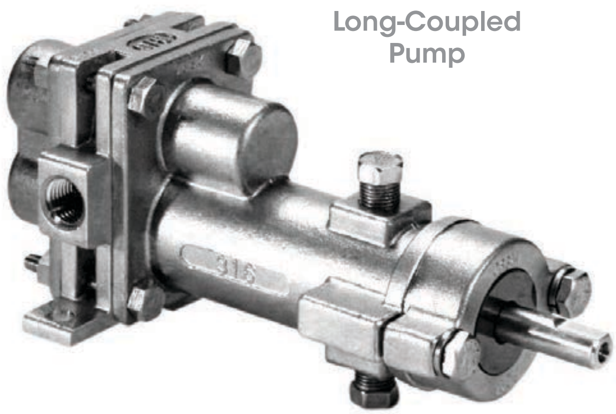
Liquiflo™
Chemical Processing Pumps

INSTALLATION, OPERATION & MAINTENANCE MANUAL

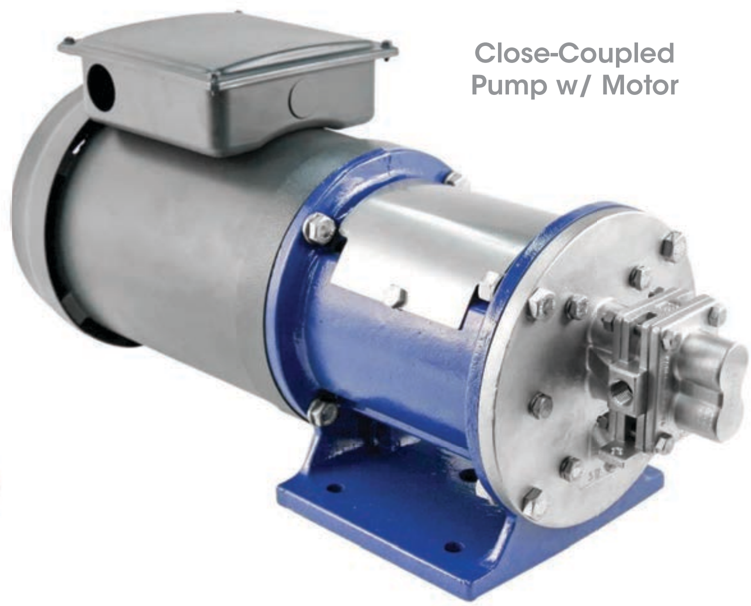
H-SERIES & 3-SERIES

SEALED GEAR PUMPS

Long-Coupled Pump



Close-Coupled Pump w/ Motor



H-SERIES: Models H1F, H3F, H5R, H5F, H7N, H7R, H7F, H9R & H9F

3-SERIES: Models 31F, 33F, 35R, 35F, 37R, 37F, 39R, 39F & 311F

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This manual provides instructions for the installation, operation and maintenance of the Liquiflo H-Series & 3-Series gear pumps, **Sealed models H1F, H3F, H5R, H5F, H7N, H7R, H7F, H9R, H9F, 31F, 33F, 35R, 35F, 37R, 37F, 39R, 39F and 311F.** It is critical for any user to read and understand the information in this manual along with any documents this manual refers to prior to installation and start-up.

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Section 1: General Information

1.1 General Instructions

This manual covers the H-Series Sealed Gear Pumps, Models H1F thru H9F; and the 3-Series Sealed Gear Pumps, Models 31F thru 39F, and 311F.

The materials for construction of the pump are selected based upon the chemical compatibility of the fluid being pumped. The user must verify that the materials are suitable for the surrounding atmosphere.

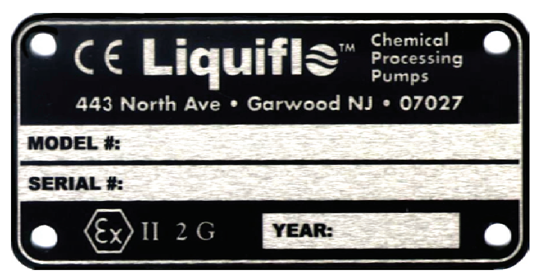
If the fluid is non-conductive, methods are available to mechanically ground the isolated shaft. This is only necessary if the surrounding atmosphere is extremely explosive or stray static charges are present.

Upon receipt of your Liquiflo pump verify the following:

- **A** That the equipment has not been damaged in transit.
- **B** Pump Serial Number is stamped on the pump's rear housing.
- **C** The *Liquiflo Stainless Steel* Nameplate is secured to the pump's housing (pictured).

D For ATEX certification, verify that the following Stainless Steel Tag is attached to the pump (Pictured).

Explanation of ATEX Tag	
Group II	Explosive atmospheres
Category 2	Equipment provides a high level of protection. Explosive atmospheres are likely to occur.
Category 3	Equipment Provides a normal level of protection. Explosive atmospheres are unlikely to occur.
D	Dust
G	Gas



E Record the following information for future reference:

Model Number:
Serial Number:
Date Received:
Pump Location:
Pump Service:

NOTE: By adding a **K** prior to the pump's model code, a **Repair Kit** can be obtained which consists of the following parts: drive and idler gears, drive and idler shafts, wear plates, bearings, retaining rings, keys, housing alignment pins, bearing lock pins and O-rings. (**See Appendix 4** for more information).

1.2 Pump Specifications

Table 1A: Performance Specifications (English System Units)

Pump Series	Pump Model	Max Flow	NPSHR[2]	Dry Lift[2]	Max Speed	Max ΔP	Max Viscosity[3]	TD[4]
	Units:	GPM	ft	ft	RPM	PSI	cP	Gal./Rev.
	H1F	0.5	3	0.5				.000276
	H3F	1.4	2	1.5				.000828
	H5R	2.4	2	2				.001379
	H5F	3.4	2	4				.001930
H-Series	H7N	5.4	5.2	6	1750	225[1]	100,000	.003070
	H7R	8.6	5.2	6				.004910
	H7F	10.7	5.2	7				.006140
	H9R	15.0	3	14				.008610
	H9F	21.5	3	14				.01228
	31F	0.5	3	0.5				.000276
	33F	1.4	2	1.5				.000828
	35R	2.4	2	2				.001379
	35F	3.4	2	4				.001930
3-Series	37R	8.6	5.2	6	1750	100	100,000	.004910
	37F	10.7	5.2	7				.006140
	39R	15.0	4	6				.008610
	39F	21.5	3	14				.01228
	311F	21.5	3	14		80		.01228

Table 1B: Performance Specifications (SI System Units)

Pump Series	Pump Model	Max Flow	NPSHR[2]	Dry Lift[2]	Max Speed	Max ΔP	Max Viscosity[3]	TD[4]
	Units:	LPM	m	m	RPM	bar	mPas	Lit./Rev.
	H1F	1.9	0.9	0.15				.001045
	H3F	5.3	0.6	0.46				.003134
	H5R	9.1	0.6	0.6				.005220
	H5F	13.0	0.6	1.2				.007306
H-Series	H7N	20.0	1.6	1.8	1750	15.5 [1]	100,000	.011621
	H7R	33.0	1.6	1.8				.018586
	H7F	40.5	1.6	2.1				.023242
	H9R	57.0	0.9	4.3				.032592
	H9F	81.4	0.9	4.3				.04648
	31F	1.9	0.9	0.15				.001045
	33F	5.3	0.6	0.46				.003134
	35R	9.1	0.6	0.6				.005220
	35F	13.0	0.6	1.2				.007306
3-Series	37R	33.0	1.6	1.8	1750	6.9	100,000	.018586
	37F	40.5	1.6	2.1				.023242
	39R	57.0	1.2	1.8				.032592
	39F	81.4	0.9	4.3				.04648
	311F	81.4	0.9	4.3		5.5		.04648

NOTES: (1) Max ΔP (Differential Pressure) is derated to 125 PSI (8.6 bar) for viscosities < 5 cP (mPas).

(2) NPSHR and Dry Lift are Specified @ Max Speed and 1 cP (mPas).

(3) Fluid viscosities > 150 cP (mPas) should use pumps with trimmed gears to reduce power consumption and increase pump efficiency. High-viscosity fluids may require larger pumps with trimmed gears operating at lower speeds. Consult factory.

(4) TD (Theoretical Displacement) is based on new pump operating @ Max Speed and ΔP = 0.

Table 2: Absolute Temperature & Pressure Ratings

Pump is designed to operate within the ambient temperature range of 32°F (0°C) and 122°F (50°C). The Pump is designed to handle fluid temperatures ranging from 32°F (0°C) to 104°F (40°C) with standard components. For fluid temperatures outside this range, gears and bearings may require a trim to compensate for thermal expansion. Reference pump model code to determine if the pump is trimmed.

Pump Series	Pump Model	Minimum Operating Temperature		Maximum Operating Temperature(1)		Maximum System Pressure(2)	
	Units:	**°F**	**°C**	**°F**	**°C**	**PSIG**	**bar (g)**
H-Series	**H1F, H3F, H5R & H5F**	-40	-40	500	260	300	20.7
	H7N, H7R, H7F, H9R & H9F	-40	-40	500	260	225	15.5
3-Series	**31F, 33F, 35R & 35F**	-40	-40	500	260	300	20.7
	37R, 37F, 39R, 39F & 311F	-40	-40	500	260	225	15.5

NOTES: (1) The actual maximum surface temperature depends not on the pump but primarily on the temperature of the fluid being pumped. Pump surfaces will be approximately 20°F (12°C) above the temperature of the fluid being pumped.

(2) For pumps with ANSI 150# RF Flanges, the Maximum Operating Pressure Rating of the flange is 285 PSIG within the temperature range of -20 to 100 °F. Above 100 °F, derate by 0.3 PSIG/°F.

Maximum Torque Specifications

For the majority of applications a Stainless Drive gear and Plastic idler are used. The most common and most desirable material choice for the Drive Gear-Idler Gear combination is a 316 Stainless Drive Gear and PEEK idler gear. PEEK is a an extremely high performance Engineered plastic that has nearly 5 times the strength and wear properties of Teflon and is corrosion resistant to the majority of chemicals. Teflon is actually one of the least desirable material to use for gears or bearings do to its extremely weak physical properties. Because of its weak physical properties and high temperature coefficient of expansion it is only recommended as gears or bearings choice when no other material choice is acceptable for the application. For high viscosity liquids (in excess of 100 Cp) a Stainless Drive Gear and Alloy-20 Idler gear are acceptable. This is refered to as a double metal gear combination. The diagram below shows the relative maximum amount of torque that gears made of various materials can safely withstand. The amount of torque required is a function of both pressure and viscosity of the liquid being pumped.

Relative Strength of Gears

Table 5: Material Data

Component		Materials
Pump Housing		316 Stainless Steel or Alloy-C
Mounting Hardware		18-8 Stainless Steel
Mounting Bracket (Pedestal) *		Cast Iron, Epoxy Painted
Motor Frames (C-Face)		NEMA 56C, 143/145TC & 182/184TC; IEC 71/80/90/100/112 (B5 Flange)
Bearings		Carbon-60, Teflon, PEEK or Silicon Carbide (1)
Wear Plates		Carbon-60, Teflon, PEEK or Silicon Carbide (1)
Gears		316 SS, Alloy-C, PEEK, Ryton, Teflon or Carbon (1)
Shafts	Base Metal	316 Stainless Steel or Alloy-C (2)
	Coating	Uncoated, Ceramic Chrome Oxide or Tungsten Carbide
Housing Pins (non-wetted)		17-4 PH
Bearing Pins		Teflon, 316 Stainless Steel or Alloy-C (2)
Retaining Rings		316 Stainless Steel or Alloy-C (2)
Keys		316 Stainless Steel or Alloy-C (2)
O-rings/Gaskets		Teflon, Viton, EPDM, Buna-N, Kalrez or SS/PTFE Encapsulated
Dynamic Seal	Packing	Braided Teflon or Graphoil
	Mechanical Seals	Seal Face: Carbon or Teflon ; Seal Seat: Silicon Carbide ; Seal Wedge: Teflon or Graphoil ; Metallic Body: Single Internal: (2) ; Double: 316 SS

NOTES: (1) Teflon is 25% glass-filled PTFE.
(2) Metallic material will match pump housing material.
* Closed-Coupled Configuration

1.3 Model Coding

A 15-position **Model Code** is used to completely describe a specific mag-drive pump. This code is required when ordering a new pump or a cartridge, repair kit or replacement parts for an existing pump. The table below describes the Model Code and gives a specific example:

Table 6: Mag-Drive Pump Model Code Description & Example

Position #	Description	Pump Model Code Example: H5FS6PEE000000US	
		Code	**Selection**
1	Pump Model (Size)	**H5**	Model H5F (H5= Pump Size; F= Full Capacity
2	Pump Model (Capacity)	**F**	
3	Basic Material & Port Type	**S**	316 SS Housing and Shafts & NPT Ports
4	Drive Gear	**6**	316 SS Drive Gear
5	Idler Gear	**P**	PEEK Idler Gear
6	Wear Plates	**E**	Carbon-60 Wear Plates
7	Bearings	**E**	Carbon-60 Bearings
8	Outer Magnet Bore (Motor Frame)	**0**	5/8" (NEMA 56 C Motor Frame)
9	Bearing Flush	**0**	No Bearing Flush (Standard Housings)
10	Shaft Coating	**0**	Uncoated (Bare 316 SS Shafts)
11	O-rings	**0**	Teflon Bearing Pins
12	Retaining Rings	**0**	316 SS Retaining Rings
13	Bearing Pins	**0**	Teflon Bearing Pins
14	Magnetic Coupling	**U**	MCU (75 in-lbs) Magnetic Coupling
15	Containment Can	**S**	Single-Wall Containment Can
Suffix	Trim Option		No Trim Options

NOTE: See the Liquiflo Product Catalog or our Website (www.Liquiflo.com) for complete Model Coding information.

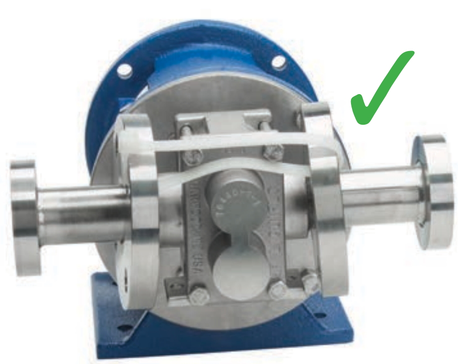
1.4 Returned Merchandise Authorization (RMA)

If it is necessary to return the pump to the factory for service:

1. Contact your local Liquiflo distributor to discuss the return, obtain a Returned Merchandise Authorization Number (**RMA #**) and provide the distributor with the required information (see RMA Record below).
2. Clean and neutralize pump. Liquiflo is not equipped to handle dangerous fluids.
3. Package the pump carefully and include the **RMA #** in a visible location on the outside surface of the box. If the pump is flanged, zip-tie the flanges together to prevent the pipes from bending.
4. Ship pump to factory, freight prepaid.

Returned Merchandise Authorization (RMA) Record	
RMA #	**(Supplied by Distributor)**
Item(s) Returned	
Serial Number(s)	
Reasons for Return	
Fluid(s) Pumped	
Time in Service	

NOTE: Pump must be cleaned and neutralized prior to shipment to the factory.



NOTE: Zip-tie flanges when applicable.

1.5 General Operation

The successful and safe operation of a pump is not only dependent on the pump but also on each of the system components. It is therefore important to monitor the entire pumping system during operation and to perform the necessary maintenance to keep the system running smoothly.

A normally operating gear pump will deliver a steady, pulse-less flow with no leakage, be relatively quiet and have a predictable flow rate based on the pump speed, fluid viscosity and differential pressure across the pump. Refer to the performance curves of the specific pump model being operated (see Liquiflo Product Catalog or website: www.liquiflo.com).

