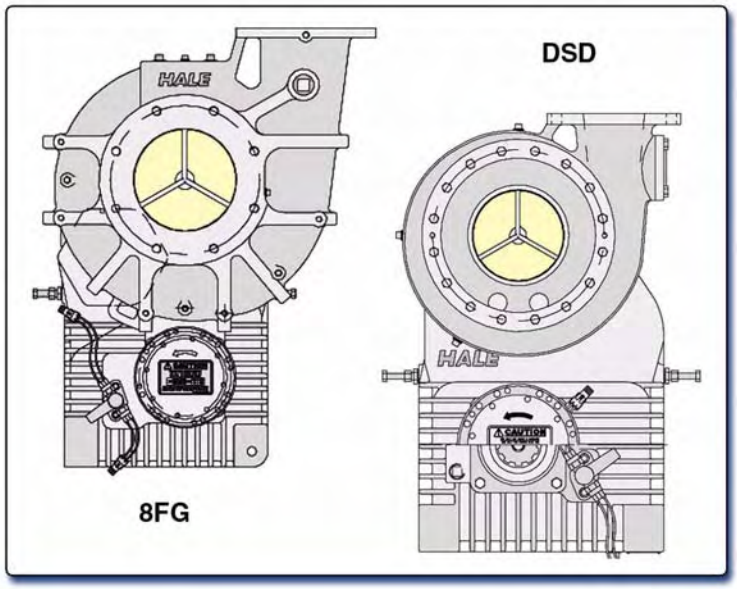
8FG / DSD Series

HIGH Volume Pumps

Operation and Maintenance Manual



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HALE PRODUCTS INC.
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Manual p/n: 029-0020-93-0


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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Manual p/n: 029-0020-93-0, Rev. -A
Printed in U.S.A.

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Hale 8FG/DSD High Volume Pump

General

The Hale line of **HIGH Volume 8FG and DSD Series Pumps** are designed specifically for high volume industrial fire fighting applications. The 8FG and DSD series pumps offer the versatility, dependability, reliability, and ease of operations necessary for effective fire fighting. (See Table A-2: “8FG / DSD High Volume Pump,” on page 3-10.)

Hale pumps are split-shaft designed for easy mounting. The pump is driven from the truck’s main driveline. When applicable, for DSD series pumps the apparatus builder must supply the transmission PTO (power takeoff) and connecting shaft.

Hale offers various models of the high volume pumps. The anticipated use and position on the apparatus determines the model selected as well as the drive unit. Flow capacities are shown in Table A-1: “HIGH Volume Pump Capacity.”

Model	Type	Volute Orientation	Capacity
8FG 8FGR Series	Single-Stage, Split-Shaft, High Volume Pump	Pump “rear” of gearbox. Pump “front” of gearbox.	Up to 4,000 GPM (15,140 LPM). NFPA Rated up to 3,000 GPM (11,355 LPM) at 150 PSI (10 BAR), per Standard 1901.
DSD DSDR Series	Single-Stage, Split-Shaft PTO High Volume Pump *(PTO option also available)*	Pump “rear” of gearbox. Pump “front” of gearbox.	Up to 1,500 GPM (5,678LPM). NFPA Rated at 750 to 1,500 GPM (2,850 to 5,678 LPM), per Standard 1901. *Note: 1,500 GPM option not available for DSDR Pump.*

Table A-1: HIGH Volume Pump Capacity

Both the 8FG and the DSD pumps are offered constructed from “Iron” or “Bronze” to meet most industrial fire fighting applications.

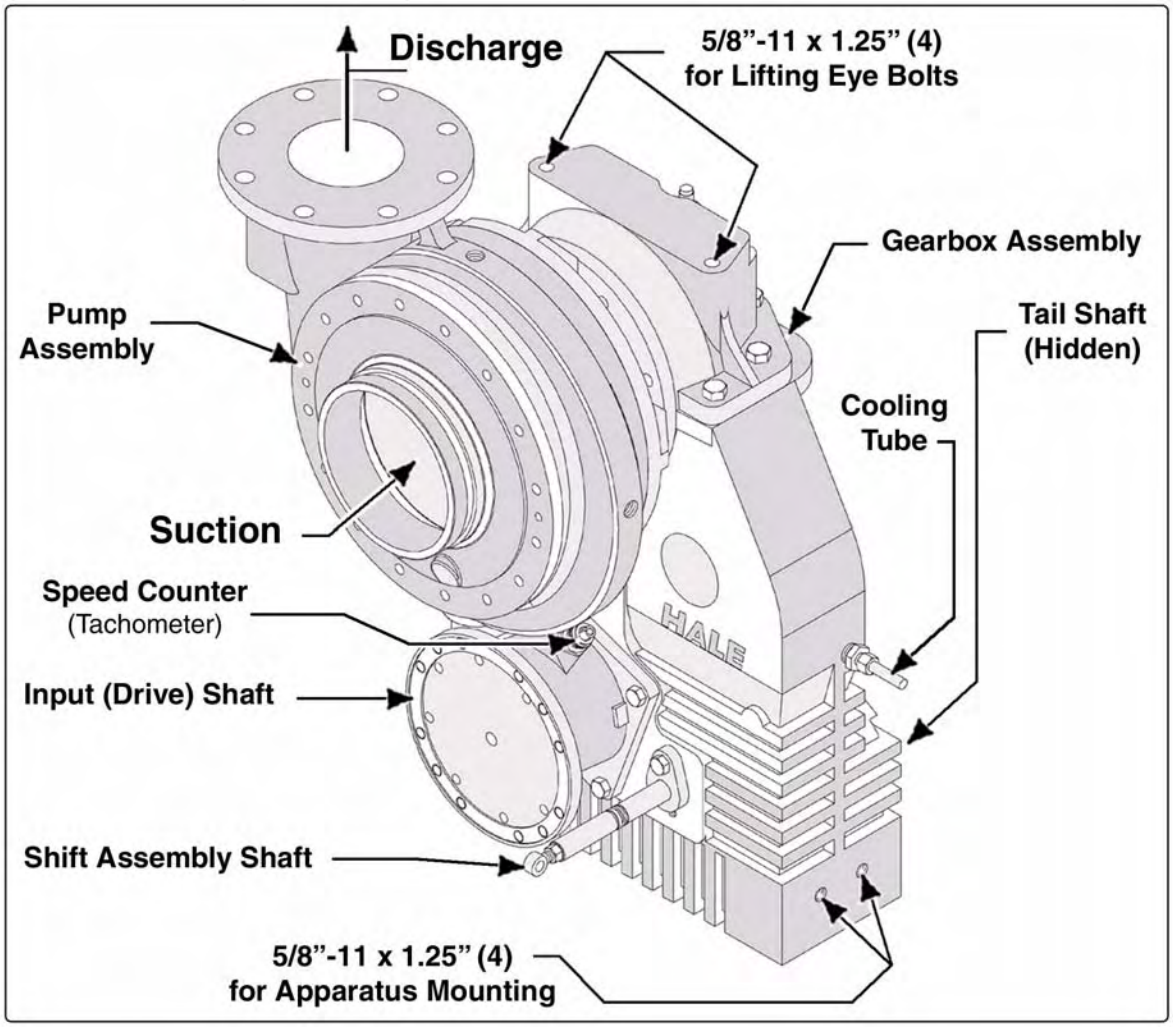

Table A-2: 8FG / DSD High Volume Pump

1 Safety Precautions

IMPORTANT !

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

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

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

1.1 GUIDELINES

NOTICE !

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

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

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

CAUTION !

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

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

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

WARNING !

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

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

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

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

WARNING!

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

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

WARNING!

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

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

- ❑ DO NOT operate the system at pressures higher than the maximum rated pressure. Always use the lowest possible relief valve settings to enhance operator and equipment safety. Also see Section 2 “Introduction” on page 15 for additional information.
- ❑ Relieve all system pressure, then drain all water from the system before servicing any of its component parts.
- ❑ Use only pipe, hose and fittings which are rated at or above the maximum pressure rating at which the water pump system operates.

- ❑ Per NFPA 1962 requirements, large diameter hose, marked “supply Hose 3-1/2” to 5” (89 - 127 mm) diameter” shall not be used at operating pressures exceeding 185 PSI (13 BAR). Large diameter hose, marked “Supply Hose 6” to 5” (152 mm) diameter” shall not be used at operating pressures exceeding 135 PSI (9 BAR).
- ❑ If leakage from the drain hole in the pump head is noticed or suspected, the impeller must be removed and the mechanical seal must be inspected and/or replaced.
- ❑ If a pump is operated without water for extended periods, or without discharging water, it could overheat. This can damage the mechanical seal, impeller or the drive mechanism.
- ❑ DO NOT attempt to pump until all the GREEN pump indicators in the cab and panel are ON. Also see Section 3 “Basic Operation” on page 27 for additional information.
- ❑ DO NOT advance the throttle unless the OK TO PUMP indicator is illuminated. Also see Section 3 “Basic Operation” on page 27 for additional information.
- ❑ DO NOT leave the cab, after selecting the PUMP mode, until all the GREEN pump indicators in the cab and panel are illuminated. Also see Section 3 “Basic Operation” on page 27 for additional information.
- ❑ DO NOT attempt emergency manual shift procedures while the engine is running. Also see Section 3 “Basic Operation” on page 27 for additional information.
- ❑ Never attempt to shift the pump (PUMP-to-ROAD, vise versa) while the truck transmission is in gear. Always shift the truck transmission to NEUTRAL (N) and verify the speedometer is ZERO (0) before shifting the pump. Also see Section 3 “Basic Operation” on page 27 for additional information.
- ❑ DO NOT reduce the pressure on the INTAKE gauge below zero (0). Serious damage to the water main could result.
- ❑ Some vehicles maintain air on the shift cylinder continuously regardless of transmission setting, and some only have air applied when the vehicle transmission is in NEUTRAL.

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

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

2 Introduction

2.1 PRINCIPLES OF OPERATION

Centrifugal Force

Hale pumps are centrifugal pumps that operate on the principle of centrifugal force created by a rapidly spinning disk. (See Figure 2-3: "Centrifugal Force - Rotating Disk.")

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

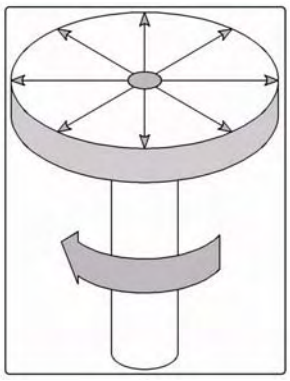

Figure 2-3: Centrifugal Force - Rotating Disk

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

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

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

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

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

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

As the impeller rotates, the water moving outward in the impeller creates reduced pressure, or a vacuum in the suction eye, allowing atmospheric pressure to push water into the pump impeller replacing the water discharged. (See Figure 2-4: “Pump Water Flow, Cutwater.”)

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

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

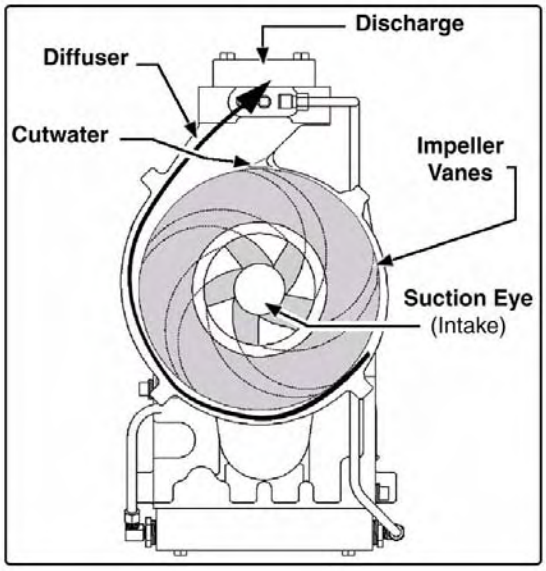

Figure 2-4: Pump Water Flow, Cutwater

2.2 PUMP COMPONENTS

(See Figure 2-5: “Typical Pump and Gearbox Overview,” on page 17.)

The Hale single-stage pump consist of:

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

Volute, Pump Body

(See Figure 2-5: “Typical Pump and Gearbox Overview,” on page 17.)

As water discharges from the impeller, it enters the volute (pump body).

The volute is constructed from fine-grain cast iron and shaped so that its area increases from the cutwater to its full capacity at the volute throat.

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

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

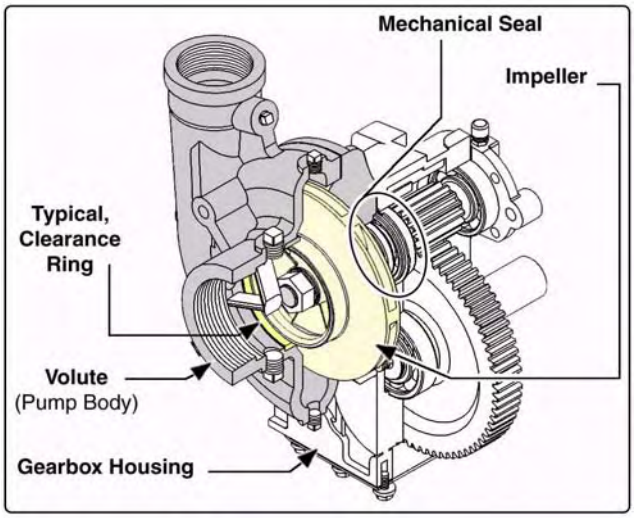

Figure 2-5: Typical Pump and Gearbox Overview

Impeller

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

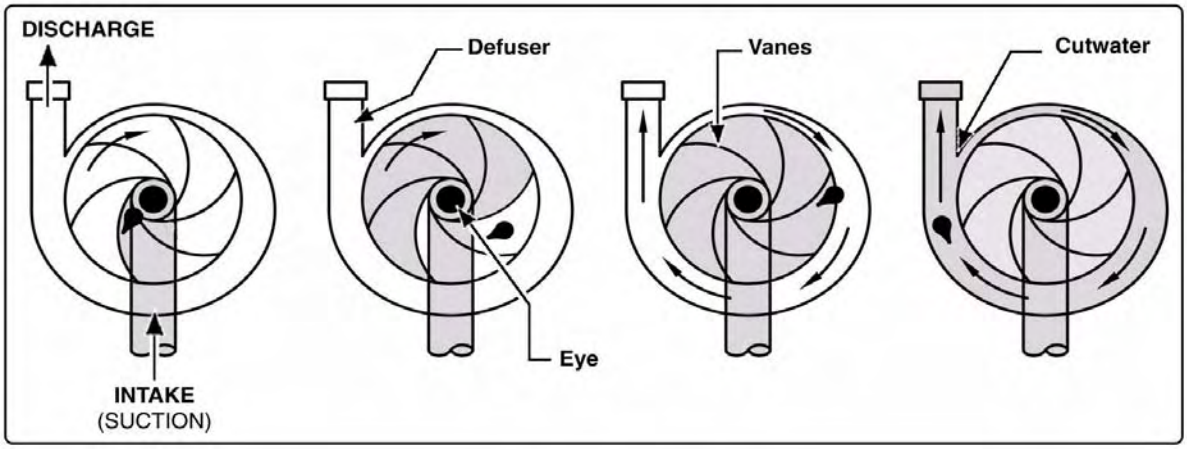

Figure 2-6: Impeller Operation

Figure 2-6: “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 2-5: “Typical Pump and Gearbox Overview” on page 17.

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

Mechanical Seal

The “maintenance-free,” mechanical seal is common to Hale pumps. (See Figure 2-7: “Mechanical Seal Overview.”)

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

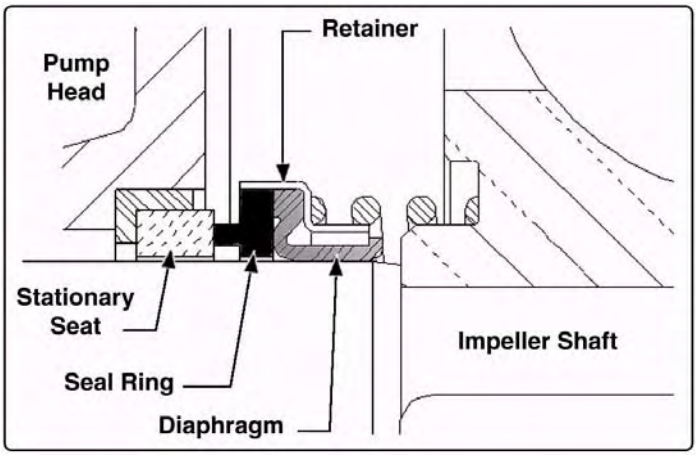

Figure 2-7: Mechanical Seal Overview

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

WARNING !

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

Ball Bearings

Ball bearings support and align the impeller and input shafts for smooth operation. They are the most common anti-friction bearings used and offer a major contribution to the life of a fire pump.

2.3 PUMP DRIVES

Hale pumps produce the volumes and pressures shown on their performance curves. However, maximum pump performance is sometimes limited by the power capacity and speed limits of the engine, transmission, and PTO. (See Figure 2-8: "Pump / Engine Rotation.")

Three common pump drives are used on fire fighting apparatus:

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

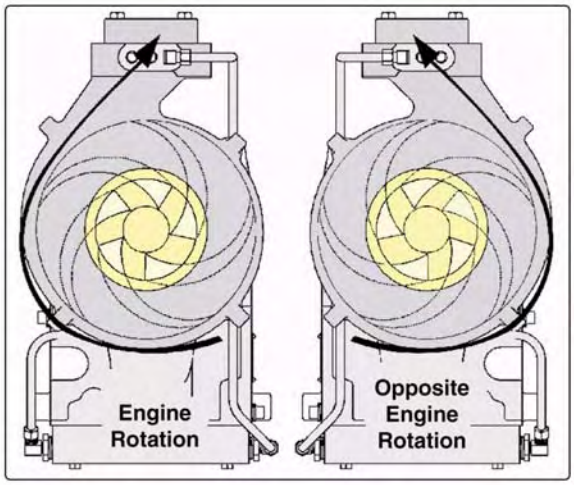

Figure 2-8: Pump / Engine Rotation

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

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

WARNING!

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

Gearbox

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

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

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

HALE Power Takeoff (PTO) Driven Pumps

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

Hale Engine Mounted Pumps

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

2a Accessories

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

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

2A.1 ANODES

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

Hale offers two types of anodes (consumables) for pump protection from galvanic corrosion:

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

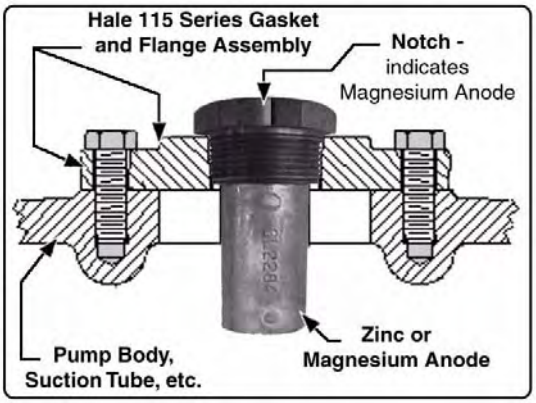

Figure 2a-1: Hale Anode

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

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

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

2A.2 AUXILIARY COOLING

For pumps not equipped with standard gearbox cooling, a cooler option is available to protect the gearbox, the apparatus engine, and the pump. The gearbox cooler circulates pump water to transfer heat from the gearbox oil to the pump discharge, thus maintaining proper operating temperatures.

2A.3 PRESSURE AND RELIEF VALVE CONTROL

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

P Series Relief Valve System

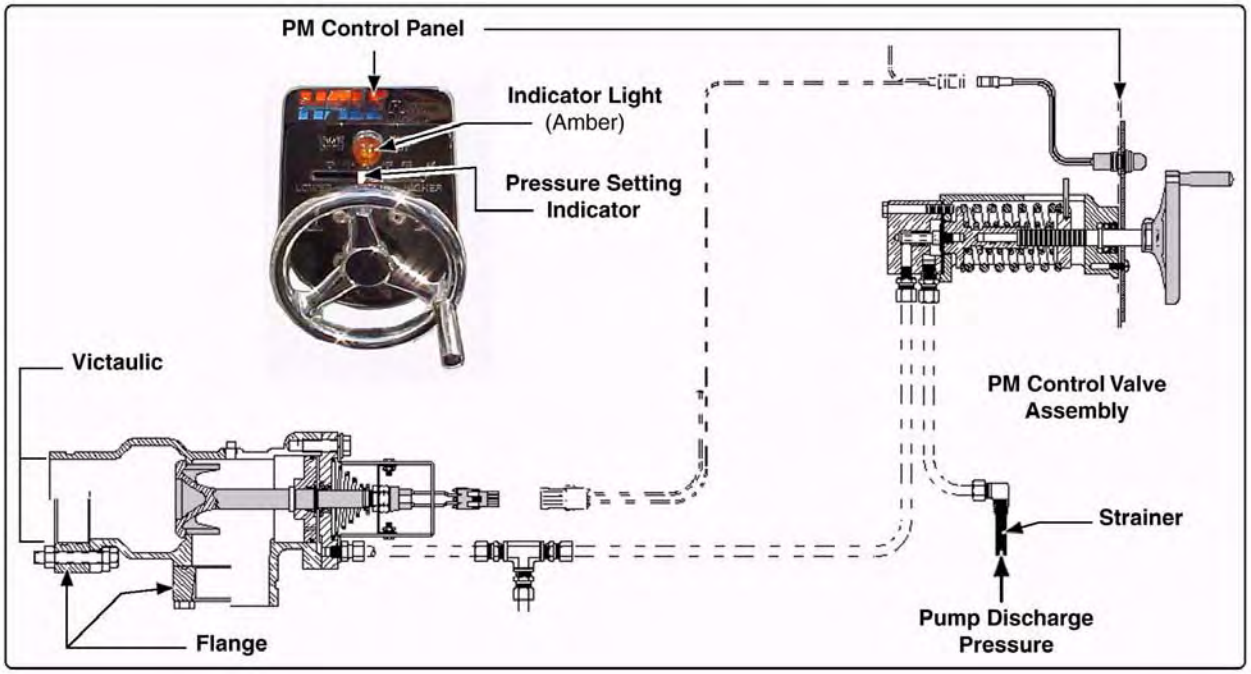

Figure 2a-2: P Series Relief Valve System Arrangement

The **P** Series relief valve system is a bronze, variable-pressure setting, relief valve that prevents undue pressure per the requirements of NFPA Standard 1901. An AMBER indicator light on the operator control panel signals when the valve is open. (See Figure 2a-2: “P Series Relief Valve System Arrangement,” on page 22.)

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

Thermal Relief Valves (TRV)

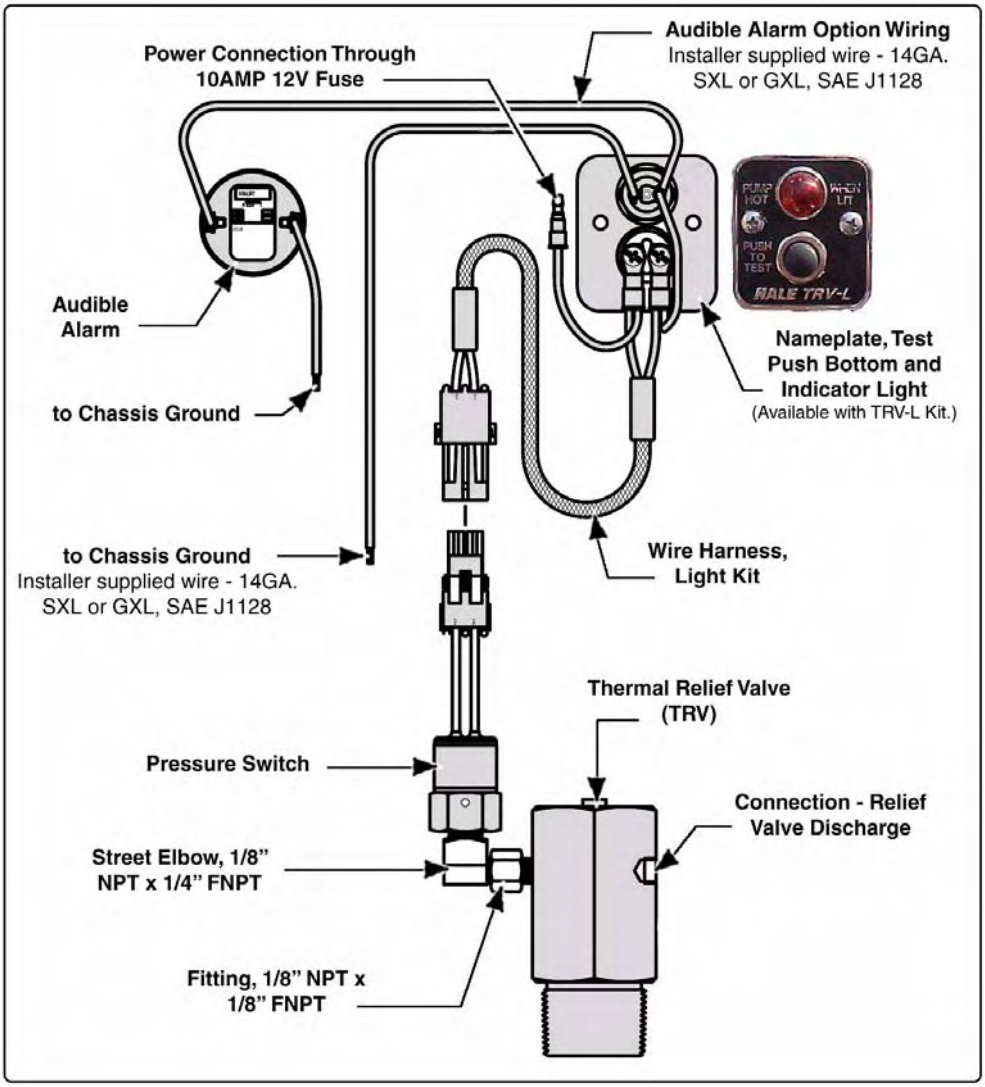

Figure 2a-3: Thermal Relief Valve, TRV

The optional TRV protects the pump from overheating. It is attached to the discharge piping either by flange mounting or 1-1/4" NPT threaded connection (38 mm for Model TRVM). (See Figure 2a-3: "Thermal Relief Valve, TRV," on page 23.)

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

TRV-L Kit

The TRV-L kit includes a chrome panel placard with a warning light, a light test button, and a pre-assembled wire harness. The RED light illuminates when the TRV is open and discharging water. Also see Figure 2a-3: "Thermal Relief Valve, TRV" on page 23.

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

2A.4 PRIMING SYSTEMS

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

Hale pumps use **Rotary Vane Positive Displacement** pumps for priming. (See Figure 2a-4: "Rotary Vane and ESP Priming Pumps," on page 25.)

The priming pump has a rotor mounted off-center (eccentric) to the pump body housing. The rotor vanes slide in grooves and are held against the body housing by centrifugal force.

As a vane turns toward the discharge, it recedes into the rotor compressing the air. As the rotor continues past the discharge, the vane advances outward from the groove and against the body housing. During this cycle, the space between the rotor and housing case fills with air. The vanes, acting as wipers, force air out of the discharge, creating a vacuum in the main pump allowing atmospheric pressure to push water into the hose and suction side of the 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. (See Figure 2a-4: "Rotary Vane and ESP Priming Pumps," on page 25.)

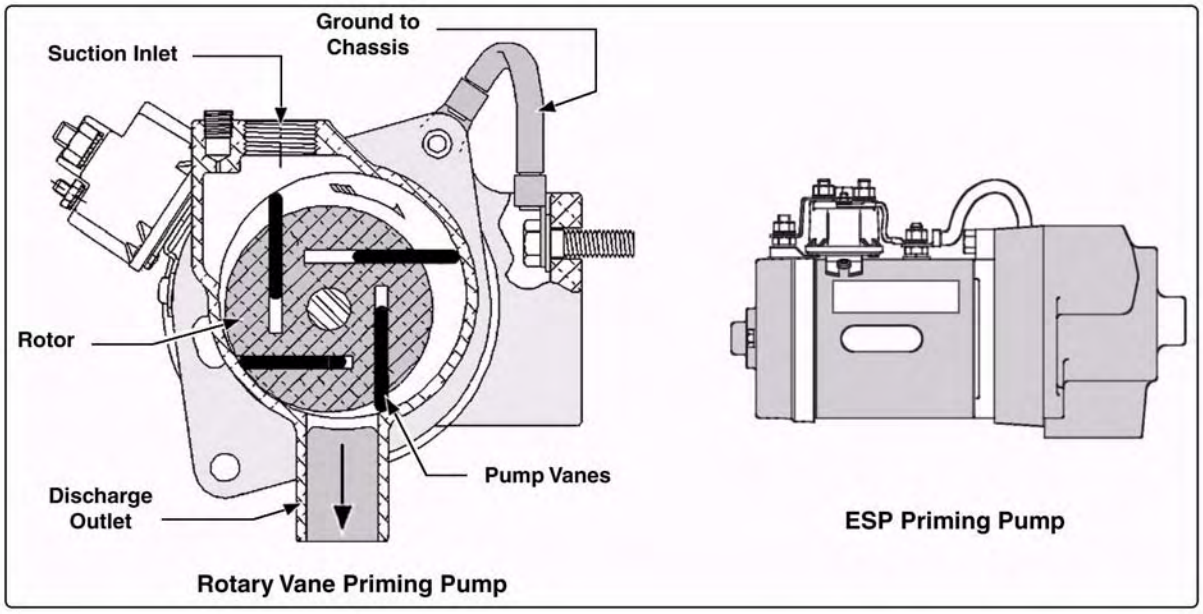

Figure 2a-4: Rotary Vane and ESP Priming Pumps

An ESP priming pump also uses a single control to open the priming valve between the pump and the priming pumps, and start the priming motor.

Priming Valves

Hale priming valves open when the priming pump is operated to allow the air to escape from the pump.

Two priming valves are offered:

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

  A hose is connected from the SPVR to the priming port on the pump body. A single push button on the operator's panel starts the priming pump motor. When a vacuum is created, the SPVR opens. (See Figure 2a-5: "SPVR Priming Valves," on page 26.)

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

- **The Hale PVG Priming Valve**

  The PVG is mounted on the pump operator's panel. The PVG is a combination valve and switch. (See Figure 2a-6: "PVG Priming Valves," on page 26.)

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

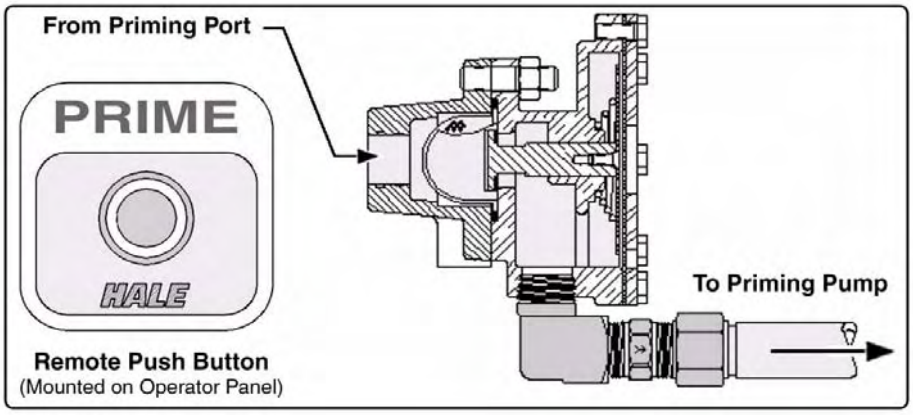

Figure 2a-5: SPVR Priming Valves

❑ **The Hale PVG Priming Valve** - continued

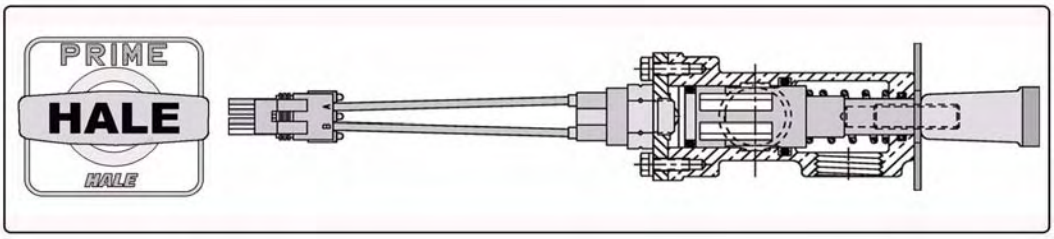

Figure 2a-6: PVG Priming Valves

2A.5 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. Numerous adapters tailor the valve to almost any installation requirement. (See Figure 2a-7: "Typical SVS Valve Primary Components.")

See separate manual for additional information.

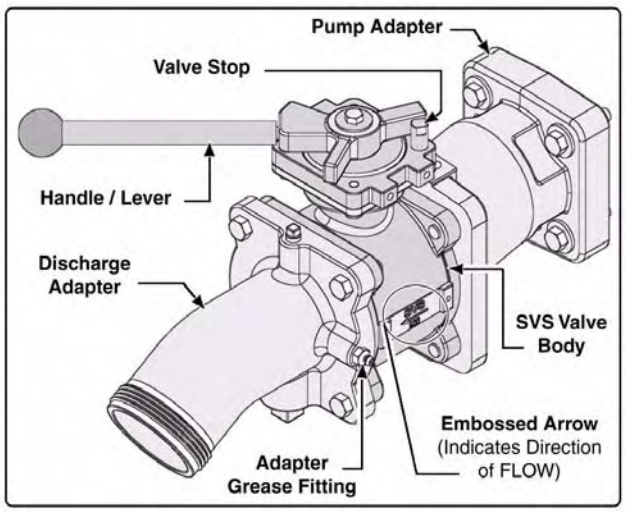

Figure 2a-7: Typical SVS Valve Primary Components

3 Basic Operation

WARNING !

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

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

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

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

3.1 OVERVIEW

This section provides typical information and procedures for the operation of Hale pumps. The procedures provided are for “split-shaft” and “PTO” pump applications:

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

3.2 STATIONARY PUMPING OPERATIONS

Pumping From a Hydrant, General Operation

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

2. Bring the truck to a complete stop and apply the truck parking brake.

3. Shift the truck transmission to the NEUTRAL position. See **WARNING !** note on page 27.

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 39.

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

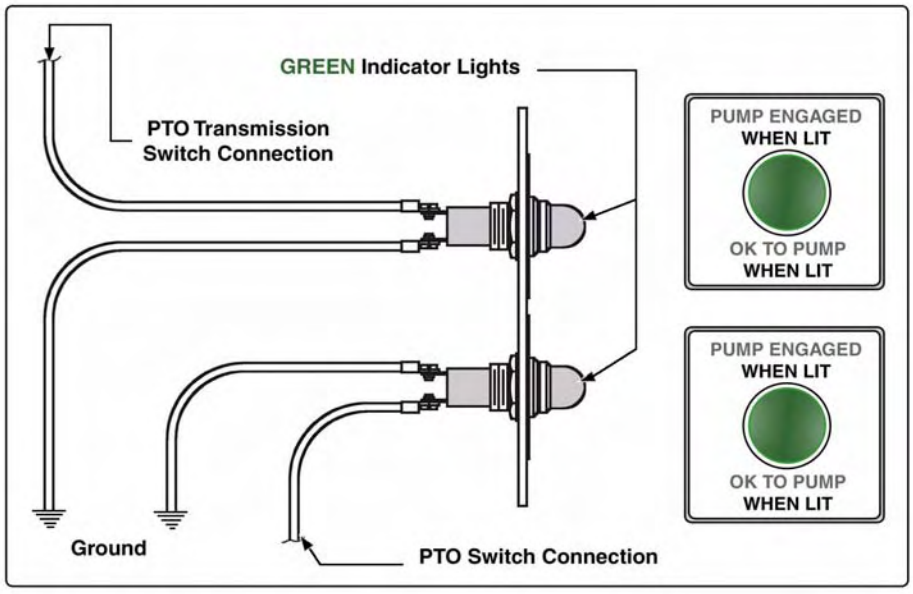

Figure 3-1: Driver’s Compartment Indicator Lights

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

CAUTION !

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

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

5. 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.

