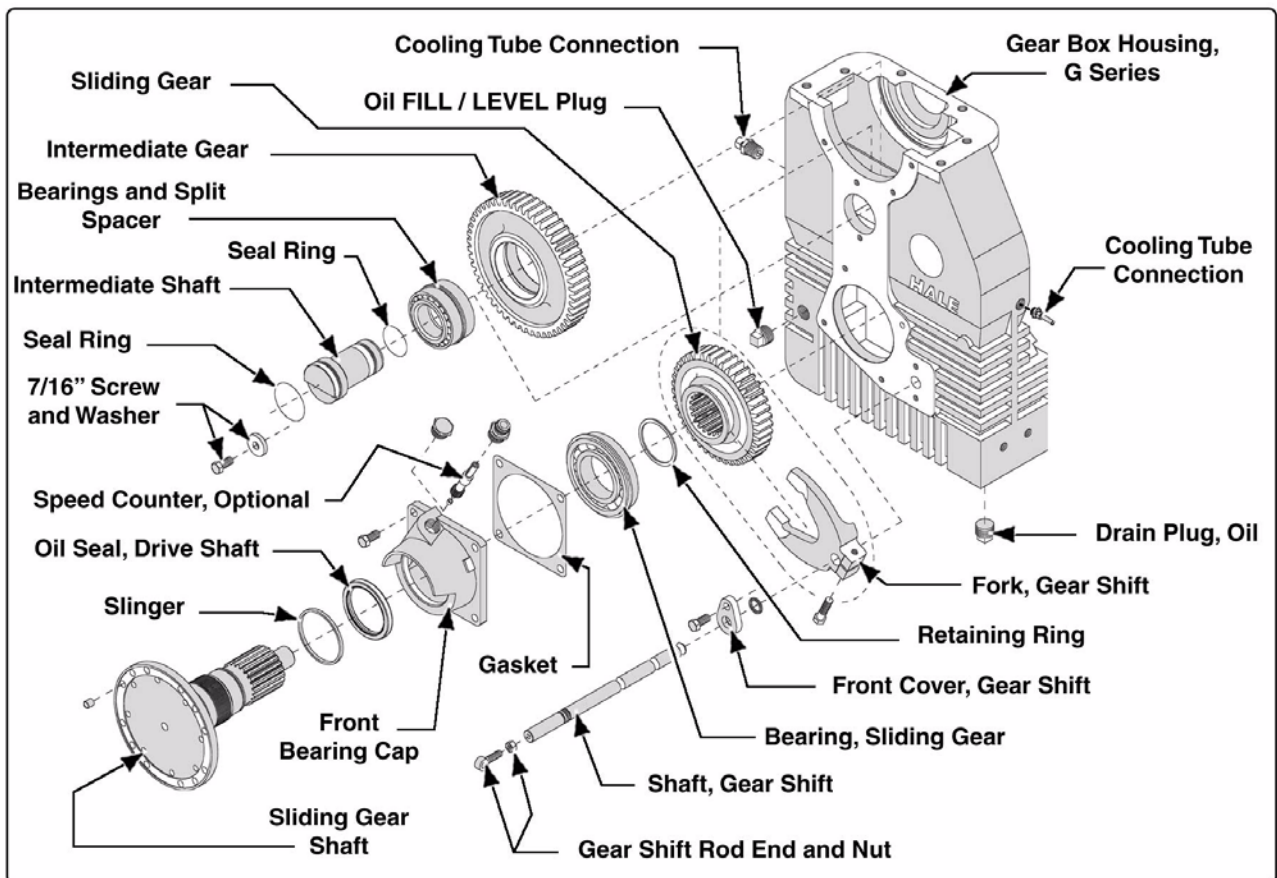


Figure 9-1: Intermediate Shaft and Sliding Gear, Typical G Series Gearbox

1. Set the gear shift to the PUMP position to center the sliding gear under the intermediate gear.
2. Remove the 7/16"-14 UNC x 1" screw and washer holding the intermediate shaft in place. (See Figure 9-1: "Intermediate Shaft and Sliding Gear, Typical G Series Gearbox" on page 149.)
3. Press the intermediate gear shaft out of the gearbox housing from the rear of the unit towards the front.
4. Remove the intermediate gear assembly, including the bearing assemblies and split spacer.
5. Remove the bearings from each side of the intermediate gear, then remove both the seal rings.
6. Clean and inspect all parts for excessive wear, chips, scoring or other damage. Repair and/or replace accordingly.

### Tail Shaft Assembly

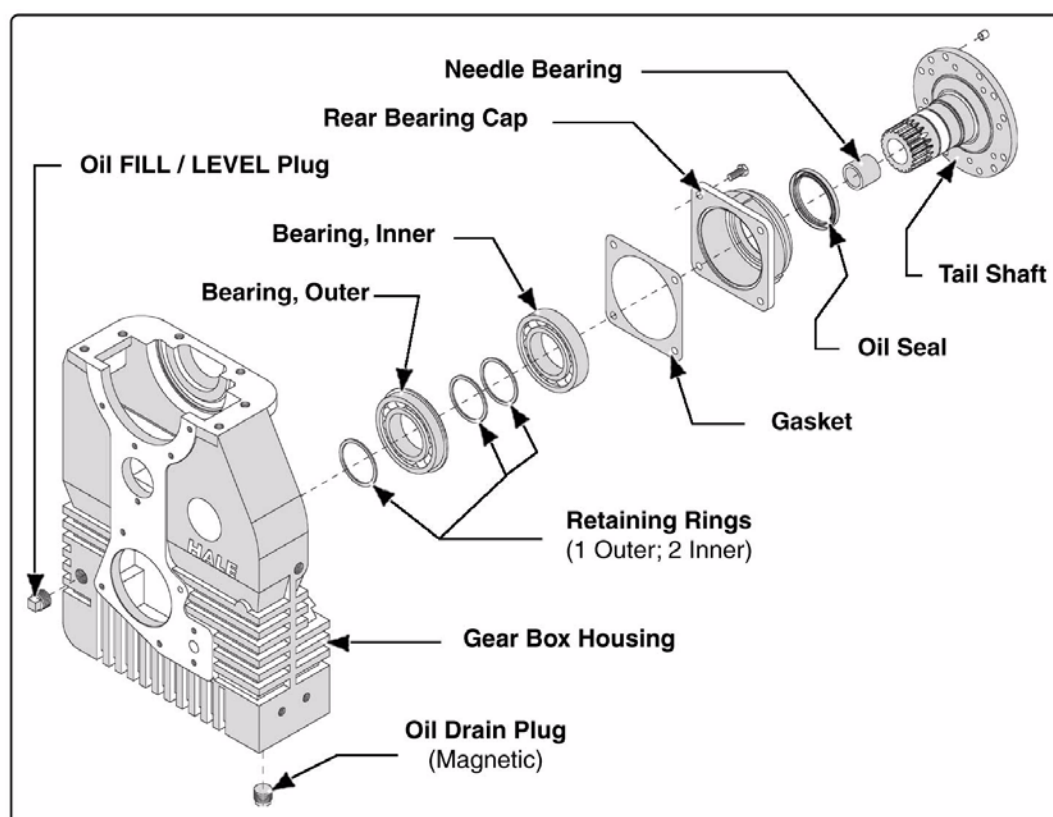


Figure 9-2: Tail Shaft Assembly

**Note:** If the tail shaft and sliding gear shaft require service it is not necessary to remove the gearbox from the apparatus. If only the tail shaft assembly needs to be removed, engage the sliding gear (PUMP position).

1. Remove and disassemble the tail shaft assembly - four 7/16"-14 hex screws. (See Figure 9-2: "Tail Shaft Assembly" on page 150.)
2. Remove in the following order:
  - ☐ Rear bearing cap gasket.
  - ☐ Outer bearing retaining ring
  - ☐ Outer bearing
  - ☐ Inner bearing retaining rings (2)
  - ☐ Inner bearing
  - ☐ Tail shaft from the rear bearing cap
  - ☐ Drive shaft oil seal
3. Clean and inspect all parts for excessive wear, chips, scoring or other damage. Repair and/or replace accordingly.

### **Power Gearshift Assembly**

(See Figure 9-3: "Power Gearshift Assembly" on page 152.)

1. Set the gear shift to the PUMP position.
2. Remove the 1/2"-20 nylon set screw, spring and ball.
3. Loosen the 3/8"-16 rod end nut. Remove the gearshift rod end and hex nut.
4. Remove the two 5/16" hex nuts and 5/16"-18 screws and remove the gear shift cover and gasket.
5. Unthread the gearshift rod extension, then remove the piston.
6. Remove the shaft bearing, then the inner retaining ring.
7. Remove two 7/16"-14 screws and remove the cylinder body and gasket.

**Note:** The gearshift fork cannot be removed from the sliding gear shaft until the sliding gear is removed. See heading "Sliding Gear and Fork" on page 152.

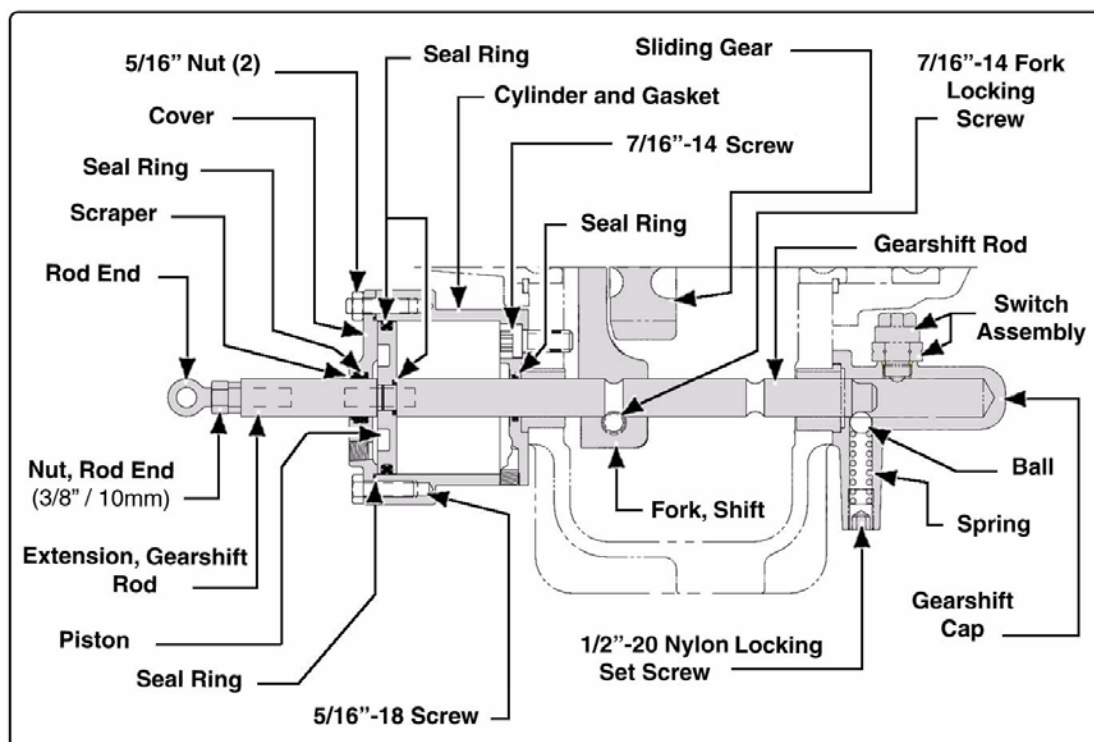


Figure 9-3: Power Gearshift Assembly

8. Clean and inspect all parts for excessive wear, chips, scoring or other damage. Repair and/or replace accordingly.

### Sliding Gear and Fork

(See Figure 9-1: "Intermediate Shaft and Sliding Gear, Typical G Series Gearbox" on page 149.)

**Note:** If your assembly includes the PTO drive option, first remove the PTO drive to enable disassembly the sliding gear and fork. See heading "PTO Drive Option, Qflo / Qflo Plus / Qpak Series Pump" on page 153.

1. If the tail shaft has not been removed, set the gear shift to the ROAD position to place the sliding gear on the tail shaft.  
If the tail shaft has been removed, leave the gearshift in the PUMP position.
2. If the optional speed counter is included, disconnect the electrical connector and unscrew the sensor from the front bearing cap.
3. Remove the front bearing cap and gasket - four 7/16"-14 screws.
4. Remove the sliding gear assembly from the housing.
5. If the tail shaft is not removed, remove the front sliding gear assembly from the gearbox housing. Reach in and slide the sliding gear from the tail shaft.

6. Make a note of the location of the fork in relation to the gearshift shaft before removing the fork. (See Figure 9-3: "Power Gearshift Assembly" on page 152.)
7. While holding the fork, loosen the 7/16"-14 screw and pull the shaft out of the fork and gearbox housing.
8. From the sliding gear assembly, remove in the following order:
  - ☐ Sliding gear bearing retaining ring - see Figure 9-1: "Intermediate Shaft and Sliding Gear, Typical G Series Gearbox" on page 149.
  - ☐ Sliding gear shaft from the front bearing cap
  - ☐ Drive shaft oil seal and slinger from the front bearing cap
  - ☐ Electrical switches from the gearshift cap - see Figure 9-3: "Power Gearshift Assembly" on page 152.
9. Inspect the cooling tube for damage and leaks.
10. Clean and inspect all parts for excessive wear, chips, scoring or other damage. Repair and/or replace accordingly.

#### **PTO Drive Option, Qflo / Qflo Plus / Qpak Series Pump**

(See Figure 9-1: "Intermediate Shaft and Sliding Gear, Typical G Series Gearbox" on page 149.) Also see Figure 9-4: "PTO Drive Option" on page 154.

1. Remove the rear bearing cap, bearing and gasket - the four (4) 7/16"-14 screws.
2. Examine the rear bearing cover bearing and if required, remove the retaining ring to separate the bearing from the cover. Replace accordingly.
3. Remove the retaining ring holding the input gear in place.
4. To remove the sliding gear shaft, gear and fork, see heading "Sliding Gear and Fork" on page 152.
5. Clean and inspect all parts for excessive wear, chips, scoring or other damage. Repair and/or replace accordingly.

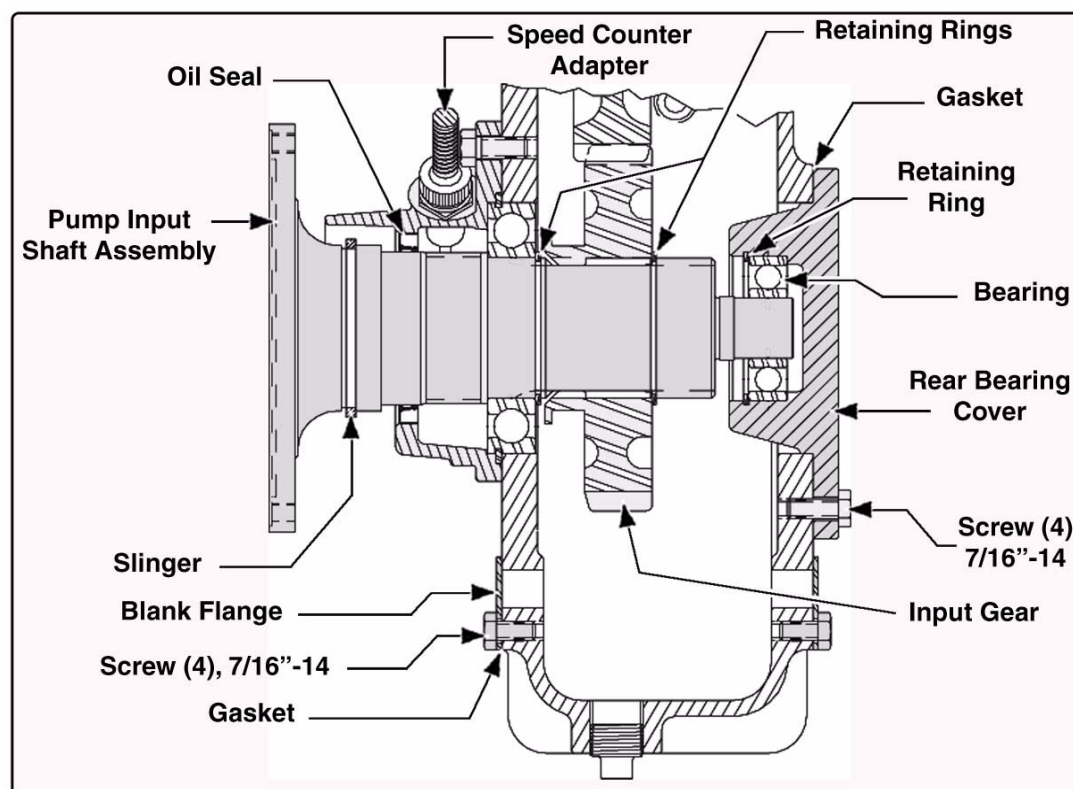


Figure 9-4: PTO Drive Option

## Assembly

### Gearshift Cap

(See Figure 9-3: "Power Gearshift Assembly" on page 152.)

1. Install new switch seal rings, then thread gearshift switch into the gear shift shaft cap.
2. Install a new gearshift cap gasket.
3. Install the gearshift shaft cap - two 7/16"-14 screws.

### Sliding Gear Assembly

(See Figure 9-1: "Intermediate Shaft and Sliding Gear, Typical G Series Gearbox" on page 149.)

1. Hold the gearshift fork in place and slide the gearshift shaft through the opening in front of the housing and the gearshift fork. Be sure the fork is in the proper position.

2. Apply Loctite #242 to the 018-8340-00-0 screw that attaches the fork to the shaft. Tighten and torque to 65 ft.-lbs. (88 N-m).
3. Place the sliding gear into the shift fork. Make sure the shift fork groove on the sliding gear is oriented towards the front of the gearbox. (See Figure 9-1: "Intermediate Shaft and Sliding Gear, Typical G Series Gearbox" on page 149.)
4. Install a new drive shaft oil seal in the front bearing cap.
5. Using a brass drift or bearing installation tool, install the sliding gear bearing. (See Figure 9-1: "Intermediate Shaft and Sliding Gear, Typical G Series Gearbox" on page 149.)
6. Install the slinger onto the sliding gear shaft.
7. Insert the sliding gear shaft into the front bearing cap by sliding it from the front to the rear. Do not damaging the oil seal.
8. Install the bearing retaining ring.
9. Apply Loctite #242 to the four 7/16"-14 screws. Install the sliding gear shaft and front bearing cap and gasket. Tighten and torque screws, in a criss-cross pattern, to 40 ft.-lbs. (54 N-m).
10. The sliding gear shaft must mesh with the sliding gear. Insure the gearshift fork is in its proper position.

### **Tail Shaft and Gear Shift Assemblies**

(See Figure 9-2: "Tail Shaft Assembly" on page 150.)

1. Using a brass drift or bearing installation tool, install the inner tail shaft bearing.
2. Install a new shaft oil seal, Hale p/n: 296-2540-00-0.
3. Insert the tail shaft into the rear bearing housing. Do not damage the oil seal.
4. Install both retaining rings.
5. Using a brass drift or bearing installation tool, install the outer tail shaft bearing.
6. Install a retaining ring to secure the outer bearing in place.
7. Install the sliding gear shaft needle bearing to the front end of the tail shaft.
8. Install the tail shaft and rear bearing cap and gasket. Ensure the needle bearing slides over the male end of the sliding gear shaft.
9. Install the rear bearing cap - four 7/16"-14 screws. (See Figure 9-2: "Tail Shaft Assembly" on page 150.) EVENLY tighten and torque the screws, in a criss-cross pattern, to 40 ft.-lbs. (54 N-m).
10. Install a new shifting cylinder gasket. (See Figure 9-3: "Power Gearshift Assembly" on page 152.)
11. Install a new shaft seal O-ring in the shifting cylinder.



12. Install the shifting cylinder assembly by sliding it over the gearshift shaft. Apply Loctite #242 to the two 7/16"-14 nylon locking screws and tighten.
13. Install the inner piston retaining ring, then install a new piston inner seal ring.  
**Note:** Install piston retaining rings with flat side (square corners) facing away from piston.
14. Install a new piston outer seal ring. (See Figure 9-3: "Power Gearshift Assembly" on page 152.)
15. Install the cylinder piston with the flat side of the piston facing the interior of the cylinder.
16. Install the outer piston retaining ring, then install a new gearshift shaft seal on the cylinder cover.
17. Install cylinder cover - two 5/16"-18 hex screws and 5/16"-18 studs and tighten.
18. Install the gearshift rod end. Tighten the 3/8"-16 hex nut.

### PTO Drive Option

(See Figure 9-4: "PTO Drive Option" on page 154.)

1. Slide the rear bearing cover and gasket, with bearing (and retaining ring) onto the sliding gear stem.
2. Install, tighten and torque accordingly - four (4) 7/16"-14 hex screws. (See Table 7-1: "Typical Torque Values Chart" on page 105.).

### Intermediate Shaft Assembly

(See Figure 9-1: "Intermediate Shaft and Sliding Gear, Typical G Series Gearbox" on page 149.)

1. Press a new intermediate gear bearing assembly (two bearings with split spacer) into the intermediate gear.
2. Install new seal O-rings.
3. Set the gearshift in the PUMP position.
4. Place the intermediate gear in position towards the front of housing, centered over the sliding gear.

**Note:** On "XG" series gearboxes, hold the intermediate gear spacer in position towards the rear of the gearbox housing. Install the intermediate shaft (front cutout facing down) through the front opening in the gearbox housing.

5. Press the intermediate shaft through the intermediate gear (and the intermediate gear spacer) until the cut out on the front of the shaft is flush with the outer surface of the gearbox housing.
6. Install the shaft washer and tighten the screw - 7/16-14 screw.



7. Rotate the sliding gear shaft and manually shift the gearshift to check for proper operation.
8. Remove the gearbox from the holding fixture and install - see heading "Installation - G Series" on page 112.

## 9.2 J SERIES GEARBOX MAINTENANCE

(See Figure 9-5: "Typical J Series Gearbox Assembly" on page 158.)



Review heading "Before You Begin..." on page 103. Also review heading "Cleaning and Inspection Guidelines" on page 106. Also review **WARNINGS!** note found on page 104.

### Disassembly

#### Idler Shaft Disassembly

1. With the gearbox secured in a holding fixture, remove and disassemble the idler shaft assembly. (See Figure 9-5: "Typical J Series Gearbox Assembly" on page 158.)
2. Remove the 1/2-13 screw and washer from the idler shaft.
3. Press the idler gear shaft out of the gearbox housing from the front of the unit towards the rear.
4. Through the top of the gearbox, remove the idler gear assembly, which includes two tapered roller bearings. Remove the bearings from each side of the idler gear.
5. Remove the idler shaft seal ring from the shaft.
6. Clean and inspect each component of the intermediate shaft assembly. Inspect bearings for wear, pitting, and damage. Inspect the gear tooth surface for wear damage and pitting.

**Note:** During reassembly, apply a thin coat of grease the seal rings to limit resistance as the seals pass through the housing and bearings.

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

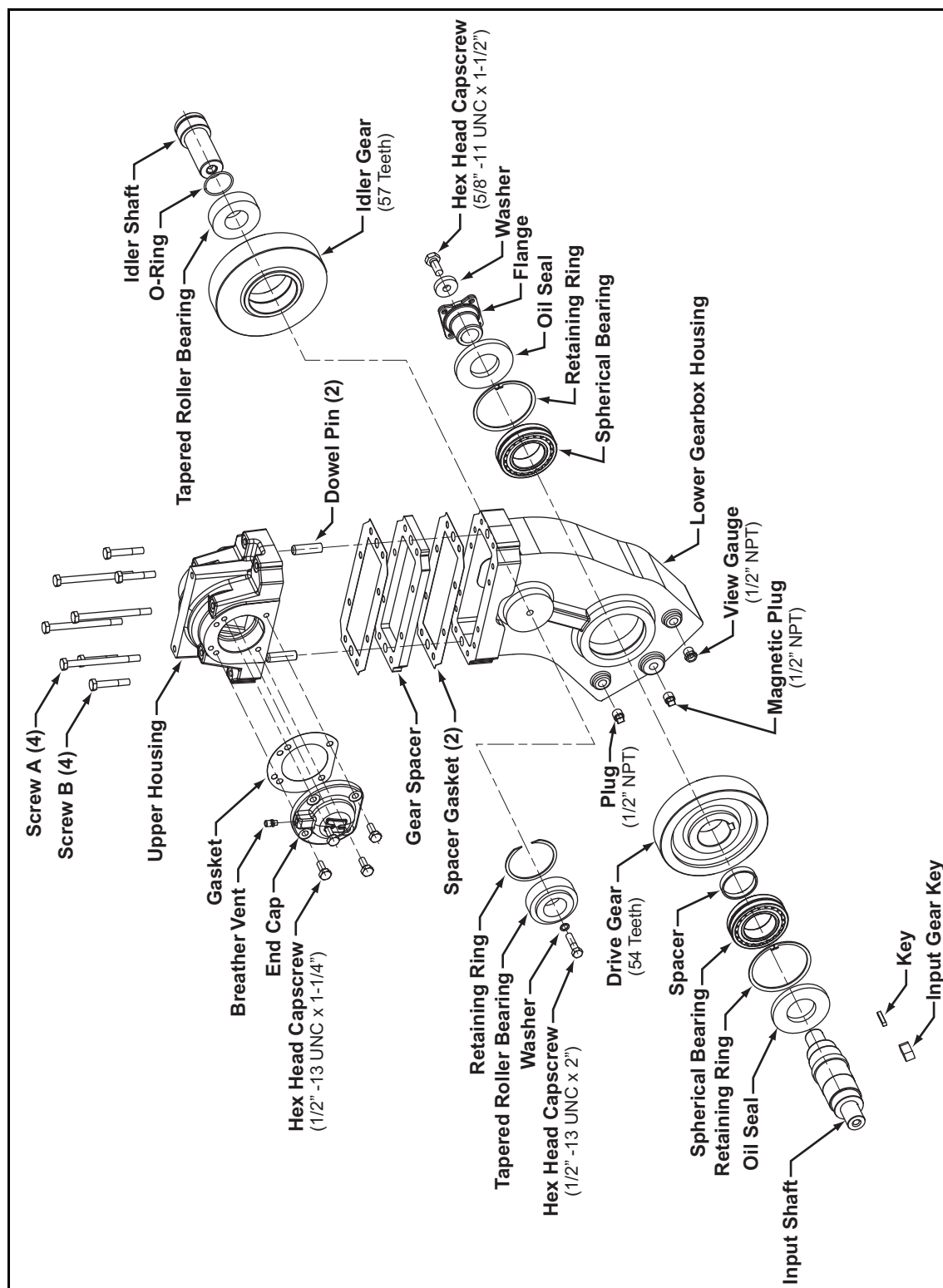


Figure 9-5: Typical J Series Gearbox Assembly

### Input Shaft Disassembly

(See Figure 9-5: "Typical J Series Gearbox Assembly" on page 158.)

1. Remove the 1/2"-13 screw and washer.
2. Using an appropriate puller, remove the companion flange from the input shaft.
3. Remove the companion flange 0.375" x 1.563" (10 x 40 mm) key from the shaft.
4. Remove the oil seal from the companion flange end of the drive shaft, then remove the bearing retaining ring.
5. Remove oil seal from other side of gearbox and remove the bearing retainer ring.
6. Using proper press, carefully press the input shaft from gearbox housing.
7. Remove the bearings and the input shaft 0.750" x 1.75" (19 x 44 mm) square key from input shaft.
8. Note the orientation of gear, then through top of gearbox housing remove the input gear from gearbox housing.
9. Using bearing puller, remove bearings from gearbox housing if necessary.

### Assembly and Installation

(See Figure 9-5: "Typical J Series Gearbox Assembly" on page 158.)

#### Input Shaft Assembly

1. On the "non-drive" side of the gearbox housing, install the following (in order):
  - ☐ A new spherical bearing.
  - ☐ A new retaining ring.
2. On the "drive" side of the gearbox housing, install the following (in order):
  - ☐ Input gear into gearbox housing in proper orientation. (See Figure 9-5: "Typical J Series Gearbox Assembly" on page 158.)
  - ☐ 3/4" x 1-3/4" (19 x 44 mm) square key in the input shaft.
  - ☐ Holding the input gear in place, insert input shaft while aligning the shaft key to the slot in the gear. Also, make sure the shaft aligns with the bearing.
  - ☐ A new spherical roller bearing over the input shaft. Align the shaft and bearing with the housing and carefully press bearing into place.
  - ☐ A new retaining ring into gearbox housing.
3. Press new oil seals into both sides of gearbox housing.

4. Install the 0.375" x 1.563" (10 x 40 mm) key on input shaft, then install the companion flange.
5. Apply Loctite #242 to 1/2"-13 UNC screws, then install the washer and screw. Tighten and torque accordingly.

#### **Idler Shaft Assembly**

1. Press new tapered roller bearings into the idler gear. (See Figure 9-5: "Typical J Series Gearbox Assembly" on page 158.)
2. Install new shaft seal ring on the end of the idler shaft.
3. Through the top of the gearbox housing, insert the idler gear in position towards the front of the gearbox housing. Ensure the teeth of the idler gear align to the teeth of the input gear.
4. Press the idler shaft through the idler gear until the shaft is seated in the gearbox housing.
5. Apply Loctite #242 to the 1/2-13 screw. Install the washer and screw. Tighten the 1/2-13 screw.
6. Rotate the input gear shaft to check for proper operation.
7. Using an appropriate lifting device, remove the gearbox from the holding fixture.
8. Install the gearbox - see heading "J Series Gearbox" on page 112.

## 9.3 K SERIES GEARBOX MAINTENANCE

### Oil seals (Input/Tail Shafts)

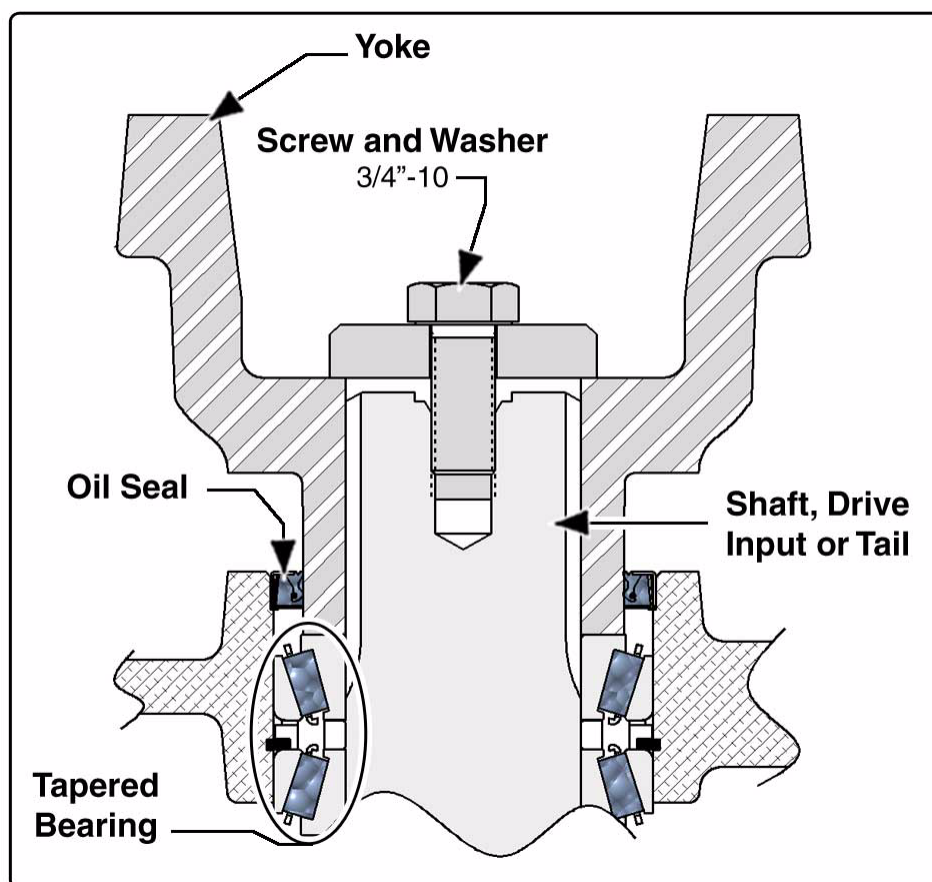


Figure 9-6: Oil Seal Replacement

Input shaft and tail shaft oil seals are replaced by disconnecting the yoke from the pump and can be accomplished with the unit installed.

1. Remove the 3/4-10 x 1-3/4" screw and washer and carefully slide the yoke from the shaft.
2. Remove the defective oil seal being careful not to score the shaft.
3. Carefully insert a new oil seal into the housing.
4. Carefully slide the yoke onto the shaft and secure using the 3/4-10 x 1-3/4" screw and washer. Torque screw to 260 ft.-lb. (352 N-m). DO NOT overtighten— the yoke must spin freely.

## Tail Shaft Assembly



### IMPORTANT!

THE MOST EFFICIENT METHOD FOR INTERNAL SERVICING OF THE GEARBOX IS TO REMOVE IT AND THE PUMP ASSEMBLY AS A COMPLETE UNIT FROM THE APPARATUS.

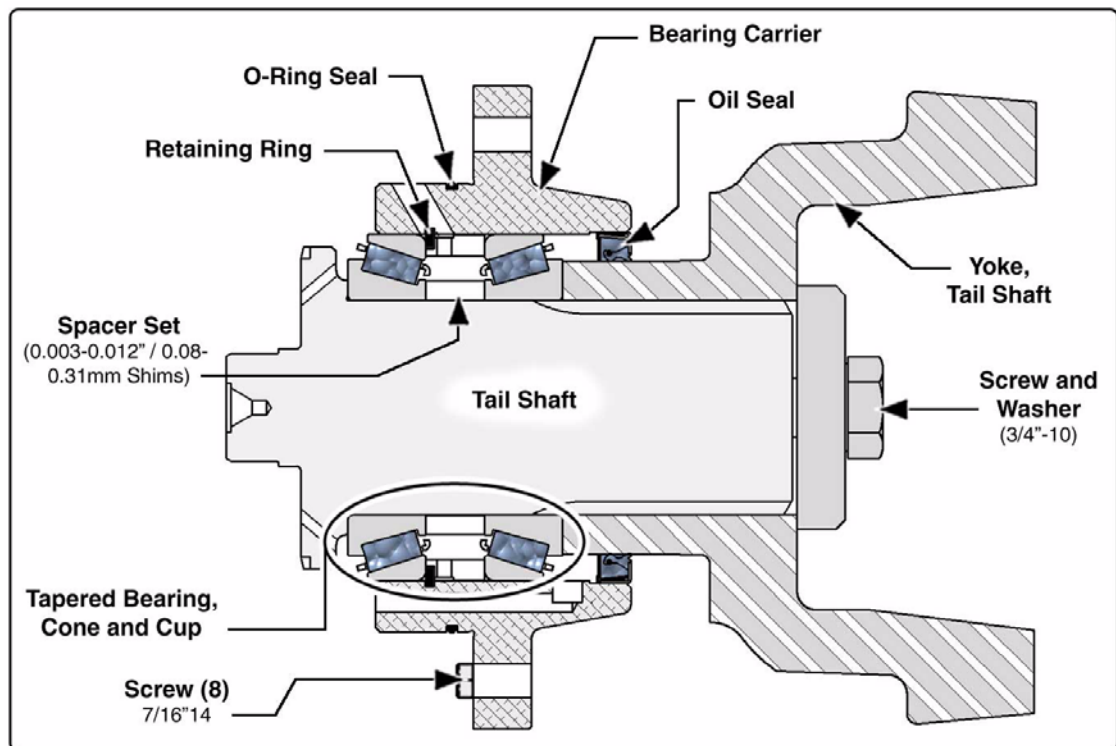


Figure 9-7: Tail Shaft Assembly

### Removal And Disassembly

1. Review preceding sections "Before You Begin..." on page 103.
2. Remove eight 7/16-14 x 1-1/2" screws securing bearing carrier to the gearbox housing.
3. Slide the complete bearing carrier assembly out of the gearbox housing.
4. Begin taking apart the bearing carrier assembly by unscrewing the 3/4-10 x 1-3/4" screw and washer from yoke. Remove the yoke from the tail shaft.
5. Drive tail shaft through bearing carrier. Use a dead blow hammer or similar to avoid marring the shaft.

6. Press the bearing cone off the tail shaft.
7. If necessary, remove the roller bearing inner race.
8. Remove the oil seal. It will be damaged during this process and must be replaced.

Replacements are ordered using Hale p/n: 296-2680-00-0.

9. Remove the bearing cone from the bearing carrier. Gently tap out the bearing cups and remove the bearing spacers.
10. Using retaining ring pliers, remove the retaining ring from the bearing carrier.
11. Remove the O-ring seal from the bearing carrier.

### Inspection

1. Clean bearings and other components using parts cleaner.
2. Carefully inspect bearings and seals for signs of excessive wear. The bearings, shims, and spacers are a matched set and must be replaced as a unit. Order using Hale p/n: 250-8140-53-0.
3. Obtain new components from Hale Products as appropriate.

### Reassembly and Installation

See Figure 9-7, "Tail Shaft Assembly," on page 162

1. Using retaining ring pliers, install retaining ring into bearing carrier.
2. Insert, on top of the retaining ring, the outer bearing spacer, then press in the bearing cup.

**Note:** Be careful not to mix bearing components with those from other bearing sets. Should the outer spacer be confused with that from the bearing carrier, the one used for the tail shaft assembly is noticeably thinner than the bearing carrier spacer.

3. To the tail shaft, press on the roller bearing inner race (see Figure 9-7: above).
4. Slide the matching inner bearing cone and spacer onto the tail shaft. Both are a tight fit.
5. Insert tail shaft into gearbox housing, aligning inner race of roller bearing with outer race on the mating input shaft. Also see Figure 9-8: "Shaft End Gap".



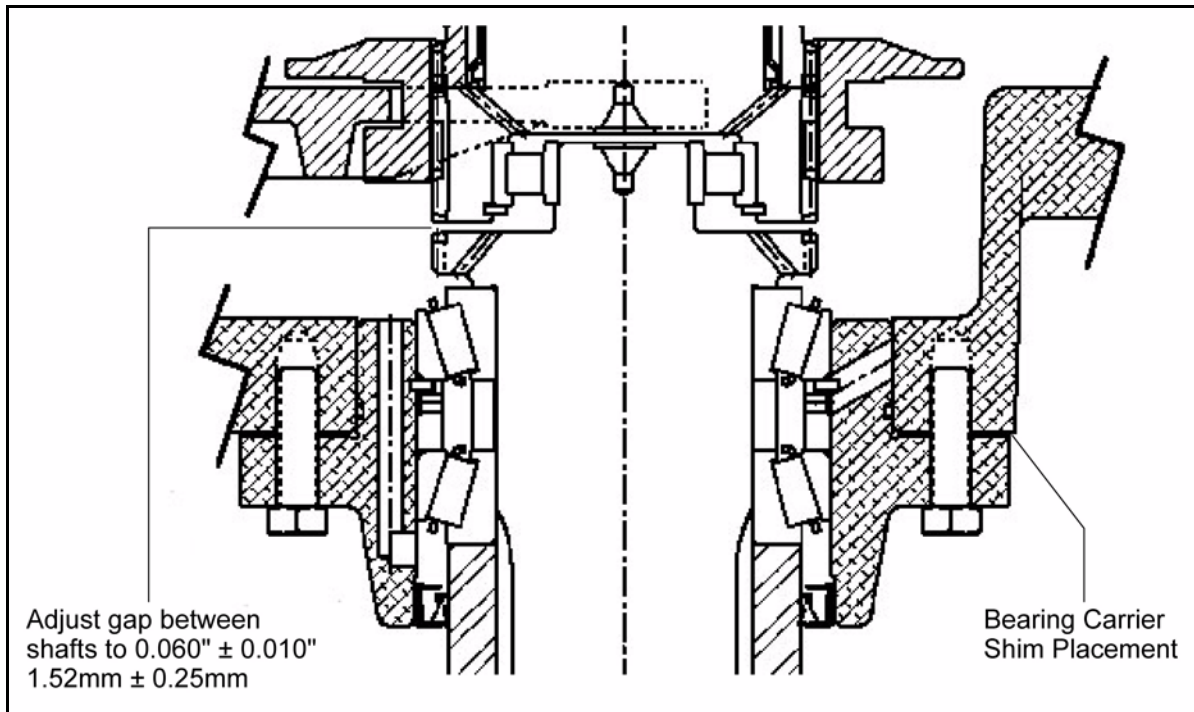


Figure 9-8: Shaft End Gap

6. Carefully slide bearing carrier over the tail shaft.
7. Temporarily secure bearing cover using eight 7/16-14 x 1-1/2" screws. Torque screws to 50 ft.-lb. (68 N-m).
8. Using a feeler gauge, measure the gap between the input and tail shafts, as shown in Figure 5-3 above.
9. Remove the bearing carrier and install correct amount of spacers to produce a  $0.060" \pm 0.010"$  (1.524 mm  $\pm$  0.254 mm) gap.

**Note:** Under normal circumstances, replacing bearings, seals, cones, etc. will have little effect on the gap setting. Reinstalling all existing shims maintains the required gap ( $0.060" \pm 0.010"$  [1.524mm  $\pm$  0.254mm]). However, if either shaft is replaced or the housing is changed, the gap must be checked and set.

10. Repeat Steps 5 through 8. Also repeat Step 9, if necessary.
11. When the gap is properly shimmed and you are ready to install the bearing carrier to the gear box, install a new gasket.  
Use a light coating of general purpose grease to hold the gasket in place.
12. Place the inner spacer onto the tail shaft. Insert the remaining bearing cone onto the tail shaft. Both are a tight fit.
13. Carefully press a new oil seal into the bearing carrier.



14. Place the yoke onto the end of the tail shaft and secure using the 3/4-10 x 1-3/4" screw and washer. Torque screw to 260 ft.-lb. (352 N-m).

Rotate the yoke to ensure free spin. If too tight, back-off slightly on the 3/4-10 bolt.

15. Secure the bearing carrier using eight 7/16-14 x 1-1/2" Grade 8 screws. Apply Loctite 246 (or equal) to the threads prior to installation. Torque screws to 50 ft.-lb (68 N-m).
16. Replace the fluid and install the gearbox cover.

## Input Shaft

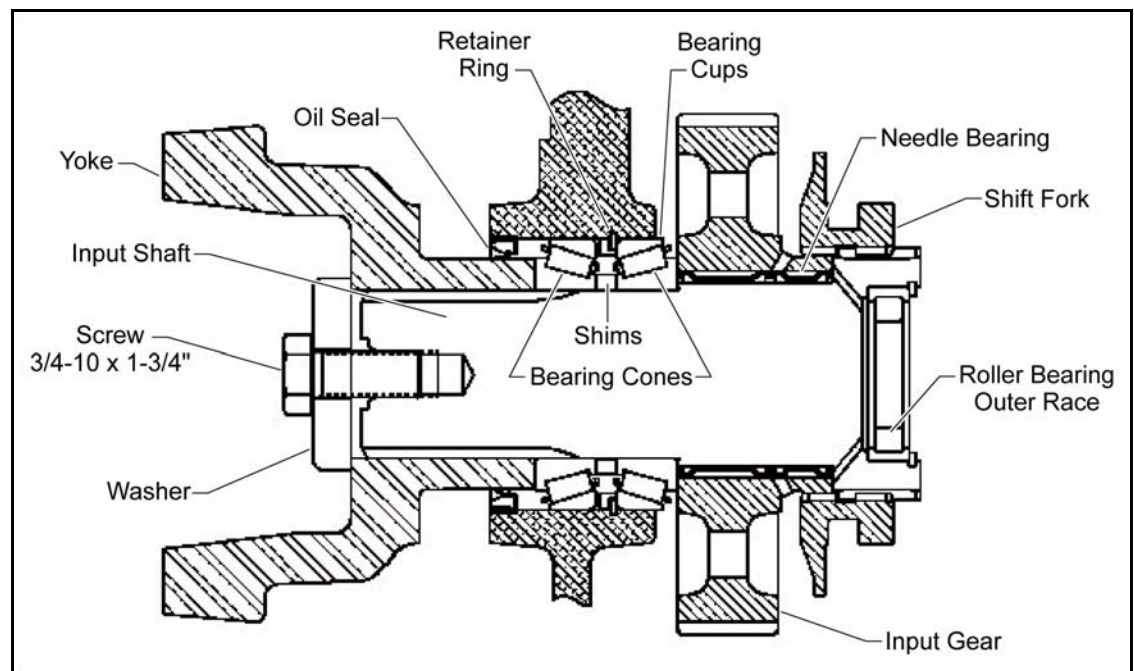


Figure 9-9: Input Shaft Assembly

## Removal and Disassembly

1. Remove gearbox cover and tail shaft assembly as previously described.
2. Unscrew the 3/4-10 x 1-3/4" bolt and washer securing the input yoke.  
Slide the yoke off the input shaft.
3. Carefully drive the input shaft into the gearbox using a dead blow hammer, or similar, to avoid marring the shaft.
4. Pull the input shaft through the bearing carrier bore and out of the gearbox housing.

**Note:** The shift collar, input gear, bearing cone, inner spacer, shims, needle bearing, and bearing cup may drop into the gearbox housing. Remove these components from the gearbox housing.

5. If necessary, remove the roller bearing outer race from the input shaft.
6. Remove the oil seal. It will be damaged during this process and must be replaced. A replacement oil seal can be ordered using Hale p/n: 296-2860-01-0.
7. Remove the remaining bearing cone out of the housing. See Figure 9-9, "Input Shaft Assembly," on page 165.
8. Tap out bearing cups and remove outer spacer.
9. Using retaining ring pliers, remove the retaining ring from the gearbox housing.

### **Inspection**

1. Clean bearings and other components using parts cleaner.
2. Carefully inspect bearings and seals for signs of excessive wear.

The tapered roller bearings, shims and spacers are a matched set and must be replaced as a unit. Order a new set using Hale p/n: 250-8140-52-0.
3. Obtain new components from Hale Products as appropriate.

### **Reassembly and Installation**

See Figure 9-9, "Input Shaft Assembly," on page 165.

1. Using retaining ring pliers, install the retaining ring into the gearbox housing.
2. Insert the outer bearing spacer and press the outer bearing cup into place.

**Note:** Should the outer bearing spacer be confused with that of the tail shaft assembly, the one used in the bearing carrier assembly is noticeably thicker.
3. Tap the inner bearing cup into place. Tap evenly around circumference to prevent an uneven fit.
4. Press the roller bearing outer race into the input shaft. Using retaining ring pliers, insert the retaining ring into the input shaft.
5. Insert the input shaft partially through the bearing cover bore and install the needle bearings, shifting collar, input gear, and bearing cone onto the shaft.
6. Insert the input shaft into the housing until the bearing cone contacts the bearing cup.
7. Install the inner bearing spacer and shims onto the input shaft and press the remaining bearing cone onto the input shaft.
8. Carefully press the oil seal into the housing.

9. Secure the input yoke onto the input shaft using the washer and 3/4-10 x 1-3/4" screw. Torque to 260 ft.-lb (350 N-m).
10. Install the tail shaft and gearbox cover.

## KPS Power Shift Assembly

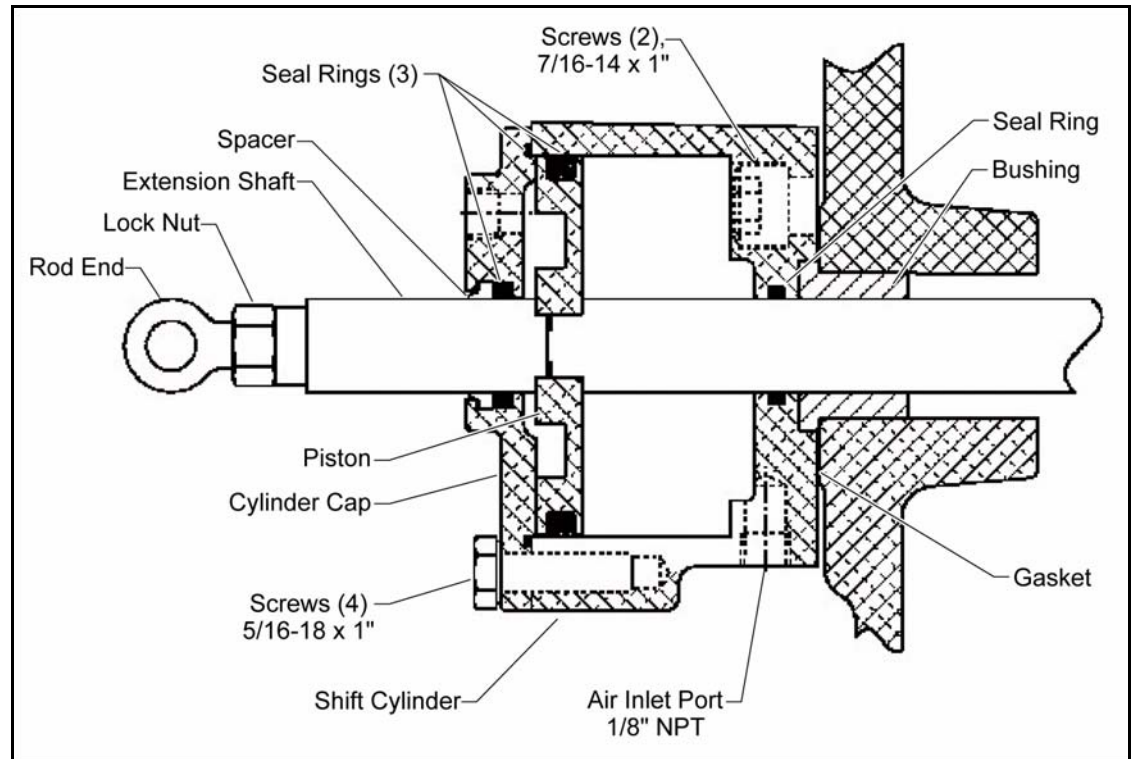


Figure 9-10: KPS Shift Cylinder Assembly

### Removal

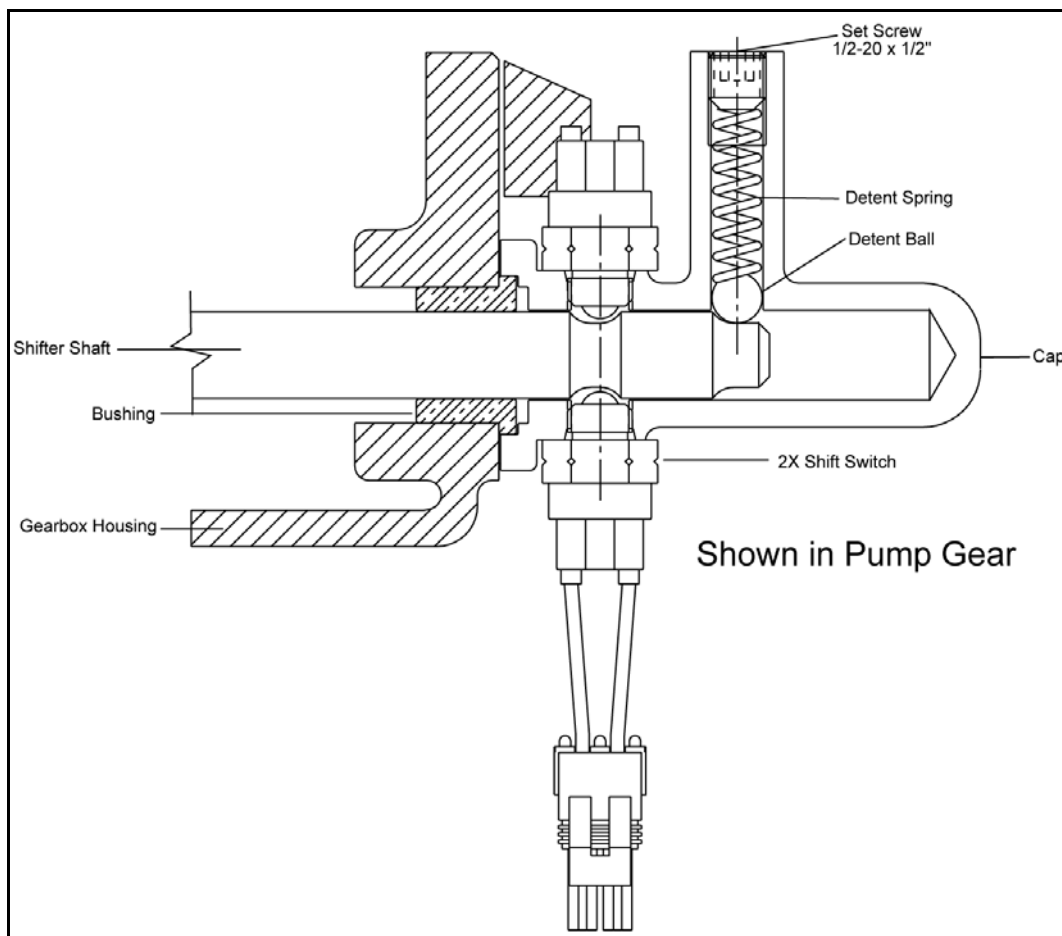
1. Pull the shift rod into PUMP position (out). Loosen 3/8-16 nut and remove rod end and nut from end of shift shaft.
2. Unscrew four 5/16-18 x 1" screws holding down KPS cover.
3. Remove cylinder cap and seal O-ring.
4. Using a seal pick, remove scraper and seal ring from the KPS cap.
5. Unscrew KPS extension shaft.
6. Remove KPS piston from shaft then remove seal rings.
7. Unscrew two 7/16-14 x 1" screws then remove KPS cylinder and gasket.
8. Remove seal ring from shift cylinder.

9. Remove and check bushing for wear. Replace accordingly with Hale p/n: 250-9550-00-0.

### **Installation**

1. Install new seal ring in cylinder groove.
2. Using a light coating of general-purpose grease to hold it in place, install gasket on gearbox.
3. Align KPS cylinder and secure using two 7/16-14 x 1" screws.
4. Apply a light coating of general-purpose grease to seal rings before installation. Install a new seal ring on the piston then install piston on shaft. Make sure the flat side of the piston is towards the inside of the cylinder.
5. Thread extension shaft onto shift rod. Prior to installation, coat threads with Loctite 246 (or equal).
6. Make sure the piston and shaft move freely in the shift cylinder.
7. Apply a light coating of general-purpose grease then install the scraper and seal rings in the KPS cover.
8. Install KPS cover with scraper and seal rings over the shaft.
9. Apply Loctite 246 (or equal) then install four 5/16-18 x 1" screws.
10. Install rod end and 3/8-16 nut on end of shift shaft. Lock the rod end with the nut.

## KPS Shift CAP and Switch



**Figure 9-11: KPS Shift Cap Assembly**

### Removal

1. Disconnect control connection.
2. Unscrew the 1/2-20 x 1/2" setscrew, then remove detent spring and ball.
3. Unscrew the switches and remove them from the cap. See Figure 9-11: "KPS Shift Cap Assembly".
4. Remove two 7/16-14 x 1" cap screws and the gearshift shaft cap (not shown).
5. Remove the gasket from the mating surface of the gearbox.

### Installation

1. Apply a light coating of general-purpose grease to hold gasket in place, then place gasket on gearbox.

2. Align the gearshift shaft cap. Apply Loctite 246 (or equal) and install two 7/16-14 x 1" screws.
3. Install the detent ball and spring. Secure using 1/2-20 x 1/2" setscrew.
4. Place detent ball into gearshift cap. Install the switches onto the cap by threading them in. Prior to installation, coat threads with Loctite 246 (or equal).
5. Reconnect the electrical control connection.

## **Gear Shift Fork**

### **Removal**

1. Remove gearbox cover, tail shaft assembly, input shaft assembly, KPS cylinder, and KPS shift switch.
2. Release the gearshift fork by unscrewing the shift fork screw.
3. Pull the shift-shaft from the gearbox and remove gearshift fork from inside the gearbox.
4. Drive shift shaft bushings out of gearbox housing, if necessary.

### **Installation**

1. If necessary, press shift shaft bushings into gearbox housing.
2. While holding the shift fork in place, insert shift shaft into gearbox housing by sliding shaft through the shift fork.
3. Install shift fork screw. This is a specialty screw that cannot be substituted with standard hardware. Contact Hale for replacement part, Part Number 018-8350-00-0.
4. Install KPS shift switch, KPS cylinder, tail shaft assembly, input shaft assembly, and gearbox cover.

## Idler Shaft

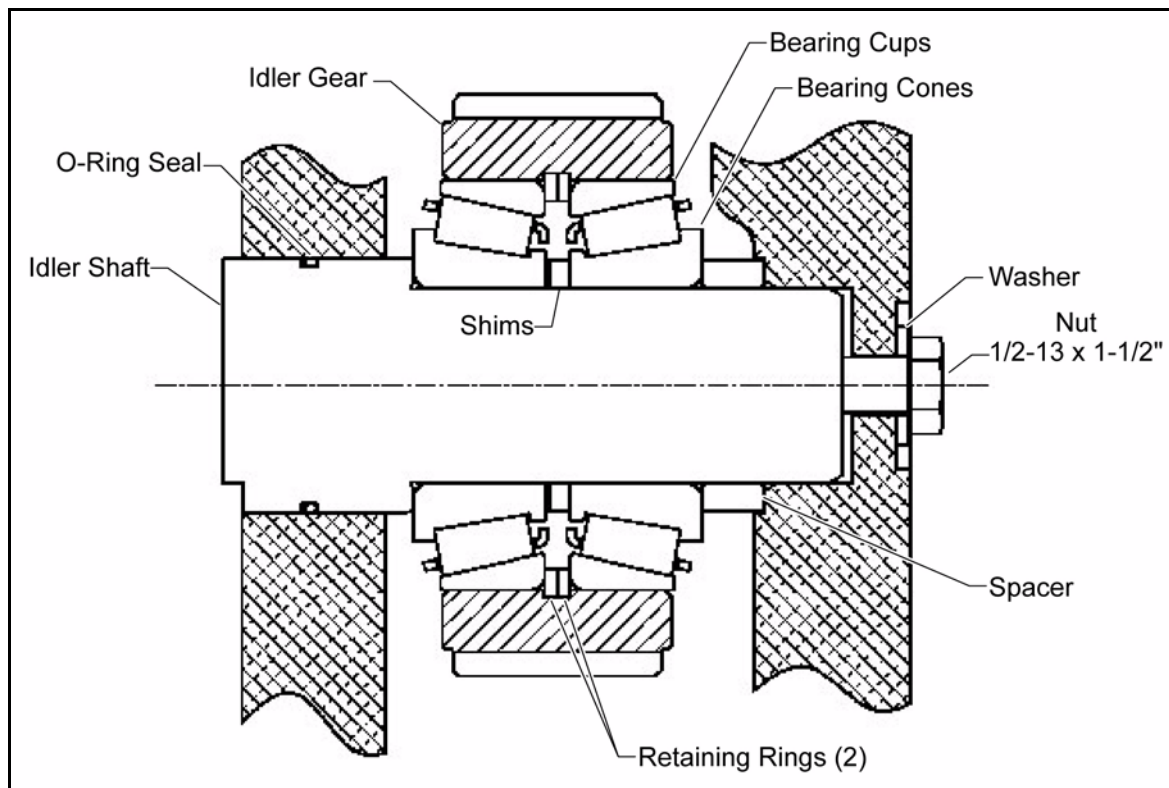


Figure 9-12: Idler Shaft Assembly

## Removal

1. Remove the gearbox cover, tail shaft, KPS, and input shaft.
2. Remove 1/2-13 x 1-1/2" screw and brass washer.
3. Insert a brass drift or similar into the 1/2-13 tapped hole and tap the idler shaft out of the gearbox housing.
4. Remove idler gear assembly and spacer from gearbox housing.
5. Begin disassembling the idler gear assembly by removing the bearing cups, shims, and inner spacer.
6. Next, tap the bearing cones from the idler gear. Take care not to damage the gear.
7. Using retaining ring pliers, remove the two retaining rings from the idler gear.
8. Remove O-ring from idler shaft.

### Inspection

1. Clean bearings and other components using parts cleaner.
2. Carefully inspect bearings and seals for signs of excessive wear.  
The bearings, shims, and spacers are a matched set and must be replaced as a unit. Order a new set using Hale p/n: 250-8310-00-0.
3. Obtain new components from Hale Products as appropriate.

### Installation

1. Assemble the idler gear assembly by first installing the two retaining rings into the idler gear using retaining ring pliers.
2. Next press the bearing cups into the idler gear.
3. Finish the assembly by installing the bearing spacer, shims, and cones.
4. Install the O-ring on the idler shaft.
5. With the gearbox housing horizontal, partially insert the idler shaft into the housing, and slide the idler gear assembly and spacer onto the shaft.
6. Apply Loctite 246 (or equal) to the 1/2-13 x 1-1/2" screw and brass washer.  
Tighten screw to 75 ft.-lb. (102 N-m). This will pull the shaft into the housing.
7. Install the input shaft, KPS, tail shaft, and gearbox cover.



## 10 Installation

### 10.1 OVERVIEW

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

### 10.2 MOUNTING

Also see Section “Installation and Parts Drawings,” located at the back of this manual.

- ☐ Plate # 923A ..... Qpak Installation
- ☐ Plate # 887A ..... Qmax Installation
- ☐ Plate # 884A ..... Qflo Installation
- ☐ Plate # 889A ..... Qtwo Installation
- ☐ Plate # 1159 ..... Qmax K
- ☐ Plate # 1173 ..... Qtwo K



#### **IMPORTANT!**

**TO FULLY SUPPORT THE MIDSHIP MUSCLE PUMP ASSEMBLY, USE ALL MOUNTING BOLT HOLES PROVIDED IN THE MIDSHIP PUMP HOUSING. ALSO SEE FIGURE 7-1: “LIFTING EYEBOLT ATTACHMENT LAYOUT” ON PAGE 174.**



#### **WARNING!**

**THE MIDSHIP 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 MIDSHIP PUMP AND GEARBOX ASSEMBLIES.**

#### **Mounting Holes**

Two 1/2-13 tapped holes mounting holes are provided for 1/2-13 UNC eyebolts. (See Figure 7-1: “Lifting Eyebolt Attachment Layout,” on page 174.)