If a significant problem is observed during operation, the pump should be stopped so that corrective action can be taken. The observed problem could have several possible causes, and multiple remedies for each cause. For help with problem solving, refer to the Troubleshooting Guide given in **Appendix 7**.

1.6 Maintenance & Repair

The pump has a dynamic seal (i.e., mechanical seal or packing), internal sleeve bearings, wear plates, gears and shafts which require replacement over time due to physical wear. The center housing of the pump may also incur physical wear and require replacement (see **Appendix 3**). O-rings and retaining rings should always be replaced when rebuilding the pump.

The main factors affecting the physical wear of the pump are operating speed, differential pressure, fluid viscosity, duty cycle, starting and stopping frequency, abrasives in the fluid and the wear properties of the materials. These factors can cause pump lifetimes to vary significantly from one application to another, making it difficult to predict when the pump will require maintenance. Therefore, the maintenance schedule for the pump is typically based on the maintenance history of the specific application. The main indicators that a pump may require maintenance are the following: (1) decreased flow rate or pressure, (2) fluid leakage, (3) unusual noise or vibrations and (4) increased power consumption.

Standard repair kits are available to facilitate repair of the pump. A repair kit for a sealed pump includes the following parts: sealing components (packing rings, or mechanical seal), bearings, wear plates, gear-shaft assemblies, O-rings and gaskets, bearing lock pins and housing alignment pins. The single mechanical seal includes the outboard seal seat and the double mechanical seal includes both the inboard and outboard seal seats. Before performing maintenance on the pump, review the safety precautions and follow the included instructions.

Section 2: Pump & Motor Installation

2.1 Installation Location of Pump, Motor & Base

Refer to the Hydraulic Institute Standards for installation procedures of the base, pump and motor.

1. **The pump inlet should be as close to the liquid source as practical and preferably below it**. Even though gear pumps have self priming and lift capability, many issues can be avoided with a flooded suction configuration.

2. **For long coupled pumps, the pump and motor shafts must be manually aligned to eliminate radial loads on the pump shaft that will cause vibration and lead to premature pump failure**. (Note: If the pump was delivered as a complete long-couple assembly, it was properly aligned at the factory.) Alignment of long coupled pumps is critical, even on small pumps, and should be checked by taking measurements of angularity and parallelism at the coupling. If these are off by more than 0.015 inches (0.4mm), the assembly should be realigned. Flexible couplings aren't intended to compensate for severe misalignment.

3. For long-coupled pumps install the coupling guard over the mechanical coupling and fasten to the base plate. (Note: If the pump was delivered as a complete long-coupled assembly, the coupling guard was properly installed at the factory. **(Note: For sealed pumps with close-coupled configuration, no alignment procedure or coupling guard is required).**

4. The mechanical coupling between the pump and motor has a **flexible insert which must be free to move axially** – a distance of 1/16 to 1/8 inches – to prevent axial loads from being applied to the pump.

2.2 General Piping Requirements

Refer to Hydraulic Institute Standards for piping guidelines.

1. All piping must be supported independently and must line up naturally with pump ports.

> **Caution!**
> ***Do not use the pump to support the piping*** *or allow the piping to apply stress to the pump ports. This can distort the alignment of the pump housing with internal parts and lead to rapid wear or malfunction.*

2. Piping that handles both hot and cold liquids require proper installation of expansion loops and joints so that thermal expansion of the piping will not cause misalignment.

3. **Suction and discharge piping should be the same size or larger than the inlet and outlet ports.** This is especially important for viscous services when the pipe diameter has a large effect on friction losses and NPSH available.

2.3 Relief Valves

1. **A positive displacement pump should have a pressure relief valve installed in the discharge line**. Operating a gear pump against a closed discharge valve will result in over pressure and likely failure of the pump or system. Install the relief valve between the pump discharge port and the discharge isolation valve. Ideally, the relief valve should bypass the discharge line back to the supply tank. Where this is not feasible, piping the relief valve back to the suction side of the pump will prevent immediate pump failure from over pressure, however, continuously running in this condition will cause heating of the fluid.

2.4 Strainers and Solids Handling

1. Liquiflo gear pumps have very close internal clearances and are designed to pump relatively clean fluids. The entrance of foreign material could cause damage or rapid wear to the pump components. While occasional small particles may not be catastrophic to the pump, **the use of a strainer on the inlet will prevent large particulates from entering the pump**. Large particulates can become lodged into the roots of the gears, causing a sudden failure. If small, abrasive particles are present, they can get in between the shaft and bearings which will accelerate or increase wear over an extended period of time. If the strainer clogs with material and is not properly maintained, the pump may be starved of liquid, causing a loss of flow and damaging the pump via dry-running or cavitation.

2. **Regardless of particle size, these pumps are intended for relatively clean liquids** where the general concentration of solids is limited to 1% by volume. Higher concentration may cause the wear rate to increase, resulting in a decrease in pump performance. In addition to solids concentration, the specific wear rate also depends on the size, shape and hardness of the particles, the operating speed and the materials used to construct the pump. Since wear rate is proportional to the square of the speed, slower operating speeds will substantially increase pump life.

2.5 Differental Pressure Requirements

The pump should be operated with at least 15 PSI (1 bar) differential pressure to ensure that the pumped fluid is forced into the sleeve bearings, which are lubricated by the pumped fluid. If adequate discharge pressure is not available, a back pressure valve can be used to generate sufficient pressure.

2.6 Controlling The Flow

A gear pump is a positive displacement pump, and flow **cannot** be controlled by throttling the discharge valve. **Adjusting the motor speed** using a VFD (Variable Frequency Drive) is the most common method to control flow. Fluid viscosity and differential pressure will also have an affect on the flow rate.

2.7 Motor Selection

1. The motor frame must be compatible with the pump mounting bracket (pedestal) and outer magnet hub. The motor frame size is part of the pump model coding and is selected at the time the pump is ordered. Pedestals and hubs are available to fit NEMA 56C, 143TC, 145TC, 182TC & 184TC, and IEC 71, 80, 90, 100 & 112 (with B5 flange). NEMA 182/184TC and IEC 100 & 112 B5 motor frames require an adapter plate to mount the motor to the bracket (see Page 29). The adapter plate is provided when required.

2. The motor is often sized at the time the pump is ordered to meet the specified conditions of service. The power requirements of the application depend on the flow rate, differential pressure and fluid viscosity. Up to 100cP, the pump performance charts can be used to determine the brake horse power (BHP) required for the application. Motor sizing and selection is further influenced by: constant torque ratios, enclosure requirements and RPM limits due to viscosity. For sizing of viscous fluid applications or for more assistance in general selection, contact the local distributor or Liquiflo.

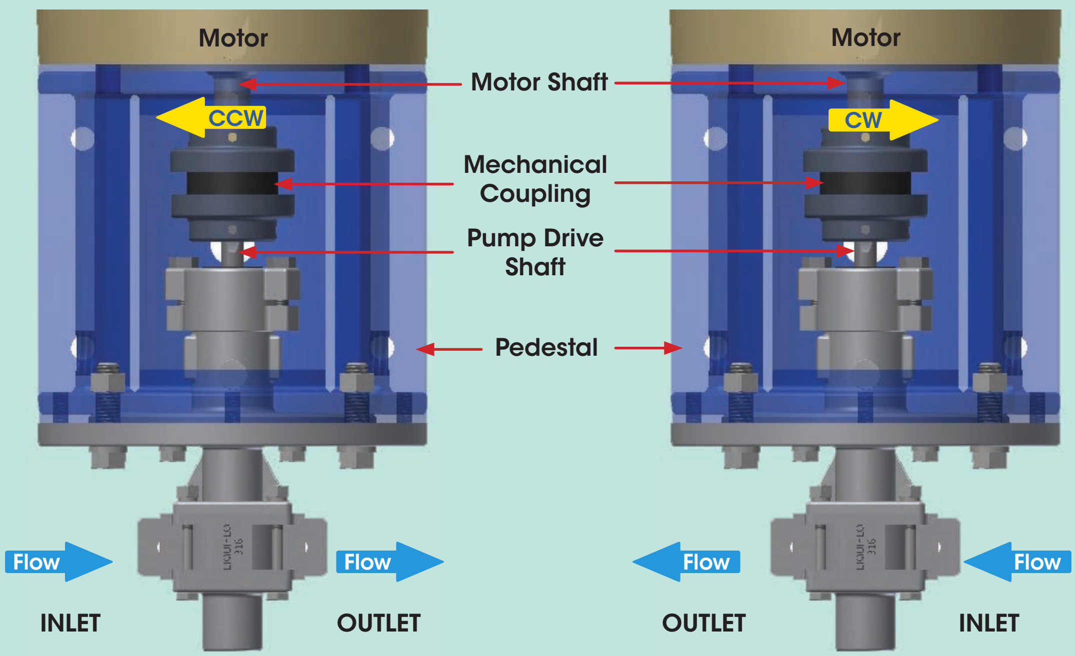
2.8 Motor Hook-Up

Please refer to the motor manufacturers instructions.

2.9 Motor Direction

The motor shaft is Mechanically coupled to the drive shaft of the pump. Both shafts will turn in the same direction. Because the gear pump is bi-directional, the pump shaft can turn in either direction to produce flow in either direction. The direction of rotation of the motor shaft (same as that of the pump drive shaft) will determine which side of the pump is the inlet (suction side) and which side is the outlet (discharge side). For the pump models covered in this manual, the flow direction will be as shown below:

Top View of Sealed Gear Pump (with Transparent Pedestal) Close-Coupled to Motor



Counterclockwise (CCW) Rotation of Motor Shaft:

Fluid will enter the pump at the left side (inlet) and be discharged at the **right** side (outlet).

Clockwise (CW) Rotation of Motor Shaft:

Fluid will enter the pump at the right side (inlet) and be discharged at the **left** side (outlet).

Section 3: Start-Up & Operation

3.1 Starting The Pump

1. Verify that the pump and motor are suitable for the conditions of service.
2. Verify that all suction and discharge **valves are open** before starting the pump.
3. Prime the pump if feasible. For a flooded suction, allow the fluid time to enter the pump before starting. While the pump is capable of pulling a certain amount of dry lift, accessive wear occurs during this period. For a suction lift, priming or wetting the internal parts greatly reduces wear, since the components are lubricated by the pumped fluid. Some material combinations, such as PEEK gears and Carbon wear plates and bearings are much more forgiving to short periods of dry running. The interface between the rotating and stationary seal faces of a single mechanical seal are lubricated by the pumped fluid. If run dry, heat can be generated which can crack the seal faces. As a general rule sealed pumps should not not run dry for more than 30 seconds.
4. Jog the motor to check the rotation (see Page 11 for diagram).
5. Monitor the pump for several minutes to insure proper operation.

NOTE: For information about dynamic seal operation refer to **Appendix 4** page 40-41.

3.2 Troubleshooting

A normally operating gear pump will deliver a steady, pulse-less flow with no leakage and be relatively quiet. A gear pump will have a predictable flow rate based on the pump speed, fluid viscosity and differential pressure across the pump. During pump operation, inspect for: (1) Unusual noise, (2) Product leakage, (3) Expected suction and discharge pressures and (4) Expected flow rate based on pump speed, fluid viscosity and differential pressure. If any problems occur, stop the pump and take corrective action. For help with problem solving, refer to the Troubleshooting Guide given in **Appendix 7**.

Section 4: Maintenance & Repair

The pump has internal sleeve bearings, wear plates, gears and shafts which require replacement over time due to physical wear. The center housing of the pump may also incur physical wear and require replacement (see **Appendix 3** for wear allowances). O-rings and retaining rings should always be replaced when rebuilding the pump.

4.1 General Precautions

- Always **lock out the power** to the pump driver when performing maintenance on the pump.
- Always **lock out the suction and discharge valves** when performing maintenance on the pump.
- **Never** use heat to disassemble pump.
- Before performing maintenance on the pump, check with appropriate personnel to determine if skin, eye or lung protection is required and how best to flush the pump.

> **Caution!**
> *Failure to observe safety precautions can result in personal injury, equipment damage or malfunction.*

4.1 General Precautions

Before servicing, prepare the pump as follows:

If the pump was used for hazardous or toxic fluids, it must be flushed and decontaminated prior to service. Refer to the Material Safety Data Sheet (MSDS) for the liquid and follow all prescribed safety precautions and disposal procedures.

1) Flush the pump.

2) Stop the motor and lock out the electrical panel.

3) Close the suction and discharge isolation valves.

4) Disconnect the pump from the system piping.

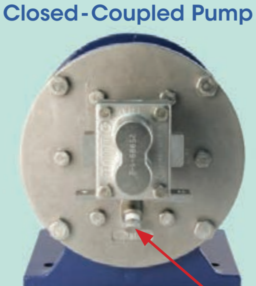
5) Drain the stuffing box by removing the 1/8" NPT plug on the pump's front housing (see box below).

Location & Removal of Drain Plug

To drain the stuffing box,
remove the **1/8" NPT** plug.

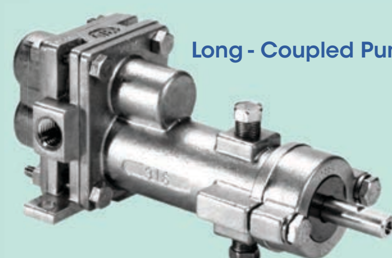
> **Caution!**
> *Some trace fluid may remain in the pump even after draining.*

Closed-Coupled Pump



1/8" NPT Plug
(Stuffing Box)

Long - Coupled Pump



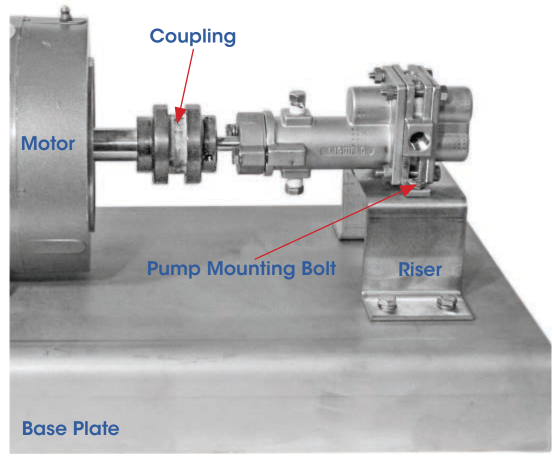
1/8" NPT Plug
(Stuffing Box)

4.3 PUMP DISASSEMBLY: Long-Coupled Configuration

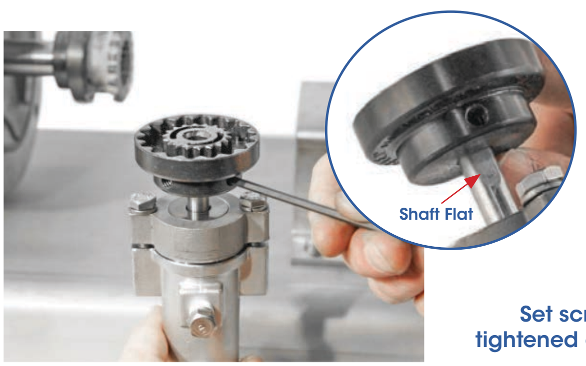
Liquiflo sealed gear pumps are available in both long and close coupled configurations. The disassembly and assembly of these two designs are very similar. Many steps, including seal installation can be used interchangeably. Pictures for the close coupled design begin on page 29. For a long coupled pump follow the procedure below and refer to the drawings in **Appendix 6**.

1 Remove the pump mounting bolts; then separate the pump from the base or riser.

NOTE: A long-coupled pump & motor assembly (without coupling guard) is shown at right. The coupling setscrews do not have to be loosened to remove the pump. The sealed pumps usually have two mounting bolts; exceptions are Models H9F, 39F and 311F, which have four mounting bolts.