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

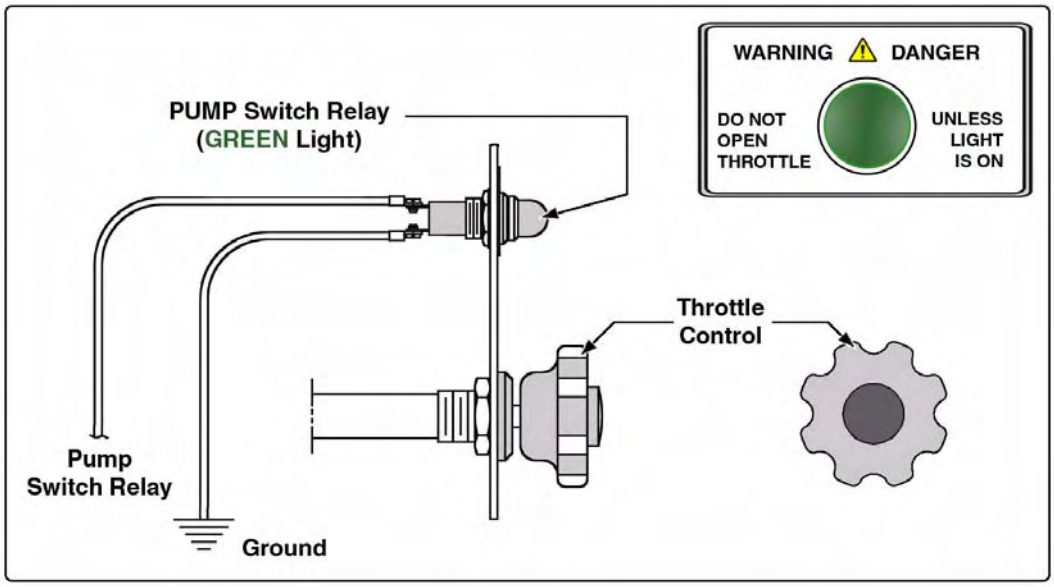

Figure 3-2: Pump Operator's Panel

For "Split-Shaft" operation

- ❑ After pump shift is completed place the truck transmission in the proper pump operating range or gear. For most pumpers this is direct drive (1:1) ratio. In addition, the speedometer should register after the shift has been completed.
- ❑ If the shift does not complete, shift truck 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.

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

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

9. To eliminate air pockets, open the appropriate valve to expel air or prime the pump, if so equipped. Also see heading “Pumping From Draft” on page 31.

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

11. 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 31.

CAUTION !

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

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

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

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

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

15. 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 trying to pump more capacity than is available from the supply. Also check the inlet strainers for possible debris restricting the flow.

16. Open the discharge valves.

IMPORTANT !

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

17. When pumping operations are completed, gradually reduce the pump pressure until the engine returns to IDLE speed. See heading “Pumping From Draft” on page 31. Disengage the PTO per the PTO manufacturer’s instructions. Also see heading “Pump-To-Road Shift Procedures” on page 39.

TPM Operation from a Hydrant

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

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

Draft Limiting Factors

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

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

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

Pumping From Draft

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

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

2. Bring the truck to a complete stop and apply the truck parking brake.

3. Shift the truck transmission to the NEUTRAL position. See **WARNING !** note on page 27.

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 39.

   Engage the PTO (power take-off) per the PTO manufacturer’s instructions (move the in-cab pump shift control valve from the ROAD position to the PUMP position). The GREEN shift warning lights illuminate in a second or two, indicating a complete shift. (See Figure 3-1: “Driver’s Compartment Indicator Lights” on page 28.)

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

CAUTION !

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

DO NOT OPEN THE THROTTLE UNLESS THE GREEN INDICATOR LIGHT IS ON. (SEE FIGURE 3-2: “PUMP OPERATOR’S PANEL” ON PAGE 29.)

5. 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.

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

   For “Split-Shaft” operation

   - ❑ After pump shift is completed place the truck transmission in the proper pump operating range or gear. For most pumpers this is direct drive (1:1) ratio. In addition, the speedometer should register after the shift has been completed.
   - ❑ If the shift does not complete, shift truck 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.

7. Activate the priming pump by pulling the control handle located on the pump panel or by pressing the push button.

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

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

CAUTION !

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

STOP THE PUMP AND CHECK FOR AIR LEAKS OR POSSIBLE PROBLEMS. SEE SECTION 5 "TROUBLESHOOTING," ON PAGE 59.

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

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

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

CAUTION !

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

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

11. If the pump is cavitating, warn personnel that the flow is being REDUCED. In this case, close the throttle slowly until you operate without cavitation.

The following possibilities can also lead to cavitation:

- ❑ **Large nozzle tips** - reduce flow by using a smaller nozzle.

- ❑ **Air enters with the water -** Even though the pump may be primed, air leaks can cause rough operation and an increase in engine speed without an increase in pressure or flow.

  If an air leak is suspected, discontinue pumping - see heading “Trouble-shooting” on page 59.

- ❑ **Hot water -** see Figure F-2: “Lift Loss from Temperature” on page 127.
- ❑ **Low barometer -** see Figure F-3a: “Lift Loss from Elevation, Barometric Reading” on page 127.
- ❑ **High lift -** see Figure F-3: “Lift Loss from Elevation” on page 127.

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

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

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

13. 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 31.

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 to IDLE speed. See heading “Pump-To-Road Shift Procedures” on page 39. Disengage the PTO per the PTO manufacturer’s instructions. Also see heading “Post Operation Procedures” on page 44.

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 and apply the truck parking brake.

3. Shift the truck transmission to the NEUTRAL position. See **WARNING !** note on page 27.

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

Move the in-cab pump shift control valve from the ROAD position to the PUMP position. The shift warning lights illuminate in a second or two, indicating a complete shift. (See Figure 3-1: “Driver’s Compartment Indicator Lights” on page 28.)

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

CAUTION !

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

DO NOT OPEN THROTTLE UNLESS ALL GREEN PUMP INDICATOR LIGHTS ARE ON. (SEE FIGURE 3-2: “PUMP OPERATOR’S PANEL” ON PAGE 29.)

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.

7. Open the tank suction valve.

8. Check the master discharge gauge to see if priming is necessary. If necessary, start the priming pump by pulling the control handle located on the pump panel or depressing the prime push button.

CAUTION !

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

STOP THE PUMP AND CHECK FOR AIR LEAKS OR POSSIBLE PROBLEMS. SEE SECTION 5 “TROUBLESHOOTING,” ON PAGE 59.

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

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

10. If the pump is cavitating, warn personnel.

WARNING !

DO NOT OPEN THROTTLE UNTIL ALL GREEN PUMP LIGHTS ARE ON. (SEE FIGURE 3-2: "PUMP OPERATOR'S PANEL" ON PAGE 29.)

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

12. 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 31.

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

14. After completion of pumping procedures, gradually reduce the engine RPM until it is at an IDLE speed. See heading "Pump-To-Road Shift Procedures" on page 39. Disengage the PTO per the PTO manufacturer's instructions. Also see heading "Post Operation Procedures" on page 44.

3.3 PUMPING IN RELAY

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

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

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

Use this procedure after the hose is positioned, the apparatus are in position, and the pumps are engaged. For setup and engagement instructions for apparatus receiving pressurized water, see heading "Pumping From a Hydrant, General Operation" on page 28.

Relay Procedures

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

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

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

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

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

   The discharge pressure must not exceed 185 PSI (13 BAR) for 5" (127 mm) large diameter hose, or 135 PSI (9 BAR) for 6" (152mm) hose, per NFPA Standards 1962. See heading "Pumping From a Hydrant, General Operation" on page 28. Also see heading "Pumping From Draft" on page 31.

IMPORTANT !

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

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

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

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

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

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

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

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

NOTICE !

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

3.4 TANDEM (SERIES) PUMPING

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

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

CAUTION !

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

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

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

Tandem Procedures

1. Using the large intake hose, connect the first pumper to the hydrant steamer. Open the hydrant until the pump is primed.

2. Position the second pumper “discharge-to-intake” with the first pumper.

3. Open a discharge to flow water.

4. Adjust the throttle on the first pumper until the intake gauge reads approximately 5 PSI (0.34 BAR)

5. Connect the second pumper to the unused streamer intake of the first pumper, using a large intake hose (approximately 2-1/2” / 64 mm).

6. Both pumpers pump water to the fire. Also see heading “Pumping From a Hydrant, General Operation” on page 28.

NOTICE!

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

3.5 PUMP-TO-ROAD SHIFT PROCEDURES

(For Split-Shaft Gearboxes)

1. Verify that the operator’s hand throttle or governor control has returned to IDLE speed.

2. Shift the truck transmission into the NEUTRAL position, and wait about four (4) seconds. Check to make sure the speedometer reads ZERO (0).

3. Move the pump shift control valve lever to the ROAD position. The in-cab and panel pump indicator lights go out when the pump transmission starts to shift into the ROAD position.

NOTICE !

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

3.6 RELIEF VALVE PROCEDURES

Be sure to select the correct procedure based on how the truck is equipped. (See Figure 3-3: “TPM / PMD Relief Valve Control” on page 41.) Some trucks may utilize a governor in place of the relief valve.

Standard Relief Valve Procedures

Note: Be sure to select the correct procedure, according to the relief valve in your system.

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

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

3. Turn the handwheel slowly clockwise until the master pressure gauge rises to the desired pressure and the pilot light goes out. The relief valve now operates at the set pressure.

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

Note: Be sure to select the correct procedure, according to the relief valve in your system.

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

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

3. The AMBER indicator light illuminates. (See Figure 3-3: “TPM / PMD Relief Valve Control” on page 41.)

4. Turn the handwheel slowly clockwise until the light goes out. The relief valve now operates at the set pressure.

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

Figure 3-3: TPM / PMD Relief Valve Control

CAUTION !

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

TPM System with Engine Governor

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

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

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

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

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

CAUTION !

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

6. Place the governor control in the PRESSURE GOVERNOR mode; the system is now set.

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

Increasing Pressure

- ❑ Set the TPM to a pressure (by the indicator) slightly higher than the desired new pressure.
- ❑ Place the governor control in the RPM mode, and increase the speed to the new pressure.
- ❑ Turn the TPM handwheel counterclockwise until the relief valve opens and the AMBER pilot light illuminates. (See Figure 3-3: “TPM / PMD Relief Valve Control” on page 41.)
- ❑ Turn the handwheel slowly clockwise, until the AMBER light just goes out. Then turn the handwheel one additional full turn clockwise for proper operation.

CAUTION !

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

- ❑ Place the governor control in the pressure governor mode; the system is now set.

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; the system is now set.

3.7 EMERGENCY PUMP SHIFT PROCEDURES

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

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

WARNING !

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

6. Employ manual override procedure at the shift cylinder on the pump gear-box as follows:
   - ❑ An eyebolt is provided in the shift shaft to accept a drift punch or screwdriver.
   - ❑ Insert the tool into the hole provided, then pull or push the shaft manually.
   - ❑ Pull the shift shaft OUT for PUMP position (after in-cab control valve selection), or push shift 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 effort.

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

3.8 POST OPERATION PROCEDURES

1. Return the engine to IDLE, then slowly close all valves.

2. Place the transmission in NEUTRAL, then slowly shift from PUMP 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 27.

4 Preventive Maintenance

4.1 OVERVIEW

Hale 8FG and DSD high volume pumps require very little care and maintenance. However, the little that is required is extremely important. Preventive maintenance tasks require very little time to accomplish and consist mainly of testing for leaks, lubrication, and cleaning.

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

4.2 POST OPERATION

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

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

3. Tighten suction caps.

4.3 EXTREME CONDITIONS

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

During Freezing Weather

In freezing weather, drain the pump as follows:

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

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

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

Pumping Salt Water, Contaminated Water, or Foam Solution

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

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

3. Drain the gearbox cooler, if installed.

4.4 WEEKLY

Weekly maintenance consists of testing the relief valve system or governor, the priming system, and the pump shift warning indicator lights. If testing criteria is not met, refer to Section 5 “Troubleshooting” on page 65 for corrective maintenance procedures.

- ❑ Test the relief valve or governor system - see page 46
- ❑ Test the priming system - see page 47.

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

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

- ❑ Test the pump shift warning indicator lights - see page 47
- ❑ Perform valve maintenance - see page 48
- ❑ Check and clean the intake strainers - see page 48
- ❑ Verify all gauges are in working order - see page 48
- ❑ Operate pump controls - see page 48
- ❑ Check auxiliary engine - see page 49

Relief Valve Test

When the relief valve is not in operation, maintain a setting above the normal operating pressure. Also see Figure 3-3: “TPM / PMD Relief Valve Control” on page 41. Also refer to NFPA 1901 standard.

1. Prepare to pump from the onboard water tank with the discharge valve back to the water tank open less than 1/2 way. Also see Section 2a.3 “Pressure and Relief Valve Control” on page 22.

2. Increase pump pressure up to 150 PSI (10 BAR), as indicated on the master pressure gauge, per normal operating procedures.

3. Turn the relief valve handwheel counterclockwise until the relief valve opens and the AMBER light illuminates. The master pressure gauge should drop at least 5 to 10 PSI (0.35 to 0.7 BAR). (See Figure 3-3: “TPM / PMD Relief Valve Control” on page 41.)

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

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

Governor Test

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

Priming System Test

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

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

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

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

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

Pump Shift Warning Indicator Lights

1. Switch to non-pumping operations, and verify the warning indicators are OFF. See Section 3 “Basic Operation” on page 27.

CAUTION !

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

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

3. Repair or replace any malfunctioning indicators.

Valve Maintenance

Properly functioning valves are integral to the operation of the pump. Refer to the separate valve manual for proper valve maintenance procedures.

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

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

Intake Strainers

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

Verify All Gauges are in Working Order

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

Operate Pump Controls

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

Inspect Water and Foam Tanks

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

Check Auxiliary Engine

See separate engine manufacturer's manual.

4.5 MONTHLY

Monthly maintenance includes the weekly maintenance procedures plus:

- ❑ Valve lubrication - see page 49
- ❑ Gearbox lubrication - see page 49
- ❑ Dry vacuum testing - see page 50
- ❑ Checking the pump and drive line bolts - see page 50

Valve Lubrication

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

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

Gearbox Lubrication

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

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

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

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

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

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.

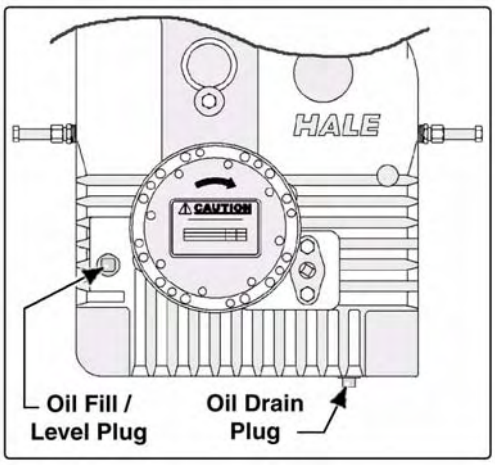

Figure 4-1: Gearbox Oil Change Plugs

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

Note: If water leak / contamination is suspected, see Section 5 Troubleshooting, heading “Water/Moisture in Pump Gearbox.” on page 65.

5. Either of these conditions indicates maintenance is required on the unit. See Section 6b “G Series Gearbox” on page 97.

Pump Mounting, Drive Line and Flange Bolts

Check all drive line and flange bolts to ensure:

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

Priming System Test (Dry Vacuum Test)

(Refer to NFPA 1901 or NFPA 1911)

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

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

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

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

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

Figure 4-2: Priming Valve Handle

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

6. Test the suction hose as follows:
   - ❑ Attach the suction hose to the pump.
   - ❑ Place 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.
   - ❑ Watch the gauge. If the vacuum falls more then 10” in 5 minutes, it is an indication of at least one air leak.
   - ❑ Verify the test gauge and the apparatus gauge display the same readings. Repair and/or replace gauges that do not display the correct pressure.

IMPORTANT !

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

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

4.6 ANNUAL

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

- ❑ Replacing the pump gearbox oil - see page 52.
- ❑ Relief valve system, check and repair - see page 53.
- ❑ Checking individual drain lines from the pump to the multi-drain to ensure proper drainage and protection from freezing - see page 54.
- ❑ Test tank-to-pump flow rate - see page 54.
- ❑ Disassembly of priming pump to clean vanes - - see page 54. (Also see separate manual provided.)

IMPORTANT !

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

- ❑ Run a yearly pump test to check performance levels - see page 54. (See NFPA 1911 standard for more details.)

Replace Gearbox Oil

1. Remove the drain plug (magnetic) and drain the gearbox oil into a suitable container. For container size based on gearbox capacity, see “Appendix C1: Lube and Sealant Specifications” on page 119. Also see Figure 4-1: “Gearbox Oil Change Plugs” on page 50.

   Have clean disposable shop rags and oil dry handy.

2. Examine the oil for contamination (e.g., water – turns the oil a milky color or settles to the bottom). Also see Section 5 Troubleshooting, heading “Water/Moisture in Pump Gearbox.” on page 65.

3. Properly dispose of the used oil.

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

Also clean the drain plug (magnetic).

5. Repair or replace components as necessary. See Section 6b “G Series Gearbox” on page 97.

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

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

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

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

Relief Valve System Check

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

2. Test relief valve system in accordance with weekly maintenance check. Also see heading “Weekly” on page 46.

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

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

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

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

   ❑ Disconnect tubing then remove strainer.

   ❑ Clean any debris from strainer and check strainer for damage.

   ❑ Apply thread sealant (Loctite PST or equivalent) and reinstall the strainer.

   ❑ Reconnect tubing.

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

5. Place apparatus into service.

Check Drain Lines to Multi-Drain

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

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

Clean Priming Pump

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

IMPORTANT !

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

Performance Testing Overview

The yearly standard performance test consists of checking the pumper, (according to rating) at three capacities and comparing the results to when the pump was first placed in service. This provides some measure of performance deterioration, if any. (See Table 4-3: “Pump Ratings (GMP/LPM)” on page 55.)

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

Tank-to-Pump Flow Rate Test

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

1. Fill the water tank until it overflows.

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

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

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

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

4. With the pump in gear, open the discharge to which the hose is attached and begin pumping water.

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

6. Close the discharge valve without changing the throttle setting. Refill the tank through the top fill opening or a direct tank line. The bypass valve may be opened during this time to prevent pump overheating.

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

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

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

Performance Testing Equipment and Materials

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

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

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

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

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

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

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

Notes:

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

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

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

Performance Testing

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

1. Test the relief valve (per NFPA 1901 standards):
   - ❑ Set the relief valve flow rate capacity at 150 PSI (10 BAR).
   - ❑ SLOWLY close the discharge valves. The rise in pressure shall not exceed 30 PSI (2 BAR), or approximately 180 PSI (12 BAR) operating pressure.
   - ❑ SLOWLY open the discharge valves to re-establish the original pressure (150 PSI).
2. Perform Steps 2 and 3 of the post operation maintenance procedures. Also see Section 3.8 “Post Operation Procedures” on page 44.
3. Run the standard pump test in accordance with NFPA 1901 standards to check pump performance.
4. Run the engine for 20 to 30 minutes to stabilize the engine temperature. Then run the pump for:
   - ❑ Two (2) hours at FULL capacity and at 150 PSI (10 BAR)
   - ❑ Thirty (30) minutes at 70% capacity and at 200 PSI (14 BAR)
   - ❑ Thirty (30) minutes at 50% capacity and at 250 PSI (17 BAR)
   - ❑ Additionally, an engine overload test is required which consists of pumping at FULL capacity and at 165 PSI (11 BAR) for ten (10) minutes.
5. If the apparatus does not reach performance levels, proceed to Section 5 “Troubleshooting” on page 65.
6. Compare results of this test to those when the apparatus was first delivered. If the apparatus performance has dropped appreciably compared to its original performance, service is needed.

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

Worn Clearance Rings and Impeller Hubs

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

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

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

It should not be necessary to replace clearance rings until a loss in pump performance is noticed during the annual test – see "Performance Testing" on page 57. For clearance ring and impeller service, see heading "Impeller" on page 83.

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 6.4 "8FG / DSD Parts Overview" on page 73 for maintenance and repair information if pump disassembly is required.

Anode Check

Hale offers two types of anodes (consumables):

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

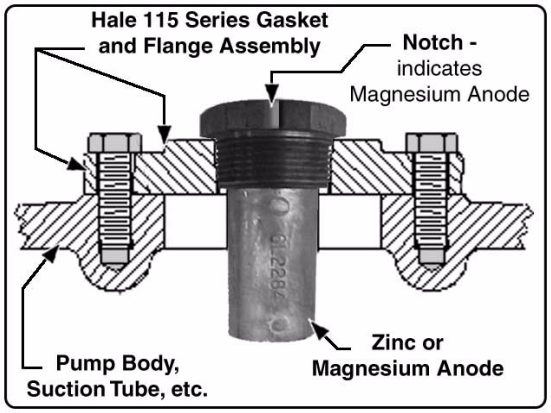

Figure 4-1: Hale Anode

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

5 Troubleshooting

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

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

Figure 5-1: Sample, Serial Nameplate

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

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

Condition	Possible Cause	Suggested Corrective Action
PTO Will Not Engage.		• Consult the PTO manufacturer’s instructions.
⚠ **WARNING !** **DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB AND PANEL ARE ILLUMINATED.** ⚠		
Pump Loses Prime or Will Not Prime.	Electric priming system. **Note:** Weekly priming is recommended to ensure proper operation.	• NO recommended engine speed is required to operate the electric primer. However, 1,000 engine RPM maintains the electrical system while providing enough speed for initial pumping operations. • See Section 2a, heading “Priming Valves” on page 25.
	Inoperative priming system or possible clogged priming pump.	**Note: Using lubricant on the vanes and vane slots during disassembly and cleaning eventually causes a gummy residue to develop, rendering the system inoperative.** **DO NOT LUBRICATE VANES AND VANE SLOTS.**

Chart continued on next page.

Figure 5-2: Troubleshooting Chart

Condition	Possible Cause	Suggested Corrective Action

Pump Loses Prime or Will Not Prime - continued.	Inoperative priming system or possible clogged priming pump - continued.	• Check the priming system by performing a “Dry Vacuum Test” per NFPA standards. If the pump holds vacuum, but primer pulls less than 22” Hg., it could indicate excessive wear in the primmer.
		  • See Section 4 Preventive Maintenance, heading “Weekly” on page 46. Also see Section 4 Preventive Maintenance, heading “Annual” on page 52.
		  • See Section 2a, heading “Priming Valves” on page 25.
		  • Repair and/or replace accordingly.
		Note: Using lubricant on the vanes and vane slots during disassembly and cleaning eventually causes a gummy residue to develop, rendering the system inoperative.

	Suction lifts too high.	• DO NOT attempt lifts exceeding 22’ (6.7 meters) except at low elevation.
	Blocked or restricted suction strainer.	• Remove obstruction from suction hose strainer. • Thoroughly clean strainer screen.
	Suction connections.	• Clean and tighten all suction connections. • Check suction hose and hose gaskets for possible defects - repair and/or replace.
	Air trapped in suction line.	• Avoid placing any part of the suction hose higher than the suction intake. • Suction hose should be laid out with continuos decline to fluid supply. • If trap in hose in unavoidable, repeated priming may be needed to eliminate air pockets in suction hose.
	Insufficient priming.	• Proper priming procedures should be followed. • Do not release the primer control before assuring a complete prime. • Open the discharge valve slowly during completion of prime to ensure complete prime.
	NOTICE ! **DO NOT RUN THE PRIMER OVER FORTH-FIVE (45) SECONDS. IF PRIME IS NOT ACHIEVED WITHIN 45 SECONDS, STOP AND LOOK FOR CAUSES (AIR LEAKS OR BLOCKED SUCTION HOSES).**	
	Pump pressure too low when nozzle is opened.	• Prime pump again and maintain higher pump pressure while opening the discharge valve slowly.

Chart continued on next page.

Figure 5-2: Troubleshooting Chart

Condition	Possible Cause	Suggested Corrective Action

Pump Loses Prime or Will Not Prime - continued.	Air leaks.	• Attempt to located and correct air leaks using the following procedures:
		  • Perform “Dry Vacuum Test” on pump per NFPA standards with 22” Hg. minimum vacuum required with loss not to exceed 10” Hg. in five (5) minutes.
		  • 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.
		  • After priming shut OFF the engine. Audible detection of a leak is often possible.
		• Connect the suction hose from the hydrant or the discharge of another pumper to pressurize the pump with water and look for visible leakage and correct. A pressure of 100 PSI (6.9 BAR) should be sufficient. DO NOT exceed pressure limitations of pump, accessories or piping connections.
		• The suction side relief valve can leak. Plug the valve outlet connection and retest

Insufficient Pump Capacity.	Insufficient engine power.	• Engine power check and tune up may be required for peak engine and pump performance. • Also see Section “Rotation Symptoms.” on page 65. • 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. • Check truck manual for proper speed counter ratio.
	Relief valve improperly set - if so equipped.	• If relief valve pressure is set too low it allows the valve to open and bypass water. • Reset the relief valve pressure accordingly. • Also see Section 4 Preventive Maintenance, heading “Relief Valve Test” on page 46.
	Suction hose diameter is too small for the volume being discharged.	• Use larger suction hose. • Shorten total length by remove one length at a time. • Reduce volume of discharge.
	Restriction in suction line at strainer.	• Remove any debris restricting entrance of water at the strainer. • Also see Section 4 Preventive Maintenance, heading “Intake Strainers” on page 48.

Chart continued on next page.

Figure 5-2: Troubleshooting Chart

Condition	Possible Cause	Suggested Corrective Action
Insufficient Pump Capacity - continued.	Air leaks.	• See heading “Air leaks.” under condition “ Pump Loses Prime or Will Not Prime” on page 61.
	Partial collapse of the lining in a suction hose.	• Damage to the outer lining may allow air between the outer and inner linings causing a partial collapse. • Replace hose and retest.
	Engine governor set incorrectly.	• If the engine governor is set too LOW (pressure), when on automatic, engine speed decelerates before the desired pressure is achieved. • Reset governor per manufacturer’s procedures.
	Truck transmission in wrong gear or clutch is slipping.	• Recheck the pumping procedures for the recommended transmission or gear range - review Section 3 “Basic Operation,” beginning on page 27. • Use a mechanical speed counter on the pump panel to check speed against possible clutch or transmission slippage or inaccurate tachometer. • Check truck manual for proper speed counter ration.
Insufficient Pressure.	Insufficient engine power.	• See previous heading “Insufficient Pump Capacity.” on page 61.
Remote Control Difficult to Operate.	Lack of lubrication.	• Lubricate the remote control linkages and collar with oil. For lubricant recommendations, see “Appendix C1: Lube and Sealant Specifications” on page 119.
Engine Speeds Too HIGH for Required Capacity or Pressure.	Truck transmission in wrong gear or range.	• Recheck the pumping procedures for the recommended transmission or gear range - review Section 3 “Basic Operation,” beginning on page 27. • Check truck manual for proper speed counter ration.
	Lift too high, suction hose too small.	• Higher than normal lift (10 ft. / 3.1m) causes higher engine speeds, high vacuum and rough operation. • Use larger suction hose. • Move the pump closer to the water source.
	Faulty suction hose.	• Inner lining of suction hose may collapse when drafting and is usually undetectable. • Try a different suction hose on the same pump. • Test for comparison against original hose.
	Blockage at suction hose entry.	• Clean suction hose strainer of obstruction. See Section 4 Preventive Maintenance, heading “Intake Strainers” on page 48. • Follow recommended practices for laying suction hose. • Keep off the bottom of the fluid supply by at least 2’ (0.6 meters) below the surface of the fluid.

Chart continued on next page.

Figure 5-2: Troubleshooting Chart

Condition	Possible Cause	Suggested Corrective Action
Engine Speeds Too HIGH for Required Capacity or Pressure - continued.	Pump is approaching "Cavitation."	• Gate the discharge valves to allow pressure to increase. This reduces the flow. • Reduce the throttle opening to the original pressure setting. • See "Appendix F: Cavitation" on page 125.
	Worn pump impeller(s) or clearance rings.	• Repair and/or replace as needed. See Section 6 Repair, heading "Servicing the Pump" on page 79.
	Impeller blockage.	• A blocked impeller can prevent loss of both capacity and pressure. • Back flushing the pump from discharge to suction may free the blockage. • Removing half the pump body may be necessary - this is considered a major repair.
Cavitation (Pump beginning to cavitate.) **Note:** Also see "Appendix F: Cavitation" on page 125.	Discharging more water than the pump is taking in.	• Increase the flow into the pump with more and/or larger intake lines. • Gate the discharge valves to reduce flow and maintain pressure.
	Air leak.	• Verify that the air bleeder on the suction tube is NOT open. • Locate and eliminate all air leaks during maintenance.
	Drafting too high.	• Verify lift hose, hose friction, water temperature and other lift limiting factors are reduced or eliminated. • Locate the pump closer to the water source.
	Water temperature too high.	• Reduce volume discharge by lowering the RPM or gating the discharge valves. • Locate a source of cooler water.
	Suction hoes diameter is too small for the volume being discharged.	• Use a large suction hose. • Shorten the total length by removing one length of hose. • Reduce volume of discharge.
	Restriction in suction line at strainer.	• Remove any debris restricting entrance of water at the strainer. • Also see Section 4 Preventive Maintenance, heading "Intake Strainers" on page 48.
Relief Valve Does Not Relieve Pressure When Relief Valves are Closed. ***Chart continued on next page.***	Incorrect setting of control (PDM) Valve.	• Check and repeat proper procedures for setting relief valve system. • See Section 3 Operation, heading 3.6 "Relief Valve Procedures" on page 40.

Figure 5-2: Troubleshooting Chart

Condition	Possible Cause	Suggested Corrective Action
Relief Valve Does Not Relieve Pressure When Relief Valves are Closed - continued.	Relief valve inoperative.	• Possibly in need of lubrication. Remove valve from pump, dismantle, clean and lubricate. • Refer to relief valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.
Relief Valve Does Not Recover and Return to Original Pressure Setting After Opening Valves.	Dirt in system causing sticky or slow reaction.	• Check and repeat proper procedures for setting the relief valve system. • See Section 3 Operation, heading 3.6 “Relief Valve Procedures” on page 40.
	Relief valve inoperative.	• Blocked bleed orifice - clean the bleed orifice with a small wire or straightened paper clip. • Refer to relief valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.
Relief Valve Opens When Control Valves are Locked Out.	Drain hole in housing, piston or sensing valve is blocked.	• Clean the valve drain hole with a small wire or straightened paper clip. • Refer to relief / sensing valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.
Unable to Obtain Proper Setting on Relief Valves.	Using the wrong procedures.	• Check instructions for setting the relief valve and reset. • See Section 3 Operation, heading 3.6 “Relief Valve Procedures” on page 40.
	Blocked strainer.	• Check and clean the strainer in the supply line from the pump discharge to the control valve. Check truck manual for location. • Also see Section 4 Preventive Maintenance, heading “Intake Strainers” on page 48. • Check and clean tubing lines related to the relief and control valves.
	Dirty control valve.	• Remove the control valve and clean.
	“Hunting” condition.	• Insufficient water supply from the pump to the control valve. • Check the strainer and relief valve system for flow restrictions. • Remove and clean the control valve.

Discharge Valves Are Difficult to Operate.
 	
Chart continued on next page.
	Lack of lubrication.	• Recommended weekly lubrication of discharge and suction valve.
		• Use a good grade, petroleum based, silicone grease.
		  • For Hale Products, SVS Valves, etc., use Never-Seez® White Food Grade with PTFE.
		  • Also see “Appendix C1: Lube and Sealant Specifications” on page 119.
		• Refer to separate valve manual for additional information.

Figure 5-2: Troubleshooting Chart

Condition	Possible Cause	Suggested Corrective Action
Discharge Valves Are Difficult to Operate - continued.	Valve in need of more clearance for operation.	• Multi-gasket design allows additional gaskets for more clearance and free operation. • **Note:** Adding too many gaskets to the valve eventually causes leakage.
Water/Moisture in Pump Gearbox.	Leak coming from above the pump.	• Check all piping connections and tank overflow for possible spillage falling directly onto the pump gearbox. • Repair accordingly.
	Operating or a driving condition that submerges the gearbox in water.	• Visually inspect the unit for external signs of water leakage. • 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 52.
	Normal condensation.	• Depending on area / region where unit is operated, normal condensation can develop over time. • Periodic inspection and possibly more frequent oil changes are needed.
	Leaking oil seal or mechanical seal.	• Inspect the oil seals and replace as needed. If the oil seal checks OK, the mechanical seal may be leaking. • There must be NO leaks at the mechanical seal. See Section 6a “Mechanical Seal Assembly” on page 93. • Hydrostatic test the system to determine leakage.
Rotation Symptoms. (Reduced pressure 60-100 PSI [4.1-6.9 BAR] and reduced flow.)	Wrong impeller installed.	• Verify the new impeller vanes are oriented the same as the old impeller before installing. (See Figure 2-7: “Typical Volute Discharge Positions,” on page 18.) • Refer to relief / sensing valve manual and follow maintenance instructions for disassembly, cleaning and lubrication.
	Wrong application attempted.	• The pump was installed on an application for which it was not intended, i.e., front mount vs. rear mount.
	NOTICE ! **IT IS POSSIBLE TO REASSEMBLE THE PUMP INCORRECTLY OR WITH THE WRONG PARTS. ALWAYS COMPARE THE REPLACEMENT PARTS WITH THE ORIGINAL HARDWARE. CONTACT CUSTOMER SERVICE AT HALE PRODUCTS TO ANSWER QUESTIONS OR CONCERNS.**	

Figure 5-2: Troubleshooting Chart

Notes

6 Repair

6.1 OVERVIEW

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

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

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

6.2 GENERAL REPAIR GUIDELINES

Before You Begin...

For a parts breakdown and identification, see Section "Drawing Package" on page 181.

READ ALL INSTRUCTIONS THOROUGHLY BEFORE BEGINNING ANY SERVICE REPAIR.

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

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

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

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

WARNINGS !

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

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

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

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

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

5. Remove necessary body panels and framework to gain access to the pump compartment and pump and gearbox assembly.

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

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

7. Where grease is called for, use a Lithium-based grease with 1% to 3% Molybdenum Disulfate. For a listing, see Section “Appendix C1: Lube and Sealant Specifications” on page 119

   Also see Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 52.

8. When replacing fasteners, use the proper nuts, bolts, and other hardware. Also ensure screws/bolts are properly torqued where required. (See Table 6-1: "Typical Torque Values Chart.")

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

Table 6-1: Typical Torque Values Chart

Many are specifically rated; that is, SAE Grade 5 or higher. Unless otherwise specified, fasteners are Grade 5 SAE.

Gearbox - Apply a coating of Loctite #246 High Temperature Removable Threadlock (or equivalent) to all bolts on the gearbox before installing.

Hale Series Pump - Apply a coating of Loctite #242 Medium Strength Threadlock (or equivalent) to all bolts on the Pump before installing.

9. 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.

When installing the mechanical seal, 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.

10. Use a pusher tool or a bearing installation tool when installing bearings and seals to avoid cocking the bearings or marking the bearing faces.

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

Gearbox Assembly

If your service involves the gearbox assembly, it is necessary to perform the following:

1. Drain oil from the gearbox - remove the magnetic pipe plug. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 52.

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

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

6.3 CLEANING AND INSPECTION GUIDELINES

When procedures call for cleaning and inspection, use the following guidelines:

1. Inspect all components for excessive or abnormal wear.

IMPORTANT !

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

2. Whenever gaskets are removed, they must be replaced. Clean all gasket material from mating surfaces before installing a new gasket. Be careful not to score the finished surfaces.

3. Bearings and seals should be inspected whenever the parts are disassembled.

- ❑ Bearings and other components should be cleaned using only recommended solvents.
- ❑ Inspect bearings for wear, pitting, and damage.
- ❑ Lightly oil or grease the shaft, O-ring seals and lip seals before reinstalling, especially when pressed-in.

4. For Hale recommended cleaners, see “Appendix C1: Lube and Sealant Specifications” on page 119

5. Inspect the gear tooth surface for wear damage and pitting. Replace all components that are worn, damaged, or pitted.

6. It is recommended to replace O-ring seals and gaskets to avoid unnecessary downtime later.

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

Tools Required

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

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

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

6.4 8FG / DSD PARTS OVERVIEW

(See Figure 6-2: “8FG / DSD Pump Parts Identification.”) Also see Figure 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox” on page 97.