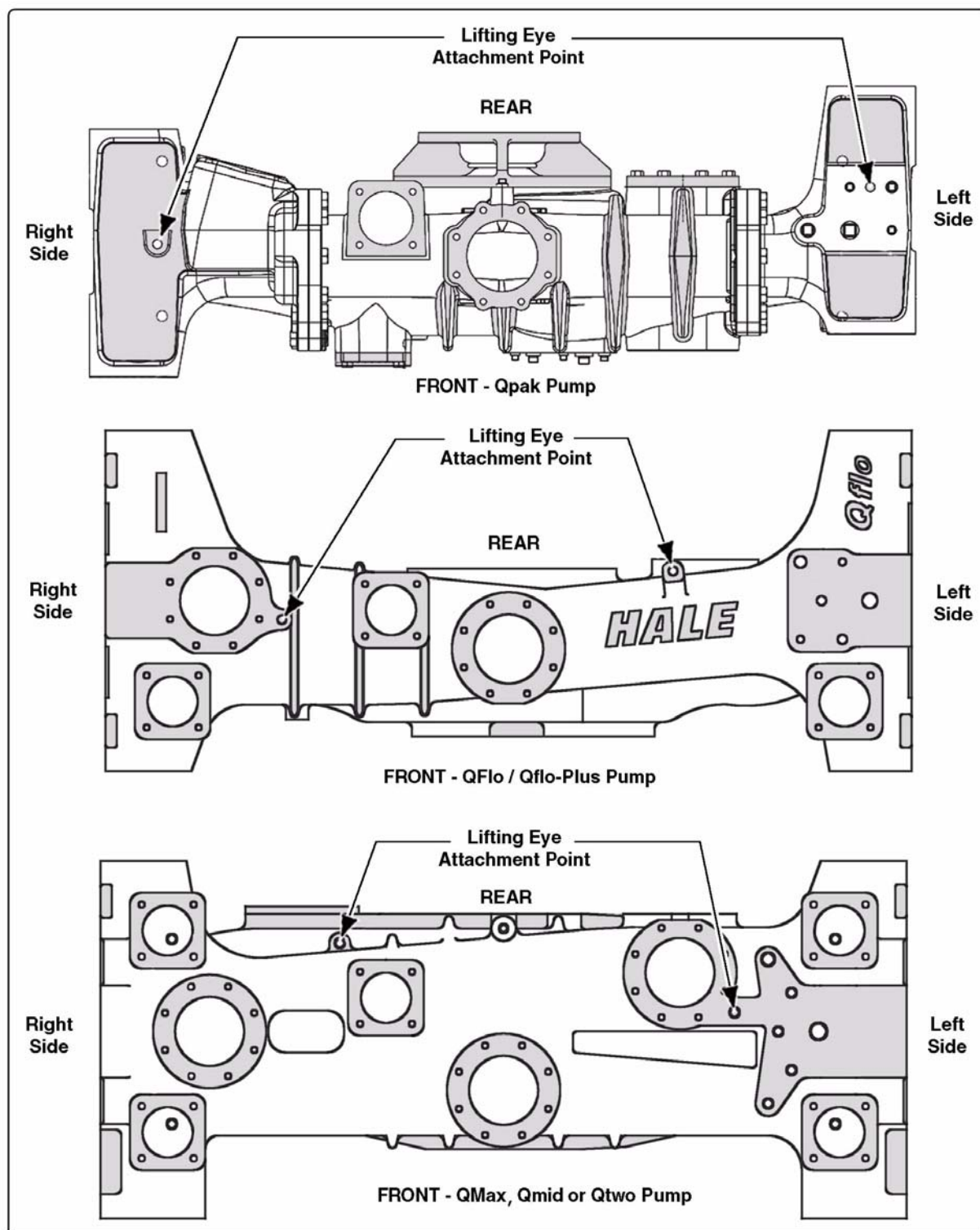


Figure 7-1: Lifting Eyebolt Attachment Layout

## 10.3 DRIVELINE ISSUES

### Drive Line and Flange Bolts

Ensure that:

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



### CAUTION!

**ALL FASTENERS ON THE HALE PUMP AND GEARBOX ASSEMBLY HAVE BEEN SELECTED FOR THEIR APPLICATION. HALE 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 use a bubble protractor to measure driveline angles. Use a digital inclinometer. Remember to zero the inclinometer on the truck frame, not the ground.
- ☐ Center the sliders.

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

Table 10-1: Maximum Recommended Driveline Lengths below lists the maximum driveline length using a safety factor of 42% of critical speed.

**Table 10-1: Maximum Recommended Driveline Lengths**

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)

This table is based on a 0.134" (3.4mm) 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.

## 10.4 PLUMBING CONNECTIONS

Also see Section “Installation and Parts Drawings,” located at the back of this manual for more detail.

- ☐ Plate # 923 ..... Qpak Installation
- ☐ Plate # 887 ..... Qmax Installation
- ☐ Plate # 1052 ..... Qflo Plus Installation
- ☐ Plate # 889 ..... Qtwo Installation

The midship muscle pumps offer a variety of suction and discharge arrangements to suite most applications and is dependent on model purchased. Review the above plate drawings for your model for additional information.

Other flanges and manifolds are available. Contact Hale Products at **610-825-6300**.

## 10.5 PANEL MOUNTED ACCESSORIES

Hale panel mounted accessories are designed with consideration given for proper drainage to prevent freezing. Due to the symmetry of the design, it is possible to install some accessories incorrectly - upside down. To insure proper installation, review the following:

- ☐ Panel mounted accessory devices must be installed above the level of the pump or a drain must be installed at the low point in the line. (Do not connect to the master drain.)
- ☐ All tubing connectors should be on the bottom of the device or pointed down to avoid traps and to provide natural drainage. Tubing should be installed with the shortest, most direct route and should not be “teed” for another purpose. No loops or bends that could create water traps should be allowed as an ice filled low spot could result in a safety device malfunction.
- ☐ All devices are designed to operate with the available water through 3/8” (9.5mm) ID tubing. If plastic or nylon tubing is being used that has a smaller ID, caution should be exercised since it could adversely affect the reaction time of the device.

## 10.6 FLUID LEVELS

To meet various shipping regulations, ALL fluids within the pump and gearbox assemblies (excluding the Auto-Lube) 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 RESERVOIR TO THE APPROPRIATE LEVELS. FOR THE PROPER OIL TO USE AND QUANTITY REQUIRED, SEE HEADING “REPLACE GEARBOX OIL” ON PAGE 80. ALSO SEE FIGURE 5-5: “MUSCLE PUMP SERVICE CHART, PART 2 OF 3” ON PAGE 89.**

The auto-lube assembly is NOT drained at shipment but must be checked prior to operation. To check the auto-lube for oil, see Step 18. of Section 7.6 “QMID/QMAX/QTWO AutoLube® Service” on page 116. Also see Figure 5-4: “Muscle Pump Service Chart, Part 1 of 3” on page 88.

## 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 mounted ahead of the vehicle's engine – usually on the front of the radiator.

**Pump**

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

**Pressure**

**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**.....The difference in pressure between discharge and suction pressure.

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

**Displacement Pump**

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

**Pressure**

**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.

**Valve** 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 B: Measurements and Conversions

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

**Table B-1: Conversion Chart**

To Convert	To	Multiply By
BAR	PSI	14.504
Feet of Head	Pounds Pressure	0.4331
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	6.895
Pounds per Square Inch (PSI)	Feet of Head	2.31

## This image shows a single 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.

## 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 .

**Table C-1: Alternate Lubricant Manufacturers (Sheet 1 of 2)**

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

Table C-1: Alternate Lubricant Manufacturers (Sheet 2 of 2)

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

## Appendix D: Lube and Sealant Specifications

Table D-1: Oil Capacity and Recommendation

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	B (Vertical)  B (Horizontal)  B (Inverted)	2	1.9	SAE 50 80W-90; 75W-80 Synthetic
APSM		1.5	1.4	SAE 50 80W-90; 75W-80 Synthetic
MBP		1.75	1.7	SAE 50 80W-90; 75W-80 Synthetic
MBPM				
4DB				
SBP				
QTWO / QMAX QPAK / QFLO QFLO PLUS DSD / SMD	G X, L and R Series	4	3.8	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.) Full Synthetic 75W-140
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.) 75W-80 Synthetic
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.)
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 60FBG	G	3	2.8	SAE EP90 80W-90 (Lubricants must meet service rating API GL-5.)

**Note:** \* 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
- ❑ Lubricate-Fiske #3000
- ❑ Shell Super Duty Grease
- ❑ Imperial #777
- ❑ Mobile Grease Special
- ❑ Sunoco Moly #2EP

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

- ❑ Green Grease for SVS Valves

## **Loctite Sealant**

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

## **Oil**

See “Alternate Lubricant Manufacturers” on page 185.

## **Recommended Cleaners**

- ❑ Safety Kleen®
- ❑ Stoddard Solvent



**IMPORTANT!**

**THE USE AND DISPOSAL OF SOLVENTS / CLEANERS MUST BE IN ACCORDANCE WITH YOUR LOCAL ENVIRONMENTAL REGULATIONS.**



## Appendix E: Hose Friction Loss

Table E-1: Hose Friction Loss (PSI (kPa) / 100 Feet)

GPM (LPM)	3/4" (19mm) Booster	1.0" (25mm) Booster	1-1/2" (38mm) Hose	GPM (LPM)	1-3/4" (44mm) Hose with 1-1/2" (38mm) Coupling	2.0" (52) Hose with 1-1/2" (38mm) Coupling	2-1/2" (65mm) Hose	3.0" (75mm) Hose with 2-1/2" (65mm) Coupling	3.0" (75mm) Hose	GPM (LPM)	3-1/2" (89mm) Hose	4.0" (100mm) Hose	5.0" (125mm) Hose
10 (38)	13.5 (93)	3.5 (24)		95 (360)	14 (97)	8 (55)				500 (1,893)	9.5 (66)	3 (34)	
20 (76)	44 (303)	6 (41)		125 (473)	24 (165)	13 (90)				750 (2,839)	20 (138)	11 (76)	5 (34)
30 (114)	99 (683)	14 (97)		150 (568)	35 (241)	18 (124)				1,000 (3,785)	34 (234)	20 (138)	8 (55)
40 (151)	176 (1213)	24 (165)	4 (28)	175 (662)	47 (324)	25 (172)	6 (41)			1,250 (4,732)	53 (365)	31 (214)	13 (90)
50 (189)		38 (262)	7 (48)	200 (757)	62 (427)	32 (221)	8 (65)			1,500 (5,678)	74 (510)	45 (310)	18 (124)
60 (227)		54 (372)	9 (62)	225 (852)			10 (69)			1,750 (6,625)		61 (402.6)	25 (172)
70 (265)			12 (83)	250 (946)			13 (90)	5 (34)	4 (28)	2,000 (7,571)			32 (221)
80 (303)			15 (103)	275 (1,041)			15 (103)						
95 (360)			22 (152)	300 (1,136)			18 (124)						
125 (473)			38 (262)	325 (1,230)			22 (151)	8 (55)					
150 (568)			54 (372)	350 (1,325)			25 (172)		8 (55)				
				500 (1,893)				20 (138)	17 (117)				
				750 (2,839)				45 (310)	36 (248)				
				1,000 (3,785)				80 (552)	68 (469)				

[illegible]

## Appendix F: Nozzle Size vs. Pressure

Table F-1: Nozzle Flow and Pressure Ratings (Part 1)

GPM (LPM) at Various Nozzle Sizes								
Nozzle Pressure	Nozzle Size in Inches (millimeters)							
PSI (kPa)	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 (207)	41 (155)	64 (242)	92 (348)	125 (473)	163 (617)	206 (780)	254 (962)	308 (1,166)
35 (241)	44 (167)	69 (261)	99 (375)	135 (511)	176 (666)	222 (840)	275 (1,041)	332 (1,257)
40 (276)	47 (178)	73 (296)	106 (401)	144 (545)	188 (711)	238 (901)	294 (1,113)	355 (1,334)
45 (310)	50 (189)	78 (295)	112 (424)	153 (579)	199 (753)	252 (954)	311 (1,177)	377 (1,437)
50 (345)	53 (201)	82 (310)	118 (447)	161 (610)	210 (795)	266 (1,007)	328 (1,242)	397 (1,503)
55 (379)	55 (208)	86 (326)	124 (469)	169 (640)	220 (833)	279 (1,056)	344 (1,302)	417 (1,647)
60 (414)	58 (220)	90 (341)	130 (492)	176 (666)	230 (871)	291 (1,102)	360 (1,363)	435 (1,363)
62 (427)	58 (220)	91 (345)	132 (500)	179 (678)	234 (886)	296 (1,121)	366 (1,385)	442 (1,673)
64 (441)	59 (223)	93 (352)	134 (507)	182 (689)	238 (901)	301 (1,139)	371 (1,404)	449 (1,700)
66 (455)	60 (227)	94 (356)	136 (515)	185 (700)	241 (912)	305 (1,155)	377 (1,427)	456 (1,726)
68 (469)	61 (231)	96 (363)	138 (522)	188 (711)	245 (927)	310 (1,174)	383 (1,450)	463 (1,753)
70 (482)	62 (235)	97 (367)	140 (530)	190 (719)	248 (939)	315 (1,192)	388 (1,469)	470 (1,779)
72 (496)	63 (238)	99 (375)	142 (538)	193 (731)	252 (954)	319 (1,208)	394 (1,492)	477 (1,806)
74 (510)	64 (242)	100 (379)	144 (545)	196 (742)	255 (965)	323 (1,223)	399 (1,510)	483 (1,828)
76 (524)	65 (246)	101 (382)	146 (553)	198 (750)	259 (980)	328 (1,242)	405 (1,553)	490 (1,855)
78 (538)	66 (250)	103 (390)	148 (560)	201 (761)	262 (992)	332 (1,257)	410 (1,552)	496 (1,878)
80 (552)	66 (250)	104 (394)	150 (568)	203 (768)	266 (1,007)	336 (1,272)	415 (1,571)	502 (1,900)
85 (586)	68 (257)	107 (405)	154 (583)	210 (795)	274 (1,037)	347 (1,314)	428 (1,620)	518 (1,961)
90 (620)	70 (265)	110 (416)	159 (602)	216 (818)	282 (1,067)	357 (1,351)	440 (1,666)	533 (2,018)
95 (655)	72 (273)	113 (428)	163 (617)	222 (840)	289 (1,094)	366 (1,386)	452 (1,711)	547 (2,071)
100 (689)	74 (280)	116 (439)	167 (362)	228 (863)	297 (1,124)	376 (1,423)	464 (1,756)	562 (2,127)
105 (724)	76 (288)	119 (451)	171 (647)	233 (882)	304 (1,151)	385 (1,457)	476 (1,802)	575 (2,177)
110 (758)	78 (295)	122 (462)	175 (663)	239 (905)	311 (1,117)	394 (1,492)	487 (1,844)	589 (2,230)
115 (793)	80 (303)	125 (473)	179 (678)	244 (924)	319 (1,208)	403 (1,526)	498 (1,885)	602 (2,279)
120 (827)	81 (307)	127 (481)	183 (712)	249 (943)	325 (1,203)	412 (1,560)	509 (1,927)	615 (2,328)

Table F-2: Nozzle Flow and Pressure Ratings (Part 2)

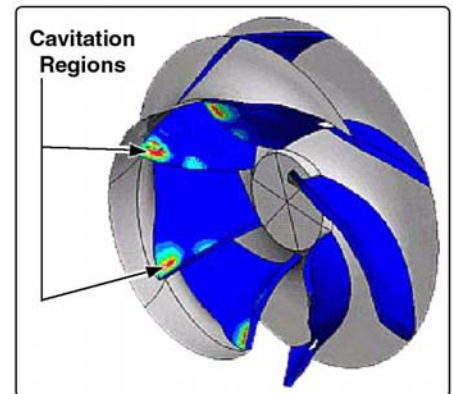
GPM (LPM) at Various Nozzle Sizes								
Nozzle Pressure	Nozzle Size in Inches (millimeters)							
PSI (kPa)	1-1/2" (38)	1-5/8" (41)	1-3/4" (44)	1-7/8" (48)	2.0" (51)	2-1/4" (57)	2-1/2" (65)	3.0" (75)
30 (207)	366 (1,386)	430 (1,628)	498 (1,885)	572 (2,065)	651 (2,464)	824 (3,119)	1,017 (3,850)	1,464 (5,542)
35 (241)	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 (276)	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 (310)	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 (345)	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 (379)	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 (414)	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 (427)	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 (441)	535 (2,025)	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 (455)	543 (2,055)	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 (469)	551 (2,086)	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 (482)	559 (2,116)	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 (496)	567 (2,146)	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 (510)	575 (2,177)	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 (524)	583 (2,207)	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 (538)	590 (2,233)	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 (552)	598 (2,264)	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 (586)	616 (2,332)	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 (620)	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 (655)	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 (689)	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 (724)	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 (758)	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 (793)	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 (827)	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)

## Appendix G: Cavitation

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

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

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



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

### G.1 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 G-1: “Sample, Cavitation Regions.”)

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

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

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

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

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

## **G.2 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.

## **G.3 ELIMINATING 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 Table G-1: "Lift Loss from Elevation.")*

**Table G-1: Lift Loss from Elevation**

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

- 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. Table G-2: "Lift Loss from Temperature" shows the amount of lift loss as temperatures rise.

**Table G-2: Lift Loss from Temperature**

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

## ☐ Cavitation

- ☐ Monitor barometric pressure. NFPA standard sets a baseline of 29.9" Hg. (See Table G-3: "Lift Loss from Barometric Reading.")

**Table G-3: Lift Loss from Barometric Reading**

Barometric Reading in. (mb)		Lift Loss, Head Ft. (Meters)	
29.9	(1,012.5)	NFPA Base Line - 2.38 ft. (0.73 m)	
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)

- ☐ 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 197.

## Preventive Measures

- ☐ Consider the size of the suction hose. Table G-4: "Hose Size vs. Pump Rating Capacity" on page 196, lists the NFPA pre-selected hose sizes for each pump-rating capacity. Using the appropriately sized hose minimizes the occurrence of cavitation. An undersized suction hose can lead to cavitation.
- ☐ Consider the piping within the truck. Suction losses can result from additional suction piping added to the fire pump during assembly.

**Table G-4: Hose Size vs. Pump Rating Capacity (Sheet 1 of 2)**

Hose Diameter in. (mm)	3" (75)	4" (100)	4.5" (110)	5" (125)	6" (150)	Dual 6" (150)	Triple 6" (150)
Flow - gpm (lpm)	Lift Loss gpm (lpm)						
250 (1,000)	5.2 (1.6)						
350 (1,300)		2.5 (0.7)					
500 (2,000)		5.0 (1.5)	3.6 (1.5)				
750 (3,000)		11.4 (3.5)	8.0 (3.5)	4.7 (1.4)	1.9 (0.6)		
1,000 (4,000)			14.5 (4.4)	8.4 (2.6)	3.4 (1.0)		
1,250 (5,000)				13.0 (4.0)	5.2 (1.6)		
1,500 (6,000)					7.6 (2.3)	1.9 (0.6)	
1,750 (7,000)						2.6 (0.8)	
2,000 (8,000)						3.4 (1.3)	



Table G-4: Hose Size vs. Pump Rating Capacity (Sheet 2 of 2)

Hose Diameter in. (mm)	3" (75)	4" (100)	4.5" (110)	5" (125)	6" (150)	Dual 6" (150)	Triple 6" (150)
Flow - gpm (lpm)	Lift Loss gpm (lpm)						
2,250 (9,000)						4.3 (1.3)	2.0 (0.6)
2,500 (10,000)						5.2 (1.6)	2.3 (0.7)

- ☐ 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 6 "Troubleshooting" on page 93.
- ☐ 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.

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

## Appendix H: Midship Flow Rates

**Table F-1: Midship Flow Rates (Sheet 1 of 2)**

Model	Type	Capacity
Qpak 50 Qpak 200M	Single-Stage Midship Muscle Pump.	500 GPM at 150 PSI 2,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qpak 75 Qpak 300M	Single-Stage Midship Muscle Pump.	750 GPM at 150 PSI 3,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qpak 100	Single-Stage Midship Muscle Pump.	1,000 GPM at 150 PSI PER NFPA 1901 Standard
Qflo 75 Qflo 300M	Single-Stage Midship Muscle Pump.	750 GPM at 150 PSI 3,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qflo 100 Qflo 400M	Single-Stage Midship Muscle Pump.	1,000 GPM at 150 PSI 4,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qflo 125	Single-Stage Midship Muscle Pump.	1,250 GPM at 150 PSI PER NFPA 1901 Standard
Qflo PLUS 75 Qflo PLUS 300M	Single-Stage Midship Muscle Pump.	750 GPM at 150 PSI 3,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qflo PLUS 100 Qflo PLUS 400M	Single-Stage Midship Muscle Pump.	1,000 GPM at 150 PSI 4,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qflo PLUS 125 Qflo PLUS 500M	Single-Stage Midship Muscle Pump.	1,250 GPM at 150 PSI 5,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qmid 100 Qmid 400M	Single-Stage Midship Muscle Pump.	1,000 GPM at 150 PSI 4,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qmid 125 Qmid 500M	Single-Stage Midship Muscle Pump.	1,250 GPM at 150 PSI 5,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qmax 100 Qmax 400M	Single-Stage Midship Muscle Pump.	1,000 GPM at 150 PSI 4,000 LPM at 1,000 kPA PER NFPA 1901 Standard
Qmax 125 Qmax 500M	Single-Stage Midship Muscle Pump.	1,250 GPM at 150 PSI 5,000 LPM at 1,000 kPA PER NFPA 1901 Standard

## □ Midship Flow Rates

**Table F-1: Midship Flow Rates (Sheet 2 of 2)**

Model	Type	Capacity
Qmax 150 Qmax 600M	Single-Stage Midship Muscle Pump.	1,500 GPM at 150 PSI 6,000 LPM at 1,000 kPa PER NFPA 1901 Standard
Qmax 175 Qmax 700M	Single-Stage Midship Muscle Pump.	1,750 GPM at 150 PSI 7,000 LPM at 1,000 kPa PER NFPA 1901 Standard
Qmax 200 Qmax 800M	Single-Stage Midship Muscle Pump.	2,000 GPM at 150 PSI 8,000 LPM at 1,000 kPa PER NFPA 1901 Standard
Qmax 225	Single-Stage Midship Muscle Pump.	2,250 GPM at 150 PSI PER NFPA 1901 Standard
Qtwo 100 Qtwo 400M	Two-Stage, Heavy-Duty Midship Muscle Pump.	1,000 GPM at 150 PSI 4,000 LPM at 1,000 kPa PER NFPA 1901 Standard
Qtwo 125 Qtwo 500M	Two-Stage, Heavy-Duty Midship Muscle Pump.	1,250 GPM at 150 PSI 5,000 LPM at 1,000 kPa PER NFPA 1901 Standard
Qtwo 150 Qtwo 600M	Two-Stage, Heavy-Duty Midship Muscle Pump.	1,500 GPM at 150 PSI 6,000 LPM at 1,000 kPa PER NFPA 1901 Standard
Qtwo 175 Qtwo 700M	Two-Stage, Heavy-Duty Midship Muscle Pump.	1,750 GPM at 150 PSI 7,000 LPM at 1,000 kPa PER NFPA 1901 Standard
Qtwo 200	Two-Stage, Heavy-Duty Midship Muscle Pump.	2,000 GPM at 150 PSI PER NFPA 1901 Standard



### **Hale Products Inc.**

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Web ..... [www.haleproducts.com](http://www.haleproducts.com)

## 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.

**THE REMEDIES PROVIDED ARE THE SOLE AND EXCLUSIVE REMEDIES AVAILABLE. IN NO EVENT SHALL HALE BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGE INCLUDING, WITHOUT LIMITATION, LOSS OF LIFE; PERSONAL INJURY; DAMAGE TO REAL OR PERSONAL PROPERTY DUE TO WATER OR FIRE; TRADE OR OTHER COMMERCIAL LOSSES ARISING, DIRECTLY OR INDIRECTLY, OUT OF PRODUCT FAILURE.**



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Web ..... [www.haleproducts.com](http://www.haleproducts.com)

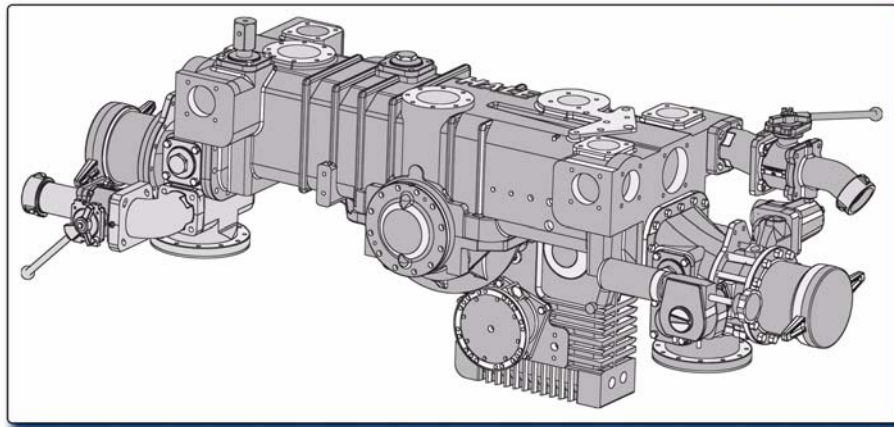




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# MUSCLE (Midship) Pumps ("Q" Series)

## Drawing Package Part 2



**Hale Products Inc.** ♦ A Unit of IDEX Corporation  
700 Spring Mill Avenue ♦ Conshohocken, PA 19428 U.S.A.  
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ECN No	REV	CHANGE FROM	BY	DATE	APVD	 <b>HALE PRODUCTS, INC.</b> A Unit of IDEX Corporation Conshohocken, PA 19428 USA			
	A	INITIAL RELEASE			MAL				
	B								
0956	C	Complete Rewrite	LwH	01/01/2006					
						WRITTEN BY	LwH	ISSUE DATE	COPYRIGHT ©
						CHECKED BY	TG	01/01/2006	NOT TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY.



# Contents - continued

## 8 Drawings - continued ..... Plate Number

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Anti-Corrosion Anode ..... 869A  
Booster Pump Mounting, High Pressure ..... 705B  
P Series Relief Valve - Option ..... 547C  
PVG Priming Valve - Option ..... 480G  
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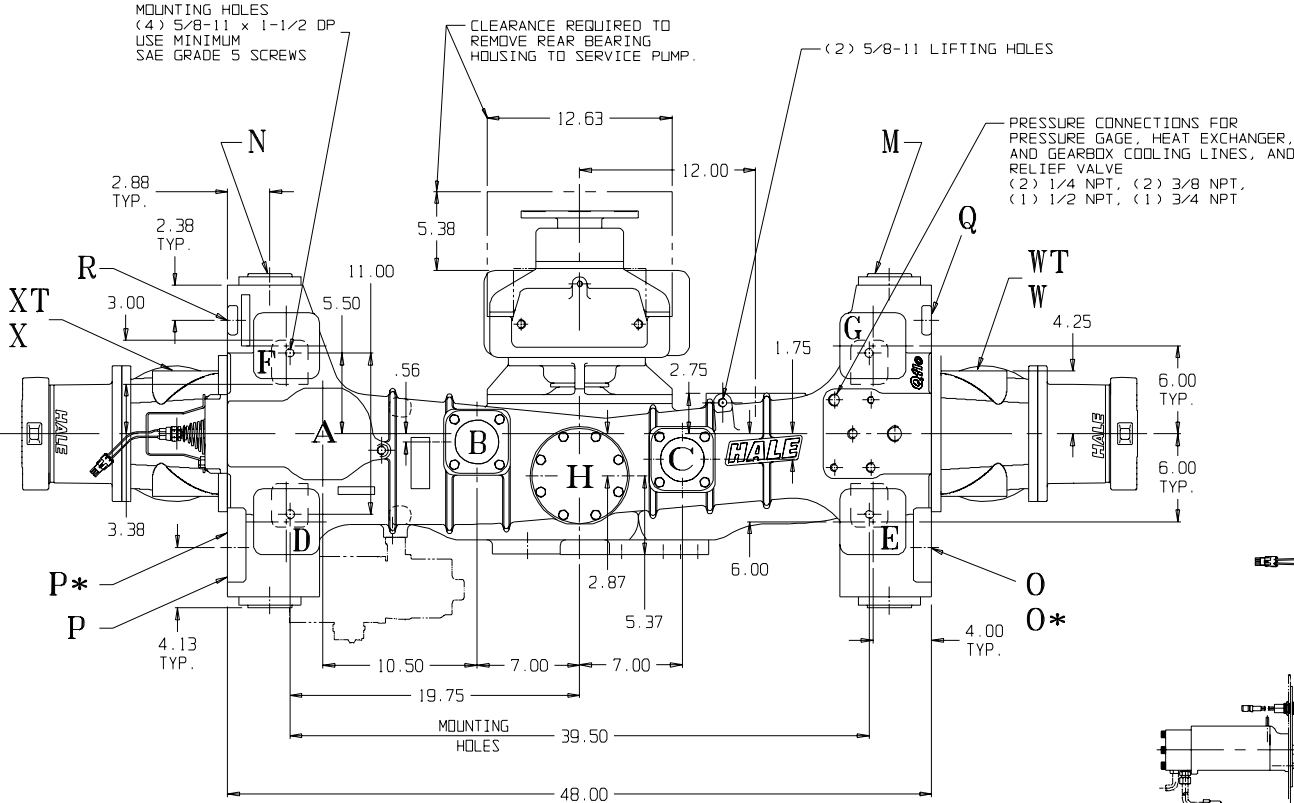
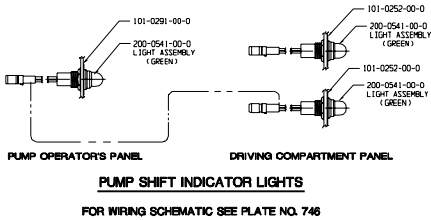
## Notes

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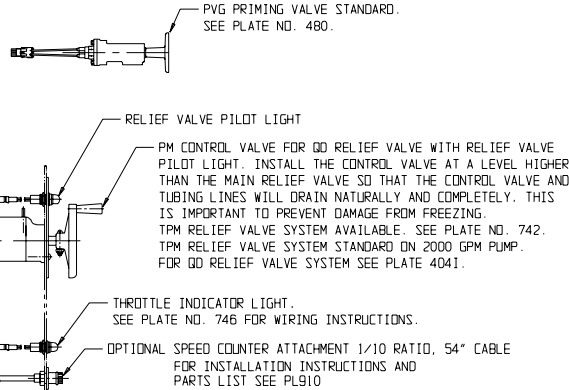
OPTIONAL DISCHARGE FLANGES			
	STANDARD	OPTIONAL	STANDARD HOLE
A	—	2-1/2, 3 & 4 NPT	CAST SOLID
B	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
C	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
D	—	1-1/4, 2, 2-1/2 & 3 NPT	CAST SOLID
E	—	1-1/4, 2, 2-1/2 & 3 NPT	CAST SOLID
F	—	1-1/4, 2, 2-1/2 & 3 NPT	CAST SOLID
G	—	1-1/4, 2, 2-1/2 & 3 NPT	CAST SOLID
H	BLANK	2-1/2, 3 & 4 NPT	4
K	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
L	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
M	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
N	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
O	—	1-1/4, 2, 2-1/2, 3 NPT	3
P	—	1-1/4, 2, 2-1/2, 3 NPT	3
Q	—	1-1/4, 2, 2-1/2 & 3 NPT	3
R	—	1-1/4, 2, 2-1/2 & 3 NPT	3
S	—	TANK SUCTION	3
UT	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
VT	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
WT	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
XT	BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
O*	BLANK	2-1/2, 3 AND 4 NPT	4
P*	BLANK	2-1/2, 3 AND 4 NPT	4

NOTES:

1. REFER TO HALE PUMP/ENGINE COMBINATION LIST TO SELECT PROPER RATIO TO MATCH PUMP WITH ENGINE.  
2. WEIGHT OF STANDARD QFLO PLUS 1250 G.P.M. PUMP AS SHOWN LESS PRIMING PUMP = 1100 LBS.



SUCTION (VACUUM) CONNECTIONS FOR VACUUM GAGE, HEAT EXCHANGER AND GEARBOX COOLING RETURNS, AND STRAINER FOR TPM RELIEF VALVE  
(2) 1/4 NPT  
(1) 1/2 NPT  
(1) 3/4 NPT



(2) FRONT AND (2) REAR OPENINGS MACHINED FOR 115 SERIES FLANGES  
STANDARD: FRONT AND REAR BLANK  
OPTIONAL: 1-1/4 NPT, 2 NPT, 2-1/2 NPT or 3 NPT, ALSO TRV, TRV-L or ANODE

3/4 NPT PRIMING TAP  
ALL PRIMING CONNECTIONS TO BE MADE HERE

TANK SUCTION CONNECTION  
STANDARD: BLANK FLANGE  
OPTIONAL: 2-1/2 NPT, 3 NPT or 4 NPT FLANGE, 3" OR 4" SVS VALVE and/or CHECK VALVE

SUCTION TUBES AVAILABLE IN 4-1/2, 5 and 6 NS THREAD  
STANDARD LENGTH: 6" LONG  
OPTIONAL LENGTH: 9" LONG  
ALSO AVAILABLE ONLY IN 6 NS THREAD ARE 4" and 7" LONG TUBES (SEE PLATE NO. 831)

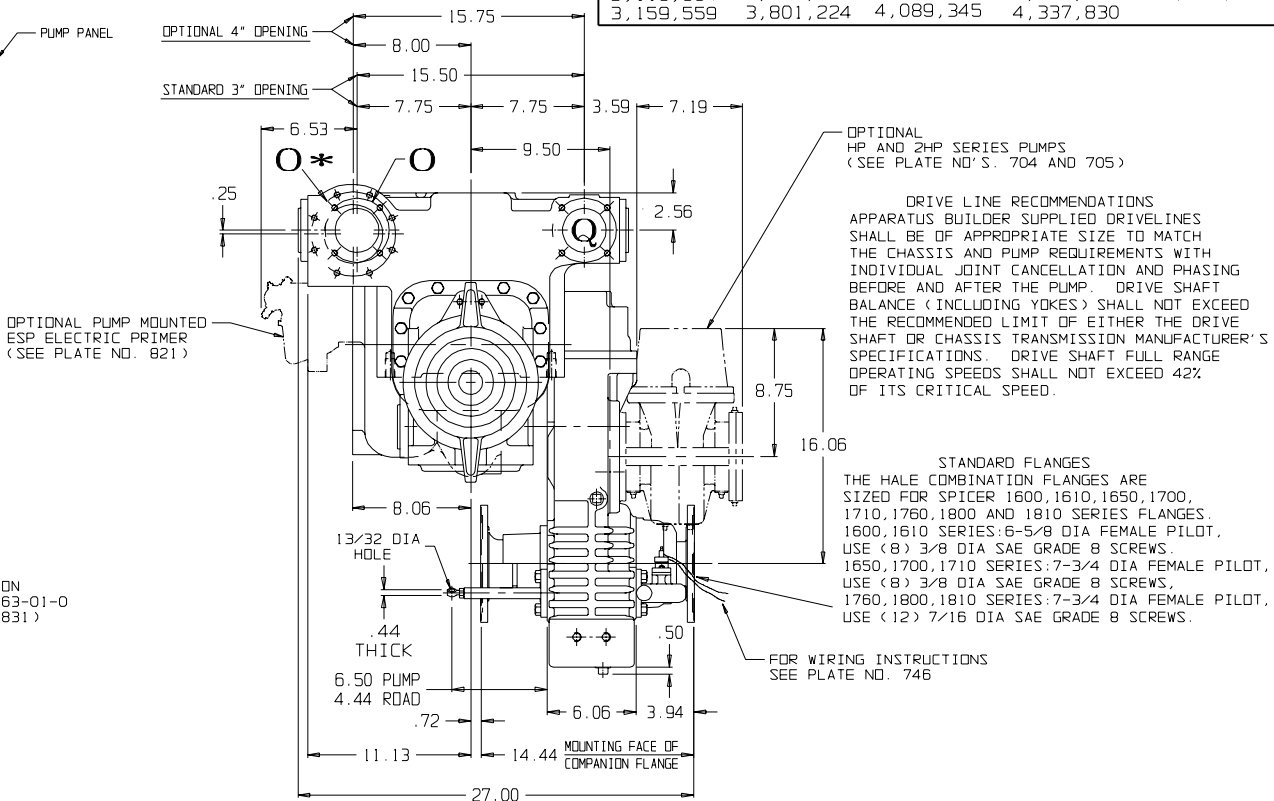
STANDARD SUCTION EXTENSION  
178-0063-00-0  
(SEE PLATE NO. 831)

OPTIONAL MASTER INTAKE VALVE (NOT SHOWN) AVAILABLE FOR MOUNTING BETWEEN THE SUCTION TUBE AND MIV SUCTION TUBE EXTENSION ON LEFT, RIGHT OR BOTH SIDES. ALSO AVAILABLE ON BOTTOM FLANGED OPENING.  
(SEE PLATE NO. 814, 815, 841 & 842)

1/4 NPT  
(2) DRAIN TAPS  
(1) EACH SIDE  
OIL LEVEL  
3/4 NPT PLUG.  
SAE EP-90 OR  
80W-90 API GL-5 OIL.  
APPROX. CAPACITY:  
LONG GEARBOX = 4 QTS.

3/4 NPT MAGNETIC DRAIN PLUG

DRIVE UNIT SHIFT  
STANDARD: MANUAL  
OPTIONAL: VPS POWER SHIFT  
(SEE PLATE NO. 533)



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0167	B	WAS CAST SOLID	ERB08-05-05	MAL
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CHECKED: MAL  
DATE 10-11-04  
SIZE: E  
SCALE: 25

PLATE NO. 1052AB

## Notes

[illegible]

THIS PRODUCT AND ITS COMPONENTS MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING: 4,089,345, 4,209,282, 4,311,440, 4,337,830 4,587,862, 4,653,978, 5,018,665, 5,139,393

SAE REGULAR DRIVE CONNECTION  
.205 - .210 ROUND DRIVE 7/8-18 THREAD

007-0040-00-0 - SPEED COUNTER DRIVE ADAPTER  
REPLACED WITH PLUG 217-3007-00-0 (NOT SHOWN)  
WHEN SPEED COUNTER OPTION IS NOT ORDERED

031-0170-00-0 SPEED COUNTER GEAR

NOT SHOWN

SPEED COUNTER DRIVEN GEAR BUSHING - 048-0070-00-0  
SUPPORTS END OF DRIVEN GEAR IN FRONT BEARING CAP

STANDARD FRONT BEARING CAP

MATING CONNECTOR NOT PROVIDED BY HALE  
TERMINAL A CONNECTS TO BATTERY & TERMINAL B CONNECTS TO SOLENOID

(REF) PUMP BODY  
010-0040-00-0 VALVE STRAINER  
040-2260-00-0 SEAL RING  
005-0010-00-0 3/4 NPT PLATE

012-0160-00-0 T-HANDLE

3/4 NPT

### PVG PRIMING VALVE

SEE PLATE NO. 480 FOR  
INSTALLATION DETAILS

### ESP PRIMING PUMP

SEE PLATE NO. 821 FOR  
INSTALLATION DETAILS

STANDARD:  
(1) 115-0010-00-0 BLANK FLANGE  
(1) 046-0060-00-0 GASKET  
(8) 018-1812-02-0  
7/16-14 X 1-1/4 LG SCREW

OPTIONAL:  
2-1/2 NPT FLG (115-0020-00-0)  
3 NPT FLANGE (115-0030-00-0)  
4 NPT FLANGE (115-0040-00-0)  
3" SVS VALVE OR 4" SVS VALVE  
and/or CHECK VALVE

(8) 018-1812-02-0  
7/16-14 X 1-1/4 LG SCREW

115-0010-00-0 FLANGE  
046-0060-00-0 GASKET

PRESSURE TAPS  
(2) 1/4 NPT PLUG  
217-0201-00-0  
(2) 3/8 NPT PLUG  
217-0301-00-0  
(1) 1/2 NPT PLUG  
217-0401-00-0  
(1) 3/4 NPT PLUG  
217-0501-00-0

VACUUM TAPS  
(2) 1/4 NPT PLUG  
217-0201-00-0  
(1) 1/2 NPT PLUG  
217-0401-00-0  
(1) 3/4 NPT PLUG  
217-0501-00-0

HALE  
PATENTED

CAUTION

SN

048-0090-00-0 DRIVE SLEEVE PROVIDES TAKE-OFF  
POINT FOR USE WITH HAND HELD TACHOMETER

SAE LIGHT DUTY DRIVE CONNECTION  
.104 - .101 SQUARE DRIVE: 5/8-18 THREAD

ROTATION

DUST CAP (SUPPLIED WITH DRIVE SLEEVE)  
AVAILABLE SEPARATELY AS 008-0070-00-0

(1) HOLE .688 DIA.

.654  
.658

(1) HOLE .188 DIA.

HOLE SIZES FOR PANEL MOUNTING

013-0010-00-0 - FLEXIBLE SHAFT ASSEMBLY  
54.00 (FLEXIBLE SHAFT CASE LENGTH)  
55.58 (FLEXIBLE SHAFT CORE LENGTH)  
WITH NO END CONNECTIONS AS NOTED

MULTIPLY MEASURED SPEED AT TAKE-OFF POINT  
BY 10 FOR ACTUAL GEARBOX INPUT SPEED.

### OPTIONAL SPEED COUNTER DETAILS

FOR INSTALLATION INSTRUCTIONS AND  
PARTS LIST SEE PL910

THROTTLE INDICATOR LIGHT

SEE PLATE NO. 746  
FOR WIRING INSTRUCTIONS

TO GROUND

TO SWITCH

PM CONTROL VALVE  
& PILOT LIGHT

PUMP OPERATORS PANEL

101-0381-00-0 OPERATOR PANEL PLATE

048-0090-00-0 ADAPTER

OPTIONAL SPEED COUNTER  
ATTACHMENT (10 TO 1 RATIO)

008-0070-00-0 CAP

### SEE PLATE NO. 914 FOR "G" SERIES GEARBOX

BEARING HSG NO.	LG GEARBOX	XG GEARBOX
062-0770-00-0	Qflo Plus-23L & Qflo Plus-15L	Qflo Plus-28X & Qflo Plus-19X
062-0770-01-0	Qflo Plus-21L & Qflo Plus-17L	Qflo Plus-25X & Qflo Plus-21X
062-0770-02-0	Qflo Plus-19L	Qflo Plus-23X

(2) 250-0211-20-0 BEARING 211W

NO. OF TEETH	GEAR PART NO.	PUMP MODEL	PUMP MODEL
18	031-0920-00-0	Qflo Plus-23L	Qflo Plus-28X
20	031-0930-00-0	Qflo Plus-21L	Qflo Plus-25X
22	031-0940-00-0	Qflo Plus-19L	Qflo Plus-23X
24	031-0950-00-0	Qflo Plus-17L	Qflo Plus-21X
26	031-0960-00-0	Qflo Plus-15L	Qflo Plus-19X

048-0170-00-0 SHIM  
AS REQUIRED

044-0260-00-0 AIR VENT

250-0409-00-0 409K BEARING

017-0300-00-0 KEY

097-0830-01-0 WASHER

	LG	XG
GEARBOX HOUSING ASSY	504-0340-00-0	504-0510-00-0
SCREW	018-2014-02-0	018-2014-02-0
GASKET	046-6370-01-0	046-6370-01-0

(1) 018-2412-02-0  
5/8-11 X 1-1/4 LG SCREW

017-0110-00-0 KEY  
017-0110-00-0 KEY

(B) 016-1080-00-0 INDUCER (5000L)

(B) 037-2300-00-0 SHAFT/PUMP (5000L)

064-5070-01-0 COTTER PIN (USED FOR BOTH CONFIGURATIONS)

037-5140-00-0 SHAFT/PUMP

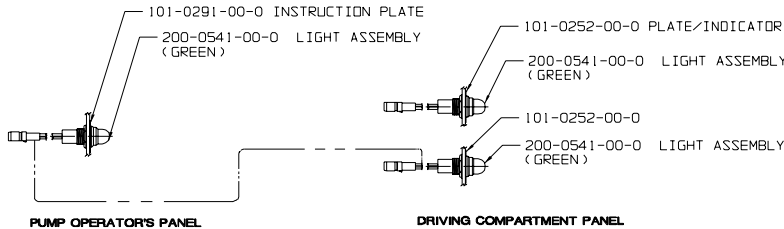
110-7040-00-0 (USED FOR BOTH CONFIGURATIONS)

1/4 NPT DRAIN (BOTH SIDES)

321-0040-00-0 CLEARANCE RING

(12) 018-1814-25-0 7/16-14 X 1-1/2 LG. (GRADE 8) SCREW

(8) 018-1812-02-0 7/16-14 X 1-1/4 LG. SCREW



### PUMP SHIFT INDICATOR LIGHTS

FOR WIRING SCHEMATIC SEE PLATE NO. 746

#### NOTES:

- SEE LIMIT CHART, HALE DOCUMENT F-72 FOR MAXIMUM ALLOWABLE PUMP PRESSURE, ENGINE HORSEPOWER AND TORQUE LIMITS FOR HALE CENTRIFUGAL PUMPS.
- APPLY LOCTITE # 246 HIGH TEMPERATURE THREAD LOCKER OR EQUIVALENT TO SCREW THREADS AND TORQUE SCREWS PER HALE ENGINEERING STANDARD ESO18-002

## HALE TYPE Qflo Plus SERIES PUMP WITH "G" SERIES GEARBOX

0176	C	WAS 13 FLANGES	ERB	08-08-05	MAL
04-246	B	ADDED B1 AND B2 FOR 5000L PUMP	FAS	12-13-04	MAL
04-256	A	RELEASE FOR PRODUCTION	FAS	10-15-04	MAL
ECO NO	REV	CHANGED FROM	BY	DATE	APVD



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A Unit of IDEX Corporation  
Conshohocken, PA 19428 USA

COPYRIGHT ©	DRAWN	FAS	DATE	10-15-04	SIZE	SCALE	: .25
NOT TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY.	CHECKED	MAL					

# PLATE NO. 1053AC

## Notes

[illegible]

THIS PRODUCT AND ITS COMPONENTS  
MAY BE PROTECTED BY ONE OR MORE  
OF THE FOLLOWING U.S. PATENTS AND  
OTHER PATENTS PENDING:  
4,089,345  
4,209,282  
4,311,440  
4,337,830  
4,587,862  
4,653,978  
5,018,665  
5,139,393



SERIAL NUMBER LOCATION

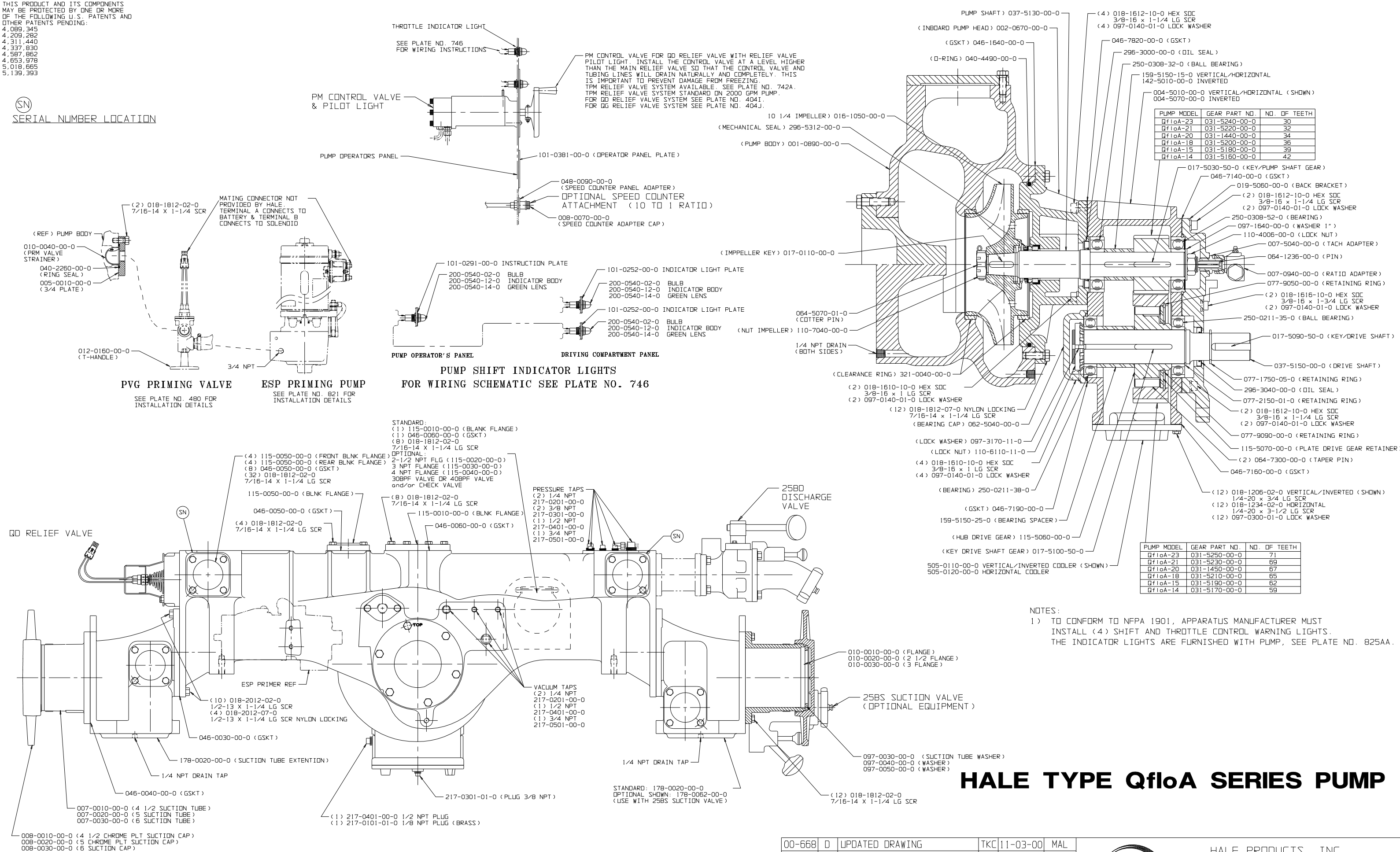


PLATE NO. 904AD

HALE TYPE Qf1oA SERIES PUMP

00-668	D	UPDATED DRAWING	TKC	11-03-00	MAL
00-458	C	UPDATED DRAWING	DJK	5-18-00	MAL
00-445	B	UPDATED DRAWING	DJK	4-10-00	MAL
98-188	A	RELEASE FOR PRODUCTION	DLM	9-1-98	RET
ECO NO	REV	CHANGED FROM	BY	DATE	APVD



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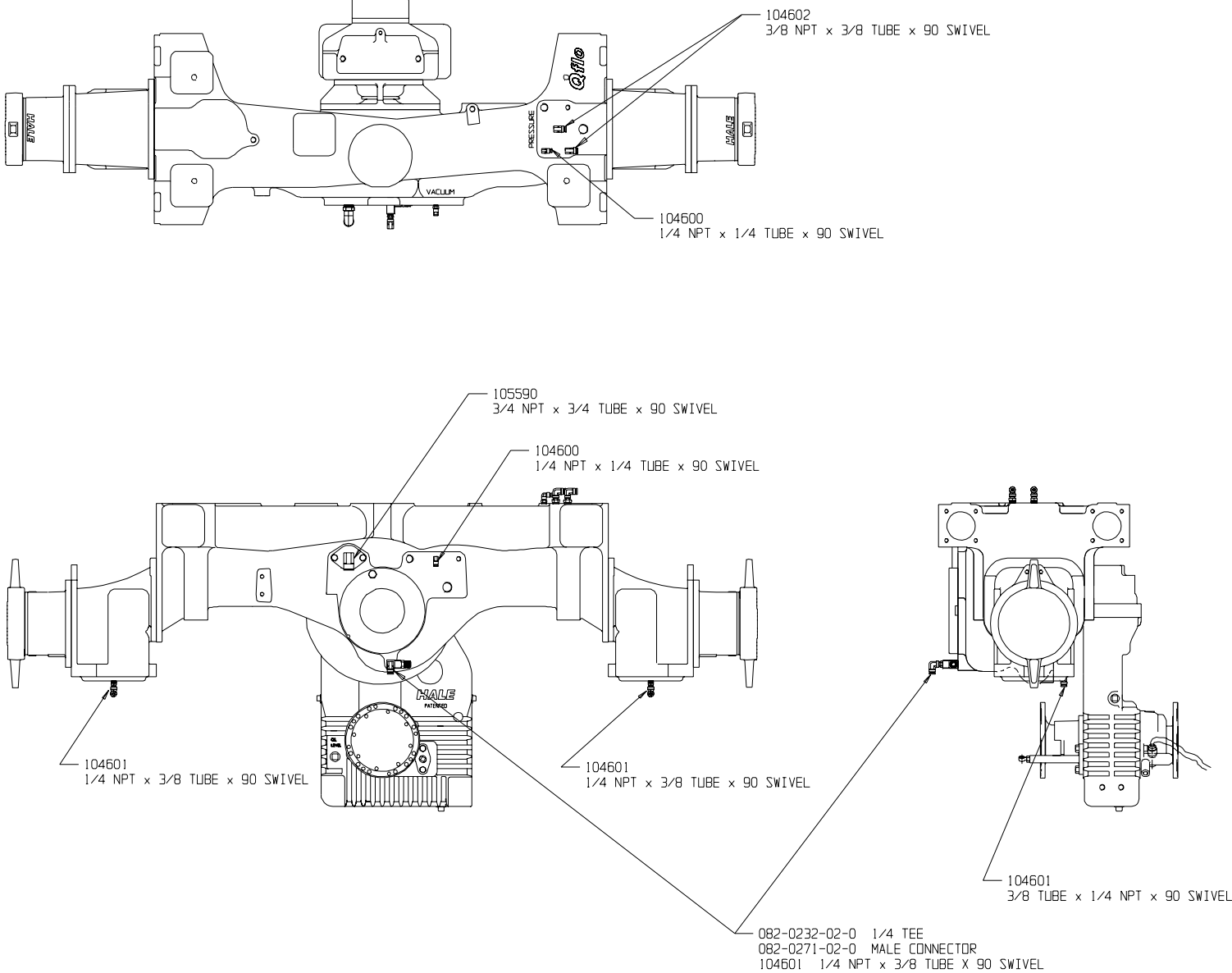
## Notes

[illegible]



# HALE Q-FLO AND Q-MAX FITTINGS

Q-FLO



Q-MAX

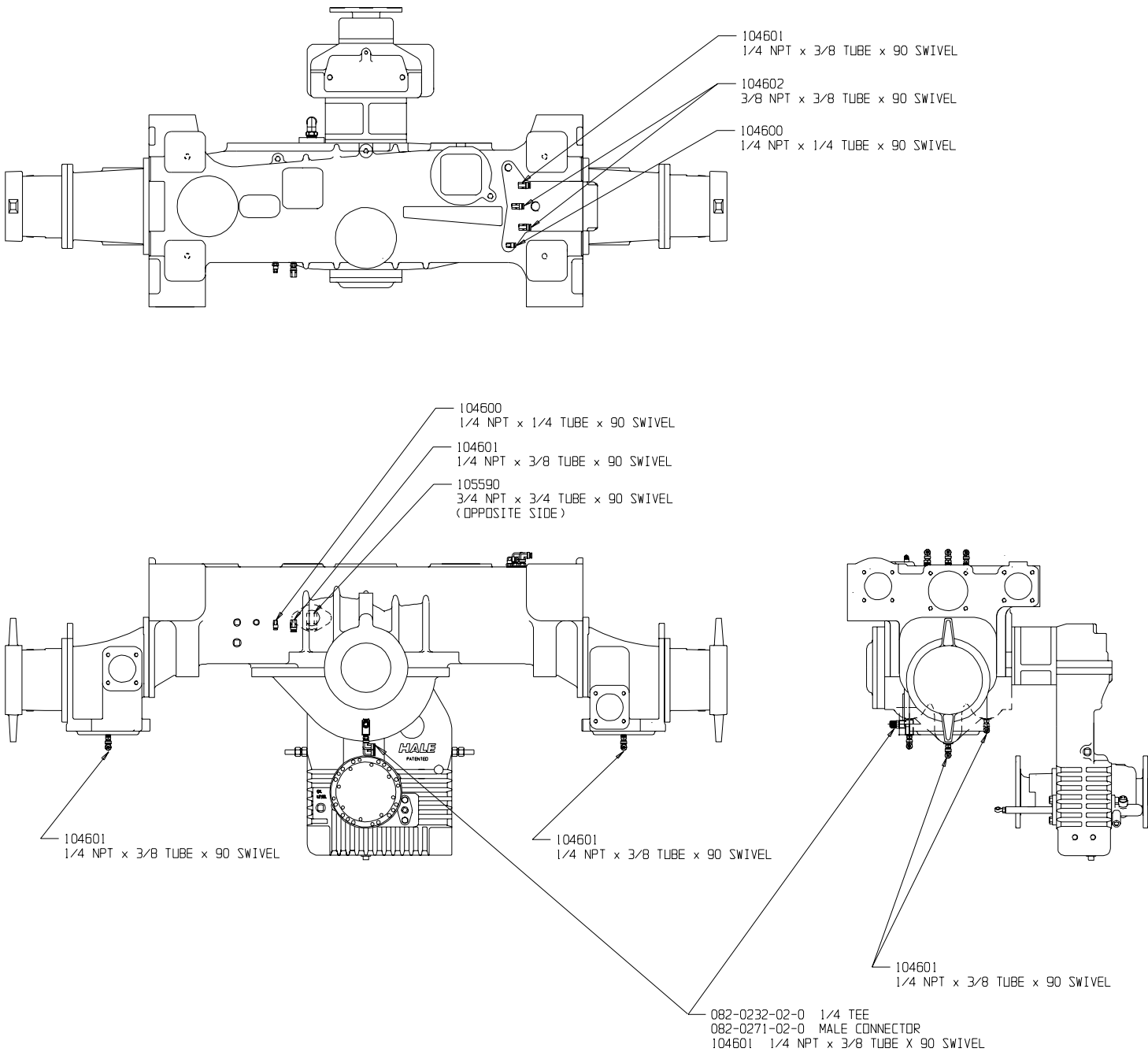
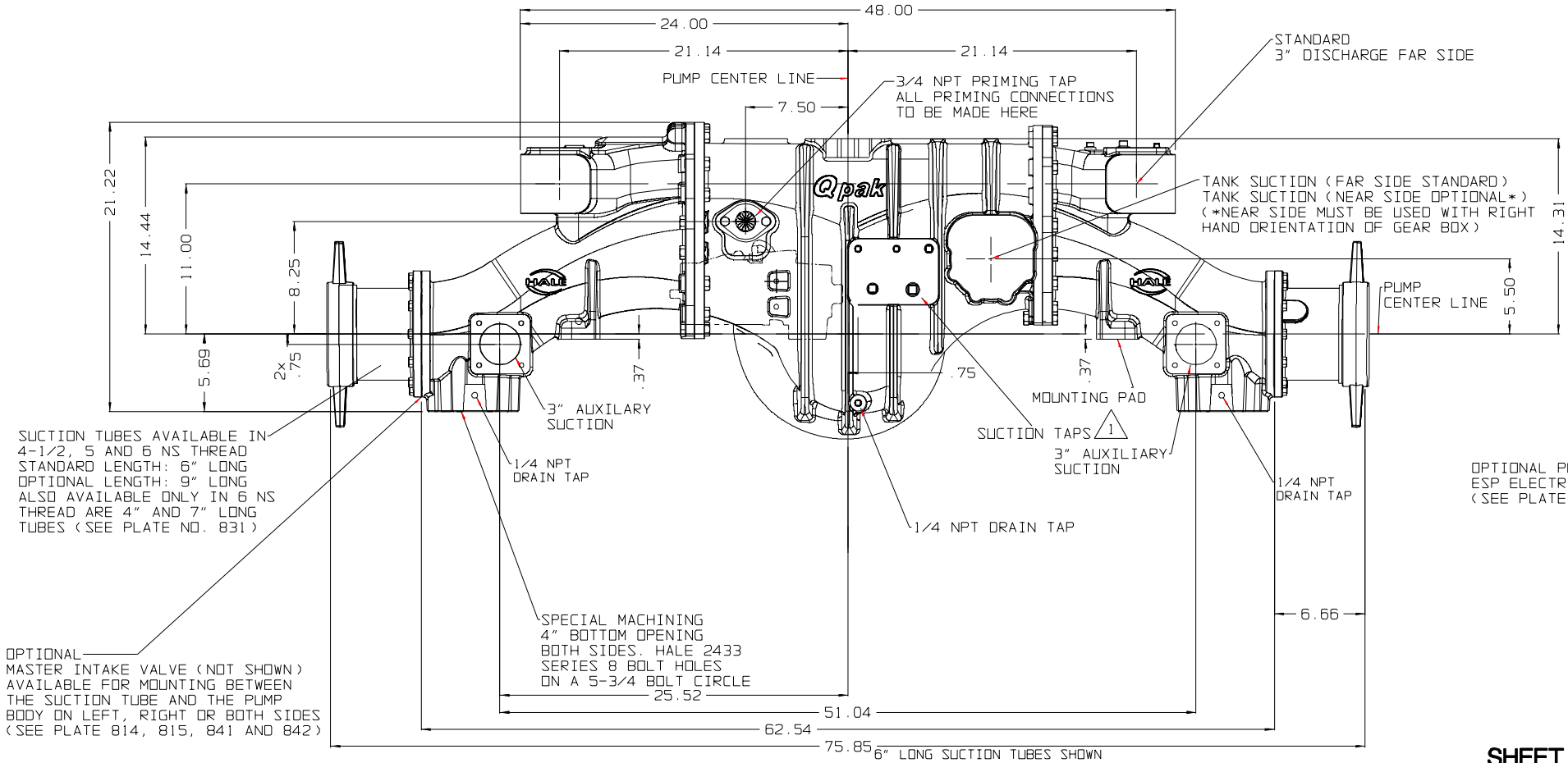
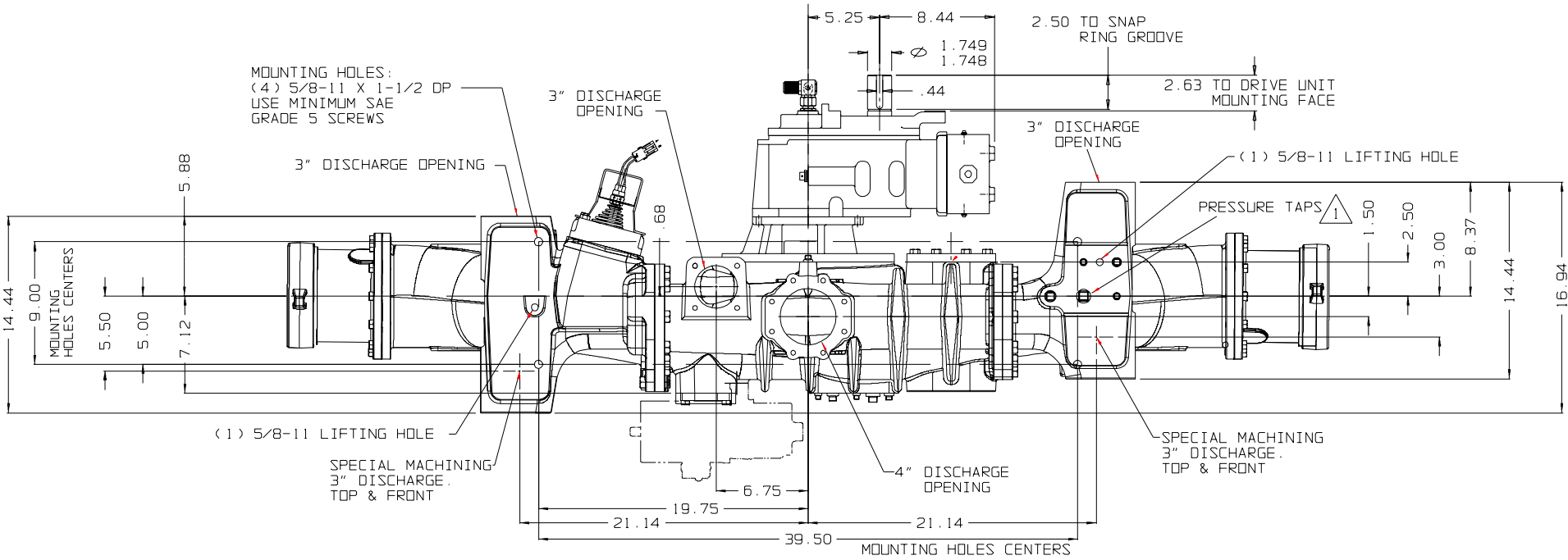


PLATE NO. 1046 AA

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	<div>HALE</div> <div>HALE PRODUCTS, INC. A Unit of IDEX Corporation Conshohocken, PA 19428 USA</div>			
04-150	A	RELEASE FOR PRODUCTION	DW	6/30/04	MAL				
						COPYRIGHT © NOT TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY.			
						DRAWN JFG	DW	DATE 06-30-04	SIZE SCALE : NONE

## Notes

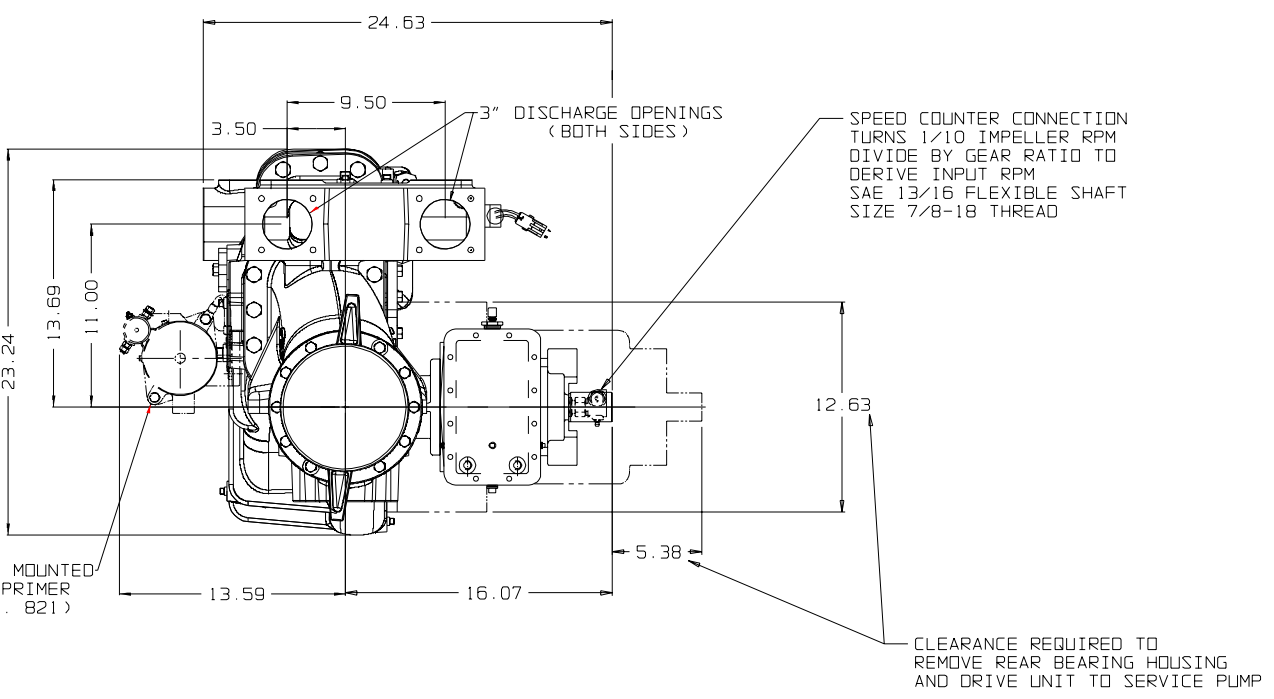
[illegible]



PUMP MODEL	GEAR RATIO
<b>Qpak A*-23</b>	<b>2.37</b>
<b>Qpak A*-21</b>	<b>2.16</b>
<b>Qpak A*-20</b>	<b>1.97</b>
<b>Qpak A*-18</b>	<b>1.81</b>
<b>Qpak A*-15</b>	<b>1.59</b>
<b>Qpak A*-14</b>	<b>1.40</b>
* RATED CAPACITY (GPM) 500, 750 AND 1000	

WARNING						
EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE RECOMMENDATIONS OUTLINED ON THIS DRAWING COULD DAMAGE THE PUMP AND/OR GEARBOX AND RESULT IN PERSONAL INJURY. MAX PUMP PRESSURE: HYDRODYNAMIC = 600 PSIG HYDROSTATIC = 600 PSIG MAXIMUM POWER INPUT FOR PUMPING = 300 HP						
PUMP MODEL	QPAKA*-23	QPAKA*-21	QPAKA*-20	QPAKA*-18	QPAKA*-15	QPAKA*-14
MAX GEARBOX INPUT RPM	2200	2410	2650	2880	3280	3720
SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA. THIS PRODUCT AND ITS COMPONENTS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING:						
	950,756	3,500,961	3,859,703	4,209,282	4,587,862	3,116,694
	3,116,694	3,726,308	3,918,681	4,311,440	4,653,978	3,159,559
	3,159,559	3,801,224	4,089,345	4,337,830		

EXAMPLE: THE MODEL NUMBER FOR A 1000 GPM RATED PUMP WITH A 2.37 GEAR RATIO WOULD BE QPAKA100-23.