2 Remove the coupling flange from the pump shaft by loosening the setscrew.



Set screw should only be tightened on flat part of the shaft

3 Inspect the end of the drive shaft and remove any high spots, scratches or burrs.

NOTE: The round part of the drive shaft may have been scored by the coupling setscrew. If necessary, polish the shaft with fine emery cloth. This will prevent damage to the teflon seal wedge when the mechanical seal is removed or installed on the shaft.

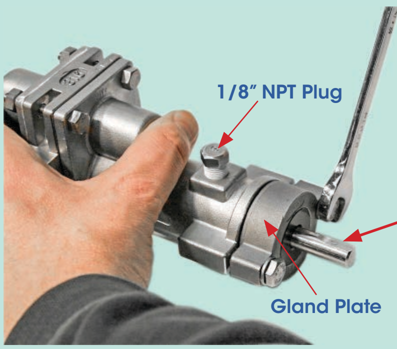
Removal of Seals

The pump can have a Single Mechancical Seal, Double Mechanical Seal or Packing. Remove the pump's seal by referring to the applicable sections below.

Single Mechanical Seal

Sectional Drawing #1 • Pg 47

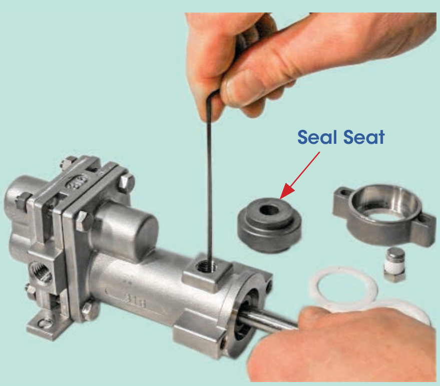
1 Remove the two screws (16) and separate the gland plate (17) and seal seat (24) from the pump. Remove the gaskets (18) from the seal seat and discard.



Caution!

Use fine emery cloth to remove any burrs or sharp edges on end of shaft that may be present prior to seal removal or replacement. This will protect teflon seal wedges on mechanical seal from damage.

2 Remove the 1/8" NPT Plug (9) then loosen **all** setscrews on the mechanical seal body (11).



NOTE: The setscrews are accessible thru the 1/8" NPT port on the front housing. Rotate the shaft to access the setscrews.

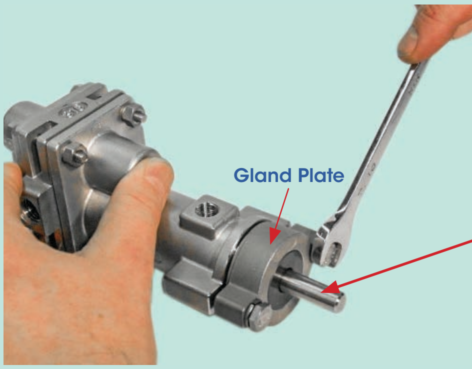
3 Slide the mechanical seal (11) out of the front housing (8) and remove it from the drive shaft.

Seal Removal *(continued)*

Double Mechanical Seal

Sectional Drawing #2 • Pg 48

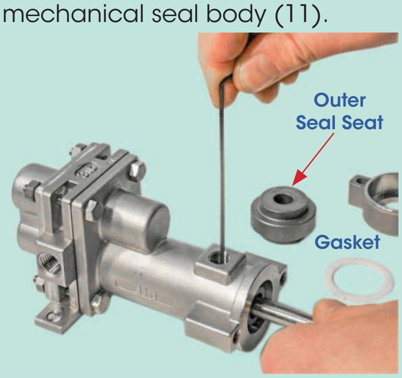
1 Remove the two screws (16) and separate the gland plate (17) and outer seal seat (24) from the pump. Remove the gaskets (18) from the seal seat and discard.



Caution!

Use fine emery cloth to remove any burrs or sharp edges on end of shaft that may be present prior to seal removal or replacement. This will protect teflon seal wedges from damage.

2 Loosen **all** setscrews on the mechanical seal body (11).



3 Remove the four housing bolts (4).

NOTE: The setscrews are accessible thru the 1/8″ NPT port on the front housing. Rotate the drive shaft to access them.

4 Remove the double mechanical seal (11) from the drive shaft (20) by lifting of the front housing (8).

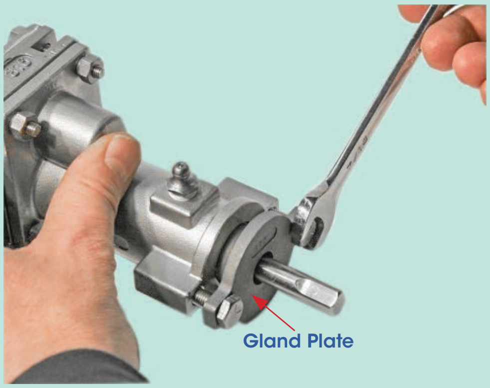
5 Gently push out the inner seal seat (25) which is held in play by the O-ring from the front housing. Discard the seal seat O-ring (26).

Seal Removal *(continued)*

Packing (Seal)

Sectional Drawing #3 • Pg 49

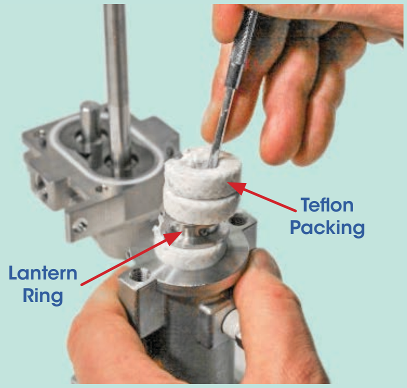
1 Remove the two screws (16) and separate the gland plate (17 from the pump.



2 Remove the housing bolts (4).

3 Lift off the front housing (8).

4 Remove the packing (18) and lantern ring (11) from the front housing.

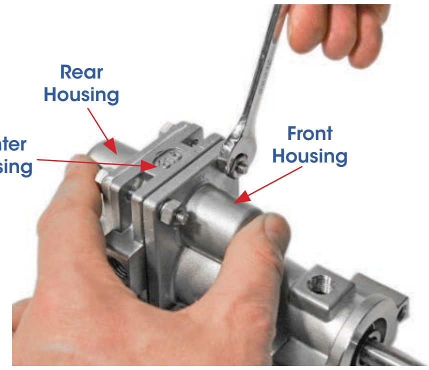


NOTE: The packing and lantern ring can be pulled out using a hooked shaped tool.

END OF SEAL REMOVAL

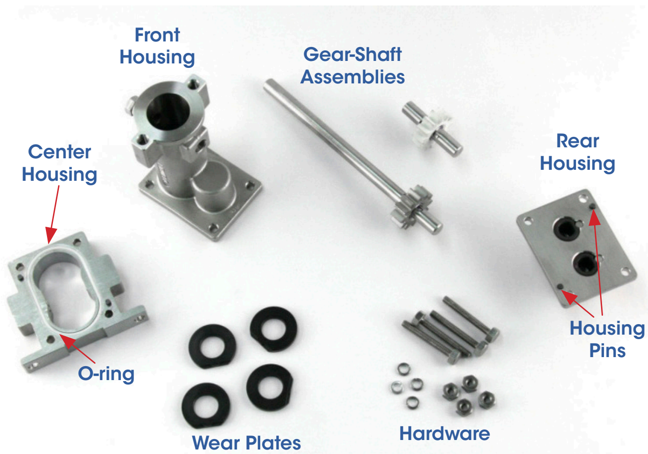
4.3 PUMP DISASSEMBLY CONTINUED: (for all seal types)

4 If not already done, remove the four housing bolts (4) and separate the front housing (8), center housing (21) and rear housing (2).



5 Remove the wear plates (7), housing pins (12) and the drive and idler gear-shaft assemblies. Remove the O-rings (5) from the center housing (21) and discard.

NOTE: Liquiflo Repair Kits come with the gears and shafts preassembled. If you are using a repair kit to rebuild the pump, it is not necessary to separate the gears from the shafts. If this is the case, skip **Step 6** and proceed directly to **Step 7**.

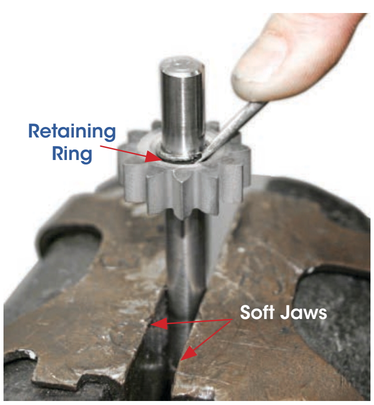


Gear - Shaft Disassembly: (**If Required**; See note above.)

6

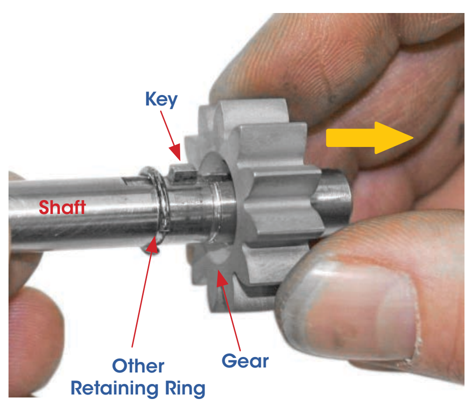
NOTE: *Be careful not to damage the drive and idler shafts.*

a) Remove the retaining ring (14) from the shaft (1 or 20).



NOTE: Use special vice jaws made of aluminum, bronze, brass or other soft material so as not to dent or damage the shaft.

b) Separate the gear (6 or 22) and key (23A or 23B) from the shaft.



c) Remove the other retaining ring (14) from the shaft.

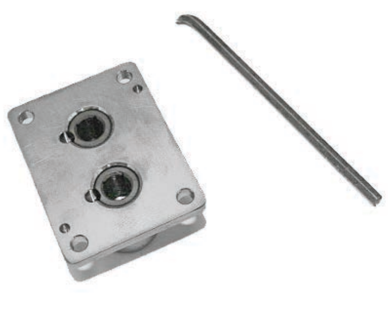
NOTE: One method for removing the retaining ring is shown at right. First bridge the shaft with a close fitting open-end wrench and then strike the wrench handle with a mallet to dislodge the retaining ring from the groove.

Removal of Bearings

The bearings for these pumps were designed to have a slip fit into the front and rear housings The Carbon or Sil-Carbide bearings can normally be pulled out by using a hooked tool (see Photos **7a** and **7b**). Plastic bearings, such as Teflon, can also be extracted by using a tap that is slightly larger than the bearing inner diameter (see Photo **7c**).

7 Remove the bearings (3A and 3B) from the front and rear housings.

7a



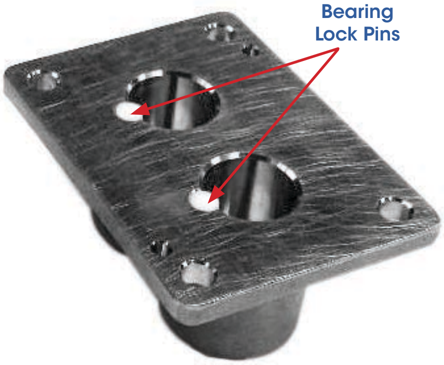
7b

7c

Removal of Carbon or Sil-carbide Bearings

Removal of PEEK or Teflon Bearings

8 Remove the bearing lock pins (13) from the front and rear housings.



END OF DISASSEMBLY PROCEDURE

4.4 PUMP ASSEMBLY: Long-Coupled Configuration

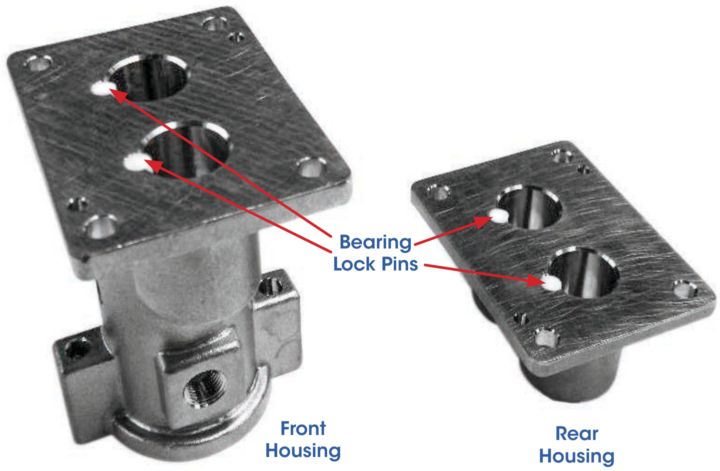
Follow the procedure below and refer to the drawings in **Appendix 6.**

Installation of Bearings

1 Insert the bearing lock pins (13) into the front housing (8) and rear housing (2).

NOTE: The pins serve to prevent the bearings from rotating. They are normally made of Teflon. Metallic pins are available for high temperature applications.

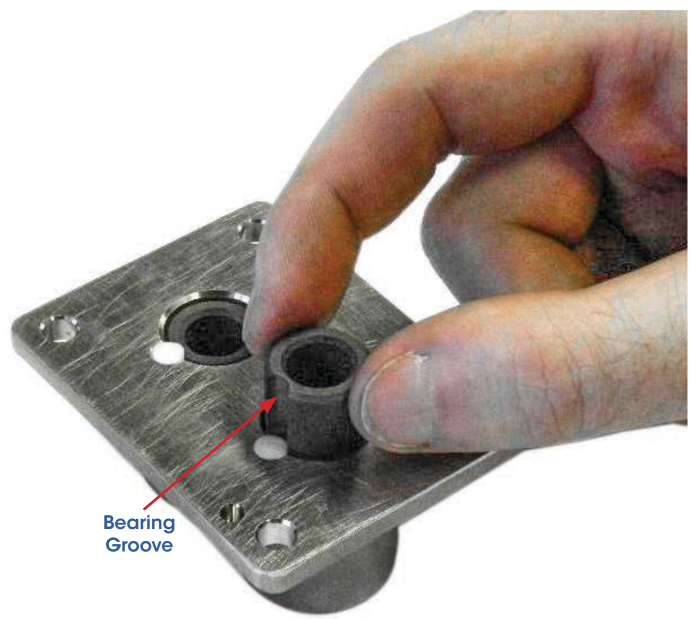
NOTE: Standard housings (not containing bearing flush grooves) shown to the right. Pumps ordered with the Internal Bearing Flush (IBF) option will have modified front and rear housings (see top of Page 21).



2 Insert the bearings (3A & 3B) into the housing bores. A light push to fit may be required.

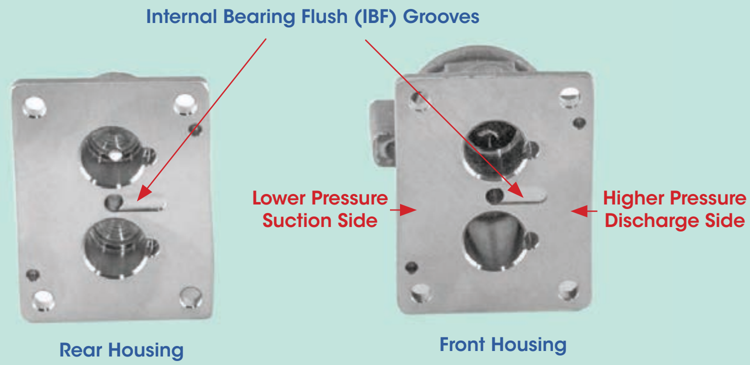
NOTE: When installing the bearings, align the bearing grooves with the bearing lock pins. The bearings have a slip-fit design, but in some cases, may require a light push fit to insert them into the housing bores.

NOTE: Models H1-H5 and 31-35 have three short bearings and one long bearing; Models H7-H9, 37-39 and 311 have four bearings of equal size.