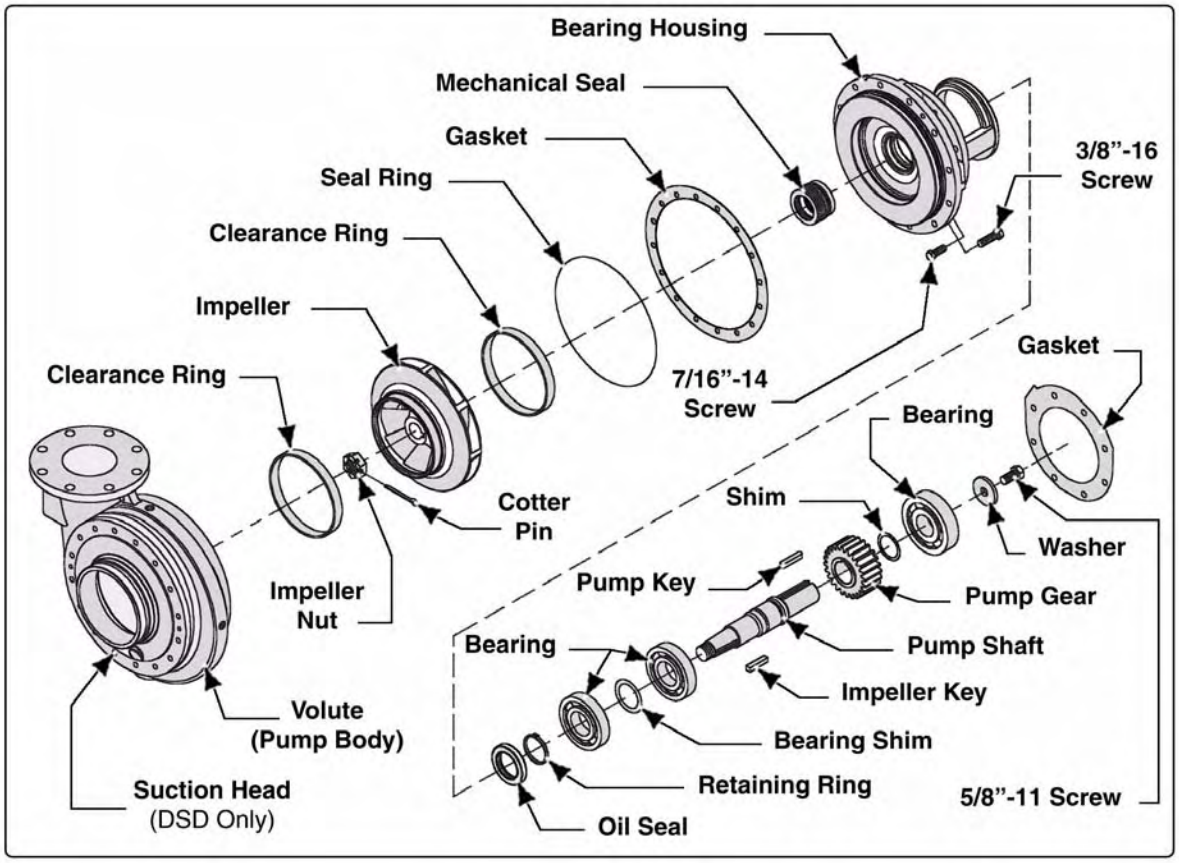

Figure 6-2: 8FG / DSD Pump Parts Identification

6.5 REMOVING ENTIRE ASSEMBLY

Review **WARNINGS !** note on pape 68 before beginning any service operation.

1. First, review preceding Section “Before You Begin...” on page 67.

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

2. Remove necessary body panels and framework to gain access to the pump compartment and pump and gearbox assembly.

Make sure there is sufficient clearance above the apparatus to lift the pump and gearbox assembly out of the apparatus.

3. Remove valve operators, discharge and suction piping and valves that would interfere with pump removal. (See Figure 6-3: “Pump / Gearbox Disconnect.”)

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

4. Drain oil from the gearbox - remove the magnetic pipe plug. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 52.

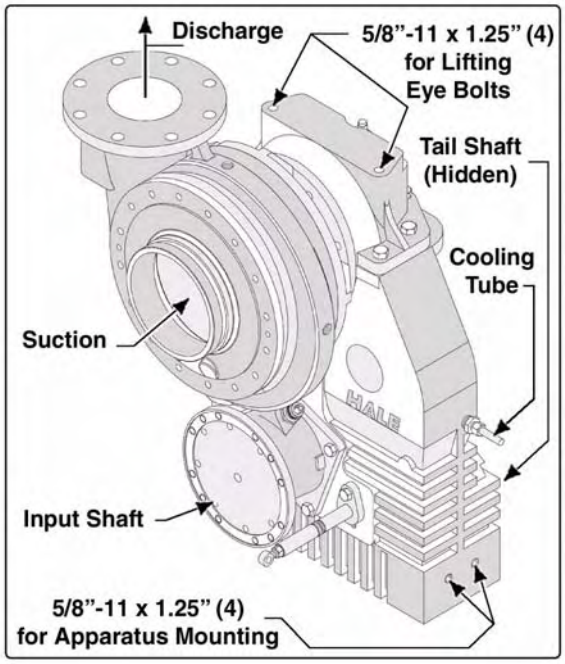

Figure 6-3: Pump / Gearbox Disconnect

   Have a suitable container available to collect fluid. For gearbox capacity, see “Appendix C1: Lube and Sealant Specifications” on page 119.

5. Disconnect drive shafts from the gearbox.

6. Install 5/8”-11 UNC eyebolts into the lifting holes on the 8FG / DSD pump body. Attach proper lifting gear to these eyebolts. (See Figure 6-3: “Pump / Gearbox Disconnect.”)

   Always use proper lifting and support apparatus (jacks, hoists, straps, chain, etc.) when servicing the unit.

   See **WARNINGS !** note on pape 68. See Section 8, heading “Drawing Package” on page 131 and review the appropriate Installation Drawing. Exercise care when using chains to protect finished surfaces from scratches.

7. With the pump assembly properly supported and balanced, disconnect the mounting brackets (5/8”-11 screws) that secure the assembly to the apparatus chassis frame.

8. Carefully remove the assembly from the apparatus.

9. Move the pump assembly to a clean work area and clamp into a suitable and stable holding device being careful not to damage the sealing surfaces.

   ❑ To service the pump - see heading 6.7 “Servicing the Pump” on page 79.

   ❑ To service the gearbox - see heading 6b.1 “Disassembly” on page 97.

Installing Entire Assembly

After completing repairs and/or maintenance, reinstall the pump and gearbox assembly to the apparatus before filling the gearbox with oil. (See Figure 6-3: “Pump / Gearbox Disconnect” on page 74.)

1. First, review preceding Section “Before You Begin...” on page 67.

2. Make sure the chassis mounting points and area around the apparatus are clean and free of obstructions.

3. Attach proper supporting devices and stabilize the assembly for transport to the apparatus. Also see **WARNINGS !** note on pape 68.

4. Place the pump assembly into position within the apparatus and align to the proper mounting points.

5. Apply Loctite and insert and tighten mounting hardware that secures the pump and gearbox assembly to the chassis frame. Torque the hardware to proper values in accordance with manufacturer’s recommendations. Also see Table 6-1: “Typical Torque Values Chart” on page 69.

6. With the pump secured to the apparatus, remove the lifting device and 5/8”-11 UNC eyebolts.

7. Connect the drive shaft to the gearbox. Apply a coating of Loctite to the fasteners and torque to the manufacturer’s specifications.

8. Connect all components to gearbox. Fill the gearbox to the proper oil level. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 52.

9. Reassemble and reconnect all components removed to gain access to the pump assembly, paying particular attention to your sketch 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 to gain access to the pump compartment.

11. Test the pump for proper operation per your departmental requirements. Note and repair any leaks.

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

6.6 REMOVING THE GEARBOX ONLY

(See Figure 6-4: “Typical G Series Gearbox Removal.”)

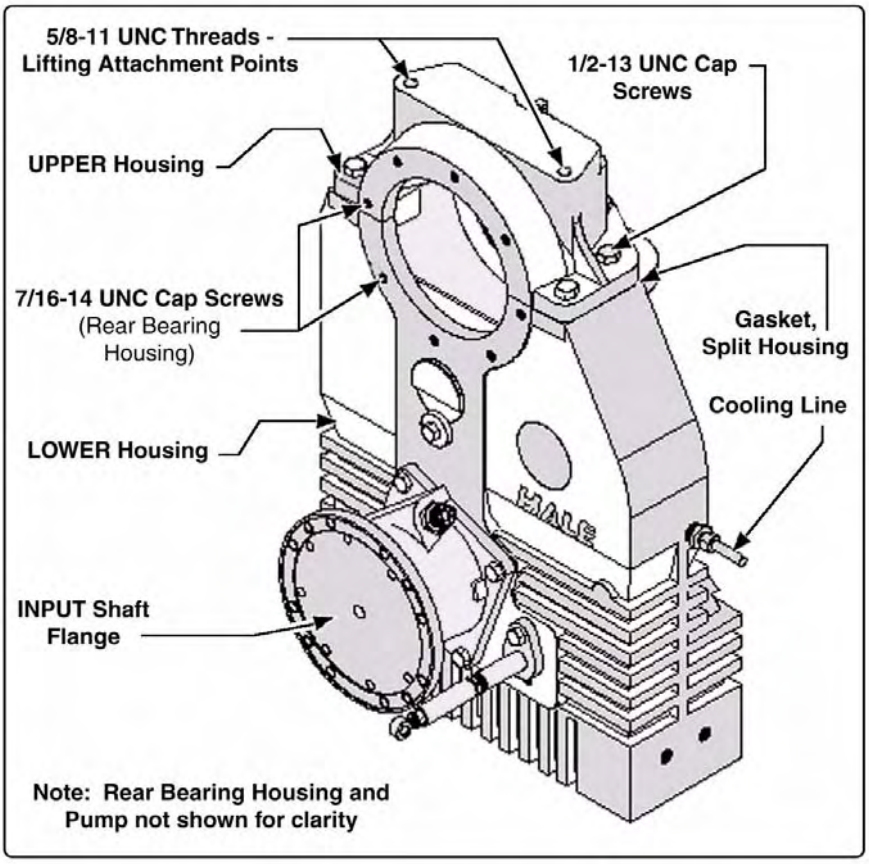

Figure 6-4: Typical G Series Gearbox Removal

1. Review preceding sections “Before You Begin...,” on page 67. Also see “WARNINGS !” on page 68.

Note: Before beginning the removal process, sketch or match-mark (tag or photograph) the plumbing and component configuration to aid in re-assembly.

WARNING !

WHEN REMOVING (UNBOLTING) THE GEARBOX FROM THE PUMP, MAKE SURE THE PUMP ASSEMBLY WITH INTERCONNECTING MANIFOLDING, VALVING, ETC. IS ADEQUATELY SUPPORT TO PREVENT THE ASSEMBLY FROM FALLING OUT OF THE APPARATUS.

2. Remove all necessary body panels and framework to gain access to the pump compartment and pump assembly. Make sure there is sufficient clearance above and/or below the apparatus to remove the gearbox assembly.

3. Drain oil from the gearbox. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 52.

   Have a suitable container available to collect excess fluid, approximately one and three (3) to four (4) quarts (3 to 4 liters), dependent on gearbox model.

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

5. Connect or position the gearbox to your supporting device and assure that the gearbox is supported. Also see **WARNINGS !** note on pape 68.

6. Remove the 1/2”-13 screws to separate the upper housing from the lower housing and to remove the service spacer plate, if installed.

   Note: The number of cap screws that secure the rear bearing housing to the gearbox depends on the gearbox model, e.g., the short gearbox uses seven (7) screws; the long gearbox uses eight (8). (See Figure 6-4: “Typical G Series Gearbox Removal” on page 76.)

7. Remove the 7/16”-14 screws securing the bearing housing to the lower gearbox housing. This frees the lower gearbox assembly.

8. Carefully remove the gearbox from the apparatus to a clean work area. Clamp the gearbox into a suitable and stable holding device being careful not to damage any sealing surfaces.

   Place a temporary cover over the exposed pump shaft and pump housing opening to prevent dirt and debris from contaminating the assembly.

9. Remove the gearbox housing gasket. Clean all gasket material from mating surfaces before installing a new gasket. Be careful not to score the finished surfaces.

10. Inspect pump shaft bearings, gear, and internal parts for signs of excessive wear or damage. Also see heading “Cleaning and Inspection Guidelines” on page 70.

    Repair and/or replace accordingly - see heading 6b “G Series Gearbox” on page 97.

Installation - Gearbox

Also see Figure 6-4: “Typical G Series Gearbox Removal” on page 76.

1. Review preceding sections “Before You Begin...,” on page 67. Also see **WARNINGS !** note on pape 68.

2. Install new gaskets to the gearbox rear bearing housing and the gearbox cover. Apply a light coat of grease to the gasket to hold them in place. Check the fit of the gaskets and carefully trim to match the contour of the gearbox, in necessary.

3. Carefully lift the gearbox into place around the rear bearing housing. Also see **WARNINGS !** note on pape 68.

4. Apply a coating of Loctite, then insert three (3) 7/16”-14 screws through the bearing housing to help hold the gearbox in place. Tighten screws hand tight.

5. Position the gearbox cover with gasket. Apply a coating of Loctite, then insert six (6) 1/2”-13 screws. Tighten screws hand tight.

6. Apply a coating of Loctite, then insert the remaining 7/16”-14 and 1/2”-13 screws through the bearing housing and gearbox cover and gaskets. Tighten all screws in a criss-cross fashion to ensure and EVEN seal and torque to:

   - ❑ 40 ft.-lb. (54 Nm) for 7/16” screw
   - ❑ 65 ft.-lb. (88 Nm) for 1/2” screw

7. Connect drive shafts, cooling lines, air hoses, and electrical connections to gearbox.

8. Fill gearbox with oil. See Section 4: Preventive Maintenance, heading “Replace Gearbox Oil” on page 52.

9. Reinstall apparatus frame work and body panels previously removed to gain access to the pump compartment.

10. Test the pump for proper operation per your departmental requirements.

Note and repair any leaks.

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

6.7 SERVICING THE PUMP

Review heading "Before You Begin..." on page 67. Also review heading "Cleaning and Inspection Guidelines" on page 70. Also review **WARNINGS !** note on pape 68.

Suction Head, DSD Pump Only

The suction head on a DSD pump is secured by sixteen (16) 3/8"-16 screws and sealed with a gasket that must be replaced whenever the joint face is disturbed. A separate seal ring is also used that must be inspected for splits, cracks, flat spots, etc. and replaced accordingly.

1. Disconnect the suction, discharge, cooling lines, and any electrical wiring.

2. Match mark the bearing housing, volute, and suction head to ensure proper realignment during reassembly. Also see Figure 6-2: "8FG / DSD Pump Parts Identification" on page 73.

3. Remove the sixteen (16) 3/8"-16 screws holding the suction head to the volute. (See Figure 6-5: "DSD Suction Head and Volute Overview.")

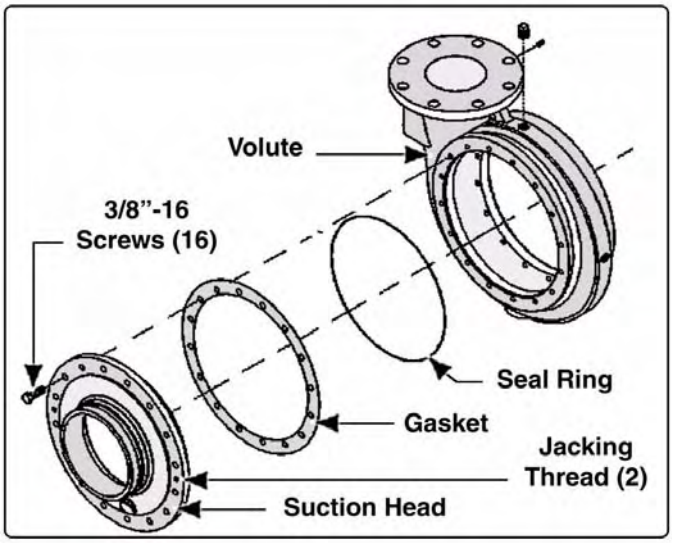

Figure 6-5: DSD Suction Head and Volute Overview

4. Install the two (2) 3/8"-16 jacking screws into the suction head flange. Tighten the jacking screws EVENLY to unseat the suction head, seal ring and gasket from the volute. Support the weight of the suction head. It is heavy and bulky.

IMPORTANT !

WHILE REMOVING THE SUCTION HEAD, BE CAREFUL NOT TO DAMAGE THE BRASS CLEARANCE RINGS OR IMPELLER.

5. Remove all remaining gasket material from the suction head and volute being careful not to scratch the finished surfaces.

6. Inspect the front clearance ring for wear and replace accordingly. (See Figure 6-6: “Volute and Pump Overview” on page 81.)

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

WARNING !

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

Note: Removing the clearance ring renders it inoperative. It must be replaced. A usual good practice is to replace both rings even if only one appears worn. Also verify the impeller clearance. Review heading “Clearance Rings, Impeller Measurement” on page 84.

Installation Notes - Suction Head, DSD Pump Only

(See Figure 6-5: “DSD Suction Head and Volute Overview” on page 79.)

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

- ❑ Review preceding sections “Before You Begin...,” on page 67 and “Cleaning and Inspection Guidelines,” on page 70 to ensure a thorough installation.
- ❑ Make sure the seal ring is seated in its groove and apply light coat of grease.
- ❑ Install a new gasket to the volute. Apply a light coat of grease to the gasket to hold it on place.
- ❑ Be careful not to damage the clearance ring or impeller during installation.
- ❑ If the clearance ring is removed, use a press to install it into the suction head being careful not to crush or damage the ring. Verify the inside diameter of the ring - see heading “Clearance Rings, Impeller Measurement” on page 84.

- ❑ Apply Loctite to all screws and tighten in a criss-cross pattern to ensure an EVEN seal.
- ❑ Refer to Table 6-1: “Typical Torque Values Chart” on page 69 for recommended torque values, fastener size and material.
- ❑ Inspect system for proper operation, then return apparatus to service.

Volute and Pump Assembly

The volute is sealed to the bearing housing with a gasket and separate seal ring. The gasket must be replaced whenever the joint face is disturbed and the seal ring must be inspected for splits, cracks, flat spots, etc. and replaced accordingly. (See Figure 6-6: “Volute and Pump Overview.”)

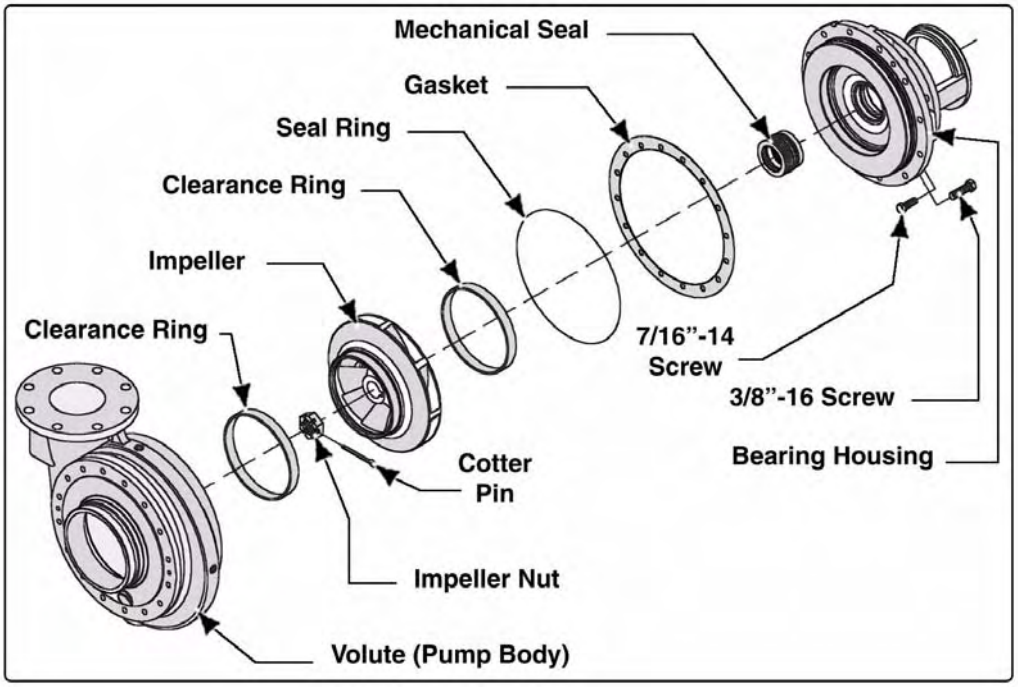

Figure 6-6: Volute and Pump Overview

1. 8FG series volutes are mounted for either engine rotation (clockwise), as viewed from the suction inlet, or opposite engine rotation (counterclockwise). Note the direction of flow before disassembly - see Section 2 Introduction, Figure 2-7: “Typical Volute Discharge Positions” on page 18.

2. Disconnect the water line compression fittings and the gearbox water cooling lines from the volute. (See Figure 6-4: “Typical G Series Gearbox Removal” on page 76.)

3. Remove the suction head (if installed) - see heading "Suction Head, DSD Pump Only" on page 79.

4. Remove the sixteen (16) 3/8"-16 screws to dismantle the volute from the bearing housing. Pull the volute body from the assembly being careful not to damage the impeller or scratch the sealing surfaces of the volute. (See Figure 6-6: "Volute and Pump Overview.")

5. If necessary, insert the two (2) 3/8"-16 jacking screws into the volute and tighten the screws EVENLY to unseat the volute, seal ring and gasket from the bearing housing.

6. Remove all remaining gasket material from the suction head and volute being careful not to scratch the finished surfaces.

IMPORTANT !

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

7. Inspect the front clearance ring for wear and replace accordingly. (See Figure 6-7: "Clearance Ring and Impeller ID / OD Measurement" on page 84.)

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

WARNING !

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

Note: Removing the clearance ring renders it inoperative. It must be replaced. A usual good practice is to replace both rings even if only one appears worn. Also verify the impeller clearance. Review heading "Clearance Rings, Impeller Measurement" on page 84.

Installation Notes - Volute

(See Figure 6-6: "Volute and Pump Overview" on page 81.)

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

- ❑ Review preceding sections “Before You Begin...,” on page 67 and “Cleaning and Inspection Guidelines,” on page 70.
- ❑ Replace all gaskets. Apply a light coat of grease to hold them in place and align on the bearing housing.
- ❑ Make sure the seal ring is seated in its groove and apply a light coat of grease.
- ❑ If the clearance rings are removed, use a press to install them into the volute being careful not to crush or damage the ring. Verify the inside diameter of the ring - see heading “Clearance Rings, Impeller Measurement” on page 84.
- ❑ When installing the volute to the bearing housing, DO NOT damage the clearance rings or impeller.
- ❑ Apply Loctite #242 or equivalent to all screws and tighten in a criss-cross pattern to ensure an EVEN seal.
- ❑ Refer to Table 6-1: “Typical Torque Values Chart” on page 69 for recommended torque values, fastener size and material.
- ❑ Reconnect all cooling lines, piping and tubing.
- ❑ Inspect the system for proper operation before returning the apparatus to service.

Impeller

(See Figure 6-2: “8FG / DSD Pump Parts Identification” on page 73.) Also see Figure 6-6: “Volute and Pump Overview” on page 81.

1. To expose the impeller, remove the:

   - ❑ Gearbox - see heading 6.6 “Removing the Gearbox Only” on page 76.
   - ❑ Bearing housing assembly - see heading 6.8 “Bearing Housing and Pump Shaft” on page 86.

   Note: On DSD pumps, the front clearance ring is pressed into the suction head. To check and/or service the front clearance ring, the suction head must be removed - see heading “Suction Head, DSD Pump Only” on page 79.

2. With the bearing housing removed from the apparatus and safely supported and secured on a suitable work surface, remove the cotter pin from the impeller nut.

3. While holding the impeller with a strap wrench, remove the impeller nut.

4. To avoid damaging the impeller, use wedges (3) or a bearing puller to remove the impeller from the pump shaft.

Place the wedges or puller at the impeller vane area where the metal is the heaviest.

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

CAUTION !

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

5. Slide the impeller from the pump shaft, then remove the impeller shaft key.

6. Inspect the rear clearance ring for wear and replace accordingly. (See Figure 6-7: “Clearance Ring and Impeller ID / OD Measurement.”)

Note: Removing the clearance ring renders it inoperative. It must be replaced. A usual good practice is to replace both rings even if only one appears worn. Also verify the impeller clearance. Review heading “Clearance Rings, Impeller Measurement” on page 84.

7. Removing the impeller may disturb the mechanical seal. A new seal must be installed - see heading 6a “Mechanical Seal Assembly” on page 93.

Clearance Rings, Impeller Measurement

(See Figure 6-7: “Clearance Ring and Impeller ID / OD Measurement.”)

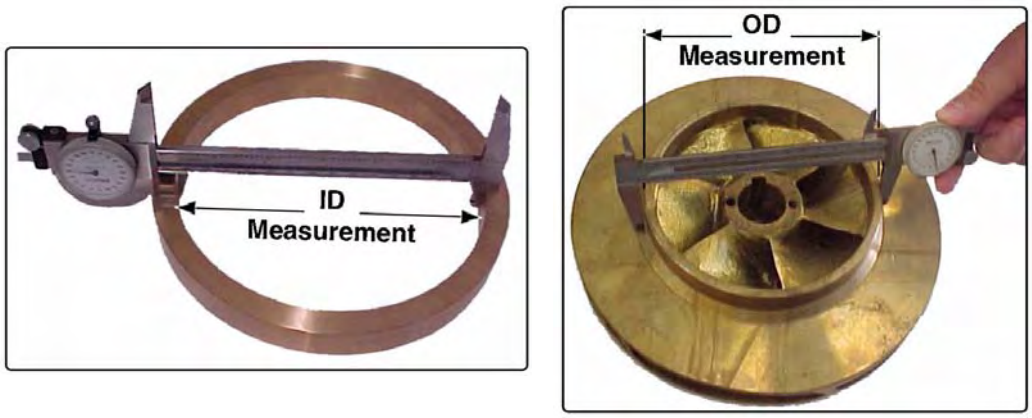

Figure 6-7: Clearance Ring and Impeller ID / OD Measurement

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. (See Figure 6-7: “Clearance Ring and Impeller ID / OD Measurement” on page 84.)

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

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

8FG Series Pump

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. 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 SEAL RING SURFACE RUNS TRUE WITH THE BORE TO WITHIN 0.002” (0.051MM).

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.

DSD Series Pump

If the gap between the impeller and the clearance rings is greater than 6.022” (153 mm) you must measure the impeller hub diameter. If the impeller diameter is greater than 6.022” (153 mm), the clearance ring must be replaced.

If the impeller diameter is less than 6.022” (153 mm) BUT more than 5.987” (152 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**.

Also see **CAUTION !** note above (on pape 85).

If the impeller diameter is less than 5.987 (152 mm) and you are not meeting pump performance, you may need to replace both the clearance rings and the impeller.

Installation Notes – Impeller

To install, follow the preceding steps in the reverse order while reviewing preceding sections “Before You Begin...” on pape 67 and “Cleaning and Inspection Guidelines” on pape 70.

- ❑ Install the impeller shaft key.
- ❑ Carefully slide the impeller over the pump shaft, aligning the keyway with the impeller key. Also see **CAUTION !** note on pape 84.
- ❑ Torque the impeller nut to 210 ft.-lbs. (285 N-m).
- ❑ Continue tightening the impeller nut until the cotter pin can be installed to lock the nut in place.
- ❑ Install cotter pin and bend over the ends.
- ❑ To install the bearing housing and gearbox, see:
  - Gearbox - see heading “Installation - Gearbox” on page 78.
  - Bearing housing assembly - see heading 6.8 “Bearing Housing and Pump Shaft” on page 86.

6.8 BEARING HOUSING AND PUMP SHAFT

Review heading “Before You Begin...” on page 67. Also review heading “Cleaning and Inspection Guidelines” on page 70.

1. To service the pump shaft assembly and oil seal you must dismantle the bearing housing assembly. (See Figure 6-8: “Bearing Housing - Oil Seal Replacement” on page 87.)

Note: Mark the bearing housing to insure it is reinstalled properly. The bore in the bearing housing is offset to provide for the different gear ratios available in the gearbox. It is imperative the bearing housing be properly oriented for reassembly.

WARNING !

SECURE THE BEARING HOUSING ASSEMBLY TO AN APPROPRIATE HOIST TO PREVENT THE HOUSING FROM FALLING, CAUSING POSSIBLE INJURY OR DAMAGE.

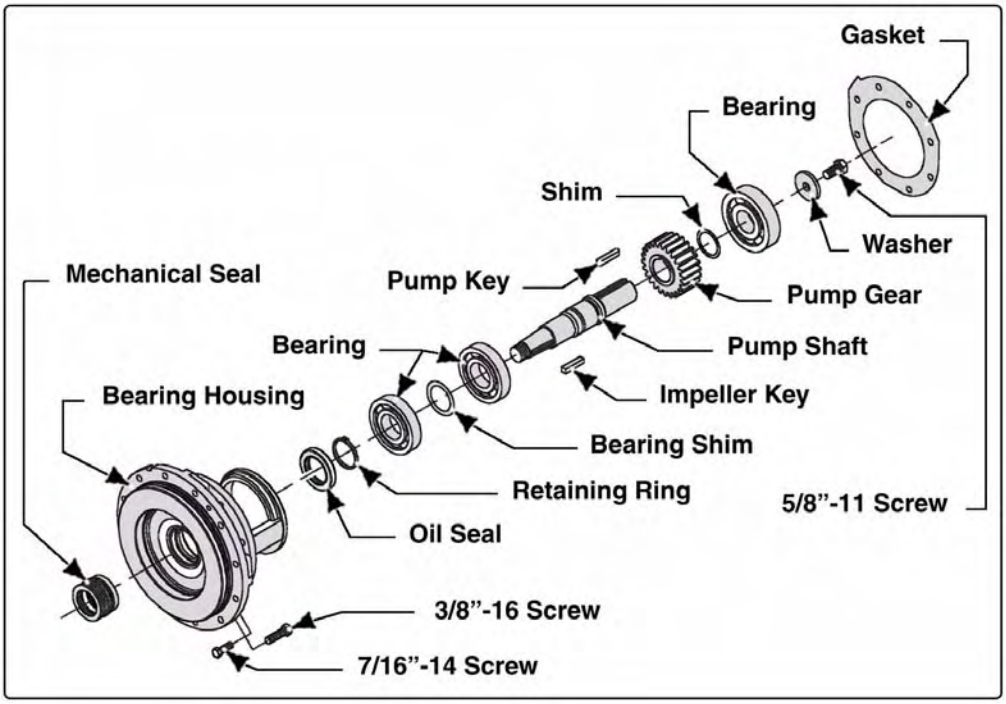

Figure 6-8: Bearing Housing - Oil Seal Replacement

2. To remove the bearing housing and expose the pump shaft assembly and oil seal, first remove the Gearbox - see heading 6.6 “Removing the Gearbox Only” on page 76. Also review **WARNINGS !** note found on page 68.

3. With the bearing housing properly supported, remove the sixteen (16) 3/8”-14 screws that secure the assembly to the volute. (See Figure 6-6: “Volute and Pump Overview” on page 81.)

4. Move the bearing housing assembly, to a suitable work area and safely support the assembly.

5. Scrape any gasket material from the bearing housing and volute.

6. If the impeller and mechanical seal are still installed, to remove them see:

   - ❑ “Impeller,” on page 83
   - ❑ “Mechanical Seal Assembly,” on page 93

7. With the impeller and mechanical seal removed, use a soft mallet to drive the pump shaft from the bearing housing. As the shaft is removed, the retaining ring assists in removing the front and rear bearings (3), bearing shim and pump gear. (See Figure 6-9: “Pump Shaft Assembly” on page 88.)

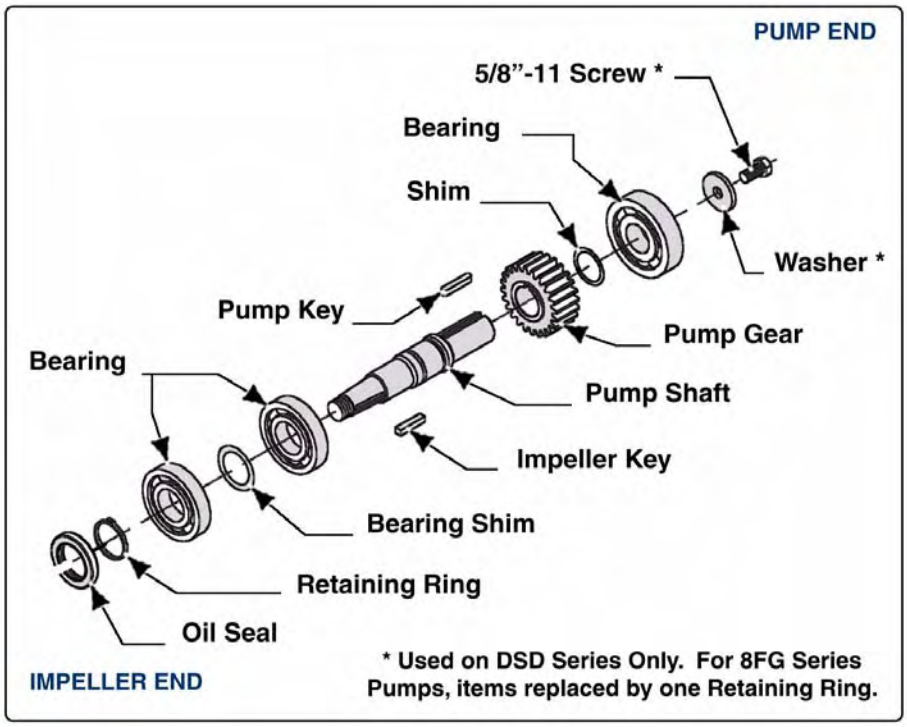

Figure 6-9: Pump Shaft Assembly

Note: If necessary use an appropriate puller to remove the rear bearing and pump gear from the pump shaft.

8. Remove the oil seal from the bearing housing and discard. Oil seals cannot be reused.

9. After all components are removed, carefully inspect the bearings, pump gear and shaft and other parts for excessive wear, chips, scoring or other damage. Repair and/or replace accordingly.

Installation – Bearing Housing and Oil Seal

Notes:

- ❑ Replace all gaskets, where applicable. Apply a thin coating of general-purpose grease to hold the gasket in place.
- ❑ When installing the bearing housing assembly to the volute, be careful not to damage the oil seal or seal ring. Apply a coating of general-purpose grease to the oil seal to ease installation.
- ❑ Apply a coating of Loctite, then install the 7/16"-14 hex screws and hardware to secure the pump head to the gearbox. Torque screws to 50 ft.-lb. (68 N-m).

- ❑ To aid in reassembly, the pump shaft may be cooled overnight in a refrigerator or freezer. It is also permissible to heat the bearings as much as 400° F (93° C) to ease installation on the shaft.

Installation

1. Insert (or press) a new oil seal into the bore of the bearing housing. Apply a coating of general-purpose grease to the oil seal to ease installation.

2. Place the pump shaft in a suitable holding fixture. On the pump end of the shaft, install:

   - ❑ one bearing up against the shaft shoulder
   - ❑ bearing shim
   - ❑ the other bearing
   - ❑ the retaining ring.

   (See Figure 6-9: “Pump Shaft Assembly” on page 88.)

3. Carefully insert the pump shaft into the bearing housing taking care to not damage the oil seal.

4. Insert pump gear shaft key and install the pump gear, from the pump end of the shaft.

5. Install a shim (approximately 0.005” / 1.5 mm), provided with the shaft replacement kit, then install the rear bearing onto the shaft. (See Figure 6-9: “Pump Shaft Assembly” on page 88.) Review Step 11. for an understand of the shim placement.

6. Secure in place using:

   - ❑ 8FG Series - retaining ring
   - ❑ DSD Series - flat washer and 5/8”-11 screw. Tighten screw to 160 ft.-lbs. (217 N-m)

7. Install the impeller, see heading “Installation Notes – Impeller,” on page 86.

8. Install the mechanical seal - see heading “Installing Seal,” on page 94.

9. Apply a light coating of grease to the new bearing housing gasket. Install the gasket to the bearing housing.

10. Using proper lifting device, position the bearing housing assembly on the gearbox. Apply a coating of Loctite, then insert the 7/16”-14 screws through the bearing housing and gasket into the gearbox to hold the assembly in place. Tighten the screws but do not torque at this time.

11. Check gap (pump shaft “float”) between the rear bearing and the gearbox housing using a 0.005” (0.127 mm) feeler gauge.

    If the float is LESS that 0.005” (0.127 mm), feeler gauge does not slide between bearing and housing, the shim must be removed.

12. Place a new gasket on the seating surface of the gearbox and gearbox cover. Check the fit of the gasket and carefully trim to match the contour of the gearbox. Once gasket is properly trimmed apply a light coating of grease to hold the gasket in place.

13. Install the gearbox cover. Apply a coating of Loctite, then insert six (6) 1/2”-13 screws. Tighten cap screws hand tight.

14. Apply a coating of Loctite, then insert the remaining four (4) 7/16”-14 screws through the bearing housing and into the gearbox cover.