1 SUCTION AND PRESSURE TAPS ARE PROVIDED.  
EACH SET WILL CONSIST OF THE FOLLOWING:  
(2) - 1/4 - 18 NPT  
(1) - 3/8 - 18 NPT  
(1) - 1/2 - 14 NPT  
(1) - 3/4 - 14 NPT

3" DISCHARGE OPENINGS AND 3" AUXILIARY SUCTION OPENINGS ARE MACHINED FOR HALE 115 SERIES 4 BOLT HOLES ON A 4-3/8 BOLT CIRCLE FLANGES.  
4" CENTER DISCHARGE AND TANK SUCTION CONNECTION ARE MACHINED FOR HALE 2433 SERIES 8 BOLT HOLES ON A 5-3/4 BOLT CIRCLE FLANGE

SHEET 1 OF 2

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD
						01-301	A	RELEASE FOR PRODUCTION	LFM	7-31-01	MAL

HALE

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MAKE OTHER DRAWINGS OR MACHINERY

DRAWN  
CHECKED

DATE 07-31-01

SIZE  
R

SCALE: FULL

PLATE NO. 941AA QPAK INSTALLATION (WITH A SERIES GEARBOX)

## Notes

[illegible]

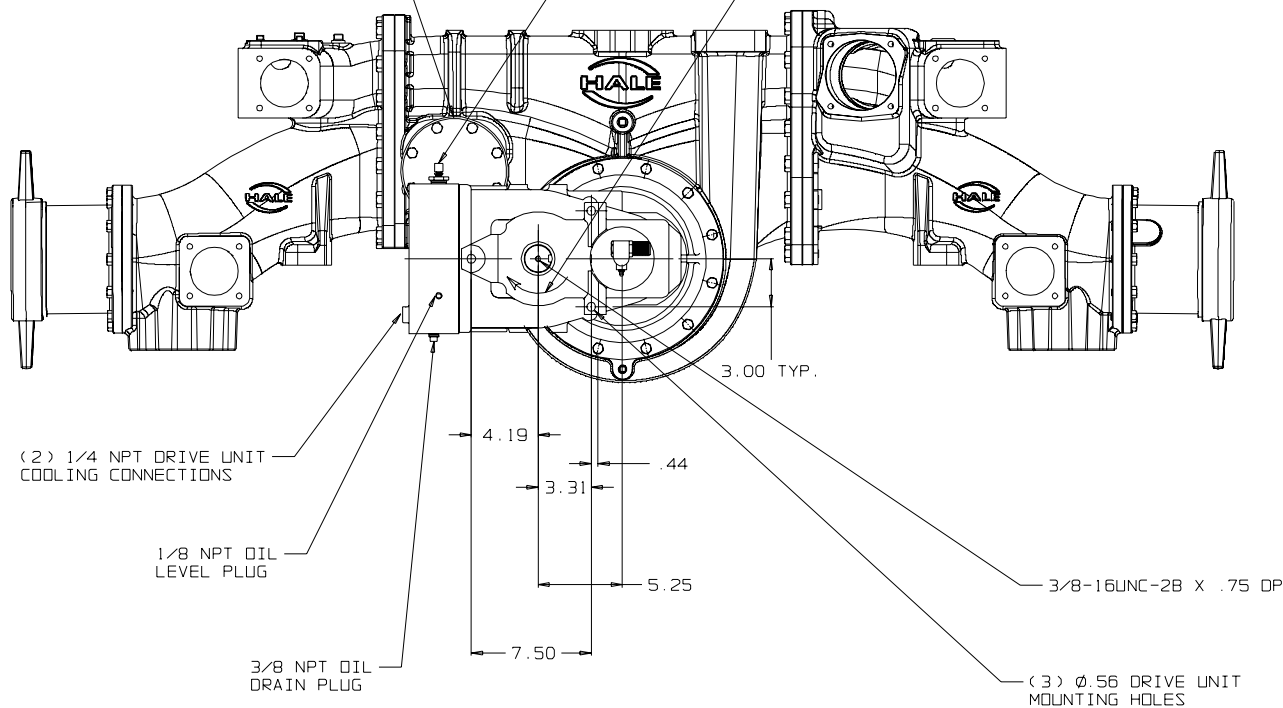
# QPAK INSTALLATION WITH A SERIES GEARBOX HORIZONTAL RIGHT DRIVE UNIT OPTION

TANK SUCTION CONNECTION:  
STANDARD: BLANK FLANGE  
OPTIONAL: 2-1/2 NPT, 3 NPT OR 4 NPT FLANGE,  
30BPF OR 40B0 VALVE AND OR CHECK VALVE.

\*CAN NOT BE USED WITH RIGHT HAND ORIENTATION  
GEARBOX (FRONT TANK OPTION MUST BE USED)

3/4 NPT VENTED OIL FILL PLUG  
FILL TO OIL LEVEL WITH (1) QUART  
SAE 20W OR SAE 30W NON-DETERGENT MOTOR OIL

ARROW DEPICTS  
ROTATION DIRECTION  
ENGINE ROTATION ONLY



DRIVELINE RECOMMENDATIONS:  
APPARATUS BUILDER SUPPLIED DRIVELINES SHALL BE OF APPROPRIATE SIZE TO  
MATCH THE CHASSIS AND PUMP REQUIREMENTS WITH INDIVIDUAL JOINT CANCELLATION  
AND PHASING. DRIVE SHAFT BALANCE (INCLUDING YOKES) SHALL NOT EXCEED THE  
RECOMMENDED LIMIT OF EITHER THE DRIVE SHAFT OR CHASSIS TRANSMISSION  
MANUFACTURER'S SPECIFICATIONS. DRIVE SHAFT FULL RANGE OPERATING SPEEDS  
SHALL NOT EXCEED 42% OF ITS CRITICAL SPEED.

PLATE NO. 941AA  
SHEET 2 OF 2

ECD NO	REV	CHANGED FROM	BY	DATE	APVD
01-301	A	RELEASE FOR PRODUCTION	LFM	7-31-01	MAL

COPYRIGHT © NOT TO BE REPRODUCED OR USED IN ANY OTHER MANNER WITHOUT THE WRITTEN PERMISSION OF HAILE		DRAWN CHECKED	LFM MAL	DATE 07-31-01	SIZE E	SCALE 1/4
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Conshohocken, PA 19428 USA

## Notes

[illegible]

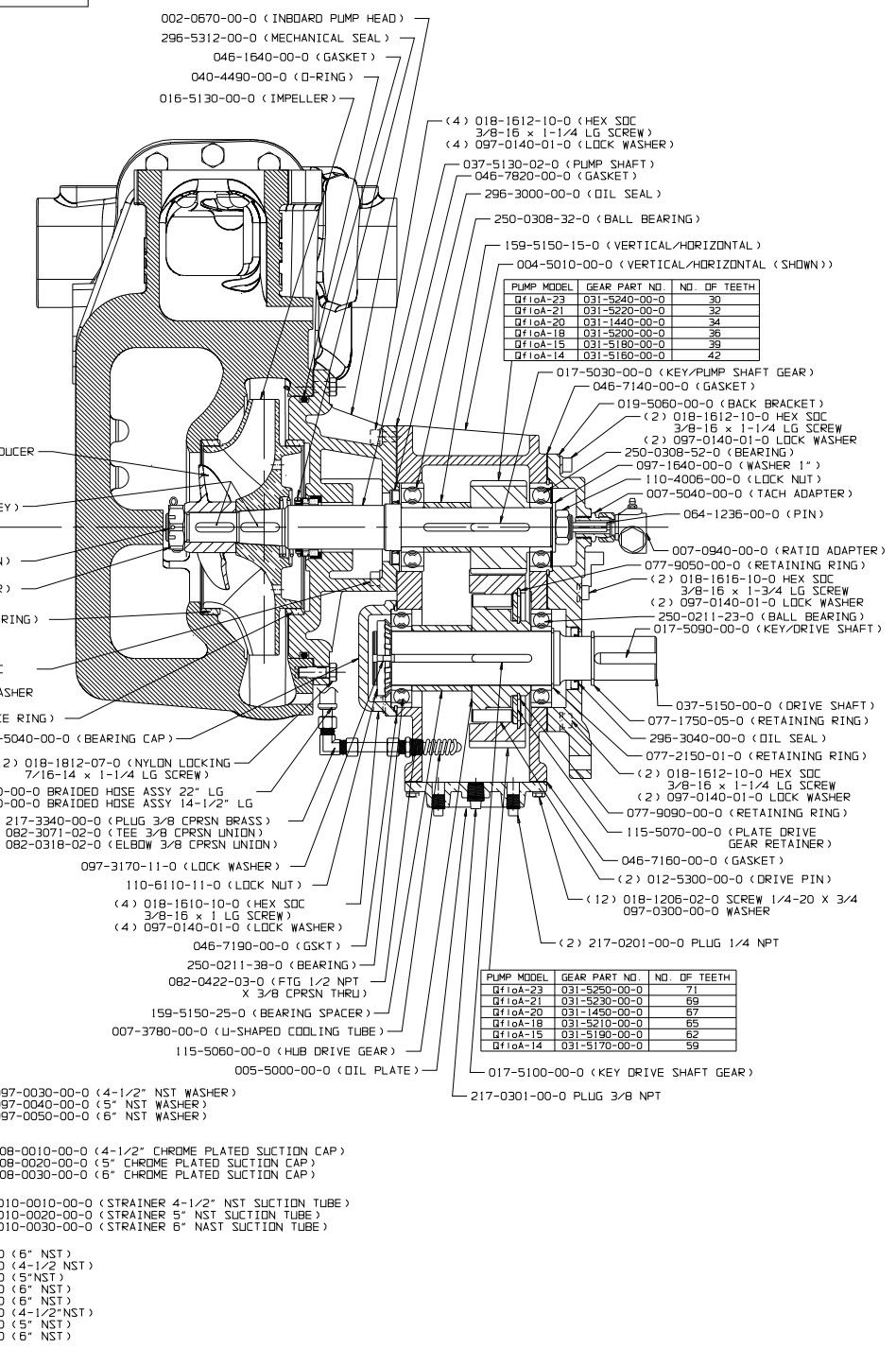
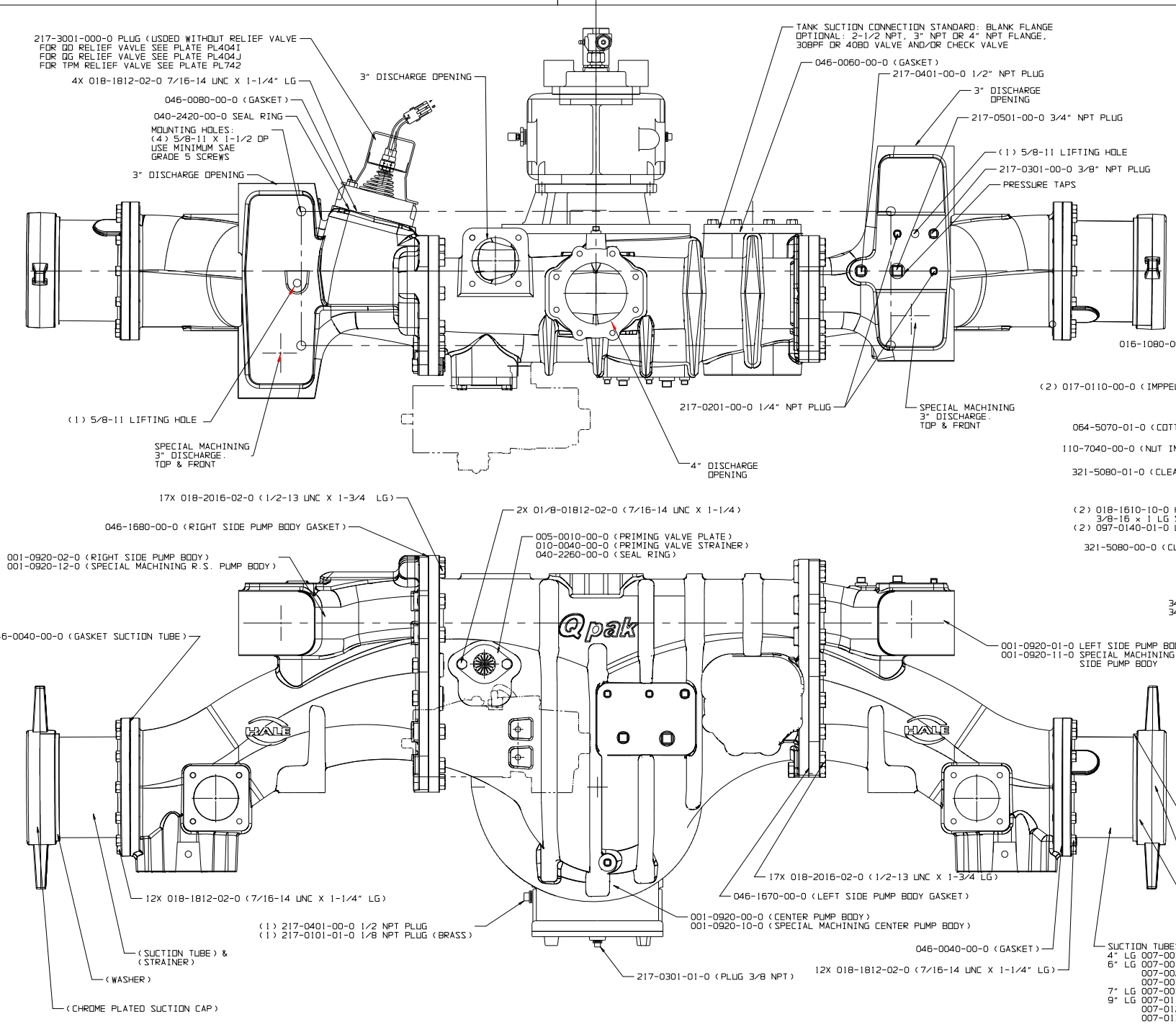
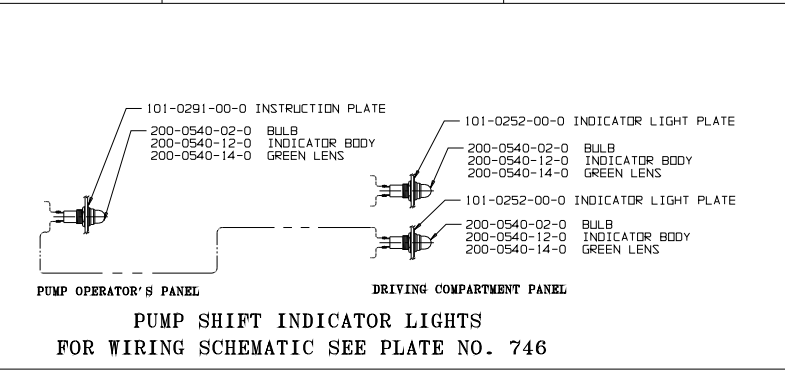
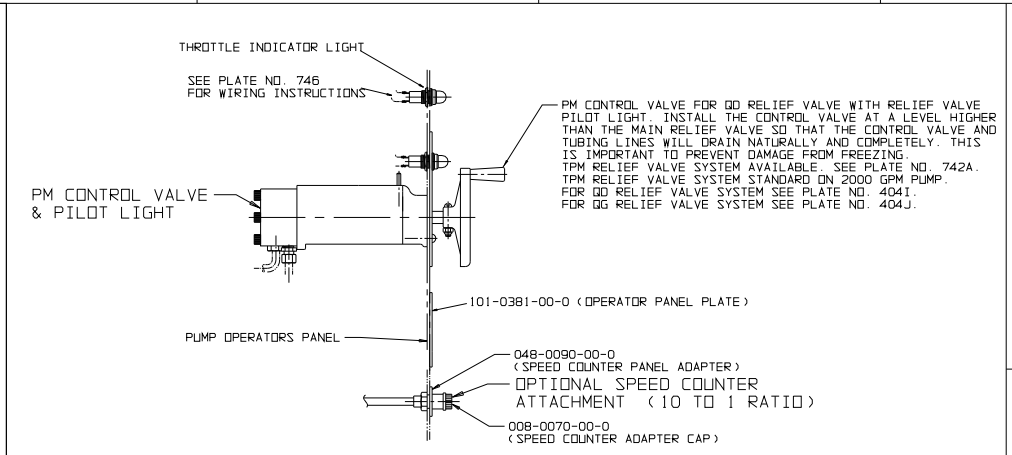
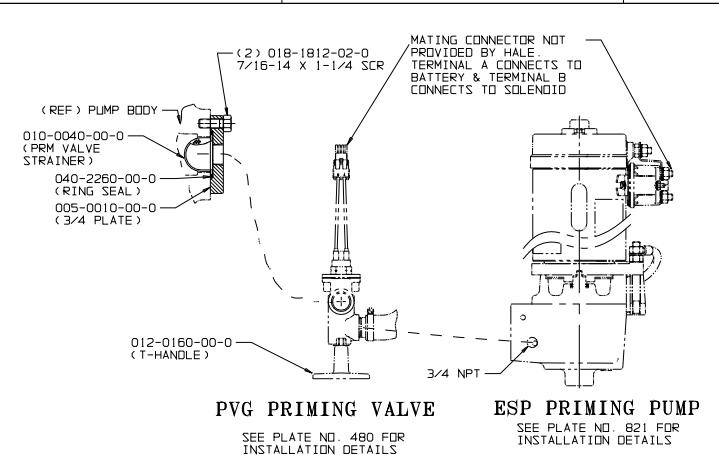


PLATE NO. 942AA

# HALE TYPE QPAKA SERIES PUMP

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
0152	A	RELEASE	EDF	7/26/05	MAL

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Conshohocken, PA 19382 USA

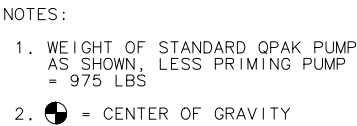
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DRAWN: JG  
 CHECKED: MAL  
 DATE: 07/26/2005  
 SIZE: A  
 SCALE: NTS

## Notes

[illegible]





PUMP MODEL		GEAR RATIO	GEARBOX TYPE	DIMENSIONS	
				"A"	"B"
QPAK	*-25	2.57	J GEARBOX LEFT (JL) OR RIGHT (JR) SIDE	12.50	8.61
QPAK	*-23	2.35		12.60	8.72
QPAK	*-21	2.08		12.78	8.90
QPAK	*-18	1.80		13.00	9.13
QPAK	*-16	1.64		13.18	9.32
* RATED CAPACITY (GPM) 500, 750 AND 1000					
EXAMPLE: THE MODEL NUMBER FOR A 1000 GPM RATED PUMP WITH A 2.35 GEARBOX OFFSET TO LEFT SIDE WOULD BE QPAK100-23JL					

WARNING					
EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE RECOMMENDATIONS OUTLINED ON THIS DRAWING COULD DAMAGE THE GEARBOX AND RESULT IN PERSONAL INJURY					
QPAK MIDSHIP MAXIMUM PUMP PRESSURE (HYDROSTATIC & HYDRODYNAMIC) = 600 PSI MAXIMUM POWER INPUT FOR PUMPING = 300 HP MAXIMUM TORQUE ON PUMP SHAFT = 2300 LBS-FT					
SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA					
PUMP MODEL	QPAK*-25J**	QPAK*-23J**	QPAK*-21J**	QPAK*-18J**	QPAK*-16J**
MAX GEARBOX INPUT RPM	2070	2260	2550	2950	3240
* RATED CAPACITY (GPM) 500, 750 AND 1000					
** GEARBOX TYPE AND SIDE JL = J GEARBOX LEFT SIDE JR = J GEARBOX RIGHT SIDE					

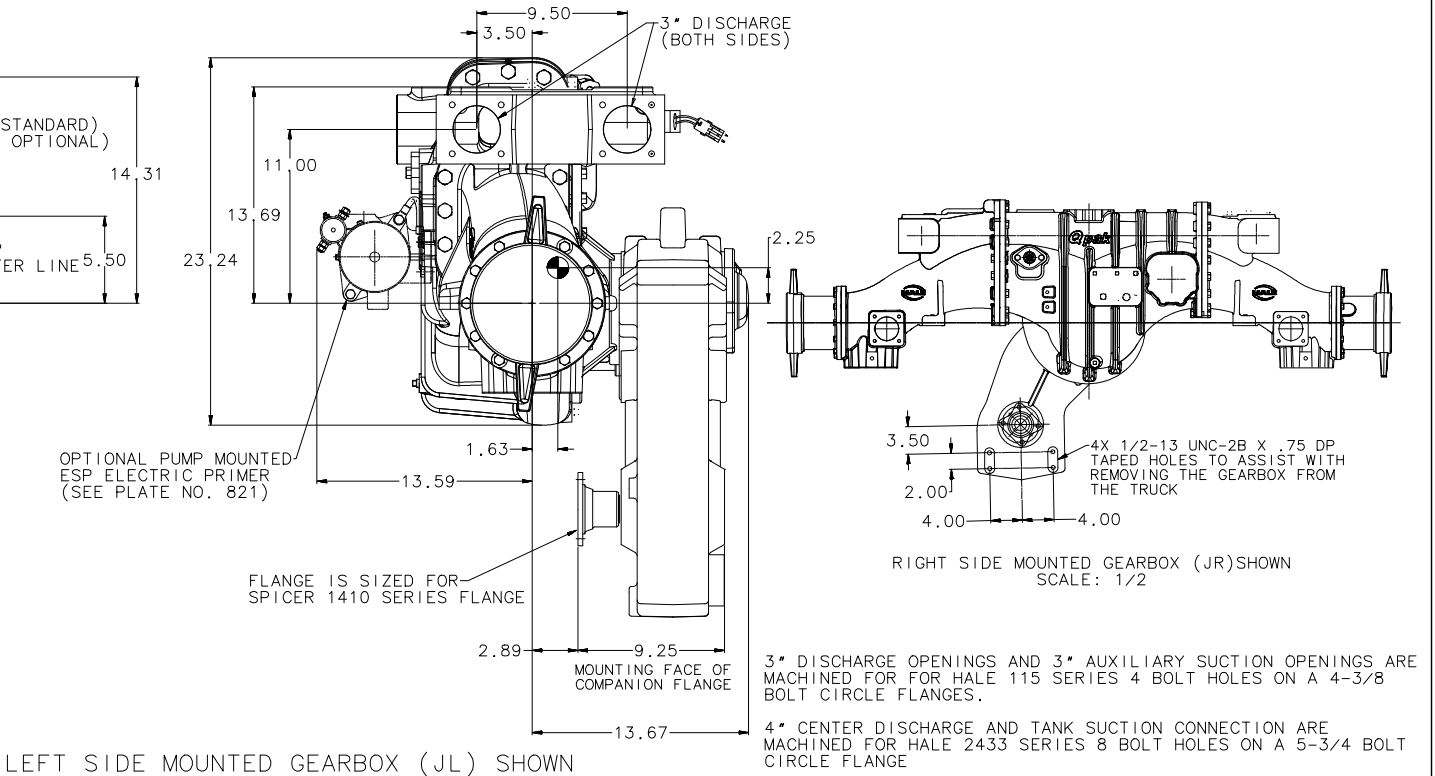

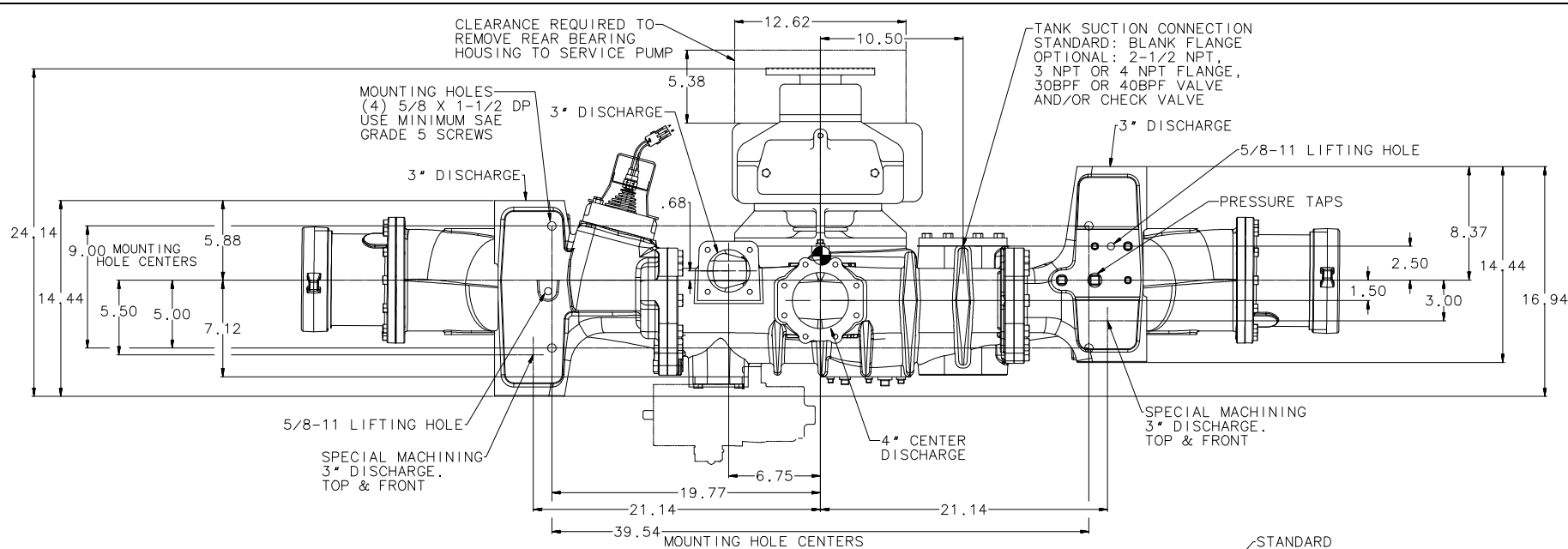


PLATE NO. 924AE QPAK INSTALLATION (WITH J SERIES GEARBOX)

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD	 <div>HALE PRODUCTS, INC. A Unit of IDEX Corporation Conshohocken, PA 19428 USA</div>
						00-624	C	ADDED DRAIN TAP CALLOUTS TO RIGHT & LEFT SIDE PUMP BODIES UPDATED *J* GEARBOX	DJK	10-06-00	MAL	
01-285	E	ADDED MAX GEARBOX INPUT RPMs	DJK	7-19-01	MAL	00-544	B	UPDATED VIEWS ONLY	DJK	8-2-00	MAL	
01-198	D	ADDED CENTER OF GRAVITY	WAW	4-18-01	MAL	00-434	A	RELEASED	DJK	4-24-00	MAL	
<div><div><div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> <div><div></div><div></div></div> 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## Notes

[illegible]



- NOTES:
1. WEIGHT OF STANDARD QPAK PUMP AS SHOWN, LESS PRIMING PUMP = 1,035 LBS
  2. ● = CENTER OF GRAVITY

PUMP MODEL		GEAR RATIO	GEARBOX TYPE	DIMENSIONS			
				"A"	"B"	"C"	"D"
QPAK	*-28	2.83	EXTRA LONG GEARBOX ONLY (X)	15.18	5.44	4.06	1.84
QPAK	*-25	2.55		15.37			
QPAK	*-23	2.32		15.52			
QPAK	*-21	2.13		15.68			
QPAK	*-19	1.96		15.87			
QPAK	*-23	2.28	** LONG (L) GEARBOX ONLY	13.00	4.31	5.18	2.00
QPAK	*-21	2.05		13.18			
QPAK	*-19	1.86		13.37			
QPAK	*-17	1.71		13.56			
QPAK	*-15	1.58		13.75			
* RATED CAPACITY (GPM) 500, 750 AND 1000			** THE LONG GEARBOX IS STANDARD AND WILL BE SUPPLIED UNLESS OTHERWISE SPECIFIED				
EXAMPLE: THE MODEL NUMBER FOR A 1000 GPM RATED PUMP WITH A 2.28 GEARBOX AND A LONG GEARBOX WOULD BE QPAK100-23L							

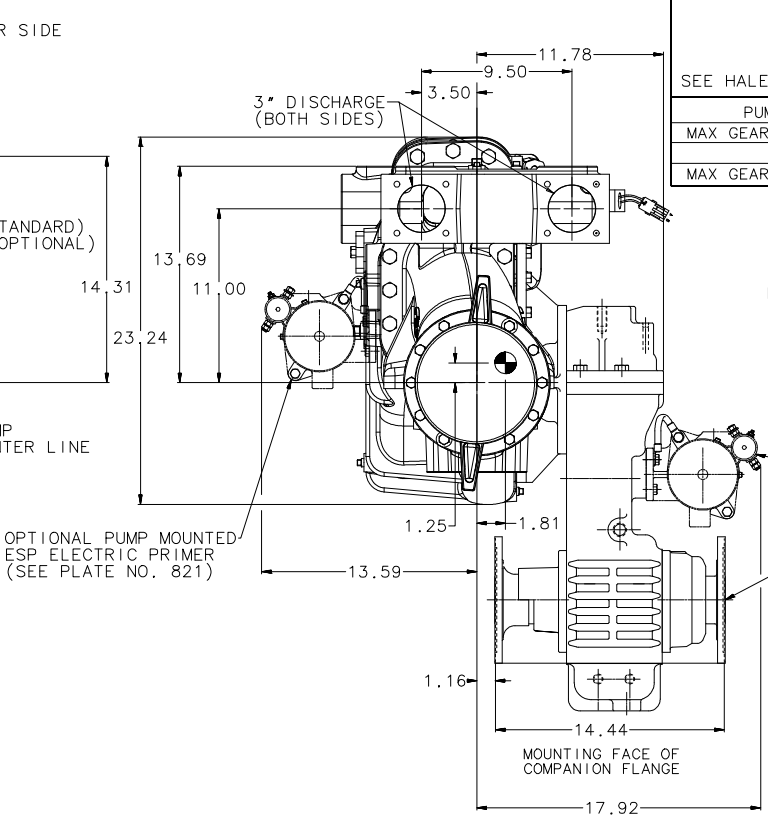
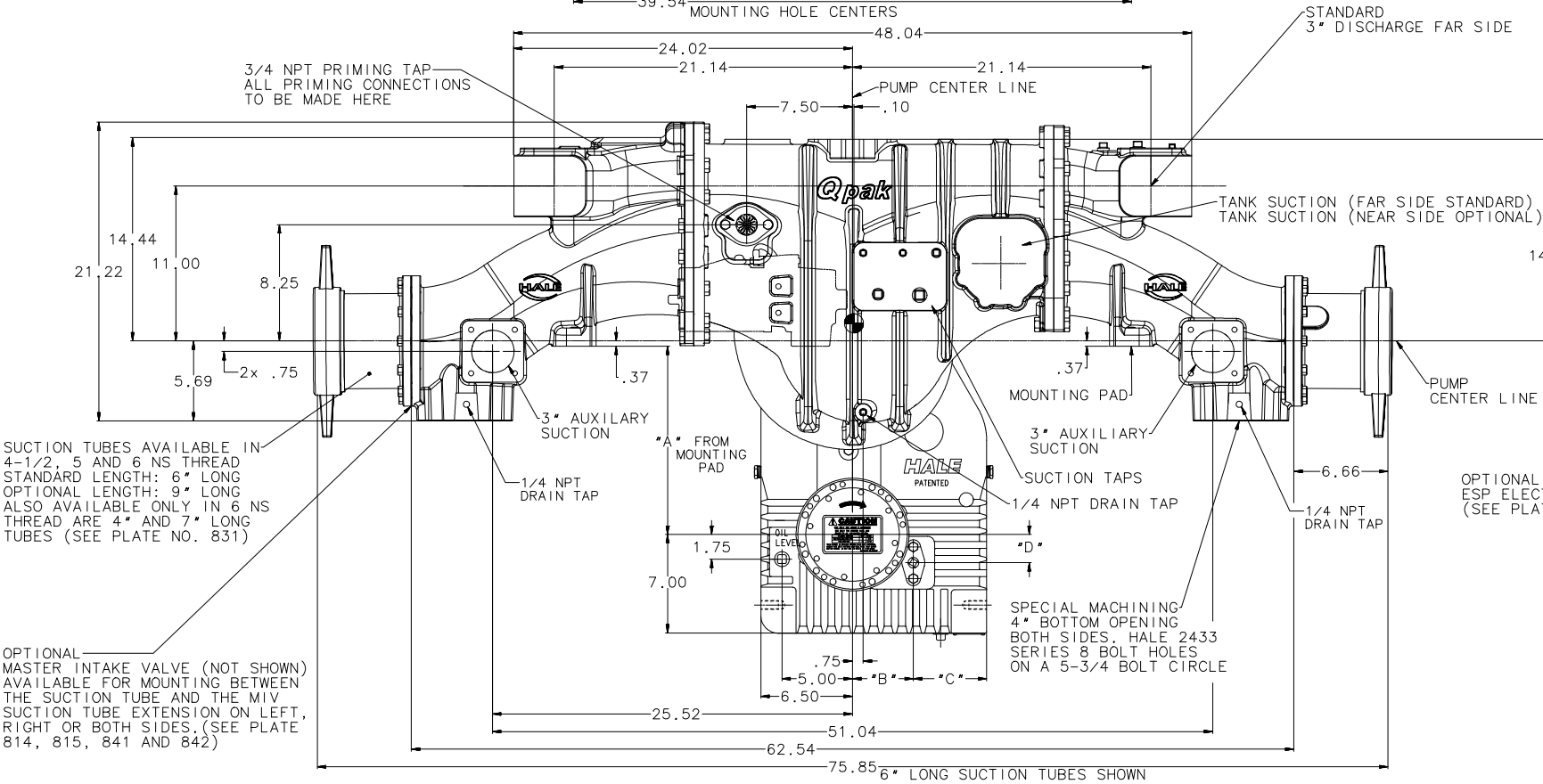
**WARNING**

EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE RECOMMENDATIONS OUTLINED ON THIS DRAWING COULD DAMAGE THE GEARBOX AND RESULT IN PERSONAL INJURY

QPAK MIDSHIP MAXIMUM PUMP PRESSURE (HYDROSTATIC & HYDRODYNAMIC) = 600 PSI  
MAXIMUM POWER INPUT FOR PUMPING = 450 HP  
MAXIMUM TORQUE ON PUMP SHAFT = 2300 LBS-FT  
MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT

SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA

PUMP MODEL	QPAK *-23L	QPAK *-21L	QPAK *-19L	QPAK *-17L	QPAK *-15L
MAX GEARBOX INPUT RPM	2630	2920	3220	3500	3800
PUMP	QPAK *-28X	QPAK *-25X	QPAK *-23X	QPAK *-21X	QPAK *-19X
MAX GEARBOX INPUT RPM	2120	2350	2580	2800	3060



3" DISCHARGE OPENINGS AND 3" AUXILIARY SUCTION OPENINGS ARE MACHINED FOR FOR HALE 115 SERIES 4 BOLT HOLES ON A 4-3/8 BOLT CIRCLE FLANGES.

4" CENTER DISCHARGE AND TANK SUCTION CONNECTION ARE MACHINED FOR HALE 2433 SERIES 8 BOLT HOLES ON A 5-3/4 BOLT CIRCLE FLANGE

OPTIONAL GEARBOX MOUNTED ESP ELECTRIC PRIMER (SEE PLATE NO. 821)

STANDARD FLANGES THE HALE COMBINATION FLANGES ARE SIZED FOR SPICER 1600, 1700 AND 1800 SERIES FLANGES. 1600 SERIES WITH 6-5/8 DIA FEMALE PILOT. USE (8) 3/8 DIA SAE GRADE 8 SCREWS. 1700 SERIES WITH 7-3/4 DIA FEMALE PILOT. USE (8) 3/8 DIA GRADE 8 SCREWS. 1800 SERIES WITH 7-3/4 DIA FEMALE PILOT. USE (12) 7/16 DIA SAE GRADE 8 SCREWS.

PLATE NO. 923AD

QPAK INSTALLATION (WITH G SERIES GEARBOX)

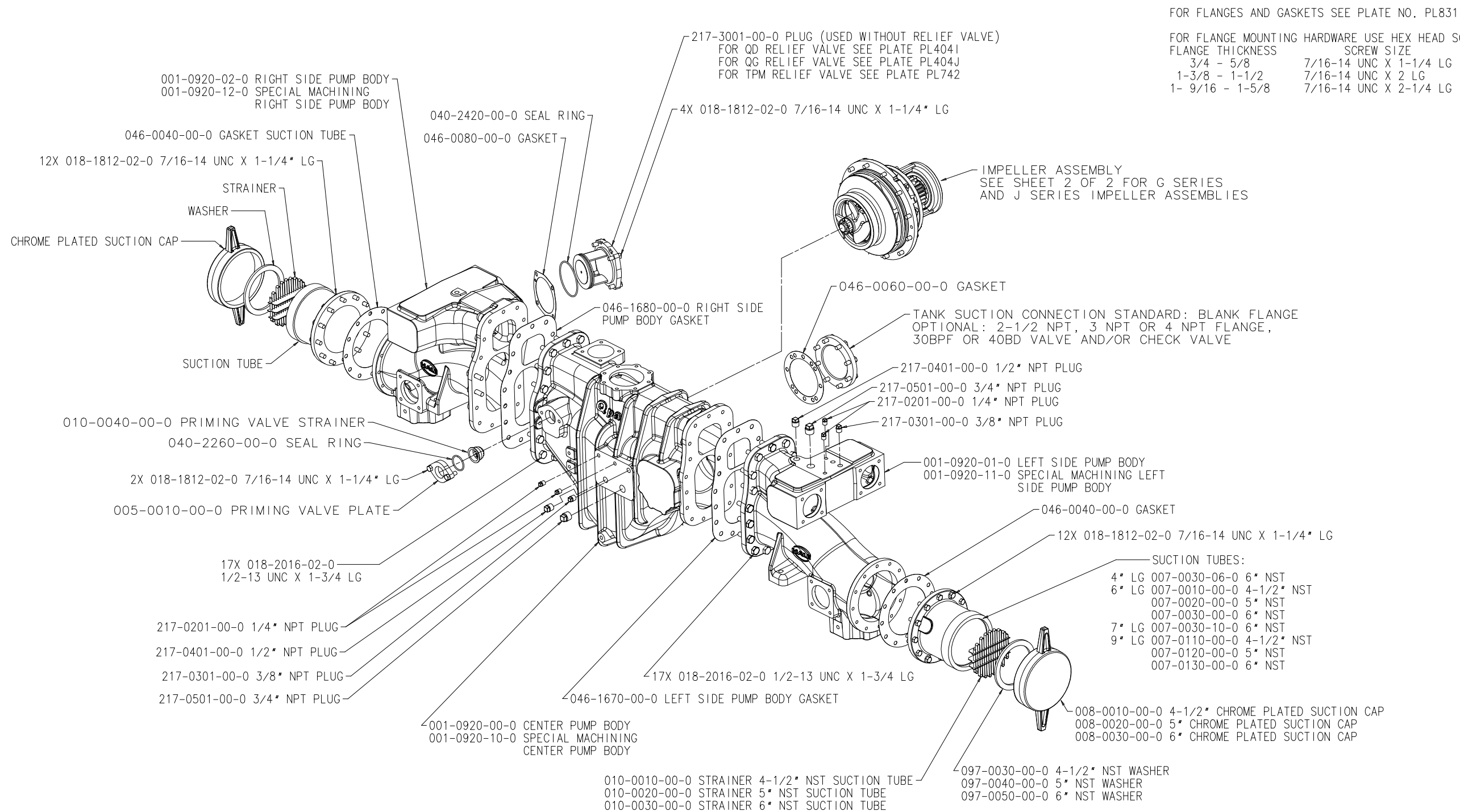
ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD				
00-624	C	ADDED DRAIN TAP CALLOUTS TO RIGHT & LEFT SIDE PUMP BODIES	DJK	10-05-00	MAL	00-544	B	UPDATED VIEWS ONLY	DJK	8-1-00	MAL				
01-198	D	ADDED CENTER OF GRAVITY	WMW	4-19-01	MAL	00-434	A	RELEASED	DJK	4-24-00	MAL				

HALE PRODUCTS, INC.  
A Unit of IDEX Corporation  
Conshohocken, PA 19428 USA

DATE 03-31-00  
SCALE: FULL

## Notes

[illegible]



FOR FLANGES AND GASKETS SEE PLATE NO. PL831

FOR FLANGE MOUNTING HARDWARE USE HEX HEAD SCREWS

FLANGE THICKNESS	SCREW SIZE
3/4 - 5/8	7/16-14 UNC X 1-1/4 LG
1-3/8 - 1-1/2	7/16-14 UNC X 2 LG
1- 9/16 - 1-5/8	7/16-14 UNC X 2-1/4 LG

# HALE TYPE QPAK SERIES PUMP (PARTS IDENTIFICATION)

PLATE 926AE (SHEET 1 of 2)

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD
						00-527	A	RELEASED	DK	06-29-00	MAL
						00-592	B	UPDATED PART ORIENTATION (SH2)	DK	09-14-00	MAL
						00-624	C	SH1: UPDATED VIEW	DK	10-06-00	MAL
01-198	E	INCORPORATED INDUCER	MMW	5-10-01	MAL	00-707	D	UP DATED SHEET 2	DK	12-04-00	MAL

HALE PRODUCTS, INC.  
A Unit of IDEX Corporation  
Conshohocken, PA 19428 USA

NOT TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY.

DRAWN BY: DK  
CHECKED BY: MAL  
DATE: 06-29-00  
SIZE: E  
SCALE: 1/4

## Notes

[illegible]

GEAR PART NO.	NO. OF TEETH	PUMP MODEL
031-0920-00-0	18	QPAK-23L & QPAK-28X
031-0930-00-0	20	QPAK-21L & QPAK-25X
031-0940-00-0	22	QPAK-19L & QPAK-23X
031-0950-00-0	24	QPAK-17L & QPAK-21X
031-0960-00-0	26	QPAK-15L & QPAK-19X

250-0409-00-0 409K BEARING  
097-0830-01-0 WASHER  
018-2412-07-0 5/8-11 UNC X 1-1/4 LG  
W/ NYLON PATCH

159-1600-04-0 SPACER  
250-8210-00-0 22309ES SPHERICAL ROLLER BEARING  
097-2160-00-0 WASHER  
018-2620-02-0 3/4-10 UNC X 2 LG

GEAR PART NO.	NO. OF TEETH	PUMP MODEL
031-1550-00-0	21	QPAK-25J
031-1560-00-0	23	QPAK-23J
031-1570-00-0	26	QPAK-21J
031-1580-00-0	30	QPAK-18J
031-1590-00-0	33	QPAK-16J

077-9170-01-0 SPLIT RING  
250-8150-00-0 NJ2210ECP CYLINDRICAL ROLLER BEARING  
296-2790-00-0 OIL SEAL  
040-2360-00-0 SEAL RING  
017-0650-02-0 KEY  
037-2260-00-0 INPUT SHAFT  
(2X) 017-0110-00-0 KEY

20X 018-1812-07-0 7/16-14 UNC X 1-1/4 W/ NYLON PATCH  
046-6020-00-0 GASKET  
296-2090-00-0 OIL SEAL  
077-2120-01-0 RETAINING RING  
250-0211-20-0 211W BEARING  
048-0150-00-0 SHIM  
250-0211-20-0 211W BEARING  
(2X) 017-0110-00-0 KEY  
037-2300-00-0 SHAFT  
017-0300-00-0 KEY

QPAK REAR BEARING HOUSING		
BEARING HOUSING	"L" GEARBOX GEAR RATIO	"X" GEARBOX GEAR RATIO
062-0770-00-0	23L & 15L	19X & 28X
062-0770-01-0	21L & 17L	25X & 21X
062-0770-02-0	19L	23X

"G SERIES"


"J SERIES"

12X 018-1812-07-0 7/16-14 UNC X 1-1/4 W/ NYLON PATCH  
062-0820-00-0 PUMP HEAD  
6X 018-2012-02-0 1/2-13 UNC X 1-1/4 LG

321-5080-01-0 CLEARANCE RING  
064-5070-01-0 COTTER PIN  
110-7040-00-0 IMPELLER NUT  
016-1080-00-0 INDUCER  
016-5130-00-0 IMPELLER  
321-5080-00-0 CLEARANCE RING  
296-5210-03-0 MECHANICAL SEAL  
040-4490-00-0 SEAL RING  
046-1640-00-0 GASKET

HALE TYPE QPAK SERIES PUMP (PARTS IDENTIFICATION)

PLATE 926AE (SHEET 2 of 2)

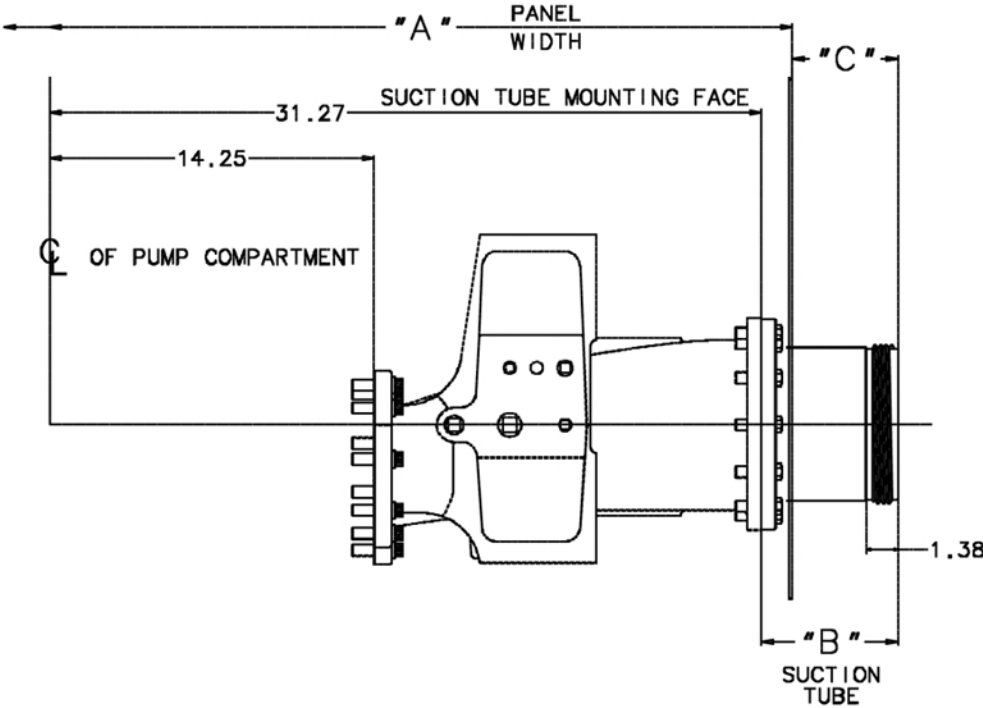
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						00-527	A	RELEASED	DK	06-29-00	MAL	<div>HALE PRODUCTS, INC. A Unit of IDEX Corporation Conshohocken, PA 19428 USA</div> <div><small>COPYRIGHT © 1999 IDEX CORPORATION. ALL RIGHTS RESERVED. NO PART OF THIS DOCUMENT IS TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY.</small></div> <div><table><tr><td>DRAWN</td><td>DK</td><td>DATE</td><td>06-29-00</td><td>SIZE</td><td>E</td></tr><tr><td>CHECKED</td><td>MAL</td><td></td><td></td><td>SCALE:</td><td>1/4</td></tr></table></div>				DRAWN	DK	DATE	06-29-00	SIZE	E	CHECKED	MAL			SCALE:	1/4
DRAWN	DK	DATE	06-29-00	SIZE	E																						
CHECKED	MAL			SCALE:	1/4																						
						00-592	B	UPDATED PART ORIENTATION	DK	09-14-00	MAL																
						00-624	C	SEE SHEET 1	DK	10-06-00	MAL																
01-198	E	INCORPORATED INDUCER	MMW	4-16-01	MAL	00-707	D	UPDATED J SERIES PARTS	DK	12-04-00	MAL																

## Notes

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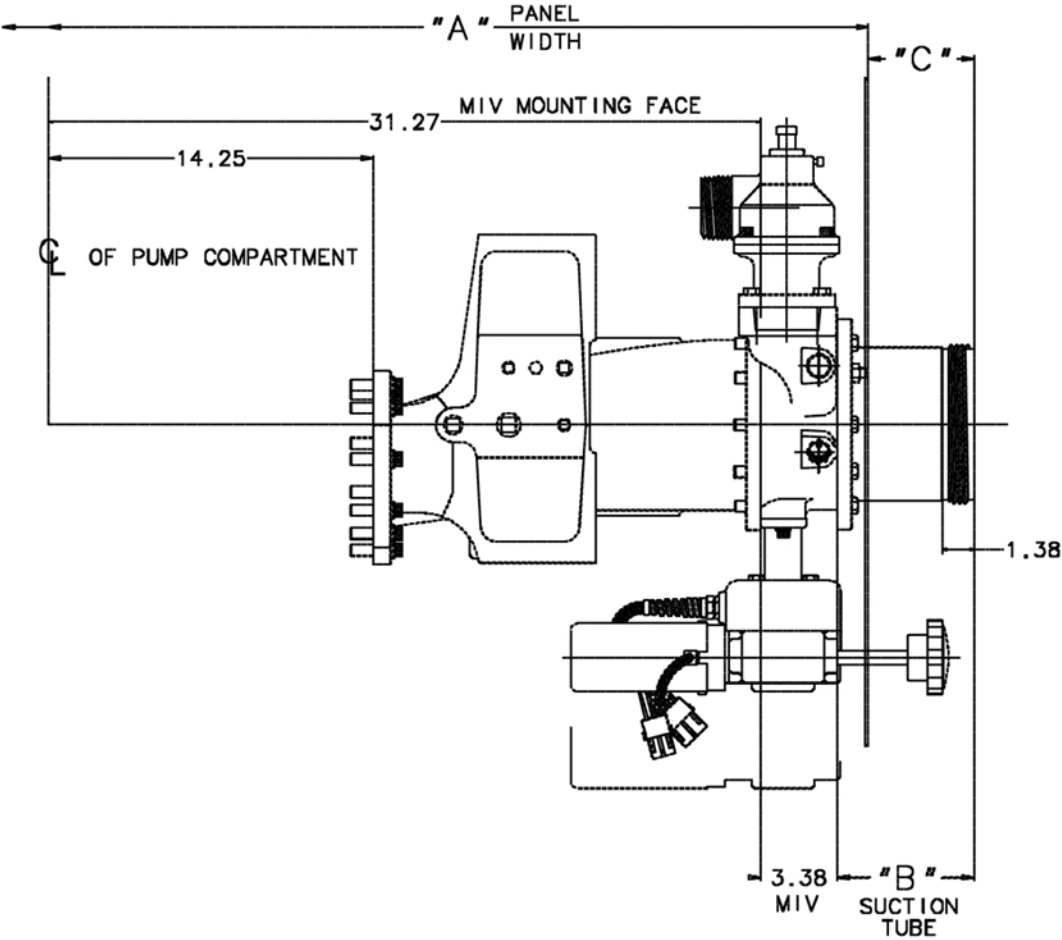


QPAK SUCTION TUBE LENGTH VERSUS TRUCK PANEL WIDTH



		TRUCK PANEL WIDTH "A"					
		70"	72"	74"	76"	78"	81"
		DIMENSION "C"					
SUCTION TUBE LENGTH "B"	4"	N/A	N/A	N/A	N/A	N/A	N/A
	6"	007-0010-00-0 (4-1/2) 007-0020-00-0 (5) 007-0030-00-0 (6)	2.27	N/A	N/A	N/A	N/A
	7"	007-0030-10-0 (6)	3.27	2.27	N/A	N/A	N/A
	9"	007-0110-00-0 (4-1/2) 007-0120-00-0 (5) 007-0130-00-0 (6)	5.27	4.27	3.27	2.27	N/A

QPAK SUCTION TUBE LENGTH  
W/ MIV VERSUS TRUCK PANEL WIDTH



		TRUCK PANEL WIDTH "A"					
		70"	72"	74"	76"	78"	81"
		DIMENSION "C"					
SUCTION TUBE LENGTH "B"	4"	007-0030-06-0 (6)	3.64	2.64	1.64	N/A	N/A
	6"	007-0010-00-0 (4-1/2) 007-0020-00-0 (5) 007-0030-00-0 (6)	5.64	4.64	3.64	2.64	1.64
	7"	007-0030-10-0 (6)	6.64	5.64	4.64	3.64	2.64
	9"	007-0110-00-0 (4-1/2) 007-0120-00-0 (5) 007-0130-00-0 (6)	8.64	7.64	6.64	5.64	4.64

PL925AA QPAK SUCTION TUBE LENGTHS

## Notes

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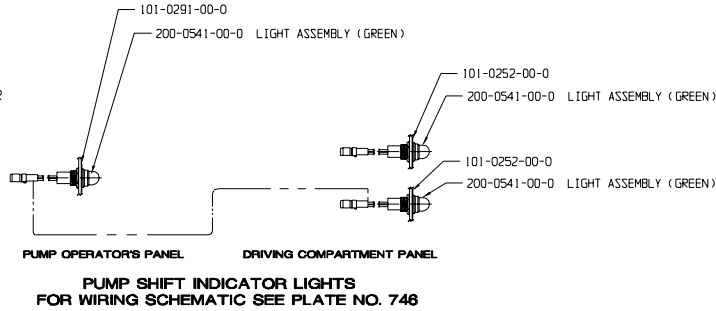
THIS PRODUCT AND ITS COMPONENTS MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING:

4,337,830  
4,587,862  
4,653,978

5,018,665  
5,139,393

NOTES

1. REFER TO HAILE PUMP/ENGINE COMBINATION LIST TO SELECT PROPER RATIO TO MATCH PUMP WITH ENGINE.
2. WEIGHT OF STANDARD QMAX 1500 G.P.M. PUMP AS SHOWN LESS PRIMING PUMP. = 1275 LBS.
3.  $\bullet$  = CENTER OF GRAVITY.
4. IMPELLER SHAFT SEAL - MECHANICAL SEAL OR PACKING AVAILABLE.
5. APPLY LOCTITE # 246 HIGH TEMPERATURE THREAD LOCKER OR EQUIVALENT TO SCREW THREADS AND TORQUE SCREWS PER HAILE ENGINEERING STANDARD ES018-002.
6. UNLESS OTHERWISE INDICATED FASTENERS ARE GRADE 5 ZINC PLATED STEEL.