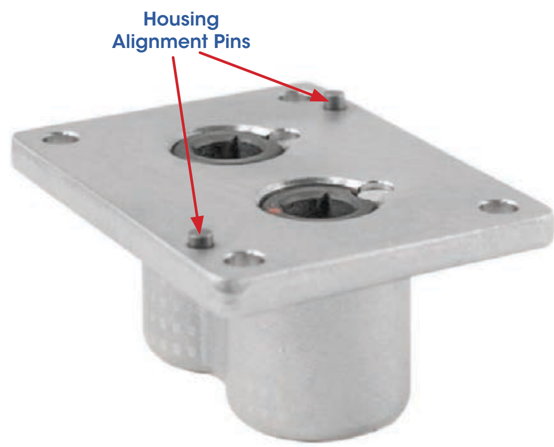


Internal Bearing Flush Options

Pumps ordered with the Internal Bearing Flush (IBF) option will have **modified front and rear housings**, as shown at right. The purpose of the IBF option is to more effectively lubricate and cool the bearings when pumping extremely thin or extremely thick liquids. When assembling the pump, the IBF grooves must be oriented on the higher pressure discharge side of the pump.



3 Insert two housing alignment pins (12) into the rear housing (2).

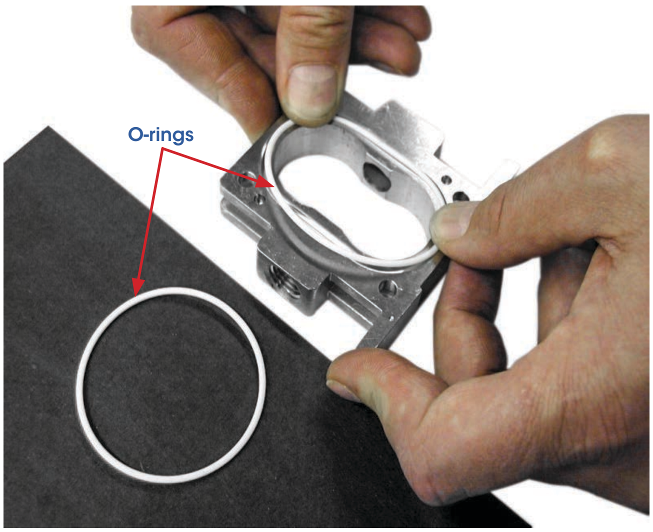


NOTE: The pins should have a slip fit into the housing. The housing pins serve to accurately align the front, center and rear housings.

---

4 Install housing O-rings (15) into the racetrack-shaped grooves of the center housing (21).

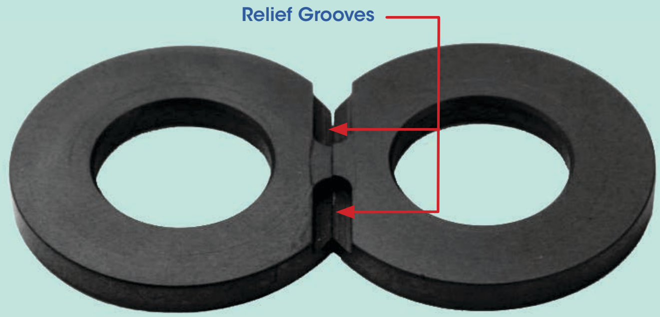
NOTE: *Do not reuse O-rings.*



Installation of Wear Plates

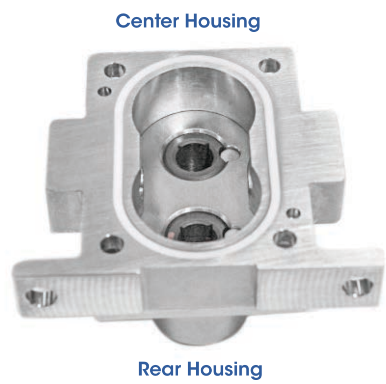
Standard Liquiflo wear plates are manufactured with relief grooves to provide liquid relief paths to minimize hydraulically induced gear separation forces that exist during pump operation. These forces decrease pump life by placing significant loads on the shafts and bearings. To be effective, **the relief grooves must face toward the gears.**

NOTE: Failure to orient the wear plates with relief grooves facing the gears will reduce the operating life of the pump.



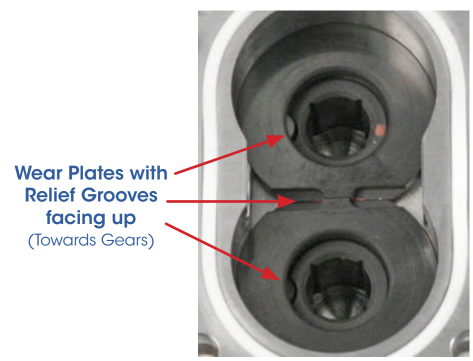
5 Place the center housing (21) onto the rear housing (2) with orientation as shown.

NOTE: Make certain the center housing seats properly over the housing alignment pins. If the rear housing has an IBF groove, the groove must face towards the discharge side of the pump (see Page 21).



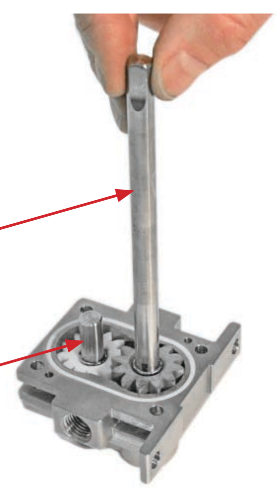
6 Insert the wear plates into the housing.

NOTE: The relief grooves of the wear plates must face up, as shown to the right. This will orient the grooves toward the gears.



7 Insert the gear-shaft assemblies into the housing.

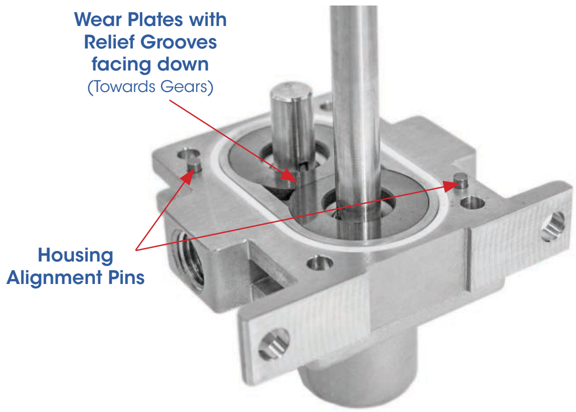
NOTE: Liquiflo Repair Kits contain the gears and shafts preassembled, as shown below. If the gears and shafts are not assembled, see **Appendix 5** for the assembly procedure.



8 Place two wear plates (7) on top of the gears.

NOTE: The relief grooves of the wear plates must face down, toward the gears.

9 Insert two housing alignment pins (12) into the center housing.



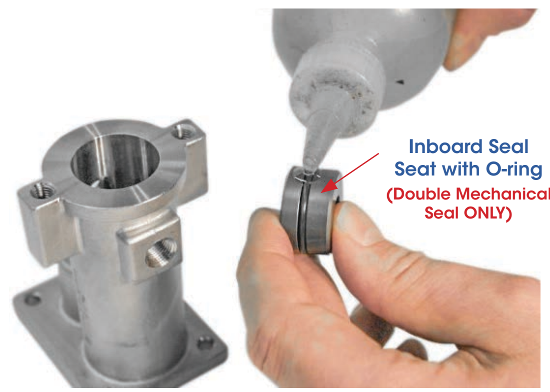
Installation of inboard Seal Seat: (Double Mechanical Seal Only)

NOTE: Perform **Step 10** only if the pump will be assembled with a double mechanical seal. For all other seal types, proceed directly to **Step 11**.

10 **a)** Install the seal seat O-ring (26) onto the seal seat (25); then lubricate the outside surface of the o-ring.

NOTE: *Do not reuse O-rings.*

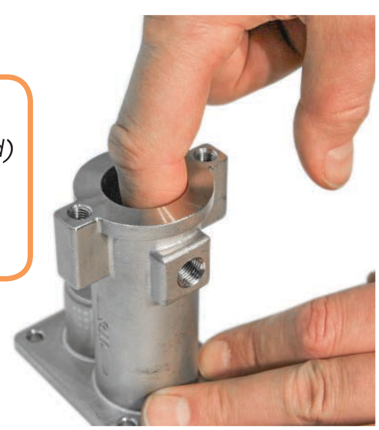
NOTE: Use a lubricant that is compatible with the elastomer and the fluid that will be pumped. This will ease installation of the seal seat into the front housing.



b) Insert the inner seal seat (25) into the front housing (8).

c) Push the seal seat firmly into the bottom of the housing.

Caution!
The lapped (polished) surface of the Seal Seat must face the mechnical Seal.



11 Install the front housing (8) to the center-rear housing.

NOTE: Be certain the front housing seats properly over the housing alignment pins in the center housing. If the pump has an IBF option, the IBF grooves in the front and rear housings must be oriented on the discharge side of the pump (see top of Page 21).

12 Attach the housings together using four sets of bolts (4), nuts (10) and lockwashers (15).

NOTE: Apply anti-seize compound to the bolts. Refer to **Appendix 1** for the torque specifications of the fasteners. When tightening the bolts, use a star pattern torque sequence on the fasteners to ensure even compression on the O-ring's surface. With Teflon (PTFE) O-rings, repeat this process several times, waiting between retightening. This is necessary because Teflon will cold flow and require a certain amount of time to properly seat. Continue the process until the bolts no longer require retightening.

13 Turn the drive shaft by hand to ensure that the gears will rotate freely inside the housing.

Installation of Seals

The pump can have a Single Mechancical Seal, Double Mechanical Seal or Packing. Install the pump's seal by referring to the applicable sections below.

Single Mechanical Seal

Sectional Drawing #1 • Pg 47

1

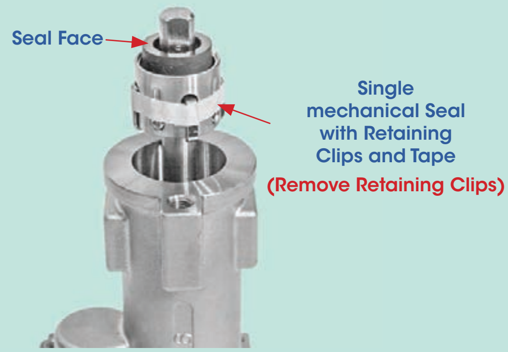
Caution!

Use fine emery cloth to remove all burrs and setscrew marks from the drive shaft prior to installation of the mechanical seal. This will protect the teflon seal wedge from damage.

Remove the retaining clips from the seal ***after*** *the seal is slid over the shaft.*

Slide the mechanical seal (11) on the drive shaft (20) with the seal face directed away from the housing.

NOTE: The retaining clips serve to compress the springs inside the seal housing allowing the internal teflon seal wedge to slip freely over the shaft.

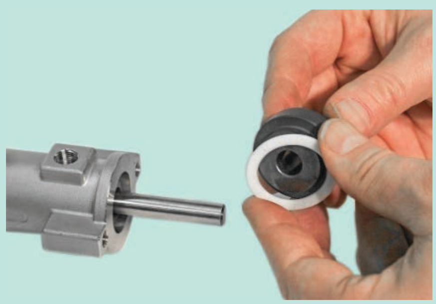


2 Remove the tape and retaining clips; then orient the seal body.

3 Push the seal into the housing until the setscrew is visible thru the 1/8" NPT port.

4 Lightly tighten the setscrews on the body of the mechanical seal to temporarily position the seal body.

5 Install one seal seat gasket (18) on the seal seat (24).



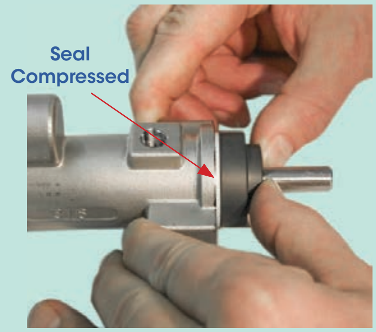
Seal Installation *(continued)*

Single Mechanical Seal (Continued)

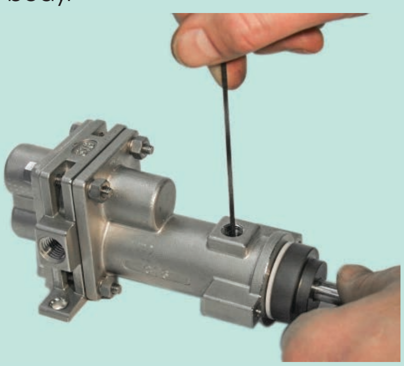
Sectional Drawing #1 • Pg 47

6 Slide the seal seat (with gasket installed) on the drive shaft, as shown; then test the compression of the seal by pushing the seal seat face against the mechanical seal face. **The proper compression gap is 1/16" (1.6 mm)**. If necessary, reposition the mechanical seal on the shaft to set the compression distance to the proper value. When positioned tighten all set screws on seal body.

NOTE: The outboard seal seat is lapped on both surfaces so orientation does not matter.

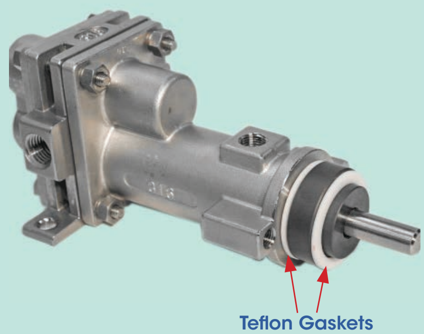


7 Once the position of the mechanical seal is properly set, tighten **<u>all</u>** setscrews on the seal body.

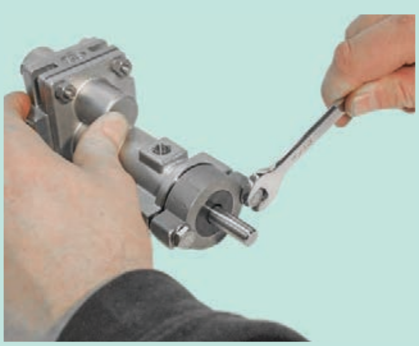


NOTE: Rotate the shaft in steps to access each setscrew thru the 1/8" NPT port on the front housing.

8 Install the other gasket (18) on the outside face of the seal seat (24).



9 Install the gland plate (17) using the gland screws (16) and lockwasher (19).



NOTE: See **Appendix 1** for the torque specifications of the gland screws.

10 Install the two 1/8" NPT plugs (9).

NOTE: Apply Teflon tape to the threads of the plugs to prevent leakage.

Seal Installation *(continued)*

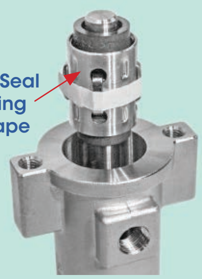
Double Mechanical Seal

Sectional Drawing #2 • Pg 48

1 If not previously done, install the inboard seal seat (25) with O-ring (26) into the front housing. (See **Step 10** of the Pump Assembly procedure on Page 23).

> **Caution!**
> *Use fine emery cloth to remove all burrs and setscrew marks from the drive shaft prior to installation of the mechanical seal. This will protect the teflon seal wedge from damage.*
> *Remove the retaining clips from the seal* ***after*** *the seal is slid over the shaft.*

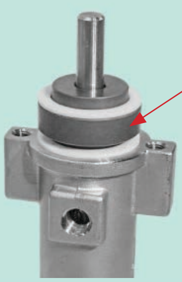
2 Slide the double mechanical seal (11) on the drive shaft (20).



3 Remove the tape and retaining clips from the mechanical seal.

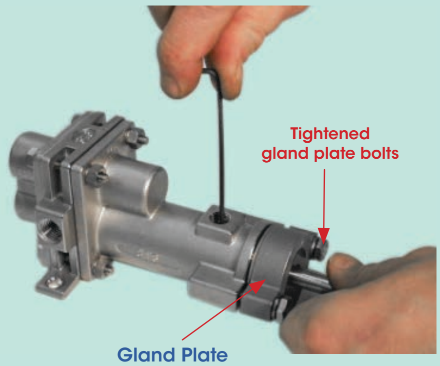
NOTE: The double mechanical seal is symmetrical, so the seal faces can be oriented either way.