15. Tighten and torque all screws as follows:

    - ❑ 7/16”-14 screws, torque to 50 ft.-lbs. (68 N-m)
    - ❑ 1/2”-13 screws, torque to 75 ft.-lbs. (102 N-m)

16. Apply a light coating of grease to the seal ring groove and install a new seal ring on the bearing housing.

17. Install a new gasket on the bearing housing, holding it in place with a light coating of grease.

18. Apply a coating of Loctite, then insert two 3/8”-16 UNC studs in the pump body to help guide the bearing housing onto the pump body.

19. Using proper lifting device, lift gearbox and bearing housing assembly into place. Use studs to guide the bearing housing into the pump body.

20. Apply a coating of Loctite, then insert sixteen (16) 3/8”-16 screws into the bearing housing and pump volute. Tighten and torque screws to 219 in.-lbs. (25 N-m).

21. Also review heading “Installation - Gearbox” on page 78.

22. Reconnect drive shafts, electrical, and airlines to gearbox.

23. Set up apparatus for pumping and test pump. Check for leaks at the piping and seal areas before returning apparatus to operation.

6.9 MAINTENANCE KITS

Disassembly of the pump and/or gearbox is a major undertaking that can remove a pump from service for a considerable period of time. Hale Products offers repair kits designed specifically for each pump and gearbox.

To purchase the repair correct kit and updated instructions for your pump, contact Hale Products, Customer Service at 1-800-220-HALE with the model and serial number of the pump. The serial number can be found on the plate located on the apparatus control panel and on the bottom of the gearbox. Also see Figure 5-1: “Sample, Serial Nameplate” on page 59.

The recommended spare parts for a three year period should include, as a minimum, one Level 1 Basic Repair Kit. An explanation of each kit follows:

Level 1, Basic

The level 1 kit contains:

- ❑ Seal rings
- ❑ Gaskets
- ❑ Retaining rings
- ❑ Oil seals
- ❑ Mechanical seal

Level 2, Intermediate

A level 2 kit is recommended as the minimum spare part kit for five years.

Level 3, Overhaul

Level 3 kits are purposed for complete overhaul of the pump. In addition to the entire contents of the Level 1 and Level 2 kits, Level 3 kits supply new a pump shaft, keys, shift fork, impellers, and gears.

Repair Kit Parts List

- p/n: 546-1690-00-0..... DSD Gasket and O-ring kit.
- p/n: 546-1690-01-0.....DSD Pump Level 1 Basic Repair Kit
- p/n: 546-1690-02-0.....DSD Pump Level 2 Intermediate Repair Kit
- p/n: 546-1690-03-0..... DSD with G gearbox Level 3 Overhaul Kit
- p/n: 546-1690-04-0.....DSD with RG gearbox Level 3 Overhaul Kit

6a Mechanical Seal Assembly

(See Figure 6a-1: “Mechanical Seal Overview / Replacement.”) Also see Figure 6-2: “8FG / DSD Pump Parts Identification” on page 73.

IMPORTANT !

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

Removing the Seal

4. To expose the mechanical seal, remove the:

   - ❑ Suction head - see heading “Suction Head, DSD Pump Only” on page 79.
   - ❑ Impeller - see heading “Impeller” on page 83.

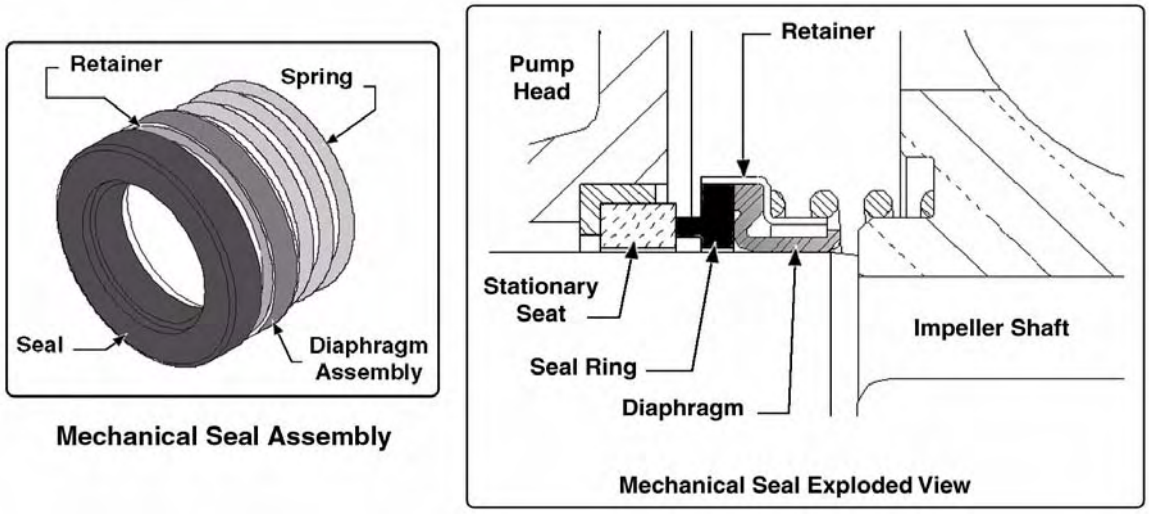

Figure 6a-1: Mechanical Seal Overview / Replacement

CAUTION !

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

CAUTION ! - continued

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

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

   - ❑ Mechanical seal spring
   - ❑ Seal diaphragm and retainer
   - ❑ Seal, stationary seat

   (See Figure 6a-1: “Mechanical Seal Overview / Replacement” on page 93.)

   Removing the mechanical seal renders it inoperative and it must be replaced.

6. After all components are removed, carefully inspect clearance rings and other parts for excessive wear or damage. Replace accordingly.

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

Installing Seal

(See Figure 6a-1: “Mechanical Seal Overview / Replacement” on page 93.)

1. See **CAUTION !** warning beginning on pape 93.

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

WARNING !

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

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

WARNING ! - continued

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

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

4. Without touching the carbon seal, slide the stationary seat into the pump head. (See Figure 6a-1: “Mechanical Seal Overview / Replacement” on page 93.)

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

6. Clean the pump shaft with alcohol swabs.

7. Apply a generous coating of PAC-EASE Rubber Lubricant Emulsion to the seal diaphragm. (See Figure 6a-1: “Mechanical Seal Overview / Replacement” on page 93.)

8. Without touching the face of the seal ring, push the ring, diaphragm, and retainer onto the shaft with the pusher tube.

9. Keep the shaft well lubricated and verify the seal ring seats against the stationary seat. If binding occurs, apply additional PAC-EASE lubricant.

10. Slide the spring (supplied with the seal) onto the shaft. The spring must seat on the seal retainer.

11. Install the impeller shaft key and carefully slide the impeller over the pump shaft, aligning the keyway with the impeller key. Also see **CAUTION !** beginning on pape 93.

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

12. To install the suction head - see heading “Installation Notes - Suction Head, DSD Pump Only” on page 80.

Notes

6b G Series Gearbox

Review heading “Before You Begin...” on page 67. Also review heading “Cleaning and Inspection Guidelines” on page 70. Also review **WARNINGS !** note found on page 68.

6B.1 DISASSEMBLY

Intermediate and Sliding Gear Shaft Assemblies

With the gearbox secured in a holding fixture, remove and disassemble the intermediate shaft assembly. (See Figure 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox.”)

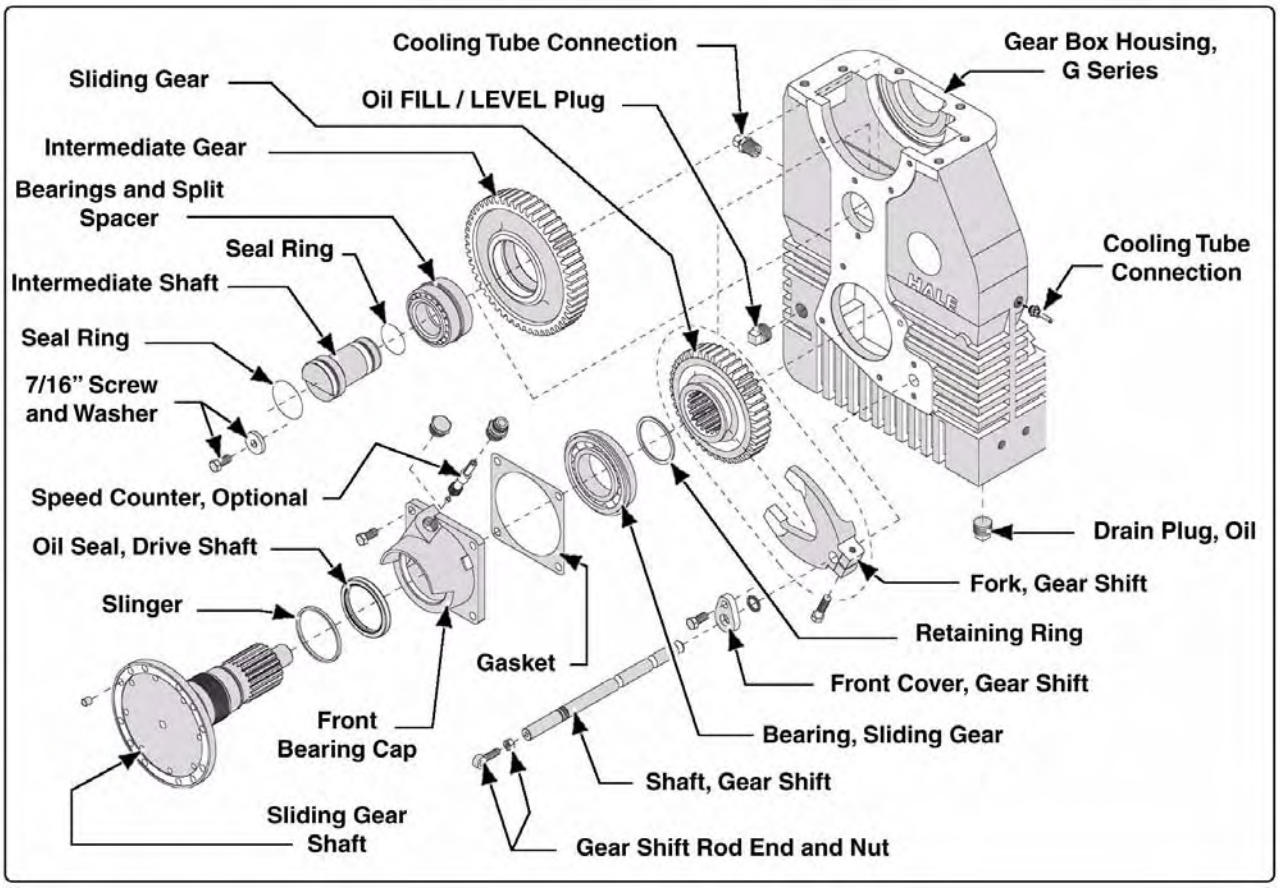

Figure 6b-1: Intermediate Shaft and Sliding Gear, Typical G Series Gearbox

1. Set the gear shift to the PUMP position to center the sliding gear under the intermediate gear and prevent dropping the intermediate gear into the gearbox housing.

2. Remove the 7/16”-14 UNC x 1” screw and washer holding the intermediate shaft in place. (See Figure 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox” on page 97.)

3. Press the intermediate gear shaft out of the gearbox housing from the rear of the unit towards the front.

4. Reach in and remove the intermediate gear assembly, which includes 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 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.

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 with the sliding gear shaft (PUMP position).

1. Remove and disassemble the tail shaft assembly by removing the four 7/16”-14 hex screws to disassemble the rear bearing cap from the gearbox. (See Figure 6b-2: “Tail Shaft Assembly” on page 99.)

2. Remove in the following order:

   - ❑ Rear bearing cap gasket. Scrape all gasket material from both mating surfaces being careful not to scratch the sealing surfaces.
   - ❑ Outer bearing retaining ring
   - ❑ Outer bearing
   - ❑ Inner bearing retaining rings (2)
   - ❑ Inner bearing

- ❑ Tail shaft from the rear bearing cap
- ❑ Drive shaft oil seal

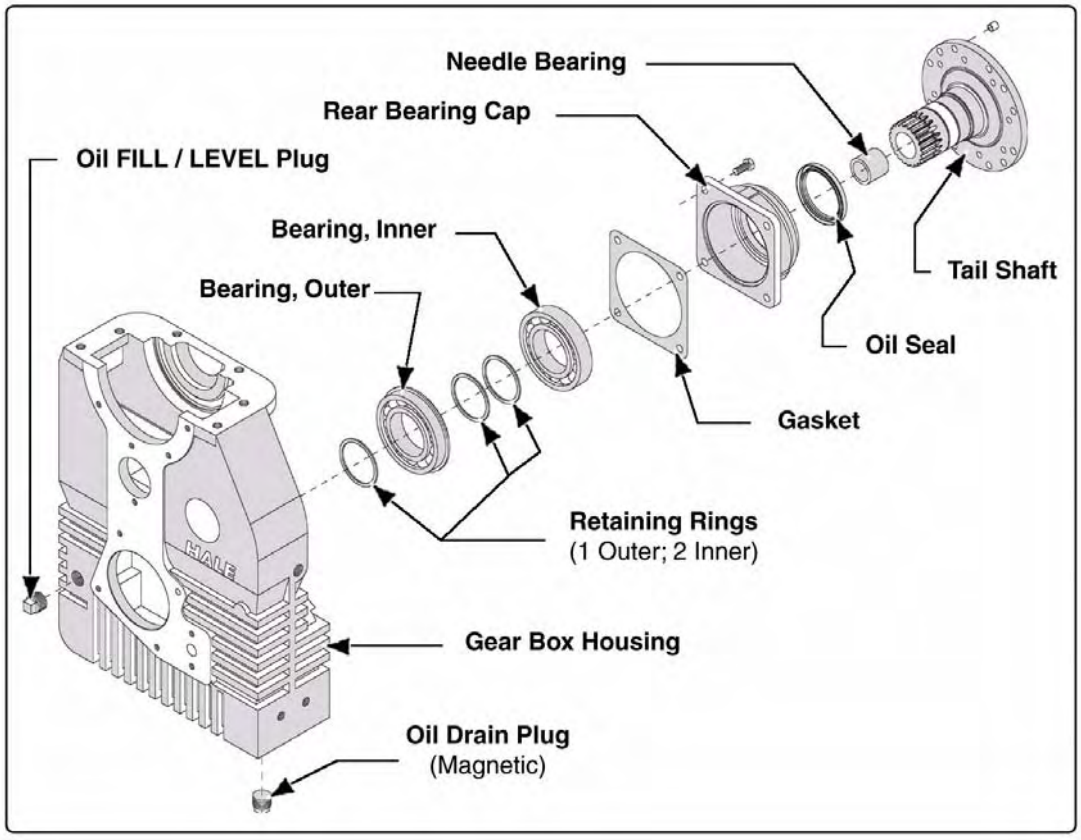

Figure 6b-2: Tail Shaft Assembly

3. Clean and inspect each component of the tail shaft assembly. Inspect bearings and needle bearing in tail shaft for wear, pitting, and damage. Inspect the gear tooth surface for wear damage and pitting.

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

Power Gearshift Assembly

(See Figure 6b-3: “Power Gearshift Assembly” on page 100.)

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.

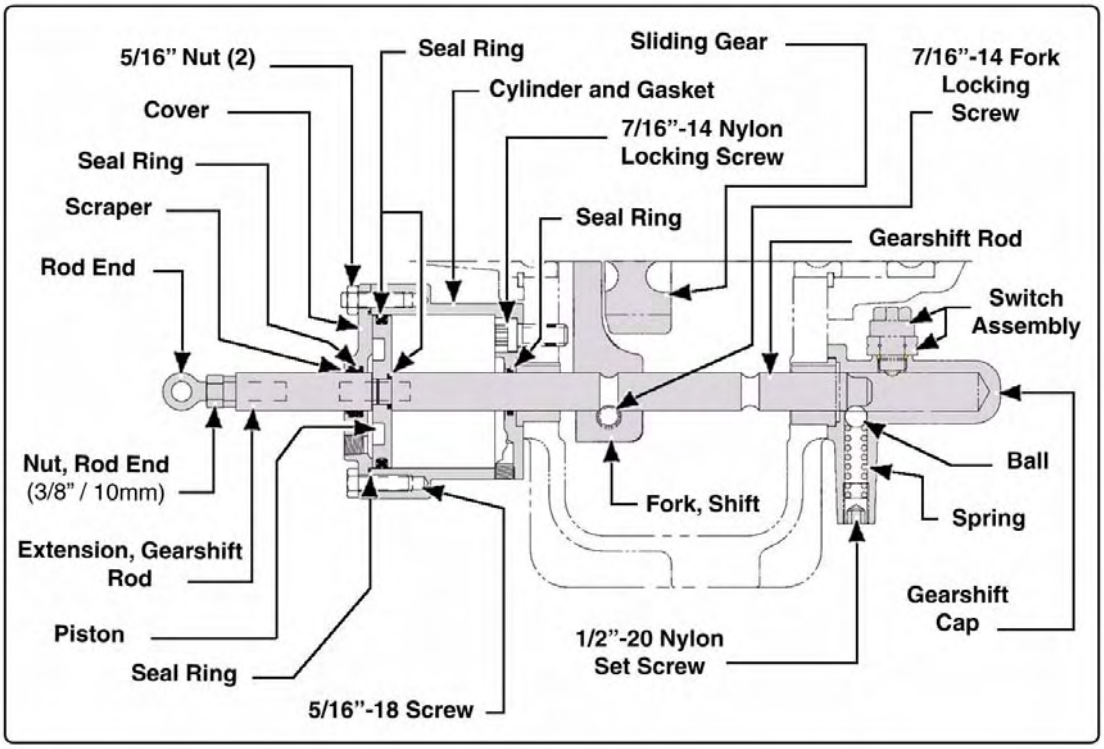

Figure 6b-3: Power Gearshift Assembly

4. Remove the two 5/16” hex nuts and 5/16”-18 screws and remove the gear shift cover. The scraper and seal ring are also removed.

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 nylon locking screws and remove the cylinder body and gasket. Scrape all gasket material from both mating surfaces being careful not to scratch the sealing surfaces.

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 101.

8. Clean and inspect each component of the gearshift shaft assembly. Inspect bearings and seal rings for wear, pitting, and damage.

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

Sliding Gear and Fork

(See Figure 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox” on page 97.)

Note: If your assembly includes the PTO drive option, you must first remove the PTO drive to enable disassembly the sliding gear and fork. See heading “PTO Drive Option, DSD Series Pump” on page 102.

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 four 7/16”-14 nylon locking screws securing the front bearing cap to the gearbox housing. Remove the bearing cap and gasket. Scrape all gasket material from both mating surfaces being careful not to scratch the sealing surfaces.

4. If the tail shaft is removed, reach in and hold the sliding gear, then remove the sliding gear assembly. Remove the sliding gear from the housing.

   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 and remove from the housing.

5. Make a note of the location of the fork in relation to the gearshift shaft before removing the fork. (See Figure 6b-3: “Power Gearshift Assembly” on page 100.)

6. Loosen the 7/16”-14 screw attaching the fork to the shaft. While holding the fork, pull the shaft out of the fork and gearbox housing. Remove the fork from the housing.

7. From the sliding gear assembly, remove in the following order:

   - ❑ Sliding gear bearing retaining ring - see Figure 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox” on page 97.
   - ❑ 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 6b-3: “Power Gearshift Assembly” on page 100.

8. Inspect the cooling tube for damage and leaks.

9. Clean and inspect each component of the sliding gear assembly for wear, pitting, and damage. Replace all components that are worn or damaged.

PTO Drive Option, DSD Series Pump

(See Figure 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox” on page 97.) Also see Figure 6b-4: “PTO Drive Option.”

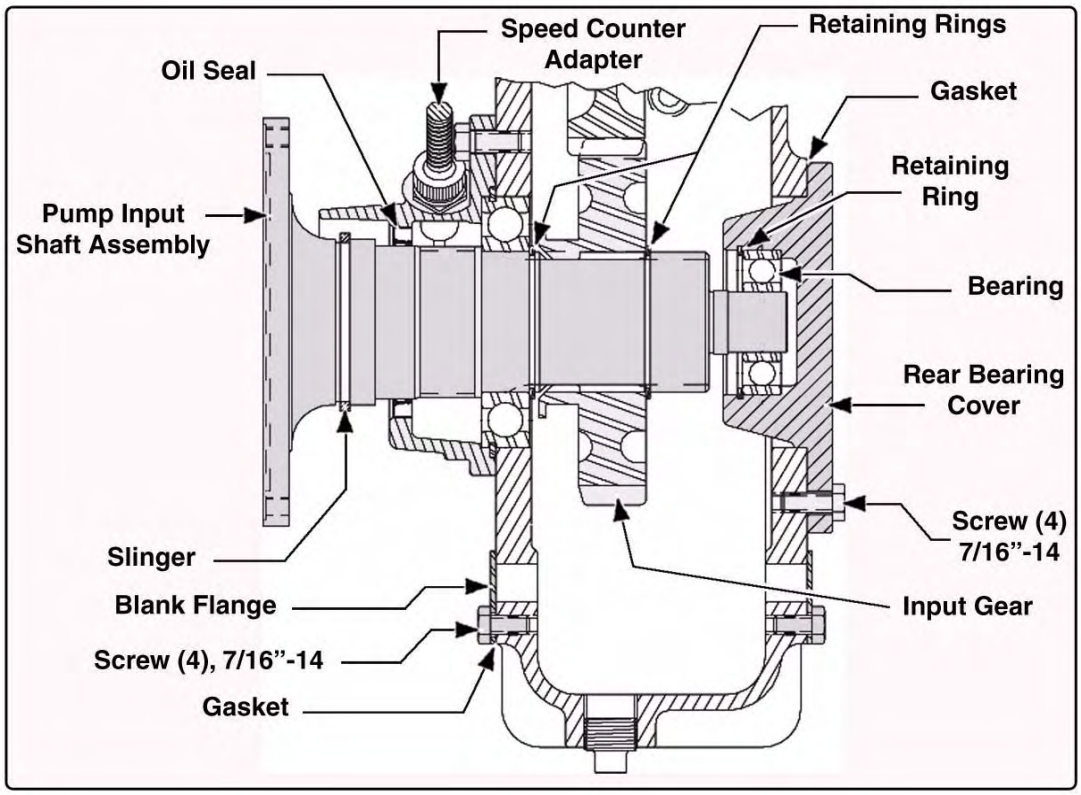

Figure 6b-4: PTO Drive Option

1. Remove the four (4) 7/16”-14 screws securing the rear bearing cap and gasket to the gearbox housing and remove the cover. Scrape all gasket material from both mating surfaces being careful not to scratch the sealing surfaces. (See Figure 6b-4: “PTO Drive Option.”)

   Removing the rear bearing cover also removes the bearing, held in place by the retaining ring.

2. Examine the rear bearing cover bearing and if required, remove the retaining ring to separate the bearing from the cover. Replace accordingly.

3. Reach inside the gearbox housing and 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 101.

5. Clean and inspect each component of the sliding gear assembly for wear, pitting, and damage. Replace all components that are worn or damaged.

6B.2 ASSEMBLY

Gearshift Cap

(See Figure 6b-3: “Power Gearshift Assembly” on page 100.)

1. Install new switch seal rings, then thread gearshift switch into the gear shift shaft cap.

2. Install a new gearshift cap gasket. Apply a thin coating of general purpose grease to hold the gasket in place.

3. Apply Loctite #242 to the two 7/16”-14 screws and install the gearshift shaft cap to the gearbox housing.

Sliding Gear Assembly

(See Figure 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox” on page 97.)

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

2. Apply Loctite #242 to the 7/16”-14 screw that attaches the fork to the shaft. Tighten and torque to 25 ft.-lbs. (34 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 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox” on page 97.)

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 allowing the retaining ring to contact the surface of the front bearing cap. (See Figure 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox” on page 97.)

6. Install the slinger on the sliding gear shaft.

7. Insert the sliding gear shaft into the front bearing cap by sliding it from the front to the rear. Be careful when sliding shaft through the drive shaft oil seal and bearing to prevent damaging the oil seal.

8. Install the bearing retaining ring.

9. Install a new front bearing cap gasket and apply a thin coating of general purpose grease to hold the gasket in place.

10. Apply Loctite #242 to the four 7/16”-14 screws. Install the sliding gear shaft and front bearing cap. Tighten and torque screws, in a criss-cross pattern, to 40 ft.-lbs. (54 N-m).

11. The sliding gear shaft must mesh with the sliding gear. Insure the gear-shift fork is in its proper position.

Tail Shaft and Gear Shift Assemblies

(See Figure 6b-2: “Tail Shaft Assembly” on page 99.)

1. Using a brass drift or bearing installation tool, install the inner tail shaft bearing in the rear bearing cap.

2. Install a new shaft oil seal.

3. Insert the tail shaft into the rear bearing housing. Be careful when sliding the shaft through the oil seal and tail shaft inner bearing to avoid damaging the oil seal.

4. Install both retaining rings.

5. Using a brass drift or bearing installation tool, install the outer tail shaft bearing onto the tail shaft until the bearing contacts the retaining ring.

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 a new gasket onto the tail shaft housing. Apply a thin coating of general purpose grease to hold the gasket in place.

9. Install the tail shaft and rear bearing cap. Ensure the needle bearing slides over the male end of the sliding gear shaft. Apply a thin coating of general purpose grease, as necessary. (See Figure 6b-2: “Tail Shaft Assembly” on page 99.)

10. Apply Loctite #242 to the four 7/16”-14 screws, then install the rear bearing cap. EVENLY tighten and torque the screws, in a criss-cross pattern, to 40 ft.-lbs. (54 N-m).

11. Install a new shifting cylinder gasket. Apply a thin coating of general purpose grease to hold the gasket in place. (See Figure 6b-3: “Power Gearshift Assembly” on page 100.)

12. Install a new shaft seal O-ring in the shifting cylinder.

13. Install the shifting cylinder by sliding it over the gearshift shaft until it contacts the gearbox housing. Apply Loctite #242 to the two 7/16”-14 nylon locking screws and tighten.

Note: Install piston retaining rings with flat side (square corners) facing away from piston.

14. Install the inner piston retaining ring, then install a new piston inner seal ring.

15. Install a new piston outer seal ring on the cylinder piston.

16. Install the cylinder piston with the flat side of the piston facing the interior of the cylinder.

17. Install the outer piston retaining ring, then install a new gearshift shaft seal on the cylinder cover.

18. Install cylinder cover. Apply Loctite #242 to the two 5/16”-18 hex screws and 5/16”-18 studs and tighten.

19. Install the gearshift rod end on the end of the gearshift shaft. Tighten the 3/8”-16 hex nut.

PTO Drive Option

(See Figure 6b-4: “PTO Drive Option” on page 102.)

1. Install a new gasket onto the rear bearing cover. Apply a thin coating of general purpose grease to hold the gasket in place.

2. Slide the rear bearing cover, with bearing (and retaining ring installed) onto the sliding gear stem. Apply a thin coating of general purpose grease to the shaft stem to assist with the installation.

3. Apply Loctite #242 to the four (4) 7/16”-14 hex screws, install, tighten and torque accordingly. (See Table 6-1: “Typical Torque Values Chart” on page 69.).

Intermediate Shaft Assembly

(See Figure 6b-1: “Intermediate Shaft and Sliding Gear, Typical G Series Gearbox” on page 97.)

1. Press a new intermediate gear bearing assembly (two bearings with split spacer) into the intermediate gear.

2. Install new seal O-rings on the ends of the intermediate shaft.

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. Apply Loctite #242 to the 7/16-14 screw, install the shaft washer and tighten the screw.

7. Rotate the sliding gear shaft and manually shift the gearshift to check for proper operation.

8. Using a lifting device remove the gearbox from the holding fixture.

9. Install the gearbox - see heading “Installation - Gearbox” on page 78.

7 Installation

7.1 OVERVIEW

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

7.2 FRAME MOUNTING

See Section 8, heading “Drawing Package” on page 127, located at the back of this manual, for the required mounting specifications. The installation drawing provides mounting configurations with bolt down specifications.

IMPORTANT!

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

WARNINGS !

THE 8FG AND DSD 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 8FG AND DSD PUMP AND GEARBOX ASSEMBLIES.

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

General Mounting

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

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

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

7.3 DRIVELINE ISSUES

Drive Line and Flange Bolts

Ensure that:

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

CAUTION !

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

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

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

Issues

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

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

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

Remember the following points while designing a driveline:

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

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

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

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

Table 7-1: Maximum Recommended Driveline Lengths

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

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

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

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

7.4 PLUMBING CONNECTIONS

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

For example:

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

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

Appendix A: Glossary

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

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

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

Capacity.....Pump flow rating.

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

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

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

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

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

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

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

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

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

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

WARNING !

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Positive Pressure .....Pressure above atmospheric.

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

Pressure .....Force per unit area.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Wear Rings.....See Clearance rings.

Appendix A-1: Measurements

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

CONVERSION CHART

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

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

Appendix C: Alternate Lubricant Manufacturers

In addition to the Hale recommended lubricants:

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

the following list of alternate oils and suppliers is provided .

Oil / Lubricant	Manufacturer
Alternate STANDARD-Temperature Lubricant (Cognis 2923/2833) See Service Manual for additional information.	
Brad Penn Full Synthetic Transmission Lube SAE-50	American Refining Group 77 N Kendall Avenue Bradford, PA 16701
Bulldog Synthetic Transmis-sion 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

Oil / Lubricant	Manufacturer
Alternate STANDARD-Temperature Lubricant (Cognis 2923/2833) See Service Manual for additional information.	
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
Alternate LOW-Temperature Lubricant (Cognis 2803) See Service Manual for additional information. CAUTION ! USE ONLY FOR EXTREME LOW TERPERTAURES, BELOW FREEZING (32° F / 0° C)	
Motorcraft Synthetic ATF	Local Ford Dealership

Table C-1: Alternate Lubricant Manufacturers

Hale Products Inc.

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

Appendix C1: Lube and Sealant Specifications

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

Table C1-2: Oil Capacity and Recommendation

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

Table C1-2: Oil Capacity and Recommendation

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

Grease

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

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

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

Loctite Sealant

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

Oil

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

Recommended Cleaners

- ❑ Safety Keen
- ❑ Stockyard Solvent

Appendix D: Hose Friction Loss

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

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

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Appendix E: Nozzle Size vs. Pressure

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

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

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

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

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Appendix F: Cavitation

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

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

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

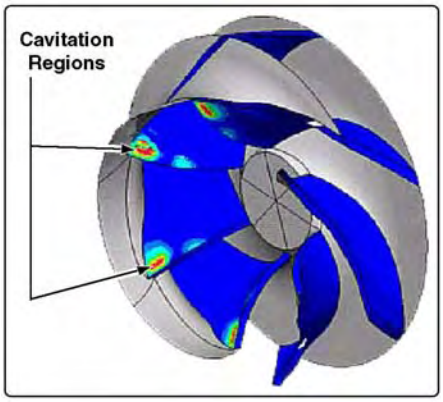

Figure F-1: Sample, Cavitation Regions

Process of Cavitation

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

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

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

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

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

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

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

Warning Signs of Cavitation (Discharge and Gauges)

Discharge Pressure

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

Vacuum Compound Gauge

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

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

To Eliminate Cavitation

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

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

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

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

During Operations

- ❑ 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. (See Figure F-3: "Lift Loss from Elevation.")
- ❑ Open the throttle gradually and watch the pressure gauge and the tachometer, if equipped. An increase in engine RPM without a corresponding increase in pressure indicates cavitation.
- ❑ Monitor the water temperature. Figure F-2: "Lift Loss from Temperature" on page 127, shows the amount of lift loss as temperatures rise.
- ❑ Monitor barometric pressure. NFPA standard sets a baseline of 29.9" Hg. (See Figure F-3a: "Lift Loss from Elevation, Barometric Reading.")
- ❑ Regularly inspect suction hoses to check for air leaks. Air leaks can also cause cavitation.

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

Figure F-2: Lift Loss from Temperature

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

Figure F-3: Lift Loss from Elevation

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

Figure F-3a: Lift Loss from Elevation, Barometric Reading

Preventive Measures

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

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

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

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

- ❑ Follow the maintenance and inspection procedures.
- ❑ Cavitation can also occur when air enters the pump. The pump could be primed; however, air leaks can cause rough operation and an increase of engine speed without an increase in pressure or flow. If an air leak is suspected, refer to Section 5 "Troubleshooting."
- ❑ Using "soft sleeve" vs. "hard sleeve." The soft sleeve has an advantage as the sleeve collapses under a partial vacuum (visual indication of cavitation), even though the intake gauge might still indicate a positive pressure. With a hard sleeve, the only indicator would be the intake gauge, which is inaccurate at close to the ZERO (0) reading.
- ❑ Clogged strainers, restricting flow. Verify the hose strainers 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 a affect on water flow which can contribute to flow restrictions, thus causing cavitation. Basket strainers are preferred due to their overall suction and straining area.

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

Express Warranty

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

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

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

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

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

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

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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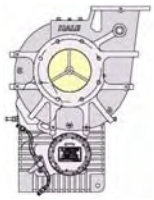

8FG / DSD Series
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Drawing Package

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IDEX CORPORATION

HALE PRODUCTS INC. ISO 9001 Certificate A4026

Manual p/n: 029-0020-93-0

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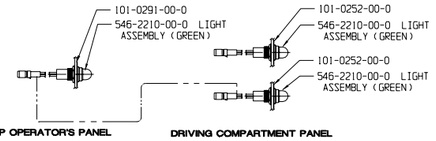
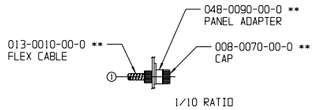
GEARBOX INDICATOR LIGHTS

FOR WIRING SCHEMATIC SEE PLATE NO. 746



OPTIONAL SPEED COUNTER ATTACHMENT (SEE PL910)



OMIT THE FOLLOWING PARTS FROM STANDARD "8FG" PUMP

217-3007-00-0 (1) PLUG-SPEEDCOUNTER

ADD THE FOLLOWING PARTS TO THE STANDARD "8FG" PUMP

007-0040-00-0 (1) ADAPTER-SPEEDCOUNTER
008-0070-00-0 (1) CAP-SPEEDCOUNTER DRIVE SLEEVE
013-0010-00-0 (1) SHAFT-SPEEDCOUNTER FLEXIBLE
031-0170-00-0 (1) GEAR-SPEEDCOUNTER DRIVEN
048-0070-00-0 (1) BUSHING-SPEEDCOUNTER DRIVE
048-0090-00-0 (1) SLEEVE-SPEEDCOUNTER DRIVE

OMIT THE FOLLOWING PARTS FROM THE STANARD "8FG" PUMP

*VPS POWER SHIFT ALL PARTS-SEE PLATE NO. 533C
*VPS CONTROL VALVE ASSY. ALL PARTS-SEE PLATE NO. 595C

ADD THE FOLLOWING PARTS TO THE STANDARD "8FG" PUMP

115-0090-00-0 (1) COVER-GEARSHIFT SHAFT FRONT
018-1810-07-0 (2) SCREW-7/16-14 X 1 LG. HEX HD ZINC PL. STL. 360 NYLON LOCKING CAP
037-1341-00-0 (1) SHAFT-GEARSHIFT
040-2109-00-0 (1) RING-GEARSHIFT SHAFT SEAL

PUMP MODEL	GEAR RATIO	"X" DIMENSION
8FGR*-23R	2.28	13.375 [340]
8FGR*-21R	2.05	13.563 [344]
8FGR*-19R	1.86	13.750 [349]
8FGR*-17R	1.71	13.938 [354]
8FGR*-15R	1.58	14.125 [359]

THE HALE TYPE 8FGR PUMP IS AVAILABLE IN 2000 & 2500 GPM NFPA RATINGS AND A 3000 GPM @ 150 PSIG RATING. THE COMPLETE PUMP MODEL NUMBER IS FORMED AS FOLLOWS:

FOR EXAMPLE, A 8FGR PUMP IS REQUIRED TO HAVE A 2500 GPM RATING WITH A 1.71 GEAR RATIO. THE PUMP MODEL NUMBER WOULD BE AS SHOWN.