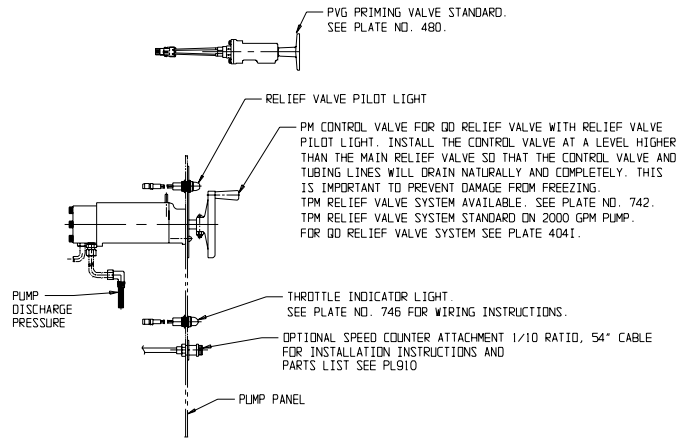
WARNING

EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE RECOMMENDATIONS OUTLINED ON THIS DRAWING COULD DAMAGE THE GEARBOX AND RESULT IN PERSONAL INJURY.  
QMAX MIDSHIP MAXIMUM PUMP PRESSURE (HYDROSTATIC & HYDRODYNAMIC) = 600 PSI  
2HP HIGH PRESSURE PUMP MAXIMUM PUMP PRESSURE (HYDROSTATIC & HYDRODYNAMIC) = 1000 PSI  
MAXIMUM POWER INPUT FOR PUMPING = 450 HP  
MAXIMUM TORQUE ON PUMP SHAFT = 2300 LBS-FT  
MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT

PUMP MODEL	QMAX*-23	QMAX*-21	QMAX*-19	QMAX*-17	QMAX*-15
MAX GEARBOX INPUT RPM	2280	2530	2780	3030	3280
PUMP MODEL	QMAX*-28X	QMAX*-25X	QMAX*-23X	QMAX*-21X	QMAX*-18X
MAX GEARBOX INPUT RPM	1840	2040	2230	2430	2650

SEE HAILE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA.  
THIS PRODUCT AND ITS COMPONENTS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING:

950,756	3,500,961	3,859,703	4,209,282	4,587,862
3,116,694	3,726,308	3,918,681	4,311,440	4,653,978
3,159,559	3,801,224	4,089,345	4,337,830	



OPTIONAL DISCHARGE FLANGES		
STANDARD	OPTIONAL	STD. CAST HOLE
A BLANK	2-1/2, 3 & 4 NPT	4
B BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
C BLANK	2-1/2, 3 & 4 NPT	3
D	2-1/2 & 3 NPT	CAST SOLID
E	2-1/2 & 3 NPT	CAST SOLID
F	2-1/2 & 3 NPT	CAST SOLID
G	2-1/2 & 3 NPT	CAST SOLID
H BLANK	2-1/2, 3 & 4 NPT	3

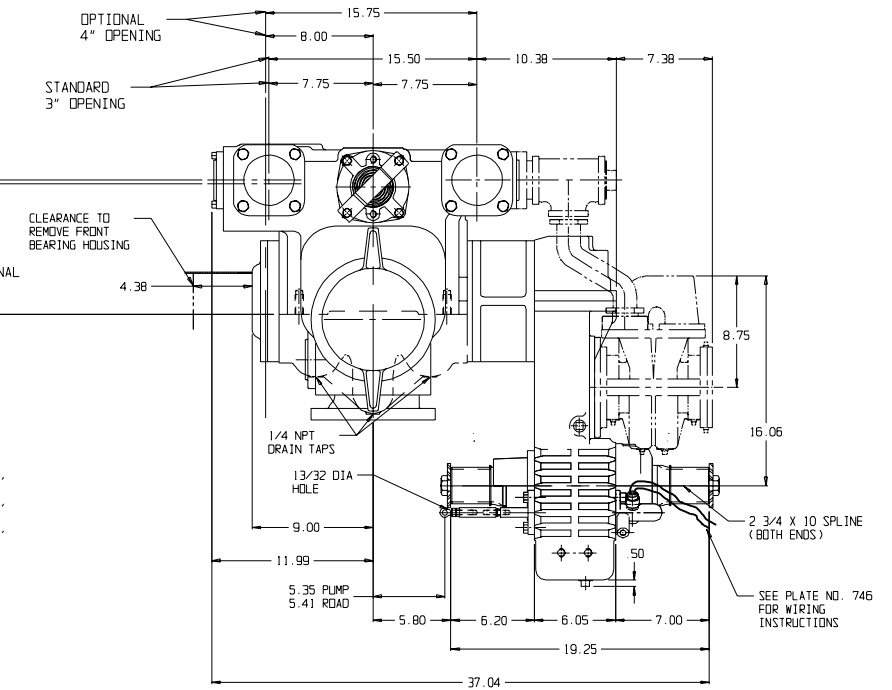
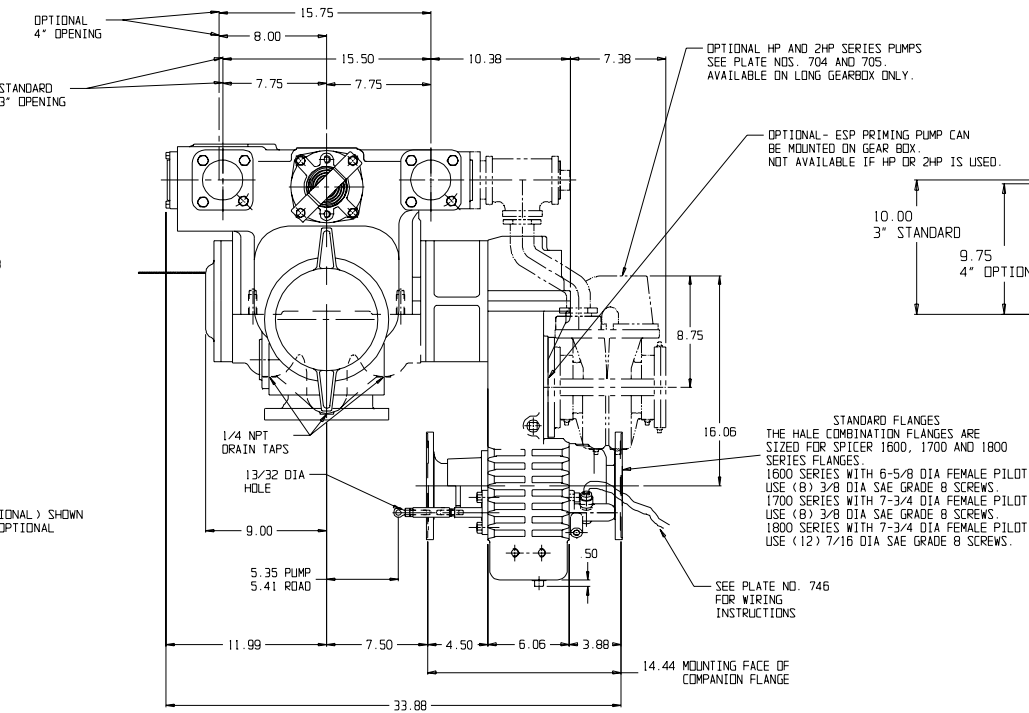
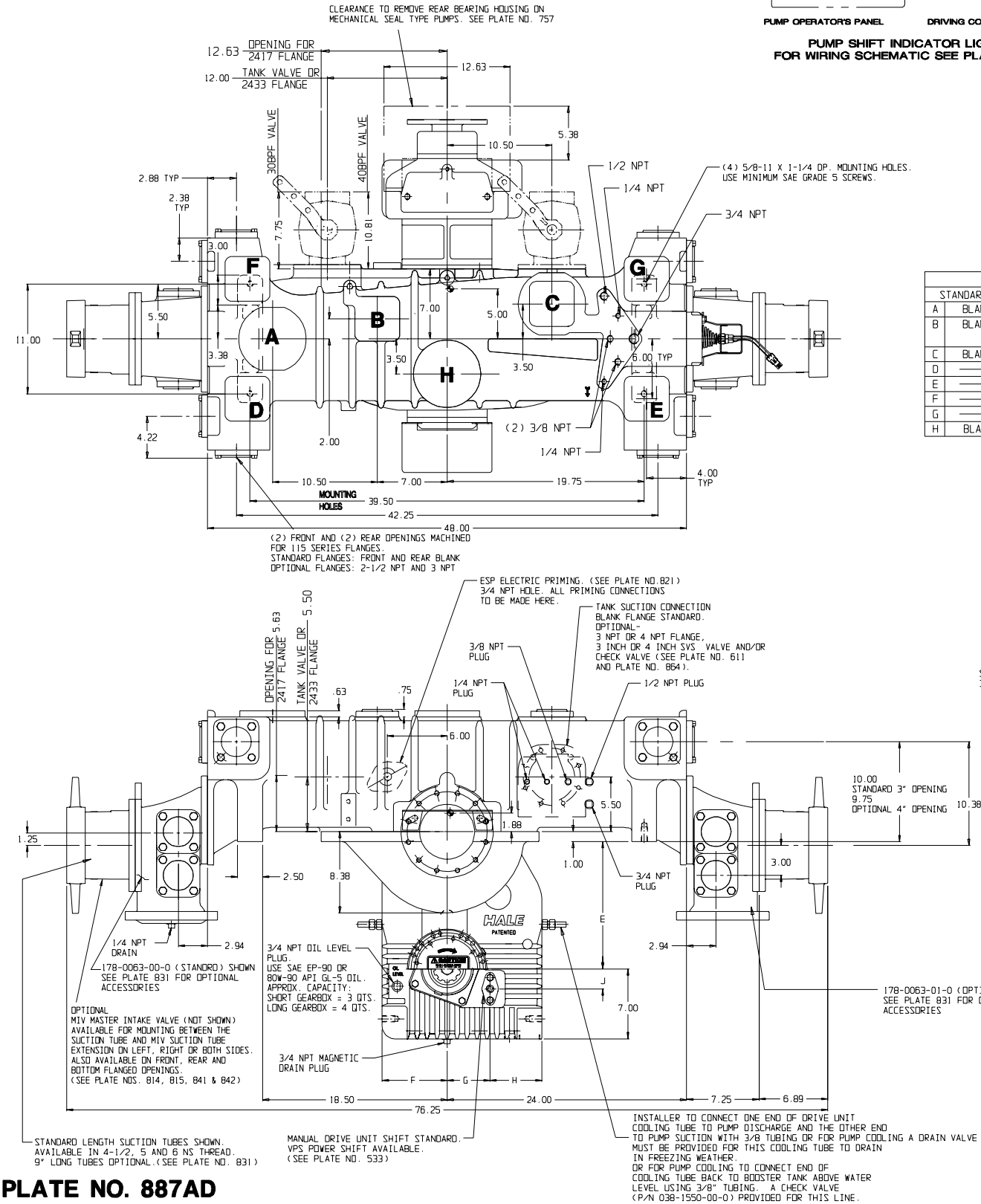
PUMP MODEL	GEAR RATIO	GEARBOX TYPE **	DIMENSIONS								
			E	F	G	H	J				
QMAX*-28	2.83	EXTRA LONG GEARBOX ONLY (X)	14.56	6.50	5.44	4.06	1.84				
QMAX*-25	2.55		14.75								
QMAX*-23	2.32		14.90								
QMAX*-21	2.13		15.06								
QMAX*-19	1.96		15.25								
QMAX*-23	2.28	LONG (L)	12.38	6.50		4.31	5.18	2.00			
		SHORT (S)	10.50						4.75	2.75	.38
QMAX*-21	2.05	LONG (L)	12.56						4.31	5.18	2.00
		SHORT (S)	10.68						4.75	2.75	.38
QMAX*-19	1.86	LONG (L)	12.75						4.31	5.18	2.00
		SHORT (S)	10.88						4.75	2.75	.38
QMAX*-17	1.71	LONG (L)	12.94						4.31	5.18	2.00
		SHORT (S)	11.06						4.75	2.75	.38
QMAX*-15	1.58	LONG (L)	13.13						4.31	5.18	2.00
		SHORT (S)	11.25						4.75	2.75	.38

\* RATED CAPACITY 1000, 1250, 1500, 1750, 2000 AND 2250 GPM  
\*\* THE SHORT (S) GEARBOX IS STANDARD AND WILL BE SUPPLIED UNLESS OTHERWISE SPECIFIED.

EXAMPLE: THE MODEL NUMBER FOR A 1500 GPM RATED PUMP WITH A 2.28 GEAR RATIO AND A SHORT GEARBOX WOULD BE QMAX150-23S.

DRIVE LINE RECOMMENDATIONS

APPARATUS BUILDER SUPPLIED DRIVELINES SHALL BE OF APPROPRIATE SIZE TO MATCH THE CHASSIS AND PUMP REQUIREMENTS WITH INDIVIDUAL JOINT CANCELLATION AND PHASING BEFORE AND AFTER THE PUMP. DRIVE SHAFT BALANCE (INCLUDING YOKES) SHALL NOT EXCEED THE RECOMMENDED LIMIT OF EITHER THE DRIVE SHAFT OR CHASSIS TRANSMISSION MANUFACTURER'S SPECIFICATIONS. DRIVE SHAFT FULL RANGE OPERATING SPEEDS SHALL NOT EXCEED 42% OF ITS CRITICAL SPEED.



0303	D	UPDATED TO CURRENT PRODUCTION	DBH01-25-06	MAL
00-441	C	UPDATED DRAWING	DJK 4-10-00	MAL
99-121	B	UPDATE DRAWING	DPL 6-15-99	RET
98-49	A	RELEASE FOR PRODUCTION	MD 4-1-98	RET
ECD NO	REV	CHANGED FROM	BY DATE	APVD

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Conshohocken, PA 19428 USA

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DRAWN BY MD CHECKED BY RET DATE 2-16-98 SCALE .20

## Notes

[illegible]

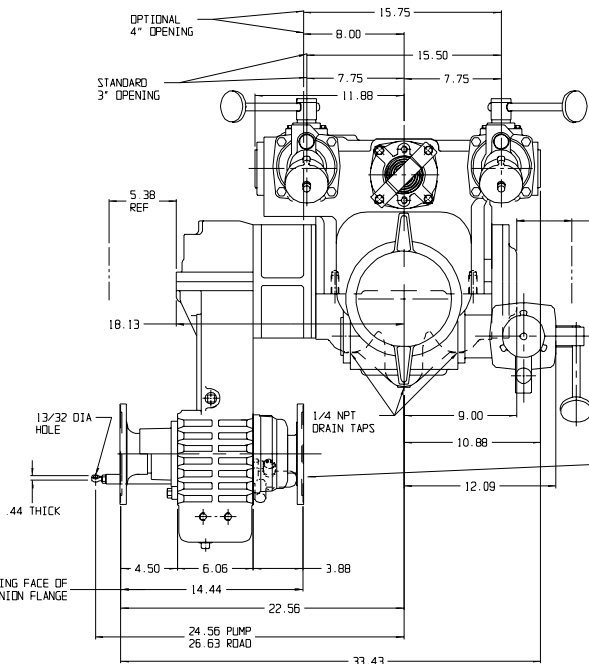
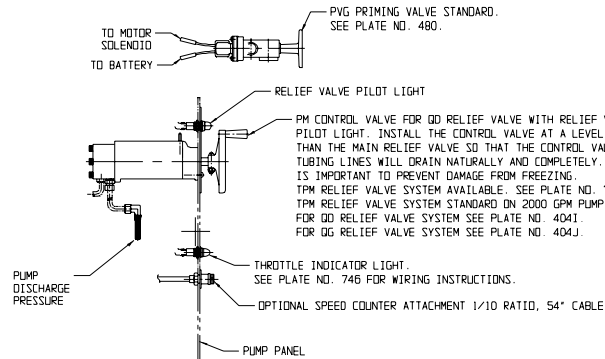
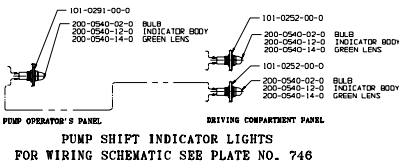
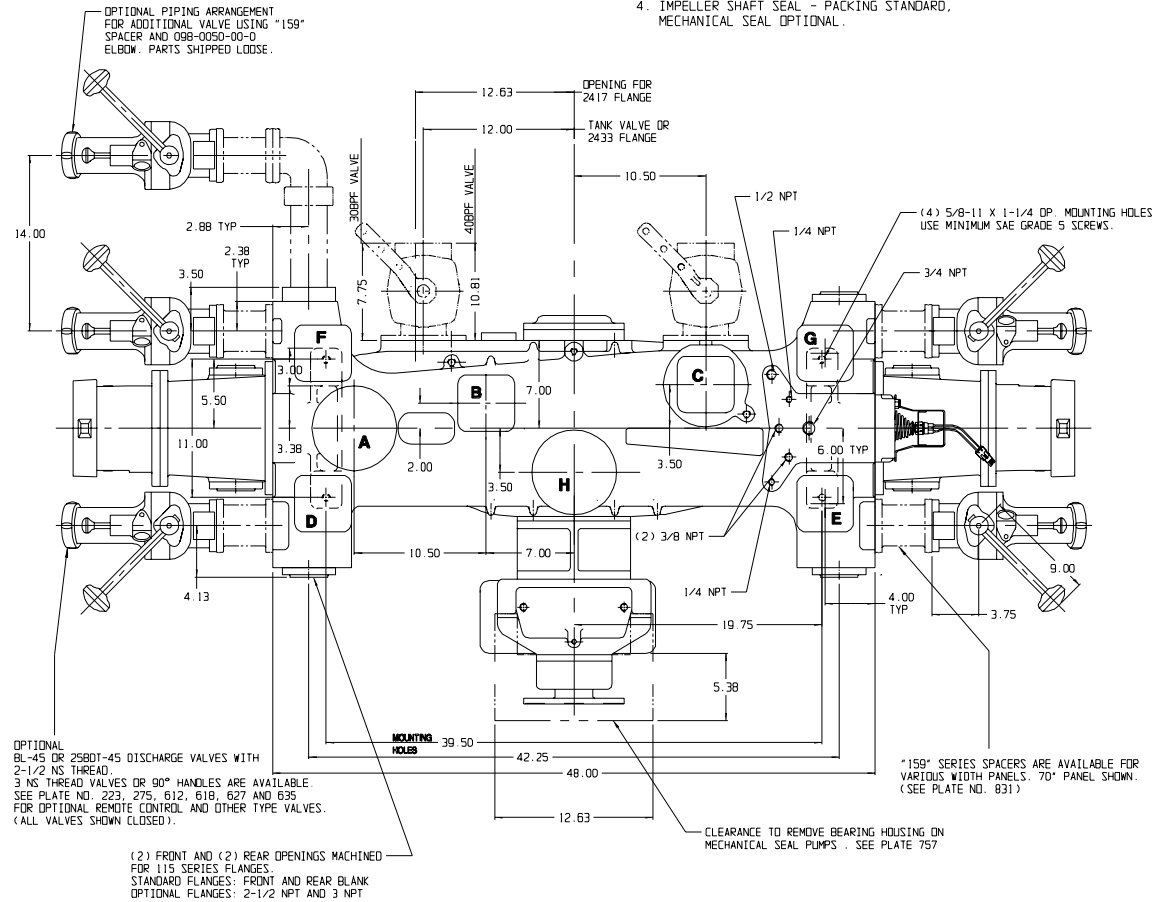
THIS PRODUCT AND ITS COMPONENTS MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING:

4,337,830  
4,587,862  
4,653,978

5,018,665  
5,139,393

NOTES

1. REFER TO HALE PUMP/ENGINE COMBINATION LIST TO SELECT PROPER RATIO TO MATCH PUMP WITH ENGINE.
2. WEIGHT OF STANDARD QMAX 1500 G.P.M. PUMP AS SHOWN WITH 6 VALVES LESS PRIMING PUMP, = 1400 LBS.
3. **G** = CENTER OF GRAVITY.
4. IMPELLER SHAFT SEAL - PACKING STANDARD, MECHANICAL SEAL OPTIONAL.



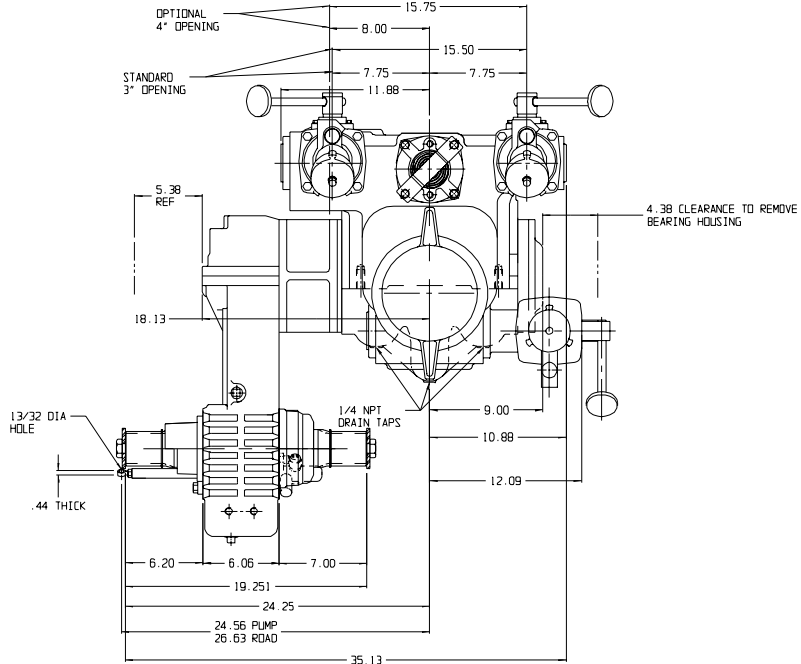
PUMP MODEL	GEAR RATIO	DIMENSIONS				
		E	F	G	H	J
QMAX*-23R	2.28	12.38	6.50	4.31	5.19	2.00
QMAX*-21R	2.05	12.56				
QMAX*-19R	1.86	12.75				
QMAX*-17R	1.71	12.94				
QMAX*-15R	1.58	13.13				

\* RATED CAPACITY 1000,1250,1500,1750, 2000 AND 2250 GPM

EXAMPLE: THE MODEL NUMBER FOR A 1500 GPM RATED PUMP WITH A 2.28 GEAR RATIO AND A FRONT MOUNTED GEARBOX WOULD BE QMAX150-23R.

DRIVE LINE RECOMMENDATIONS

APPARATUS BUILDER SUPPLIED DRIVELINES SHALL BE OF APPROPRIATE SIZE TO MATCH THE CHASSIS AND PUMP REQUIREMENTS WITH INDIVIDUAL JOINT CANCELLATION AND PHASING BEFORE AND AFTER THE PUMP. DRIVE SHAFT BALANCE (INCLUDING YOKES) SHALL NOT EXCEED THE RECOMMENDED LIMIT OF EITHER THE DRIVE SHAFT OR CHASSIS TRANSMISSION MANUFACTURER'S SPECIFICATIONS. DRIVE SHAFT FULL RANGE OPERATING SPEEDS SHALL NOT EXCEED 42% OF ITS CRITICAL SPEED.



00-000	C	ADDED OPTIONAL OUTPUT	JGV	10-01-01	MAL
00-446	B	UPDATED DRAWING	DLK	4-18-00	MAL
99-197	A	RELEASE FOR PRODUCTION	DPL	7-23-99	RET
ECG	NO REV	CHANGED FROM	BY	DATE	APVD

HALE PRODUCTS, INC. A Unit of IDEX Corporation Conshohocken, PA 19428 USA

DATE 7-23-99

SCALE : .20

## Notes

[illegible]

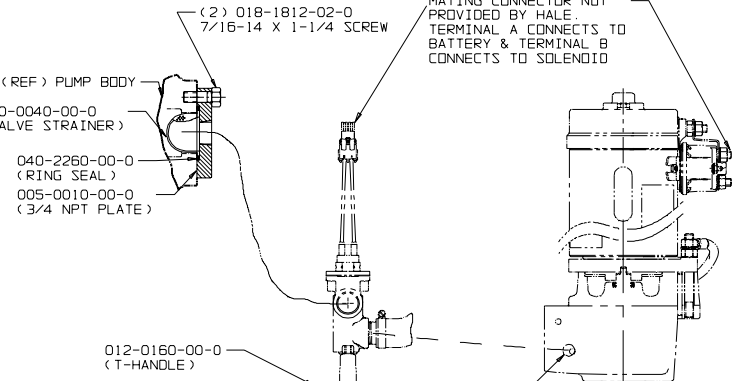
THIS PRODUCT AND ITS COMPONENTS MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING:  
4,337,830, 4,587,862, 4,653,978, 5,018,665, 5,139,393

SAE REGULAR DRIVE CONNECTION  
.205 - .210 ROUND DRIVE 7/8 - 18  
THREAD

007-0040-00-0 - SPEED COUNTER DRIVE ADAPTER  
REPLACED WITH PLUG 217-3007-00-0 (NOT SHOWN)  
WHEN SPEED COUNTER OPTION IS NOT ORDERED

031-0170-00-0 SPEED COUNTER GEAR  
NOT SHOWN  
SPEED COUNTER DRIVEN GEAR BUSHING - 048-0070-00-0  
SUPPORTS END OF DRIVEN GEAR IN FRONT BEARING CAP  
STANDARD FRONT BEARING CAP

SN  
SERIAL NUMBER LOCATION



PVG PRIMING VALVE  
SEE PLATE NO. 480 FOR  
INSTALLATION DETAILS

ESP PRIMING PUMP  
SEE PLATE NO. 821 FOR  
INSTALLATION DETAILS

048-0090-00-0 DRIVE SLEEVE PROVIDES TAKE-OFF  
POINT FOR USE WITH HAND HELD TACHOMETER  
SAE LIGHT DUTY DRIVE CONNECTION  
104 - .101 SQUARE DRIVE - 5/8-18 THREAD

DUST CAP (SUPPLIED WITH DRIVE SLEEVE)  
AVAILABLE SEPARATELY AS 008-0070-00-0  
(1) HOLE .688 DIA.  
(1) HOLE .188 DIA.

013-0010-00-0 - FLEXIBLE SHAFT ASSEMBLY  
54.00 (FLEXIBLE SHAFT CASE LENGTH)  
55.56 (FLEXIBLE SHAFT CORE LENGTH)  
WITH NO END CONNECTIONS AS NOTED

MULTIPLY MEASURED SPEED AT TAKE-OFF POINT  
BY 10 FOR ACTUAL GEARBOX INPUT SPEED.

OPTIONAL SPEED COUNTER DETAILS

FOR INSTALLATION INSTRUCTIONS AND  
PARTS LIST SEE PL910

STANDARD SLIDING GEAR SHAFT  
MOST SLIDING GEAR SHAFTS WILL HAVE  
SPIRAL GEAR FOR SPEED COUNTER OPTION

SEE PLATE NO. 746  
FOR WIRING INSTRUCTIONS

SEE PLATE NO. 746  
FOR WIRING INSTRUCTIONS

PM CONTROL VALVE  
& PILOT LIGHT

PUMP OPERATORS PANEL

101-0381-00-0  
(OPERATOR PANEL  
PLATE)

PM CONTROL VALVE FOR QD RELIEF VALVE WITH RELIEF VALVE  
PILOT LIGHT. INSTALL THE CONTROL VALVE AT A LEVEL HIGHER  
THAN THE MAIN RELIEF VALVE SO THAT THE CONTROL VALVE AND  
TUBING LINES WILL DRAIN NATURALLY AND COMPLETELY. THIS  
IS IMPORTANT TO PREVENT DAMAGE FROM FREEZING.  
TPM RELIEF VALVE SYSTEM AVAILABLE. SEE PLATE NO. 742.  
TPM RELIEF VALVE SYSTEM STANDARD ON 2000 GPM PUMP.  
FOR QD RELIEF VALVE SYSTEM SEE PLATE NO. 404.

(4) 115-0050-00-0 FRONT FLANGE  
(4) 115-0050-00-0 REAR FLANGE  
(8) 142-0390-00-0 SEAL RING  
(8) 018-1812-02-0 FRONT  
7/16-14 X 1-1/4 LG SCREW  
(16) 018-1812-02-0 REAR  
7/16-14 X 1-1/4 LG SCREW

(1) 115-0010-00-0 BLANK FLANGE  
(1) 046-0060-00-0 GASKET  
(8) 018-1812-02-0  
7/16 - 14 X 1 1/4 LG CAP SCREW  
OPTIONAL  
115-0030-00-0 3NPT FLANGE  
115-0040-00-0 4NPT FLANGE  
3 INCH OR 4 INCH SVS VALVE  
AND/OR CHECK VALVE

(2) 115-0010-00-0 FLANGE  
(2) 046-0060-00-0 GASKET  
(16) 018-1812-02-0  
7/16-14 X 1-1/4 LG SCREW

115-0050-00-0  
FLANGE, BLANK  
142-0390-00-0  
115 GASKET

(4) 018-1812-02-0  
7/16-14 X 1-1/4 LG SCREW

001-0870-00-0 ASSEMBLY  
001-0900-00-0 ASSEMBLY  
(QMAX225 ONLY)  
046-0940-00-0 GASKET

QD RELIEF VALVE  
(TPM RELIEF VALVE SYSTEM  
ON 2000 GPM PUMP  
DUAL TPM WITH PMD RELIEF  
VALVES ON 2250 GPM PUMP)

010-0020-00-0 5" SUCTION TUBE STRAINER  
010-0030-00-0 6" SUCTION TUBE STRAINER

097-0040-00-0 5" WASHER  
097-0050-00-0 6" WASHER

(12) 018-1812-02-0  
7/16-14 X 1-1/4 LG SCREW

178-0063-01-0 (OPTIONAL) SHOWN  
SEE PLATE 831 FOR OPTIONAL  
ACCESSORIES

	LG & SG GEARBOX	XG GEARBOX
062-0130-00	(QMAX-23 & QMAX-15)	(QMAX-28 & QMAX-19)
062-0140-00	(QMAX-21 & QMAX-17)	(QMAX-25 & QMAX-21)
062-0150-00	(QMAX-19)	(QMAX-23)

046-6020-00-0 (GASKET LG & XG GEARBOX)  
046-6460-00-0 (GASKET SG GEARBOX)

NO. OF TEETH	GEAR PART NO.	PUMP MODEL	PUMP MODEL
18	031-0920-00-0	QMAX-23	QMAX-28X
20	031-0930-00-0	QMAX-21	QMAX-25X
22	031-0940-00-0	QMAX-19	QMAX-23X
24	031-0950-00-0	QMAX-17	QMAX-21X
26	031-0960-00-0	QMAX-15	QMAX-19X

	LG	SG	XG
GEARBOX HOUSING ASSY	504-0340-00-0	504-0380-00-0	504-0510-00-0
SCREW	018-2014-02-0	018-2014-02-0	018-2014-02-0
GASKET	046-6370-01-0	046-6370-01-0	046-6370-01-0

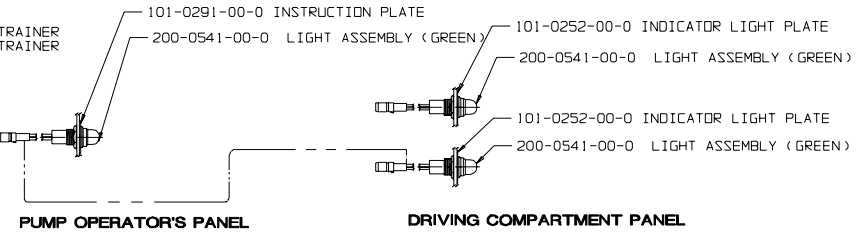
097-0830-01-0 WASHER IMP. SHAFT  
(1) 018-2414-02-0  
5/8-11 X 1-1/2 LG SCREW

FOR WIRING SCHEMATIC  
SEE PLATE NO. 746

SEE PLATE NO. 914 FOR "G" SERIES GEARBOX

NOTES:

- SEE LIMIT CHART, HALE DOCUMENT F-72 FOR MAXIMUM  
ALLOWABLE PUMP PRESSURE, ENGINE HORSEPOWER AND TORQUE LIMITS  
FOR HALE CENTRIFUGAL PUMPS.
- APPLY LOCTITE # 246 HIGH TEMPERATURE THREAD LOCKER OR EQUIVALENT  
TO SCREW THREADS AND TORQUE SCREWS PER HALE ENGINEERING  
STANDARD ESO18-002
- UNLESS OTHERWISE INDICATED FASTENERS ARE GRADE 5 ZINC PLATED STEEL




PUMP SHIFT INDICATOR LIGHTS  
FOR WIRING SCHEMATIC SEE PLATE NO. 746

## HALE QMAX SERIES PUMP WITH "G" SERIES GEARBOX

PLATE NO. 886AF

0303	F	UPDATE DRAWING TO MATCH CURRENT PRODUCTION	DBH	01-25-06	MAL	00-458	D	UPDATED DRAWING	DJK	5-18-00	MAL
00-665	E	UPDATED DRAWING	TKC	10-31-00	MAL	00-445	C	UPDATED DRAWING	DJK	4-10-00	MAL
ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD
99-121	B	UPDATE DRAWING				98-49	A	RELEASE FOR PRODUCTION	DPL	6-15-99	RET
									MD	4-1-98	RET



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DRAWN	MD	DATE 2-13-98	SIZE	SCALE: .25
CHECKED	RET			

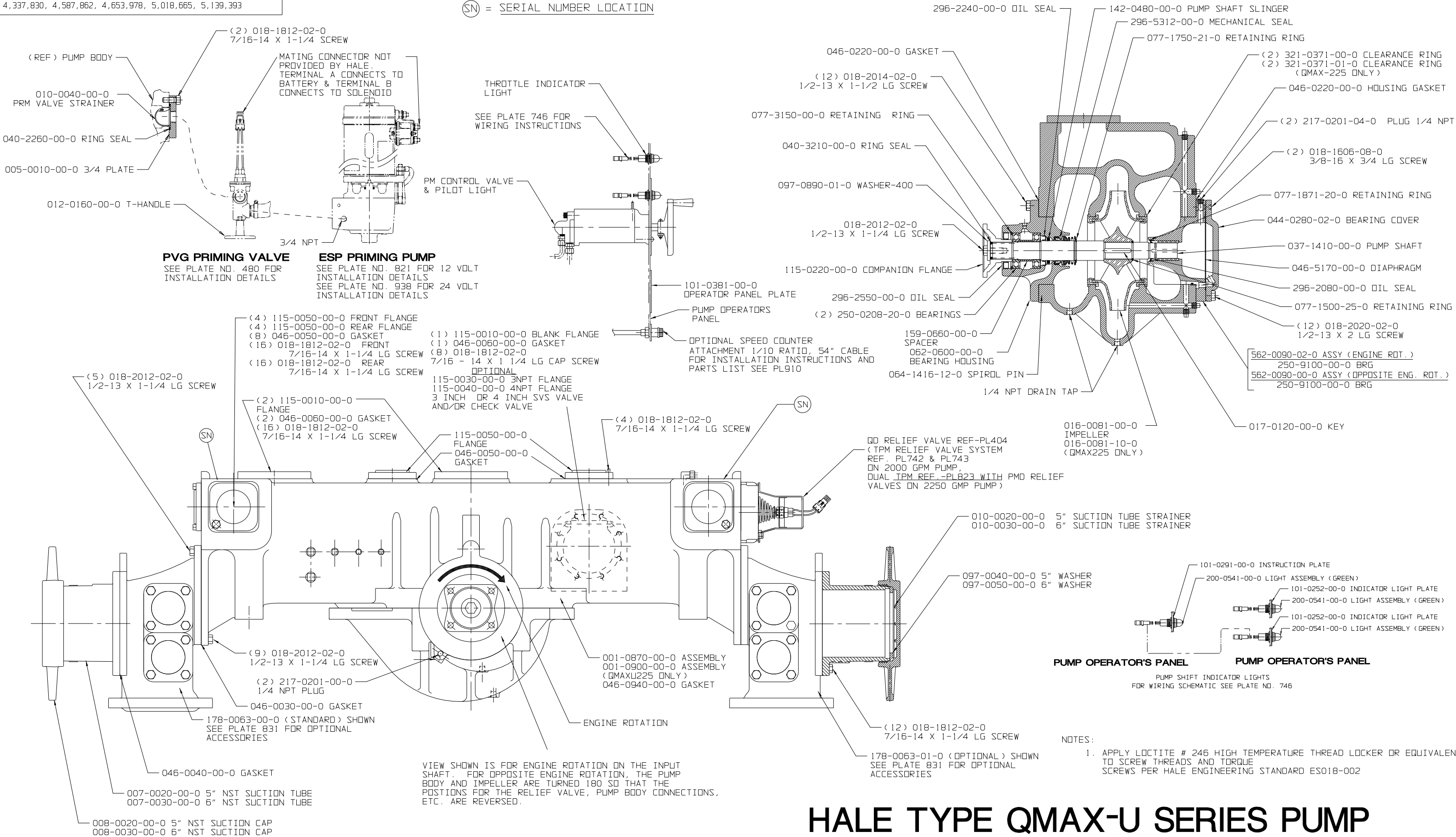
## Notes

[illegible]



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(SN) = SERIAL NUMBER LOCATION



# HALE TYPE QMAX-U SERIES PUMP

PLATE NO. 905AC

0959	C	UPDATE SUCTION EXTENSION, CLARIFIED ROTATION	MM	03-01-10	MAL
00-670	B	UPDATED DRAWING	TKC	10-6-00	MAL
99-197	A	RELEASE FOR PRODUCTION	DPL	7-23-99	RET
ECO NO	REV	CHANGED FROM	BY	DATE	APVD

		HALE PRODUCTS, INC. A Unit of IDEX Corporation Conshohocken, PA 19428 USA	
		DATE 7-23-99	SIZE D
NOT TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY.		DRAWN	DPL
		CHECKED	RET
		DATE 7-23-99	SCALE: .25

## Notes

[illegible]



(2) 018-1812-02-0  
7/16-14 X 1-1/4" SCREW

(REF) PUMP BODY  
00-0040-00-0  
(VALVE STRAINER)

040-2260-00-0  
(RING SEAL)

005-0010-00-0  
(3/4" NPT PLATE)

012-0160-00-0  
(T-HANDLE)

PROVIDED BY HALE  
TERMINAL A CONNECTS TO  
BATTERY & TERMINAL B  
CONNECTS TO SOLENOID

3/4" NPT

**ESP PRIMING PUMP**  
SEE PLATE NO. 821 FOR  
INSTALLATION DETAILS

OPTIONAL SPEED COUNTER ATTACHMENT 1/10 RATIO  
54" CABLE. FOR INSTALLATION INSTRUCTIONS AND  
PARTS LIST SEE PLATE NO.910

— PUMP PANEL

VE WITH RELIEF VALVE  
VALVE AT A LEVEL HIGHER  
THE CONTROL VALVE AND  
AND COMPLETELY. THIS  
4 FREEZING.  
SEE PLATE NO. 742.  
N 2000 GPM PUMP.  
TE NO. 404.

040-2550-00-0  
RING-SEAL  
040-2340-00-0  
SEAL RING  
296-5210-03-0  
MECHANICAL SEAL  
077-2000-21-0  
RETAINING RING  
040-2260-10-0  
TEFLON SEAL RING  
1/4 NPT PLUG  
(12) 018-2016-02-0  
1/2-13 X 1-3/4 LG SCREW  
(2) 046-0220-00-0  
GASKET  
062-0850-00-0 REAR BEARING HOUSING  
(LK-21 & LK-19 RATIO)  
(XK-21 & XK-19 RATIO)  
062-0860-00-0 REAR BEARING HOUSING  
(LK-25, LK-23, LK-17, LK-16 RATIO)  
(XK-25, XK-23, XK-17, XK-16 RATIO)  
040-2260-10-0 TEFLON SEAL RING  
046-6800-00-0 GASKET  
142-0010-00-0  
SLINGER  
296-2050-00-0 OIL SEAL  
250-8240-00-0 BEARING  
159-2020-00-0 SPACER  
017-0650-02-0 KEY  
159-1730-00-0 SPACER  
250-8340-00-0 BEARING  
110-6110-09-0 N-09 NUT  
097-3170-09-0 W-09 WASHER  
097-2400-00-0 WASHER  
097-2570-00-0 BEARING PLATE  
(4) 018-1206-02-0  
1/4 X 3/4 LG SCREW  
031-1660-00-0 GEAR (21 TEETH) (LK-25 & XK-25)  
031-1670-00-0 GEAR (23 TEETH) (LK-23 & XK-23) SHOWN  
031-1680-00-0 GEAR (26 TEETH) (LK-21 & XK-21)  
031-1690-00-0 GEAR (28 TEETH) (LK-19 & XK-19)  
031-1700-00-0 GEAR (31 TEETH) (LK-17 & XK-17)  
031-1710-00-0 GEAR (33 TEETH) (LK-16 & XK-16)  
077-2000-21-0 RETAINING RING  
046-0220-00-0 GASKET  
(2) 217-0201-04-0  
PLUG-1/4 NPT  
062-0110-00-1 HOUSING#30 CI  
(2) 018-1606-08-0  
3/8-16 X 3/4 LG  
SOCKET HEAD SCREW  
077-1871-20-0  
RETAINING RING  
044-0280-00-0  
COVER FR. BEARING  
250-9100-00-0  
FRONT SLEEVE BEARING  
159-1200-02-0  
AUTO LUBE SPACER  
037-2610-00-0  
PUMP SHAFT  
046-5170-00-0  
DIAPHRAGM  
296-2080-00-0  
OIL SEAL  
077-1500-25-0  
RETAINING RING  
(12) 018-2020-02-0  
1/2-13 X 2 LG SCREW  
321-0371-00-0 CLEARANCE RING  
321-0371-01-0 CLEARANCE RING  
(QMAX225 ONLY)  
016-0081-00-0 IMPELLER  
016-0081-10-0  
(QMAX225 ONLY)  
017-0120-00-0  
(KEY)  
1/4 NPT DRAIN TAP  
062-0680-00 HOUSING  
MECHANICAL SEAL  
064-1416-12-0 PIN  
044-1250-00-0 SEAL COVER  
(4) 018-1812-02-0  
7/16-14 X 1-1/4 SCREW

QD WITH PM CONTROL (UP TO 1250 GPM)  
QG WITH PM CONTROL (UP TO 1750 GPM)  
TPM WITH PMD CONTROL (REQ'D 2000 GPM)  
DUAL TPM WITH PMD CONTROL (REQ'D 2250 GPM)

SEE PLATE NO. 978 FOR "K" SERIES GEARBOY

**SEE PLATE NO. 978 FOR "K" SERIES GEARBOX**

1. SEE LIMIT CHARACTER DATA SHEET DOCUMENT F-72 FOR MAXIMUM ALLOWABLE PUMP PRESSURE, ENGINE HORSEPOWER AND TORQUE LIMITS FOR HALE CENTRIFUGAL PUMPS.
2. APPLY LOCTITE # 246 HIGH TEMPERATURE THREAD LOCKER OR EQUIVALENT TO SCREW THREADS AND TORQUE SCREWS PER HALE ENGINEERING STANDARD ES018-002
3. UNLESS OTHERWISE INDICATED FASTENERS ARE GRADE 5 ZINC PLATED STEEL

Diagram illustrating the wiring for Pump Shift Indicator Lights, showing connections between the Pump Operator's Panel and the Driving Compartment Panel.

**PUMP OPERATOR'S PANEL**

- 101-0291-00-0 INSTRUCTION PLATE
- 200-0541-00-0 LIGHT ASSEMBLY (GREEN)

**DRIVING COMPARTMENT PANEL**

- 101-0252-00-0 INDICATOR LIGHT PLATE
- 200-0541-00-0 LIGHT ASSEMBLY (GREEN)
- 101-0252-00-0 INDICATOR LIGHT PLATE
- 200-0541-00-0 LIGHT ASSEMBLY (GREEN)

**PUMP SHIFT INDICATOR LIGHTS**

**FOR WIRING SCHEMATIC SEE PLATE NO. 746**

PLATE NO. 1156AA

ECD NO	REV	CHANGED FROM	BY	DATE	APVD	ECD NO	REV	CHANGED FROM	BY	DATE	APVD

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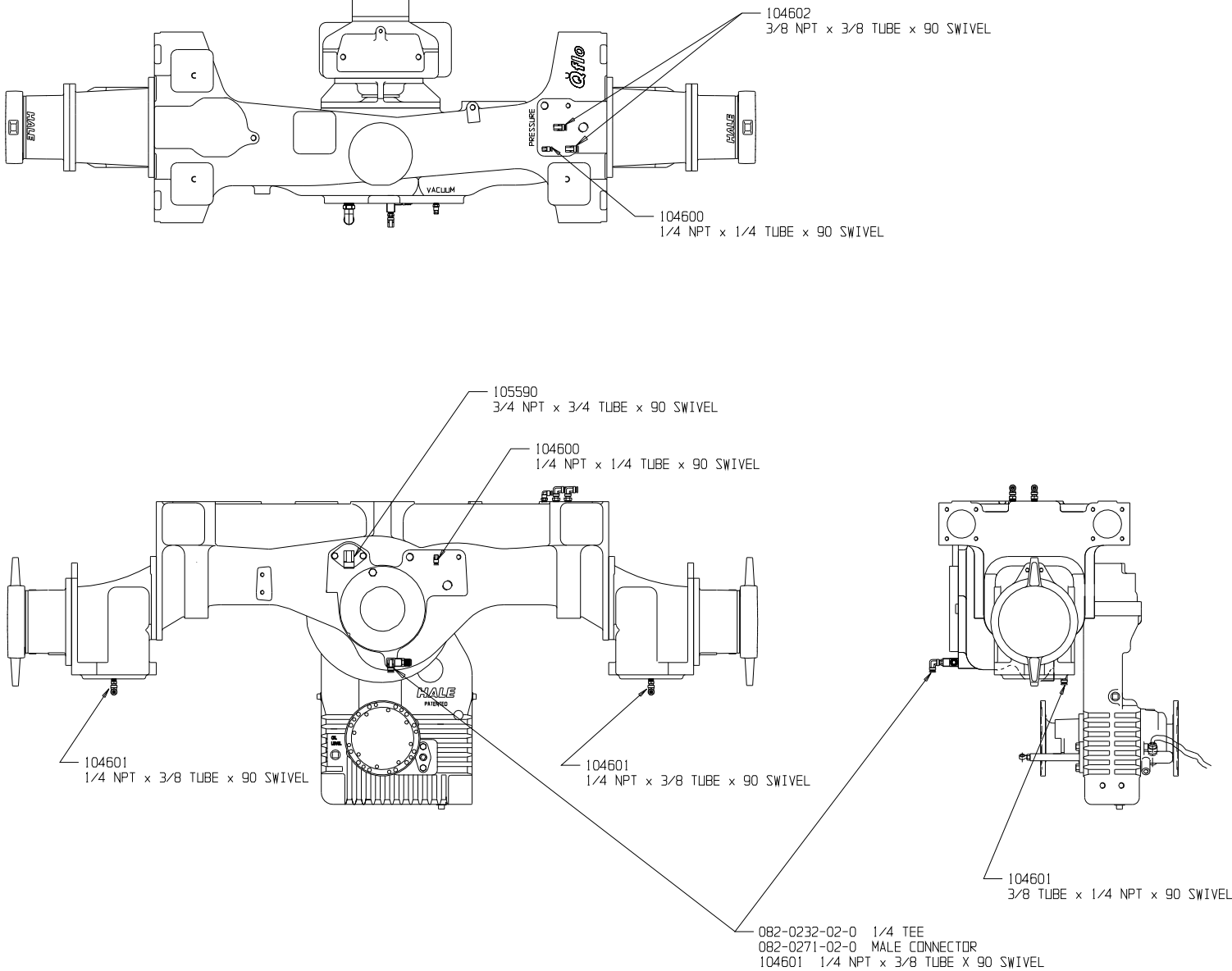
DRAWN	SJM	DATE 8-03-07	SIZE	SCALE: FULL
CHECKED	MAI		D	

## Notes

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# HALE Q-FLO AND Q-MAX FITTINGS

Q-FLO



Q-MAX

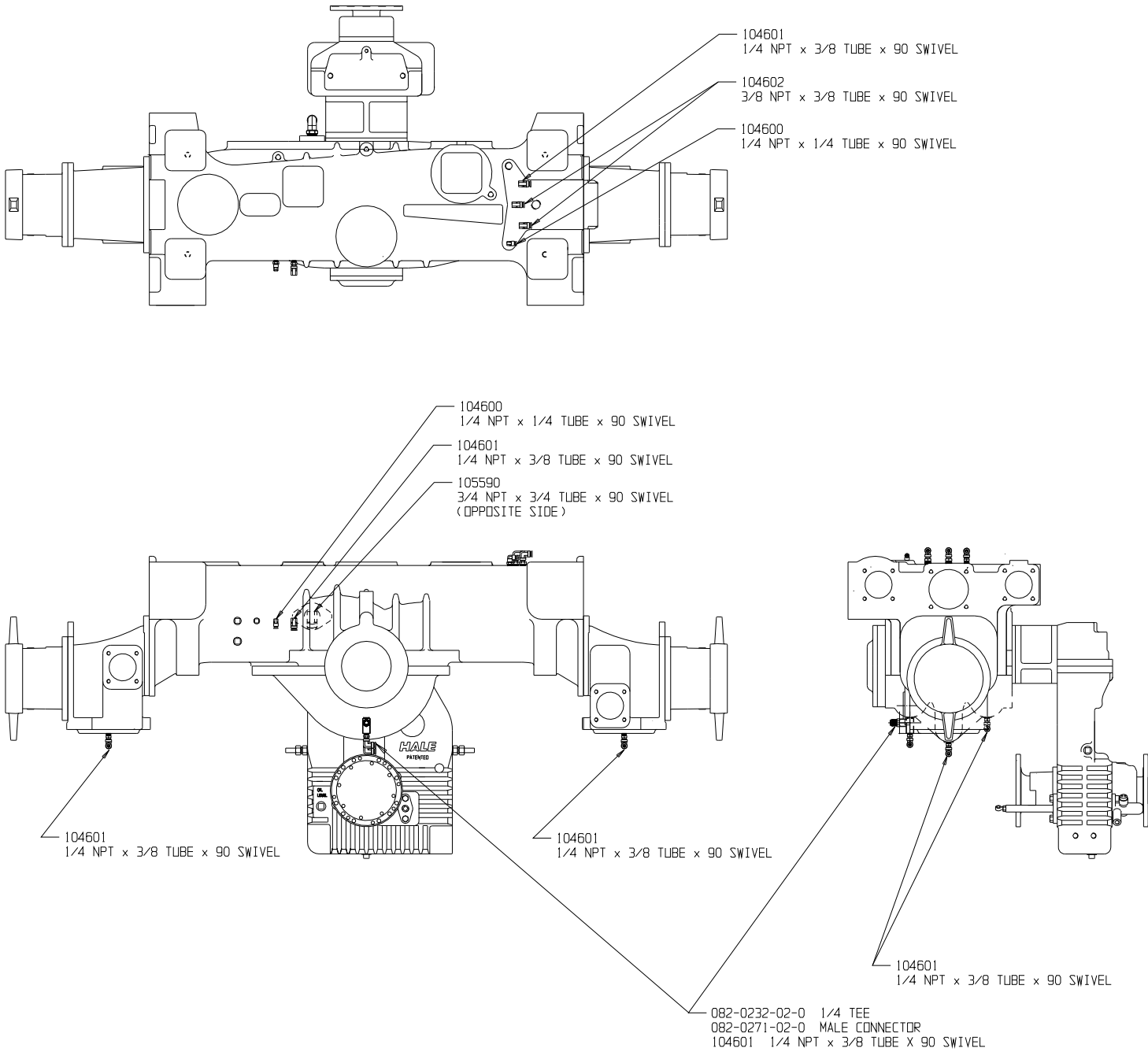



PLATE NO. 1046 AA

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	<div><div></div><div>HALE PRODUCTS, INC. A Unit of IDEX Corporation Conshohocken, PA 19428 USA</div></div>
04-150	A	RELEASE FOR PRODUCTION	DW	6/30/04	MAL	
						<div><div><div><div>COPYRIGHT ©</div><div>NOT TO BE REPRODUCED OR USED TO</div><div>MAKE OTHER DRAWINGS OR MACHINERY.</div></div><div><div>DRAWN</div><div>CHECKED</div></div><div><div>DW</div><div>JFG</div></div><div>DATE 06-30-04</div><div>SIZE</div><div>SCALE : NONE</div></div></div>

## Notes

[illegible]



## Notes

[illegible]



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4,089,345, 4,209,282, 4,311,440, 4,337,830, 4,587,862, 4,653,978, 5,018,665, 5,139,393

SAE REGULAR DRIVE CONNECTION  
205 - .210 ROUND DRIVE 7/8 - 18  
THREAD

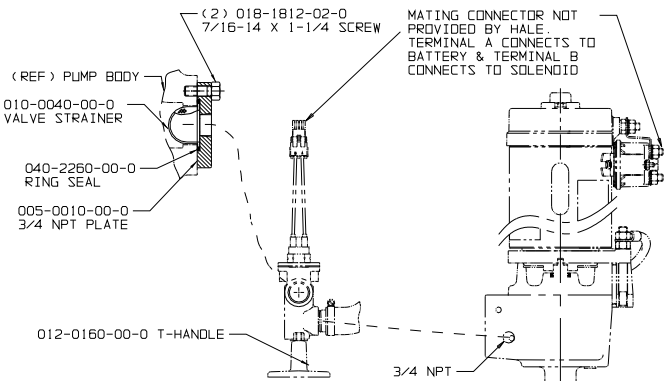
007-0040-00-0 - SPEED COUNTER DRIVE ADAPTER  
REPLACED WITH PLUG 217-3007-00-0 (NOT SHOWN)  
WHEN SPEED COUNTER OPTION IS NOT ORDERED

031-0170-00-0 (SPEED COUNTER GEAR)

NOT SHOWN  
SPEED COUNTER DRIVEN GEAR BUSHING - 048-0070-00-0  
SUPPORTS END OF DRIVEN GEAR IN FRONT BEARING CAP  
STANDARD FRONT BEARING CAP

SN

SERIAL NUMBER LOCATION



PVG PRIMING VALVE  
SEE PLATE NO. 480 FOR  
INSTALLATION DETAILS

ESP PRIMING PUMP  
SEE PLATE NO. 821 FOR  
INSTALLATION DETAILS

DD RELIEF VALVE WITH PM CONTROL  
(UP TO 1250 GPM)  
GG RELIEF VALVE WITH PM CONTROL  
(UP TO 1750 GPM)  
TPM RELIEF VALVE WITH PMO CONTROL  
STANDARD ON 2000 GPM PUMPS

(4) 115-0050-00-0 FRONT BLANK FLANGE  
(4) 115-0050-00-0 REAR BLANK FLANGE  
(8) 142-0390-00-0 SEAL RING  
(16) 018-1812-02-0 FRONT  
7/16-14 X 1-1/4 LG SCREW  
(16) 018-1812-02-0 REAR  
7/16-14 X 1-1/4 LG SCREW

(2) 115-0010-00-0 FLANGE  
(2) 046-0060-00-0 GASKET  
(16) 018-1812-02-0  
7/16 - 14 X 1 1/4 LG CAP SCREW

OPTIONAL  
115-0030-00-0 3NPT FLANGE  
115-0040-00-0 4NPT FLANGE  
3 INCH OR 4 INCH SVS VALVE  
AND/OR CHECK VALVE

(2) 115-0010-00-0  
(2) 046-0060-00-0 GASKET  
(16) 018-1812-02-0  
7/16-14 X 1-1/4 LG SCREW

(2) 115-0050-00-0 FLANGE  
(8) 018-1812-02-0  
7/16-14 X 1-1/4 LG SCREW  
142-0390-00-0 SEAL RING

(2) 038-0082-00-0  
CHECK VALVE  
(2) 044-0101-00-0  
CHECK VALVE COVER  
(2) 142-0530-00-0  
SEAL RING  
(8) 018-2012-02-0  
1/2-13 X 1 1/4 LG  
(2) 029-0110-00-0  
P-250 ANODE  
(4) 250-9632-00-0  
BUSHINGS

(9) 018-2012-02-0  
1/2-13 X 1-1/4 LG SCREW

046-0030-00-0 GASKET  
178-0063-00-0 (STANDARD) SHOWN  
SEE PLATE 831 FOR OPTIONAL  
ACCESSORIES

007-0020-00-0 5" NST SUCTION TUBE  
007-0030-00-0 6" NST SUCTION TUBE

008-0020-00-0 5" NST SUCTION CAP  
008-0030-00-0 6" NST SUCTION CAP

048-0090-00-0 DRIVE SLEEVE PROVIDES TAKE-OFF  
POINT FOR USE WITH HAND HELD TACHOMETER

SAE LIGHT DUTY DRIVE CONNECTION  
104 - .101 SQUARE DRIVE - 5/8-18 THREAD

DUST CAP (SUPPLIED WITH DRIVE SLEEVE)  
AVAILABLE SEPERATELY AS 008-0070-00-0

(1) HOLE .688 DIA.  
.654  
.658

(1) HOLE .188 DIA.

HOLE SIZES FOR PANEL MOUNTING

013-0010-00-0 - FLEXIBLE SHAFT ASSEMBLY  
54.00 (FLEXIBLE SHAFT CASE LENGTH)  
55.56 (FLEXIBLE SHAFT CORE LENGTH)  
WITH NO END CONNECTIONS AS NOTED

MULTIPLY MEASURED SPEED AT TAKE-OFF POINT  
BY 10 FOR ACTUAL GEARBOX INPUT SPEED.

OPTIONAL SPEED COUNTER DETAILS  
FOR INSTALLATION INSTRUCTIONS AND  
PARTS LIST SEE PL910

THROTTLE INDICATOR LIGHT  
SEE PLATE NO. 746  
FOR WIRING INSTRUCTIONS

PM CONTROL VALVE  
& PILOT LIGHT

PUMP OPERATORS PANEL

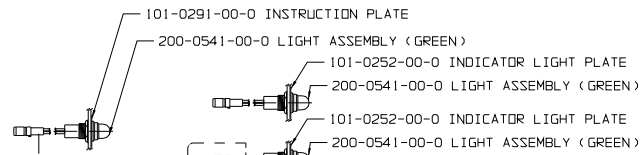
101-0381-00-0  
OPERATOR PANEL  
PLATE

PM CONTROL VALVE WITH RELIEF VALVE PILOT LIGHT.  
INSTALL THE CONTROL VALVE AT A LEVEL HIGHER  
THAN THE MAIN RELIEF VALVE SO THAT THE CONTROL VALVE AND  
TUBING LINES WILL DRAIN NATURALLY AND COMPLETELY. THIS  
IS IMPORTANT TO PREVENT DAMAGE FROM FREEZING.  
TPM RELIEF VALVE SYSTEM AVAILABLE. SEE PLATE NO. 742.  
FOR DD RELIEF VALVE SYSTEM SEE PLATE NO. 404.  
FOR GG RELIEF VALVE SYSTEM SEE PLATE NO. 404.