4 Slide the mechanical seal into the front housing (8); then install the outboard seal seat (24) with gaskets (18).



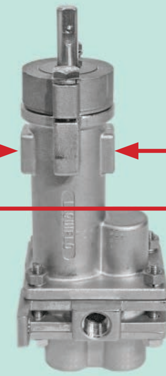
NOTE: The outboard seal seat is lapped on both surfaces so orientation does not matter. The double mechanical seal will self-position once the gland plate is installed.

5 **First** install the gland plate (17) and tighten bolts. Second after the gland plate is installed then tighten **all** seal setscrews.



NOTE: The open 1/8" NPT ports must be connected to the barrier fluid lubrication system for supporting the double mechanical seal during pump operation (see **Appendix 4**).

> **Caution!**
> *Failure to properly support the double mechanical seal with a barrier fluid lubrication system will result in Immediate Seal Failure.*

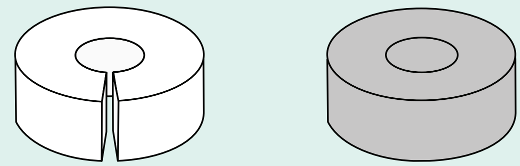


Seal Installation *(continued)*

Packing

The "stuffing box" section of the pump's front housing requires five rings of packing and a lantern ring, positioned as shown in Sectional Drawing #3. The lantern ring allows grease or flush fluid to enter the pump and lubricate the packing. The standard packing material is braided Teflon, which is suitable for application temperatures up to 350°F. Above 350°F, Graphoil packing should be used.

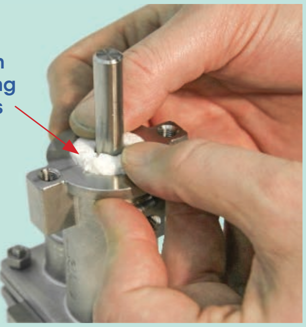
The Teflon packing used in Liquiflo pumps has a split-ring design. Adjacent rings should be staggered by 180° to increase performance and minimize leakage. Graphoil packing has a solid-ring design and therefore does not require staggering.



Packing (Seal)

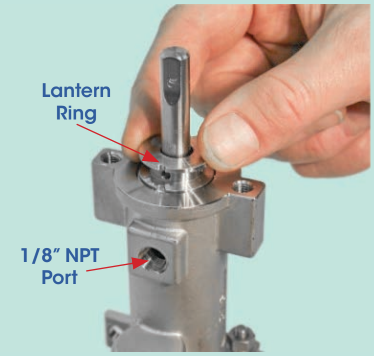
Sectional Drawing #3 • Pg 49

1 Insert the first three packing rings (18) into the front housing (8).



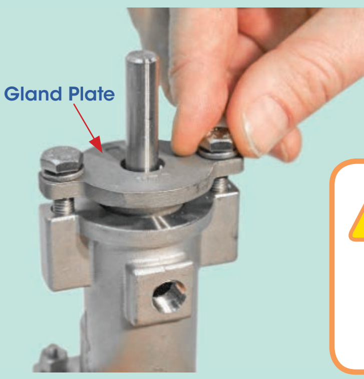
NOTE: For teflon rings be sure to stagger the splits in adjacent rings 180° apart.

2 Install the lantern ring (11).



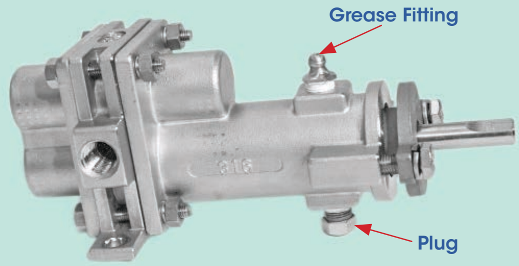
NOTE: After installation, the lantern ring should be visible thru the 1/8" NPT ports.

3 Install the two remaining packing rings (18); then install the gland plate (17) using the gland screws (16). Tighten the screws by hand.



Caution!
Do not over-tighten the gland screws. Tighten by hand only.

4 Install the grease fitting (24) and plug (9) into the front housing.



Pump with Packing Seal

NOTE: Apply Teflon tape to the threads of the fitting and plug to prevent leakage.

END OF ASSEMBLY PROCEDURE

4.5 CLOSE-COUPLED CONFIGURATION

Liquiflo sealed pumps are also available in a Close-Coupled configuration. These pumps offer several advantages over long-coupled sealed pumps. Close-coupled pumps are inherently self-aligning. This feature simplifies installation and eliminates the maintenance issues caused by misalignment of the pump and motor. The pump and motor are both supported by a sturdy Cast Iron pedestal (see **Appendix 6**).

The Close-Coupled sealed pumps are compatible with several NEMA and IEC motor frames (see Table 5, Page 6) and are available with either packing or mechanical seals.

4.5.1 PUMP DISASSEMBLY: Close-Coupled Configuration with Single Mechanical Seal

For closed coupled pumps with double mechanical seal or packing, refer to the previous pages for Seal Installation instructions. **NOTE:** Refer to Exploded View Drawing #2 on Page 51.

1. Unbolt the front housing (8) from the pedestal (34).

2. Remove the pump module.

3. Remove the coupling flange (37) from the shaft (20).

4. Remove the gland plate (17).

5. Remove the seal seat (24) and gasket (18).

6. Remove one 1/8″ NPT plug (9).

NOTE: Remove any burrs or scratches from the end of the drive shaft prior to removing the mechanical seal.

7 Loosen **all** setscrews on body of seal (11).

8 Slide out the mechanical seal.

9 Remove the seal from the drive shaft.

10 Remove the six seal housing bolts (29).

11 Remove the seal housing (28).

12 Remove the seal housing O-ring (27) and discard.

13 Remove the four housing bolts (4).

14 Remove the front housing (8).

15 Remove the center and rear housings (21 & 2).

16 Separate the wear plates (7), housing pins (12) and gear-shaft assemblies.

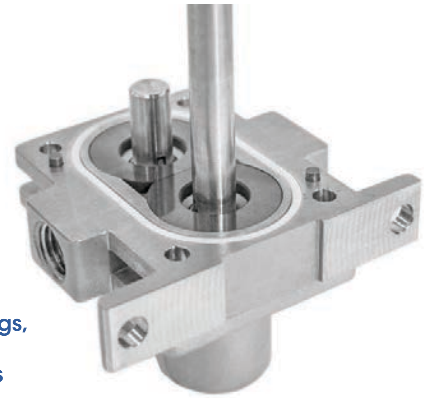
17 Remove the O-rings (5) from the center housing and discard.

NOTE: To separate the gears from the shafts or to remove the bearings and bearing lock pins from the front and rear housings, see pages 18 & 19.

4.5.2 PUMP ASSEMBLY: Close-Coupled Configuration with Single Mechanical Seal

NOTE: Refer to Exploded View Drawing #2 on Page 51.

1 Perform **Steps 1** to **9** of **Section 4.4** (page 20) to assemble this section of the pump.



Assembly of rear and center housings, O-rings, bearings, bearing lock pins, wear plates, housing alignment pins and gear-shaft assemblies

2 Install the front housing (8).

NOTE: Be certain the front housing seats properly over the housing pins.

3 Install the housing hardware (4, 10 and 15) and tighten.

NOTE: Apply anti-seize compound to the bolts. Full details in note from **step 12**. on page 24.

4 Rotate the drive shaft (20).

NOTE: The gears should rotate freely inside the housing.

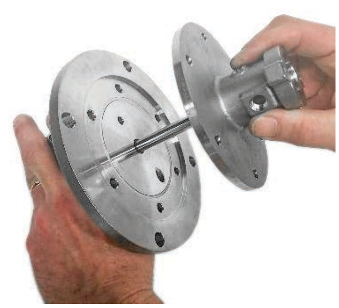
5 Install the seal housing O-ring (27).

NOTE: *Do not reuse O-rings.*

6 Install one 1/8″ NPT plug (9) into the seal housing (28).

NOTE: Apply Teflon tape to the threads of the pug to prevent leakage.

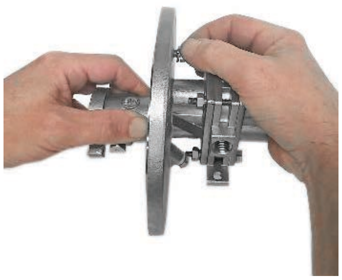
7 Install the seal housing (28) on the front housing (8).



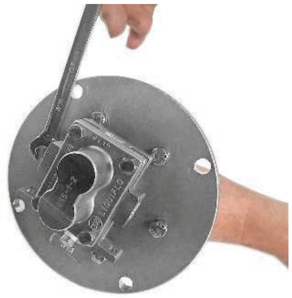
NOTE: The seal housing should mate freely with the front housing.

Caution!
After the coupling setscrews are tightened, be certain the flexible coupling insert is free to move or axial loads will be applied to the pump during operation. This can cause premature pump failure.

8 Install the seal housing hardware (29 & 30).

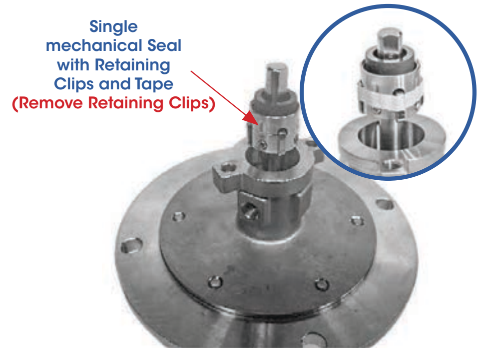


9 Fasten the seal housing bolts (29).



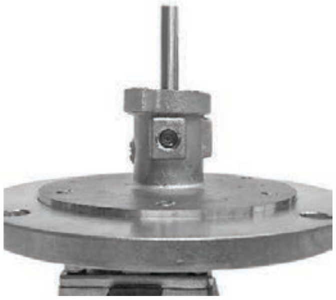
NOTE: Apply anti-seize compound to the bolts. Full details in note from **step 12**. on page 24.

10 Install the single mechanical seal (11).



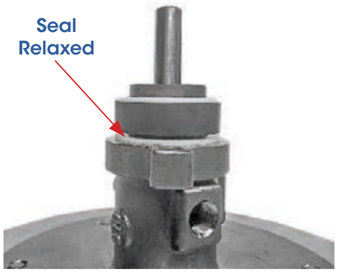
NOTE: Do not remove the seal retaining clips until after the seal is installed on the drive shaft.

11 Remove the seal retaining clips and push the seal inside the seal housing.



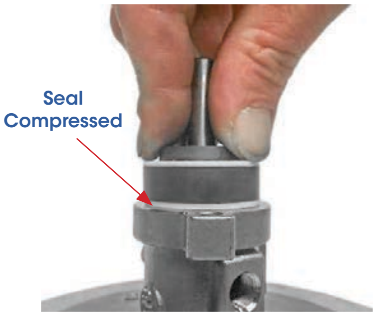
NOTE: The setscrew on the seal body should be visible thru the 1/8″ NPT port.

12 Lightly tighten the setscrew and then install the seal seat (24) with gaskets (18).



NOTE: The outboard seal seat is lapped on both surfaces so orientation does not matter.

13 Measure the compression gap of the seal. The gap should be **1/16″ (1.6 mm)**.



NOTE: If necessary, loosen the set-screw and reposition the seal to the proper compression gap.

14 Tighten **all** setscrews on the body of the seal.

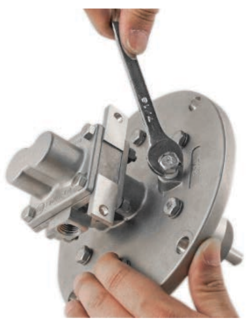
NOTE: Rotate the shaft in steps to access each setscrew thru the 1/8″ NPT port.

15 Install the gland plate (17) using the gland screws (16) and lockwashers (19).

16 Install the other 1/8″ NPT plug (9) into the seal housing (28).

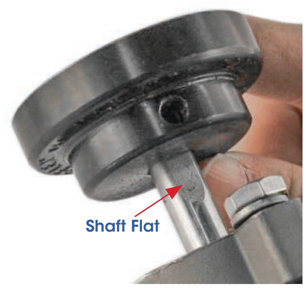
NOTE: Apply Teflon tape to the threads of the plug to prevent leakage.

17 Install the drain plug (9) into the front housing (8).



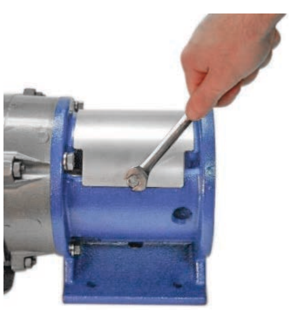
NOTE: Apply Teflon tape to the threads of the plug to prevent leakage.

18 Install the coupling flange (37) so that the end of the flange is flush with the end of the drive shaft; then lightly tighten the setscrew on the **flat part of the shaft**.



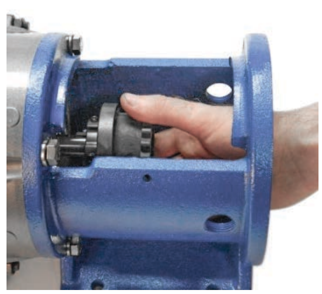
NOTE: Tighten the setscrew on the flat part of the shaft ONLY. If the coupling has a second setscrew, it should not be tightened. This will prevent damaging the round part of the shaft.

19 Remove the door (35) from the pedestal (34).



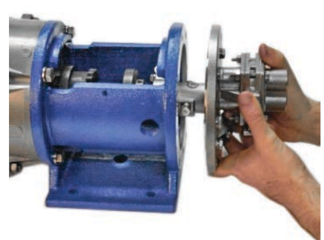
NOTE: The door is secured to the pedestal with two bolts on opposite sides.

20 Install the motor coupling flange and insert (37 & 38).



NOTE: Do not tighten the coupling setscrew at this time.

21 Install the pump module to the pedestal.



NOTE: Ensure that the pump coupling flange mates with the flexible insert.

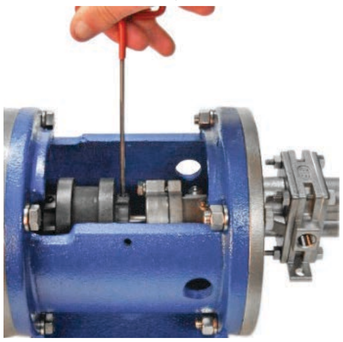
22 Attach the front housing to the pedestal using the mounting hardware (31,32 & 33).

23 Loosen the setscrew on the pump coupling flange and then adjust the position of both flanges so that the flexible insert is free to move axially - a distance of about 1/16 to 1/8 inches.

Caution!
After the coupling setscrews are tightened, be certain the flexible coupling insert is free to move or axial loads will be applied to the pump during operation. This can cause premature pump failure.

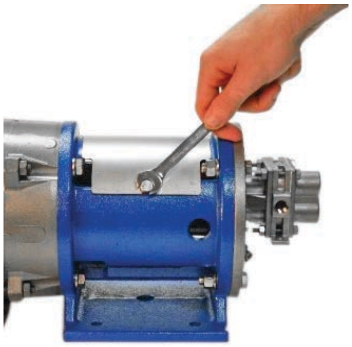
NOTE: Refer to **Appendix 1** for the torque specifications of the fasteners.

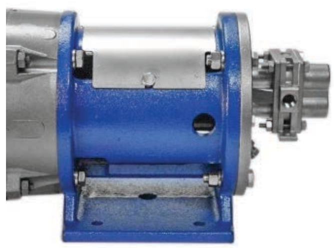
24 Tighten the pump and motor coupling setscrews.