8FGR 2500 - 17 R
PUMP MODEL | RATED CAPACITY | PUMP RATIO

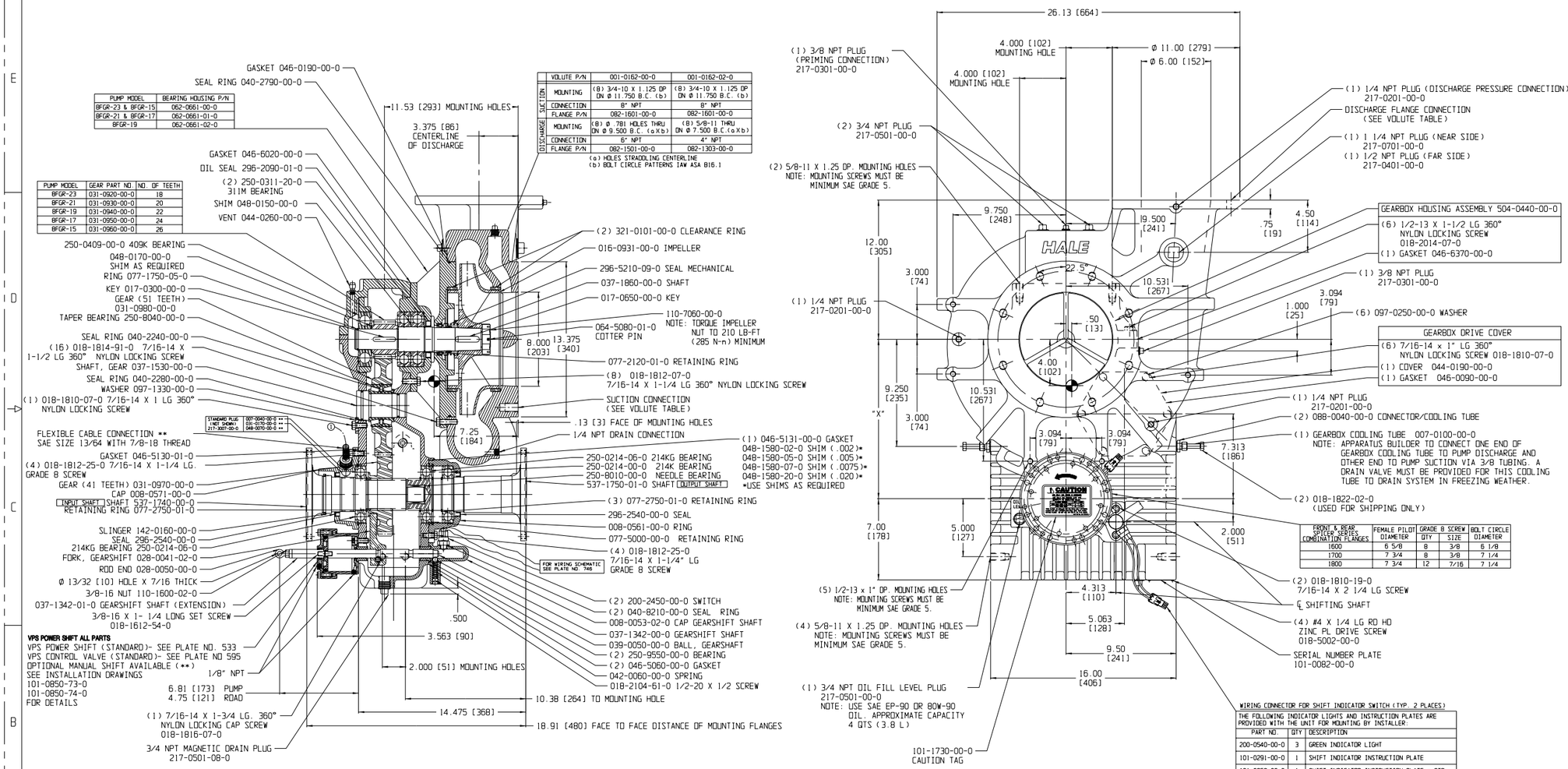
WARNING

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

MAXIMUM TORQUE ON PUMP SHAFT = 2300 LBS-FT (3118 N-m)
MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT (21,693 N-m)

PUMP MODEL	MAX GEARBOX INPUT RPM
8FGR*-23R	2630
8FGR*-21R	2920
8FGR*-19R	3220
8FGR*-17R	3500
8FGR*-15R	3800

SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA.
MAXIMUM ALLOWABLE HYDROSTATIC PRESSURE: 500 PSIG
MAXIMUM ALLOWABLE HYDRODYNAMIC PRESSURE: 400 PSIG



VOLUTE P/N		001-0162-00-0	001-0162-02-0
SUCTION	MOUNTING	(8) 3/4-10 X 1.125 DP DN Ø 11.750 B.C. (b)	(8) 3/4-10 X 1.125 DP DN Ø 11.750 B.C. (b)
	CONNECTION	8" NPT	8" NPT
	FLANGE P/N	082-1601-00-0	082-1601-00-0
DISCHARGE	MOUNTING	(8) Ø .781 HOLES THRU DN Ø 9.500 B.C. (a)(b)	(8) 5/8-11 THRU DN Ø 7.500 B.C.(a)(b)
	CONNECTION	6" NPT	4" NPT
	FLANGE P/N	082-1501-00-0	082-1303-00-0

(a) HOLES STRADDLE CENTERLINE
(b) BOLT CIRCLE PATTERNS IAW ASA B16.1

PUMP MODEL	BEARING HOUSING P/N
8FGR-23 & 8FGR-15	062-0661-00-0
8FGR-21 & 8FGR-17	062-0661-01-0
8FGR-19	062-0661-02-0

PUMP MODEL	GEAR PART NO.	NO. OF TEETH
8FGR-23	031-0920-00-0	18
8FGR-21	031-0930-00-0	20
8FGR-19	031-0940-00-0	22
8FGR-17	031-0950-00-0	24
8FGR-15	031-0960-00-0	26

FRONT & REAR SPICER SERIES COMBINATION FLANGES	FEMALE PILOT DIAMETER	GRADE 8 SCREW QTY	GRADE 8 SCREW SIZE	BOLT CIRCLE DIAMETER
1600	6 5/8	8	3/8	6 1/8
1700	7 3/4	8	3/8	7 1/4
1800	7 3/4	12	7/16	7 1/4

WIRING CONNECTOR FOR SHIFT INDICATOR SWITCH (TYP. 2 PLACES)

THE FOLLOWING INDICATOR LIGHTS AND INSTRUCTION PLATES ARE PROVIDED WITH THE UNIT FOR MOUNTING BY INSTALLER.

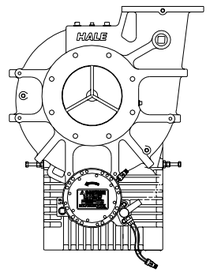
PART NO.	QTY	DESCRIPTION
200-0540-00-0	3	GREEN INDICATOR LIGHT
101-0291-00-0	1	SHIFT INDICATOR INSTRUCTION PLATE
101-0252-00-0	1*	SHIFT INDICATOR INSTRUCTION PLATE - STD.
101-0072-00-0	1*	SHIFT INDICATOR INSTRUCTION PLATE - VPS

* VPS INSTRUCTION PLATE IS REPLACED BY (1) ADDITIONAL 101-0252-00-0 INSTRUCTION PLATE FOR MANUAL SHIFT UNITS.

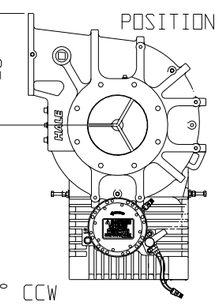
SEE HALE PLATE 746 - WIRING SCHEMATIC FOR SHIFT INDICATOR LIGHTS, FOR INSTALLATION DETAILS.

VOLUTE POSITIONS

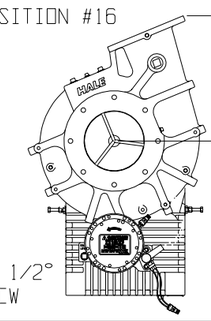
POSITION #1



POSITION #13



POSITION #16



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. DRIVELINE SHALL BE INSTALLED PER SAE UNIVERSAL JOINT AND DRIVESHAFT DESIGN MANUAL, PUBLICATION # AE-7

NOTES:

1) DIMENSIONS ARE IN INCHES & [MILLIMETERS].
2) WEIGHT 575 LBS (261 kg).
3) PRIMING SYSTEM, DISCHARGE & SUCTION VALVES ARE AVAILABLE.
4) OPTIONAL EQUIPMENT INDICATED BY (**).

ITEMS NOT SHOWN

101-0310-00-0 (1) OIL WARNING TAG
101-0940-00-0 (1) INSTRUCTION TAG

FASTENER NOTE:

UNLESS OTHERWISE NOTED FASTENERS TO BE USED ARE GRADE 5.
MAKE SURE GRADE 5 FASTENERS ARE USED TO REPLACE BROKEN OR DAMAGED FASTENERS.
DURING ASSEMBLY COAT FASTENERS WITH LOCTITE #246 (OR EQUIL) HIGH TEMPERATURE REMOVABLE THREAD LOCKER.

PLATE NO. 765AG

HALE TYPE 8FGR SERIES PUMP

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
03-132	E	REDRAWN - UPDATED	JG	4-25-03	MAL
04-017	F	018-1812-02-0 TO 018-1812-25-0	JFG	3-5-04	MAL
04-280	G	046-5130-01-0 TO 046-5131-00-0 & SHIMS	JFG	11-16-04	MAL

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

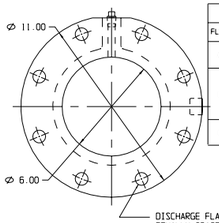
DRAWN JDR | CHECKED RET | DATE 10-24-95 | SIZE | SCALE: FULL

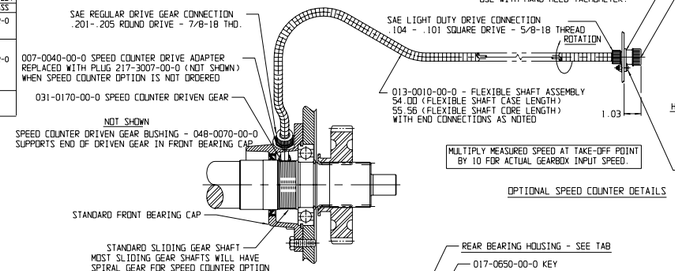
Notes

PUMP MODEL	GEAR RATIO	GEARBOX TYPE **	DIMENSIONS D	E	F	G	H	J	K	L	M	PUMP DRIVE GEAR PART NO. TEETH	INTERMEDIATE GEAR PART NO. (TEETH)	REAR BEARING HOUSING CAST IRON (STD)	REAR BEARING HOUSING BRONZE (OPTION)	GEARBOX HOUSING ASSY	DRIVE UNIT COVER GASKET
8FGF*-28	2.83	EXTRA LONG GEARBOX ONLY (X)	20.94	15.56	6.50	5.44	4.06	1.84	9.15	14.44	27.94	031-0920-00-0 (18T)	031-1310-00-0 (59T)	062-0661-00-0	062-0661-03-0	504-0510-00-0	046-6370-01-0
8FGF*-25	2.55			15.75								031-0930-00-0 (20T)		062-0661-01-0	062-0661-04-0		
8FGF*-23	2.32			15.90								031-0940-00-0 (22T)		062-0661-02-0	062-0661-05-0		
8FGF*-21	2.13			16.06								031-0950-00-0 (24T)		062-0661-01-0	062-0661-04-0		
8FGF*-19	1.96			16.25								031-0960-00-0 (26T)		062-0661-03-0			
8FGF*-23	2.28	LONG GEARBOX ONLY (L)	18.56	13.38	6.50	4.31	5.18	2.00	7.00	23.03	25.56	031-0920-00-0 (18T)	031-0980-00-0 (51T)	062-0661-00-0	062-0661-03-0	504-0340-00-0	046-6370-01-0
8FGF*-21	2.05			13.56								031-0930-00-0 (20T)		062-0661-01-0	062-0661-04-0		
8FGF*-19	1.86			13.75								031-0940-00-0 (22T)		062-0661-02-0	062-0661-05-0		
8FGF*-17	1.71			13.94								031-0950-00-0 (24T)		062-0661-01-0	062-0661-04-0		
8FGF*-15	1.58			14.13								031-0960-00-0 (26T)		062-0661-00-0	062-0661-03-0		

OPTIONAL SUCTION AND DISCHARGE FLANGES

FLANGE	FLANGE BOLT PATTERN ON VOLUTE BODY	FLANGE PART NO. (THREAD SIZE) 125 LB. CAST IRON	150 LB. BRASS
A	(8) 3/4-10UNC-2B X 1.13 DEEP TAPPED HOLES EQUALLY SPACED ON 11.75 DIA. BOLT CIRCLE AND ROTATED 22.5° FROM CENTERLINES AS SHOWN	082-1601-00-0 (8" NPT)	082-1601-02-0 (8" NPT)
B	(8) 3/4-10UNC-2B X 1.13 DEEP TAPPED HOLES EQUALLY SPACED ON 9.50 DIA. BOLT CIRCLE AND ROTATED 22.5° FROM CENTERLINES AS SHOWN (8) .781 DIA. THRU HOLES EQUALLY SPACED ON 9.50 DIA. BOLT CIRCLE AND ROTATED 22.5° FROM CENTERLINES AS SHOWN (PUMP DISCHARGE)	082-1501-00-0 (6" NPT)	082-1501-02-0 (6" NPT)
C	(8) 5/8-11UNC-2B THRU TAPPED HOLES EQUALLY SPACED ON 7.50 DIA. BOLT CIRCLE AND ROTATED 22.5° FROM CENTERLINES AS SHOWN	082-1303-00-0 (4" NPT)	N / A



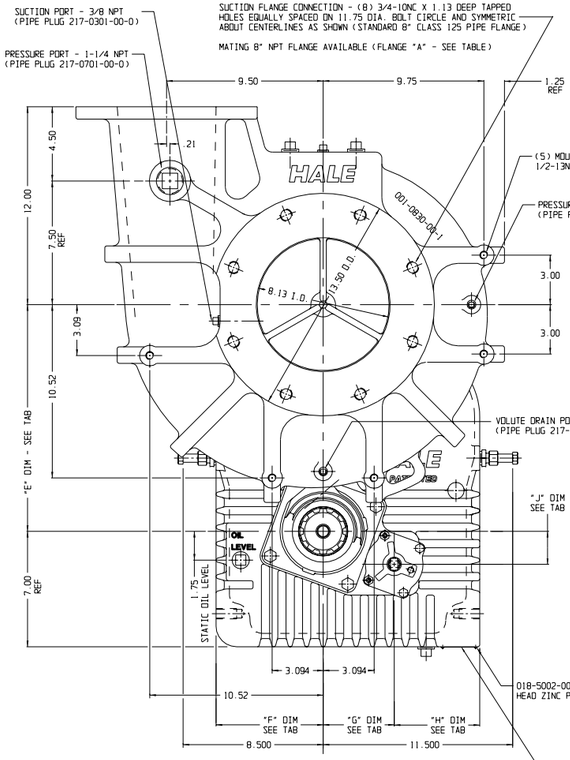


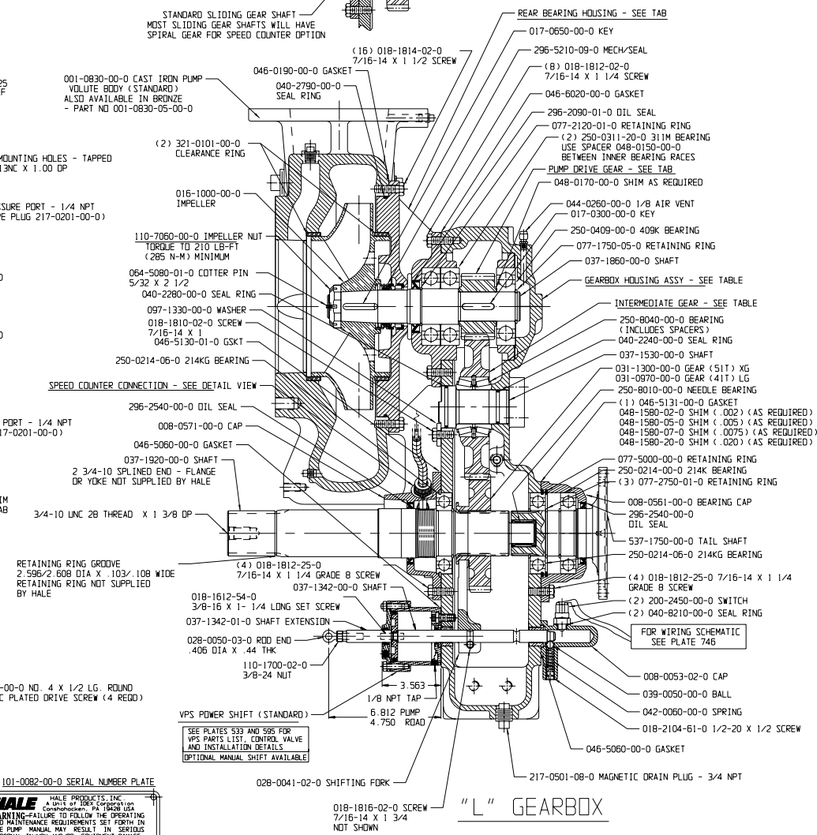
⚠ WARNING ⚠

EXCEEDING THESE LIMITS OR FAILURE TO FOLLOW THE RECOMMENDATIONS OUTLINED ON THIS DRAWING COULD DAMAGE THE GEARBOX AND RESULT IN PERSONAL INJURY.
8FGF MIDSHIP MAXIMUM PUMP PRESSURE:
HYDROSTATIC = 500 PSIG
HYDRODYNAMIC = 400 PSIG
MAXIMUM GEARBOX INPUT TORQUE (ROAD) = 16,000 LBS-FT

PUMP MODEL	8FGF*-23L	8FGF*-21L	8FGF*-19L	8FGF*-17L	8FGF*-15L
MAX GEARBOX INPUT RPM	2630	2920	3220	3500	3800
PUMP MODEL	8FGF*-28X	8FGF*-25X	8FGF*-23X	8FGF*-21X	8FGF*-19X
MAX GEARBOX INPUT RPM	2120	2350	2580	2810	3060

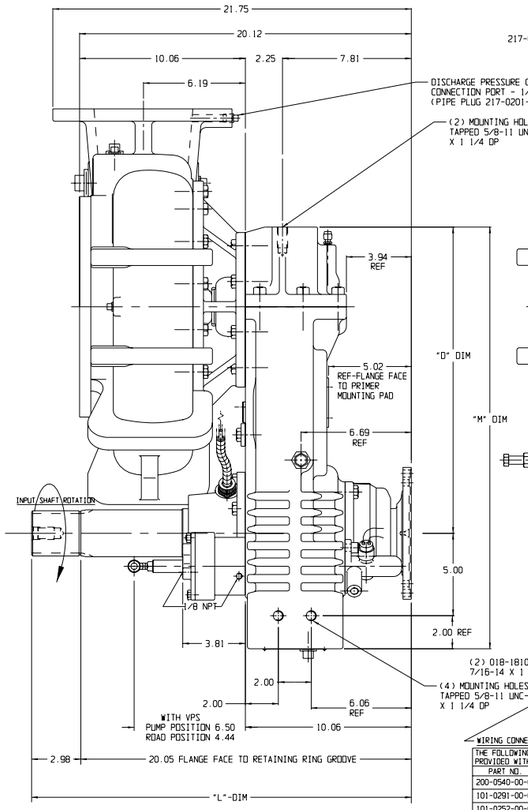
SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA.

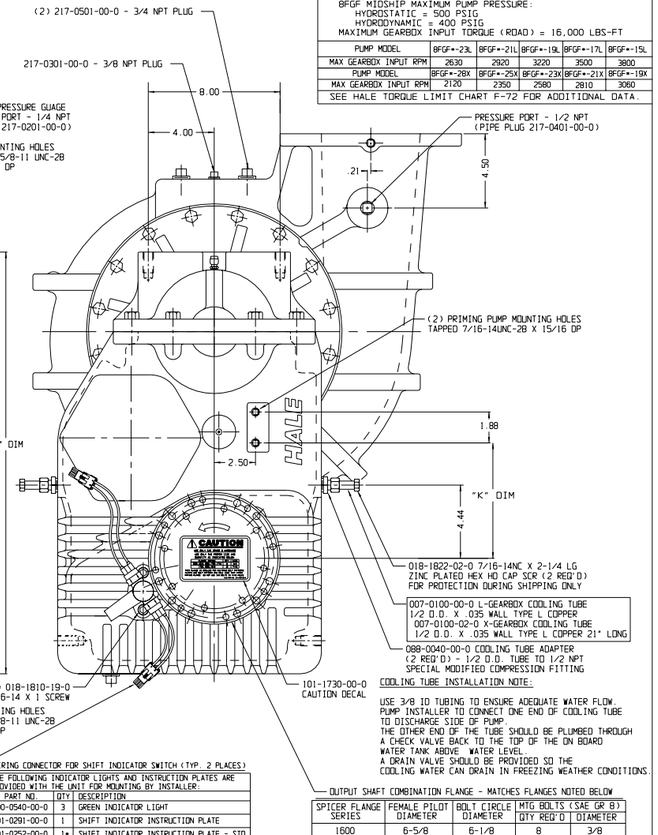




"L" GEARBOX

SOME COMPONENTS IN SECTION VIEW ARE SHOWN OUT-OF-POSITION FOR CLARITY





COOLING TUBE INSTALLATION NOTE:

USE 3/8 ID TUBING TO ENSURE ADEQUATE WATER FLOW. PUMP INSTALLER TO CONNECT ONE END OF COOLING TUBE TO DISCHARGE SIDE OF PUMP. THE OTHER END OF THE TUBE SHOULD BE PLUMBED THROUGH A CHECK VALVE BACK TO THE TOP OF THE DN BOARD WATER TANK ABOVE WATER LEVEL. A DRAIN VALVE SHOULD BE PROVIDED SO THE COOLING WATER CAN DRAIN IN FREEZING WEATHER CONDITIONS.

WIRING CONNECTOR FOR SHIFT INDICATOR SWITCH (TYP. 2 PLACES)

THE FOLLOWING INDICATOR LIGHTS AND INSTRUCTION PLATES ARE PROVIDED WITH THE UNIT FOR MOUNTING BY INSTALLER: PART NO	QTY	DESCRIPTION
200-0540-00-0	3	GREEN INDICATOR LIGHT
101-0291-00-0	1	SHIFT INDICATOR INSTRUCTION PLATE
101-0252-00-0	1*	SHIFT INDICATOR INSTRUCTION PLATE - STD.
101-0072-00-0	1*	SHIFT INDICATOR INSTRUCTION PLATE - VPS

* VPS INSTRUCTION PLATE IS REPLACED BY (1) ADDITIONAL 101-0252-00-0 INSTRUCTION PLATE FOR MANUAL SHIFT UNITS.

SEE HALE PLATE 746 - WIRING SCHEMATIC FOR SHIFT INDICATOR LIGHTS, FOR INSTALLATION DETAILS.

OUTPUT SHAFT COMBINATION FLANGE - MATCHES FLANGES NOTED BELOW

SPICER FLANGE SERIES	FEMALE PILOT DIAMETER	BOLT CIRCLE DIAMETER	MTG BOLTS (SAE GR 8) QTY REQ'D	DIAMETER
1600	6-5/8	6-1/8	8	3/8
1700	7-3/4	7-1/4	8	3/8
1800	7-3/4	7-1/4	12	7/16

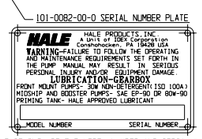
HALE TYPE 8FGF MODEL IDENTIFICATION

THE HALE TYPE 8FGF PUMP IS AVAILABLE WITH 2000 AND 2500 GPM NFPA RATINGS, AND A 3000 GPM AT 150 PSI RATING. FIVE DRIVE RATIOS ARE AVAILABLE TO ADAPT THE 8FGF TO A WIDE VARIETY OF APPLICATIONS (SEE RATIO CHART).
THE RATING, RATIO, AND DRIVE UNIT TYPE DETERMINE THE MODEL NUMBER. FOR EXAMPLE, THE FULL MODEL NUMBER FOR AN 8FGF RATED AT 3000 GPM WITH A 2.28 : 1 DRIVE RATIO AND HALE "L" TYPE DRIVE UNIT WOULD BE:

8FGF-3000-23 L

- PUMP TYPE
- CAPACITY IN U.S. GALLONS PER MINUTE
- DRIVE RATIO (23 = 1 : 2.28)
- INPUT RPM X RATIO = IMPELLER RPM
- DRIVE UNIT TYPE

BE SURE TO INCLUDE THE MODEL NUMBER AND SERIAL NUMBER WHEN ORDERING PARTS OR REQUESTING INFORMATION. THE MODEL / SERIAL NUMBER PLATE IS LOCATED ON BOTTOM OF GEAR DRIVE AS SHOWN IN DRAWING.

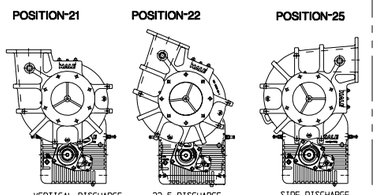


101-0082-00-0 SERIAL NUMBER PLATE

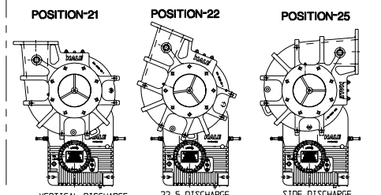
PLEASE INCLUDE THE MODEL NUMBER AND SERIAL NUMBER WHEN ORDERING PARTS OR REQUESTING INFORMATION

⚠ 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

"L"-SERIES GEARBOX



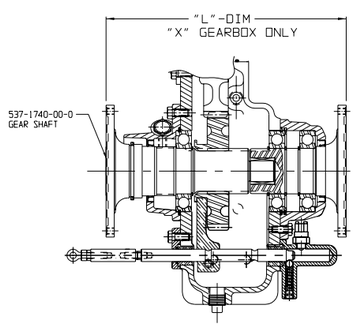
"X"-SERIES GEARBOX



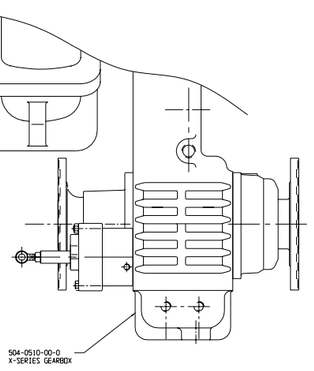
INPUT SHAFT AND PUMP SHAFT ROTATE CLOCKWISE ("ENGINE ROTATION") IN THESE VIEWS

VERTICAL DISCHARGE IS STANDARD UNLESS 22.5 OR SIDE DISCHARGE IS SPECIFIED ON ORDER. ADDITIONAL PUMP BODY AND GEARBOX POSITIONS ARE POSSIBLE - PLEASE CONSULT THE FACTORY

NOTE:
REFER TO SECTION VIEW ABOVE FOR ALL OTHER PARTS.



"X" GEARBOX ONLY



FASTENER NOTE:

UNLESS OTHERWISE NOTED FASTENERS TO BE USED ARE GRADE 5.
MAKE SURE GRADE 5 FASTENERS ARE USED TO REPLACE BROKEN OR DAMAGED FASTENERS.
DURING ASSEMBLY COAT FASTENERS WITH LOCTITE #246 (OR EQUAL) HIGH TEMPERATURE REMOVABLE THREAD LOCKER.

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 5,018,665
4,587,862 5,139,393
4,653,978

PLATE 784AH

HALE TYPE 8FGF SERIES PUMP

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
04-017	G	UPDATED VPS ADDED SPLIT SHIFT SHAFT-037-1342-00-0 AND SHOWN 037-1342-01-0 SHAFT EXTENSION 018-1812-02-0 TO 018-1812-25-0	TKC	1-22-04	MAL
04-280	H	046-5130-01-0 TO 046-5131-00-0 & SHIMS	JFG	11-16-04	MAL

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
99-215	D	1) WAS 250-0311-00-0 2) WAS 018-1815-07-0 3) WAS 296-2540-00-0 (2) PL	DPL	8-20-99	RET
01-151	E	UPDATE W/DESCRIPTIONS	TKC	3-22-01	MAL
01-210	F	ADDED SHIM 048-0170-00-0	TKC	4-27-01	MAL

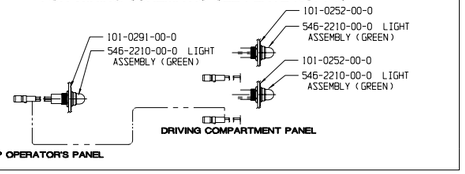
ECO NO	REV	CHANGED FROM	BY	DATE	APVD
95-291	A	RELEASED FOR PRODUCTION	AJD	6-1-95	ROT
97-42	B	ADDED "L" TO MODEL DESIGNATION AND TO RATIO TABLE. ADDED NOTES FOR EXTRA LONG GEARBOX. ENG. WAS MARKED "PRELIMINARY"	AJD	3-31-97	MD

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

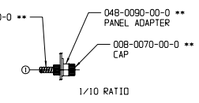
DRAWN: AJD | DATE: 11-1-95 | SIZE: 37 X 22 | SCALE: 1/4
CHECKED: ROT

Notes

FOR WIRING SCHEMATIC SEE PLATE NO. 746



OPTIONAL SPEED COUNTER ATTACHMENT (SEE PL910)



OMIT THE FOLLOWING PARTS FROM STANDARD "8FG" PUMP

217-3007-00-0 (1) PLUG-SPEEDCOUNTER

ADD THE FOLLOWING PARTS TO THE STANDARD "8FG" PUMP

007-0040-00-0 (1) ADAPTER-SPEEDCOUNTER
008-0070-00-0 (1) CAP-SPEEDCOUNTER DRIVE SLEEVE
013-0010-00-0 (1) SHAFT-SPEEDCOUNTER FLEXIBLE
031-0170-00-0 (1) GEAR-SPEEDCOUNTER DRIVEN
048-0070-00-0 (1) BUSHING-SPEEDCOUNTER DRIVE
048-0090-00-0 (1) SLEEVE-SPEEDCOUNTER DRIVE

OPTIONAL VPS ATTACHMENT (SEE PL533)

OMIT THE FOLLOWING PARTS FROM THE STANARD "8FG" PUMP

*VPS POWER SHIFT ALL PARTS-SEE PLATE NO. 533C
*VPS CONTROL VALVE ASSY. ALL PARTS-SEE PLATE NO. 595C

ADD THE FOLLOWING PARTS TO THE STANDARD "8FG" PUMP

115-0090-00-0 (1) COVER-GEARSHIFT SHAFT FRONT
018-1810-07-0 (2) SCREW-7/16-14 X 1 LG. HEX HD ZINC PL. STL. 360 NYLON LOCKING CAP
037-1341-00-0 (1) SHAFT-GEARSHIFT
040-2109-00-0 (1) RING-GEARSHIFT SHAFT SEAL

WARNING

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

MAXIMUM TORQUE ON PUMP SHAFT = 2300 LBS-FT (3118 N-m)
MAXIMUM GEARBOX SHAFT TORQUE (RDAD) = 16,000 LBS-FT (21,693 N-m)

PUMP MODEL	MAX GEARBOX INPUT RPM
8FGR*-28R	2120
8FGR*-25R	2350
8FGR*-23R	2630
8FGR*-21R	2920
8FGR*-19R	3220

SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA.
MAXIMUM ALLOWABLE HYDROSTATIC PRESSURE: 500 PSIG
MAXIMUM ALLOWABLE HYDRODYNAMIC PRESSURE: 400 PSIG

HALE TYPE 8FGR MODEL IDENTIFICATION

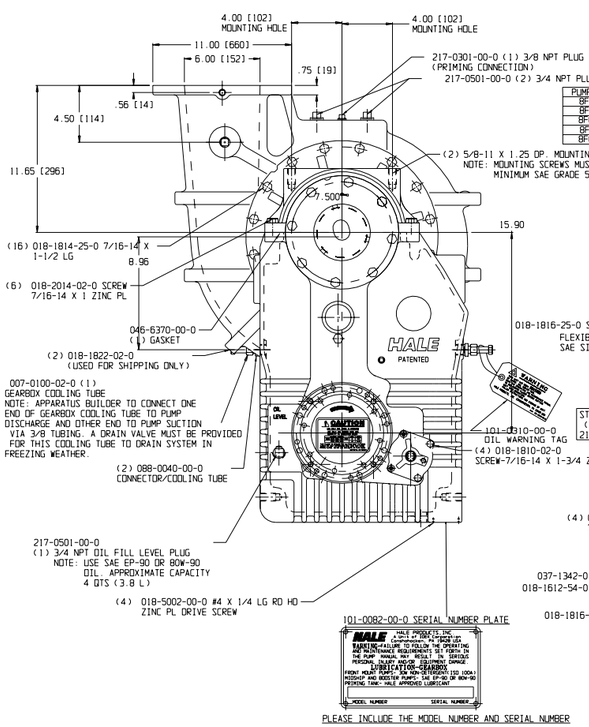
THE HALE TYPE 8FGR PUMP IS AVAILABLE WITH FIVE DRIVE RATIOS TO ADAPT THE 8FGR TO A WIDE VARIETY OF APPLICATIONS (SEE RATIO CHART). THE RATING, RATIO, AND DRIVE UNIT TYPE DETERMINE THE MODEL NUMBER. FOR EXAMPLE, THE FULL MODEL NUMBER FOR AN 8FGR RATED AT 3000 GPM WITH A 2.83 : 1 DRIVE RATIO AND HALE "X" TYPE DRIVE UNIT WOULD BE:

8FGR-3000-28 X
- PUMP TYPE
- CAPACITY IN U.S. GALLONS PER MINUTE
- DRIVE UNIT TYPE

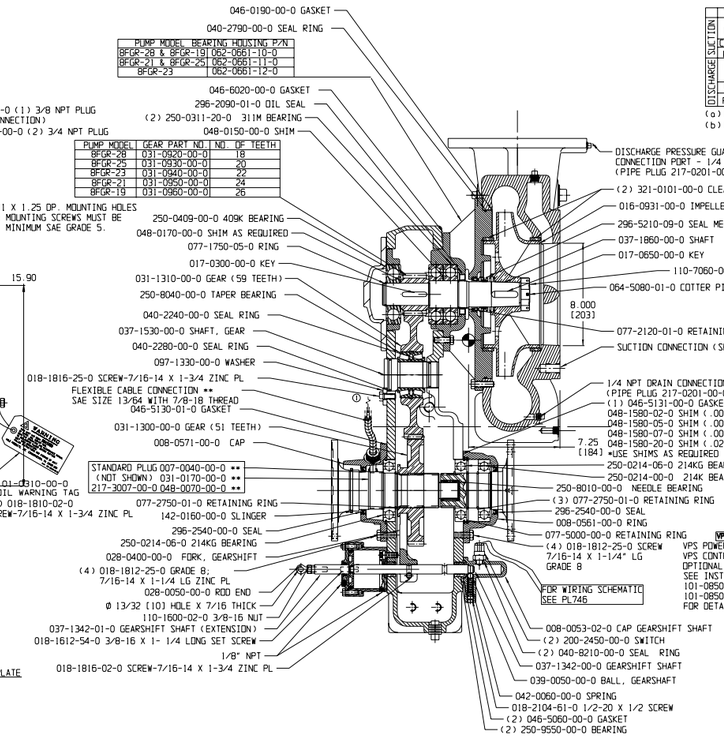
DRIVE RATIO (28 = 1 : 2.83)
INPUT RPM X RATIO = IMPELLER RPM

BE SURE TO INCLUDE THE MODEL NUMBER AND SERIAL NUMBER WHEN ORDERING PARTS OR REQUESTING INFORMATION. THE MODEL / SERIAL NUMBER PLATE IS LOCATED ON BOTTOM OF GEAR DRIVE AS SHOWN IN DRAWING.