DLF TRANSFER VALVE  
(MANUAL SHOWN REFERENCE PL-472)  
POWER OPERATED VALVE &  
TOP MOUNT MANUAL OPTIONAL

SEE PLATE NO. 914 FOR "G" SERIES GEARBOX

FOR WIRING SCHEMATIC  
SEE PLATE NO. 746



PUMP OPERATOR'S PANEL

DRIVING COMPARTMENT PANEL

PUMP SHIFT INDICATOR LIGHTS  
FOR WIRING SCHEMATIC SEE PLATE NO. 746

NOTES:

- SEE LIMIT CHART, HALE DOCUMENT F-72 FOR MAXIMUM ALLOWABLE PUMP PRESSURE, ENGINE HORSEPOWER AND TORQUE LIMITS FOR HALE CENTRIFUGAL PUMPS.
- APPLY LOCTITE # 246 HIGH TEMPERATURE THREAD LOCKER OR EQUIVALENT TO SCREW THREADS AND TORQUE SCREWS PER HALE ENGINEERING STANDARD ES018-002
- UNLESS OTHERWISE INDICATED FASTENERS ARE GRADE 5 ZINC PLATED STEEL

## HALE QTWO SERIES PUMP WITH "G" SERIES GEARBOX

0698	E	UPDATED DRAWING	SJM	03-03-08	MAL
0307	D	ADD SPLINED SHAFT OPTION UPDATE SUCTION EXTENSION	DBH	01-31-06	MAL
00-665	C	UPDATED DRAWING	TKC	10-31-00	MAL
00-441	B	UPDATED DRAWING	DJK	4-10-00	MAL
99-121	A	RELEASE FOR PRODUCTION	DPL	6/15/99	RET
ECO NO	REV	CHANGED FROM	BY	DATE	APVD



HALE PRODUCTS, INC.  
A Unit of IDEX Corporation  
Conshohocken, PA 19428 USA

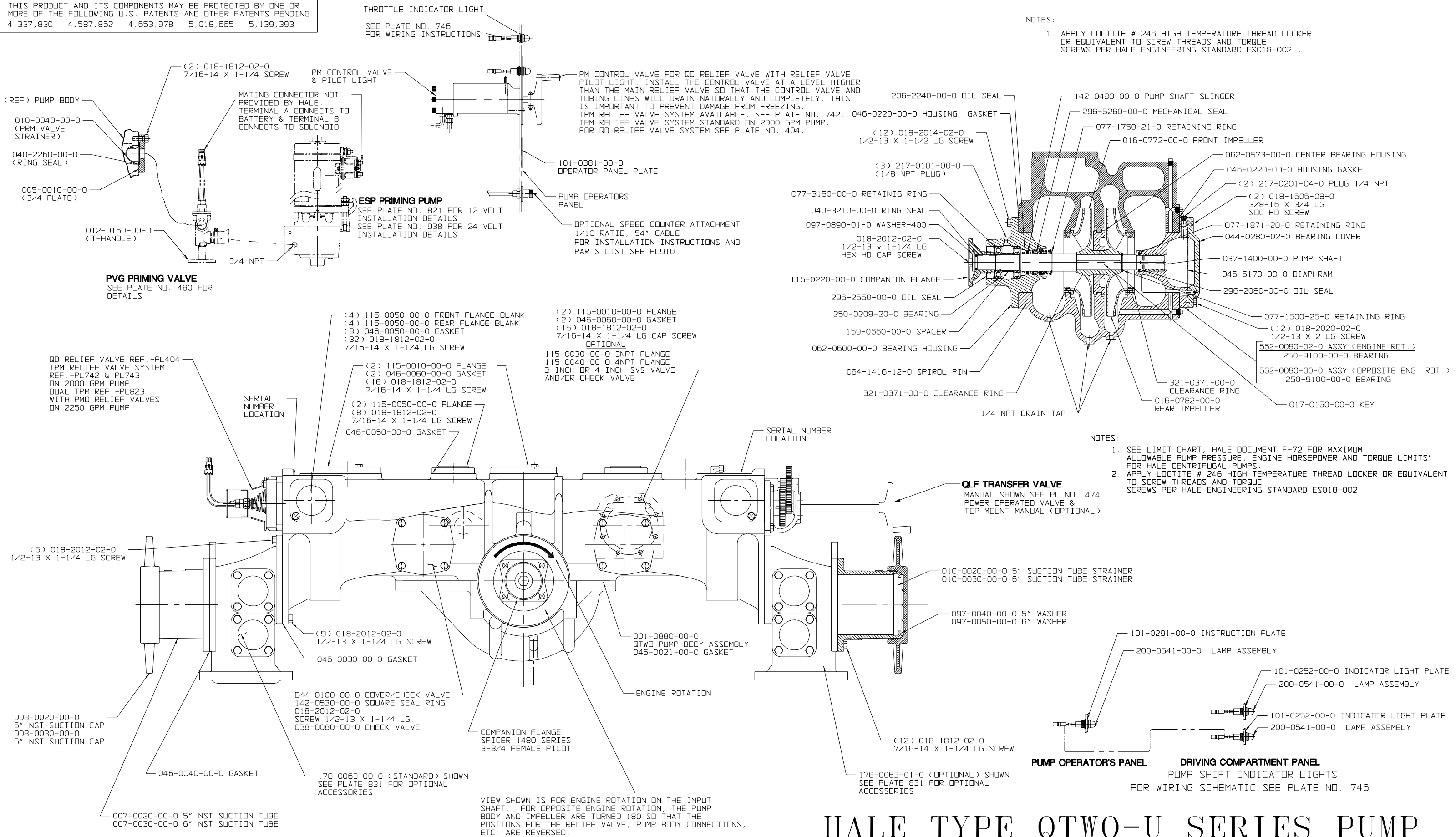
COPYRIGHT © 1999 HALE PRODUCTS, INC.  
NOT TO BE REPRODUCED OR USED TO  
MAKE OTHER DRAWINGS OR MACHINERY.  
DRAWN WFM  
CHECKED RET  
DATE 5-15-98  
SIZE D  
SCALE : .25

PLATE NO. 888AE

## Notes

[illegible]

THIS PRODUCT AND ITS COMPONENTS MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING:  
4,337,830 4,587,862 4,653,978 5,018,665 5,139,393



04-265	D	UPDATE SUCTION EXTENSION, CLARAFIED ROTATION	TKC	10-24-04	MAL
00-671	C	UPDATED DRAWING	TKC	10-6-00	MAL
00-446	B	UPDATED DRAWING	DJK	4-18-00	MAL
99-197	A	RELEASE FOR PRODUCTION	DPL	7-23-99	RET
ECD NO	REV	CHANGED FROM	BY	DATE	APVD



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DRAWN  
CHECKED

DPL  
RET

DATE 7-23-99

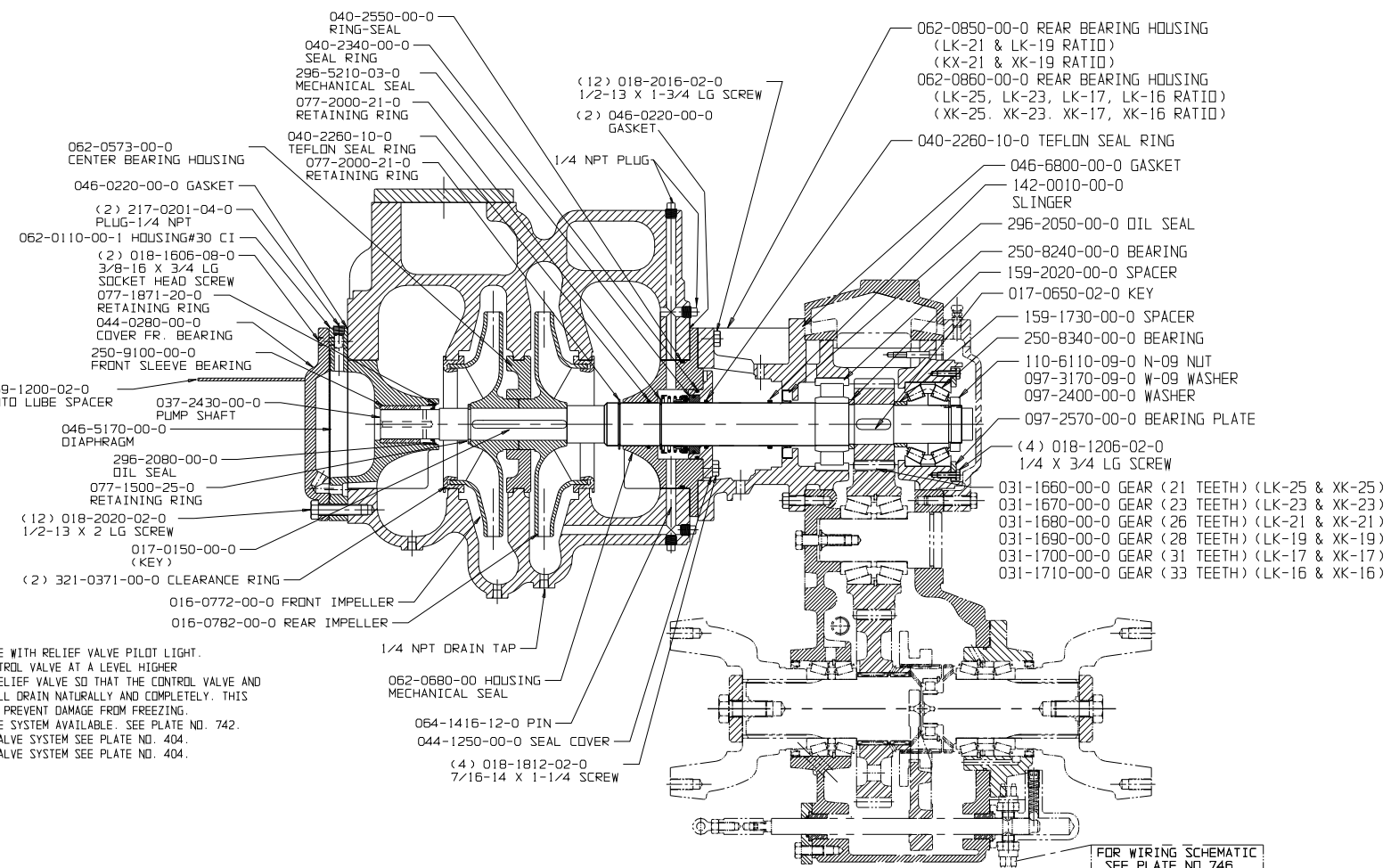
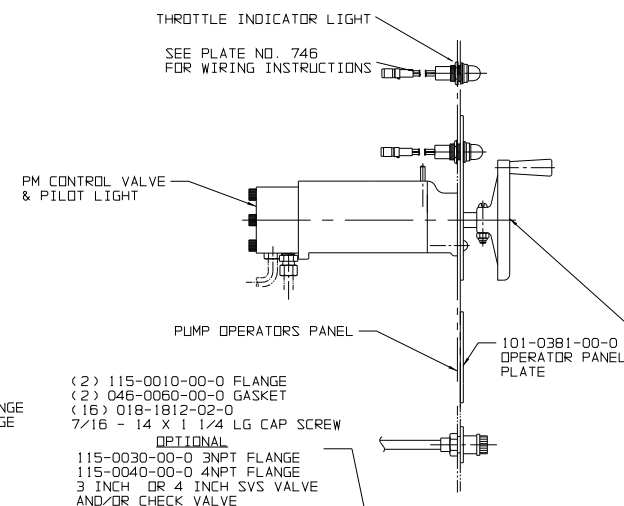
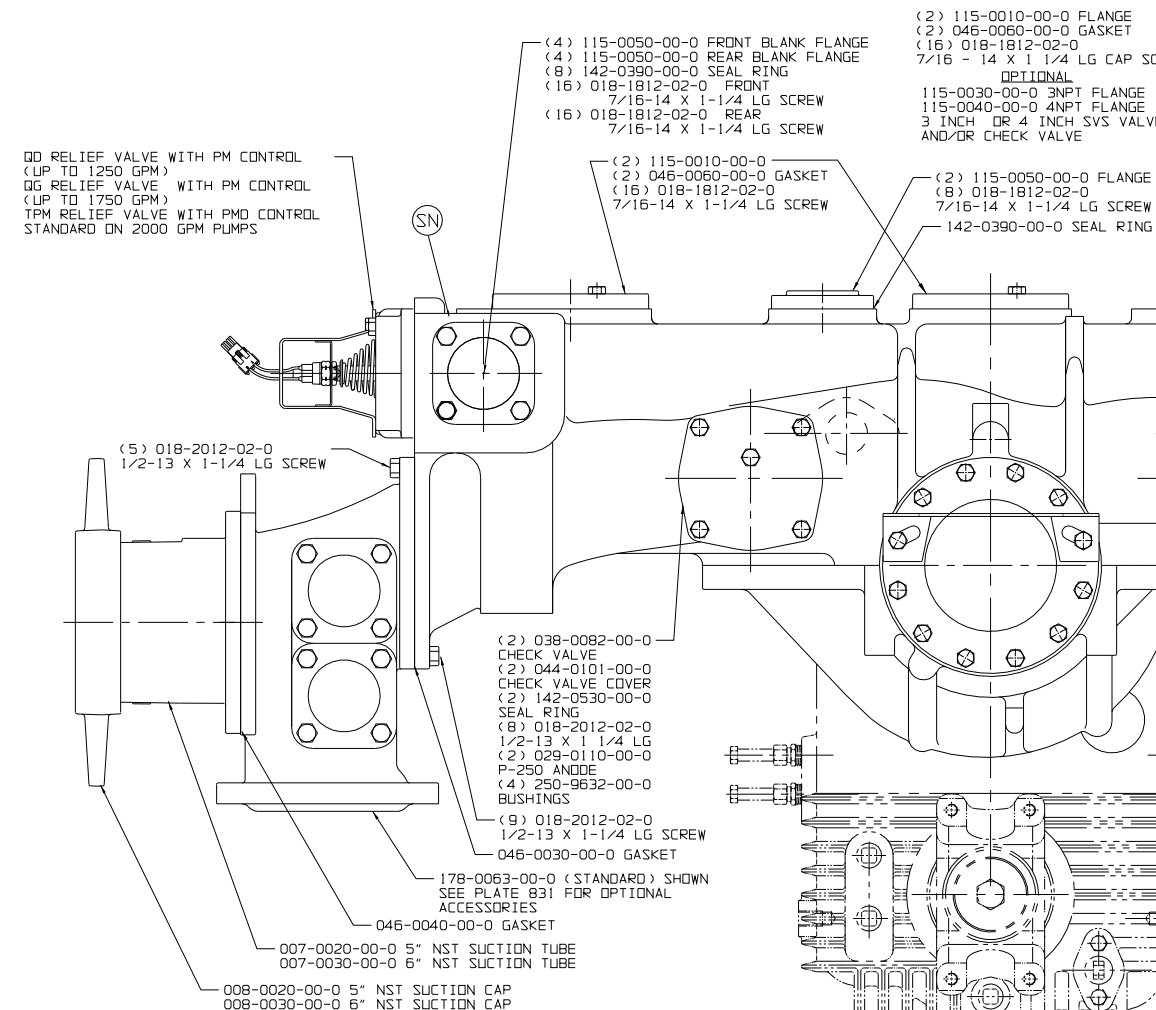
SIZE  
D

SCALE: .25

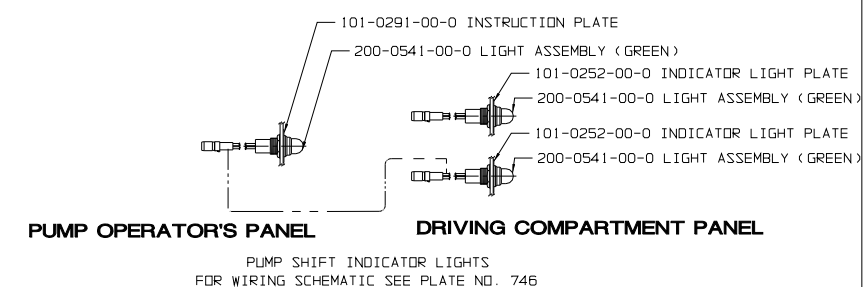
## Notes

[illegible]

① SN  
SERIAL NUMBER LOCATION



SEE PLATE NO. 978 FOR "K" SERIES GEARBOX



NOTES:

1. SEE LIMIT CHART, HALE DOCUMENT F-72 FOR MAXIMUM ALLOWABLE PUMP PRESSURE, ENGINE HORSEPOWER AND TORQUE LIMITS FOR HALE CENTRIFUGAL PUMPS.
2. APPLY LOCTITE # 246 HIGH TEMPERATURE THREAD LOCKER OR EQUIVALENT TO SCREW THREADS AND TORQUE SCREWS PER HALE ENGINEERING STANDARD ES018-002.
3. UNLESS OTHERWISE INDICATED FASTENERS ARE GRADE 5 ZINC PLATED STEEL.

# HALE QTWO SERIES PUMP WITH "K" SERIES GEARBOX

PLATE NO. 1173AA

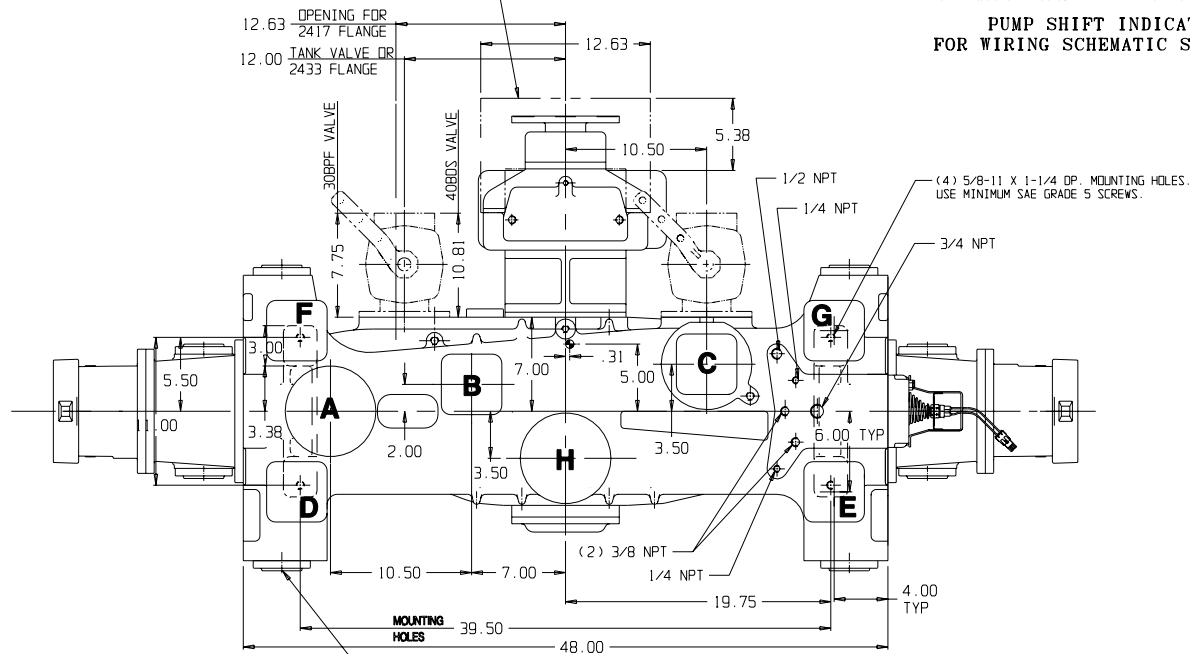
						 <div>HALE PRODUCTS, INC. A Unit of IDEX Corporation Conshohocken, PA 19428 USA</div>	
0712	A	RELEASE FOR PRODUCTION	MD	4-15-08	MAL		
ECO NO	REV	CHANGED FROM	BY	DATE	APVD	<div><div>COPYRIGHT © NOT TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY.</div><div>DRAWN CHECKED</div><div>MD MAL</div><div>DATE 4-2-08</div><div>SIZE D</div><div>SCALE: FULL</div></div>	

## Notes

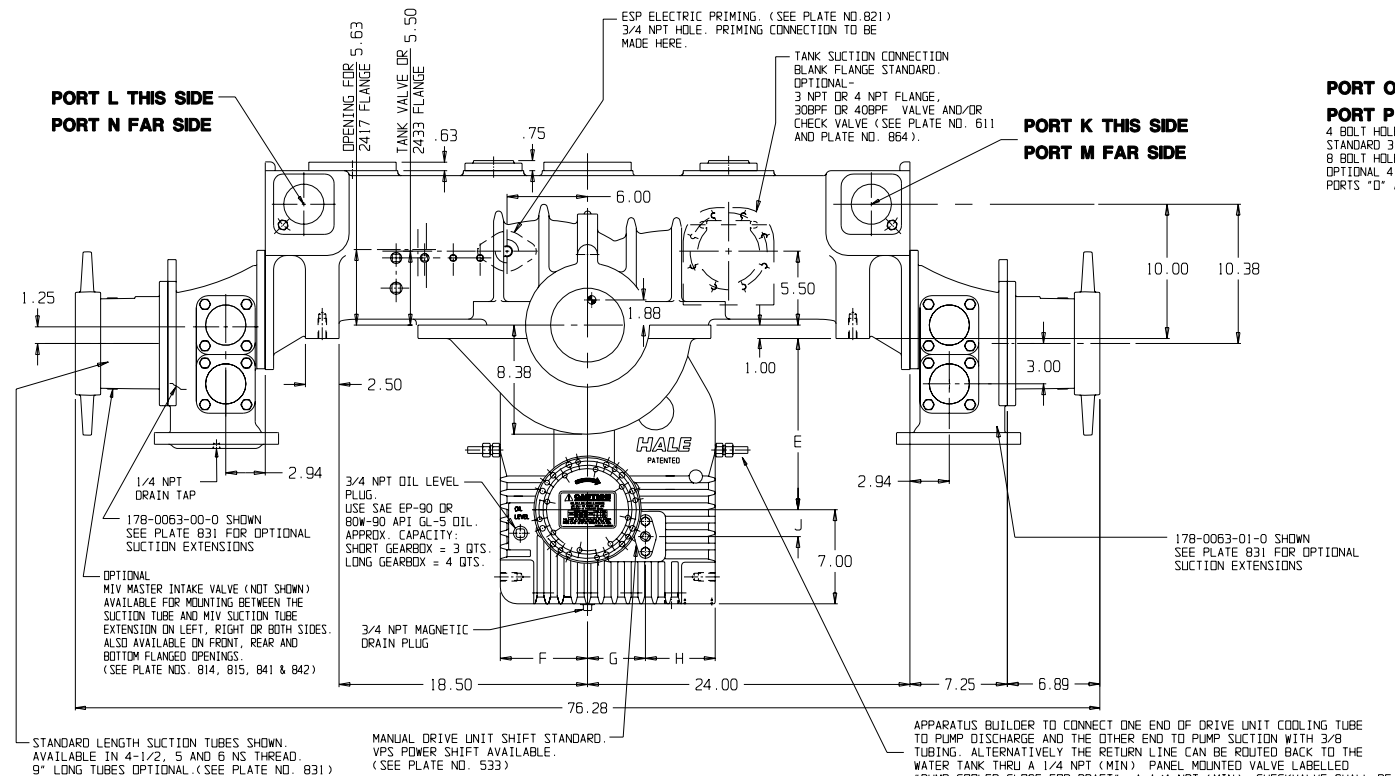
[illegible]

OPTIONAL DISCHARGE FLANGES		
STANDARD	OPTIONAL	STD. CAST HOLE
A BLANK	2-1/2, 3 & 4 NPT	4
B BLANK	1-1/4, 2, 2-1/2 & 3 NPT	3
C BLANK	2-1/2, 3 & 4 NPT	3
D	2-1/2 & 3 NPT	CAST SOLID
E	2-1/2 & 3 NPT	CAST SOLID
F	2-1/2 & 3 NPT	CAST SOLID
G	2-1/2 & 3 NPT	CAST SOLID
H BLANK	2-1/2, 3 & 4 NPT	3

CLEARANCE TO REMOVE REAR BEARING HOUSING ON MECHANICAL SEAL TYPE PUMPS. SEE PLATE NO. 757



(2) FRONT AND (2) REAR OPENINGS MACHINED FOR 115 SERIES FLANGES. STANDARD FLANGES: FRONT AND REAR BLANK. OPTIONAL FLANGES: 2-1/2 NPT AND 3 NPT



MANUAL DRIVE UNIT SHIFT STANDARD. VPS POWER SHIFT AVAILABLE. (SEE PLATE NO. 533)

APPARATUS BUILDER TO CONNECT ONE END OF DRIVE UNIT COOLING TUBE TO PUMP DISCHARGE AND THE OTHER END TO PUMP SUCTION WITH 3/8 TUBING. ALTERNATIVELY THE RETURN LINE CAN BE ROUTED BACK TO THE WATER TANK THRU A 1/4 NPT (MIN.) PANEL MOUNTED VALVE LABELLED "PUMP COOLER CLOSE FOR DRAFT". A 1/4 NPT (MIN.) CHECKVALVE SHALL BE INSTALLED IN THIS LINE. A DRAIN VALVE MUST BE PROVIDED FOR THIS COOLING TUBE TO DRAIN IN FREEZING WEATHER.

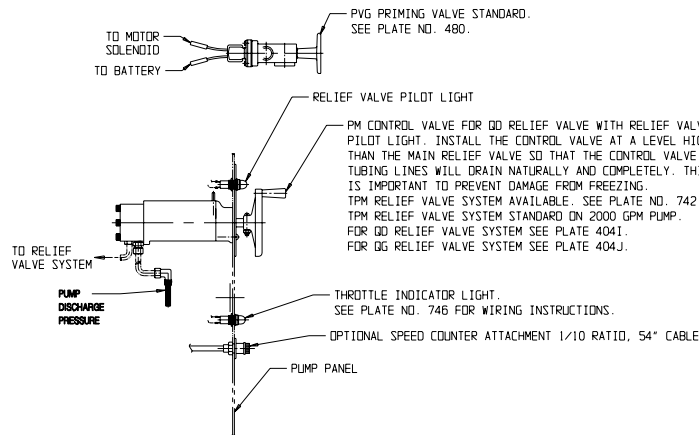
## WARNING

EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE RECOMMENDATIONS OUTLINED ON THIS DRAWING COULD DAMAGE THE GEARBOX AND RESULT IN PERSONAL INJURY. QMAX MIDSHIP MAXIMUM PUMP PRESSURE (HYDROSTATIC & HYDRODYNAMIC) = 500 PSI. MAXIMUM POWER INPUT FOR PUMPING = 350 HP. MAXIMUM TORQUE ON PUMP SHAFT = 2300 LBS-FT. MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT.

PUMP MODEL	QMID*-23	QMID*-21	QMID*-19	QMID*-17	QMID*-15
MAX GEARBOX INPUT RPM	2280	2530	2780	3030	3280
PUMP MODEL	QMID*-28X	QMID*-25X	QMID*-23X	QMID*-21X	QMID*-19X
MAX GEARBOX INPUT RPM	1840	2040	2230	2430	2650

SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA. THIS PRODUCT AND ITS COMPONENTS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING:

950,756	3,500,961	3,859,703	4,209,282	4,587,862
3,116,694	3,726,308	3,918,681	4,311,440	4,653,978
3,159,559	3,801,224	4,089,345	4,337,830	



PUMP MODEL	GEAR RATIO	GEARBOX TYPE **	DIMENSIONS				
			E	F	G	H	J
QMID*-28	2.83	EXTRA LONG GEARBOX ONLY (X)	14.56	6.50	5.44	4.06	1.84
QMID*-25	2.55		14.75				
QMID*-23	2.32		14.90				
QMID*-21	2.13		15.06				
QMID*-19	1.96		15.25				
QMID*-23	2.28	LONG (L)	12.38	6.50			
QMID*-21	2.05	SHORT (S)	10.50				
		LONG (L)	12.56				
QMID*-19	1.86	SHORT (S)	10.68				
		LONG (L)	12.75				
QMID*-17	1.71	SHORT (S)	10.88				
		LONG (L)	12.94				
QMID*-15	1.58	SHORT (S)	11.06				
		LONG (L)	13.13				
		SHORT (S)	11.25				

\* RATED CAPACITY 1000 AND 1250 GPM. \*\* THE SHORT (S) GEARBOX IS STANDARD AND WILL BE SUPPLIED UNLESS OTHERWISE SPECIFIED.

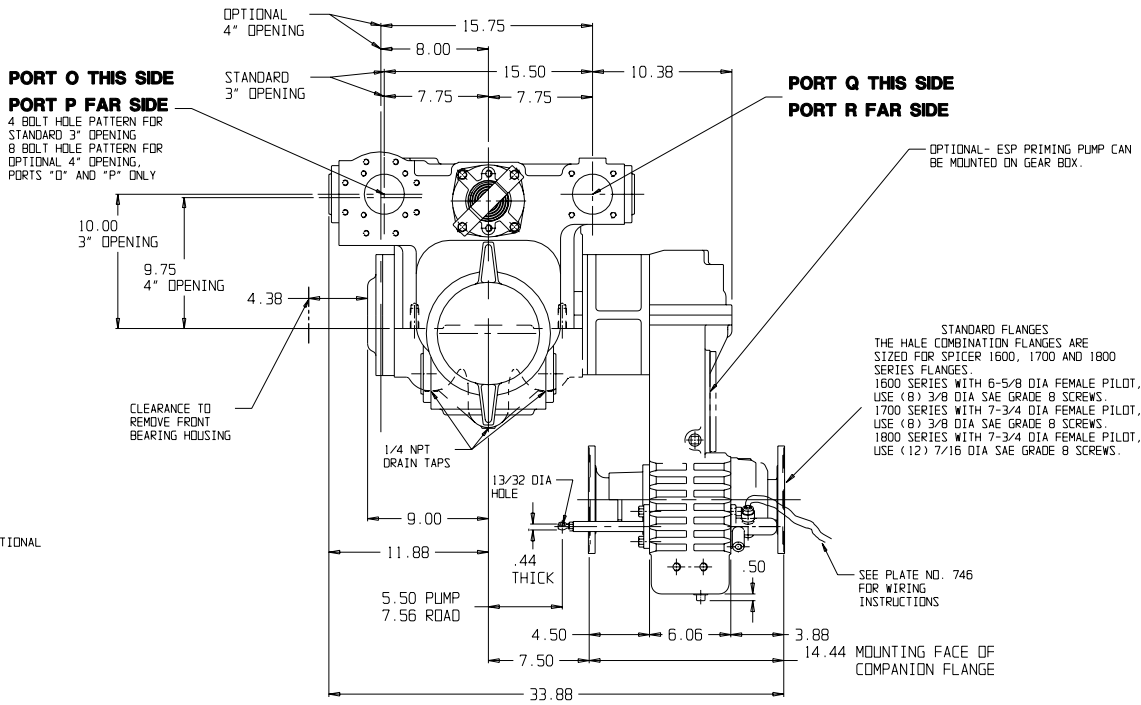
EXAMPLE: THE MODEL NUMBER FOR A 1250 GPM RATED PUMP WITH A 2.28 GEAR RATIO AND A SHORT GEARBOX WOULD BE QMID125-23S.

### DRIVE LINE RECOMMENDATIONS

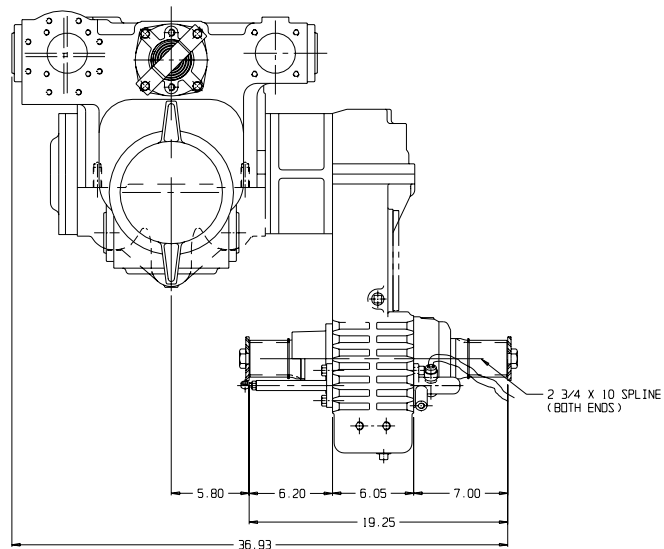
APPARATUS BUILDER SUPPLIED DRIVELINES SHALL BE OF APPROPRIATE SIZE TO MATCH THE CHASSIS AND PUMP REQUIREMENTS WITH INDIVIDUAL JOINT CANCELLATION AND PHASING BEFORE AND AFTER THE PUMP. DRIVE SHAFT BALANCE (INCLUDING YOKES) SHALL NOT EXCEED THE RECOMMENDED LIMIT OF EITHER THE DRIVE SHAFT OR CHASSIS TRANSMISSION MANUFACTURER'S SPECIFICATIONS. DRIVE SHAFT FULL RANGE OPERATING SPEEDS SHALL NOT EXCEED 42% OF ITS CRITICAL SPEED.

### NOTES

- REFER TO HALE PUMP/ENGINE COMBINATION LIST TO SELECT PROPER RATIO TO MATCH PUMP WITH ENGINE.
- WEIGHT OF STANDARD QMID 1250 G.P.M. PUMP AS SHOWN LESS PRIMING PUMP. = 1400 LBS.
- = CENTER OF GRAVITY.
- IMPELLER SHAFT SEAL - PACKING STANDARD, MECHANICAL SEAL OPTIONAL.



STANDARD FLANGES. THE HALE COMBINATION FLANGES ARE SIZED FOR SPICER 1600, 1700 AND 1800 SERIES FLANGES. 1600 SERIES WITH 6-5/8 DIA FEMALE PILOT. USE (8) 3/8 DIA SAE GRADE 8 SCREWS. 1700 SERIES WITH 7-3/4 DIA FEMALE PILOT. USE (8) 3/8 DIA SAE GRADE 8 SCREWS. 1800 SERIES WITH 7-3/4 DIA FEMALE PILOT. USE (12) 7/16 DIA SAE GRADE 8 SCREWS.



CHANGED FROM				HALE PRODUCTS, INC. A Unit of IDEX Corporation Conshohocken, PA 19428 USA			
03-279	A	RELEASE FOR PRODUCTION	JFG	9-09-03	MAL	APVD	DATE 9-09-03
ECO NO	REV	CHANGED FROM	BY	DATE	APVD	CHECKED	SCALE : 20

## Notes

[illegible]



**! WARNING !**

EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE RECOMMENDATIONS OUTLINED IN THIS DRAWING COULD DAMAGE THE GEARBOX AND RESULT IN PERSONAL INJURY.

MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 18,500 LBS-FT (25,083 N-m) SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA

**DRIVE LINE RECOMMENDATIONS**

APPARATUS BUILDER SUPPLIED DRIVELINES SHALL BE OF APPROPRIATE SIZE TO MATCH THE CHASSIS AND PUMP REQUIREMENTS WITH INDIVIDUAL JOINT CANCELLATION AND PHASING BEFORE AND AFTER THE PUMP. DRIVE SHAFT BALANCE (INCLUDING YOKES) SHALL NOT EXCEED THE RECOMMENDED LIMIT OF EITHER THE DRIVE SHAFT OR CHASSIS TRANSMISSION MANUFACTURER'S SPECIFICATIONS. DRIVE SHAFT FULL RANGE OPERATING SPEEDS SHALL NOT EXCEED 42% OF ITS CRITICAL SPEED.

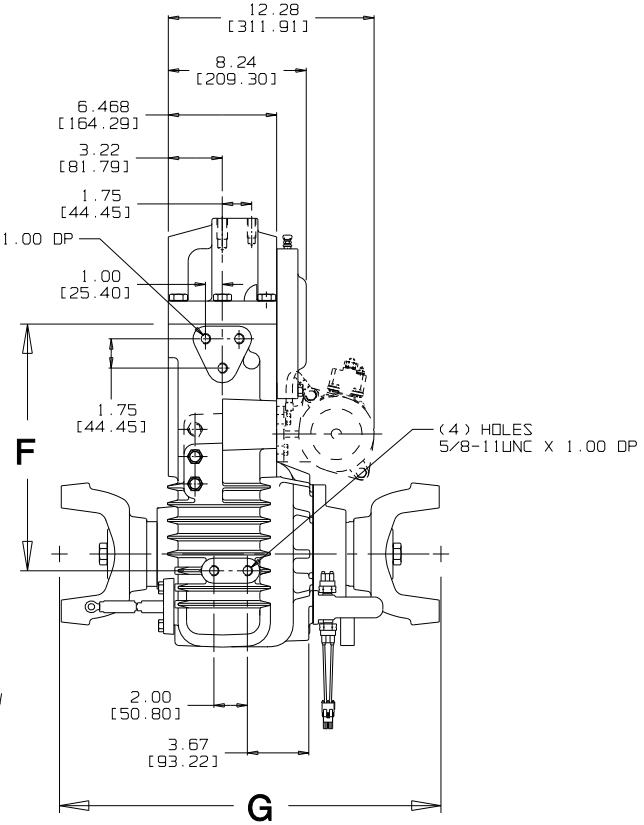
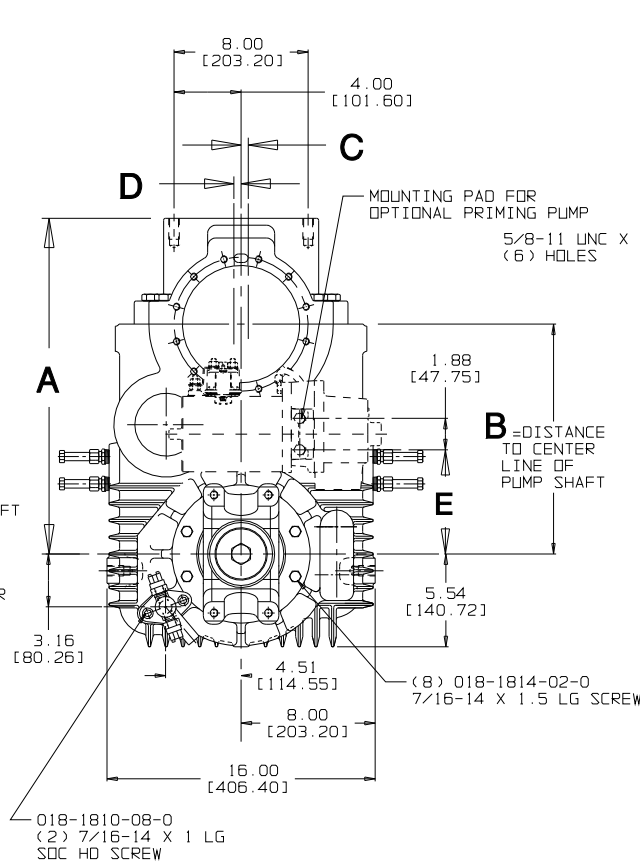
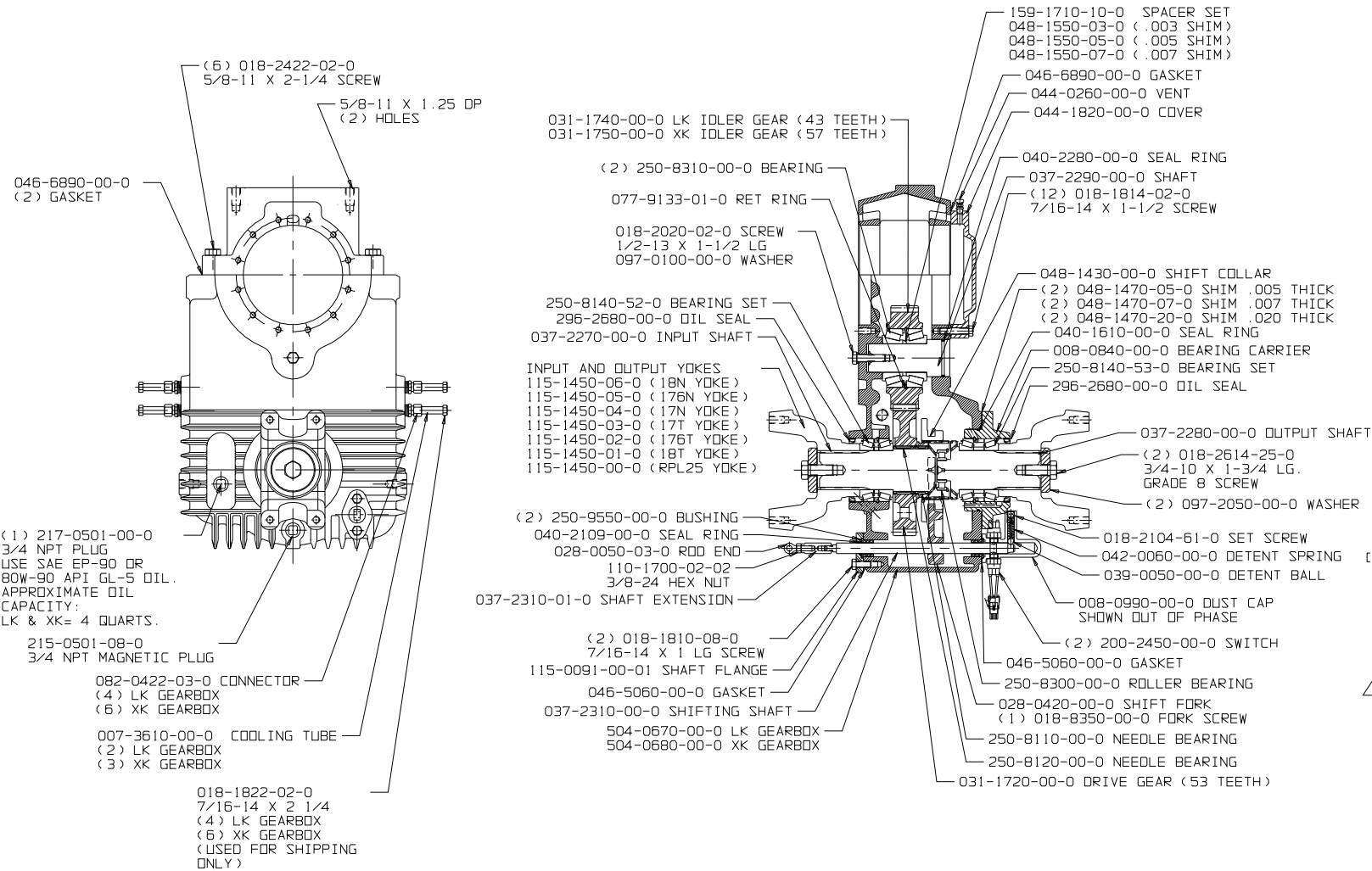
**NOTES:**

- 1) UNLESS OTHERWISE NOTED FASTENERS TO BE USED ARE GRADE 5. WHEN REPLACING BROKEN OR DAMAGED FASTENERS MAKE SURE THE PROPER GRADE IS USED. DURING ASSEMBLY COAT FASTENERS WITH LOCTITE #246 (OR EQUIV.) HIGH TEMPERATURE REMOVABLE THREAD LOCKER.
- 2) (SN) = LOCATION OF SERIAL NUMBER
- 3) FOR MANUAL SHIFT OVER RIDE SEE INSTALLATION DRAWINGS 101-0850-73-0 & 101-0850-74-0 FOR DETAILS
- 4) REFER TO HALE STANDARD ES018-002 FOR RECOMMENDED TORQUE VALUES UNLESS OTHERWISE STATED.
- 5) DIMENSIONS IN INCHES AND MILLIMETERS

**DIMENSIONS**

G	YOKES
( 538.5 ) 21.2	17T 115-1450-03-0
	17N 115-1450-04-0
( 555.5 ) 21.9	18T 115-1450-01-0
	18N 115-1450-06-0
( 550.7 ) 21.7	176T 115-1450-02-0
	176N 115-1450-05-0
( 525.3 ) 20.7	RPL25 115-1450-00-0

GEARBOX MODEL	GEAR RATIO	GEARBOX PART NO.	A	B	C	D	E	F
LK	2.52	504-0670-00-0	20.03 (508.76)	13.22 (335.79)	-	-	6.22 (157.99)	14.72 (373.89)
	2.30			13.28 (337.31)	.25 (6.35)	-		
	2.04			13.59 (345.19)	-	-		
	1.89			13.78 (350.01)	-	.11 (2.79)		
	1.71			13.97 (354.84)	-	.43 (10.92)		
XK	1.60	504-0680-00-0	22.23 (564.64)	14.15 (359.41)	-	.25 (6.35)	7.36 (186.94)	17.01 (432.05)
	2.52			15.51 (393.95)	-	-		
	2.30			15.58 (395.73)	.25 (6.35)	-		
	2.04			15.89 (403.61)	-	-		
	1.89			16.08 (408.43)	-	.11 (2.79)		
	1.71			16.27 (413.26)	-	.43 (10.92)		
	1.60			16.45 (418.08)	-	.25 (6.35)		



# HALE TYPE "K" SERIES GEARBOX

**PLATE NO. 978AA**

ECD NO	REV	CHANGED FROM	BY	DATE	APVD
0712	A	RELEASE FOR PRODUCTION	ZML	4-15-08	MAL

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Conshohocken, PA 19428 USA

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DRAWN ZML  
CHECKED MAL

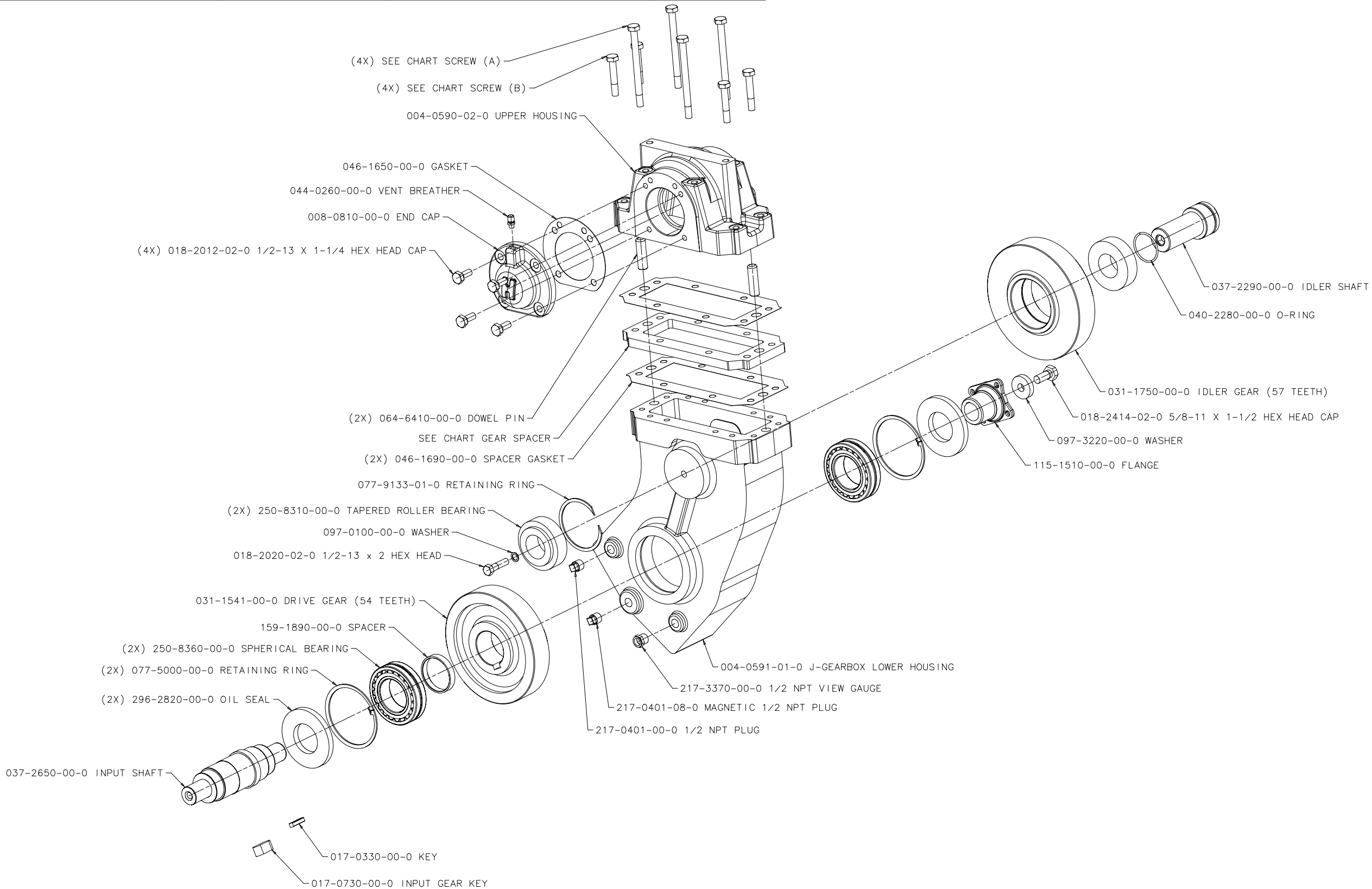
DATE 8-23-07

SIZE --  
SCALE: FULL

## Notes

[illegible]

J	GEARBOX RATIO	GEAR SPACER	SCREW (A) PART NO.	SCREW LENGTH	SCREW (B) PART NO.	SCREW LENGTH
	1.63 (-16)	159-1600-03-0	018-2074-02-0	7.500	018-2036-02-0	3.750
	1.80 (-18)	159-1600-02-0	018-2070-02-0	7.000	018-2034-02-0	3.500
	2.08 (-21)	159-1600-01-0	018-2070-02-0	7.000	018-2034-02-0	3.500
	2.35 (-23)	159-1600-00-0	018-2064-02-0	6.500	018-2030-02-0	3.000
	2.57 (-25)	NONE	018-2064-02-0	6.500	018-2030-02-0	3.000



HALE TYPE "J" SERIES GEARBOX (PARTS IDENTIFICATION)

PLATE 928AC

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
00-527	A	RELEASED	DK	07-28-00	MAL
00-636	B	WAS 097-0890-01-0	DK	10-10-00	MAL
777	C	UPDATED PARTS LIST	MSJ	10-07-08	MAL
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NOT TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY.					
DRAWN		DK	DATE		06-29-00
CHECKED		MAL	SIZE		E
			SCALE:		1/4

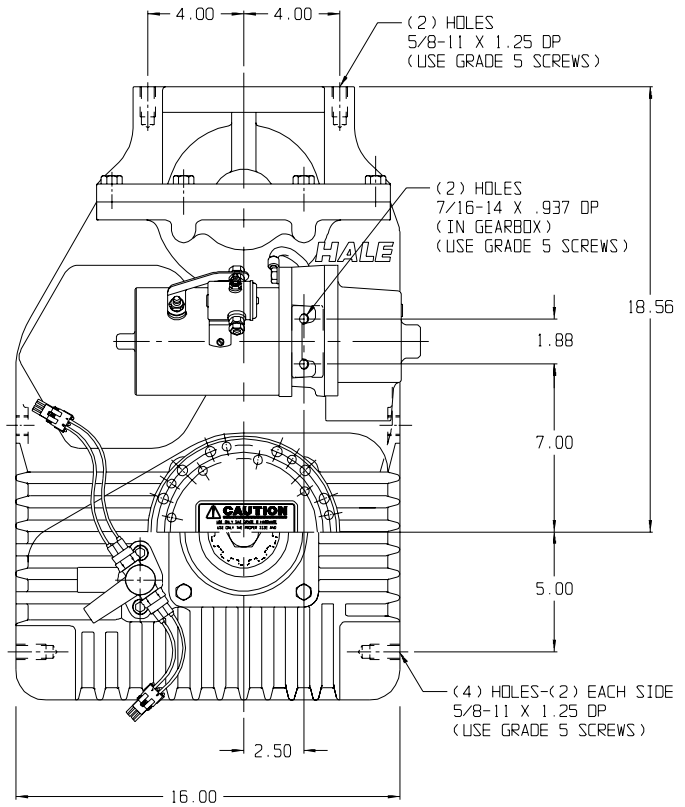
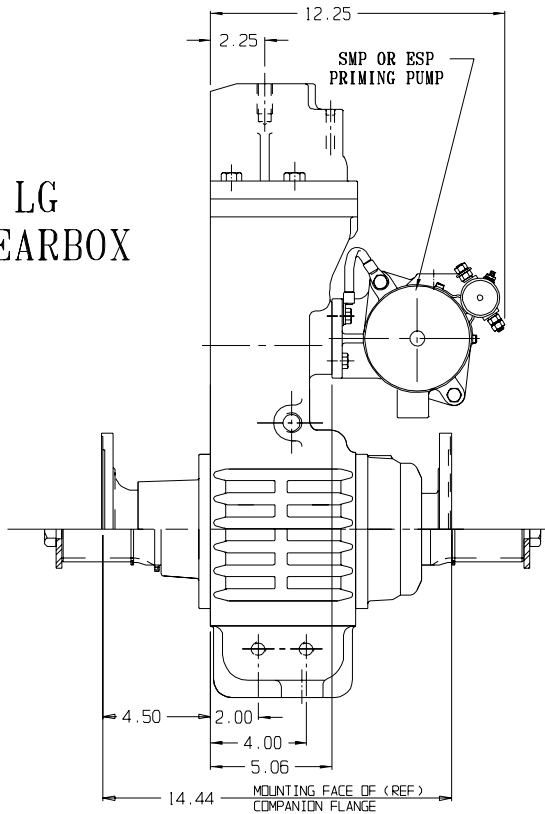
## Notes

[illegible]

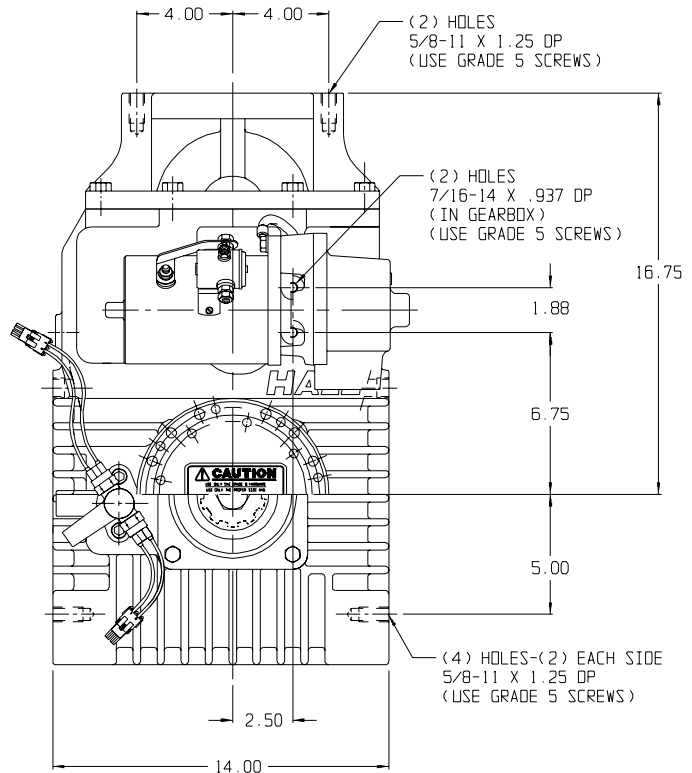
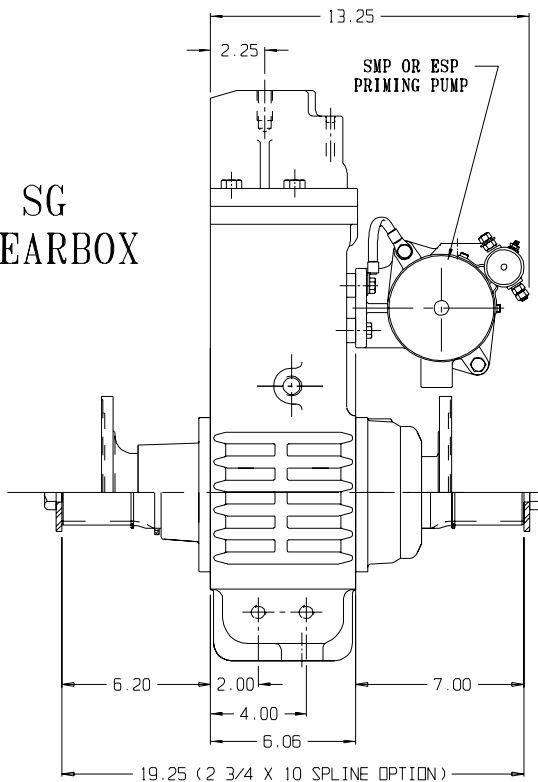
# MODEL LG & SG GEARBOX

LOCATION OF TOP AND BOTTOM MOUNTING HOLES AND  
MOUNTING HOLES FOR ESP PRIMING PUMPS

LG  
GEARBOX



SG  
GEARBOX



ECD NO	REV	CHANGED FROM	BY	DATE	APVD
95-31	A	RELEASE FOR PRODUCTION	MD	5-11-95	ROT
99-190	B	UPDATE DRAWING	DPL	7-13-99	RET
04-286	C	ADD SPLINED SHAFT OPTION	TKC	11-24-04	MAL



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MAKE OTHER DRAWINGS OR MACHINERY

DRAWN MD DATE 5-8-95  
CHECKED ROT

SIZE E SCALE :HALF

## Notes

[illegible]

THIS PRODUCT AND ITS COMPONENTS MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING: 4,337,830; 4,587,862; 4,653,978; 5,018,665; 5,139,363

SAE REGULAR DRIVE CONNECTION  
.205 - .210 ROUND DRIVE 7/8 - 18  
THREAD

007-0040-00-0 - SPEED COUNTER  
DRIVE ADAPTER REPLACED WITH  
PLUG 217-3007-00-0 (NOT SHOWN)  
WHEN SPEED COUNTER OPTION  
IS NOT ORDERED (SEE NOTE 2)

STANDARD FRONT BEARING CAP

031-0170-00-0 SPEED COUNTER GEAR\*

\*NOT SHOWN

SPEED COUNTER DRIVEN GEAR  
BUSHING - 048-0070-00-0 SUPPORTS END  
OF DRIVEN GEAR IN FRONT BEARING CAP

STANDARD SLIDING GEAR SHAFT  
MOST SLIDING GEAR SHAFTS WILL HAVE  
SPIRAL GEAR FOR SPEED COUNTER OPTION

### OPTIONAL SPEED COUNTER DETAILS (SCALE 2:1)

FOR INSTALLATION INSTRUCTIONS AND PARTS LIST SEE PL910

GEARBOX MODEL	GEAR RATIO	HOUSING ASS'Y	A	B	C	D	E	F	G	H	J	K
XG	2.83	504-0510-00-0	5.06	12.63	16.00	20.94	15.56	6.50	5.44	4.06	1.84	9.16
	2.55						15.75					
	2.32						15.90					
	2.13						16.06					
	1.96						16.25					
LG	2.28	504-0340-00-0	5.06	12.63	16.00	18.56	13.38	6.50	4.31	5.19	2.00	7.00
	2.05						13.56					
	1.86						13.75					
	1.71						13.94					
	1.58						14.13					
SG	2.28	504-0380-00-0	6.06	13.63	14.00	16.75	11.50	6.50	4.75	2.75	.38	6.75
	2.05						11.68					
	1.86						11.88					
	1.71						12.06					
	1.58						12.25					

NOTE: APPARATUS BUILDER TO CONNECT ONE END OF  
GEARBOX COOLING TUBE TO PUMP DISCHARGE AND  
OTHER END TO PUMP SUCTION VIA 3/8 TUBING. A  
DRAIN VALVE MUST BE PROVIDED FOR THIS COOLING  
TUBE TO DRAIN SYSTEM IN FREEZING WEATHER.

018-1810-02-0  
7/16-14 X 1 LG SCREW  
097-1330-00-0  
SHAFT WASHER

(2) 088-0040-00-0  
CONNECTOR  
(2) 018-1822-02-0  
7/16-14 X 2 1/4  
(USED FOR SHIPPING  
ONLY)

007-0100-00-0 (LG GEARBOX)  
COOLING TUBE  
007-0170-00-0 (SG GEARBOX)  
COOLING TUBE  
007-0100-02-0 (XG GEARBOX)  
COOLING TUBE

217-0501-00-0  
3/4 NPT OIL FILL  
& LEVEL PLUG  
**USE SAE EP-90 OR 80W-90  
API GL-5 OIL.**  
**APPROXIMATE OIL CAPACITY:**  
**SG= 3 QUARTS,**  
**LG & XG= 4 QUARTS.**

(2) 101-1730-00-0  
CAUTION STICKER  
(TYP. BOTH SIDES)

(2) 018-1810-02-0  
7/16-14 X 1" LG SCREW

217-0501-08-0  
3/4 NPT MAGNETIC  
DRAIN PLUG

101-0082-00-0  
SERIAL NUMBER PLATE

HOUSING ASSY - SEE TABLE  
031-0980-00-0 (51 TEETH, LG GEARBOX)  
031-1310-00-0 (59 TEETH, XG GEARBOX)  
031-1040-00-0 (40 TEETH, SG GEARBOX)  
040-2280-00-0  
SHAFT SEAL RING

046-5130-01-0 GASKET  
(4) 018-1812-25-0  
7/16-14 X 1 1/4 LG  
GRADE 8 SCREW  
TORQUE TO 45 LB-FT

217-3007-00-0 PLUG/TACH  
040-0180-00-0 SEAL RING  
048-0070-00-0 SPEED  
COUNTER BUSHING

296-2540-00-0  
OIL SEAL

537-1740-00-0  
SLIDING GEAR SHAFT  
008-0571-00-0  
FRONT BEARING CAP

077-2750-01-0  
RETAINING RING

142-0160-00-0  
SLINGER  
250-0214-06-0  
214KG BEARING

028-0050-03-0  
ROD-END  
110-1700-02-0  
NUT 3/8-24

037-1342-01-0  
SHIFT SHAFT  
018-1612-54-0  
SET SCREW  
3/8-16 X 1-1/4

037-1342-00-0  
SHIFT SHAFT  
115-0091-00-0  
FLANGE

040-2109-00-0  
SEAL RING  
046-5060-00-0  
GASKET

250-9550-00-0 BEARING  
028-0041-02-0 (LG & SG)  
SHIFT/FORK  
028-0400-00-0 (XG)  
SHIFT/FORK

(4) 018-5002-00-0  
#4 X 1/4 LG  
SCREW

044-0260-00-0  
1/8 AIR VENT  
(6) 018-2014-02-0  
1/2-13 X 1-1/2 LG SCREW  
046-6370-01-0  
HOUSING GASKET

250-8040-00-0 TAPER BEARING  
159-1460-00-0 BEARING SPACER  
(XG GEARBOX ONLY)  
037-1530-00-0 SHAFT  
040-2240-00-0 SEAL RING  
(1) 046-5131-00-0 GASKET  
048-1580-02-0 SHIM (.002)\*  
048-1580-05-0 SHIM (.005)\*  
048-1580-07-0 SHIM (.0075)\*  
048-1580-20-0 SHIM (.020)\*  
\*USE SHIMS AS REQUIRED

250-0214-06-0 214KG BEARING  
077-5000-00-0 RETAINING RING  
008-0561-00-0 BEARING CAP  
250-0214-00-0 214K BEARING  
296-2540-00-0 OIL SEAL  
537-1750-00-0 TAIL SHAFT

(3) 077-2750-01-0 RING RETAINING  
250-8010-00-0 NEEDLE BEARING.  
(2) 200-2450-00-0 SWITCH  
(2) 040-8210-00-0 SEAL RING

FOR WIRING SCHEMATIC  
SEE PLATE NO.746

008-0053-02-0  
GEARSHIFT CAP  
(4) 018-1812-25-0  
7/16-14 X 1 1/4 LG  
GRADE 8 SCREW  
TORQUE TO 45 LB-FT  
039-0050-00-0 T-22 BALL  
TORQUE TO 45 LB-FT  
042-0060-00-0 T-23 SPRING  
018-2104-61-0  
1/2-20 X 1/2 LG. 360°  
NYLON LOCKING SET SCREW

046-5060-00-0  
GASKET  
250-9550-00-0 BEARING

031-0970-00-0 (41 TEETH LG & SG GEARBOX)  
031-1300-00-0 (51 TEETH XG GEARBOX)  
018-1816-25-0  
7/16-14 X 1 3/4 LG SCREW  
GRADE 8  
TORQUE TO 65 LB-FT

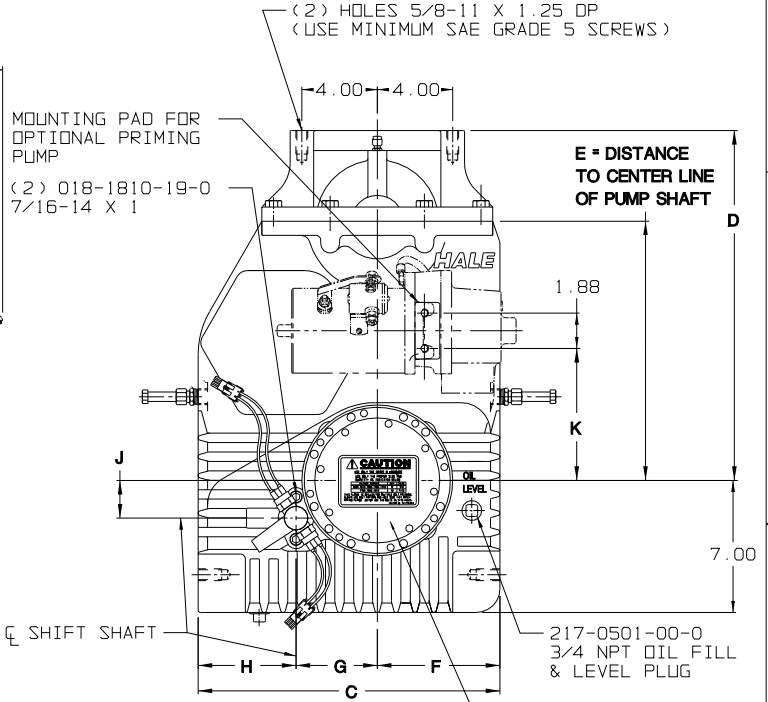
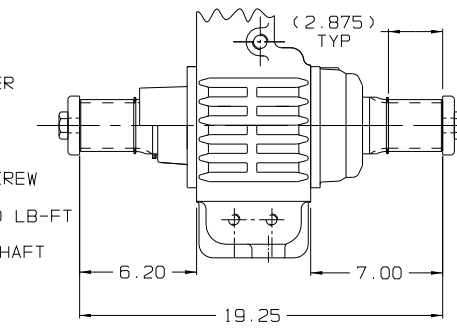
(2) 097-2050-00-0  
DRIVE FLANGE WASHER

(2) 018-2616-25-0  
3/4-10 X 1 -3/4 SCREW  
GRADE 8  
TORQUE BOLT TO 260 LB-FT

037-1330-05-0 TAIL SHAFT  
2-3/4 X 10 SPLINE  
(2) 077-2750-01-0  
RETAINING RING

### OPTIONAL SPLINE INPUT/OUTPUT SHAFTS AND SHIFTING

SEE PL533 FOR VPS INFORMATION



STANDARD FLANGES  
THE HALE COMBINATION FLANGES ARE  
SIZED FOR SPICER 1600, 1700 AND 1800  
SERIES FLANGES.  
1600 SERIES WITH 6-5/8 DIA FEMALE PILOT,  
USE (8) 3/8 DIA SAE GRADE 8 SCREWS.  
1700 SERIES WITH 7-3/4 DIA FEMALE PILOT,  
USE (8) 3/8 DIA SAE GRADE 8 SCREWS.  
1800 SERIES WITH 7-3/4 DIA FEMALE PILOT,  
USE (12) 7/16 DIA SAE GRADE 8 SCREWS.