NOTE: Tighten only the setscrew on the **flat part of the pump shaft**. This will prevent damaging the round part of the shaft.

25 Re-attach the door to the pedestal using two bolts (36).





Sealed Pump Close-Coupled to Motor

NOTE: Models H9/39 used with NEMA 56C thru 184TC or IEC 90 motor frames require a special Adapter Plate between the motor and pedestal. This adapter will be supplied with the pump when applicable. For the disassembly and assembly of Close-Coupled pumps having other types of seals, refer to Exploded View Drawing #2 on page 51.

END OF ASSEMBLY PROCEDURE

Appendix 1: Fastener Torque Specifications

Maximum Torque Specifications for 18-8 Stainless Steel Bolts

Function	Pump Models	Bolt Size	Bolt Type	Qty. (Per Pump)	Max Torque Specifications (in-lbs)	Max Torque Specifications (N-m)
Housing Assembly	H1F & H3F / 31F & 33F	10-32 UNF x 1 ½	HHCS	4	31	3.5
Housing Assembly	H5R & H5F / 35R & 35F	10-32 UNF x 1.80	HHCS	4	31	3.5
Housing Assembly	H7N & H7R / 37R	1/4-20 UNC x 2 ¼	HHCS	4	75	8.5
Housing Assembly	H7F / 37F	1/4-20 UNC x 2 ½	HHCS	4	75	8.5
Housing Assembly	H9R / 39R	1/4-20 UNC x 3	HHCS	4	75	8.5
Housing Assembly	H9F / 39F & 311F	1/4-20 UNC x 3 ¾	HHCS	4	75	8.5
Containment Can Assembly	H1F-H9F / 31F-39F & 311F	1/4-28 UNF x 5/8	HHCS	6	94	10.6
Cartridge-Pedestal Assembly	H1F-H9F / 31F-39F & 311F	3/8-16 UNC x 1 ¼	HHCS	4	236	26.7
BOLTS for MOTOR-PEDESTAL ASSEMBLY:						
Motor(1)-Pedestal Assembly	H1F-H9F / 31F-39F & 311F	3/8-16 UNC x 1	HHCS	4	236	26.7
Motor(2)- Adapter Assembl	H1F-H9F / 31F-39F & 311F	1/2-13 UNC x 1	SHCS	4	517	58.4
Adapter(2)-Pedestal Assembly	H1F-H9F / 31F-39F & 311F	3/8-16 UNC x 1	HHCS	4	236	26.7
Motor(3)-Pedestal Assembly	H1F-H9F / 31F-39F & 311F	3/8-16 UNC x 1 ½	SHCS	4	236	26.7
Motor(4)-Pedestal Assembly	H1F-H9F / 31F-39F & 311F	M10 x 40 mm	SHCS	4	327	37.0
Motor(5)-Pedestal Assembly	H1F-H9F / 31F-39F & 311F	1/2-13 UNC x 2	FH-SHCS	4	517	58.4

(1) NEMA 56C, 143TC & 145TC motor frames
(2) NEMA 182TC & 184TC motor frames
(3) IEC 71 (B5) motor frame
(4) IEC 80 & 90 (B5) motor frames
(5) IEC 100 & 112 (B5) motor frames

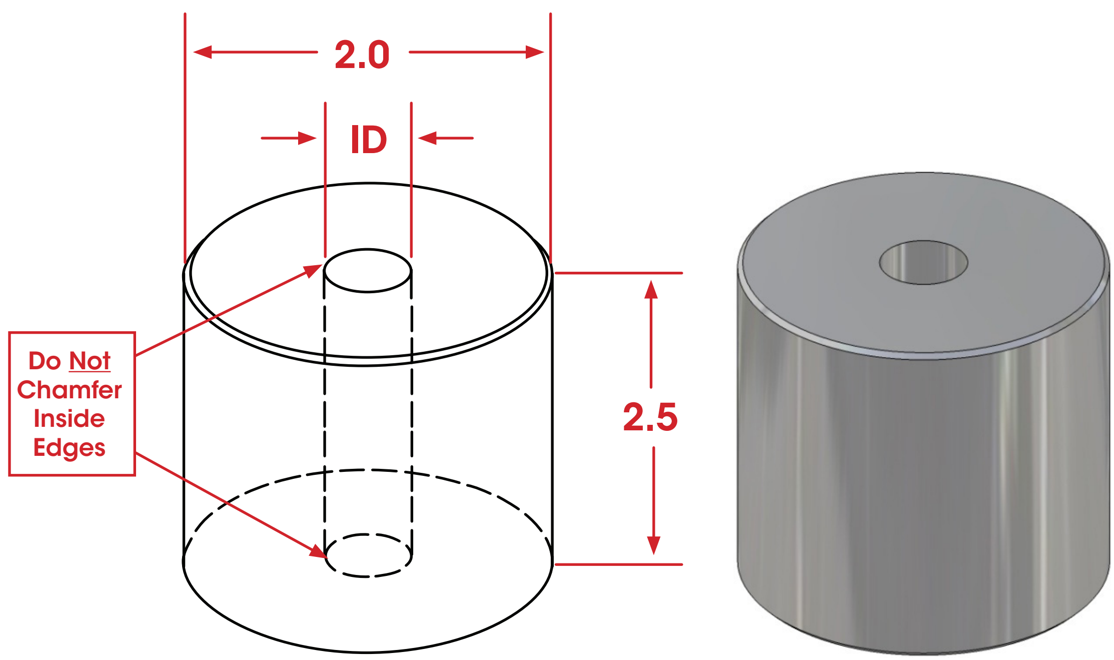
HHCS = Hex Head Cap Screw
SHCS = Socket Head Cap Screw
FH-SHCS = Flat Head, Socket Head Cap Screw

Appendix 2: Retaining Ring Tool Specifications

The following tool is recommended for the efficient and safe installation or removal of the retaining rings used in the pump. It should be manufactured from a hard material, such as steel.

Tool Dimensional Specifications (Inches)

Tool #	For Pump Models	ID	ID Tolerance
1	H1F & H3F; 31F thru 35F	.378	+/- .001
2	H5R & H5F; 37R, 37F & 311F	.503	+/- .001
3	H7N thru H9F; 39R & 39F	.628	+/- .001



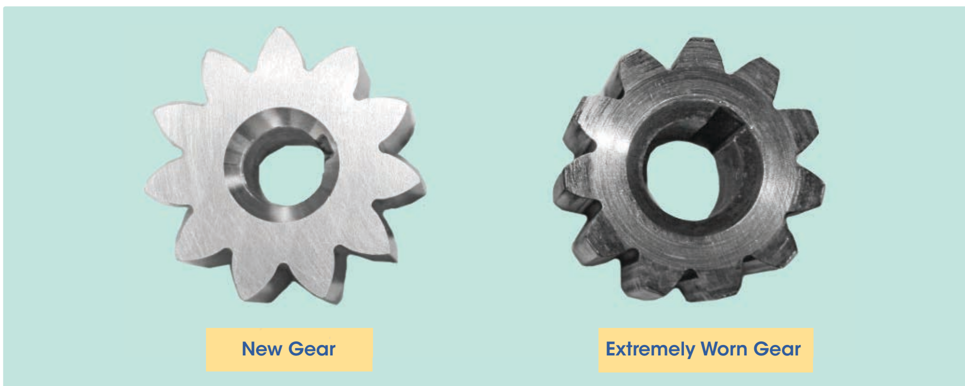
NOTE: The retaining ring tool is especially useful when assembling the gears on the drive and idler shafts (see **Appendix 5**).

Appendix 3: Wear Allowances

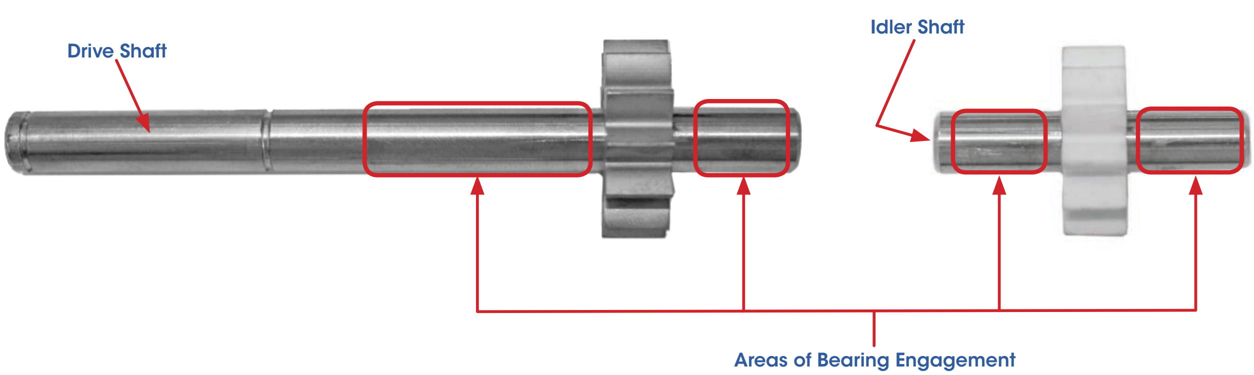
When a pump requires maintenance, a convenient way to restore the pump to like-new condition is to use a repair kit. The repair kit contains all internal wear parts as well as O-rings, retaining rings, bearing lock pins, housing alignment pins and keys.

In some cases, only certain parts may need to be replaced. The primary wear parts of the pump are the gears, shafts, wear plates and bearings. The center housing (secondary wear part) may also incure physical wear by contact with the gears caused by excessively worn bearings. (Note: the center housing is not included in a standard repair kit.) These wear parts can be reused if they are in acceptable condition. O-rings and retaining rings should not be reused. The following used parts should be inspected and evaluated for reuse based on the specifications given in the **Wear Allowances Chart** (see Page 35).

Gears: Spur gears should have a uniform tooth profile on both the leading and trailing edges. If the outer diameter of the gear is worn, pumping performance will degrade. Gears with minor wear should be evaluated for reuse by measuring the outer diameter and comparing it to the minimum diameter specification given in the Wear Allowances Chart. Gears with obvious major wear, such as flattened teeth or other significant wear on the profile, should be replaced (see photo below).

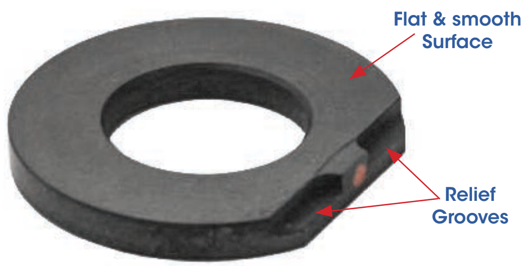


Shafts: The area of the shaft that is engaged in the bearings will wear over time depending on the service conditions and materials of construction (see photo below). Hard-coated shafts are available to minimize or eliminate wear of the shaft surfaces. Worn shafts may allow the gears to contact the center housing and accelerate both gear and center housing wear. The shaft journal area should be round and have a minimum diameter as specified in the Wear Allowances Chart.

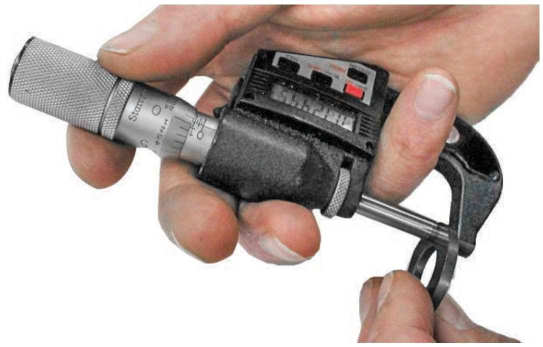


Appendix 3: Wear Allowances (Continued)

Wear Plates: This is a sacrificial part of the pump designed to protect the front and rear housings from wear by continual contact with the sides of the gears. Erosion of the wear plates increase clearances causing slip to increase. This results in a reduction in pump performance. Wear plates should have smooth surfaces and meet the minimum thickness requirements given in the Wear Allowances Chart. (Note: Standard Liquiflo wear plates are manufactured with cut-outs or relief grooves to minimize hydraulically induced gear separation forces. These relieved wear plates increase pump life by reducing loads on bearings and shafts. A typical relieved wear plate is shown below).

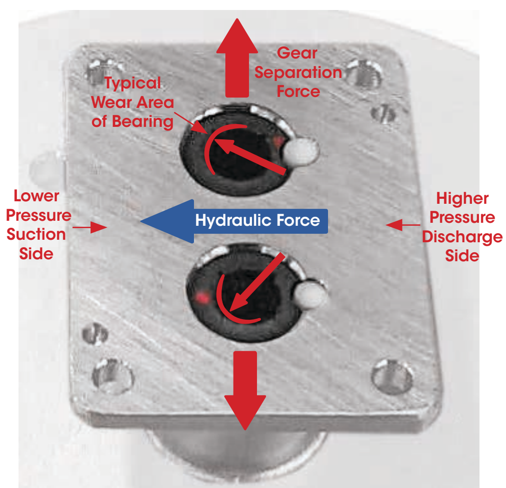


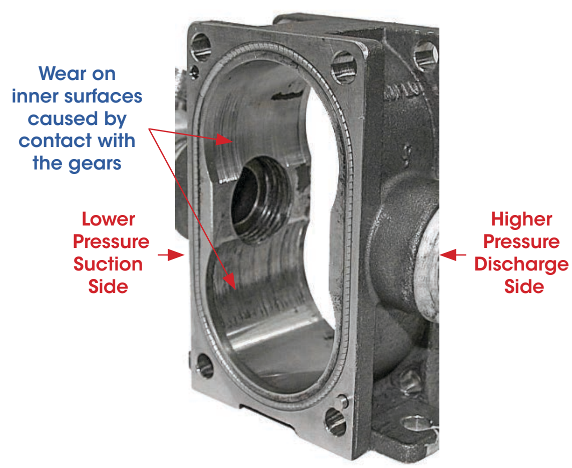
Wear Plate



Measuring Wear Plate Thickness

Bearings: The 3-Series and H-Series pumps use sleeve-type bearings that are also known as journal bearings These bearings are designed to support the shafts and precisely position the gears inside the housing. Worn bearings will eventually allow the rotating gears to contact the center housing, causing wear and eventual failure of both of these components. (See photo below left for the typical wear mechanism of the bearings.)If any wear of the bearings is observed, they should be replaced. The Wear Allowances Chart gives the maximum inner diameter that is acceptable for worn bearings.





Center Housing: The typical failure mode for the center housing is from contact with the rotating gears, caused by extreme wear of the bearings and shafts. Evidence of contact or slight wear on the inside surfaces can be expected. However, if deep grooves or excessive wear is observed, the center housing should be replaced (See photo above right for the typical wear pattern of the center housing.) Reusing an excessively worn center housing in a rebuilt pump will cause pump performance to be lower than expected because of increased slip.