PUMP MODEL	GEAR RATIO	"X" DIMENSION
8FGR*-28X	2.83	15.56 [395]
8FGR*-25X	2.55	15.75[400]
8FGR*-23X	2.32	15.90[404]
8FGR*-21X	2.13	16.06[408]
8FGR*-19X	1.96	16.25[412]

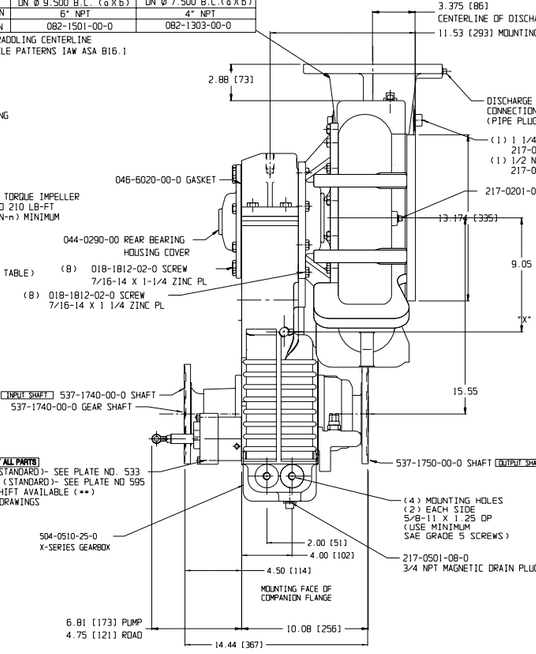


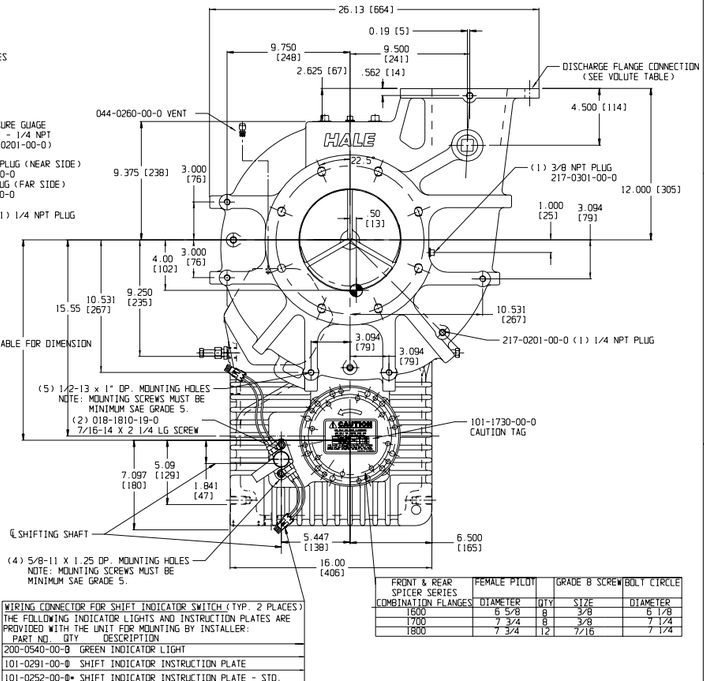
PLEASE INCLUDE THE MODEL NUMBER AND SERIAL NUMBER WHEN ORDERING PARTS OR REQUESTING INFORMATION



DISCHARGE SUCTION	VOLUTE P/N	001-0162-00-0	001-0162-02-0
	MOUNTING	(8) 3/4-10 X 1.125 DP ON Ø 11.750 B.C. (b)	(8) 3/4-10 X 1.125 DP ON Ø 11.750 B.C. (b)
	CONNECTION	8" NPT	8" NPT
	FLANGE P/N	082-1601-00-0	082-1601-00-0
	MOUNTING	(8) Ø .781 HOLES THRU ON Ø 9.500 B.C. (a)(b)	(8) 5/8-11 THRU ON Ø 7.500 B.C.(a)(b)
	CONNECTION	6" NPT	4" NPT
	FLANGE P/N	082-1501-00-0	082-1303-00-0

(a) HOLES STRADDLING CENTERLINE
(b) BOLT CIRCLE PATTERNS IAW ASA B16.1





WIRING CONNECTOR FOR SHIFT INDICATOR SWITCH (TYP. 2 PLACES)
THE FOLLOWING INDICATOR LIGHTS AND INSTRUCTION PLATES ARE PROVIDED WITH THE UNIT FOR MOUNTING BY INSTALLER:

PART NO.	QTY	DESCRIPTION
200-0540-00-0	1	GREEN INDICATOR LIGHT
101-0291-00-0	1	SHIFT INDICATOR INSTRUCTION PLATE
101-0252-00-0*	1	SHIFT INDICATOR INSTRUCTION PLATE - STD.
101-0072-00-0*	1	SHIFT INDICATOR INSTRUCTION PLATE - VPS

* VPS INSTRUCTION PLATE IS REPLACED BY (1) ADDITIONAL 101-0252-00-0 INSTRUCTION PLATE FOR MANUAL SHIFT UNITS. SEE HALE PLATE 746 - WIRING SCHEMATIC FOR SHIFT INDICATOR LIGHTS, FOR INSTALLATION DETAILS.

FRONT & REAR SPICER SERIES COMBINATION FLANGES	FEMALE PILOT DIAMETER	GRADE 8 SCREW QTY	GRADE 8 SCREW SIZE	BOLT CIRCLE DIAMETER
1600	6 5/8	8	3/8	6 1/8
1700	7 3/4	8	3/8	7 1/4
1800	7 3/4	12	7/16	7 1/4

NOTES:

1) WEIGHT 575 LBS. (261 KG).
2) PRIMING SYSTE, DISCHARGE & SUCTION VALVES ARE AVAILABLE.
3) OPTIONAL EQUIPMENT INDICATED BY (**).
4) DIMENSIONS ARE IN INCHES & [MILLIMETERS].
5)101-0940-00-0 (1) INSTRUCTION TAG NOT SHOWN.

FASTENER NOTE:
UNLESS OTHERWISE NOTED FASTENERS TO BE USED ARE GRADE 5.
MAKE SURE GRADE 5 FASTENERS ARE USED TO REPLACE BROKEN OR DAMAGED FASTENERS.
DURING ASSEMBLY COAT FASTENERS WITH LOCTITE #246 (OR EQUIL) HIGH TEMPERATURE REMOVABLE THREAD LOCKER.

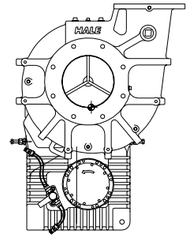
⚠ WARNING ALL WIRING AND INSTALLATION DETAILS MUST CONFORM TO ALL APPLICABLE NFPA AND SAE STANDARDS. VERIFY OPERATION OF PUMP ENGAGED INDICATOR LIGHTS AND INTERLOCKS BEFORE PLACING APPARATUS IN SERVICE.

DRIVE LINE RECOMMENDATIONS:

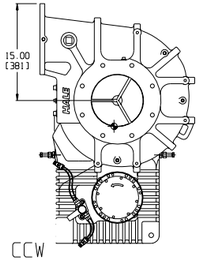
APPARATUS BUILDER SUPPLIED DRIVELINES SHALL BE OF APPROPRIATE SIZE TO MATCH THE CHASSIS AND PUMP REQUIREMENTS WITH INDIVIDUAL JOINT CANCELLATION AND PHASING BEFORE AND AFTER THE PUMP. DRIVE SHAFT BALANCE (INCLUDING YOKES) SHALL NOT EXCEED THE RECOMMENDED LIMIT OF EITHER THE DRIVE SHAFT OR CHASSIS TRANSMISSION MANUFACTURER'S SPECIFICATIONS. DRIVE SHAFT FULL RANGE OPERATING SPEEDS SHALL NOT EXCEED 42% OF ITS CRITICAL SPEED. DRIVELINE SHALL BE INSTALLED PER SAE UNIVERSAL JOINT AND DRIVESHAFT DESIGN MANUAL, PUBLICATION # AE-7. ALL DRIVELINES MUST CONFORM TO HALE BULLETIN #957. U-JOINT ANGLES SHOULD BE NO LESS THAN 1°; THE MAXIMUM ALLOWABLE ANGLE AND TUBE DIAMETER SHOULD BE CONFIRMED WITH THE MANUFACTUREER OF THE DRIVELINE FOR THE PARTICULAR APPLICATION.

VOLUTE POSITIONS

POSITION #1



POSITION #13



POSITION #16

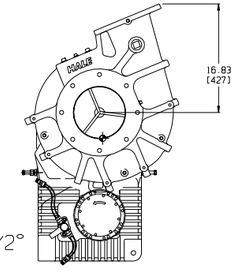


PLATE NO. 1075AA HALE TYPE 8FGR SERIES PUMP

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
0060	A	RELEASE FOR PRODUCTION	EDF	8/15/05	

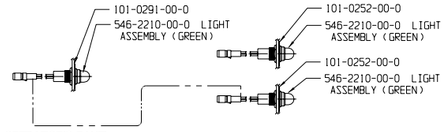
HALE PRODUCTS, INC.
A Unit of IDEX Corporation
Conshohocken, PA 19428 USA

DRAWN EDF | CHECKED MAL | DATE 06/02/05 | SIZE | SCALE: FULL

Notes

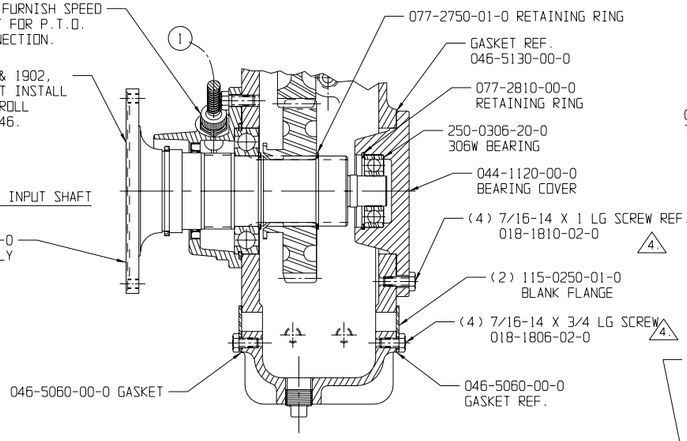
GEARBOX INDICATOR LIGHTS

FOR WIRING SCHEMATIC SEE PLATE NO. 746

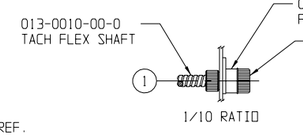


NOTE: APPARATUS MANUFACTURER TO FURNISH SPEED COUNTER ADAPTER TO CORRECT FOR P.T.O. RATIO. 1"-20 THREADED CONNECTION.

NOTE: TO CONFORM TO NFPA 1901 & 1902, THE APPARATUS MANUFACTURER MUST INSTALL INDICATOR LIGHTS FOR PUMP AND ROLL OPERATION PER HALE PLATE NO. 746.



PTO DRIVE OPTION
REAR OUTPUT SHAFT BLANKED-OFF



SPEED COUNTER ATTACHMENT
SEE PLATE 910 FOR FURTHER DETAIL

PUMP MODEL 'XG' GEARBOX	GEAR RATIO	PUMP MODEL 'LG' GEARBOX	GEAR RATIO
DSD*-28X	2.83	DSD*-23L	2.28
DSD*-25X	2.55	DSD*-21L	2.05
DSD*-23X	2.32	DSD*-19L	1.86
DSD*-21X	2.13	DSD*-17L	1.71
DSD*-19X	1.96	DSD*-15L	1.58

THE HALE TYPE DSD PUMP IS AVAILABLE IN 750, 1000, 1250 & 1500 GPM NFPA RATINGS. THE COMPLETE PUMP MODEL NUMBER IS FORMED AS FOLLOWS: DSD 125 23 X

FOR EXAMPLE, A DSD PUMP IS REQUIRED TO HAVE A 1250 GPM RATING WITH A 2.28 GEAR RATIO. THE PUMP MODEL NUMBER WOULD BE AS SHOWN.

PUMP MODEL | RATED CAPACITY | PUMP RATIO | GEARBOX TYPE

WARNING

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

MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT (21,693 N-m)

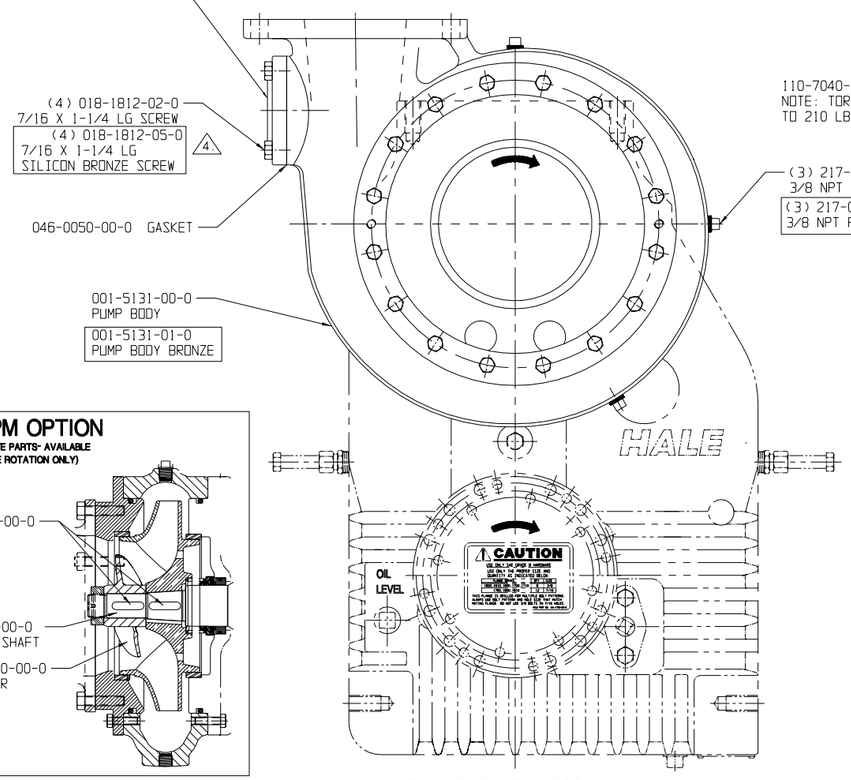
PUMP MODEL	MAX GEARBOX INPUT RPM	PUMP MODEL	MAX GEARBOX INPUT RPM
DSD*-23L	2630	DSD*-28X	2120
DSD*-21L	2920	DSD*-25X	2350
DSD*-19L	3220	DSD*-23X	2580
DSD*-17L	3500	DSD*-21X	2810
DSD*-15L	3800	DSD*-19X	3060

SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA.
MAXIMUM ALLOWABLE HYDRODYNAMIC PRESSURE: 400 PSIG
MAXIMUM ALLOWABLE HYDROSTATIC PRESSURE: 600 PSIG

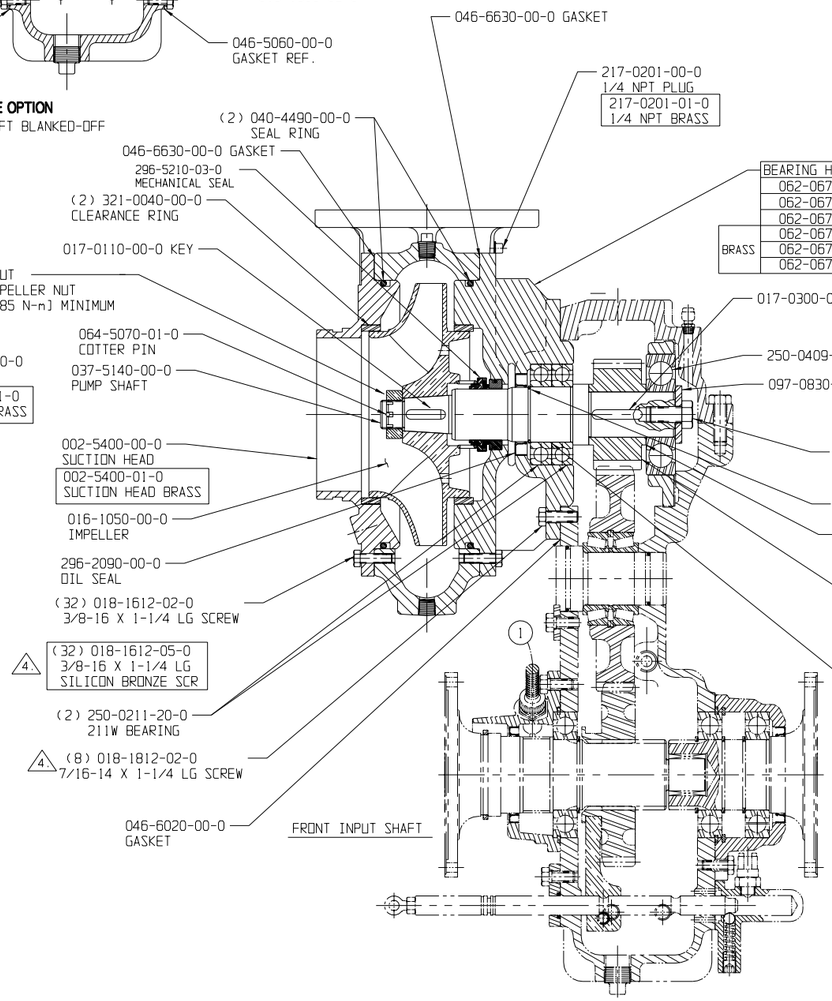
THIS PRODUCT AND ITS COMPONENTS MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING:
4,337,830 5,018,665
4,587,862 5,139,393
4,653,978

FLANGE DISCHARGE CONNECTION OPTIONS		FLANGE DISCHARGE BRASS OPTIONS	
PART NUMBER	CONNECTION THREAD	PART NUMBER	CONNECTION THREAD
115-0050-00-0	BLANK (STANDARD)	115-0050-01-0	BLANK (STANDARD)
115-1260-00-0	1-1/4" NPT	115-1260-01-0	1-1/4" NPT
115-0060-00-0	2" NPT	-	-
115-0070-00-0	2-1/2" NPT	115-0070-01-0	2-1/2" NPT
115-0080-00-0	3" NPT	115-0080-01-0	3" NPT
TRV	SEE PLATE 729	TRV	SEE PLATE 729
ZINC OR MAGNESIUM ANODE*	SEE PLATE 869	ZINC OR MAGNESIUM ANODE*	SEE PLATE 869

*ANODE INSTALLATION REQUIRES SPACER 159-0010-02-0 AND (4) 018-1822-02-0 IN PLACE OF (4) 018-1812-02-0



SEE PLATE 914 FOR 'G' SERIES GEARBOX DATA



BEARING HOUSING P/N		'LG' GEARBOX	'XG' GEARBOX
	062-0672-00-0	DSD-23 & DSD-15	DSD-19 & DSD-28
	062-0672-01-0	DSD-21 & DSD-17	DSD-25 & DSD-21
	062-0672-02-0	DSD-19	DSD-23
BRASS	062-0672-03-0	DSD-23 & DSD-15	DSD-19 & DSD-28
BRASS	062-0672-04-0	DSD-21 & DSD-17	DSD-25 & DSD-21
BRASS	062-0672-05-0	DSD-19	DSD-23

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

1500GPM OPTION
(ALTERNATE PARTS- AVAILABLE IN ENGINE ROTATION ONLY)

TABLE-"A" TORQUE SPECIFICATIONS	TORQUE	
SIZE	LB-FT	N-m
3/8-16 CARBON STEEL SAE GRADE 5	30	30
3/8-16 SILICON BRONZE	18	24
7/16-14 CARBON STEEL SAE GRADE 5	50	68
7/16-14 SILICON BRONZE	29	39
5/8-11 CARBON STEEL SAE GRADE 5	150	203
5/8-11 SILICON BRONZE	85	115

NOTES:

1) PRIMING SYSTEM, DISCHARGE & SUCTION VALVES ARE AVAILABLE.
2) RELIEF VALVES ARE AVAILABLE IN THE FOLLOWING MODELS:

RELIEF VALVE MAXIMUM FLOW LIMIT	RELIEF VALVE MODEL
1000 GPM [3785 L]	P30F
1250 GPM [4731 L]	P35

3) CAUTION: ALL FASTENERS ON THIS UNIT HAVE BEEN SELECTED PER THEIR APPLICATION. HALE PRODUCTS DOES NOT RECOMMEND REPLACING FASTENERS WITH ANYTHING OTHER THAN HALE PART NUMBERS PROVIDED. REPLACING WITH A WEAKER ALTERNATIVE POSES A SAFETY RISK.

4) FOR ALL TORQUE SEPCIFICATIONS REFERENCE TABLE- "A"

5) ITEMS SHOWN IN [ ] ARE FOR BRONZE VERSION ONLY

6) ALL FASTENERS SHALL BE INSTALLED WITH A NUT LOCKING ANAEROBIC ADHESIVE/SEALANT: LOCTITE #246 HIGH TEMPERATURE THREADLOCKER OR EQUIVALENT.

HALE TYPE DSD SERIES PUMP

WITH "G" SERIES GEARBOX

PLATE NO. 789AE

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
05-213	E	UPDATED NOTES AND PART NUMBERS TO REFELCT CURRENT PRODUCTION.	DH	10-6-05	MAL

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

DRAWN | DPL
CHECKED | MD
DATE 8-6-99
SIZE D
SCALE: .25

Notes

GEARBOX MODEL	GEAR RATIO
DSD*-23R	2.28
DSD*-21R	2.05
DSD*-19R	1.86
DSD*-17R	1.71
DSD*-15R	1.58

THE HALE TYPE DSD XXX-XXR PUMP IS AVAILABLE IN 750, 1000 & 1250 GPM NFPA RATINGS. THE COMPLETE PUMP MODEL NUMBER IS FORMED AS FOLLOWS: DSD 125 23 R

FOR EXAMPLE, A DSD PUMP IS REQUIRED TO HAVE A 1250 GPM RATING WITH A 2.28 GEAR RATIO. THE PUMP MODEL NUMBER WOULD BE AS SHOWN.

PUMP MODEL — RATED PUMP CAPACITY — RGA GEARBOX RATIO

WARNING

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

MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT (21,693 N-m)

PUMP MODEL	MAX GEARBOX INPUT RPM
DSD*-23R	2630
DSD*-21R	2920
DSD*-19R	3220
DSD*-17R	3500
DSD*-15R	3800

SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA.

MAXIMUM ALLOWABLE HYDRODYNAMIC PRESSURE: 400 PSIG
MAXIMUM ALLOWABLE HYDROSTATIC PRESSURE: 600 PSIG

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

4,337,030 5,018,665
4,587,862 5,139,393
4,653,978

013-0010-00-0 TACH FLEX SHAFT
048-0090-00-0 PANEL ADAPTER
008-0070-00-0 ADAPTER CAP
1/10 RATIO

SPEED COUNTER ATTACHMENT
SEE PLATE 910 FOR FURTHER DETAIL

NOTE: APPARATUS MANUFACTURER TO FURNISH SPEED COUNTER ADAPTER TO CORRECT FOR P.T.O. RATIO. 1"-20 THREADED CONNECTION.

NOTE: TO CONFORM TO NFPA 1901 & 1902, THE APPARATUS MANUFACTURER MUST INSTALL INDICATOR LIGHTS FOR PUMP AND ROLL OPERATION PER HALE PLATE NO. 746.

FRONT INPUT SHAFT

537-1740-01-0 INPUT SHAFT ASSEMBLY

077-2750-01-0 RETAINING RING
GASKET REF. 046-5130-00-0
077-2810-00-0 RETAINING RING
250-0306-20-0 306W BEARING
044-1120-00-0 BEARING COVER
(4) 7/16-14 X 1 LG GR. 8 (4.) 018-1810-25-0
(2) 115-0250-01-0 BLANK FLANGE
(4) 7/16-14 X 3/4 LG SCREW (4.) 018-1806-02-0
046-5060-00-0 GASKET REF.
046-5060-00-0 GASKET

PTO DRIVE OPTION
REAR OUTPUT SHAFT BLANKED-OFF

217-0201-00-0 1/4 NPT PLUG
217-0201-01-0 1/4 NPT BRASS

(2) 046-6630-00-0 GASKET

	BEARING HOUSING P/N	PUMP MODEL
	062-0672-00-0	DSD-23 & DSD-15
	062-0672-01-0	DSD-21 & DSD-17
	062-0672-02-0	DSD-19
BRASS	062-0672-03-0	DSD-23 & DSD-15
BRASS	062-0672-04-0	DSD-21 & DSD-17
BRASS	062-0672-05-0	DSD-19

040-4490-00-0 SEAL RING
296-5210-05-0 MECHANICAL SEAL
250-0409-00-0 409K BEARING
017-0300-00-0 KEY
097-0830-01-0 WASHER
(4.) 018-2412-02-0 5/8-11 x 1-1/4 LG SCREW
077-2120-01-0 RETAINING RING

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

048-0150-00-0 SHIM

321-0040-00-0 CLEARANCE RING
017-0110-00-0 KEY
110-7040-00-0 NUT
NOTE: TORQUE IMPELLER NUT TO 210 LB-FT (285 N-m) MINIMUM
002-5400-00-0 SUCTION HEAD
002-5400-01-0 SUCTION HEAD BRASS
064-5070-01-0 COTTER PIN
037-5140-00-0 PUMP SHAFT
016-5410-00-0 IMPELLER
(32) 018-1612-02-0 3/8-16 x 1-1/4 LG SCREW (4.)
(32) 018-1612-05-0 3/8-16 X 1-1/4 LG SILICON BRONZE SCR
296-2090-00-0 OIL SEAL
250-0211-20-0 211W BEARING
(8) 018-1812-02-0 7/16-14 X 1-1/4 LG (4.)
046-6020-00-0 GASKET
FRONT INPUT SHAFT
REAR OUTPUT SHAFT

TABLE-"A" TORQUE SPECIFICATIONS	TORQUE	
SIZE	LB-FT	N-m
3/8-16 CARBON STEEL SAE GRADE 5	30	30
3/8-16 SILICON BRONZE	18	24
7/16-14 CARBON STEEL SAE GRADE 5	50	68
7/16-14 SILICON BRONZE	29	39
5/8-11 CARBON STEEL SAE GRADE 5	150	203
5/8-11 SILICON BRONZE	85	115

(3) 217-0303-00-0 3/8 NPT PLUG
(3) 217-0301-01-0 3/8 NPT PLUG BRASS

(4) 018-1812-02-0 7/16 X 1-1/4 LG SCR (4.)
(4) 018-1812-05-0 7/16 X 1-1/4 LG SILICON BRONZE SCREW

FLANGE DISCHARGE CONNECTION OPTIONS		FLANGE DISCHARGE BRASS OPTIONS	
PART NUMBER	CONNECTION THREAD	PART NUMBER	CONNECTION THREAD
115-0050-00-0	BLANK (STANDARD)	115-0050-01-0	BLANK (STANDARD)
115-1260-00-0	1-1/4" NPT	115-1260-01-0	1-1/4" NPT
115-0060-00-0	2" NPT	-	-
115-0070-00-0	2-1/2" NPT	115-0070-01-0	2-1/2" NPT
115-0080-00-0	3" NPT	115-0080-01-0	3" NPT
TRV	SEE PLATE 729	TRV	SEE PLATE 729
ZINC OR MAGNESIUM ANODE*	SEE PLATE 869	ZINC OR MAGNESIUM ANODE*	SEE PLATE 869

*ANODE INSTALLATION REQUIRES SPACER 159-0010-02-0 AND (4) 018-1822-02-0 IN PLACE OF (4) 018-1812-02-0

046-0050-00-0 GASKET
001-5131-00-0 PUMP BODY
001-5131-01-0 PUMP BODY BRONZE

NOTES:

1) PRIMING SYSTEM, DISCHARGE & SUCTION VALVES ARE AVAILABLE.
2) RELIEF VALVES ARE AVAILABLE IN THE FOLLOWING MODELS:

RELIEF VALVE MAXIMUM FLOW LIMIT	RELIEF VALVE MODEL
1000 GPM [3785 L]	P30F
1250 GPM [473] L]	P35

3) CAUTION: ALL FASTENERS ON THIS UNIT HAVE BEEN SELECTED PER THEIR APPLICATION. HALE PRODUCTS DOES NOT RECOMMEND REPLACING FASTENERS WITH ANYTHING OTHER THAN HALE PART NUMBERS PROVIDED. REPLACING WITH A WEAKER ALTERNATIVE POSES A SAFETY RISK.
4) FOR ALL TORQUE SEPCIFICATIONS REFERENCE TABLE- "A"
5) ITEMS SHOWN IN [ ] ARE FOR BRONZE VERSION ONLY
6) ALL FASTENERS SHALL BE INSTALLED WITH A NUT LOCKING ANAEROBIC ADHESIVE/SEALANT: LOCTITE #246 HIGH TEMPERATURE THREADLOCKER OR EQUIVALENT.

SEE PLATE 766 FOR 'RG' GEARBOX PARTS NOT IDENTIFIED

101-0291-00-0 INSTRUCTION PLATE
200-0540-02-0 BULB
200-0540-12-0 INDICATOR BODY
200-0540-14-0 GREEN LENS

PUMP OPERATOR'S PANEL

101-0252-00-0 INDICATOR PLATE
200-0540-02-0 BULB
200-0540-12-0 INDICATOR BODY
200-0540-14-0 GREEN LENS
101-0252-00-0 INDICATOR PLATE
200-0540-02-0 BULB
200-0540-12-0 INDICATOR BODY
200-0540-14-0 GREEN LENS

DRIVING COMPARTMENT PANEL

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

HALE TYPE DSD SERIES PUMP
WITH "RG" GEARBOX

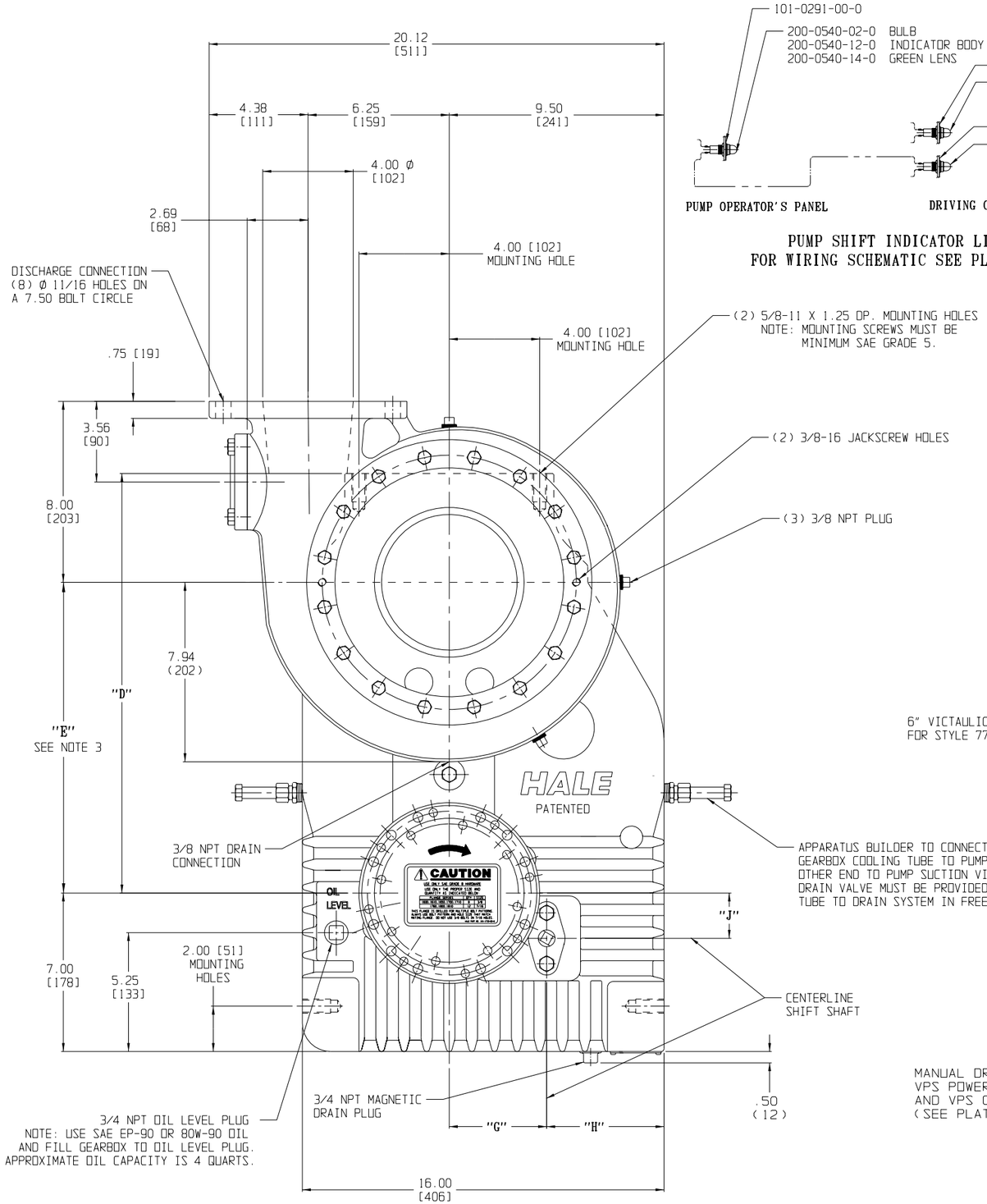
PLATE NO. 790AC

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
05-213	C	UPDATED NOTES AND PART NUMBERS TO REFLECT CURRENT PRODUCTION	DH	10-5-05	MAL
01-041	B	ADDED PART DESCRIPTIONS. 002-5180-00-0 & 321-5080-00-0. REMOVED 016-1050-00-0	JBS	01-23-01	MAL
99-211	A	RELEASE TO PRODUCTION	DL	8-6-99	RET

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

DRAWN DPL | CHECKED MD | DATE 9-6-99 | SIZE D | SCALE: .25

Notes

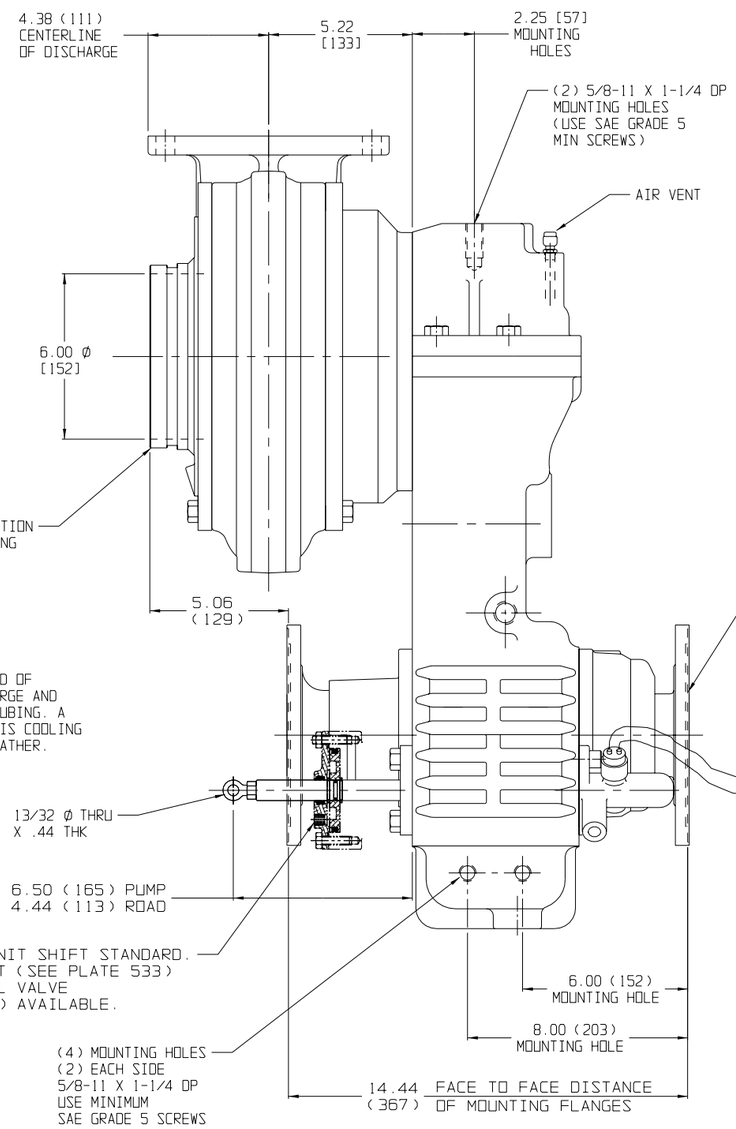


PUMP SHIFT INDICATOR LIGHTS
FOR WIRING SCHEMATIC SEE PLATE NO. 746

PUMP MODEL	GEARBOX MODEL	GEAR RATIO	D	E	G	H	J
DSD*-28X	XG	2.83	20.94 (532)	15.56 (395)	5.44 (138)	4.06 (103)	1.84 (47)
DSD*-25X		2.55		15.75 (400)			
DSD*-23X		2.32		15.91 (404)			
DSD*-21X		2.13		16.06 (408)			
DSD*-19X		1.96		16.25 (413)			
DSD*-23L	LG	2.28	18.56 (471)	13.38 (340)	4.31 (109)	5.19 (132)	2.00 (51)
DSD*-21L		2.05		13.56 (344)			
DSD*-19L		1.86		13.75 (349)			
DSD*-17L		1.71		13.94 (354)			
DSD*-15L		1.58		14.13 (359)			

THE HALE TYPE DSD PUMP IS AVAILABLE IN 750, 1000, 1250 & 1500 GPM NFPA RATINGS.
THE COMPLETE PUMP MODEL NUMBER IS FORMED AS FOLLOWS:
FOR EXAMPLE, A DSD PUMP IS REQUIRED TO HAVE A 1250 GPM RATING WITH A 2.28 GEAR RATIO. A X-SERIES GEARBOX IS DESIRED. THE PUMP MODEL NUMBER WOULD BE AS SHOWN.