### WARNING

EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE  
RECOMMENDATIONS OUTLINED IN THIS DRAWING COULD  
DAMAGE THE GEARBOX AND RESULT IN PERSONAL INJURY.

MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT  
(21,693 N-m) SEE HALE TORQUE LIMIT CHART F-72 FOR  
ADDITIONAL DATA

### DRIVE LINE RECOMMENDATIONS

APPARATUS BUILDER SUPPLIED DRIVELINES SHALL BE OF  
APPROPRIATE SIZE TO MATCH THE CHASSIS AND PUMP  
REQUIREMENTS WITH INDIVIDUAL JOINT CANCELLATION AND  
PHASING BEFORE AND AFTER THE PUMP. DRIVE SHAFT  
BALANCE (INCLUDING YOKES) SHALL NOT EXCEED THE  
RECOMMENDED LIMIT OF EITHER THE DRIVE SHAFT OR CHASSIS  
TRANSMISSION MANUFACTURER'S SPECIFICATIONS. DRIVE  
SHAFT FULL RANGE OPERATING SPEEDS SHALL NOT EXCEED 42%  
OF ITS CRITICAL SPEED.

PLATE 914AF

# HALE TYPE "G" SERIES GEARBOX

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
0330	E	UPDATED DRAWING	JFG	12-9-05	MAL
0427	F	046-5130-01-0 TO 046-5131-00-0 & SHIMS	KSM	8-31-06	MAL



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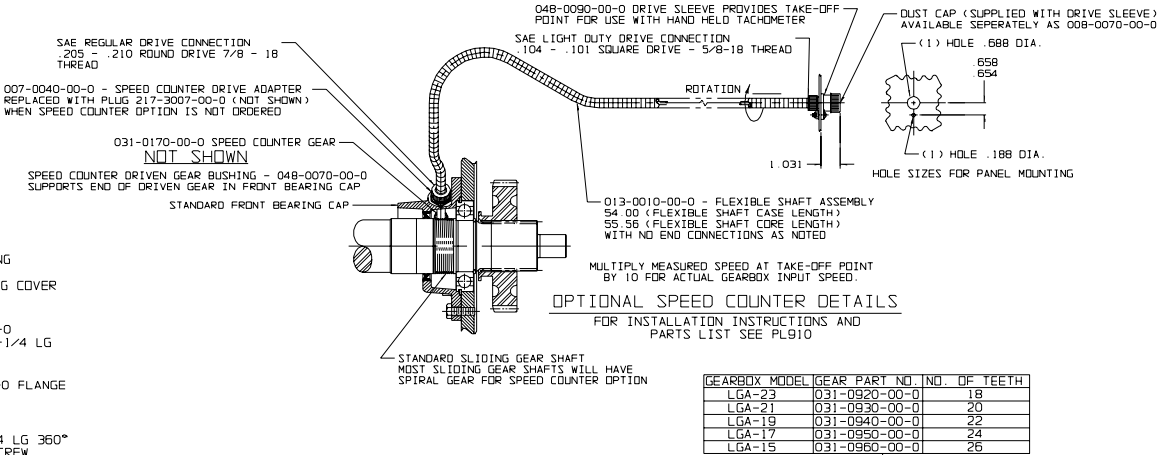
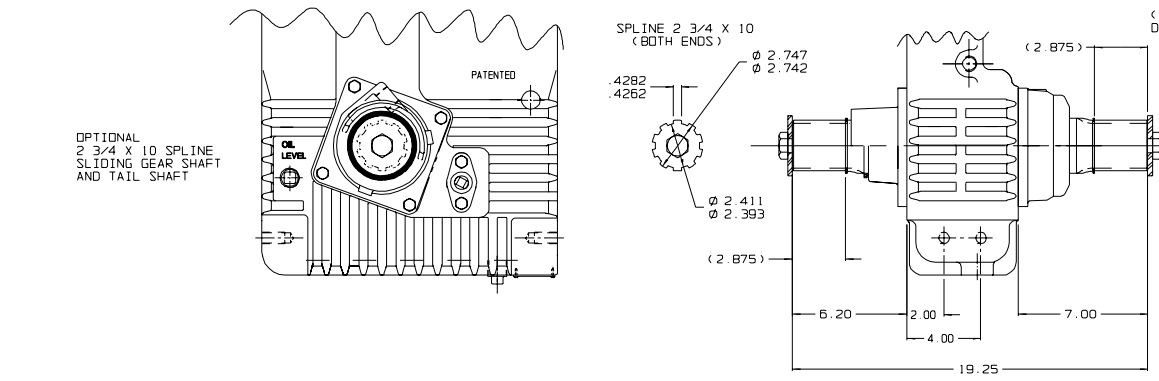
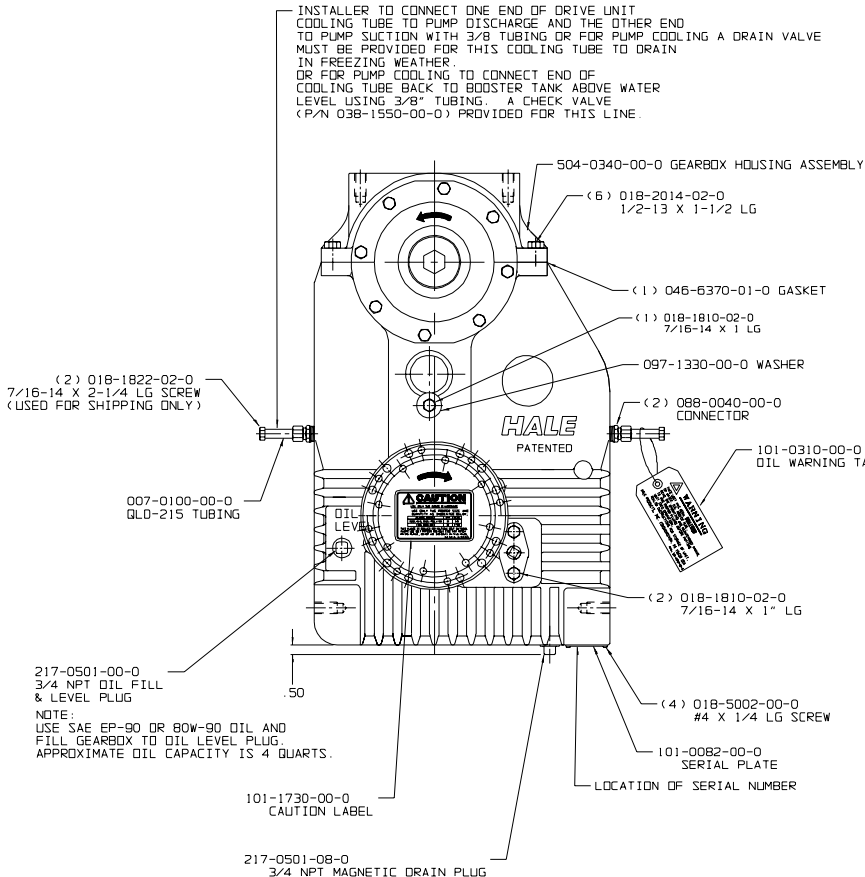
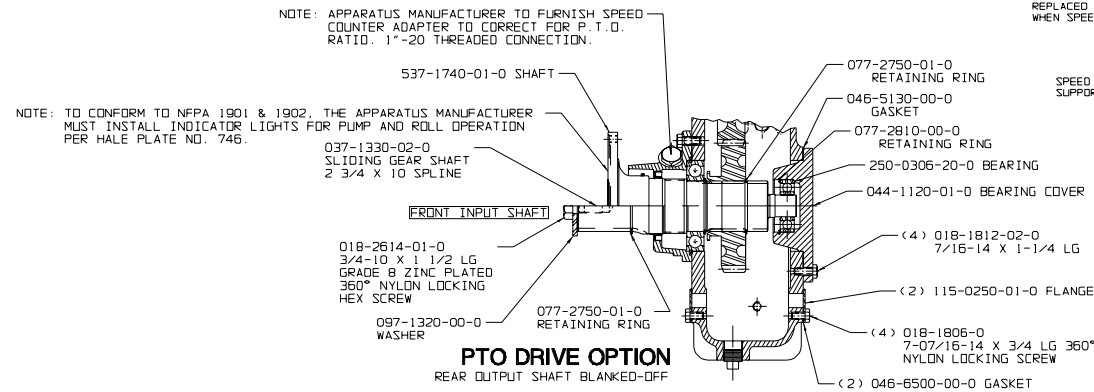
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MAKE OTHER DRAWINGS OR MACHINERY  
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CHECKED: [ ]  
DATE 7/16/99  
SIZE: [ ]  
SCALE: FULL

## Notes

[illegible]



THIS PRODUCT AND ITS COMPONENTS MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING: 4,337,830, 4,587,862, 4,653,978, 5,018,665, 5,139,393



GEARBOX MODEL	GEAR RATIO	A	DRIVE LINE RECOMMENDATIONS
LGA	2.28	13.38	APPARATUS BUILDER SUPPLIED DRIVELINES SHALL BE OF APPROPRIATE SIZE TO MATCH THE CHASSIS AND PUMP REQUIREMENTS WITH INDIVIDUAL JOINT CANCELLATION AND PHASING BEFORE AND AFTER THE PUMP. DRIVE SHAFT BALANCE (INCLUDING YOKES) SHALL NOT EXCEED THE RECOMMENDED LIMIT OF EITHER THE DRIVE SHAFT OR CHASSIS TRANSMISSION MANUFACTURER'S SPECIFICATIONS. DRIVE SHAFT FULL RANGE OPERATING SPEEDS SHALL NOT EXCEED 42% OF ITS CRITICAL SPEED.
	2.05	13.56	
	1.86	13.75	
	1.71	13.94	
	1.58	14.13	

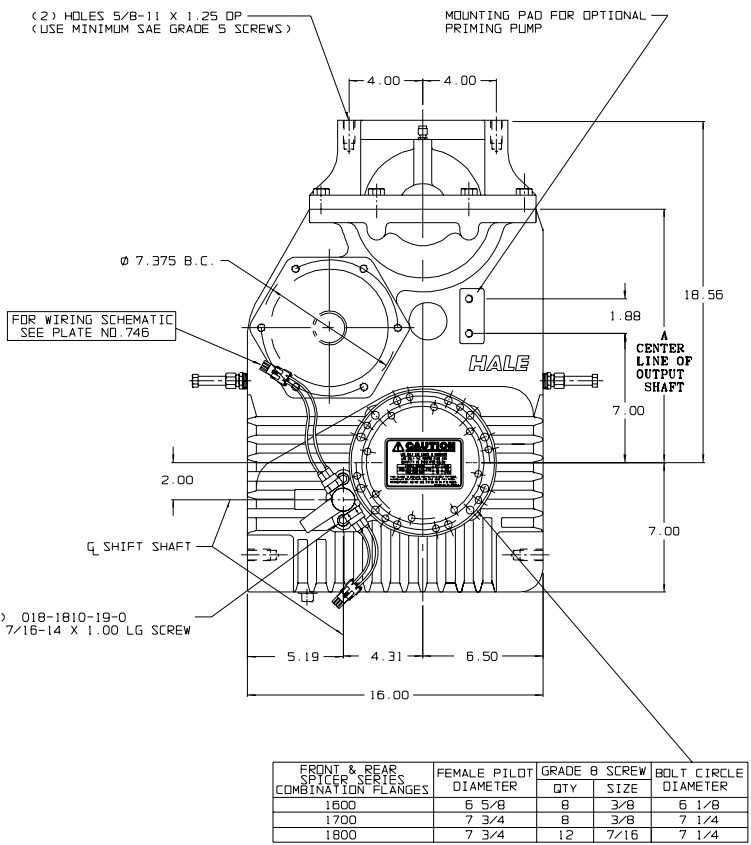
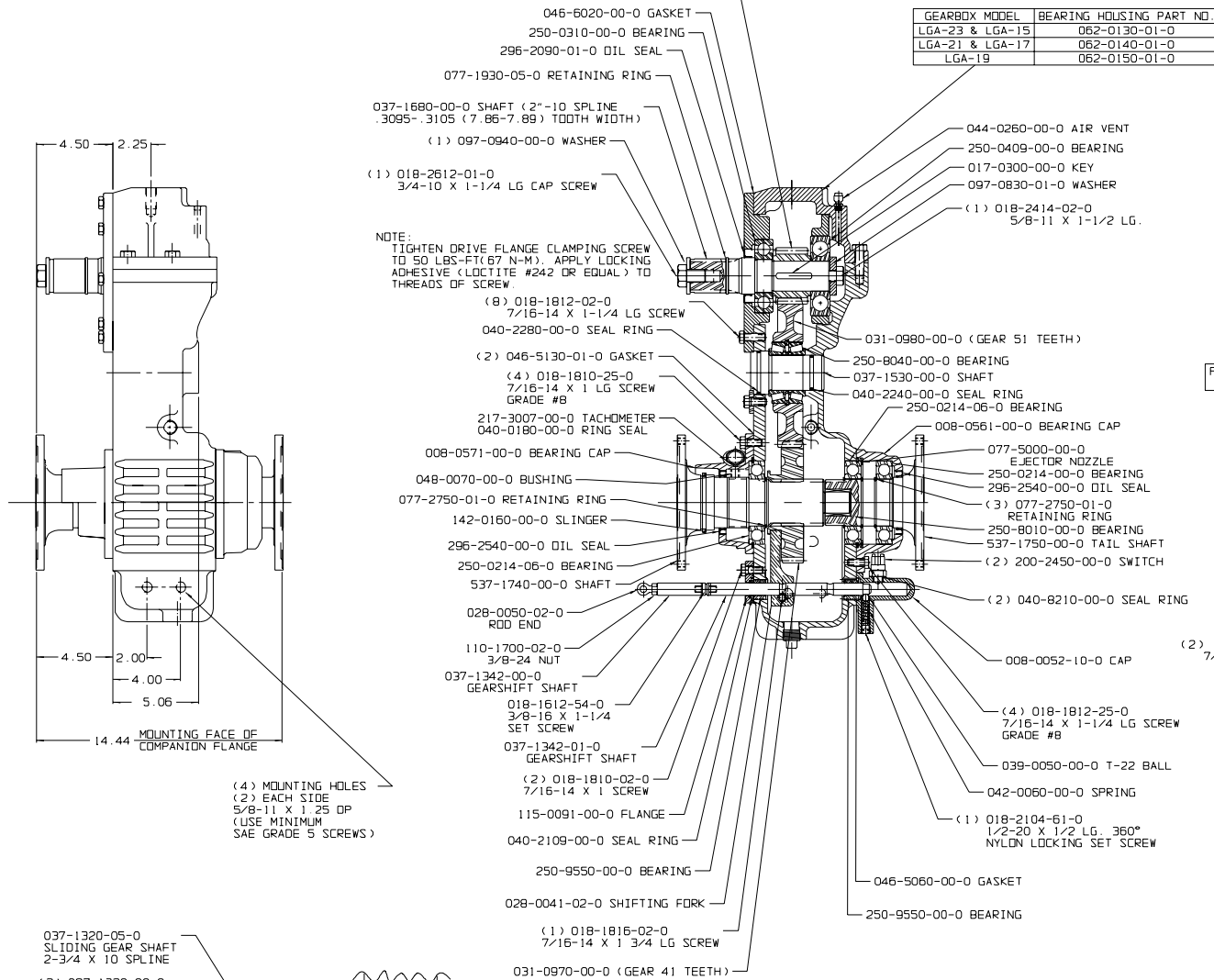
**WARNING**

EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE RECOMMENDATIONS OUTLINED IN THIS DRAWING COULD DAMAGE THE GEARBOX AND RESULT IN PERSONAL INJURY.

MAXIMUM TORQUE ON AUXILIARY OUTPUT SHAFT = 2300 LBS-FT (3118 N-m)  
MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT (21,693 N-m)

GEARBOX MODEL	MAX GEARBOX INPUT RPM
LGA-23	2630
LGA-21	2920
LGA-19	3220
LGA-17	3500
LGA-15	3800

SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA



NOTE: 1. APPLY LOCTITE # 246 HIGH TEMPERATURE THREAD LOCKER OR EQUIVALENT TO SCREW THREADS AND TORQUE SCREWS TO HALE ENGINEERING STANDARD ES018-002.

## HALE TYPE "LGA" SERIES GEARBOX

# PLATE 907AB

04-286	B	ADD SPLINED SHAFT OPTION	TKC	11-24-04	MAL
00-455	A	RELEASE FOR PRODUCTION	DJK	5-15-00	MAL
ECO NO	REV	CHANGED FROM	BY	DATE	APVD

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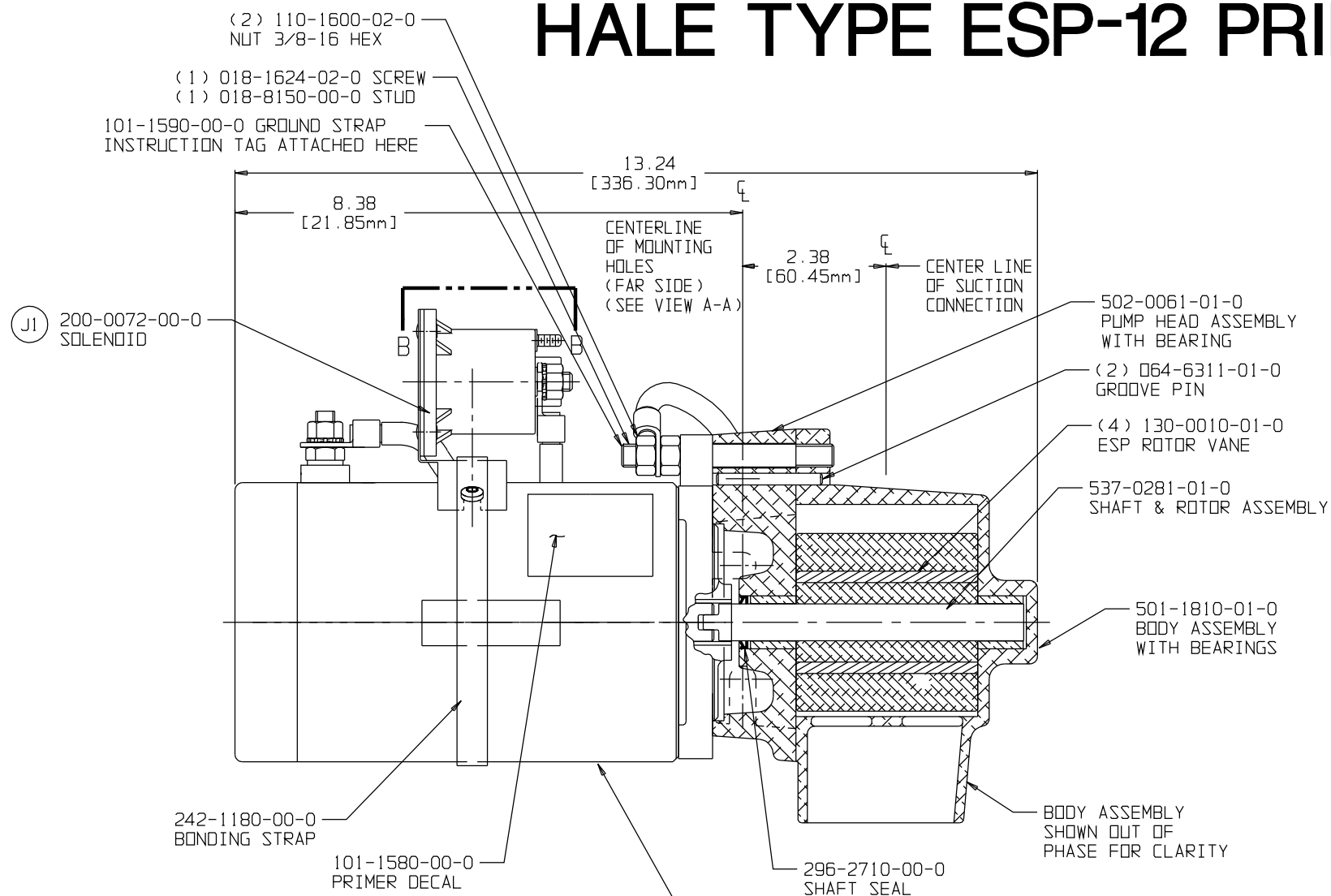
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DRAWN: DJK  
CHECKED: MAL  
DATE: 7/16/99  
SIZE: E  
SCALE: FULL

## Notes

[illegible]

# HALE TYPE ESP-12 PRIMING PUMP



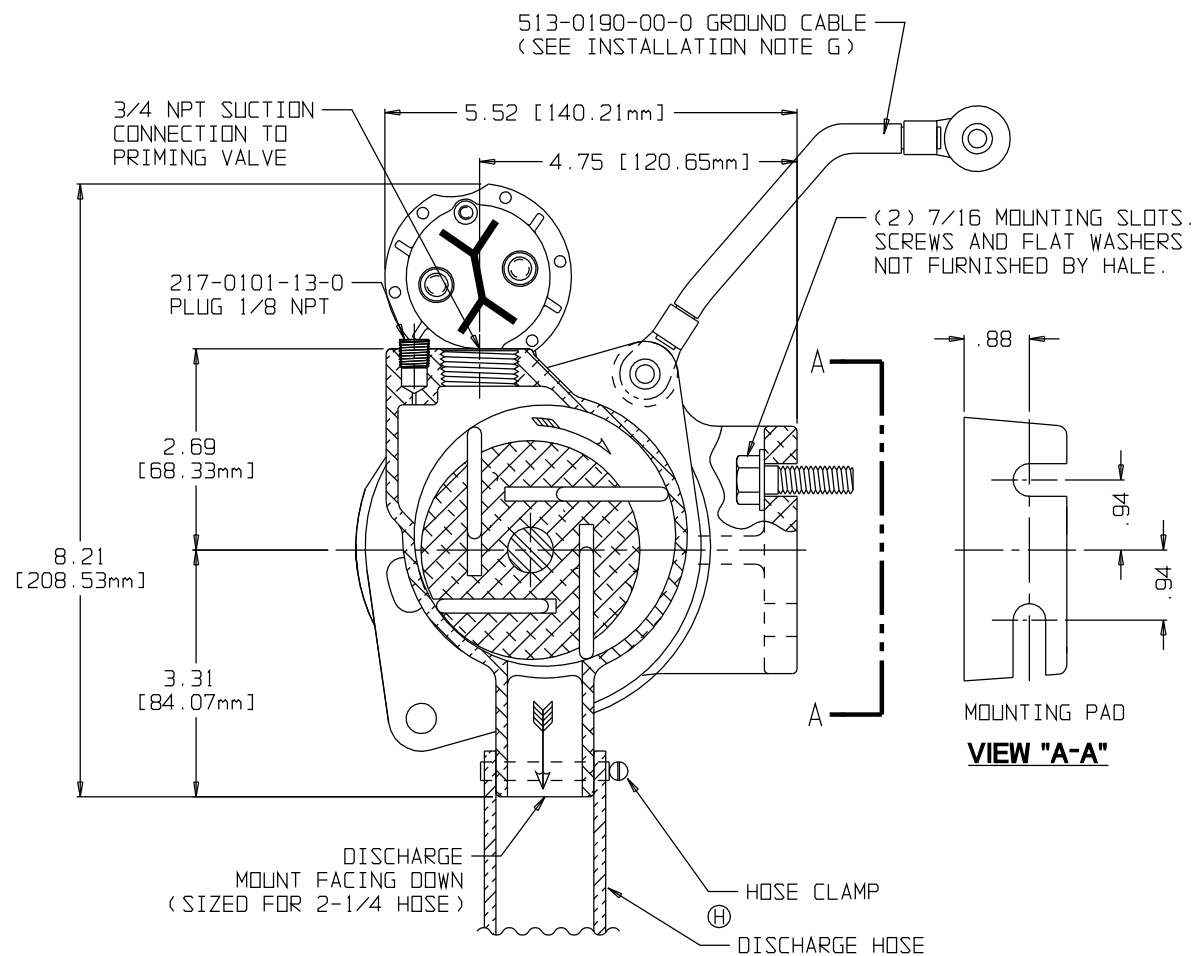
PART NO.	VOLTAGE DC	AMPERES MAX.
200-0043-00-0	12	280

## INSTALLATION NOTES:

- USE A MINIMUM OF 1/2 TUBING FOR BOOSTER PUMPS.
- USE A MINIMUM OF 3/4 PIPE FOR MIDSHIP PUMPS.
- CONNECT TO HIGHEST POINT ON DISCHARGE OF MAIN PUMP IF PRIMING WHILE THE PUMP IS STATIONARY.
- CONNECT TO HIGHEST POINT ON THE SUCTION NEAR THE IMPELLER EYE IF PRIMING WHEN THE MAIN PUMP IS RUNNING.
- A SHUT-OFF VALVE, SUCH AS A HALE PVG OR SPV PRIMING VALVE, MUST BE LOCATED IN THE PRIMING LINE BETWEEN THE PRIMING PUMP AND THE MAIN PUMP.
- THE PRIMING PUMP MUST BE MOUNTED SO THAT THE MOTOR SHAFT IS IN A HORIZONTAL PLANE WITH THE PRIMING PUMP DISCHARGE FACING DOWN.
- GROUND THE PRIMING PUMP TO THE TRUCK CHASSIS, USING THE GROUND STRAP FURNISHED. THE GROUND STRAP IS REQUIRED FROM THE TRUCK CHASSIS TO THE TERMINAL STUD ON THE PRIMING PUMP. THIS IS TO INSURE A GROUND FOR THE MOTOR. THE CABLE IS SIZED FOR A 12 VOLT DC 300 AMP LOAD.
- DURING THE PRIMING OPERATION (EVACUATING AIR), DO NOT RUN MOTOR FOR MORE THAN 60 SECONDS.

## NOTES:

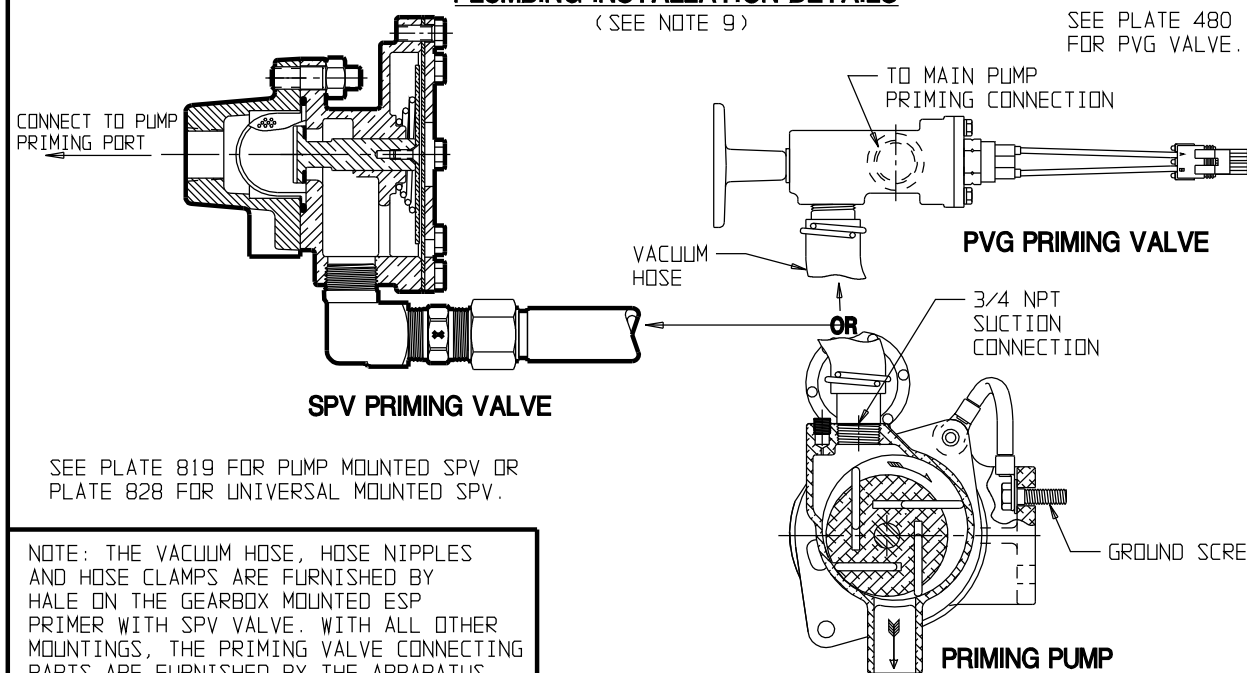
- WEIGHT OF PRIMING PUMP AND MOTOR IS 27 LBS. (12.2 Kg).
- THEORETICAL DISPLACEMENT IS .066 GAL. (.25 LITERS) PER REVOLUTION OR 47,000 CU. IN. (770,000 CU. CM) AIR PER MINUTE.
- VACUUM CAPABILITY: 24 IN. Hg (610 MM Hg).
- TO AID IN LONG PRIMER LIFE AND PROPER PERFORMANCE, IT IS RECOMMENDED THAT THE PRIMING PUMP BE CLEANED YEARLY OR AFTER 500 CYCLES OF USE. SEPARATE THE PUMP BODY AND HEAD FROM THE MOTOR AND REMOVE ANY BLACK BUILD UP OR CONTAMINATES WITH SAFETY KLEEN OR STODDARD SOLVENT. USE CARE TO REINSTALL THE VANES IN THE SAME ORIENTATION AND TO GREASE THE SHAFT SEAL.
- SEE PLATE NO. 938 FOR 24V PRIMING PUMP DETAILS.
- TO PREVENT DAMAGE TO PLASTIC HOUSING WHEN INSTALLING OR REMOVING LEADS, DO NOT APPLY SIDE LOADS TO NUTS.
- WHEN USING A TERMINAL LUG ON THE BATTERY CONNECTION WITH A 5/16 DIA. HOLE, LOWER WASHER IS NOT NEEDED. IF HOLE DIA. IS LARGER THAN 5/16, WASHERS ARE REQUIRED BOTH ABOVE AND BELOW THE TERMINAL.
- FOR ELECTRICAL DETAILS REFER TO SHEET 2



## PLUMBING INSTALLATION DETAILS

(SEE NOTE 9)

SEE PLATE 480 FOR PVG VALVE.



# PLATE NO. 821AJ (SHEET 1 OF 2)

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD
Q2-251	G	ADDED TOP VIEW OF SOLENOID AND DIMENSIONS IN MILLIMETER. FIXED GROUND STRAP TO BE ATTACHED TO APPARATUS CHASSIS.	BVP	08-15-02	MAL	0815	J1	WAS 200-0042-00-0 & 200-0071-00-0	JRP	01-22-09	MAL
Q411	H	ADDED DETAIL C AND HOSE	KSM	7-24-06	MAL	0815	J2	ADDED NOTE I	JRP	01-22-09	MAL
Q526	I	REDRAWN AND ADDED SHEET 2	MLJ	2-22-07	MAL						



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DRAWN: JRP  
ROT: JRP  
CHECKED: JRP  
DATE: 2-19-95  
SIZE: D  
SCALE: FULL

## Notes

[illegible]

# HALE TYPE ESP-12 PRIMING PUMP

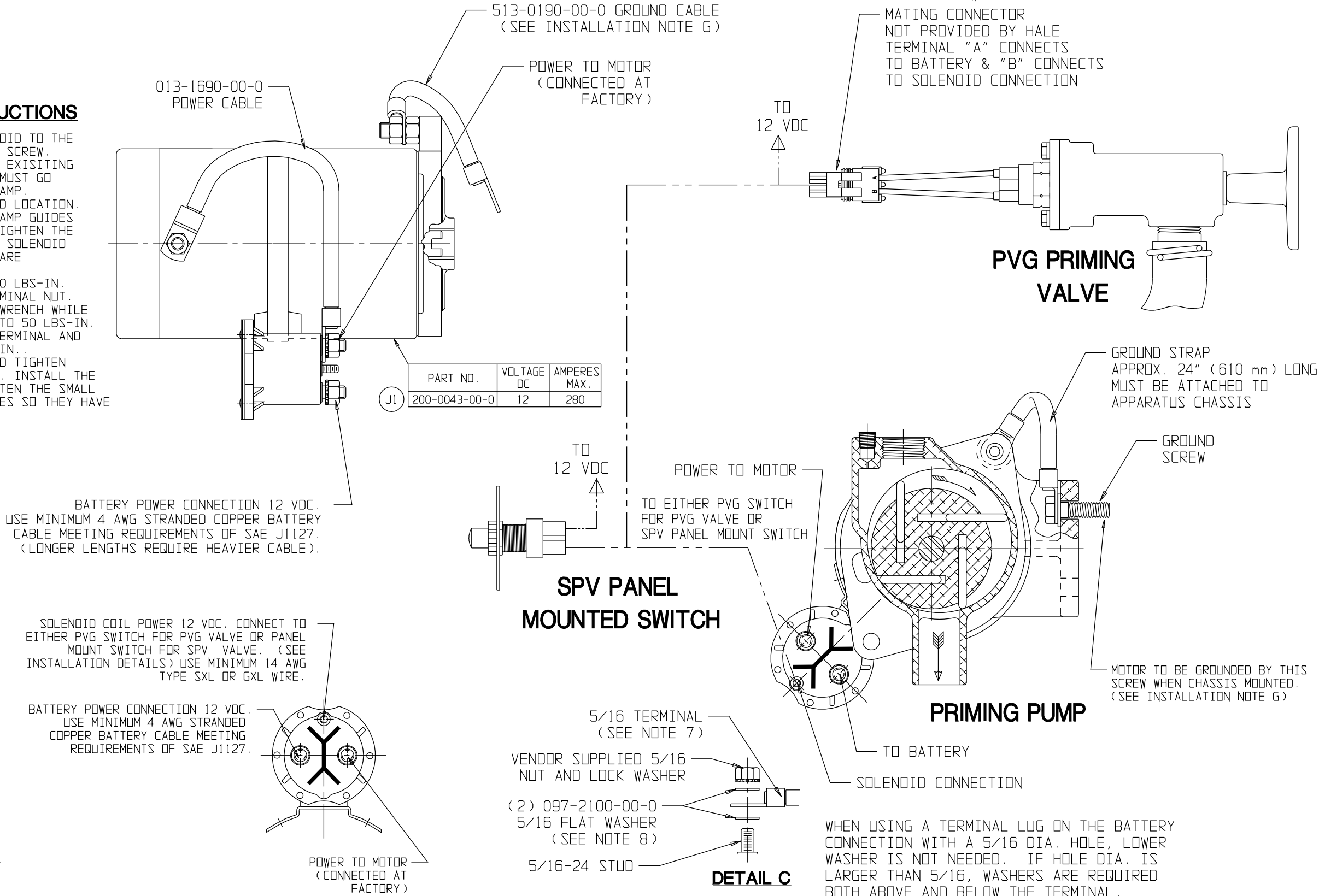
## ELECTRICAL INSTALLATION DETAILS

MATING CONNECTOR NOT PROVIDED BY HALE  
CAN BE PURCHASED AS HALE KIT # 546-1780-00-0  
PACKARD WEATHER PACK SEALED CONNECTOR:  
(1) P/N: 12010973 (2 CONTACT) SHROUD HALF  
(2) P/N: 12124582 (16-14 GAGE) MALE TERMINAL  
(2) P/N: 12010293 (16-14 GAGE) LT GRAY CABLE SEAL  
USE A MINIMUM OF 14 AWG SXL, GXL OR TXL  
SAE J1128 WIRE TYPE

MATING CONNECTOR  
NOT PROVIDED BY HALE  
TERMINAL "A" CONNECTS  
TO BATTERY & "B" CONNECTS  
TO SOLENOID CONNECTION

### SOLENOID RELOCATION INSTRUCTIONS

- 1-REMOVE (2) SCREWS HOLDING THE SOLENOID TO THE MOTOR AND LOOSEN THE SOLENOID CLAMP SCREW.
- 2-LOOSELY INSTALL THE CLAMP USING THE EXISTING SOLENOID MOUNTING HOLES. THE SCREWS MUST GO THROUGH TWO OF THE HOLES IN THE CLAMP.
- 3-POSITION THE SOLENOID IN THE DESIRED LOCATION. PLACE THE CLAMP BETWEEN THE FOUR CLAMP GUIDES ON THE SOLENOID MOUNTING BRACKET. TIGHTEN THE THE SOLENOID CLAMP, THEN TIGHTEN THE SOLENOID SCREWS. MAKE SURE CLAMP AND SCREWS ARE TIGHTENED IN THIS ORDER.
- 4-TIGHTEN THE LOWER TERMINAL NUT TO 50 LBS-IN. INSTALL THE CABLE AND THE UPPER TERMINAL NUT. HOLD THE LOWER TERMINAL NUT WITH A WRENCH WHILE TIGHTENING THE UPPER TERMINAL NUT TO 50 LBS-IN.
- 5-INSTALL THE CABLE TO THE SOLENOID TERMINAL AND TIGHTEN THE TERMINAL NUT TO 35 LBS-IN.
- 6-INSTALL THE SOLENOID POWER CABLE AND TIGHTEN THE LARGE SOLENOID NUT TO 35 LBS-IN. INSTALL THE SOLENOID "ACTIVATION" WIRE AND TIGHTEN THE SMALL NUT TO 15 LBS-IN. POSITION THE CABLES SO THEY HAVE THE LEAST POSSIBILITY FOR DAMAGE.



### SOLENOID FASTENER TORQUE SPECIFICATION

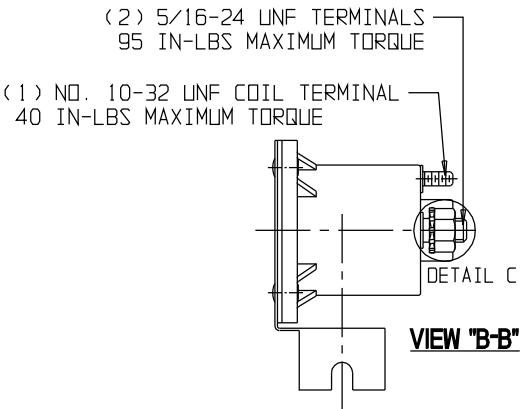


PLATE NO. 821AJ (SHEET 2 OF 2)

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD
02-251	G	ADDED TOP VIEW OF SOLENOID AND DIMENSIONS IN MILLIMETER. FIXED GROUND STRAP TO BE ATTACHED TO APPARATUS CHASSIS.	BVP	08-15-02	MAL	0815	J1	WAS 200-0042-00-0 & 200-0071-00-0	JRP	01-22-09	MAL
0411	H	ADDED DETAIL C AND HOSE	KSM	7-24-06	MAL	0815	J2	ADDED SOLENOID ROTATION NOTE	JRP	01-22-09	MAL
0526	I	REDRAWN AND ADDED SHEET 2	MLJ	2-22-07	MAL						

HALE

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CHECKED

ROT  
ROT

DATE 2-19-95

SIZE  
D

SCALE: FULL

## Notes

[illegible]

INSTALLATION NOTES:

- A) USE A MINIMUM OF 1/2 TUBING FOR BOOSTER PUMPS.  
B) USE A MINIMUM OF 3/4 PIPE FOR MIDSHIP PUMPS.  
C) CONNECT TO HIGHEST POINT ON DISCHARGE OF MAIN PUMP IF PRIMING WHILE THE PUMP IS STATIONARY.  
D) CONNECT TO HIGHEST POINT ON THE SUCTION NEAR THE IMPELLER EYE IF PRIMING WHEN THE MAIN PUMP IS RUNNING.  
E) A SHUT-OFF VALVE, SUCH AS A HALE PVG OR SPV PRIMING VALVE, MUST BE LOCATED IN THE PRIMING LINE BETWEEN THE PRIMING PUMP AND THE MAIN PUMP.  
F) THE PRIMING PUMP MUST BE MOUNTED SO THAT THE MOTOR SHAFT IS IN A HORIZONTAL PLANE WITH THE PRIMING PUMP DISCHARGE FACING DOWN.  
G) GROUND THE PRIMING PUMP TO THE TRUCK CHASSIS, USING THE GROUND STRAP FURNISHED. THE GROUND STRAP IS REQUIRED, FROM THE TRUCK CHASSIS TO THE TERMINAL STUD ON THE PRIMING PUMP. THIS IS TO INSURE A GROUND FOR THE MOTOR. THE CABLE IS SIZED FOR A 24 VOLT DC 150 AMP LOAD.  
H) DURING THE PRIMING OPERATION (EVACUATING AIR), DO NOT RUN THE MOTOR FOR MORE THAN 60 SECONDS.

NOTES:

- 1) MOTOR ROTATION IS THE SAME FOR BOTH NEGATIVE AND POSITIVE GROUND SYSTEMS.  
2) WEIGHT OF PRIMING PUMP AND MOTOR IS 27 LBS. (12.2 Kg).  
3) THEORETICAL DISPLACEMENT IS .066 GAL. (.25 LITERS) PER REVOLUTION OR 47,000 CU. IN. (770,000 CU. CM) AIR PER MINUTE.  
4) VACUUM CAPABILITY: 24 IN. Hg (610 MM Hg).  
5) TO AID IN LONG PRIMER LIFE AND PROPER PERFORMANCE, IT IS RECOMMENDED THAT THE PRIMING PUMP BE CLEANED YEARLY OR AFTER 500 CYCLES OF USE. SEPARATE THE PUMP BODY AND HEAD FROM THE MOTOR AND REMOVE ANY BLACK BUILD UP OR CONTAMINATES WITH SAFETY KLEEN OR STODDARD SOLVENT. USE CARE TO REINSTALL THE VANES IN THE SAME ORIENTATION AND TO GREASE THE SHAFT SEAL.  
6) SEE PLATE NO. 821 FOR 12V PRIMING PUMP CONFIGURATION.  
7) TO PREVENT DAMAGE TO PLASTIC HOUSING WHEN INSTALLING OR REMOVING LEADS, DO NOT APPLY SIDE LOADS TO NUTS.  
8) WHEN USING A TERMINAL LUG ON THE BATTERY CONNECTION WITH A 5/16 DIA. HOLE, LOWER WASHER IS NOT NEEDED. IF HOLE DIA. IS LARGER THAN 5/16, WASHERS ARE REQUIRED BOTH ABOVE AND BELOW THE TERMINAL.  
9) FOR ELECTRICAL DETAILS REFER TO SHEET 2  
10) FOR MECHANICAL DETAILS REFER TO SHEET 1

SOLENOID COIL POWER 24 VDC CONNECT TO EITHER PVG SWITCH FOR PVG VALVE OR PANEL MOUNT SWITCH FOR SPV VALVE. (SEE INSTALLATION DETAILS) USE MINIMUM 14 AWG TYPE SXL OR GXL WIRE

POWER TO MOTOR  
(CONNECTED AT FACTORY)

SOLENOID GROUND  
(CONNECTED AT FACTORY)

VIEW "B-B"

SOLENOID FASTENER  
TORQUE SPECIFICATION

BATTERY POWER  
CONNECTION 24 VDC.  
USE MINIMUM 4 AWG  
STRANDED COPPER  
BATTERY CABLE MEETING  
REQUIREMENTS OF  
SAE J1127.

DETAIL C

(2) 10-32 UNC TERMINALS  
TORQUE TO 15-20 IN LBS MAX  
(SEE NOTE 7)

(2) 5/16-18 UNC TERMINALS  
TORQUE TO 50-60 IN LBS MAX  
(SEE NOTE 7)

VENDOR SUPPLIED 5/16  
NUT AND LOCK WASHER

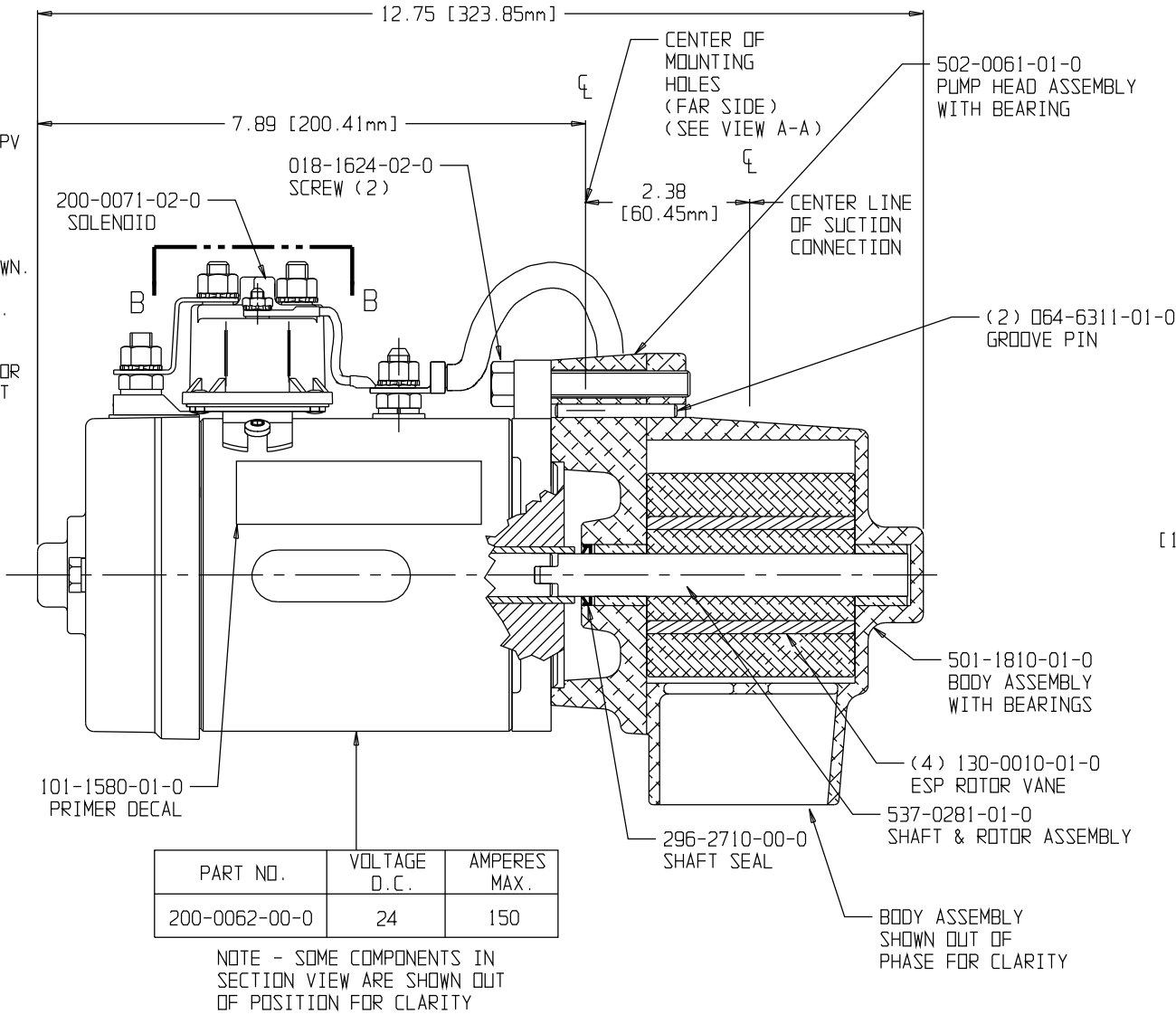
(2) 097-2100-00-0  
5/16 FLAT WASHER  
(SEE NOTE 8)

5/16-18 STUD

5/16 TERMINAL  
(SEE NOTE 8)

DETAIL C

# HALE TYPE ESP-24 PRIMING PUMP



PART NO.	VOLTAGE D.C.	AMPERES MAX.
200-0062-00-0	24	150

NOTE - SOME COMPONENTS IN SECTION VIEW ARE SHOWN OUT OF POSITION FOR CLARITY

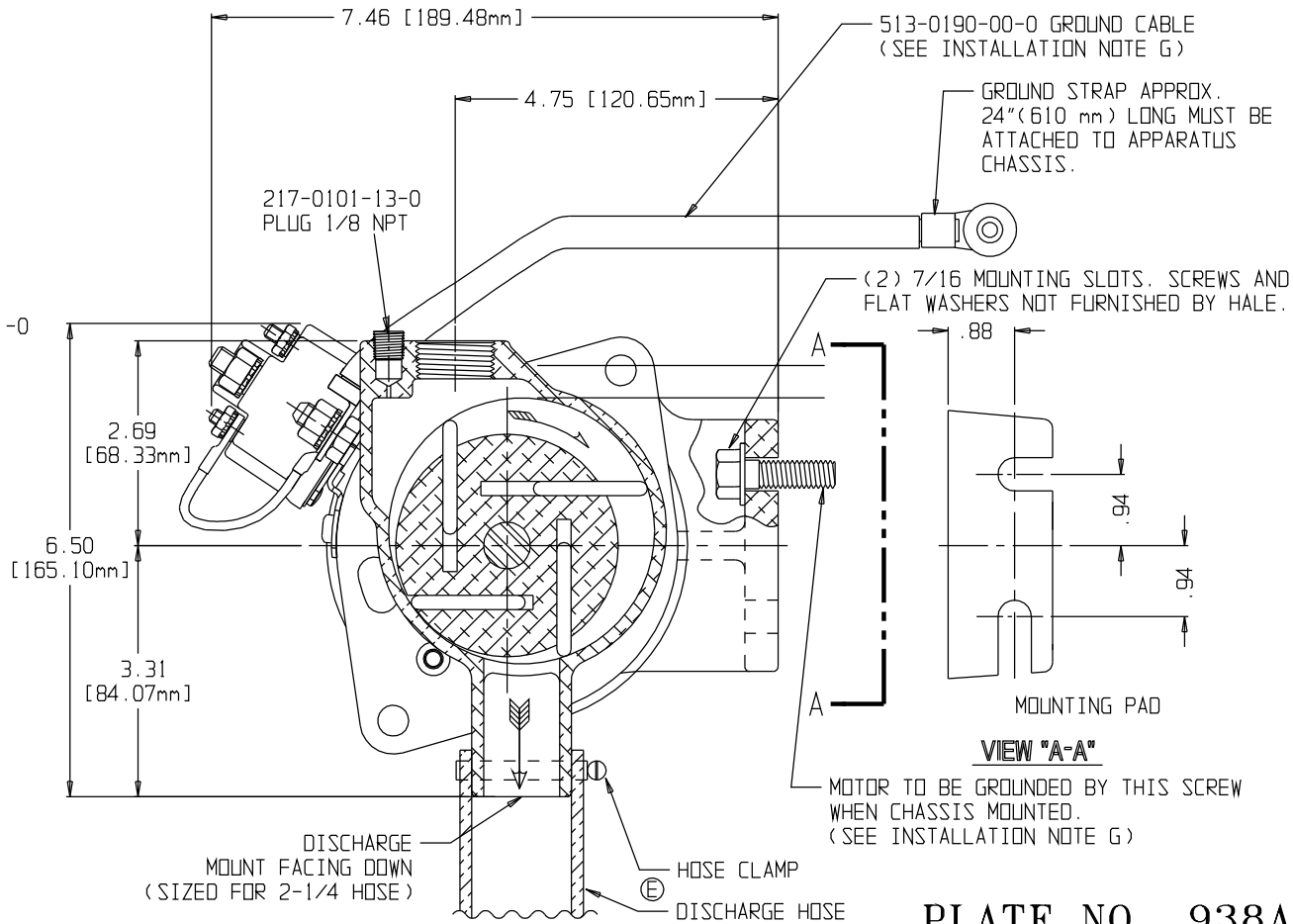
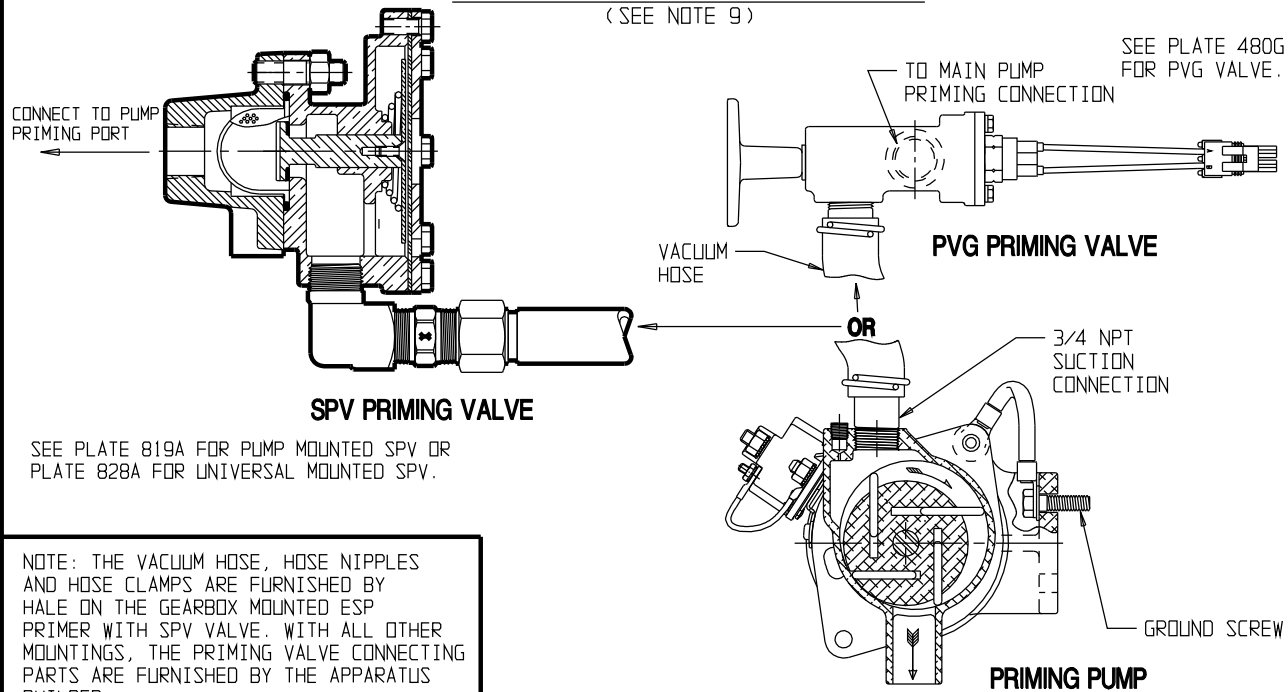


PLATE NO. 938AF

## PLUMBING INSTALLATION DETAILS

(SEE NOTE 9)



NOTE: THE VACUUM HOSE, HOSE NIPPLES AND HOSE CLAMPS ARE FURNISHED BY HALE ON THE GEARBOX MOUNTED ESP PRIMER WITH SPV VALVE. WITH ALL OTHER MOUNTINGS, THE PRIMING VALVE CONNECTING PARTS ARE FURNISHED BY THE APPARATUS BUILDER.

PLATE NO. 938AF (SHEET 1 OF 2)

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD
02-251	D	ADDED TOP VIEW OF SOLENOID AND DIMENSIONS IN MILLIMETER. FIXED GROUND STRAP TO BE ATTACHED TO APPARATUS CHASSIS.	BVP	08-15-02	MAL	01-172	A	RELEASE FOR PRODUCTION	ERB	4-03-01	MAL
0411	E	ADDED DETAIL C AND HOSE	KSM	7-24-06	MAL	01-257	B	UPDATED SOLENOID CONNECTION CALLOUTS	DJK	06-12-01	MAL
0526	F	REDRAWN AND ADDED SHEET 2	MLJ	2-22-07	MAL	01-258	C	(INSTRUCTION NOTE 7) REMOVED. "WHEN THE PRIMING PUMP IS MOUNTED ON THE PUMP GEARBOX". ADDED SOLENOID TROUBLE SPACE	DJK	06-22-01	MAL



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CHECKED PDW  
DATE 4-3-01

SIZE 0  
SCALE: FULL

## Notes

[illegible]



# HALE TYPE ESP-24 PRIMING PUMP

## ELECTRICAL INSTALLATION DETAILS

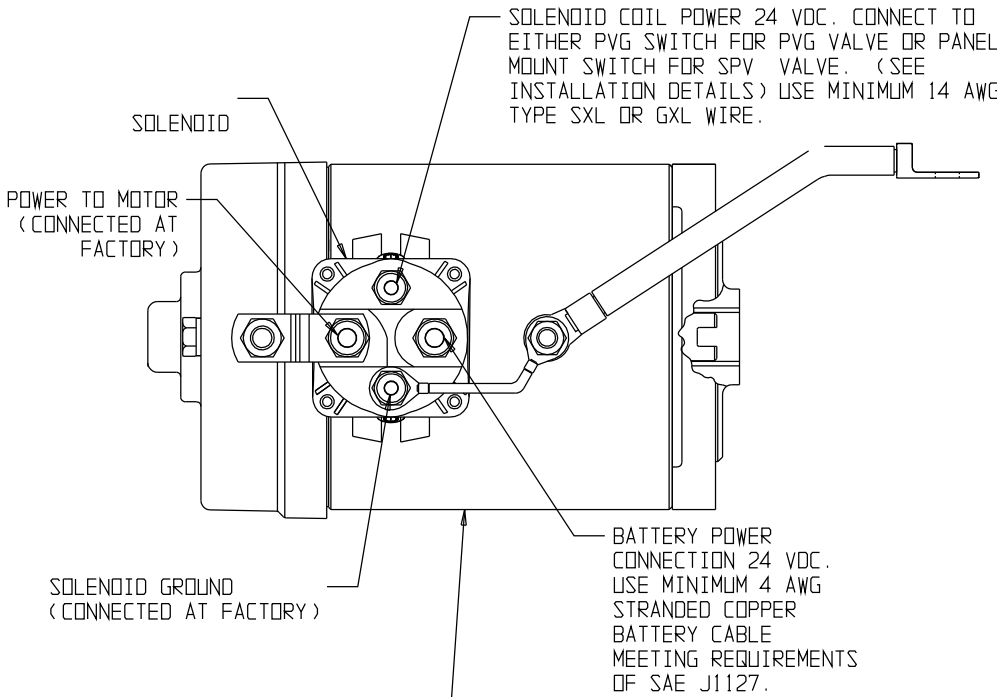
(SEE NOTE 10)

### INSTALLATION NOTES:

- USE A MINIMUM OF 1/2 TUBING FOR BOOSTER PUMPS.
- USE A MINIMUM OF 3/4 PIPE FOR MIDSHIP PUMPS.
- CONNECT TO HIGHEST POINT ON DISCHARGE OF MAIN PUMP IF PRIMING WHILE THE PUMP IS STATIONARY.
- CONNECT TO HIGHEST POINT ON THE SUCTION NEAR THE IMPELLER EYE IF PRIMING WHEN THE MAIN PUMP IS RUNNING.
- A SHUT-OFF VALVE, SUCH AS A HALE PVG OR SPV PRIMING VALVE, MUST BE LOCATED IN THE PRIMING LINE BETWEEN THE PRIMING PUMP AND THE MAIN PUMP.
- THE PRIMING PUMP MUST BE MOUNTED SO THAT THE MOTOR SHAFT IS IN A HORIZONTAL PLANE WITH THE PRIMING PUMP DISCHARGE FACING DOWN.
- GROUND THE PRIMING PUMP TO THE TRUCK CHASSIS, USING THE GROUND STRAP FURNISHED. THE GROUND STRAP IS REQUIRED FROM THE TRUCK CHASSIS TO THE TERMINAL STUD ON THE PRIMING PUMP. THIS IS TO INSURE A GROUND FOR THE MOTOR. THE CABLE IS SIZED FOR A 24 VOLT DC 150 AMP LOAD.
- DURING THE PRIMING OPERATION (EVACUATING AIR), DO NOT RUN THE MOTOR FOR MORE THAN 60 SECONDS.