Appendix 3: Wear Allowances (Continued)

Wear Allowances Chart (Units: Inches)

Pump Series	Pump Model	Gears		Shafts		Wear Plates		Bearings	
		Nom. O.D.	Min O.D.	Nom. O.D.	Min O.D.	Nom. Thick.	Min Thick.	Nom. I.D.	Max I.D.
H-Series	H1F	1.163	1.158	0.375	0.373	0.250	0.247	0.375	0.378
	H3F	1.163	1.158	0.375	0.373	0.125	0.122	0.375	0.378
	H5R	1.163	1.158	0.500	0.498	0.250	0.247	0.500	0.503
	H5F	1.163	1.158	0.500	0.498	0.125	0.122	0.500	0.503
	H7N	1.711	1.705	0.625	0.623	0.312	0.309	0.625	0.628
	H7R	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	H7F	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	H9R	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	H9F	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
3-Series	31F	1.163	1.158	0.375	0.373	0.250	0.247	0.375	0.378
	33F	1.163	1.158	0.375	0.373	0.125	0.122	0.375	0.378
	35R	1.163	1.158	0.375	0.373	0.250	0.247	0.375	0.378
	35F	1.163	1.158	0.375	0.373	0.125	0.122	0.375	0.378
	37R	1.711	1.705	0.500	0.498	0.125	0.122	0.500	0.503
	37F	1.711	1.705	0.500	0.498	0.125	0.122	0.500	0.503
	39R	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	39F	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	311F	1.711	1.705	0.500	0.498	0.125	0.122	0.500	0.503

O.D. = Outer Diameter **I.D. =** Inner Diameter

NOTES:

1) Pump models that are **not** highlighted in the above table have gears with an even number of teeth. The diameter for these gears is measured from the tip of one tooth to the tip of the opposite tooth (see **Photo 1**). This measurement method gives the true diameter of the gears.

2) Pump models that are highlighted in orange in the above table have gears with an odd number of teeth. Because no two teeth have tips that coincide with the actual geardiameter, this makes the true gear diameter difficult to measure. A practical field method for determining gear wear is to measure the "three-point diameter" of the gear. That is, place one jaw of the caliper on the tip of one tooth and the other jaw on the tips of both opposite teeth and then record the distance (see **Photo 2**). The highlighted diameter values are based on this measurement method and are less than the true gear diameters. (For the true nominal gear diameters, see the chart on Page 39).

3) All diameter values listed in the above table are based on standard (untrimmed) parts. Parts requiring viscosity or temperature trims willhave dimensions based on the application. Consult factory.

Photo 1

Photo 2

Appendix 4: Operation of Dynamic Seals

Liquiflo sealed pumps can be configured with any one of three distinct types of dynamic seals. The choice of seal will depend mainly on the pumping application. To maximize the lifetime of the seal and to ensure that it operates properly, it must be correctly installed and applied, and in some cases, properly adjusted or supported. This section covers the basic operation of the various seal arrangements used in Liquiflo pumps. (Refer to the Sectional Drawings in **Appendix 6**.)

Packing (Seal)

Although Packing is still used, it is not very common in the chemical processing industry because of its normal leak rate with low to moderate viscosity fluids. It is still considered to be an acceptable solution when pumping safe liquids or where the seal drainage can be captured. Flocculants, water and resins are common examples of fluids which use this type of seal. Teflon is the standard packing material. Graphoil packing is used for high temperature applications over 350 °F up to 500 °F.

During operation, the shaft-packing interface must be lubricated to reduce frictional forces on the rotating drive shaft. Depending on the fluid, this can be accomplished in several ways: The gland screws are adjusted to provide a leak rate of about **8 to 10 drops per minute with low to moderate viscosity liquids**. With **high viscosity liquids, the packing can be greased** via the grease fitting. For crystallizing liquids, a flush fluid can be made to flow across the seal chamber, via the two 1/8" NPT ports. In all cases, the packing should be properly compressed by adjusting the glands screws. Under-compression will result in excessive leakage, and over-compression can cause excessive loading and heating of the drive shaft, which will lead to premature failure of the packing seal.

Single Mechanical Seal

The Single Mechanical Seal arrangement is the standard style of dynamic seal and is the most commonly used when pumping any type of chemical where leakage needs to be minimized. **During normal operation this type of seal does not need to be adjusted.** Although widely used, this seal has some important limitations. During normal operation, the equivalent of 3-5 drops of fluid per day will cross the seal face as a vapor. This is important to note when pumping toxic or flammable fluids which may not be compatible with the surrounding environment. The seal can tolerate only limited amounts of abrasive particles and because it is non-hermetic, it is not ideal for pumping fluids that can crystallize on contact with air. Crystals can build up around the edges of the seal and cause premature seal failure. The maximum recommended fluid viscosity for single mechanical seal is 5,000 cP.

During operation, the rotating seal face seals against a stationary seal seat. To be effective, the working surfaces of the seal faces must be extremely flat and the pumped fluid must be present to lubricate the interface and remove the heat caused by friction. The sealing and frictional forces are a result of the mechanical spring pressure inside the seal body and the hydraulic pressure inside the seal chamber. **Do not run the pump dry for more than 30 seconds;** the frictional forces will cause rapid wear and damage the seal. Pumping very high viscosity fluids can also cause premature seal wear because of poor lubrication.

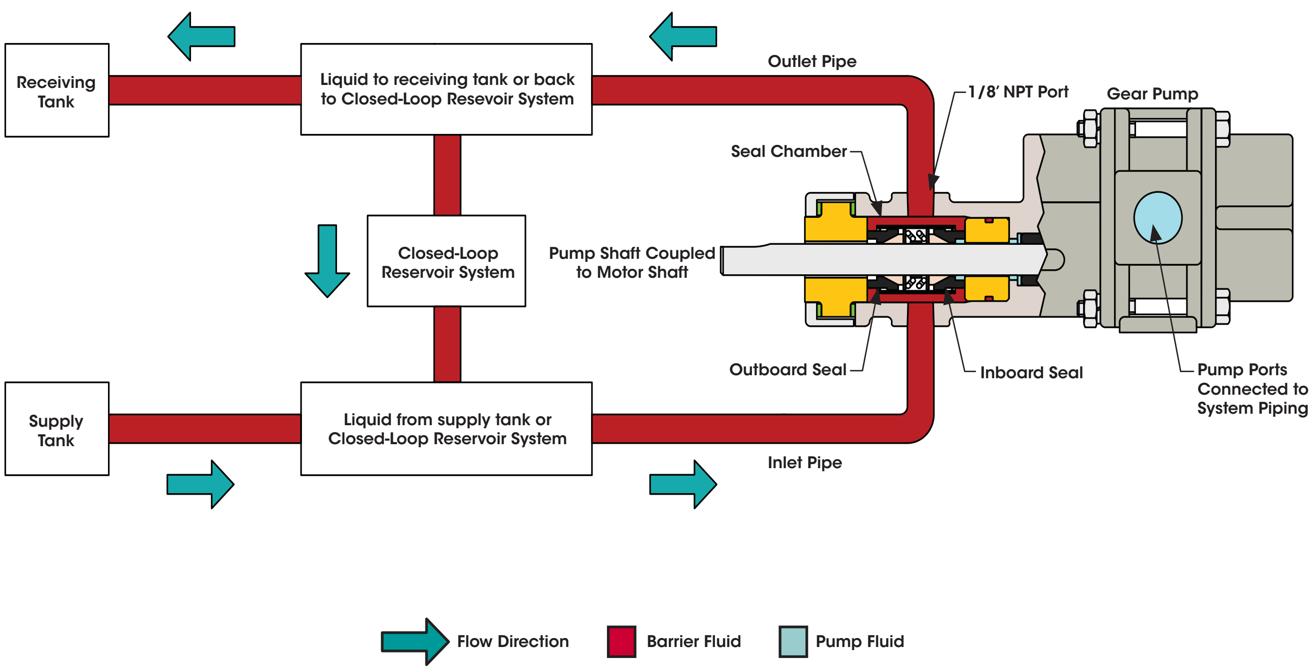
The most common seal combination is a Carbon seal face vs. a Silicon Carbide (SiC) seal seat. If the seal is properly applied, it can be used to pump many chemicals up to differential pressures of 225 PSI or higher. For fluids not compatible with Carbon, Teflon can be used for the seal face material. However, due to its weaker physical strength, the working pressure of a Teflon seal must be limited to about 50 PSI. For fluids containing very low levels of abrasives, a SiC vs. SiC seal combination can be used. For higher levels of abrasives, a double mechanical seal can be used (see Page 41).

Appendix 4: Operation of Dynamic Seals (Continued)

Double Mechanical Seal

The Double Mechanical Seal is a more complex sealing arrangement, but when properly supported, it overcomes the limitations of the other seal types discussed above. As shown below, the double mechanical seal requires a barrier fluid lubrication system to cool and flush the seal faces. The barrier fluid must be safe and compatible with the pumpage, have a net flow across the seal chamber via the 1/8" NPT ports and must be pressurized to at least 15 PSI above the pump discharge pressure. The double mechanical seal is preferred for pumping abrasive, crystallizing or extremely hazardous fluids because the seal faces are only exposed to the flush fluid and thepumpage is completely contained by the inboard seal. The double seal can also be used for viscous fluids greater than 5,000 cP. **Failure to sup- port the double seal will cause rapid wear and ensuing failure of both the inboard and outboard seals.** The main disadvantage of the double seal is the added complexity and cost of the barrier fluid lubrication system. An alternative to the sealed pump, with a properly supported double mechanical seal, is the sealless (magnetic-drive) pump. In addition to its simpler containment system, the mag-drive pump can prove to be a more reliable and cost-effective solution over time.

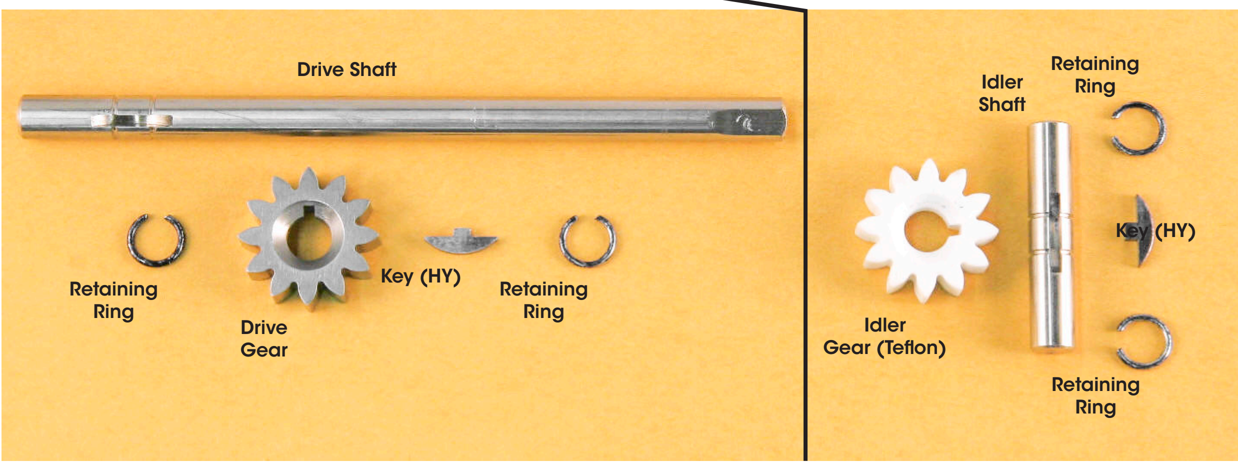
Barrier Fluid Support System for Pump with Double Mechanical Seal



Appendix 5: Gear-Shaft Assembly

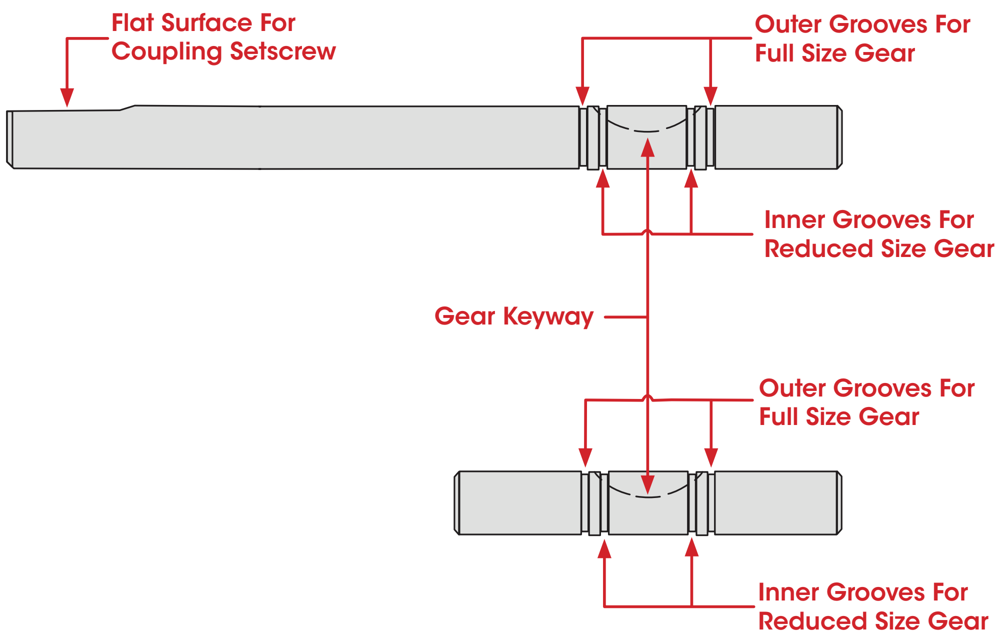
Parts List for Gear-Shaft Assemblies

Drive Gear-Shaft Parts		Idler Gear-Shaft Parts	
Parts	**Quantity**	**Part**	**Quantity**
Drive Gear	1	Idler Gear	1
Drive Shaft	1	Idler Shaft	1
Key	1	Key	1
Retaining Ring	2	Retaining Ring	2



Description of Parts:

Shafts: As shown above, the pump contains the drive shaft and the idler shaft. Both shafts have retaining ring grooves and a keyway for positioning the gears. The drive shaft also has a flat surface on one end to drive the mechanical coupling. The gears are positioned on the shafts using two retaining rings per gear. Depending on the pump model, some shafts may contain an inner and outer set of grooves to fit both full (F) and reduced (R) size gears. (See diagram below).