DSD 125 23 X
PUMP MODEL — RATED CAPACITY — PUMP RATIO — GEARBOX TYPE



WARNING

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

MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT (21,693 N-m)

PUMP MODEL	MAX GEARBOX INPUT RPM
DSD*-23	2630
DSD*-21	2920
DSD*-19	3220
DSD*-17	3500
DSD*-15	3800

SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA.
MAXIMUM ALLOWABLE HYDRODYNAMIC PRESSURE: 400 PSIG
MAXIMUM ALLOWABLE HYDROSTATIC PRESSURE: 600 PSIG

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 5,018,665
4,587,862 5,139,393
4,653,978

NOTES:

1) DIMENSIONS ARE IN INCHES & (MILLIMETERS).
2) PRIMING SYSTEM, DISCHARGE & SUCTION VALVES ARE AVAILABLE.
3) CENTERLINE OF INPUT SHAFT TO CENTERLINE OF IMPELLER
4) RELIEF VALVES ARE AVAILABLE IN THE FOLLOWING MODELS:

RELIEF VALVE MAXIMUM FLOW LIMIT	RELIEF VALVE MODEL
1000 GPM [3785 L]	P30F
1250 GPM [4731 L]	P35
1500 GPM [5678 L]	TPM/P35 SYSTEM

PLATE NO. 916AA

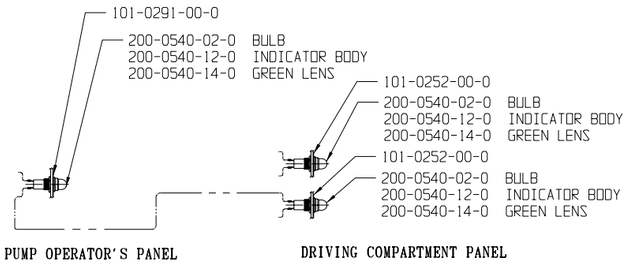
HALE TYPE DSD SERIES PUMP
WITH "G" SERIES GEARBOX

99-211	A	RELEASE TO PRODUCTION	DL	8-6-99	RET
ECO NO	REV	CHANGED FROM	BY	DATE	APVD

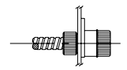
HALE PRODUCTS, INC.
A Unit of IDEX Corporation
Conshohocken, PA 19428 USA

DRAWN DPL DATE 8-6-99 SIZE D SCALE: .25
CHECKED MD

Notes



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



SPEED COUNTER ATTACHMENT
SEE PLATE 910 FOR
FURTHER DETAIL

PUMP MODEL	GEAR RATIO	E (SEE NOTE 3)
DSD*-23R	2.28	13.38 (340)
DSD*-21R	2.05	13.56 (344)
DSD*-19R	1.86	13.75 (349)
DSD*-17R	1.71	13.94 (354)
DSD*-15R	1.58	14.13 (359)

THE HALE TYPE DSD PUMP IS AVAILABLE IN 750, 1000, 1250 & 1500 GPM NFPA RATINGS. THE COMPLETE PUMP MODEL NUMBER IS FORMED AS FOLLOWS:

FOR EXAMPLE, A DSD PUMP IS REQUIRED TO HAVE A 1250 GPM RATING WITH A 2.28 GEAR RATIO. THE PUMP MODEL NUMBER WOULD BE AS SHOWN.

DSD 125 23 R
(PUMP MODEL) (RATED CAPACITY) (PUMP RATIO) (GEARBOX TYPE)

WARNING

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

MAXIMUM GEARBOX SHAFT TORQUE (ROAD) = 16,000 LBS-FT [21,693 N-m]

PUMP MODEL	MAX GEARBOX INPUT RPM
DSD*-23R	2630
DSD*-21R	2920
DSD*-19R	3220
DSD*-17R	3500
DSD*-15R	3800

SEE HALE TORQUE LIMIT CHART F-72 FOR ADDITIONAL DATA.
MAXIMUM ALLOWABLE HYDRODYNAMIC PRESSURE: 400 PSIG
MAXIMUM ALLOWABLE HYDROSTATIC PRESSURE: 600 PSIG

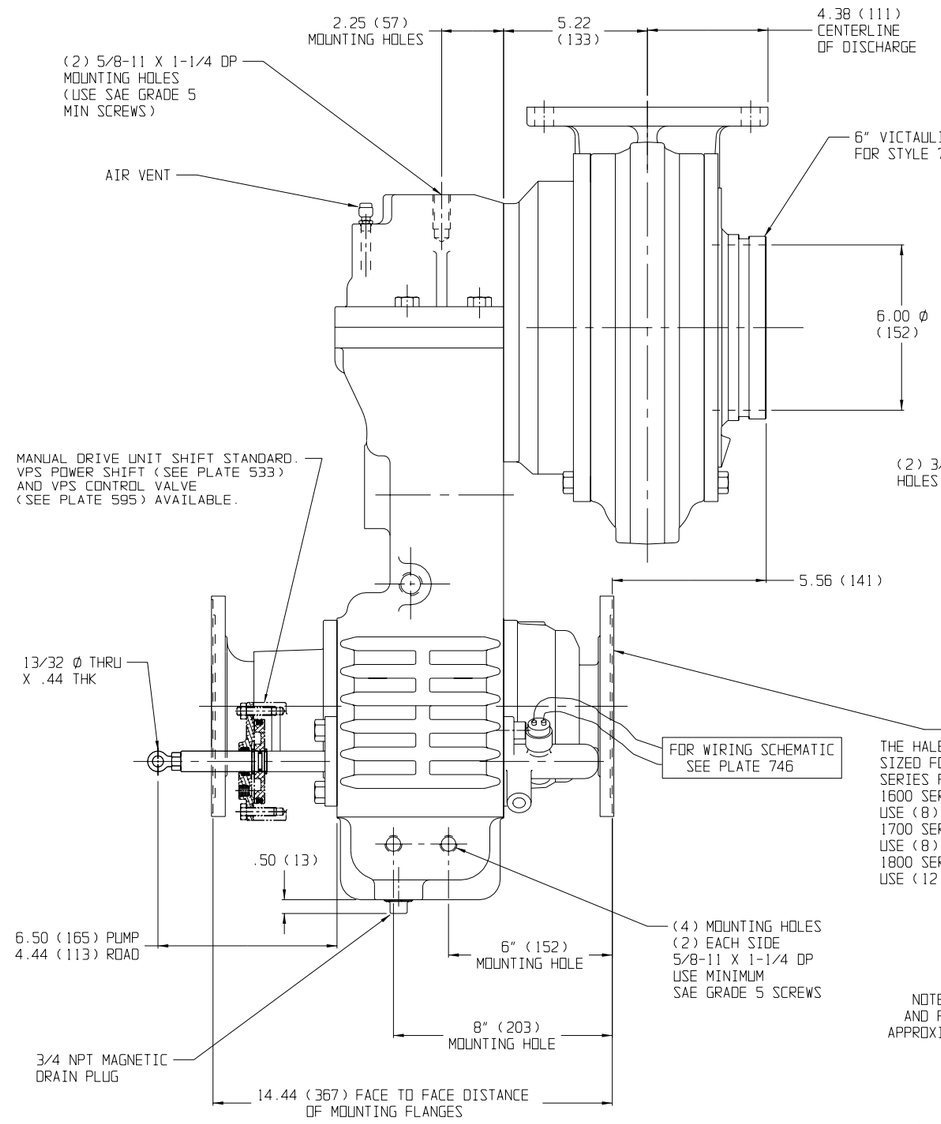
THIS PRODUCT AND ITS COMPONENTS MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS AND OTHER PATENTS PENDING:

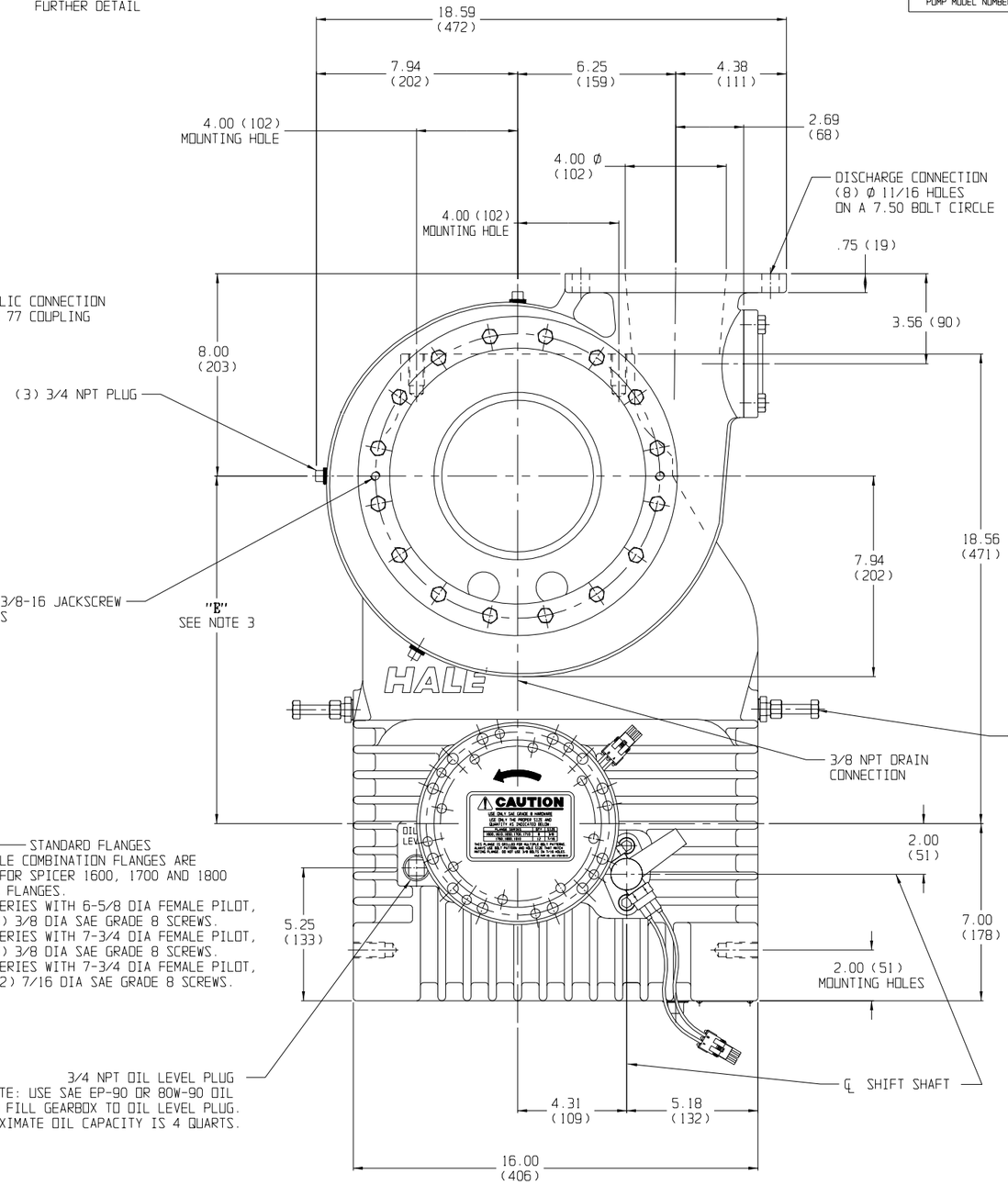
4,337,830 5,018,665
4,587,862 5,139,393
4,853,978

NOTES:

1) DIMENSIONS ARE IN INCHES & [MILLIMETERS].
2) PRIMING SYSTEM, DISCHARGE & SUCTION VALVES ARE AVAILABLE.
3) CENTERLINE OF INPUT SHAFT TO CENTERLINE OF IMPELLER
4) RELIEF VALVES ARE AVAILABLE IN THE FOLLOWING MODELS:

RELIEF VALVE MAXIMUM FLOW LIMIT	RELIEF VALVE MODEL
1000 GPM [3785 L]	P30F
1250 GPM [4731 L]	P35
1500 GPM [5678 L]	TPM/P35 SYSTEM





HALE TYPE DSD SERIES PUMP
WITH "RG" GEARBOX

PLATE NO. 918AA

ECO NO	REV				
99-211	A	RELEASE TO PRODUCTION	DL	8-6-99	RET
		CHANGED FROM	BY	DATE	APVD

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

DRAWN DPL
CHECKED MD
DATE 8-6-99
SIZE D
SCALE: .25

Notes

HALE ANTI-CORROSION ANODES

SACRIFICIAL GALVANIC ANODES DESIGNED TO HELP MINIMIZE CORROSION IN THE PUMPING SYSTEM

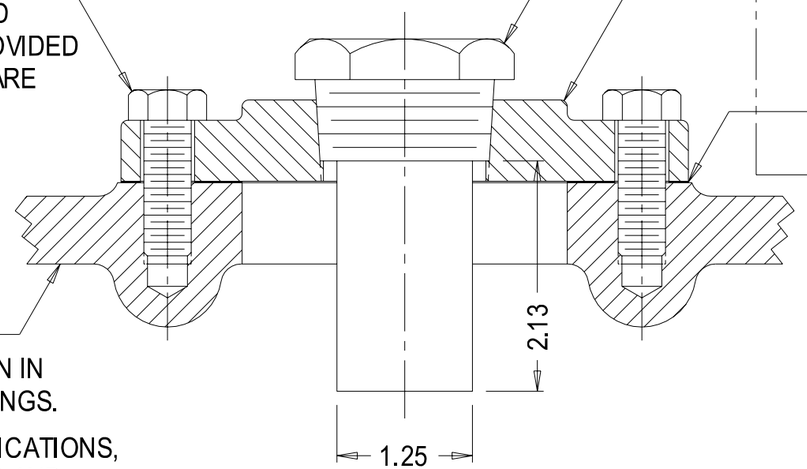
ANODE KIT - HALE PART NO. 529-0080-00-0
INCLUDES ANODE, 115 FLANGE, AND GASKET

ZINC ANODE ASSEMBLY - 1-1/4 NPT
HALE PART NO. 029-0510-00-0

HALE 115 FLANGE - 1-1/4 NPT
HALE PART NO. 115-1260-00-0
MATERIAL: CAST IRON

HALE 115 SERIES FLANGE GASKET
HALE PART NO. 046-0050-00-0

7/16-14NC X 1-1/4 HEX HEAD CAP SCREW
HALE PART NO. 018-1812-02-0 - (4) REQ'D
SAE GRADE 5, 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 029-0510-00-0 ANODES DIRECTLY.

NOTES:

1) A MINIMUM OF TWO ANODES PER PUMP ARE RECOMMENDED. INSTALL ONE ANODE ON THE SUCTION SIDE AND ONE ON THE DISCHARGE SIDE. ANODES CAN BE MOUNTED IN ANY POSITION; I.E., HORIZONTAL OR VERTICAL.

2) THE CONSUMABLE ZINC ANODES SHOULD BE INSPECTED AT LEAST EVERY 12 MONTHS. REPLACE WHEN OVER 75% OF THE ZINC HAS BEEN CONSUMED. PERFORMANCE AND ANODE LIFE WILL VARY WITH WATER QUALITY AND PH. ANODES CONFORM TO MIL SPEC A18001.

3) 029-0510-00-0 IS REPLACED AS AN ASSEMBLY. THE CONSUMABLE ZINC ANODE IS PERMANENTLY ASSEMBLED WITH THE BRONZE PLUG AND CANNOT BE REPLACED SEPARATELY.

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
97-139	A	RELEASED FOR PRODUCTION	AJD	6-24-97	RET

PLATE NO. 869AA

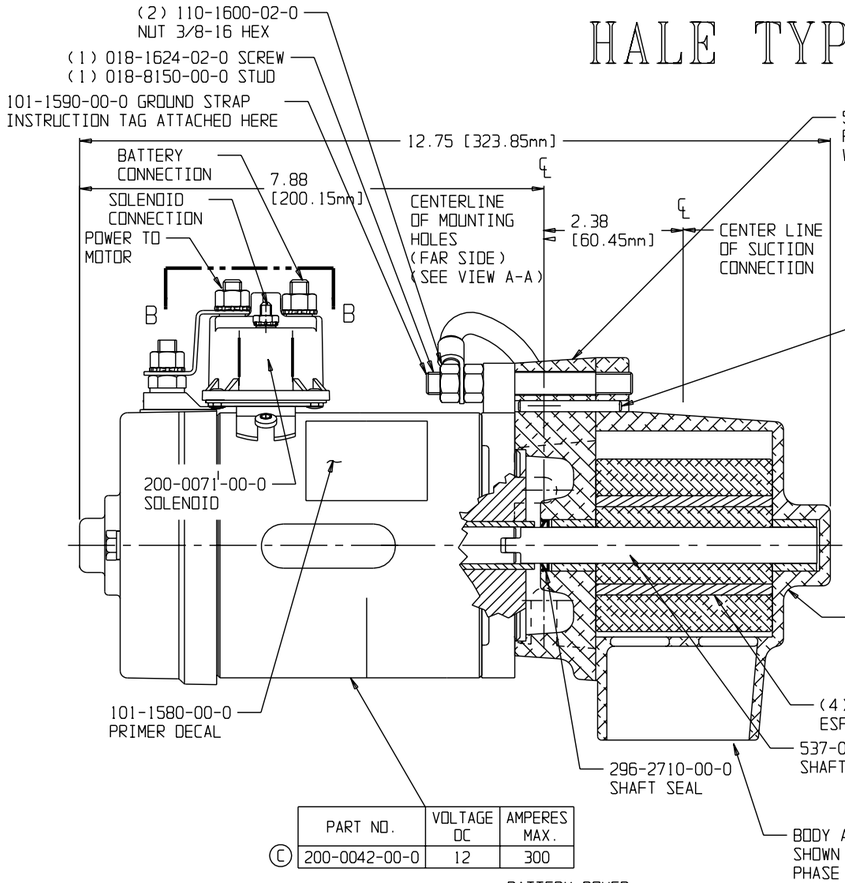
HALE PRODUCTS, INC.
A Unit of IDEX Corporation
Conshohocken, PA 19428 USA

DRAWN: AJD	DATE: 6-24-97	DWG. SIZE: A
CHECKED: RET	SCALE: 1/2=1	SHEET 1 OF 1

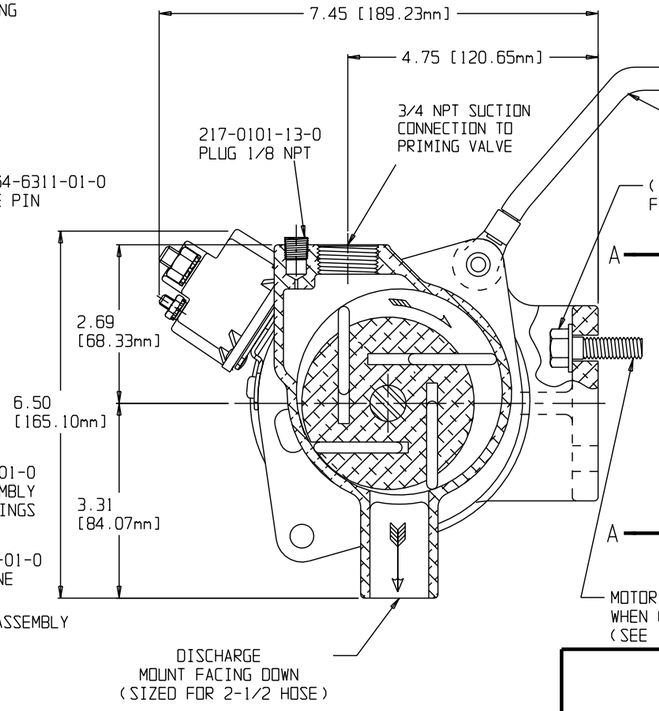
Notes

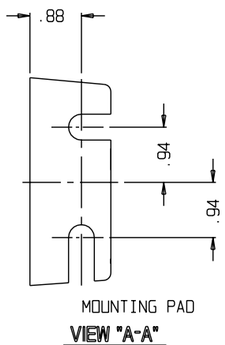
HALE TYPE ESP-12 PRIMING PUMP

PLATE NO. 821AG



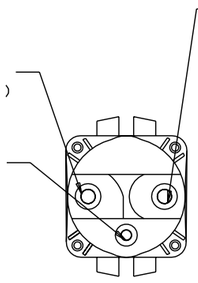
	PART NO.	VOLTAGE DC	AMPERES MAX.
Ⓒ	200-0042-00-0	12	300



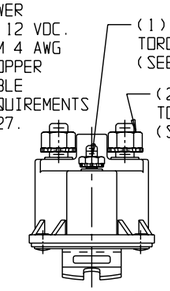


INSTALLATION NOTES:

1) USE A MINIMUM OF 1/2 TUBING FOR BOOSTER PUMPS.
2) USE A MINIMUM OF 3/4 PIPE FOR MIDSHIP PUMPS.
3) CONNECT TO HIGHEST POINT ON DISCHARGE OF MAIN PUMP IF PRIMING WHILE THE PUMP IS STATIONARY.
4) CONNECT TO HIGHEST POINT ON THE SUCTION NEAR THE IMPELLER EYE IF PRIMING WHEN THE MAIN PUMP IS RUNNING.
5) 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.
6) THE PRIMING PUMP MUST BE MOUNTED SO THAT THE MOTOR SHAFT IS IN A HORIZONTAL PLANE WITH THE PRIMING PUMP DISCHARGE FACING DOWN.
7) 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.
8) DURING THE PRIMING OPERATION (EVACUATING AIR), DO NOT RUN THE MOTOR FOR MORE THAN 60 SECONDS.



VIEW "B-B"



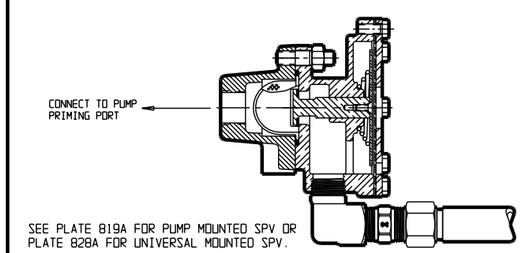
SOLENOID FASTENER TORQUE SPECIFICATION

NOTES:

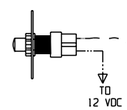
1) MOTOR ROTATION IS THE SAME FOR BOTH NEGATIVE AND POSITIVE GROUND SYSTEMS.
2) WEIGHT OF PRIMING PUMP AND MOTOR IS 27 LBS. (12.2 Kg).
3) THEORETICAL DISPLACEMENT IS .066 GAL. (.25 LITERS) PER REVOLUTION OR 47,000 CU. IN. (770,000 CU. CM) AIR PER MINUTE.
4) VACUUM CAPABILITY: 24 IN. Hg (610 MM Hg).
5) 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. 938 FOR 24V PRIMING PUMP DETAILS.
7) TO PREVENT DAMAGE TO PLASTIC HOUSING WHEN INSTALLING OR REMOVING LEADS, DO NOT APPLY SIDE LOADS TO NUTS.

INSTALLATION DETAILS

SEE PLATE 480G FOR PVG VALVE.



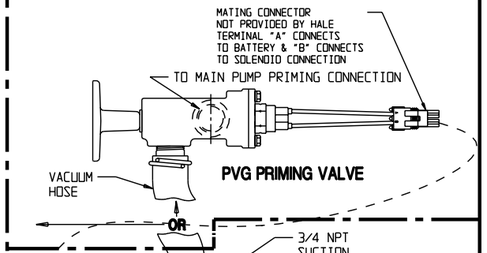
SPV PRIMING VALVE



SPV PANEL MOUNTED SWITCH

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.

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



PRIMING PUMP

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

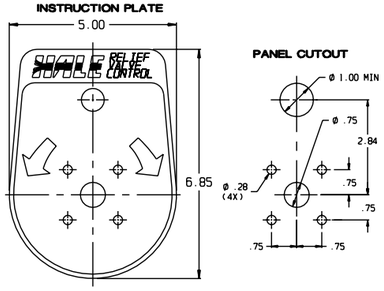
ECO NO	REV	CHANGED FROM	BY	DATE	APVD
01-172	D	REMOVED 24V DETAIL AND INFO	ERB	4-03-01	MAL
01-257	E	UPDATED SOLENOID CONNECTION CALLOUTS	DJK	06-12-01	MAL
01-258	F	(INSTRUCTION NOTE 7) REMOVED: "WHEN THE PRIMING "PUMP IS MOUNTED ON THE PUMP GEARBOX". ADDED: SOLENOID TORQUE SPECS	DJK	06-22-01	MAL

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

DRAWN RDT | CHECKED RDT | DATE 2-19-95 | SIZE D | SCALE: FULL

Notes

INSTRUCTION PLATE



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 LITHUM BASE GREASE WITH 1% TO 3% MOLYBEDNUM DISULFIDE ON THE THREADED PART OF THE ADJUSTING STEM.

SOME RECOMMENDED LUBRICANTS INCLUDE:

DOW CORNING BR2-PLUS	IMPERIAL NO. 777
FISKE - LUBRIPLATE NO. 3000	MOBIL - MOBILGREASE SPECIAL
SHELL SUPER DUTY GREASE	SUN OIL - SUNOCO 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 RESPONSIBLITY OF HALE PRODUCTS.

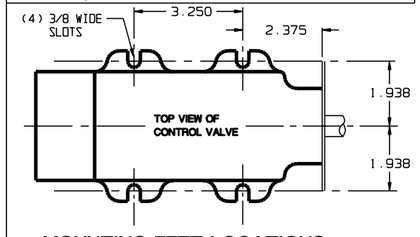
SELECTION AND INSTALLATION OF ELECTRICAL COMPONENTS AND WIRING OTHER THAN THAT PROVIDED IS NOT THE RESPONSIBILITY OF HALE PRODUCTS. SYSTEM DESIGN AND INSTALLATION MUST BE DONE ONLY BY PROPERLY QUALIFIED PERSONS.

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

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.

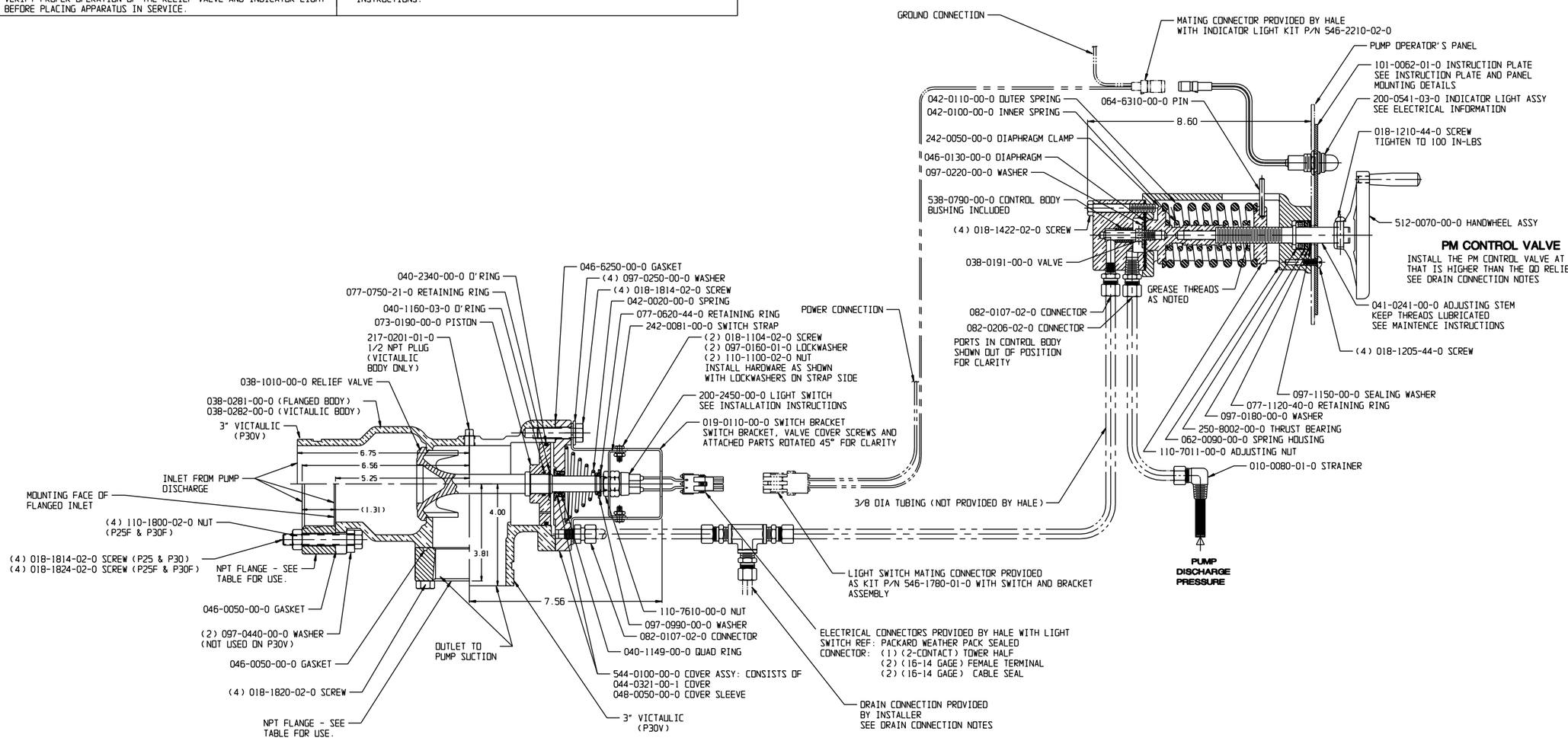
5- WHEN THE PUMP IS RUNNING, A LIT INDICATOR LIGHT INDICATES THE RELIEF VALVE IS IN OPERATION.

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

PLATE NO. 547CF

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
04-117	E	UPDATED LAMP ASSEMBLY	JGV	12-16-02	MAL
04-117	F	REPLACED SCREW/HANDLE ASSY. VALVE P/N	SNK	06-04-03	MAL

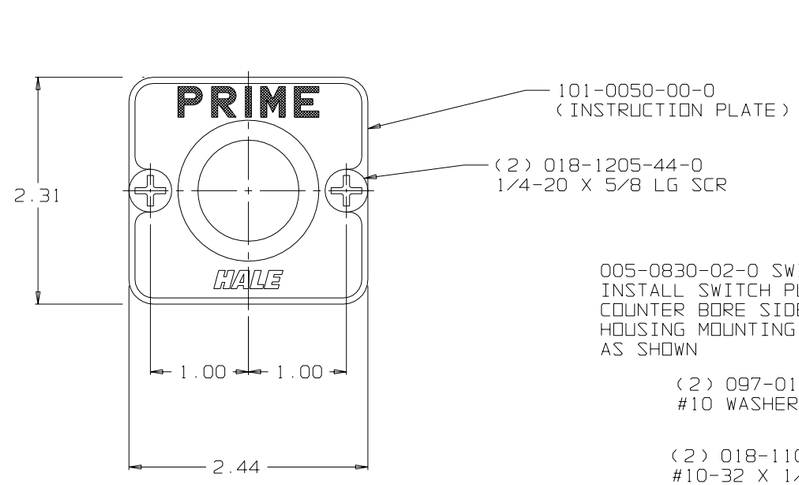
ECO NO	REV	CHANGED FROM	BY	DATE	APVD
95-034	A	ADDED REVISION BLOCK	AJD	5-22-95	RDT
99-036	B	PLACED ON CAD & UPDATED	JBS	9-26-99	RET
00-657	C	UPDATED DRAWING	DJK	10-24-00	MAL
01-173	D	UPDATED PART REQUIREMENTS	DJK	4-02-01	MAL

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

DRAWN WFM | CHECKED RDT | DATE 04-23-93 | SIZE N/A | SCALE: NONE

Notes

HALE TYPE PVG PRIMING VALVE



101-0050-00-0
(INSTRUCTION PLATE)

(2) 018-1205-44-0
1/4-20 X 5/8 LG SCR

042-0091-00-0
SPRING

073-0041-00-0
PISTON

040-2140-03-0
SEAL RING

040-2090-03-0
SEAL RING

005-0830-02-0 SWITCH PLATE
INSTALL SWITCH PLATE WITH
COUNTER BORE SIDE FACING
HOUSING MOUNTING BOSSES
AS SHOWN

(2) 097-0160-01-0
#10 WASHER

(2) 018-1104-02-0
#10-32 X 1/2 LG SCR
HEX HD PLATED

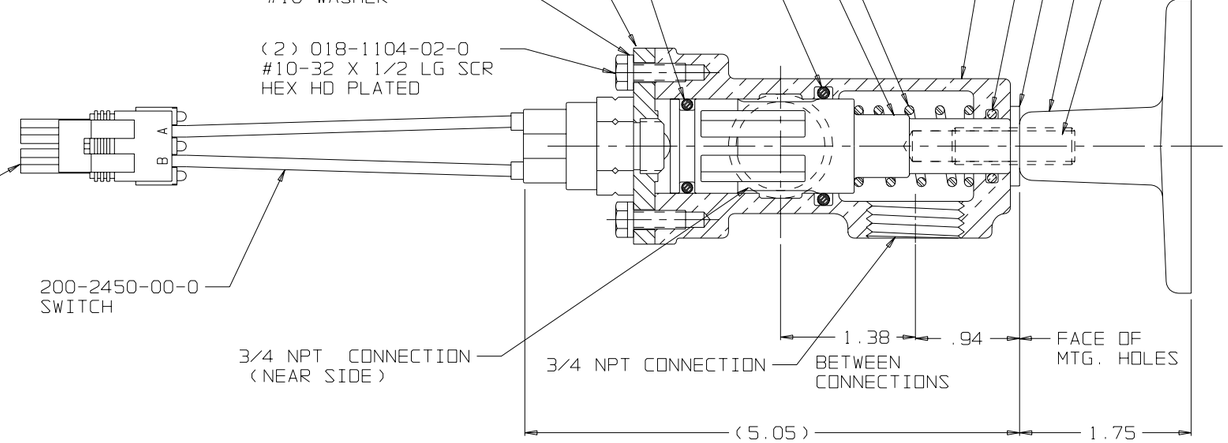
038-0171-00-0
VALVE BODY

040-1139-03-0
SEAL RING

097-0170-00-0
WASHER-3/8

012-0160-00-0
T-HANDLE

018-1612-54-0
3/8-16 X 1-1/4 LG SET SCREW



MATING CONNECTOR NOT PROVIDED BY HALE
CAN BE PURCHASED AS HALE KIT # 546-1780-00-0
PACKERD 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

200-2450-00-0
SWITCH

PANEL CUTOUT

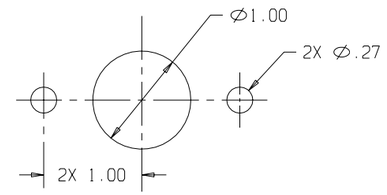


PLATE NO. 480GC

ECO 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

HALE PRODUCTS, INC.
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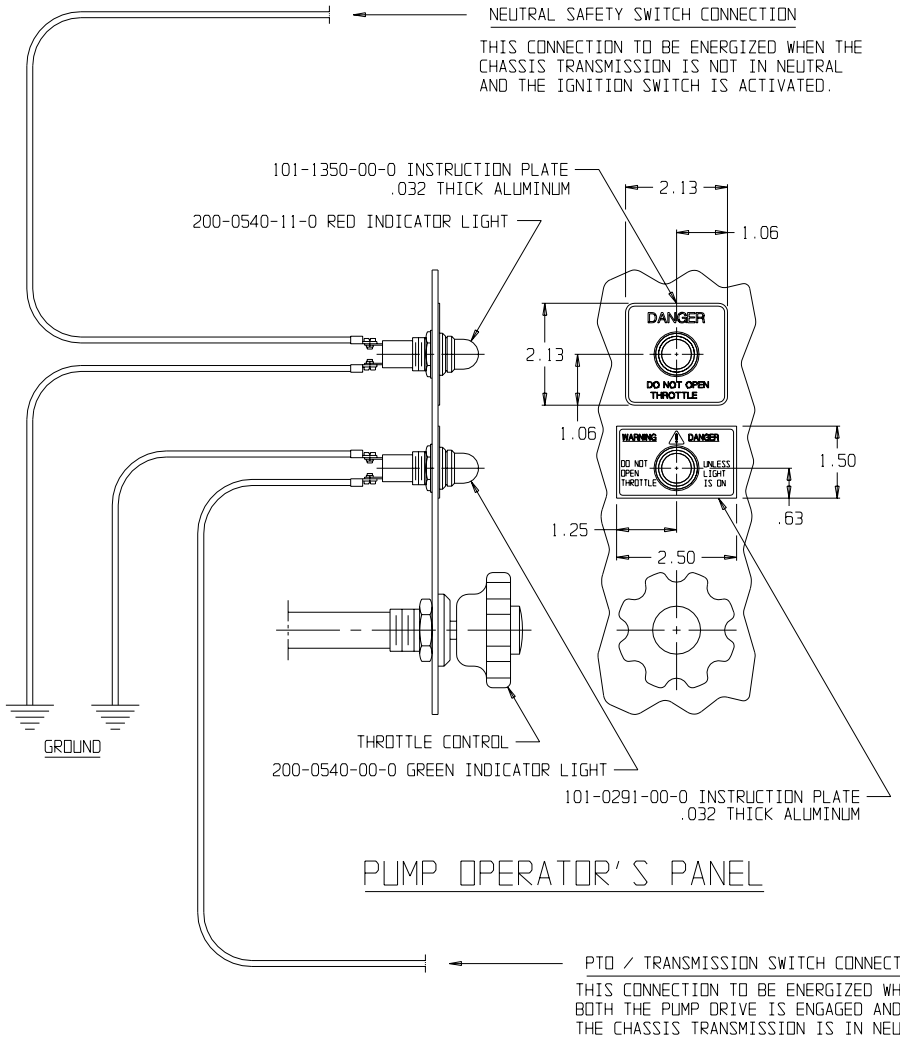
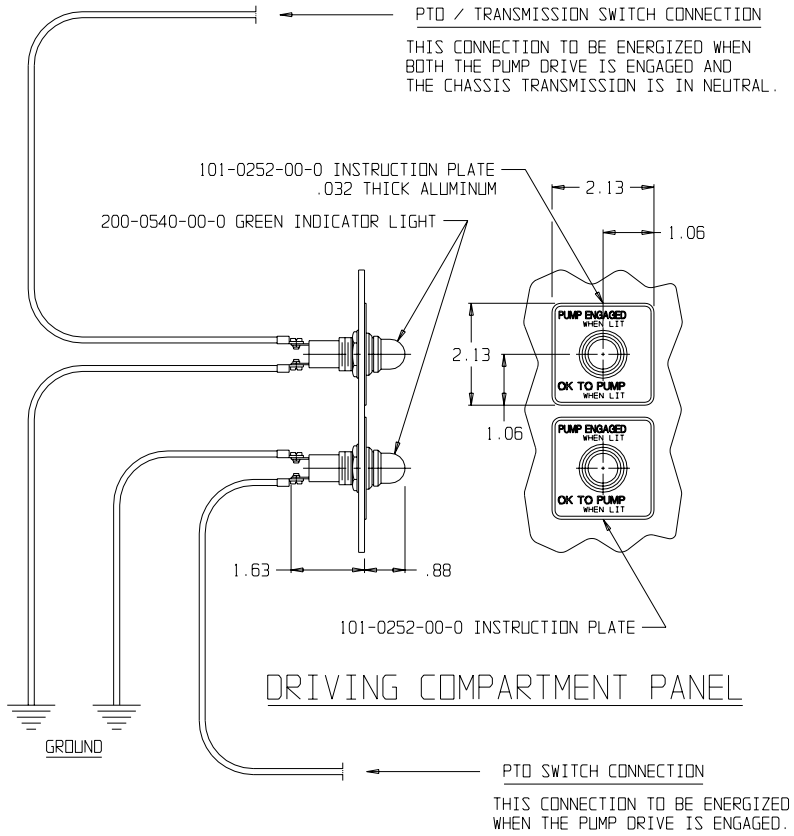
Conshohocken, PA 19428 USA

DRAWN	TKC	DATE 10-6-00	SIZE C	SCALE: FULL
CHECKED	MAL			

Notes



PUMP OPERATOR'S PANEL



DRIVING COMPARTMENT PANEL

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

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
95-39	A	RELEASED FOR PRODUCTION WAS SHEET 2 OF PLATE 746AA	AJD	5-17-95	RDT

PLATE NO. 825AA

HALE PRODUCTS, INC.
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Conshohocken, PA 19428 USA

DRAWN AJD | CHECKED RDT | DATE: 5-17-95 | SIZE C | SCALE: HALF

Notes

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 SPOT 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-S01 WITH SUPRESSED 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.