### NOTES:

- MOTOR ROTATION IS THE SAME FOR BOTH NEGATIVE AND POSITIVE GROUND SYSTEMS.
- WEIGHT OF PRIMING PUMP AND MOTOR IS 27 LBS. (12.2 Kg).
- THEORETICAL DISPLACEMENT IS .066 GAL. (.25 LITERS) PER REVOLUTION OR 47,000 CU. IN. (770,000 CU. CM) AIR PER MINUTE.
- VACUUM CAPABILITY: 24 IN. Hg (610 MM Hg).
- TO AID IN LONG PRIMER LIFE AND PROPER PERFORMANCE, IT IS RECOMMENDED THAT THE PRIMING PUMP BE CLEANED YEARLY OR AFTER 500 CYCLES OF USE. SEPARATE THE PUMP BODY AND HEAD FROM THE MOTOR AND REMOVE ANY BLACK BUILD UP OR CONTAMINATES WITH SAFETY KLEEN OR STODDARD SOLVENT. USE CARE TO REINSTALL THE VANES IN THE SAME ORIENTATION AND TO GREASE THE SHAFT SEAL.
- SEE PLATE NO. 821 FOR 12V PRIMING PUMP DETAILS.
- TO PREVENT DAMAGE TO PLASTIC HOUSING WHEN INSTALLING OR REMOVING LEADS, DO NOT APPLY SIDE LOADS TO NUTS.
- WHEN USING A TERMINAL LUG ON THE BATTERY CONNECTION WITH A 5/16 DIA. HOLE, LOWER WASHER IS NOT NEEDED. IF HOLE DIA. IS LARGER THAN 5/16, WASHERS ARE REQUIRED BOTH ABOVE AND BELOW THE TERMINAL.
- FOR ELECTRICAL DETAILS REFER TO SHEET 2
- FOR MECHANICAL DETAILS REFER TO SHEET 1



PART NO.	VOLTAGE DC	AMPERES MAX.
200-0062-00-0	24	150

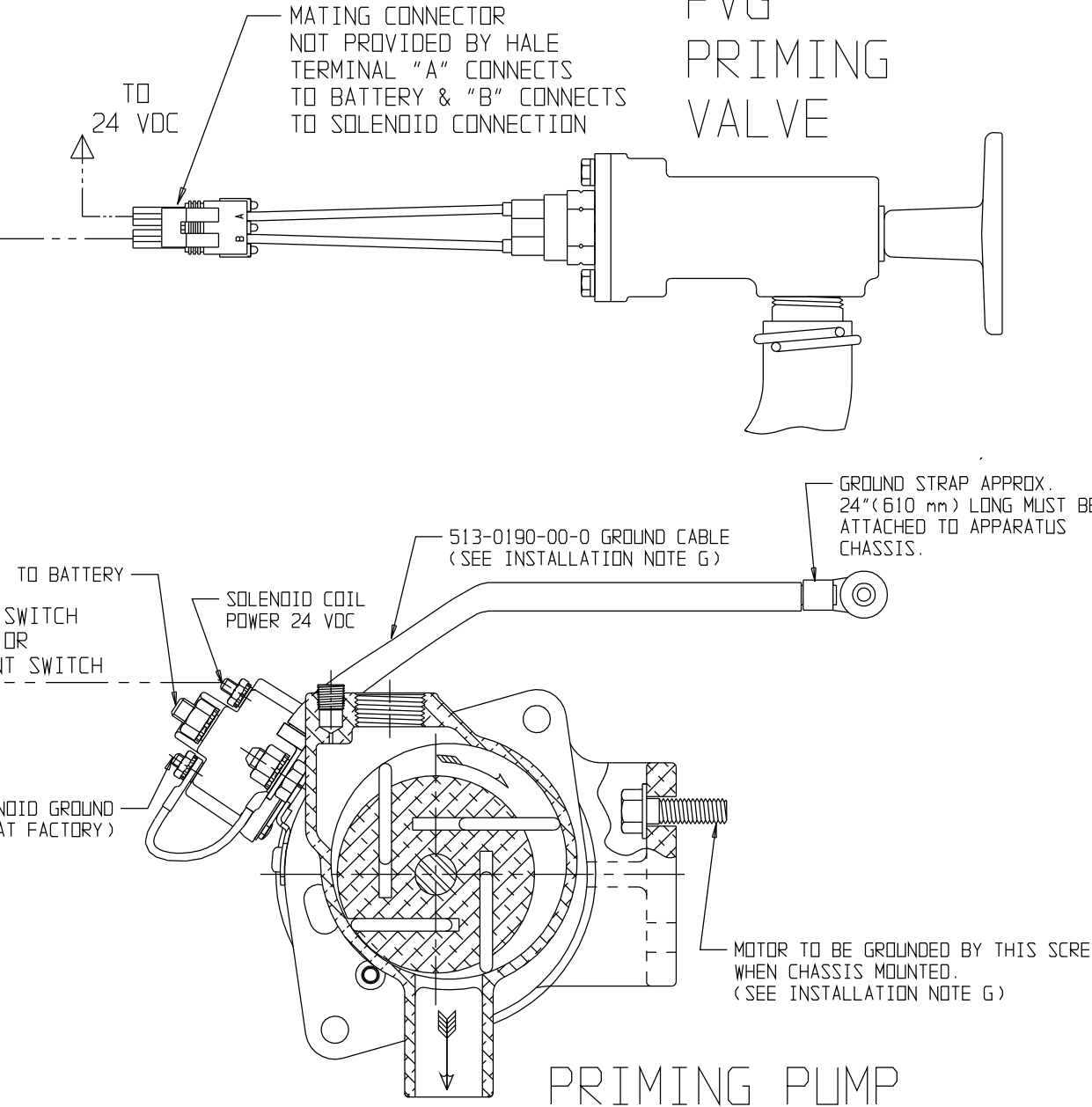
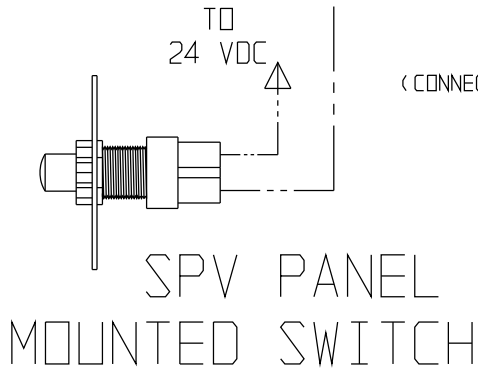


PLATE NO. 938AF (SHEET 2 OF 2)

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD
02-251	G	ADDED TOP VIEW OF SOLENOID AND DIMENSIONS IN MILLIMETER. FIXED GROUND STRAP TO BE ATTACHED TO APPARATUS CHASSIS.	BVP	08-15-02	MAL	01-257	E	UPDATED SOLENOID CONNECTION CALLOUTS	DJK	06-12-01	MAL
0411	H	ADDED DETAIL C AND HOSE	KSM	7-24-06	MAL	01-258	F	(INSTRUCTION NOTE 7) REMOVED: "WHEN THE PRIMING PUMP IS MOUNTED ON THE PUMP GEARBOX". ADDED: SOLENOID TUBING SPECS	DJK	06-22-01	MAL
0526	I	REDRAWN AND ADDED SHEET 2	MLJ	2-22-07	MAL						



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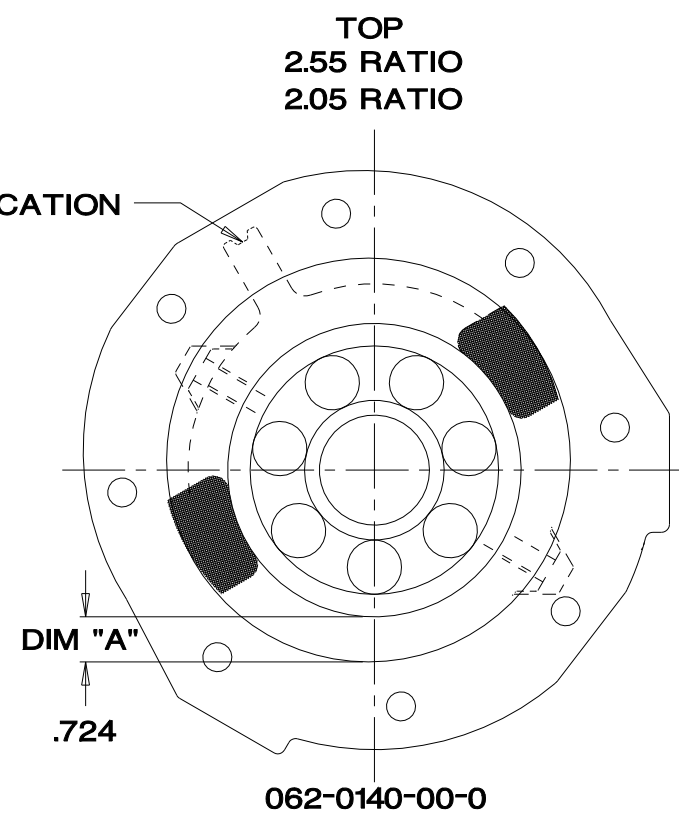
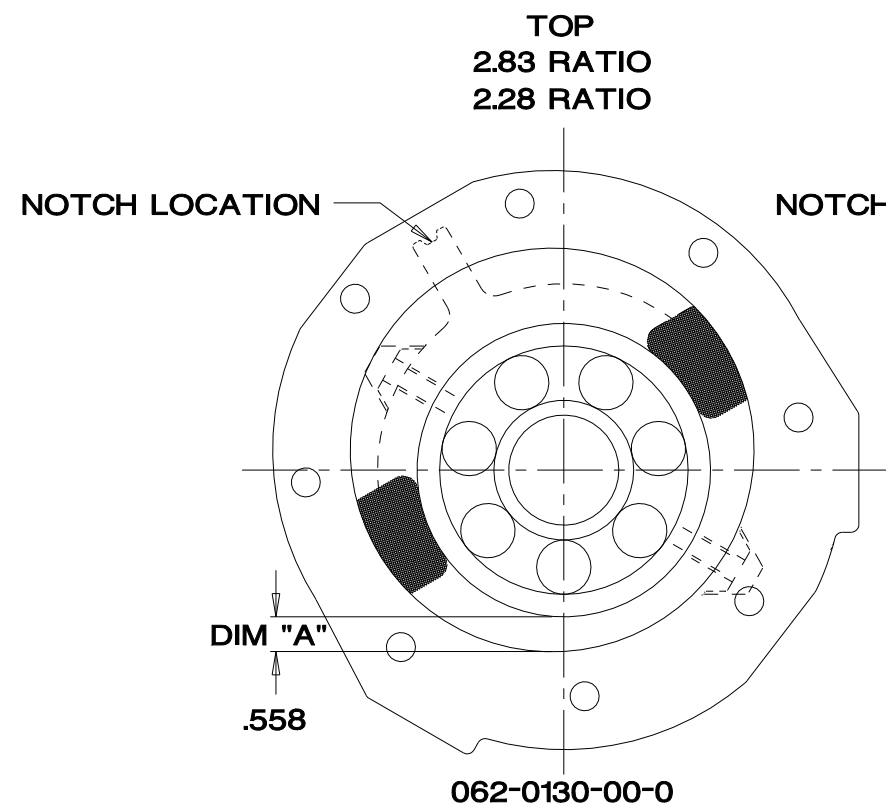
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## Notes

[illegible]

# QMAX, QTWO, QMID SERIES PUMPS

## QG, QLG, QSG, QSMG



GEARBOX TYPE	GEAR RATIO	RATIO DESIGNATOR	NUMBER OF GEAR TEETH	DIM "A"
G SERIES EXTRA LONG	2.83	- 28	18	0.558
	2.55	- 25	20	0.724
	2.32	- 23	22	0.888
	2.13	- 21	24	1.051
	1.96	- 19	26	1.207
G SERIES LONG OR SHORT	2.28	- 23	18	0.558
	2.05	- 21	20	0.724
	1.86	- 19	22	0.888
	1.71	- 17	24	1.051
	1.58	- 15	26	1.207

**NOTES:**

1. DIM "A" IS THE REAR BEARING HOUSING OFFSET
2. VIEW OF THE REAR BEARING HOUSING IS LOOKING FROM THE REAR OF THE TRUCK TOWARDS THE FRONT

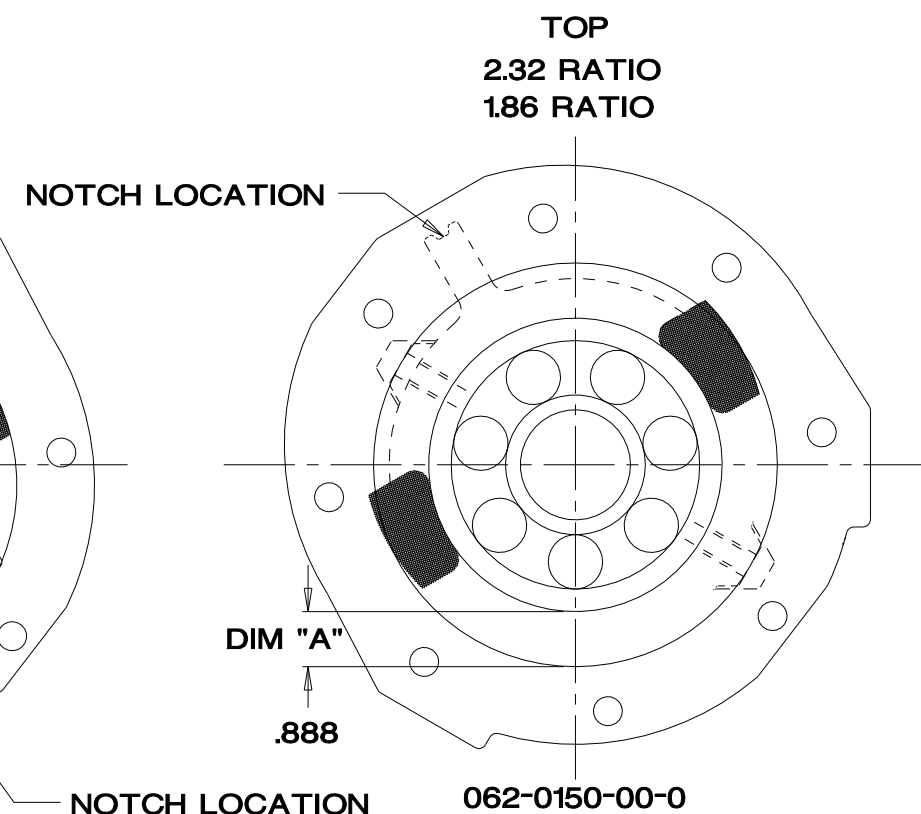
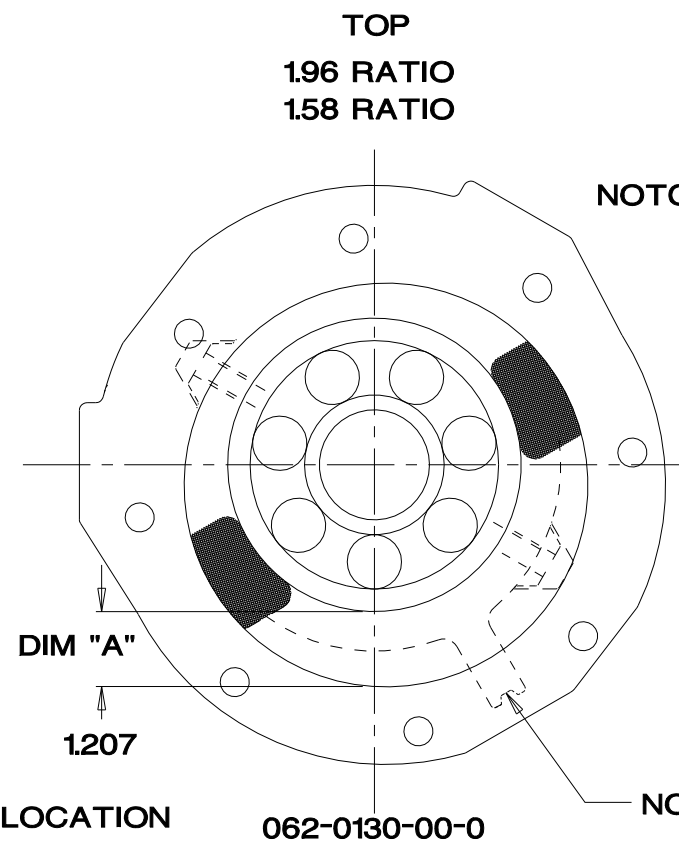
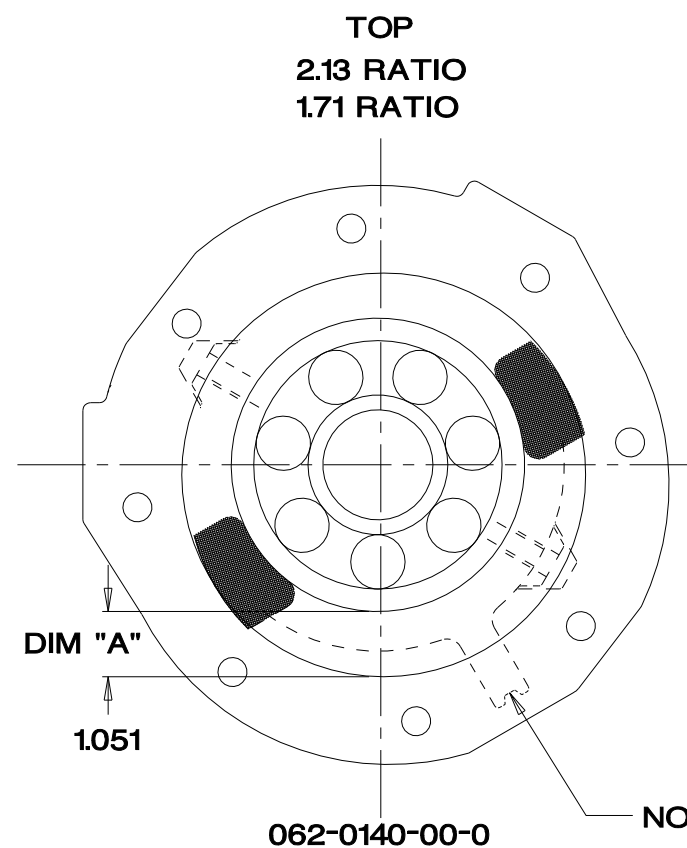



PLATE NO. 1153AA

ECD NO	REV	CHANGED FROM	BY	DATE	APVD						
0673	A	RELEASED FOR PRODUCTION	SJM	12-5-07	MAL						



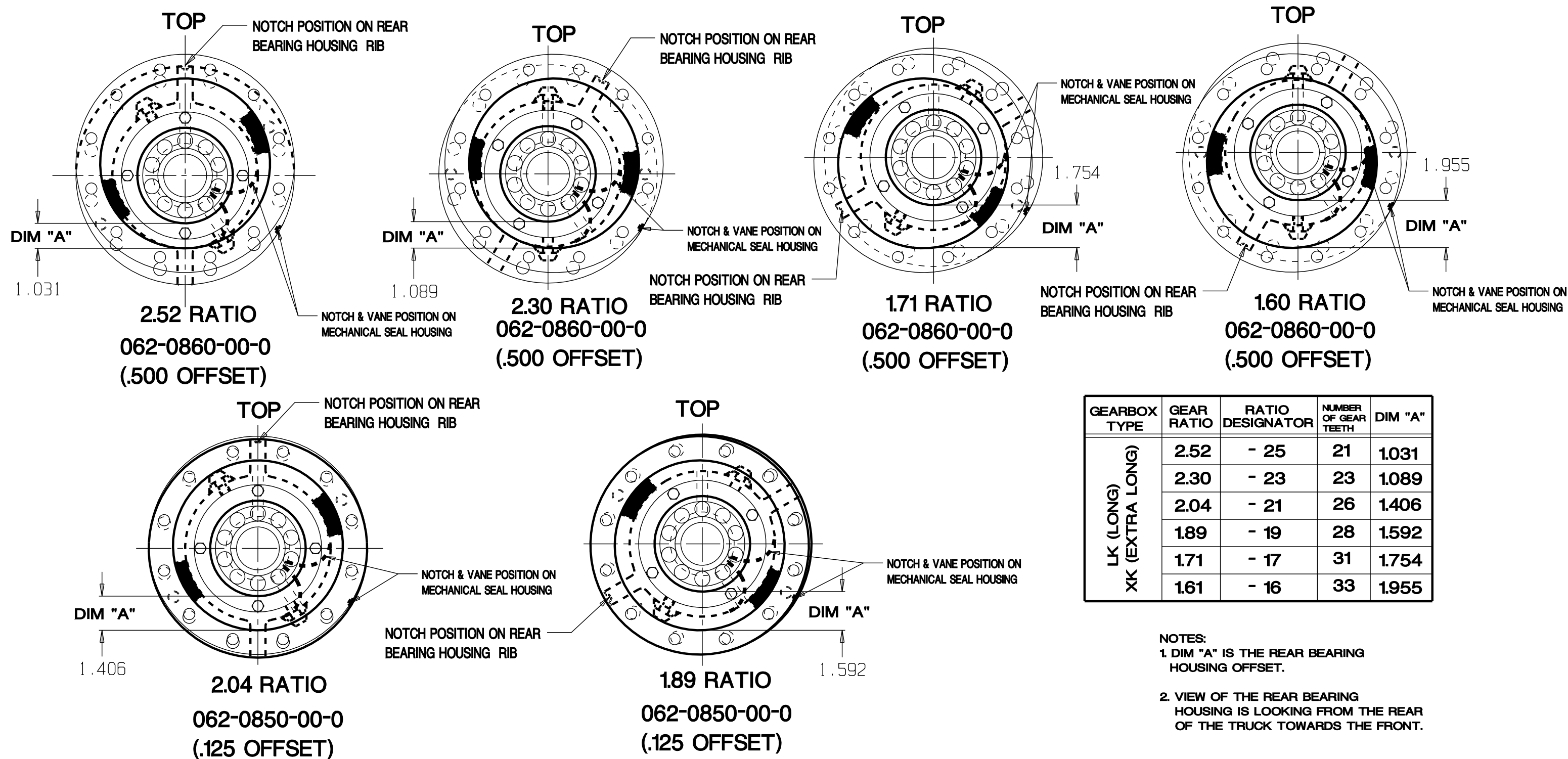
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## Notes

[illegible]

# QMAX, QTWO, QMID, 8FK SERIES PUMPS WITH "LK" OR "XK" GEARBOX



GEARBOX TYPE	GEAR RATIO	RATIO DESIGNATOR	NUMBER OF GEAR TEETH	DIM "A"
LK (LONG) XK (EXTRA LONG)	2.52	- 25	21	1.031
	2.30	- 23	23	1.089
	2.04	- 21	26	1.406
	1.89	- 19	28	1.592
	1.71	- 17	31	1.754
	1.61	- 16	33	1.955

- NOTES:
1. DIM "A" IS THE REAR BEARING HOUSING OFFSET.
2. VIEW OF THE REAR BEARING HOUSING IS LOOKING FROM THE REAR OF THE TRUCK TOWARDS THE FRONT.

PLATE NO. 1157AA

ECD NO	REV	CHANGED FROM	BY	DATE	APVD
0942	A	RELEASED FOR PRODUCTION	MD	01-19-10	PRW

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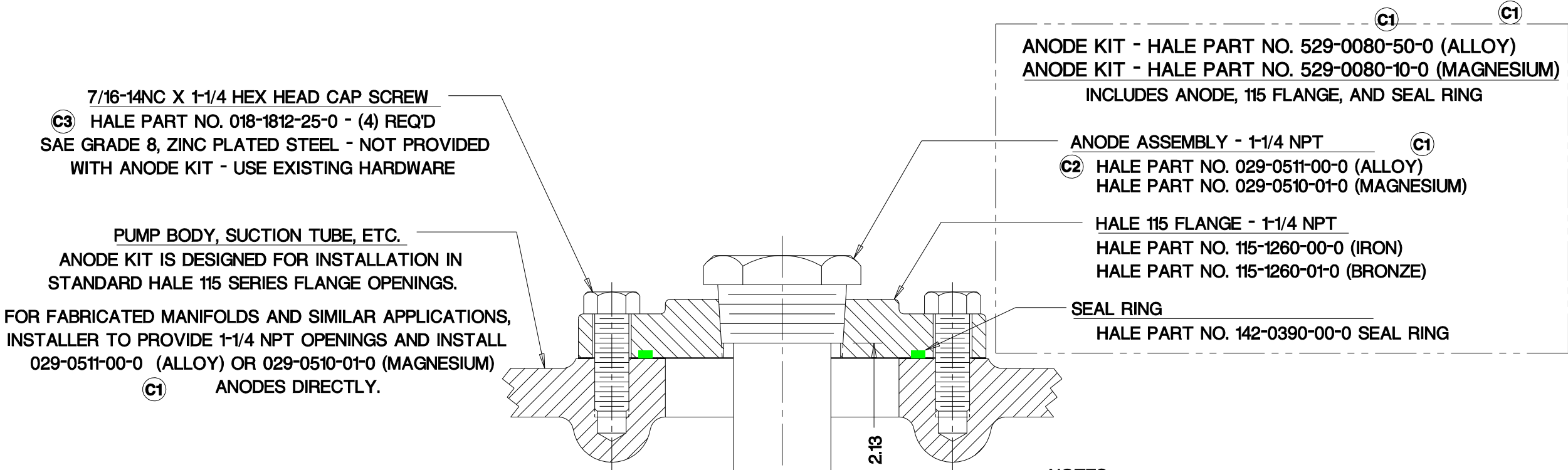
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## Notes

[illegible]

# HALE ANTI-CORROSION ANODES

SACRIFICIAL GALVANIC ANODES DESIGNED TO HELP MINIMIZE CORROSION IN THE PUMPING SYSTEM



7/16-14NC X 1-1/4 HEX HEAD CAP SCREW  
(C3) HALE PART NO. 018-1812-25-0 - (4) REQ'D  
SAE GRADE 8, ZINC PLATED STEEL - NOT PROVIDED  
WITH ANODE KIT - USE EXISTING HARDWARE

PUMP BODY, SUCTION TUBE, ETC.  
ANODE KIT IS DESIGNED FOR INSTALLATION IN  
STANDARD HALE 115 SERIES FLANGE OPENINGS.  
FOR FABRICATED MANIFOLDS AND SIMILAR APPLICATIONS,  
INSTALLER TO PROVIDE 1-1/4 NPT OPENINGS AND INSTALL  
029-0511-00-0 (ALLOY) OR 029-0510-01-0 (MAGNESIUM)  
(C1) ANODES DIRECTLY.

(C1) ANODE KIT - HALE PART NO. 529-0080-50-0 (ALLOY)  
ANODE KIT - HALE PART NO. 529-0080-10-0 (MAGNESIUM)  
INCLUDES ANODE, 115 FLANGE, AND SEAL RING

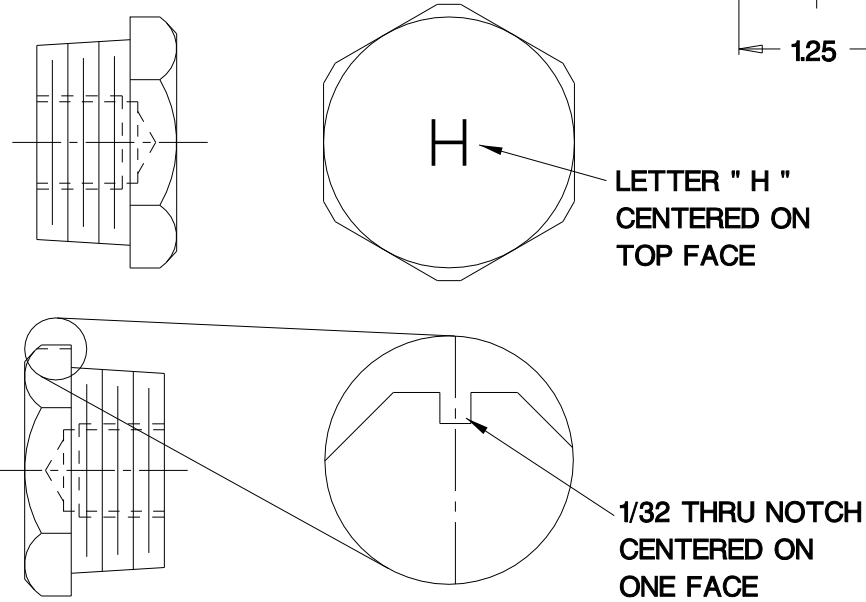
ANODE ASSEMBLY - 1-1/4 NPT (C1)  
(C2) HALE PART NO. 029-0511-00-0 (ALLOY)  
HALE PART NO. 029-0510-01-0 (MAGNESIUM)

HALE 115 FLANGE - 1-1/4 NPT  
HALE PART NO. 115-1260-00-0 (IRON)  
HALE PART NO. 115-1260-01-0 (BRONZE)

SEAL RING  
HALE PART NO. 142-0390-00-0 SEAL RING

(C4) ALLOY ANODE  
IDENTIFICATION DETAIL  
HALE PART NO. 029-0511-00-0

MAGNESIUM ANODE  
IDENTIFICATION DETAIL  
HALE PART NO. 029-0510-01-0



- NOTES:
- 1) A MINIMUM OF THREE ANODES PER PUMP ARE RECOMMENDED.  
INSTALL ONE ANODE ON EACH SUCTION SIDE AND ONE ON THE  
DISCHARGE SIDE. ANODES CAN BE MOUNTED IN ANY POSITION;  
I.E., HORIZONTAL OR VERTICAL.
  - 2) ANODES SHOULD BE INSPECTED REGULARLY.  
MINIMUM RECOMMENDED INSPECTION INTERVAL IS:  
ALLOY: 12 MONTHS (C1)  
MAGNESIUM: 4 MONTHS  
THE ANODE MUST BE REPLACED WHEN 75% OF THE ANODE  
MATERIAL HAS BEEN CONSUMED. PERFORMANCE AND ANODE  
LIFE WILL VARY WITH WATER QUALITY AND PH.  
(C1) ALLOY ANODE CONFORMS TO MIL-A-24779 (SH).  
MAGNESIUM ANODE CONFORMS TO ASTM B 843.  
(C2)
  - 3) 029-0511-00-0 OR 029-0510-01-0 IS REPLACED AS AN ASSEMBLY.  
THE CONSUMMABLE ANODE IS PERMANENTLY ASSEMBLED  
WITH THE BRONZE PLUG AND CANNOT BE REPLACED SEPARATELY.

PLATE NO. 869AC

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
902	C1	ALLOY WAS ZINC	ZLW	7-29-09	MAL
902	C2	029-0511-00-0 WAS 029-0510-00-0 529-0080-50-0 WAS 529-0080-00-0	ZLW	7-29-09	MAL
902	C3	GRADE 8 WAS GRADE 5, 018-1812-25-0 WAS 018-1812-02-0	ZLW	7-29-09	MAL
902	C5	ADDED ALLOY ANODE I.D. DETAIL	ZLW	7-29-09	MAL



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## Notes

[illegible]



082-0203-02 (1/4 NPT x 3/8 TUBE ELBOW)  
HP & 2HP PUMPS-ONE 3/8 TUBING LINE TO MIDSHIP  
PUMP SUCTION CONNECTION.

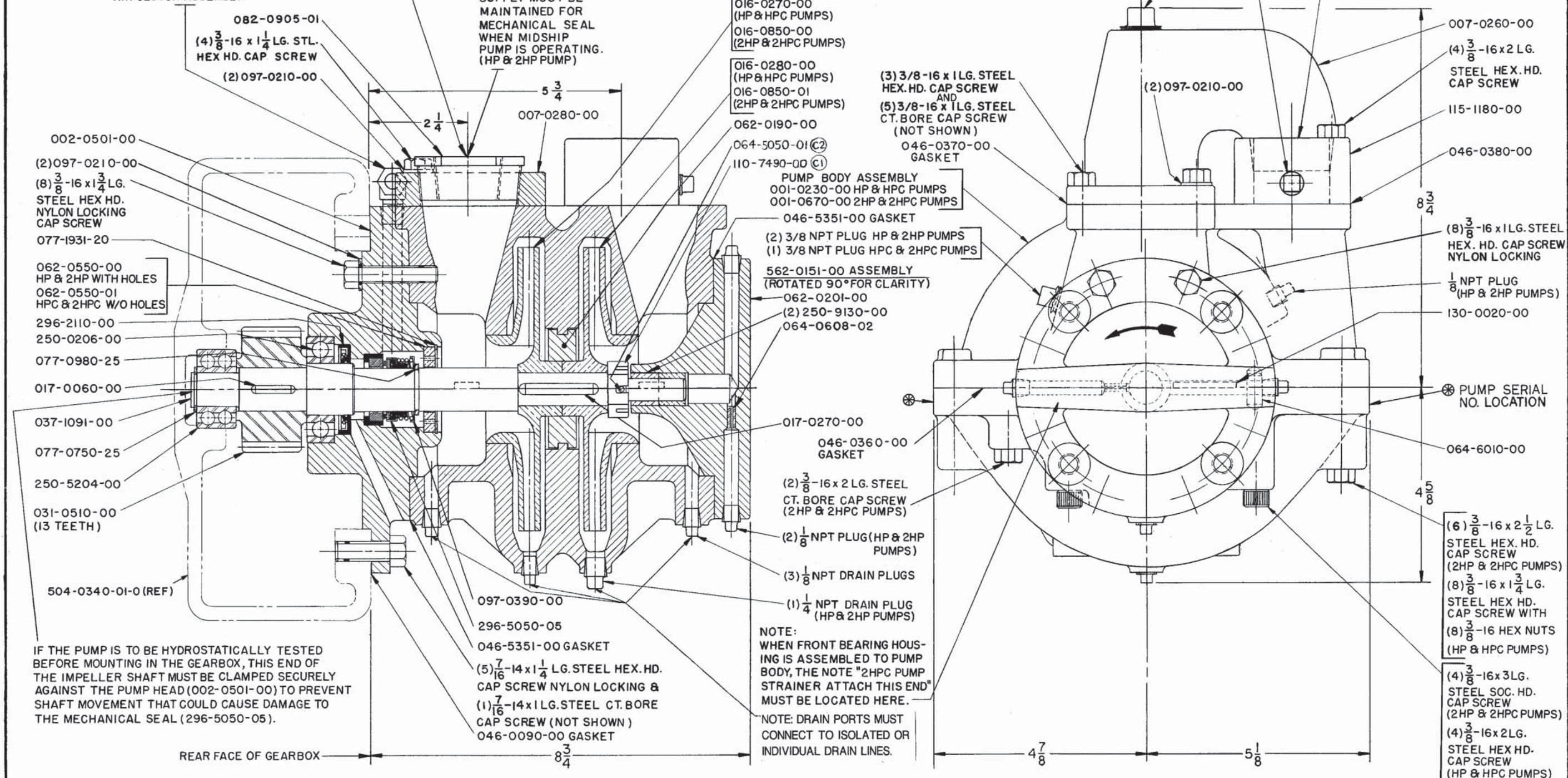
HPC & 2HPC PUMPS-TWO TUBING LINES.  
ONE 3/8 TUBING LINE TO CHECK VALVE  
AND MIDSHIP PUMP SUCTION CONNECTION.  
ONE ADDITIONAL 1/8 NPT x 1/4 TUBE ELBOW  
WITH 1/4 TUBING LINE TO BOOSTER PUMP  
FRONT BEARING HOUSING. SEE PLATE NO.704  
AIR CLUTCH ASSEMBLY.

1 1/2 NPT SUCTION CONNECTION  
CONNECT TO DISCHARGE OUTLET  
ON MIDSHIP PUMP USING  
340-0460-00 HOSE

CONSTANT WATER  
SUPPLY MUST BE  
MAINTAINED FOR  
MECHANICAL SEAL  
WHEN MIDSHIP  
PUMP IS OPERATING.  
(HP & 2HP PUMP)

HALE MODEL	RATIO	USED WITH PUMP	CAPACITY
HP3I	1:3.15	QLG, QSG, QSMG, QG	100 GPM
HPC3I			
2HP3I		WITH "LONG TYPE" G GEARBOX	200 GPM
2HPC3I			

**WARNING**  
EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE RECOMMENDATIONS OUT-  
LINED ON THIS DWG. COULD DAMAGE THE PUMP AND RESULT IN PERSONAL INJURY.  
MAX. PUMP PRESSURE, HYDRODYNAMIC AND HYDROSTATIC, = 1000 PSI



# HALE TYPE HP, HPC, 2HP & 2HPC SERIES PUMPS

HIGH PRESSURE BOOSTER PUMP MOUNTED ON MIDSHIP PUMP GEARBOX

PLATE NO. 705BC

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
02-323	A	EDITED PUMP PART NUMBERS	MAB	11-01-02	MAL
0444	B	UPDATED IMPELLER HARDWARE	JRP	07-07-08	MAL
0746	C1	110-7490-00-0 WAS 110-2711-11-0	JRP	04-02-09	MAL
0746	C2	ADDED 064-5050-01-0	JRP	04-02-09	MAL



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DATE: 5-19-94

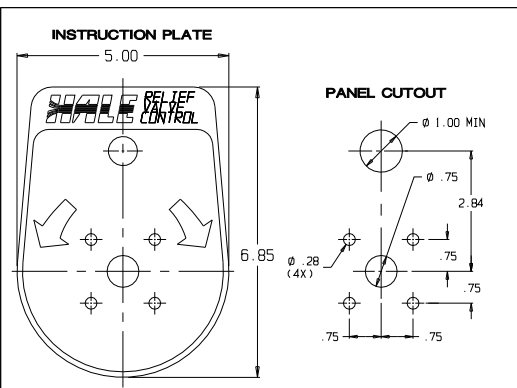
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## Notes

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FOR PANEL THICKNESSES OVER .125, SCREWS LONGER THAN THE (4) 1/4-20 X 5/8 LG SUPPLIED BY HALE WILL BE REQUIRED. MAINTAIN AT LEAST 3/8 THREAD ENGAGEMENT IN SPRING HOUSING.

INSTRUCTION PLATE AND PANEL MOUNTING DETAILS

**MAINTENANCE INSTRUCTIONS**  
TEST THE RELIEF VALVE OFTEN TO BE SURE THAT IT MOVES FREELY. TO DO THIS, FIRST TURN THE ADJUSTING HANDWHEEL CLOCKWISE AS FAR AS POSSIBLE. NEXT, BRING THE PUMP PRESSURE UP TO 150 PSI AND TURN THE HANDWHEEL COUNTERCLOCKWISE UNTIL THE RELIEF VALVE OPENS. ALSO VERIFY THAT THE INDICATOR LIGHT IS OPERATING.

TURNING THE HANDWHEEL CLOCKWISE AND COUNTERCLOCKWISE AT 150 PSI WILL CAUSE THE RELIEF VALVE AND CONTROL VALVE TO OPERATE. THIS WORKING ACTION MAKES SURE THAT THE VALVE MOVES FREELY AND HELPS TO ENSURE PROPER OPERATION.

THE PM CONTROL SHOULD BE LUBRICATED AT LEAST EVERY 5 MONTHS. TO DO THIS, TURN THE HANDWHEEL CLOCKWISE AS FAR AS POSSIBLE AND APPLY A LITHIUM BASE GREASE WITH 1% TO 3% MOLYBDENUM DISULFIDE ON THE THREADED PART OF THE ADJUSTING STEM.

SOME RECOMMENDED LUBRICANTS INCLUDE:	
DOW CORNING BR2-PLUS FISKE - LUBRIPLATE NO. 3000 SHELL SUPER DUTY GREASE	IMPERIAL NO. 777 MOBIL - MOBILGREASE SPECIAL SUN OIL - SUNDOL MOLY NO. 2EP

**ELECTRICAL INFORMATION**  
THE HALE 200-2450-00-0 LIGHT SWITCH IS INTENDED FOR USE ONLY WITH THE HALE PROVIDED INDICATOR LIGHT. ELECTRICAL CHARACTERISTICS: 10 AMPS AT 24 VOLTS DC, NORMALLY CLOSED.

THE STANDARD HALE 200-0541-03-0 AMBER INDICATOR LIGHT IS INTENDED FOR 12 VOLT DC SERVICE. REPLACEMENT 12 VOLT BULB IS HALE PART NO. 200-0540-02-0. FOR 24 VOLT DC SERVICE USE BULB PART NO. 200-0540-09-0.

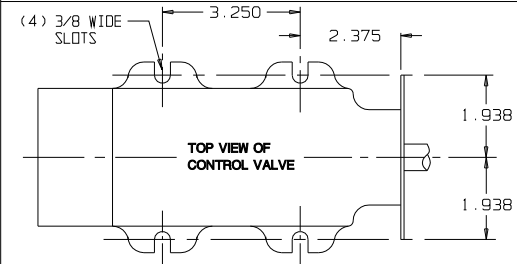
CIRCUIT PROTECTION (FUSE, CIRCUIT BREAKERS, ETC.) IS RECOMMENDED, BUT IS NOT THE RESPONSIBILITY OF HALE PRODUCTS.

SELECTION AND INSTALLATION OF ELECTRICAL COMPONENTS AND WIRING OTHER THAN THAT PROVIDED IS NOT THE RESPONSIBILITY OF HALE PRODUCTS. SYSTEM DESIGN AND INSTALLATION MUST BE DONE ONLY BY PROPERLY QUALIFIED PERSONS.

**DRAIN CONNECTION NOTES**  
THE RELIEF VALVE REQUIRES A SEPARATE DRAIN CONNECTION. DO NOT CONNECT TO THE PUMP MASTER DRAIN.

THE DRAIN MUST ALLOW THE RELIEF VALVE, PM CONTROL VALVE AND ALL TUBING TO DRAIN NATURALLY AND COMPLETELY TO PROTECT FROM FREEZING WHEN NOT IN USE.

THE HALE MMD6 DRAIN VALVE IS RECOMMENDED. THE MMD6 HAS 6 INDEPENDENT DRAIN PORTS CONTROLLED BY A SINGLE KNOB AND IS INTENDENT FOR THIS TYPE OF APPLICATION. FOR MORE INFORMATION, SEE CURRENT REVISION OF HALE PLATE NO. 950AA.



MOUNTING FEET LOCATIONS  
**PLATE NO. 547CG**

- INSTRUCTIONS FOR INSTALLING LIGHT SWITCH**

  - 1- ASSEMBLE THE 200-2450-00-0 LIGHT SWITCH TO 242-0081-00-0 SWITCH STRAP USING NUT 110-7610-00-0.
  - 2- INSTALL THE SWITCH STRAP AND LIGHT SWITCH IN THE SWITCH BRACKET, LEAVE THE TWO SCREWS ATTACHING THE SWITCH STRAP TO THE SWITCH BRACKET SLIGHTLY LOOSE TO ALLOW THE SWITCH TO MOVE IN AND OUT FOR ADJUSTMENT.
  - 3- CONNECT THE PANEL MOUNTED INDICATOR LIGHT OR SUITABLE TEST LIGHT TO THE SWITCH TERMINALS. WITH THE LIGHT SWITCH PLUNGER NOT IN CONTACT WITH THE END OF THE POPPET, THE LIGHT SHOULD BE LIT.
  - 4- WITH THE PUMP NOT RUNNING AND THE RELIEF VALVE FULLY CLOSED (AS SHOWN), PUSH THE LIGHT SWITCH IN UNTIL THE SWITCH PLUNGER MAKES CONTACT WITH THE END OF THE POPPET AND THE LIGHT GOES OUT. THE SWITCH IS NOW IN THE PROPER POSITION. TIGHTEN THE SCREWS HOLDING THE SWITCH STRAP TO THE BRACKET.
  - 5- VERIFY PROPER OPERATION OF THE RELIEF VALVE AND INDICATOR LIGHT BEFORE PLACING APPARATUS IN SERVICE.
- INSTRUCTIONS FOR SETTING "P" SERIES RELIEF VALVE**

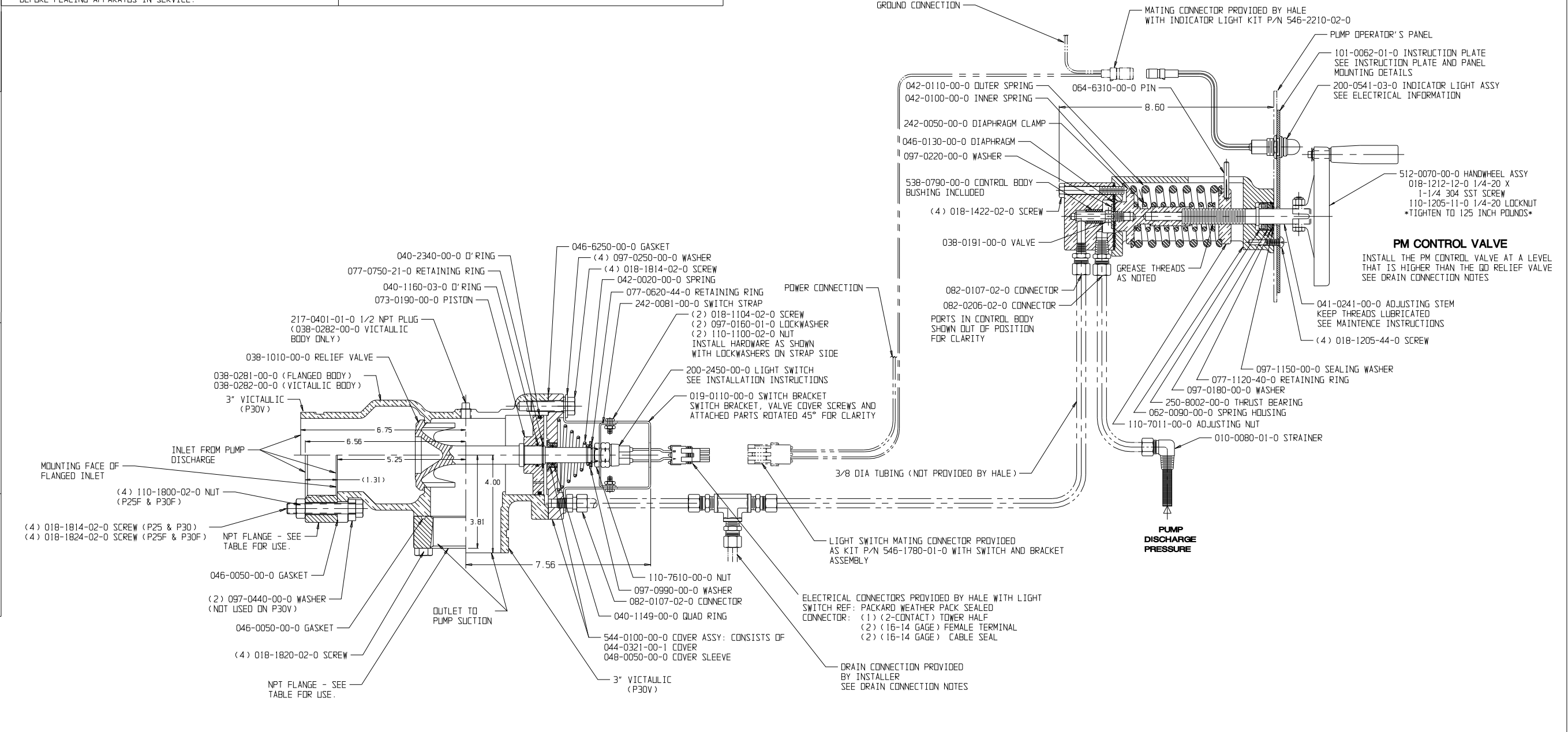
  - 1- TO SET THE RELIEF VALVE. BRING THE PUMP UP TO DESIRED OPERATING PRESSURE. USE THE DISCHARGE PRESSURE GAUGE.
  - 2- ONCE YOU HAVE REACHED THE DESIRED OPERATING PRESSURE ON THE PUMP DISCHARGE PRESSURE GAUGE (WITH OR WITHOUT THE PUMP DISCHARGING WATER) SLOWLY MOVE THE ADJUSTING HANDWHEEL COUNTERCLOCKWISE UNTIL THE RELIEF VALVE OPENS AND THE AMBER INDICATOR LIGHT COMES ON.
  - 3- TURN HANDWHEEL ABOUT 1/2 TURN CLOCKWISE UNTIL THE AMBER INDICATOR LIGHT GOES OFF. THE RELIEF VALVE WILL NOW OPERATE AT THE SET PRESSURE.
  - 4- WHEN THE PUMP IS NOT IN OPERATION THE HANDWHEEL SHOULD BE TURNED CLOCKWISE BACK TO A POSITION SLIGHTLY ABOVE THE NORMAL OPERATING PRESSURE.
  - 5- WHEN THE PUMP IS RUNNING, A LIT INDICATOR LIGHT INDICATES THE RELIEF VALVE IS IN OPERATION.
  - 6- READ THE OPERATING AND INSTRUCTION MANUAL FOR ADDITIONAL OPERATING INSTRUCTIONS.

**WARNING**

FAILURE TO FOLLOW THE INSTALLATION, OPERATION, LUBRICATION AND MAINTENANCE REQUIREMENTS SET FORTH HERE AND IN THE OPERATION AND INSTRUCTION MANUAL MAY RESULT IN SERIOUS PERSONAL INJURY AND/OR DAMAGE TO EQUIPMENT


ALL INSTALLATION DETAILS MUST CONFORM TO APPLICABLE NFPA AND SAE STANDARDS. VERIFY PROPER RELIEF VALVE OPERATION BEFORE PLACING APPARATUS IN SERVICE

ASSEMBLY PART NO.	NAME	PIPE CONNECTIONS	WEIGHT
538-1040-79-0	P RELIEF VALVE LESS PM CONTROL VALVE	FLG. INLET, OUTLET FOR "115" FLG.	20
538-1040-51-0	P25F RELIEF VALVE WITH PM CONTROL VALVE	2 1/2 NPT INLET AND OUTLET	36
538-1040-52-0	P25 RELIEF VALVE WITH PM CONTROL VALVE	FLG. INLET, 2 1/2 NPT OUTLET	33
538-1040-53-0	P30 RELIEF VALVE WITH PM CONTROL VALVE	FLG. INLET, 3 NPT OUTLET	32
538-1040-54-0	P30F RELIEF VALVE WITH PM CONTROL VALVE	3 NPT INLET AND OUTLET	34
562-0080-50-0	PM CONTROL VALVE		10
538-1040-13-0	P30V RELIEF VALVE WITH PM CONTROL VALVE	3 VICTAULIC INLET AND OUTLET	30



# HALE TYPE P SERIES RELIEF VALVE WITH PM CONTROL VALVE

04-117	E	UPDATED LAMP ASSEMBLY	JGV	12-16-02	MAL	95-034	A	ADDED REVISION BLOCK	AJO	5-22-95	ROT
04-117	F	REPLACED SCREW/HANDLE ASSY. VALVE P/N	SNK	06-04-03	MAL	99-036	B	PLACED ON CAD & UPDATED	JBS	9-26-99	RET
0608	G	UPDATED HANDWHEEL ASSY	KSM	09-28-07	MAL	00-657	C	UPDATED DRAWING	DJK	10-24-00	MAL
						01-173	D	UPDATED PART REQUIREMENTS	DJK	4-02-01	MAL
ECD NO	REV	CHANGED FROM	BY	DATE	APVD	ECD NO	REV	CHANGED FROM	BY	DATE	APVD



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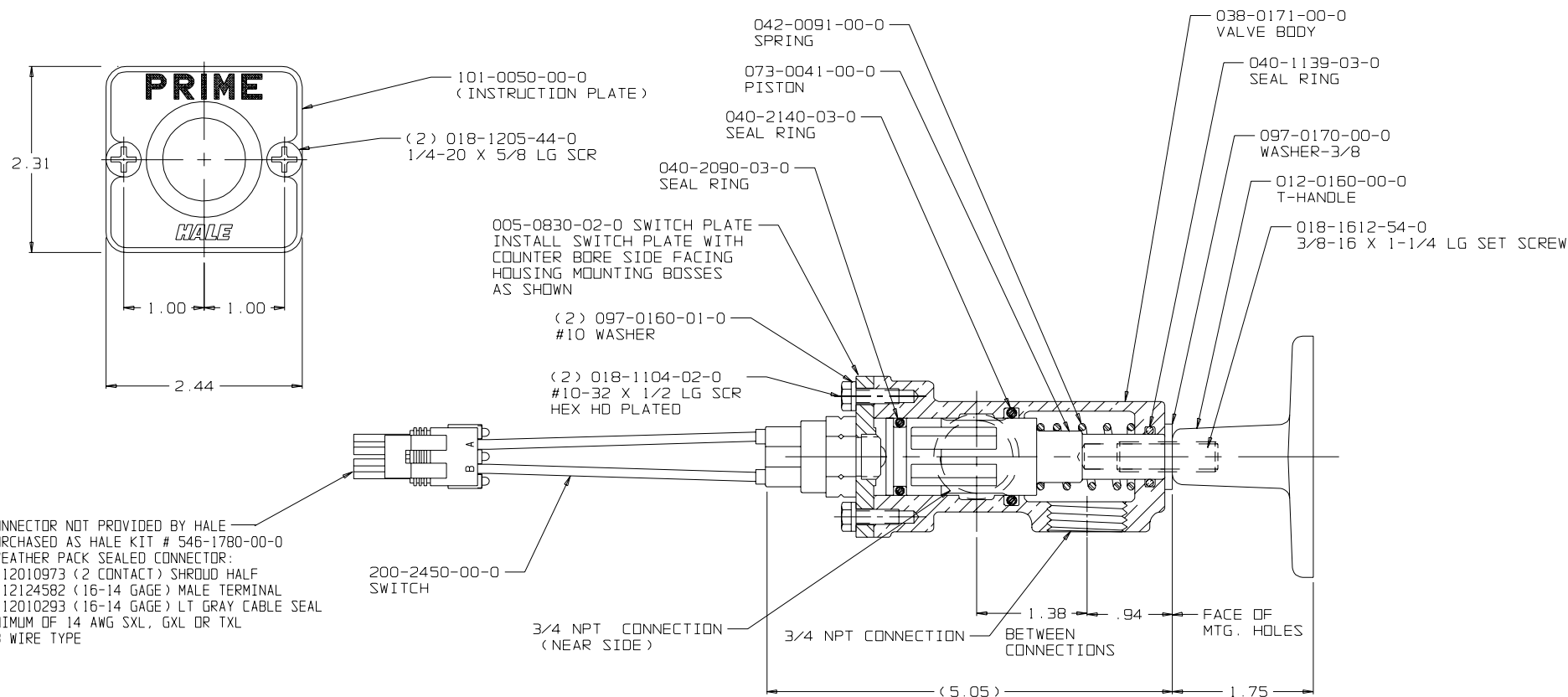
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## Notes

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# HALE TYPE PVG PRIMING VALVE



## PANEL CUTOUT

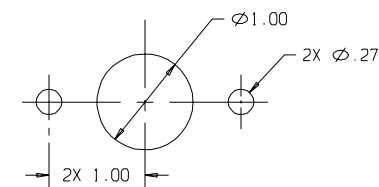


PLATE NO. 480GC

ECD NO	REV	CHANGED FROM	BY	DATE	APVD
01-035	A	REDESIGNED PLATE NO. 480FA	TKC	1-19-01	MAL
01-091	B	CLARIFIED SWITCH PLATE ORIENTATION	DJK	02-20-01	MAL
03-277	C	ADDED PANEL CUTOUT	JBS	09-03-03	MAL



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CHECKED

TKC  
MAL

DATE 10-6-00

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SCALE: FULL

## Notes

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# HALE TYPE QLF TRANSFER VALVE

## (MANUAL OPERATION)

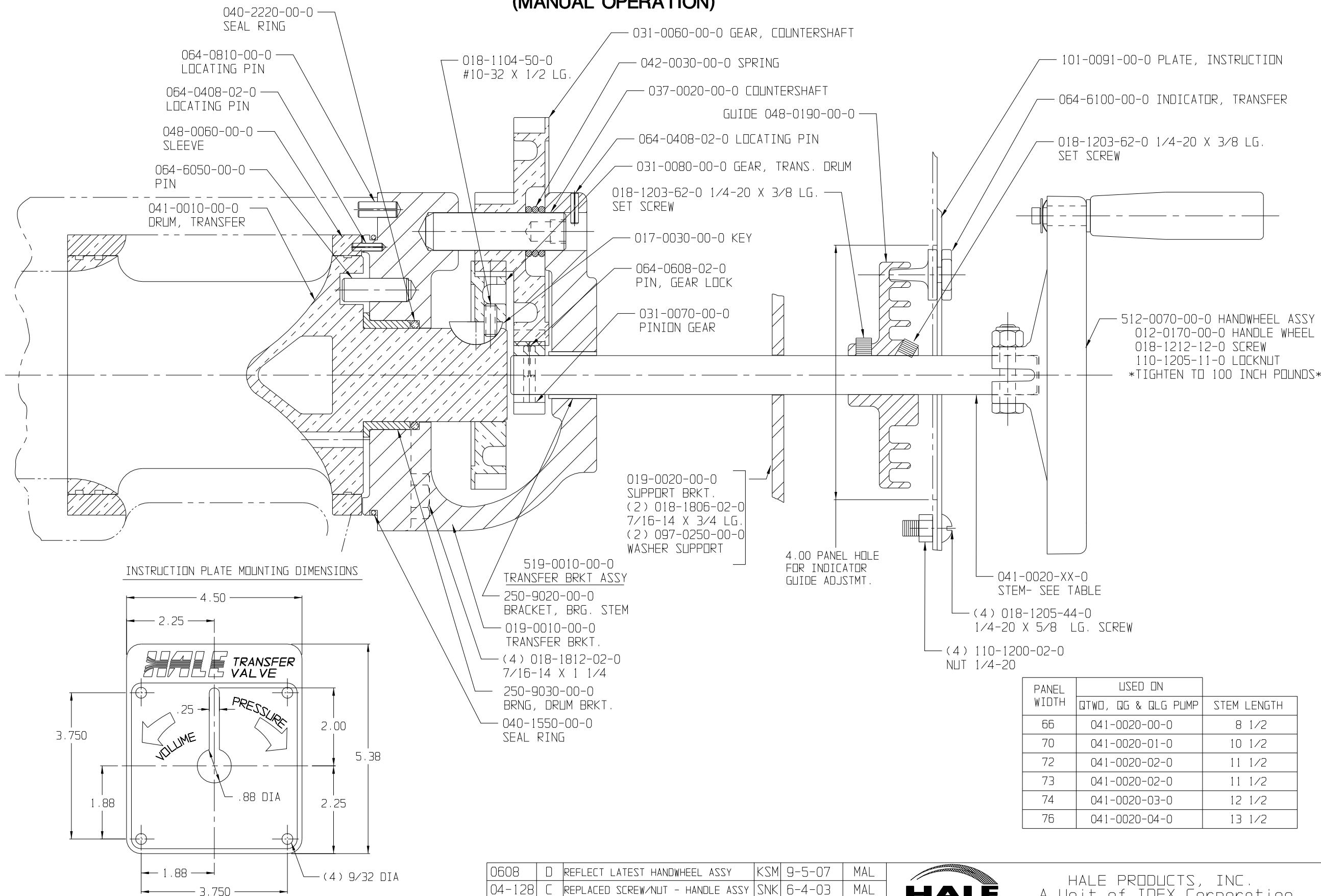


PLATE NO. 472ED

0608	D	REFLECT LATEST HANDWHEEL ASSY	KSM	9-5-07	MAL
04-128	C	REPLACED SCREW/NUT - HANDLE ASSY	SNK	6-4-03	MAL
01-158	B	UPDATED DRAWING W/DESCRIPTIONS	TKC	3-28-01	MAL
99-121	A	REDRAWN ON CAD - UPDATED	DPL	6-15-99	RET
ECO NO	REV	CHANGED FROM	BY	DATE	APVD



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DRAWN  
CHECKED

JDR  
MO

DATE 1-5-94

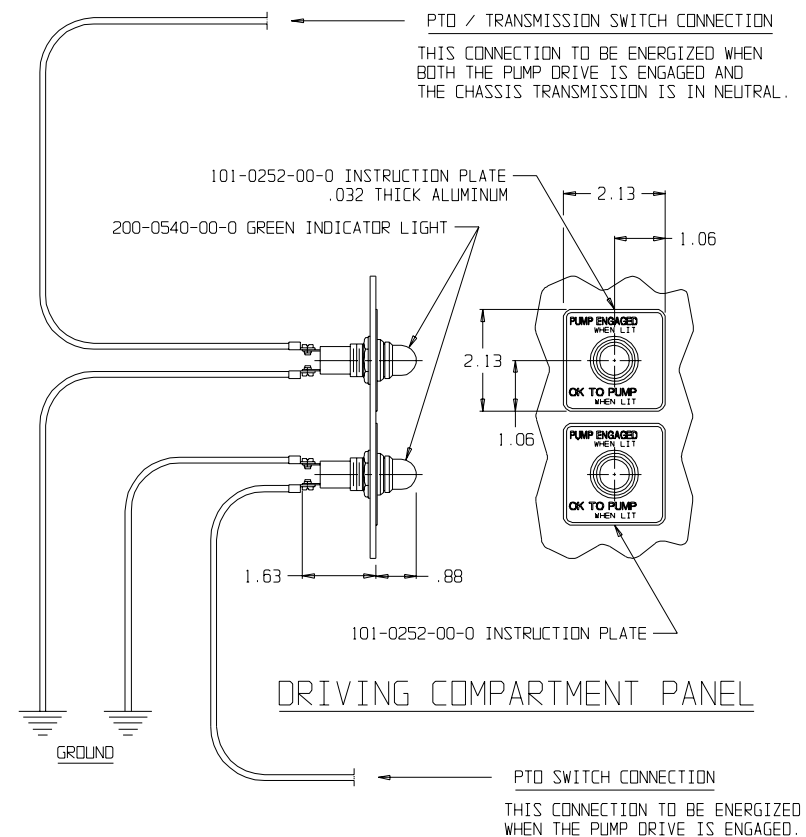
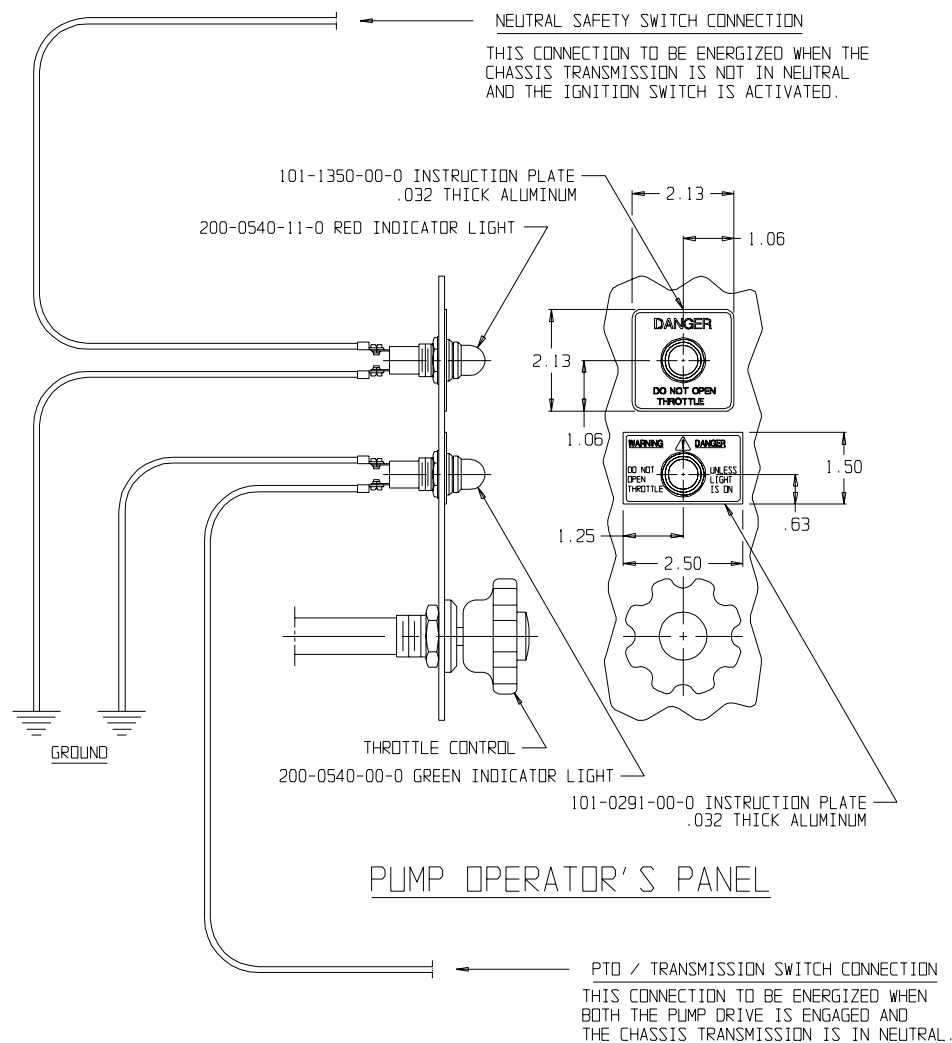
SIZE  
C

SCALE: FULL

## Notes

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.





#### NOTES:

- 1) SWITCHES: NOT SUPPLIED BY HALE.
- 2) INDICATOR LIGHTS: THE STANDARD HALE 200-0540-00-0 (GREEN) AND 200-0540-11-0 (RED) INDICATOR LIGHT ASSEMBLIES ARE RETAINED WITH A HEX NUT AND INTERNAL STAR WASHER. BOTH THE LENS AND THE PANEL FLANGE HAVE SEALING RINGS TO MAKE THE LIGHT ASSEMBLY LIQUID TIGHT TO FRONT OF PANEL. MOUNTING HOLE DIAMETER IS 11/16. THE MAXIMUM PANEL THICKNESS IS 3/16 (WHEN USED WITH .062 THICK INSTRUCTION PLATES). STANDARD BULB IS FOR 12 VOLT DC SERVICE. LIGHT ELECTRICAL TERMINALS ARE SCREW TYPE. NOTE REFERENCE DIMENSIONS.
- 3) INSTRUCTION PLATES: THE RECOMMENDED HALE INSTRUCTION PLATES FOR TYPICAL POWER TAKE-OFF DRIVEN PUMP INDICATOR LIGHT INSTALLATIONS ARE ILLUSTRATED. DIMENSIONS SHOWN ARE FOR REFERENCE ONLY.
- 4) SYSTEM DESIGN AND WIRING: SELECTION AND INSTALLATION OF WIRING AND ELECTRICAL COMPONENTS IS NOT THE RESPONSIBILITY OF HALE. SYSTEM DESIGN AND INSTALLATION MUST BE DONE BY PROPERLY QUALIFIED PERSONS. CIRCUIT PROTECTION (FUSES, CIRCUIT BREAKERS, ETC.) IS NOT THE RESPONSIBILITY OF HALE.



**WARNING** ALL WIRING AND INSTALLATION DETAILS MUST CONFORM TO ALL APPLICABLE NFPA AND SAE STANDARDS.

VERIFY OPERATION OF PUMP ENGAGED INDICATOR LIGHTS AND INTERLOCKS BEFORE PLACING APPARATUS IN SERVICE

## WIRING SCHEMATIC FOR SHIFT INDICATOR LIGHTS

### POWER TAKE-OFF DRIVEN PUMPS

PLATE NO. 825AA

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
95-39	A	RELEASED FOR PRODUCTION WAS SHEET 2 OF PLATE 746AA	AJD	5-17-95	ROT

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CHECKED

AJD  
ROT

DATE: 5-17-95  
SIZE: C  
SCALE: HALF

## Notes

[illegible]

THE DUAL SHIFT INDICATOR SWITCH ARRANGEMENT SHOWN HERE PROVIDES TWO INDEPENDENT SWITCHES.

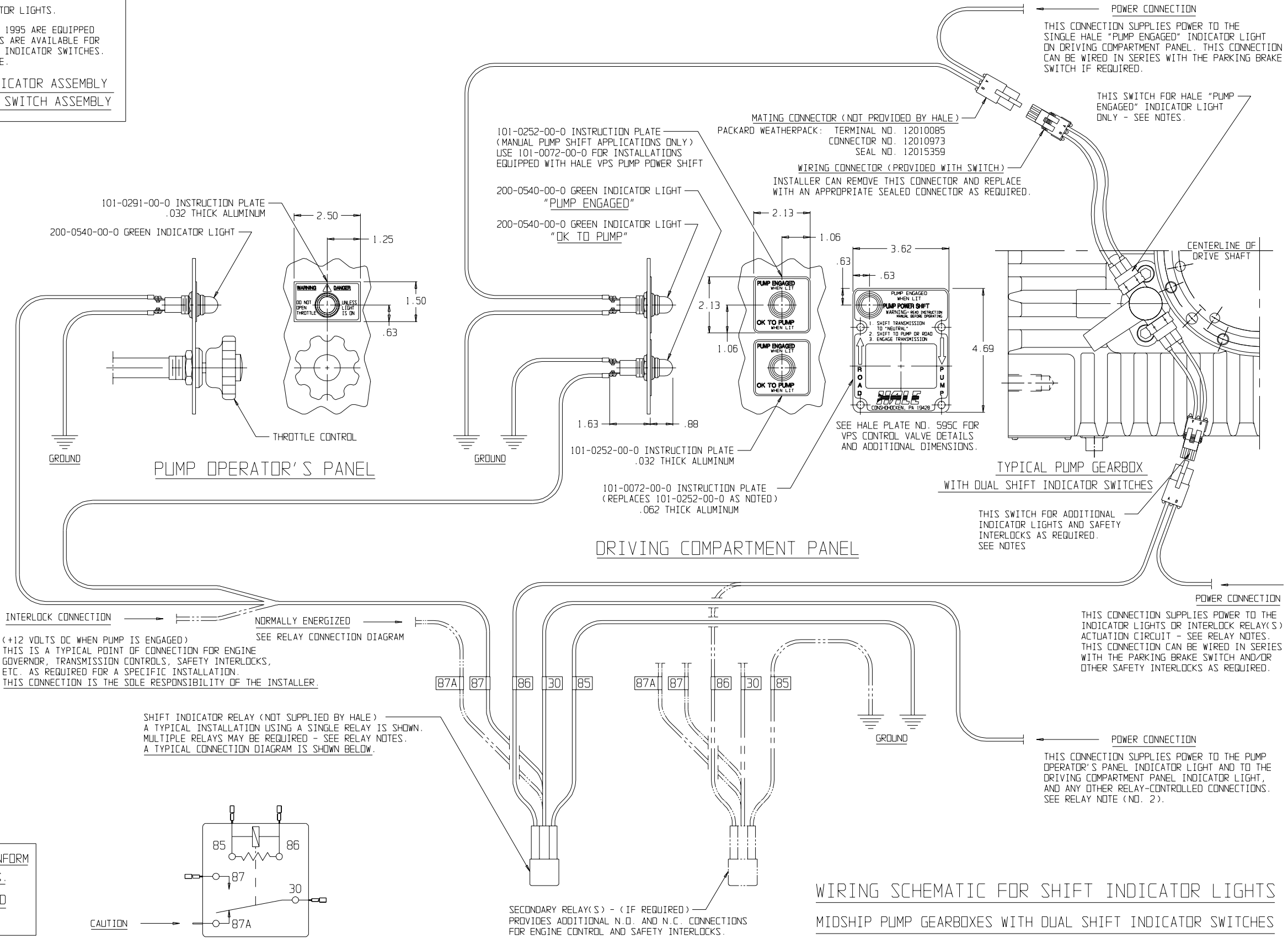
THE LOWER SWITCH IS FOR VEHICLE OEM PROVIDED INTERLOCKS (I.E. PARKING BRAKE, TRANSMISSION, ENGINE CONTROLS, AS APPLICABLE). THIS SWITCH SHOULD BE USED WITH A RELAY AS NOTED.

THE UPPER SWITCH IS FOR USE ONLY WITH THE HALE-PROVIDED PUMP SHIFT INDICATOR LIGHTS.

ALL STANDARD HALE SPLIT SHAFT PUMP TRANSMISSIONS MANUFACTURED AFTER APRIL 1995 ARE EQUIPPED WITH DUAL SHIFT INDICATOR SWITCHES. DUAL SHIFT INDICATOR SWITCH COMPONENTS ARE AVAILABLE FOR RETROFIT ON MOST HALE GEARBOXES ORIGINALLY MANUFACTURED WITH SINGLE SHIFT INDICATOR SWITCHES. FOR PARTS AND RETROFIT INFORMATION PLEASE CONSULT YOUR HALE REPRESENTATIVE.

SEE HALE PLATE NO. 827A "MIDSHIP PUMP GEARBOX SHIFT INDICATOR ASSEMBLY WITH DUAL SWITCHES" FOR DETAILS OF THE SHIFT INDICATOR SWITCH ASSEMBLY

- NOTES:
- 1) SWITCHES: THE STANDARD HALE 200-2450-00-0 SHIFT INDICATOR SWITCH HAS A MAXIMUM LOAD LIMIT OF 4 AMPS AT 12 VOLTS DC. THESE SWITCHES ARE ADEQUATE FOR OPERATING THE THREE STANDARD PUMP SHIFT INDICATOR LIGHTS SHOWN. IF ADDITIONAL CONNECTIONS ARE TO BE MADE, USE ONE OR MORE RELAYS IN CIRCUIT AS REQUIRED. DO NOT WIRE RELAYS IN SERIES WITH INDICATOR LIGHTS OR WITH EACH OTHER. INDICATOR LIGHTS SHOULD BE WIRED THROUGH RELAY(S) AS SHOWN TO CONFIRM ENERGIZING OF INTERLOCK CIRCUITS.
  - 2) RELAYS: A SINGLE POTTER-BRUMFIELD VF4-1511 AUTOMOTIVE SPDT RELAY (FORM C) WILL NORMALLY BE ADEQUATE FOR MOST INSTALLATIONS. THIS RELAY IS RATED FOR 40 AMPS AT 12 VOLTS DC. IF MULTIPLE RELAYS ARE REQUIRED, USE MULTIPLE POTTER-BRUMFIELD VF4-1511-SD1 WITH SUPPRESSED COIL. THE RELAYS NOTED MEASURE APPROXIMATELY 1.09 SQUARE X 1.00 LONG (PLUS LENGTH OF TERMINALS). A POTTER-BRUMFIELD VCF4-1000 WIRING HARNESS CONNECTOR CAN BE USED AS ILLUSTRATED. (CONNECTOR BODY ONLY; FEMALE SPADE TERMINALS NOT INCLUDED WITH CONNECTOR). A VARIETY OF OTHER MOUNTING OPTIONS ARE AVAILABLE, INCLUDING TERMINAL BLOCKS. THIS RELAY IS NOT SUPPLIED BY HALE, AND IS NOTED FOR REFERENCE ONLY. RELAY SELECTION, MOUNTING, AND WIRING WILL VARY FOR EACH APPLICATION, AND IS THE RESPONSIBILITY OF THE INSTALLER.
  - 3) INDICATOR LIGHTS: THE STANDARD HALE 200-0540-00-0 GREEN INDICATOR LIGHT ASSEMBLY IS RETAINED WITH A HEX NUT AND INTERNAL STAR WASHER. BOTH THE LENS AND PANEL FLANGE HAVE SEALING RINGS TO MAKE LIGHT LIQUID TIGHT TO FRONT OF PANEL. MOUNTING HOLE DIAMETER IS 11/16. MAXIMUM PANEL THICKNESS IS 3/16 (WHEN USED WITH .062 THICK INSTRUCTION PLATE). STANDARD BULB IS FOR 12 VOLT DC SERVICE. LIGHT ELECTRICAL TERMINALS ARE SCREW TYPE. NOTE REFERENCE DIMENSIONS.
  - 4) INSTRUCTION PLATES: THE RECOMMENDED HALE INSTRUCTION PLATES FOR TYPICAL PUMP SHIFT INDICATOR LAMP INSTALLATIONS ARE ILLUSTRATED. DIMENSIONS SHOWN ARE FOR REFERENCE ONLY.
  - 5) SYSTEM DESIGN AND WIRING: SELECTION AND INSTALLATION OF WIRING AND ELECTRICAL COMPONENTS IS NOT THE RESPONSIBILITY OF HALE. SYSTEM DESIGN AND INSTALLATION MUST BE DONE BY PROPERLY QUALIFIED PERSONS. CIRCUIT PROTECTION (FUSES, CIRCUIT BREAKERS, ETC.) IS NOT THE RESPONSIBILITY OF HALE PRODUCTS.
  - 6) ALL ELECTRICAL RATINGS GIVEN ARE FOR 12 VOLT DC NEGATIVE GROUND SYSTEMS. FOR OTHER APPLICATIONS, CONSULT YOUR HALE REPRESENTATIVE.
  - 7) IF AN AUTOMATIC CHASSIS TRANSMISSION IS USED, ALL THREE INSTRUCTION PLATES AND LIGHTS MUST BE INSTALLED. IF A MANUAL CHASSIS TRANSMISSION IS USED THE DRIVING COMPARTMENT "PUMP ENGAGED" INSTRUCTION PLATE AND LIGHT MUST BE INSTALLED. INSTALLER IS RESPONSIBLE FOR CONFORMANCE WITH ALL APPLICABLE NFPA AND SAE STANDARDS.



**WARNING** ALL WIRING AND INSTALLATION DETAILS MUST CONFORM TO ALL APPLICABLE NFPA AND SAE STANDARDS. VERIFY OPERATION OF PUMP ENGAGED INDICATOR LIGHTS AND INTERLOCKS BEFORE PLACING APPARATUS IN SERVICE

PLATE NO. 746AB

ECD NO	REV	CHANGED FROM	BY	DATE	APVD				
95-39	A	RELEASED FOR PRODUCTION SHEET 2 IS NOW PLATE 825AA	AJD	5-10-95	ROD				
99-101	B	GEARSHIFT SHAFT CAP CONFIG. CHANGE	JBS	5-11-99	RET				

HALE

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## Notes

[illegible]

MOST HALE GEARBOXES ARE SHIPPED WITH A PLASTIC CAP  
INSTALLED OVER THE SPEED COUNTER DRIVE ADAPTER.  
THIS CAP IS INTENDED ONLY TO PROTECT THE THREADS AND  
KEEP THE SPEED COUNTER DRIVEN GEAR IN PLACE DURING  
SHIPMENT, HANDLING, AND PAINTING. IF THE GEARBOX WILL  
BE PLACED IN SERVICE WITHOUT THE SPEED COUNTER CABLE  
INSTALL A HALE 008-0070-00-0 DUST CAP AND 046-1620-00-0  
GASKET ON THE SPEED COUNTER DRIVE ADAPTER.  
THE SPEED COUNTER DRIVEN GEAR CAN REMAIN IN PLACE  
IF SPEED COUNTER WILL BE RECONNECTED IN THE FUTURE.  
REMOVE DRIVEN GEAR AND REPLACE DRIVE ADAPTER WITH PLUG  
217-3007-00-0 IF SPEED COUNTER IS BEING DELETED

SAE REGULAR DRIVE CONNECTION  
.205 - .201 ROUND DRIVE - 7/8-18 THREAD

007-0040-00-0 - SPEED COUNTER DRIVE ADAPTER  
REPLACED WITH PLUG 217-3007-00-0 (NOT SHOWN)  
WHEN SPEED COUNTER OPTION IS NOT ORDERED

031-0170-00-0 - SPEED COUNTER DRIVEN GEAR

NOT SHOWN  
SPEED COUNTER DRIVEN GEAR  
BUSHING - 048-0070-00-0  
SUPPORTS END OF DRIVEN GEAR  
IN FRONT BEARING CAP

STANDARD SLIDING GEAR SHAFT  
MOST SLIDING GEAR SHAFTS WILL HAVE  
SPIRAL GEAR FOR SPEED COUNTER OPTION

STANDARD FRONT BEARING CAP

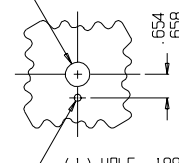
013-0010-00-0 - FLEXIBLE SHAFT ASSEMBLY  
54.00 (FLEXIBLE SHAFT CASE LENGTH  
55.56 (FLEXIBLE SHAFT CORE LENGTH  
WITH END CONNECTIONS AS NOTED

SAE LIGHT DUTY DRIVE CONNECTION  
.104 - .101 SQUARE DRIVE - 5/8-18 THREAD

048-0090-00-0 - DRIVE SLEEVE  
PROVIDES TAKE-OFF POINT FOR  
USE WITH HAND-HELD TACHOMETER

DUST CAP (SUPPLIED WITH DRIVE SLEEVE)  
AVAILABLE SEPARATELY AS 008-0070-00-0

(1) HOLE .688 DIAMETER



HOLE SIZES FOR PANEL MOUNTING

MOUNTING HARDWARE (PROVIDED BY INSTALLER AS REQUIRED)  
NO. 10-24NC X 3/4 ROUND HEAD MACHINE SCREW WITH SELF  
LOCKING NUT AND FLAT WASHER SHOWN FOR ILLUSTRATION.

MULTIPLY THE MEASURED SPEED AT THE TAKE-OFF  
POINT BY 10 FOR THE ACTUAL GEARBOX INPUT SPEED

SUPPORTED AND PROTECTED FROM DAMAGE.

AVOID KINKS AND SHARP BENDS.

FLEXIBLE SHAFT ASSEMBLY IS SUPPLIED PRELUBRICATED  
AND READY FOR INSTALLATION. CABLE CAN BE RELUBRICATED  
IF DESIRED OR WHENEVER THE VEHICLE SPEEDOMETER AND/OR  
TACHOMETER CABLES ARE SERVICED. USE NLGI NO.2 GENERAL  
PURPOSE GREASE, OR SPEEDOMETER CABLE LUBRICANT AS  
REQUIRED BY THE CHASSIS MANUFACTURER AND CLIMATE.

KEEP DUST CAP AND ALL CONNECTIONS TIGHT. LIGHTLY  
GREASE ALL THREADS AND OUTSIDE OF SHAFT ASSEMBLY  
TO MINIMIZE CORROSION AND PREVENT WATER FROM  
ENTERING FLEXIBLE SHAFT ASSEMBLY OR GEARBOX.

TYPICAL HALE MIDSHIP SPLIT-SHAFT GEARBOX SHOWN

FOR HALE GEARBOXES WHERE POWER TAKE-OFF DRIVE IS  
USED INSTEAD OF THE SPLIT-SHAFT ARRANGEMENT, AN  
ADAPTER GEARBOX MAY BE REQUIRED TO CORRECT FOR  
THE POWER TAKE-OFF RATIO IF OTHER THAN 1:1

## INSTALLATION DETAILS AND PARTS LIST

### OPTIONAL HALE SPEED COUNTER ASSEMBLY

SHOWN INSTALLED ON TYPICAL HALE GEARBOX

ECD NO	REV	CHANGED FROM	BY	DATE	APVD
99-131	A	RELEASED FOR PRODUCTION	AJD	5-18-99	RET

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## Notes

[illegible]

538-1580-10-0

# HALE TYPE SPV SEMI-AUTOMATIC PRIMING VALVE ( WITH UNIVERSAL MOUNTING ADAPTER )

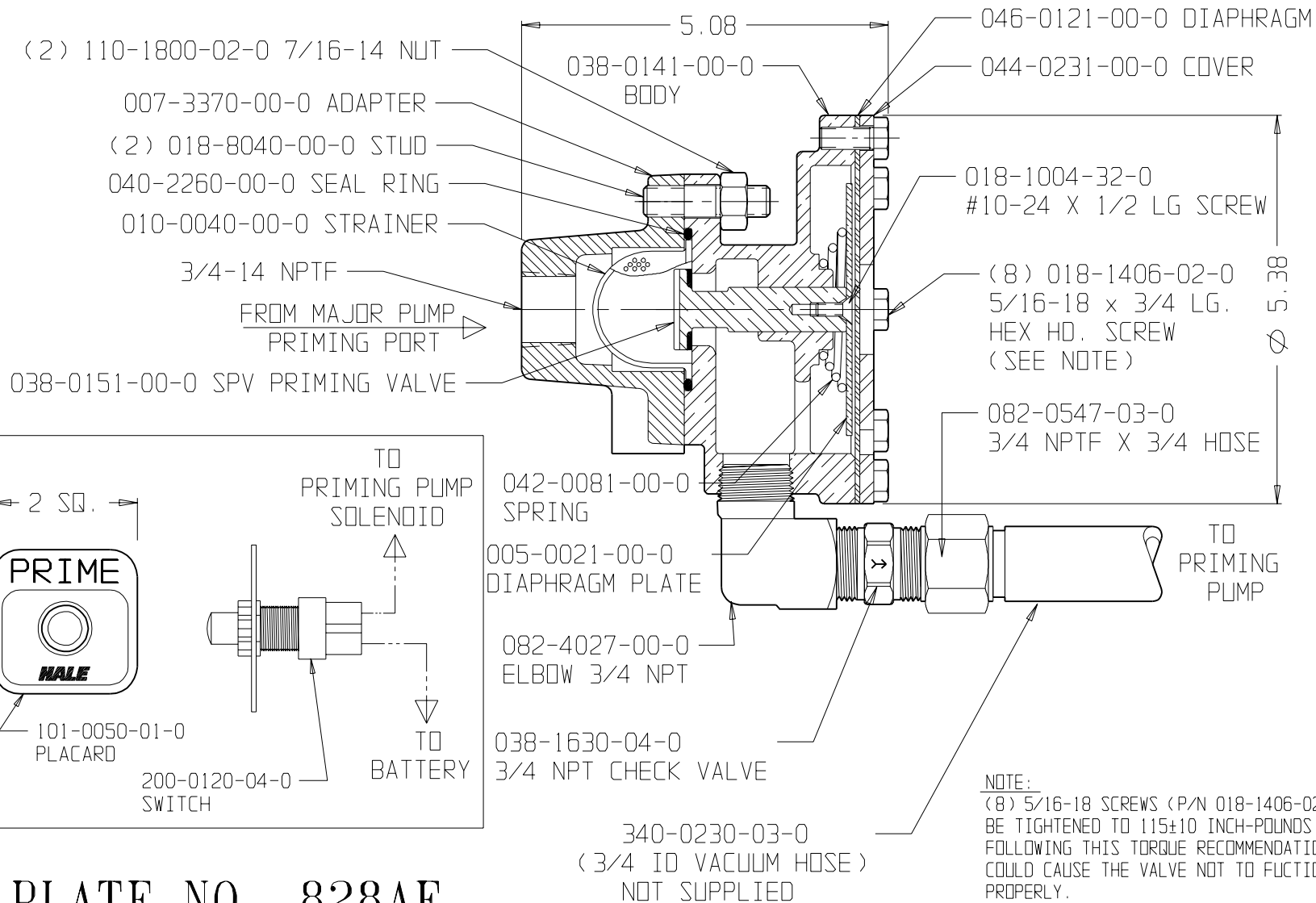


PLATE NO. 828AE

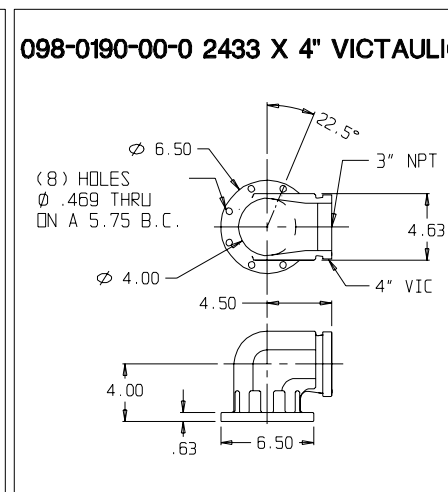
ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD	HALE PRODUCTS, INC. A Unit of IDEX Corporation Conshohocken, PA 19428 USA	
01-177	E	UPDATED W/DESCRIPTIONS	TKC	4-5-01	MAL	95-169	A	RELEASED FOR PRODUCTION	DLM	8-15-95	RET		
						96-63	B	B1. ADDED; B2. 082-4027-01-0; B3. 340-0640-00-1	PRW	3-29-96	RET	COPYRIGHT © NOT TO BE REPRODUCED OR USED TO MAKE OTHER DRAWINGS OR MACHINERY	
						00-525	C	DELETED 038-1630-03-0, 082-0501-02-0 & 082-0547-02-0 ADDED 038-1630-04-0 & 082-0547-03-0	JBS	07-14-00	MAL		
						00-602	D	ADDED NOTE	JBS	09-20-00	MAL	DATE 8-15-95	SIZE C SCALE: FULL


## Notes

[illegible]



**PLATE NO. 831AF**



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DATE 10-24-95		SIZE SCALE : NTS	

## Notes

[illegible]

TEST PROCEDURE:

1. CLOSE ALL DISCHARGE VALVES INCLUDING PUMP AND ENGINE COOLERS SO THERE IS NO FLOW THROUGH THE PUMP.

2. USE CARE THAT ENGINE DOES NOT OVERHEAT, SET THE PUMP DISCHARGE PRESSURE TO ONE OF THE PRESSURES LISTED.
3. THE THERMAL RELIEF VALVE SHOULD DISCHARGE WATER THROUGH THE 1/8 NPT OR ISO DISCHARGE LINE WITHIN THE TIME SPECIFIED.

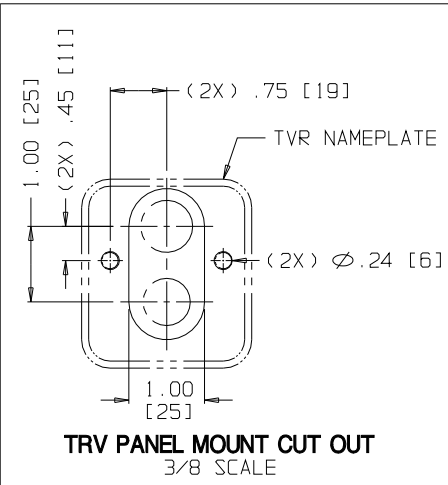
4. THE TABLE IS FOR MIDSHIP TYPE PUMPS. THE THERMAL RELIEF VALVE WILL OPEN FASTER ON SMALLER PUMPS.

5. THE TABLE IS BASED ON 70°F(21°C) WATER AND 70°F(21°C) AIR TEMPERATURE. THE THERMAL RELIEF VALVE WILL OPEN FASTER IN HOTTER CONDITIONS AND SLOWER IN COOLER CONDITIONS. UNITS EQUIPPED W/TRV-L KIT WILL FLOW UP TO 1-2 GPM OF WATER BEFORE LAMP TURNS ON.

PRESSURE	TIME IN MINUTES	
	TRV120/TRVM120/ TRVF120	TRV170/TRVM170/ TRVF170
200 PSIG(13.8 BAR)	10	20
400 PSIG(27.6 BAR)	4	8
600 PSIG(41.4 BAR)	2	4

018-1607-58-0 ADJUSTING SCREW. THIS SCREW IS PRESET AND LOCKED IN PLACE. IF A PART OF THE RELIEF VALVE IS REPLACED, IT MAY NEED READJUSTMENT. ATTACH A WATER SUPPLY OF 30-60 PSIG (2-4 BARS) TO THE 1/8 NPT OR ISO HOLE. APPLY A THREAD SEALING ADHESIVE TO THE THREADS AND TURN SCREW CLOCKWISE UNTIL INCOMING WATER PASSES THRU HOLE "X" AND STARTS TO FLOW OUT OF THE STRAINER. AT THIS POINT, TURN THE ADJUSTING SCREW COUNTERCLOCKWISE 2-1/2 TURNS SO THE FLOW STOPS AND THE PISTON IS POSITIONED.

1/8 N.P.T. OR ISO 228/1-G 1/8 CONNECTION FOR RELIEF VALVE DISCHARGE LINE. USE 3/8 (10) TUBING TO ATMOSPHERE OR RETURN LINE TO THE TRUCK TANK. A DRAIN VALVE MUST BE PROVIDED IN THIS LINE TO DRAIN IN FREEZING WEATHER. IF THE VALVE IS MOUNTED HORIZONTAL, THIS CONNECTION SHOULD BE IN A DOWNWARD POSITION TO AID IN DRAINING OF THE TUBING LINE.



082-4032-02-0 1/8 MNPT X 1/8 FBSP SUPPLIED WITH TRVM ONLY. FITTING IS HAND TIGHTENED FROM MANUFACTURER OEM. MUST USE LOCTITE PST OR EQUAL AND TIGHTEN.

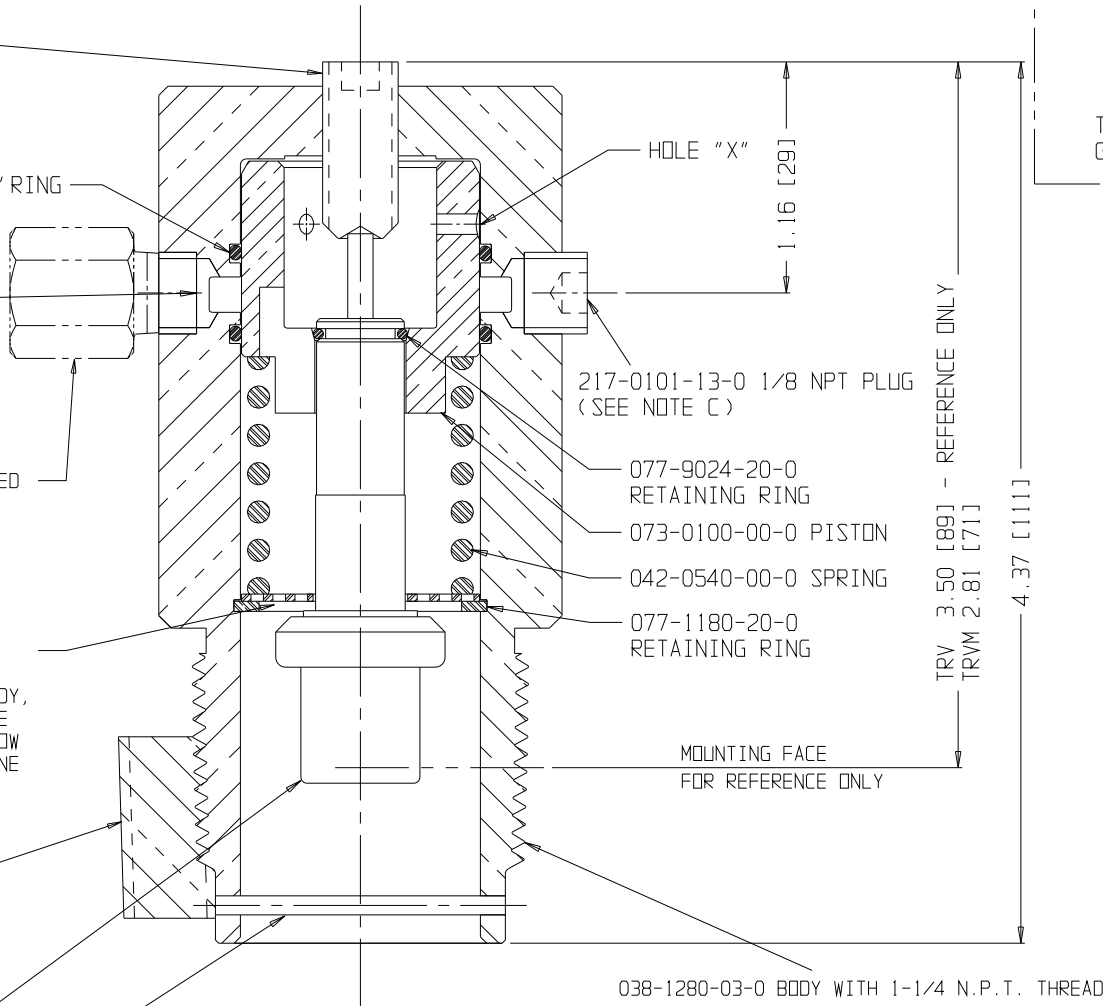
010-0580-00-0 INLET STRAINER. CHECK FOR BLOCKAGE ONCE A YEAR OR MORE FREQUENTLY IF PUMPING WATER WITH IMPURITIES. THE BODY, PISTON & O-RINGS, AT THIS TIME, SHOULD BE CLEANED, INSPECTED AND LUBRICATED WITH DOW 55M SILICONE GREASE OR EQUIVALENT SILICONE GREASE.

082-4032-02-0 2" MALE BSPT ADAPTER FOR TRVM ONLY. FITTING IS HAND TIGHTENED FROM MANUFACTURER OEM. MUST USE LOCTITE PST OR EQUAL AND TIGHTEN.

SENSING ELEMENT 038-1251-00-0 (120°F)[49°C]  
038-1251-01-0 (170°F)[77°C]

064-0322-02-0 SPRING PIN

INSTALL THIS END IN UPWARDS POSITION SO THE RELIEF VALVE DRAINS IN FREEZING WEATHER OR USE DRAIN AS NOTED.



038-1280-03-0 BODY WITH 1-1/4 N.P.T. THREAD. INSTALL ON PUMP DISCHARGE MANIFOLD. THE THERMAL RELIEF VALVE IS INSTALLED IN THE PUMP DISCHARGE PIPING, MOUNT CLOSE TO THE PUMP BODY OUTLET. APPLY LOCTITE PST OR EQUAL BEFORE ASSEMBLY.

OPTIONAL AUDIBLE ALARM

200-1310-00-0 12VDC ALARM OR  
200-1310-03-0 24VAC/VDC ALARM

TO CHASSIS GROUND

INSTALLER SUPPLIED WIRING FOR AUDIBLE ALARM OPTION ONLY. (14 GA. SXL OR GXL SAE J1128)

200-0540-16-0 LIGHT INDICATOR BODY  
200-0540-02-0 BULB  
200-0540-13-0 RED LENS

POWER CONNECTION THRU 10 AMP 12V FUSE

200-0120-04-0 STARTER SWITCH

101-1720-00-0 TRV-L NAMEPLATE

513-0360-01-0 WIRE HARNESS

TRV-L KIT  
3/8 SCALE

TO CHASSIS GROUND  
INSTALLER SUPPLIED WIRE (14 GA. SXL OR GXL SAE J1128)

200-2560-00-0 PRESSURE SWITCH

082-0145-02-0 ELBOW

082-0146-02-0 FITTING  
REMOVE 1/8 N.P.T. PLUG

2.75 [70]

CONNECTION FOR RELIEF VALVE DISCHARGE LINE

5.75 MIN. [114] CLEARANCE FOR CURVED WIRES

NOTE:

- A. TRV-L KIT P/N: 200-2600-00-0 DOES NOT INCLUDE TRV.  
B. TRV-L KIT CAN ONLY BE USED ON TRV UNITS MANUFACTURED AFTER 2/1/97. TRVS MUST HAVE SECOND 1/8 N.P.T. TAP AS SHOWN.  
C. REMOVE 1/8 N.P.T. PLUG WHEN INSTALLING TRV-L KIT.

DIMENSIONS ARE IN INCHES.  
DIMENSIONS IN [ ] ARE MM.

MODEL

TEMPERATURE RATING

TRV120/TRVM120

120° F. [49° C]

TRV170/TRVM170

170° F. [77° C]

HALE TYPE TRV/TRVM THERMAL RELIEF VALVE

PLATE NO. 729AH

PATENT NO. 5,018,665

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
00-540	E	ADDED TRV WITH FLANGE (TRVF)	OK	07-31-00	MAL
04-106	F	ADDED 082-4032-02-0 REMOVED 038-1282-00-0 FLANGE	TC	5-16-04	MAL
0128	G	ADDED "200-1310-01-0 24VAC/VDC" NOTE	AB	7-1-05	MAL
0583	H	ADDED PANEL MOUNT CUT OUT VIEW	KSM	6-1-07	MAL



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DRAWN  
CHECKED

DJK  
MAL

DATE 7-31-00

SIZE  
9.5 X 13

SCALE: NTS

## Notes

[illegible]

## INSTRUCTION PLATE AND PANEL MOUNTING DETAILS

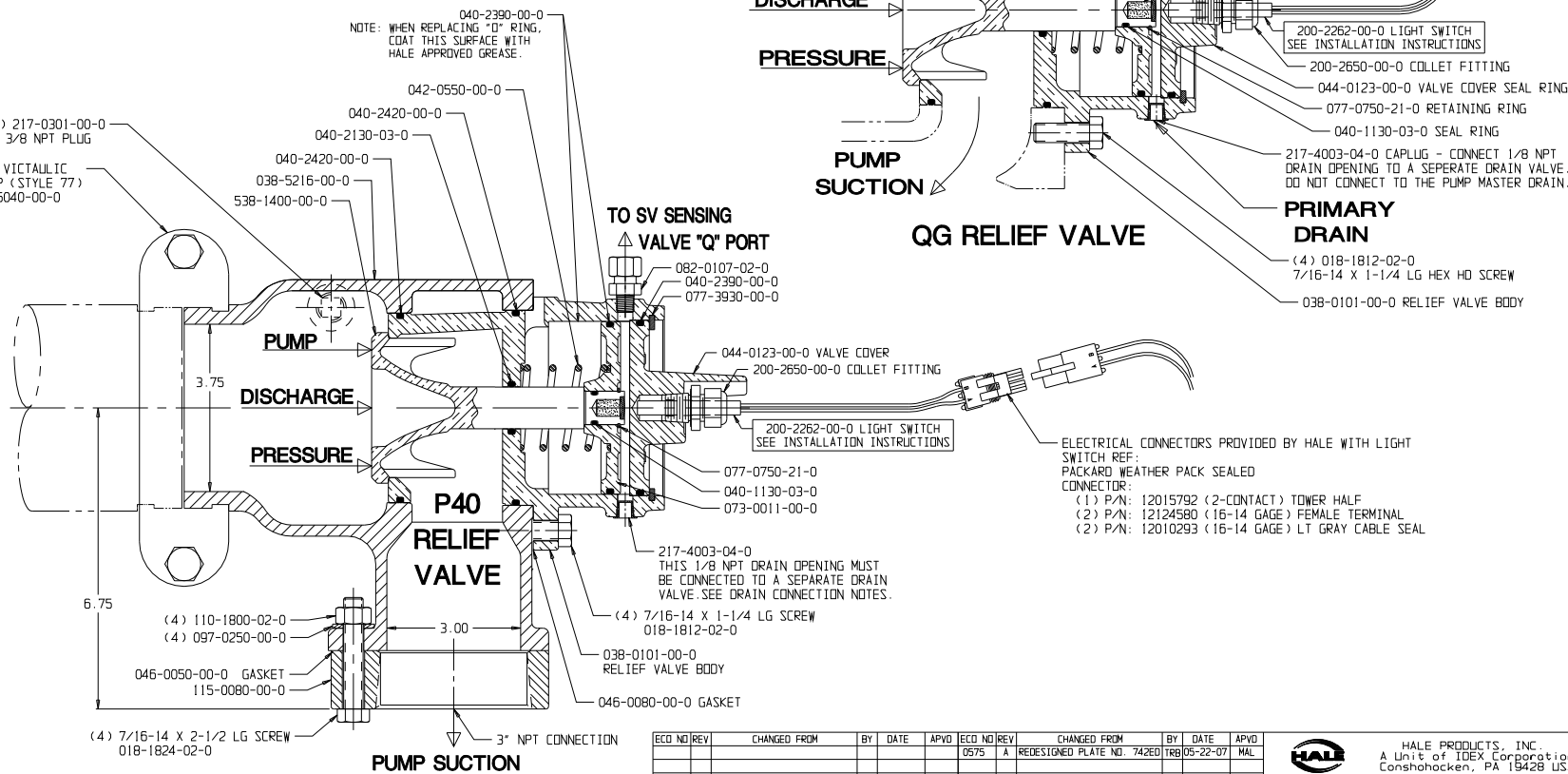
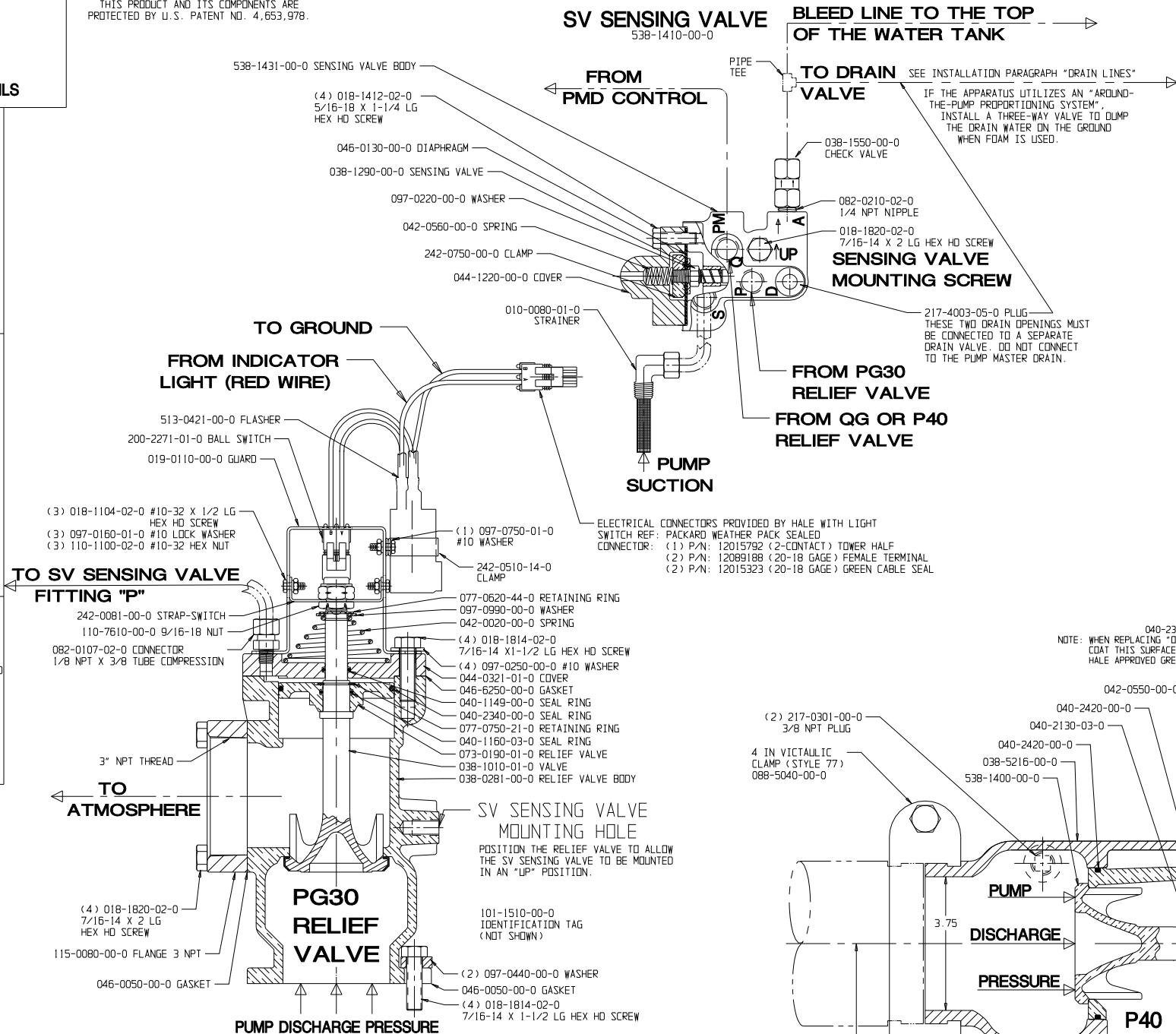
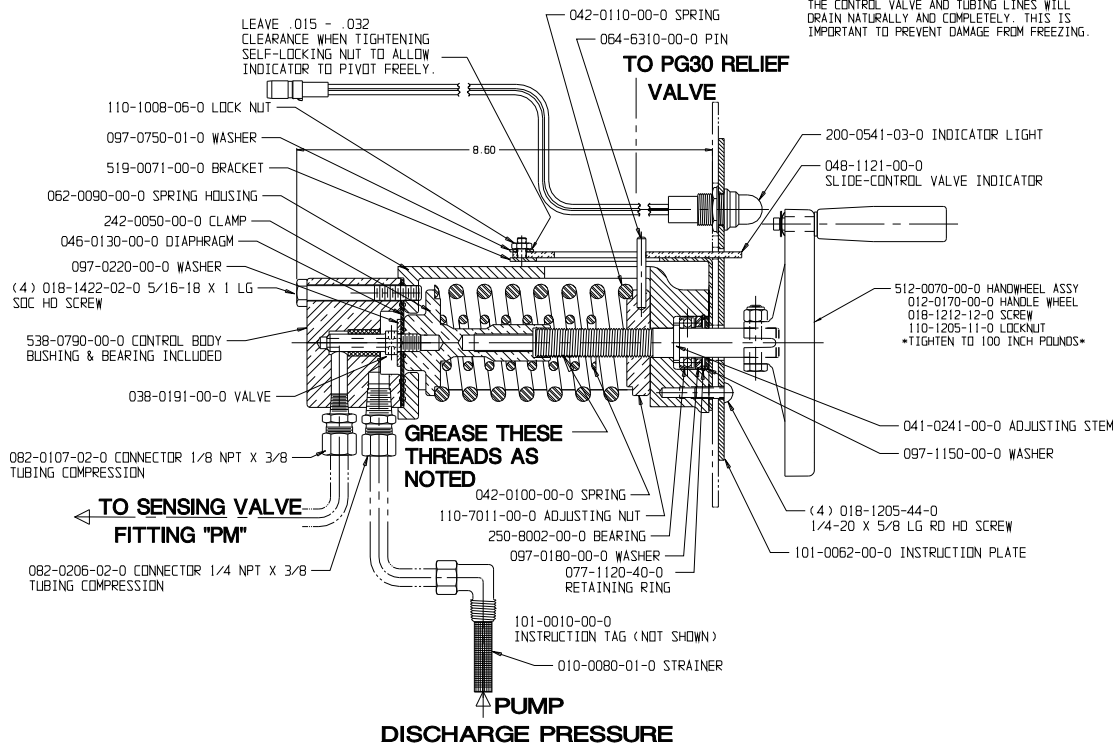
SOME RECOMMENDED LUBRICANTS INCLUDE:

OW CORNING BR2-PLUS	IMPERIAL NO. 777
FISKE - LUBRIPLATE NO. 3000	MOBIL - MOBILGREASE SPECIAL
SHELL SUPER DUTY GREASE	SUN OIL - SINOCD MOLY NO. 2EP

FOR WIRING AND TUBING  
CONNECTIONS SEE PL743


THIS PRODUCT AND ITS COMPONENTS ARE  
PROTECTED BY U.S. PATENT NO. 4,653,978.

INSTALL THE PMD CONTROL VALVE AT A LEVEL HIGHER THAN THE MAIN RELIEF VALVE SO THAT THE CONTROL VALVE AND TUBING LINES WILL DRAIN NATURALLY AND COMPLETELY. THIS IS IMPORTANT TO PREVENT DAMAGE FROM FREEZING.



**"PATENTED"**

PLATE NO. 742FA

ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD	 <b>HALE PRODUCTS, INC.</b> A Unit of IDEX Corporation Conshohocken, PA 19428 USA
						0575	A	REDESIGNED PLATE NO. 74262	TRB	05-22-07	MAL	

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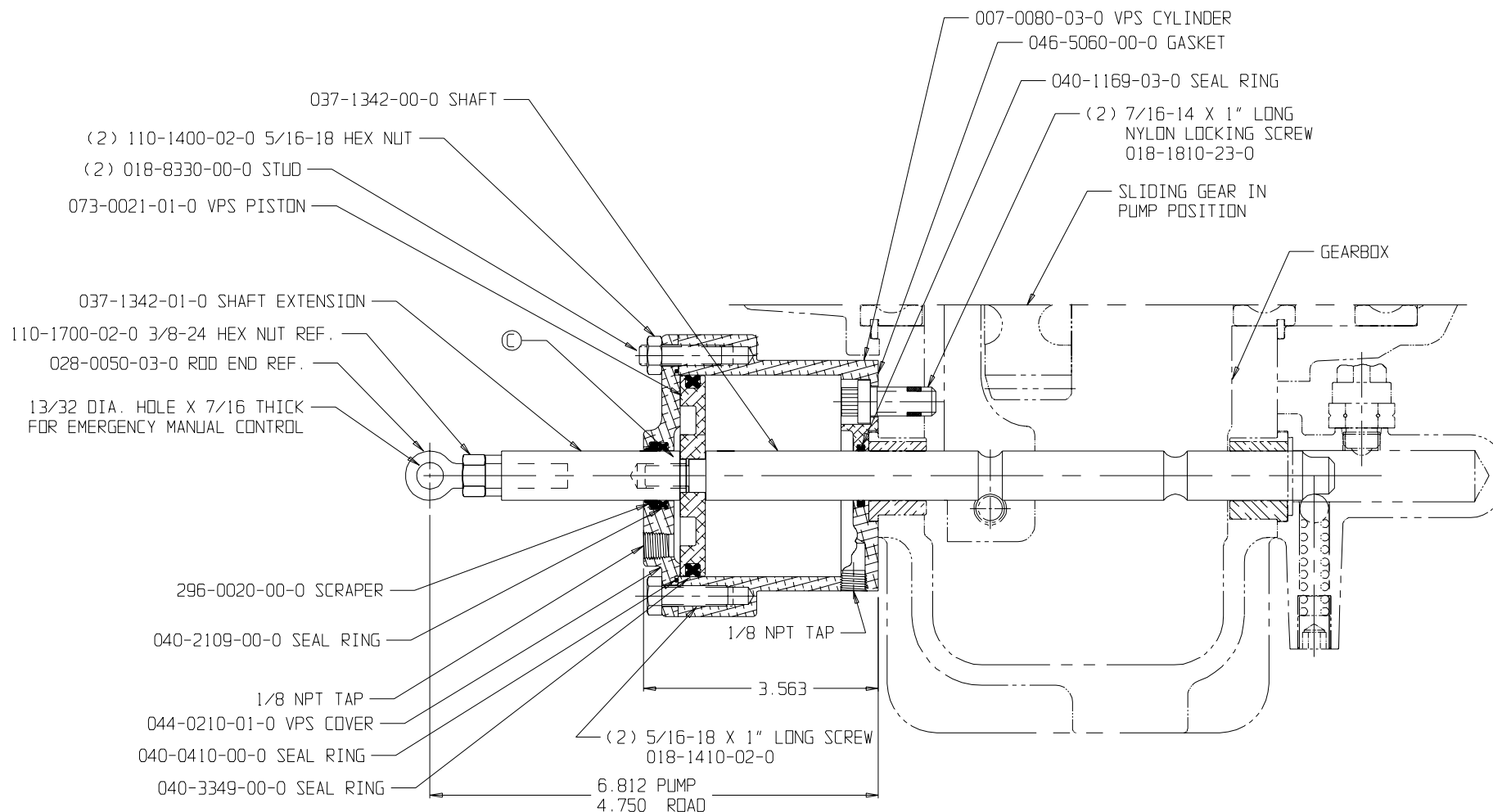
DRAWN BY: DATE: 3-19-95  
 SIZE: SCALE: FULL

## Notes

[illegible]

ASSEMBLY PART NUMBER	VPS POWER SHIFT FOR THE FOLLOWING PUMP MODELS
507-0110-03-0	QSMG, QSG, QMAX, QTWD, QFLO, QPAK, MG & 4DG

# HALE TYPE VPS POWER SHIFT



ECO NO	REV	CHANGED FROM	BY	DATE	APVD	ECO NO	REV	CHANGED FROM	BY	DATE	APVD
						03-085	A	REDESIGNED PLATE NO. 533CE	MD	3-26-03	MAL
						04-002	B	ADDED BEARINGS IN GEARBOX FOR REFERENCE	TKC	1-5-04	MAL
						05-070	C	ADDED SHAFT W-EXTRNL THRODS ADDED PISTON W/O O-RING GRV DELETED O-RING SEAL	BCJ	7-29-05	MAL



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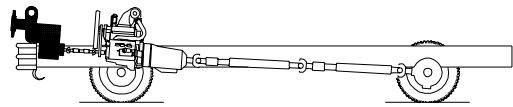
PLATE NO. 533DC

## Notes

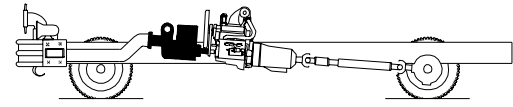
This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



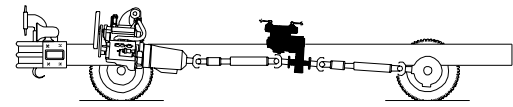
# HALE PRODUCTS VEHICLE MOUNTED PUMP APPLICATIONS



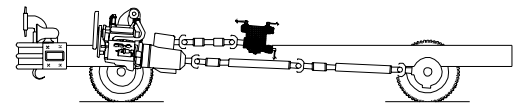
FRONT MOUNT



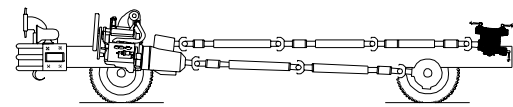
INTRA-CAB MOUNT



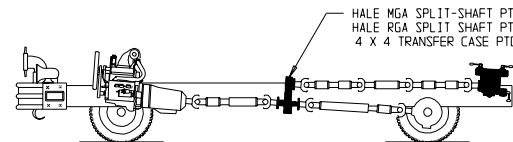
MIDSHIP SPLIT-SHAFT



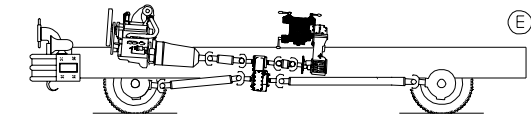
MIDSHIP PTO



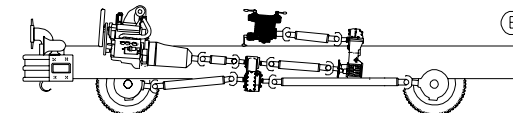
REAR MOUNT PTO



REAR MOUNT SPLIT-SHAFT



HALE MIDSHIP WITH  
4 X 4 TRANSFER CASE PTO



HALE MIDSHIP WITH LGA &  
4 X 4 TRANSFER CASE PTO

TABLE 1

	PUMP MODELS	GPM RANGE	STAGES	INTEGRAL MANIFOLD	GEAR BOX (SEE TABLE 2)
FRONT MOUNT	CSD	750-1500	SINGLE	NO	A
	HFM	750-1500	SINGLE	YES	A
INTRA-CAB MOUNT	CSD	750-1500	SINGLE	NO	A
MIDSHIP SPLIT-SHAFT	QSG	750-1250	SINGLE	YES	S,L,X
	QMAX	1000-2250	SINGLE	YES	S,L,R,X
	QFLO	750-1250	SINGLE	YES	L,X
	QPAK	500-1000	SINGLE	YES	L,X
	QTWO	1000-2000	TWO	YES	S,L,R,X
	DSD	750-1500	SINGLE	NO	L,R,X
	8FG	1500-3000	SINGLE	NO	L,X,R
MIDSHIP PTO	MG	500-1000	SINGLE	NO	MG
	PSD	750-1500	SINGLE	NO	A
	QPAKJ	500-1000	SINGLE	YES	J
	QFLOA	750-1250	SINGLE	YES	A
	MG	500-1000	SINGLE	NO	MG
	AP	250-500	SINGLE	OPTIONAL	P1
	2CBP	50-100	TWO	NO	P2
REAR MOUNT PTO	CBP	250	SINGLE	NO	P2
	PSD	750-1500	SINGLE	NO	A
	QFLOA	750-1250	SINGLE	YES	A
	AP	250-500	SINGLE	OPTIONAL	P1
REAR MOUNT SPLIT-SHAFT	PSD	750-1500	SINGLE	NO	A
	QFLOA	750-1250	SINGLE	YES	A
	QMAXJ	1000-2250	SINGLE	YES	DIRECT DRIVE
	QTWOJ	1000-2000	TWO	YES	DIRECT DRIVE
	RMB	500-1000	SINGLE	OPTIONAL	DIRECT DRIVE
	RMC	1000-1500	SINGLE	OPTIONAL	DIRECT DRIVE
	RME	1500-3000	SINGLE	OPTIONAL	DIRECT DRIVE
	RGA	SPLIT-SHAFT PTO GEARBOX			R
	MGA	SPLIT-SHAFT PTO GEARBOX			MG
	QSG	750-1250	SINGLE	YES	S,L
HALE MIDSHIP WITH 4X4 TRANSFER CASE PTO	QFLO	750-1250	SINGLE	YES	L
	QPAK	500-1000	SINGLE	YES	L
	QMAX	1000-2250	SINGLE	YES	S,L
	QTWO	1000-2000	TWO	YES	S,L
	DSD	750-1500	SINGLE	NO	L
	MG	500-1000	SINGLE	NO	MG
	QMAXJ	1000-2250	SINGLE	YES	DIRECT DRIVE
	QTWOJ	1000-2000	TWO	YES	DIRECT DRIVE
	LGA	PTO DRIVE GEARBOX			L
	LGA	PTO DRIVE GEARBOX			L

TABLE 2

GEAR BOX (SEE TABLE 1)	GEAR RATIOS
S,L,R	1: 1.58, 1.71, 1.86, 2.05, 2.28
X	1: 1.96, 2.13, 2.32, 2.55, 2.83
MG	1: 1.27, 1.71, 1.92, 2.18, 2.67, 3.00
P1	1: 2.00, 2.30, 2.55, 2.85
P2	1: 2.00, 2.83, 3.94, 4.93
A	1: 1.40, 1.59, 1.81, 1.97, 2.16, 2.37
J	1: 1.64, 1.80, 2.05, 2.35, 2.57

PLATE 843AF

ECO NO/REV	REVISION DESCRIPTION	BY	DATE	APVD	ECO NO/REV	REVISION DESCRIPTION	BY	DATE	APVD
00-000   E	ADDED RGA & MGA GEARBOXES + 4 X 4 VERSIONS	EAM	9-25-98	RET	98-169   A	RELEASED FOR PRODUCTION	EAM	9-25-98	RET
01-129   F	CORRECT QPAK FLOW RATE, REMOVE QPAKA, ADD P2, ADD LGA	PEW	3-14-01	MAL	97-123   B	ADDED RATINGS, RATIOS, STAGES	LN	6-4-97	RET
					98-107   C	ADDED QFLO, QMAX, QTWO, AND QSG. REARRANGED ROWS AND COLUMNS	AJD	6-2-98	RET
					98-195   D	ADDED 1:97 GEAR RATIO TO PSD & QFLOA PUMP MODELS	OLM	8-31-98	RET



HALE PRODUCTS, INC.  
A Unit of IOEX Corporation  
Conehocken, PA 19428 USA

DATE: 8-23-98  
SIZE: 12.7 x 17.4  
SCALE: 80%



**Hale Products, Inc.**

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