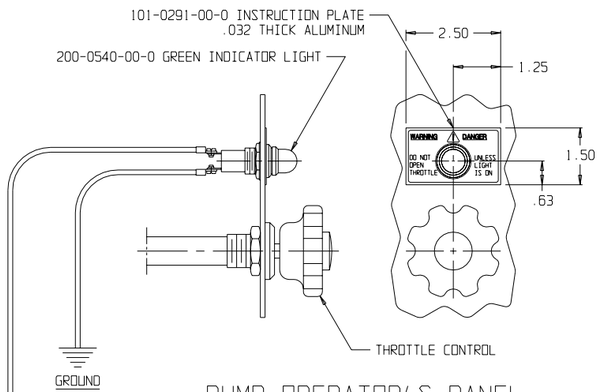
3) INDICATOR LIGHTS: THE STANDARD HALE 200-0540-00-0 GREEN INDICATOR LIGHT ASSEMBLY IS RETAINED WITH A HEX NUT AND INTERNAL STAR WASHER. BOTH THE LENS AND PANEL FLANGE HAVE SEALING RINGS TO MAKE LIGHT LIQUID TIGHT TO FRONT OF PANEL. MOUNTING HOLE DIAMETER IS 11/16. MAXIMUM PANEL THICKNESS IS 3/16 (WHEN 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.

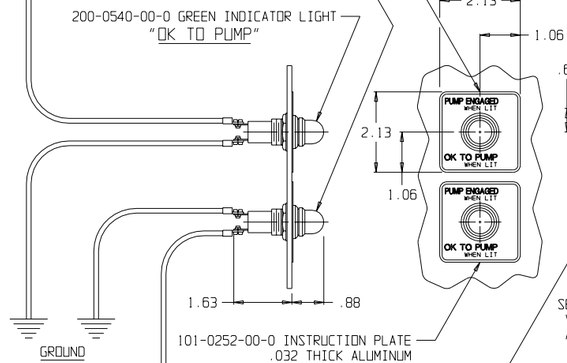
5) SYSTEM DESIGN AND WIRING: SELECTION AND INSTALLATION OF WIRING AND ELECTRICAL COMPONENTS IS NOT THE RESPONSIBILITY OF HALE. SYSTEM DESIGN AND INSTALLATION MUST BE DONE BY PROPERLY QUALIFIED PERSONS. CIRCUIT PROTECTION (FUSES, CIRCUIT BREAKERS, ETC.) IS NOT THE RESPONSIBILITY OF HALE PRODUCTS.

6) ALL ELECTRICAL RATINGS GIVEN ARE FOR 12 VOLT DC NEGATIVE GROUND SYSTEMS. FOR OTHER APPLICATIONS, CONSULT YOUR HALE REPRESENTATIVE.

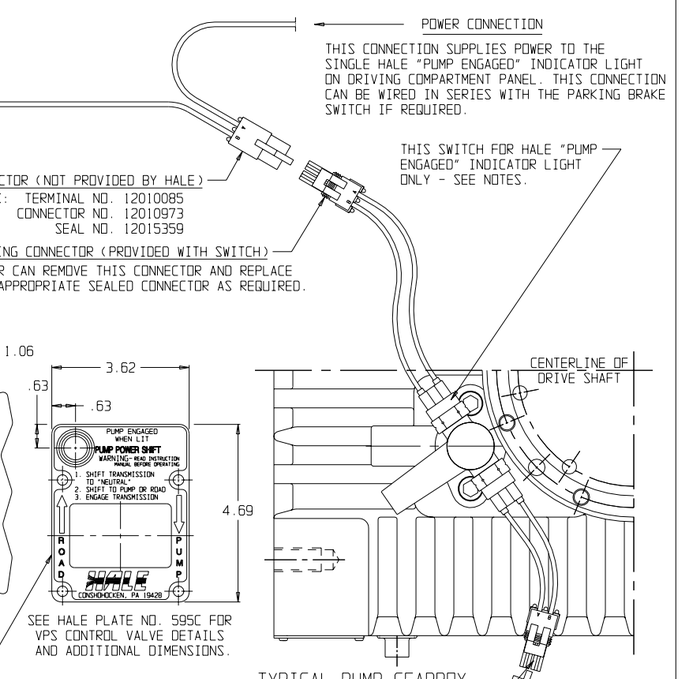
7) IF AN AUTOMATIC CHASSIS TRANSMISSION IS USED, ALL THREE INSTRUCTION PLATES AND LIGHTS MUST BE INSTALLED. IF A MANUAL CHASSIS TRANSMISSION IS USED THE DRIVING COMPARTMENT "PUMP ENGAGED" INSTRUCTION PLATE AND LIGHT MUST BE INSTALLED. INSTALLER IS RESPONSIBLE FOR CONFORMANCE WITH ALL APPLICABLE NFPA AND SAE STANDARDS.



PUMP OPERATOR'S PANEL



DRIVING COMPARTMENT PANEL



TYPICAL PUMP GEARBOX
WITH DUAL SHIFT INDICATOR SWITCHES

THIS SWITCH FOR ADDITIONAL INDICATOR LIGHTS AND SAFETY INTERLOCKS AS REQUIRED. SEE NOTES

POWER CONNECTION

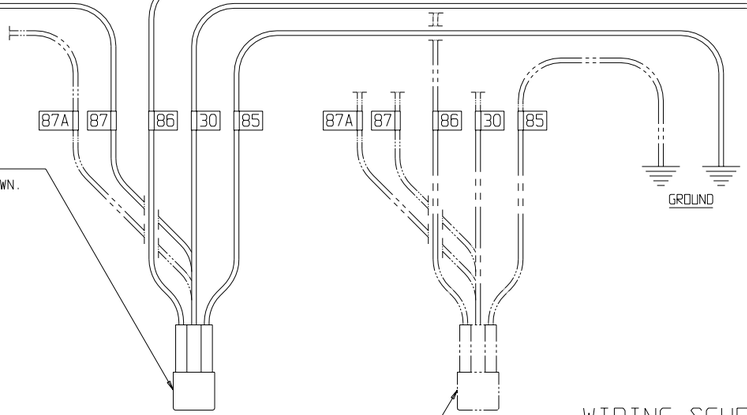
THIS CONNECTION SUPPLIES POWER TO THE INDICATOR LIGHTS OR INTERLOCK RELAY(S) ACTUATION CIRCUIT - SEE RELAY NOTES. THIS CONNECTION CAN BE WIRED IN SERIES WITH THE PARKING BRAKE SWITCH AND/OR OTHER SAFETY INTERLOCKS AS REQUIRED.

INTERLOCK CONNECTION

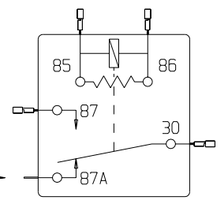
(+12 VOLTS DC WHEN PUMP IS ENGAGED)
THIS IS A TYPICAL POINT OF CONNECTION FOR ENGINE GOVERNOR, TRANSMISSION CONTROLS, SAFETY INTERLOCKS, ETC. AS REQUIRED FOR A SPECIFIC INSTALLATION.
THIS CONNECTION IS THE SOLE RESPONSIBILITY OF THE INSTALLER.

NORMALLY ENERGIZED

SEE RELAY CONNECTION DIAGRAM



SHIFT INDICATOR RELAY (NOT SUPPLIED BY HALE)
A TYPICAL INSTALLATION USING A SINGLE RELAY IS SHOWN.
MULTIPLE RELAYS MAY BE REQUIRED - SEE RELAY NOTES.
A TYPICAL CONNECTION DIAGRAM IS SHOWN BELOW.



CAUTION

THIS RELAY TERMINAL (87A) IS ENERGIZED WHEN PUMP IS DISENGAGED. IT CAN BE USED FOR A SUPPLEMENTARY "ROAD POSITION" INDICATOR LIGHT, AND / OR RELATED INTERLOCKS IF REQUIRED FOR SPECIFIC INSTALLATIONS. THIS TERMINAL MUST BE PROPERLY INSULATED IF NOT USED.

SECONDARY RELAY(S) - (IF REQUIRED)
PROVIDES ADDITIONAL N.O. AND N.C. CONNECTIONS FOR ENGINE CONTROL AND SAFETY INTERLOCKS.

POWER CONNECTION

THIS CONNECTION SUPPLIES POWER TO THE PUMP OPERATOR'S PANEL INDICATOR LIGHT AND TO THE DRIVING COMPARTMENT PANEL INDICATOR LIGHT, AND ANY OTHER RELAY-CONTROLLED CONNECTIONS. SEE RELAY NOTE (NO. 2).

⚠ 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

MIDSHIP PUMP GEARBOXES WITH DUAL SHIFT INDICATOR SWITCHES

FOR USE ON G, MG, RG AND 4DG SERIES GEARBOXES

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
95-39	A	RELEASED FOR PRODUCTION SHEET 2 IS NOW PLATE 825AA	AJD	5-10-95	RDT
99-101	B	GEARSHIFT SHAFT CAP CONFIG. CHANGE	JBS	5-11-99	RET

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

DRAWN AJD | CHECKED RDT | DATE 5-10-95 | SIZE D | SCALE: HALF

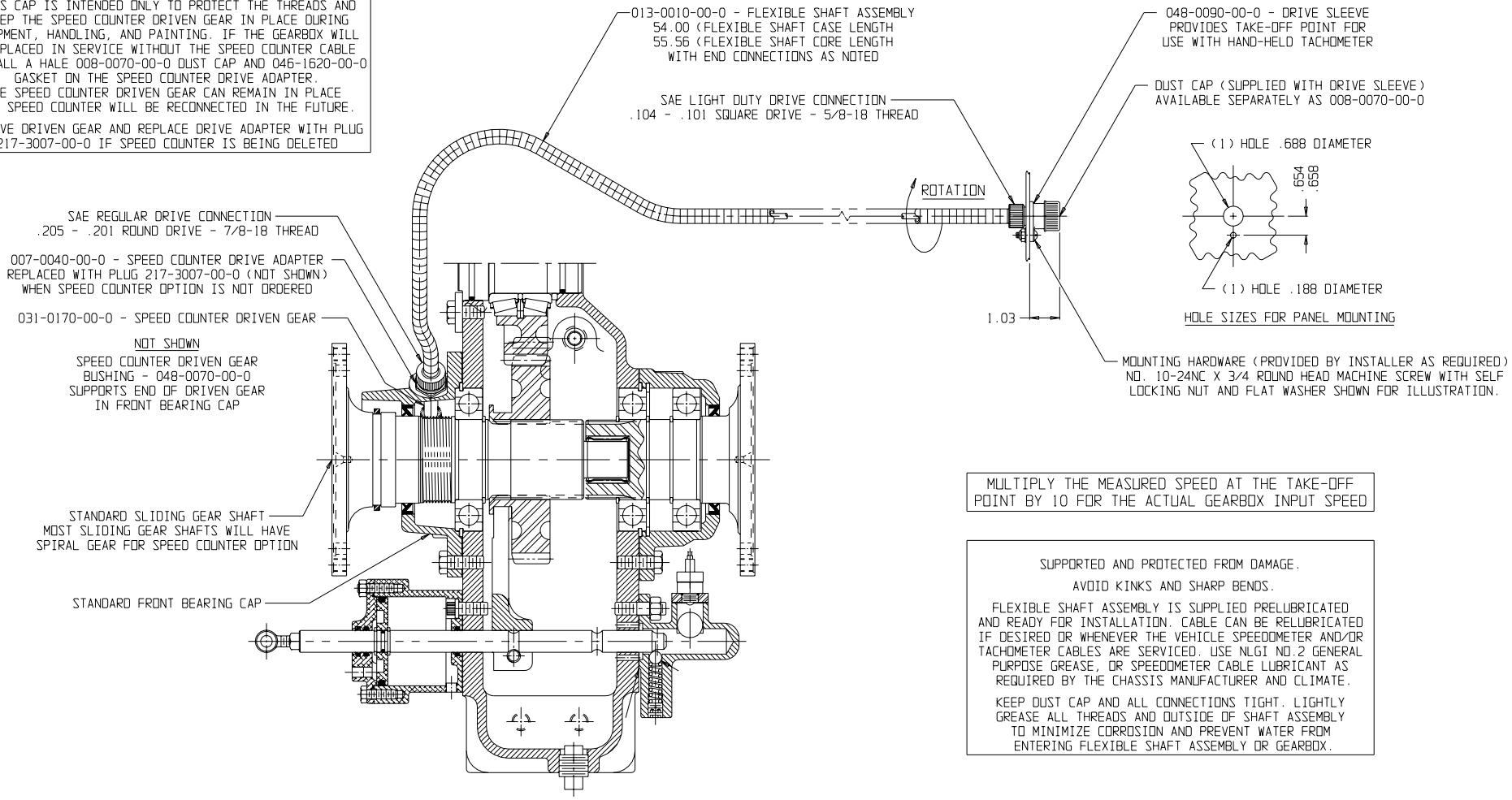
PLATE NO. 746AB

Notes

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



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

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
99-131	A	RELEASED FOR PRODUCTION	AJD	5-18-99	RET

HALE PRODUCTS, INC.
A Unit of IDEX Corporation
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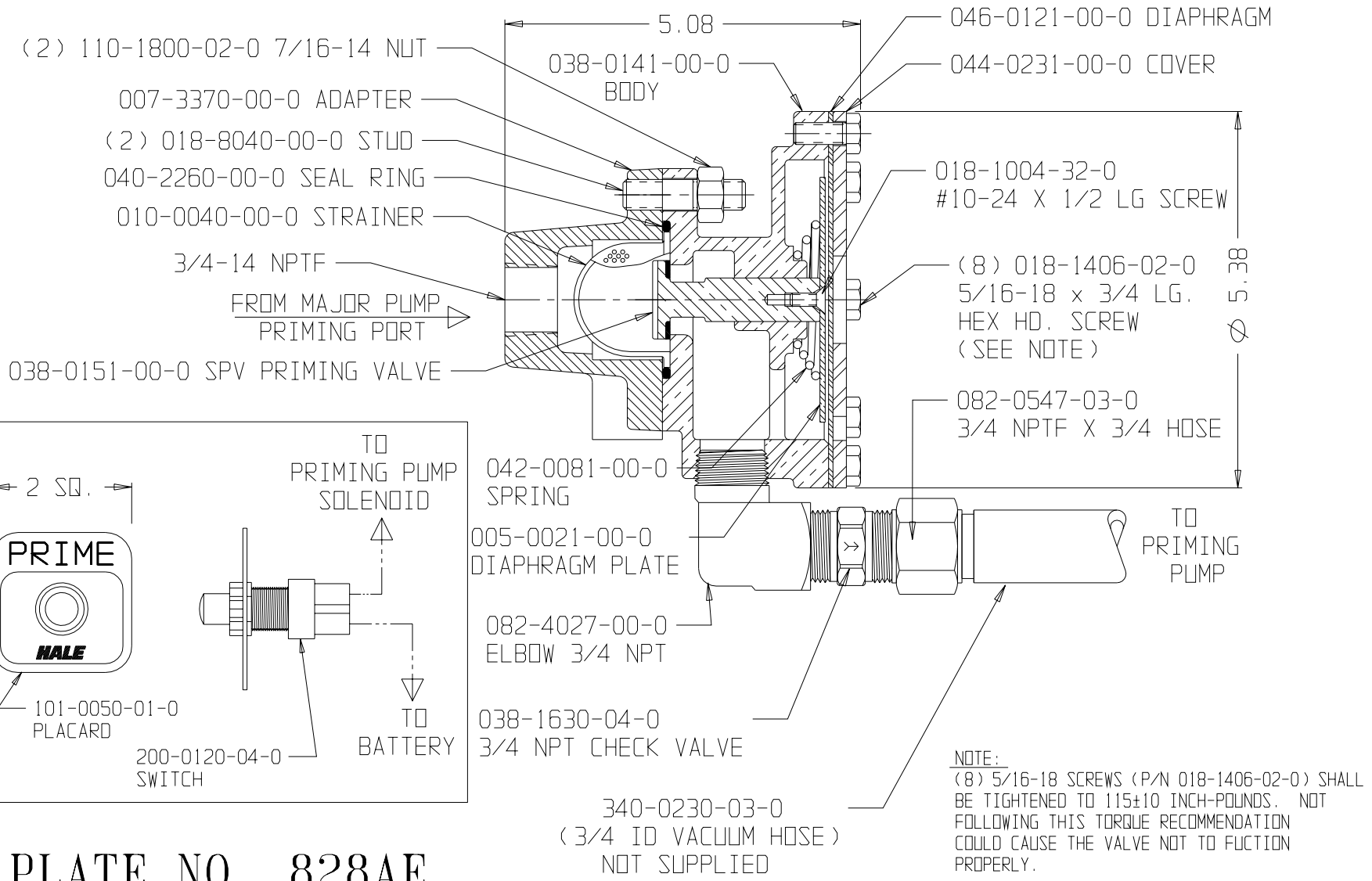
DRAWN AJD | CHECKED RET | DATE: 5-18-99 | SIZE 59 X 45 | SCALE: 17.5%

PLATE 910AA

Notes

538-1580-10-0

HALE TYPE SPV SEMI-AUTOMATIC PRIMING VALVE (WITH UNIVERSAL MOUNTING ADAPTER)



NOTE:
(8) 5/16-18 SCREWS (P/N 018-1406-02-0) SHALL BE TIGHTENED TO 115±10 INCH-POUNDS. NOT FOLLOWING THIS TORQUE RECOMMENDATION COULD CAUSE THE VALVE NOT TO FUCTION PROPERLY.

PLATE NO. 828AE

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
01-177	E	UPDATED W/DESCRIPTIONS	TKC	4-5-01	MAL

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
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
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

HALE PRODUCTS, INC.
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DRAWN DLM | CHECKED RDT | DATE 8-15-95 | SIZE C | SCALE: FULL

Notes

TEST PROCEDURE:

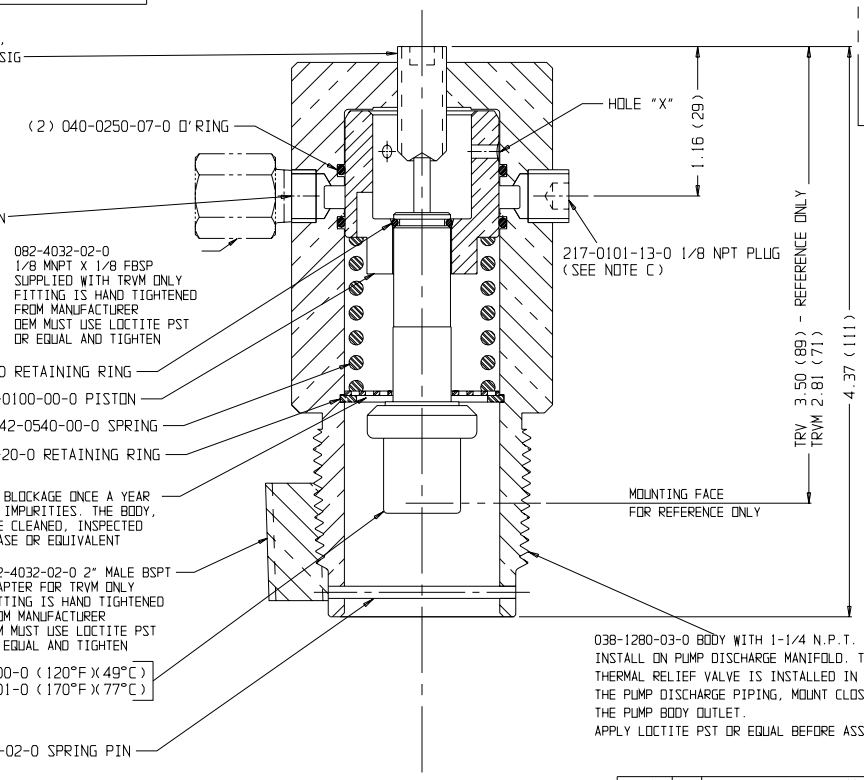
1. CLOSE ALL DISCHARGE VALVES INCLUDING PUMP AND ENGINE COOLERS SO THERE IS NO FLOW THROUGH THE PUMP.
2. USE CARE THAT ENGINE DOES NOT OVERHEAT, SET THE PUMP DISCHARGE PRESSURE TO ONE OF THE PRESSURES LISTED.
3. THE THERMAL RELIEF VALVE SHOULD DISCHARGE WATER THROUGH THE 1/8 NPT OR ISO DISCHARGE LINE 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.
6. UNITS EQUIPPED W/TRV-L KIT WILL FLOW UP TO 1-2 GPM OF WATER BEFORE LAMP TURNS ON.

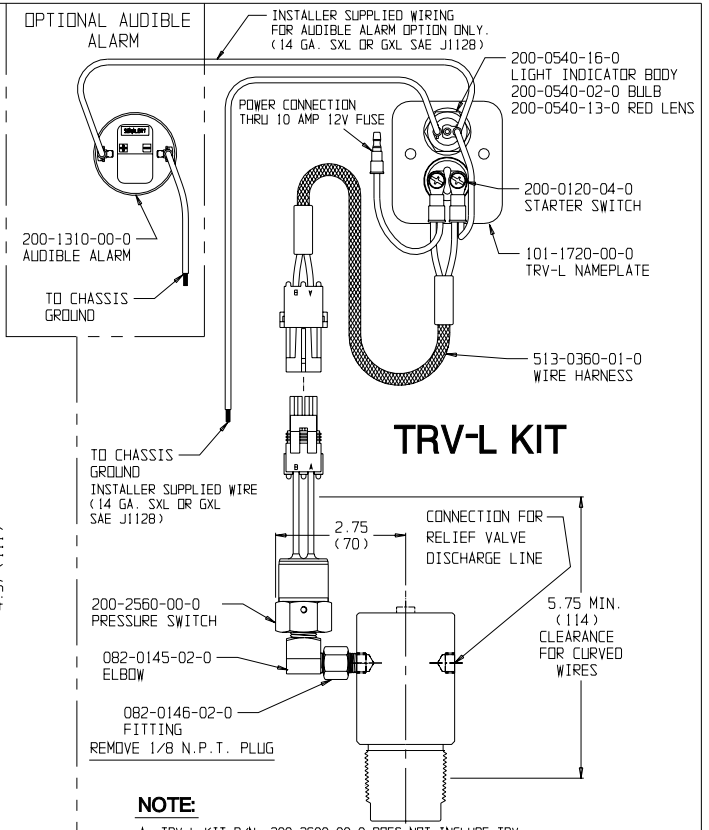
PRESSURE	TIME IN MINUTES TRV120/TRVM120/ TRVF120	TRV170/TRVM170/ TRVF170
200 PSIG(13.8 BAR)	10	20
400 PSIG(27.6 BAR)	4	8
600 PSIG(41.4 BAR)	2	4

INSTALL THIS END IN UPWARDS POSITION SO THE RELIEF VALVE DRAINS IN FREEZING WEATHER OR USE DRAIN AS NOTED.

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.





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.

MODEL	TEMPERATURE RATING
TRV120/TRVM120	120° F. (49° C)
TRV170/TRVM170	170° F. (77° C)

DIMENSIONS ARE IN INCHES.
DIMENSIONS IN ( ) ARE MM.

HALE TYPE TRV/TRVM THERMAL RELIEF VALVE

PLATE NO. 729AF

PATENT NO. 5,018,665

ECO NO	REV	CHANGED FROM	BY	DATE	APVD
97-225	D	CHANGED BODY FROM 038-1280-00-0 TO 038-1280-03-0 (TRV170 ONLY)	MD	12-4-97	RET
00-540	E	ADDED TRV WITH FLANGE (TRVF)	DK	07-31-00	MAL
04-106	F	ADDED 082-4032-02-0 REMOVED 038-1282-00-0 FLANGE	TC	5-16-04	MAL

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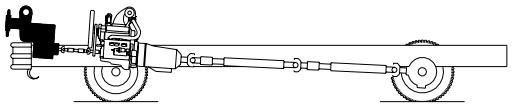
Conshohocken, PA 19428 USA

DRAWN	DJK
CHECKED	MAL

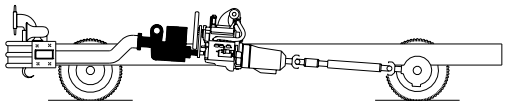
DATE 7-31-00 | SIZE 9.5 X 13 | SCALE: FULL

Notes

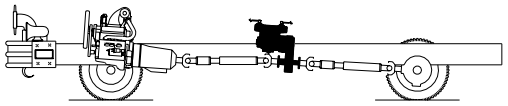
HALE PRODUCTS
VEHICLE MOUNTED PUMP APPLICATIONS



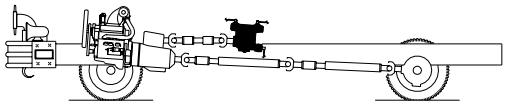
FRONT MOUNT



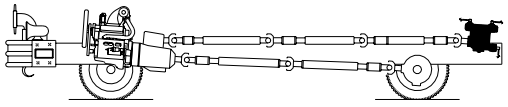
INTRA-CAB MOUNT



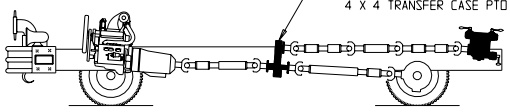
MIDSHIP SPLIT-SHAFT



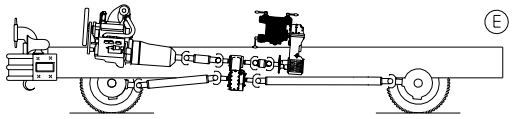
MIDSHIP PTO



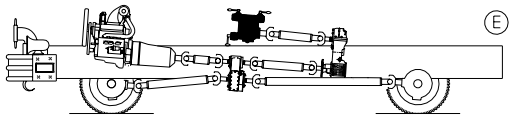
REAR MOUNT PTO



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
	QFLD	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
	MG	500-1000	SINGLE	NO	MG
MIDSHIP PTO	PSD	750-1500	SINGLE	NO	A
	QPAKJ	500-1000	SINGLE	YES	J
	QFLDA	750-1250	SINGLE	YES	A
	MG	500-1000	SINGLE	NO	MG
	AP	250-500	SINGLE	OPTIONAL	P1
	2CBP	50-100	TWO	NO	P2
	CBP	250	SINGLE	NO	P2
REAR MOUNT PTO	PSD	750-1500	SINGLE	NO	A
	QFLDA	750-1250	SINGLE	YES	A
	AP	250-500	SINGLE	OPTIONAL	P1
REAR MOUNT SPLIT-SHAFT	PSD	750-1500	SINGLE	NO	A
	QFLDA	750-1250	SINGLE	YES	A
	QMAXU	1000-2250	SINGLE	YES	DIRECT DRIVE
	QTWOU	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
HALE MIDSHIP WITH 4X4 TRANSFER CASE PTO	QSG	750-1250	SINGLE	YES	S,L
	QFLD	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
HALE MIDSHIP WITH LGA & 4 X 4 TRANSFER CASE PTO	QMAXU	1000-2250	SINGLE	YES	DIRECT DRIVE
	QTWOU	1000-2000	TWO	YES	DIRECT DRIVE
	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
00-560	E	ADDED RGA & MGA GEARBOXES + 4 X 4 VERSIONS	EAW	9-25-96	RET
01-129	F	CORRECT QPAK FLOW RATE, REMOVE QPAKA, ADD P2, ADD LGA	PRW	3-14-01	MAL

ECO NO	REV	REVISION DESCRIPTION	BY	DATE	APVD
96-169	A	RELEASED FOR PRODUCTION	EAW	9-25-96	RET
97-123	B	ADDED RATINGS, RATIOS, STAGES	LN	6-4-97	RET
98-107	C	ADDED QFLD, QMAX, QTWO, AND QGU, REARRANGED ROWS AND COLUMNS	AJD	6-2-98	RET
98-185	D	ADDED 1.97 GEAR RATIO TO PSD & QFLDA PUMP MODELS	DLM	8-31-98	RET

HALE PRODUCTS, INC.
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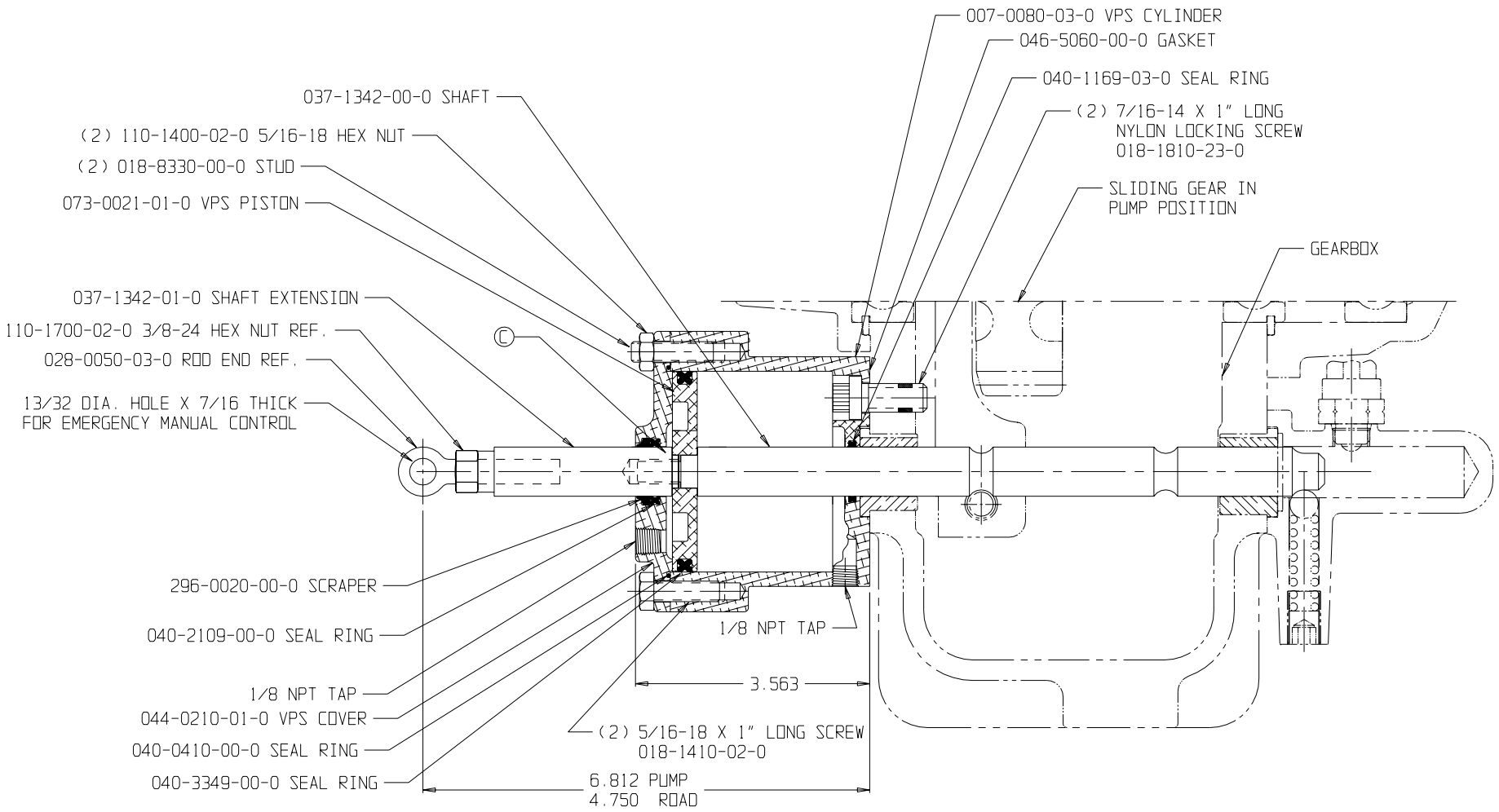
DRAWN: EW | CHECKED: RET | DATE: 8-23-96 | SIZE: 12.7 X 17.4 | SCALE: 60%

Notes

ASSEMBLY PART NUMBER	VPS POWER SHIFT FOR THE FOLLOWING PUMP MODELS
507-0110-03-0	QSMG, QSG, QMAX, QTWO, QFLO, QPAK, MG & 4DG

HALE TYPE VPS POWER SHIFT



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 THROS ADDED PISTON W/O O-RING GRV DELETED O-RING SEAL	BCJ	7-29-05	MAL

PLATE NO. 533DC

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

DRAWN	JDR
CHECKED	RDT

DATE: 6-7-95 | SIZE 26.25 X 19 | SCALE: FULL

Notes