Appendix 5: Gear-Shaft Assembly (Continued)

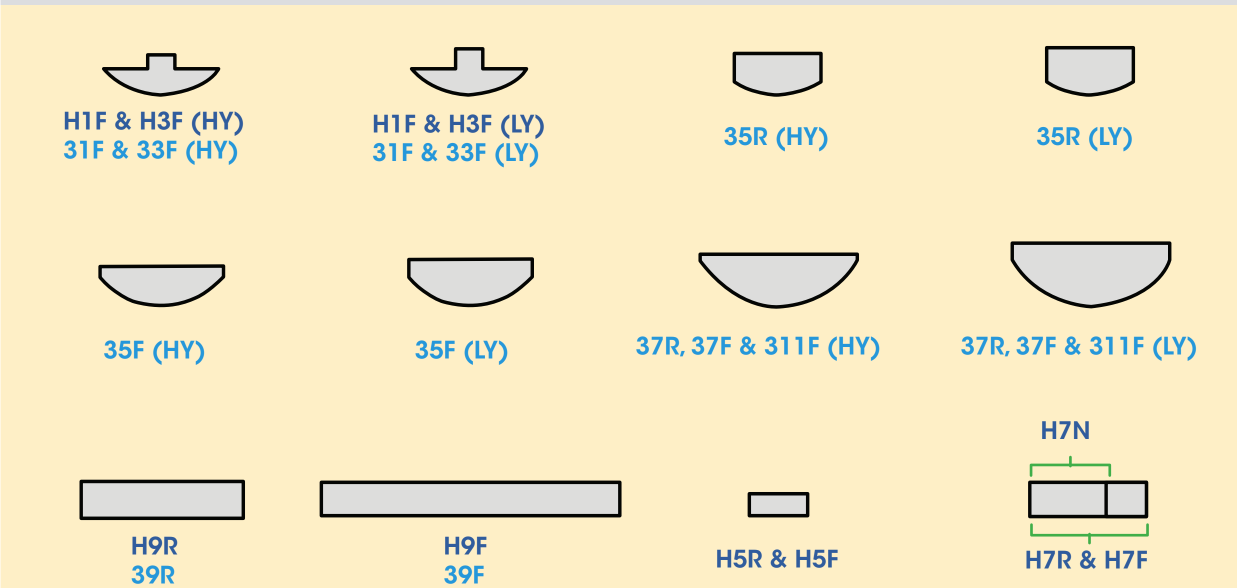
To identify the pump shafts, refer to the following chart:

Shaft Identification Chart

Pump Series	For Pump Models	Shaft Diameter	Drive Shaft Length	Idler Shaft Length	# of Gear Retaining Ring Grooves
	Units:	in	in	in	–
H-Series	H1F & H3F	3/8	6.39	1.91	2
	H5R & H5F	1/2	6.87	2.40	4
	H7N	5/8	7.88	3.81	2
	H7R & H7F	5/8	7.88	3.81	4
	H9R	5/8	9.25	4.31	2
	H9F	5/8	10.00	5.06	2
3-Series	31F & 33F	3/8	6.39	1.91	2
	35R & 35F	3/8	6.87	2.40	4
	37R & 37F	1/2	7.88	3.81	4
	39R	5/8	9.25	4.31	2
	39F	5/8	10.00	5.06	2
	311F	1/2	10.00	5.06	2

Keys: Three types of gear keys are used in the pumps: High-yield (HY), low-yield (LY) and rectangular. For Models H1F, H3F, 31F thru 37F, and 311F, high-yield keys are used for all gear materials except Teflon; low-yield keys are used only for Teflon gears. (Note: High-yield keys have a lower height than low-yield keys For Models H5R thru H9F, 39R and 39F, rectangular keys are used for all gears. To identify the keys, use the following chart:

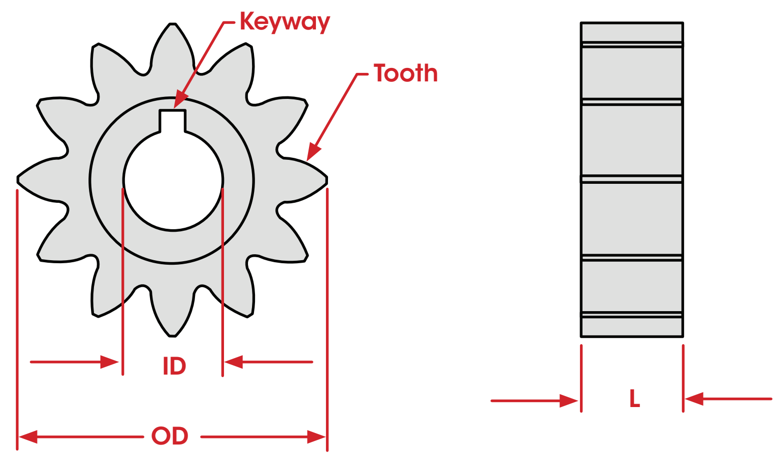
Key Identification Chart



Note: Key profiles are shown in actual size.

Appendix 5: Gear-Shaft Assembly (Continued)

Gears: The H-Series and 3-Series pumps use spur style gears, as shown below:



To identify the gears, use the following chart:

Gear Identification Chart

Pump Series	Pump Model	Gear Outer Diameter (OD)	Gear Inner Diameter (ID)	Gear Length (L)	# of Teeth
	Units:	in	in	in	–
H-Series	H1F	1.163	3/8	.125 (3/8 Hub)	12
	H3F	1.163	3/8	.375	12
	H5R	1.163	1/2	.625	12
	H5F	1.163	1/2	.875	12
	H7N	1.750	5/8	.625	11
	H7R	1.750	5/8	1.000	11
	H7F	1.750	5/8	1.250	11
	H9R	1.750	5/8	1.750	11
	H9F	1.750	5/8	2.500	11
3-Series	31F	1.163	3/8	.125 (3/8 Hub)	12
	33F	1.163	3/8	.375	12
	35R	1.163	3/8	.625	12
	35F	1.163	3/8	.875	12
	37R	1.750	1/2	1.000	11
	37F	1.750	1/2	1.250	11
	39R	1.750	5/8	1.750	11
	39F	1.750	5/8	2.500	11
	311F	1.750	1/2	2.500	11

Retaining Rings: The retaining rings are used to position the gears on the shafts. They should always be replaced when repairing the pump. (The retaining rings for the pumps are shown at right in actual size).

H1F & H3F
31F thru 35F

H5R & H5F
37R, 37F & 311F

H7N thru H9F
39R & 39F

Appendix 5: Gear-Shaft Assembly (Continued)

Gear-Shaft Assembly Procedure

1 Place one retaining ring (28) on a firm rubber mat and then place the shaft over the retaining ring.

NOTE: *Be Careful not to damage the shaft.*

2 **Gentrly** Strike the top end of the shaft with a rubber mallet to force the retaining ring onto the bottom end of the shaft.

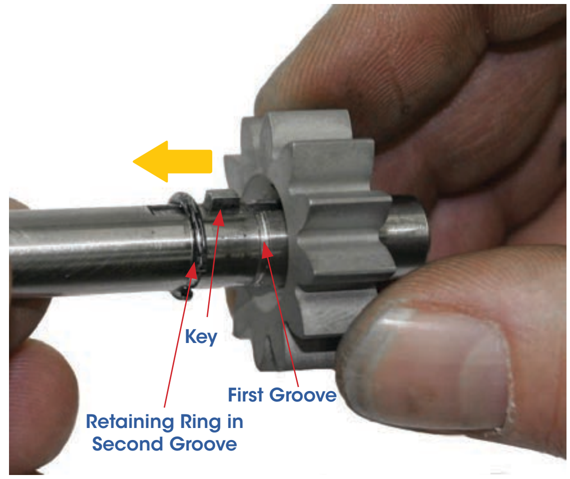
3 Using the retaining ring tool, tap the shaft to slide the retaining ring into the first groove.

NOTE: See **Appendix 2** for specifications on producing the retaining ring tool.

4 Strike the end of the shaft to dislodge the retaining ring from the first groove; then slide the retaining ring into the second groove by tapping the shaft.

Appendix 5: Gear-Shaft Assembly (Continued)

5 Install the key (23A) and gear (22) on the shaft.

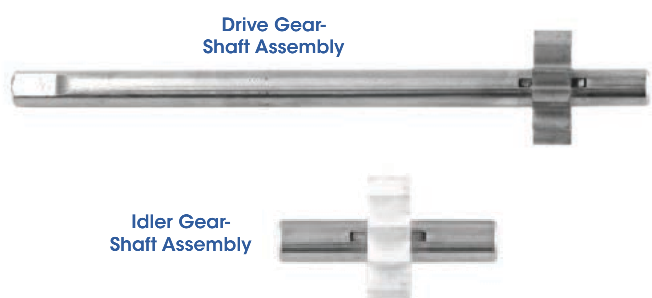


NOTE: Align the keyway of the gear with the key on the shaft; then slide the gear over the key until the gear contacts the retaining ring.

6 While holding the gear in place, force the other retaining ring (28) onto the end of the shaft by striking the shaft with the rubber mallet.

NOTE: Align the keyway of the gear with the key on the shaft; then slide the gear over the key until the gear contacts the retaining ring.

7 Slide the retaining ring into the first groove. This will ock the gear on the shaft.

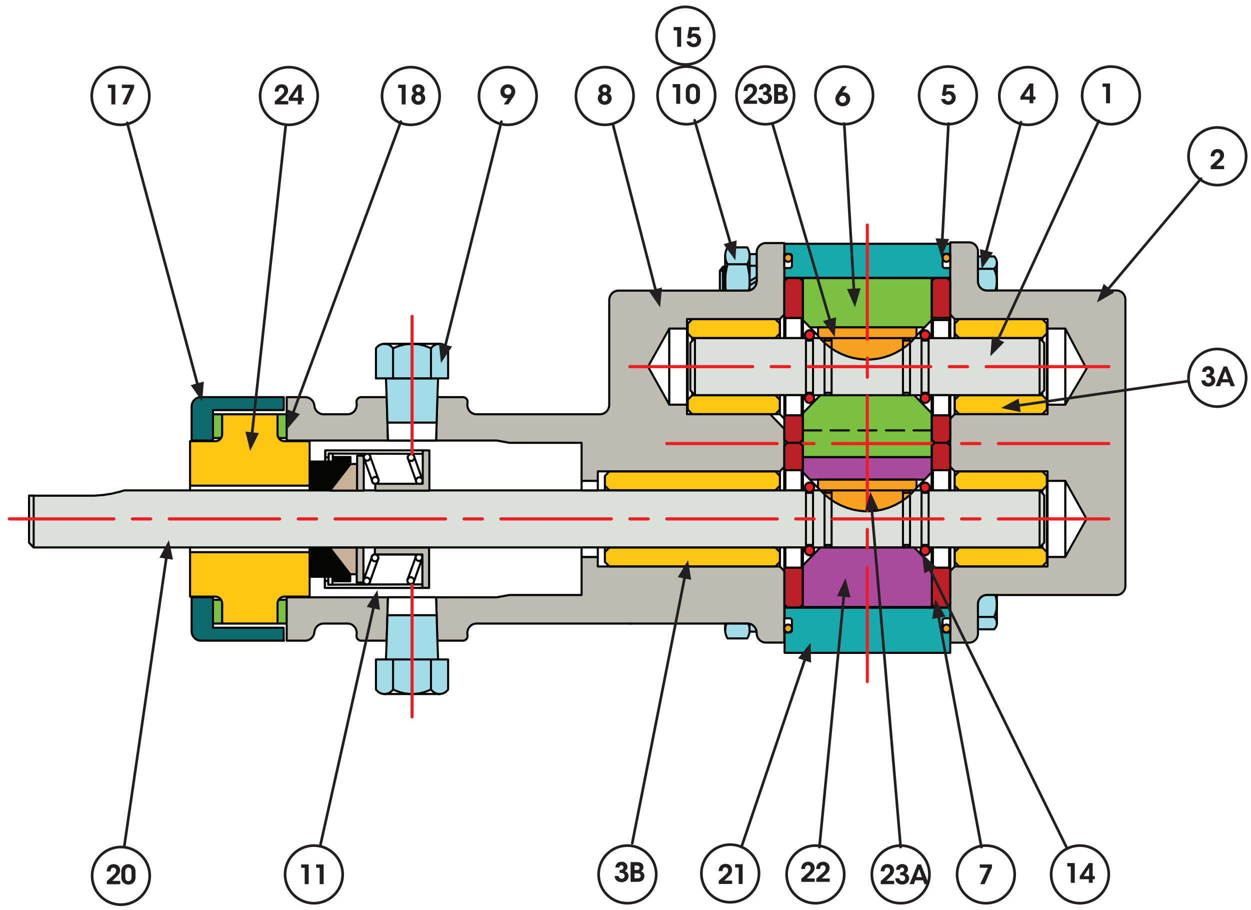


NOTE: As a check, pull the gear by hand along the axis of the shaft to make sure it is securely locked into position.

END OF PROCEDURE

Appendix 6: Reference Drawings

Sectional Drawing #1 – Pump with SINGLE MECHANICAL SEAL



Ref. #	Description	Qty.	Ref. #	Description	Qty.
1	Idler Shaft	1	13	Pin, Bearing Lock (Not Shown)	4
2	Rear Housing	1	14	Retaining Ring, Gear	4
3A	Bearing, Short *	3	15	Lockwasher, Housing **	4
3B	Bearing, Long *	1	16	Screw, Gland (1/4-28 x 3/4 HHCS) (Not Shown)	2
4	Bolt, Housing (HHCS) **	4	17	Gland Plate	1
5	O-ring, Housing	2	18	Gasket, Seal Seat	2
6	Idler Gear	1	19	Lockwasher, Gland (1/4) (Not Shown)	2
7	Wear Plate	4	20	Drive Shaft	1
8	Front Housing	1	21	Center Housing	1
9	Plug, 1/8 NPT	2	22	Drive Gear	1
10	Nut, Housing **	4	23A	Key, Drive Gear	1
11	Lantern Ring	1	23B	Key, Idler Gear	1
12	Pin, Housing Alignment (Not Shown)	4	24	Seal Seat	1

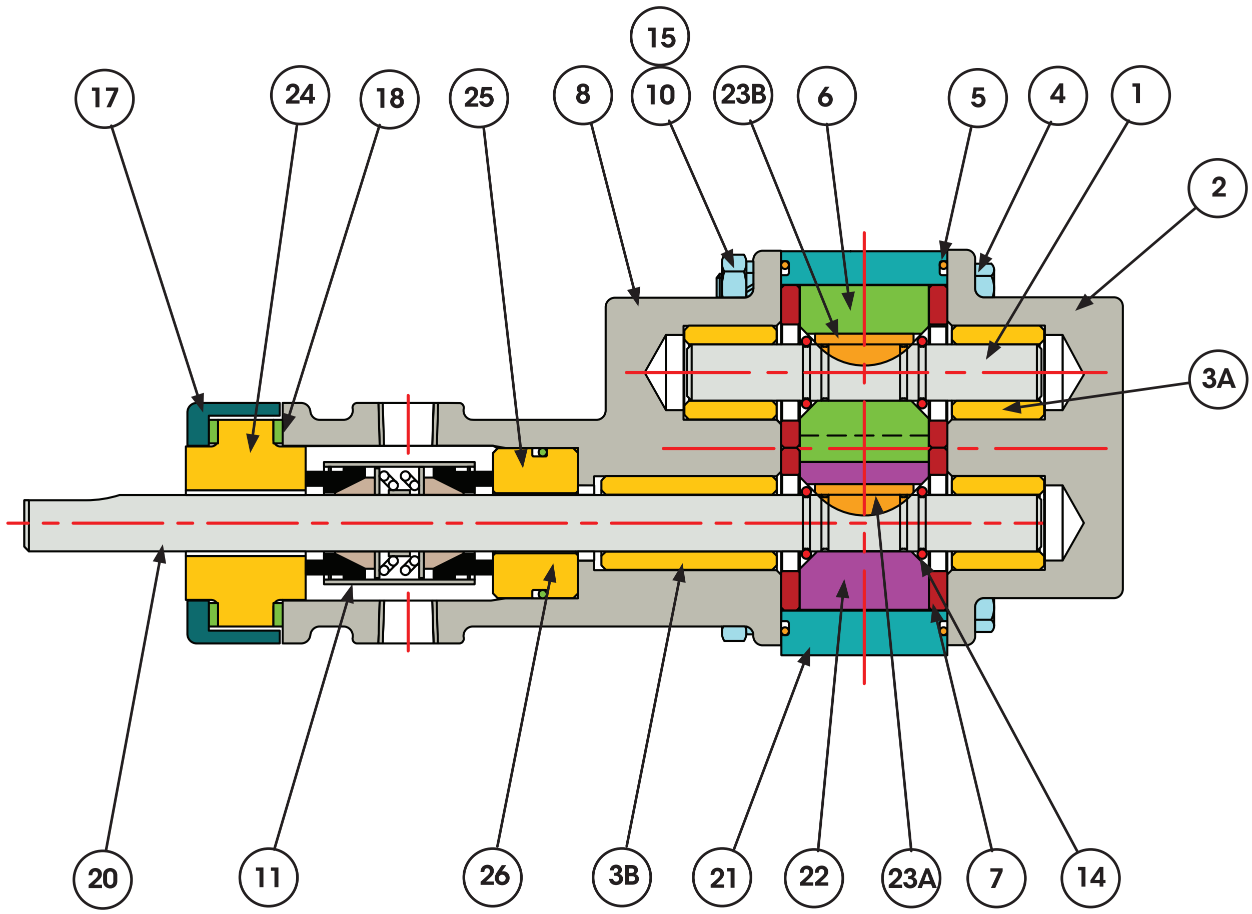
* Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size.

** See Page 35 for bolt size.

NOTE: For Liquiflo Part Numbers, refer to H-Series or 3-Series Consolidated Bill of Materials (BOM).

Appendix 6: Reference Drawings (Continued)

Sectional Drawing #2 – Pump with DOUBLE MECHANICAL SEAL



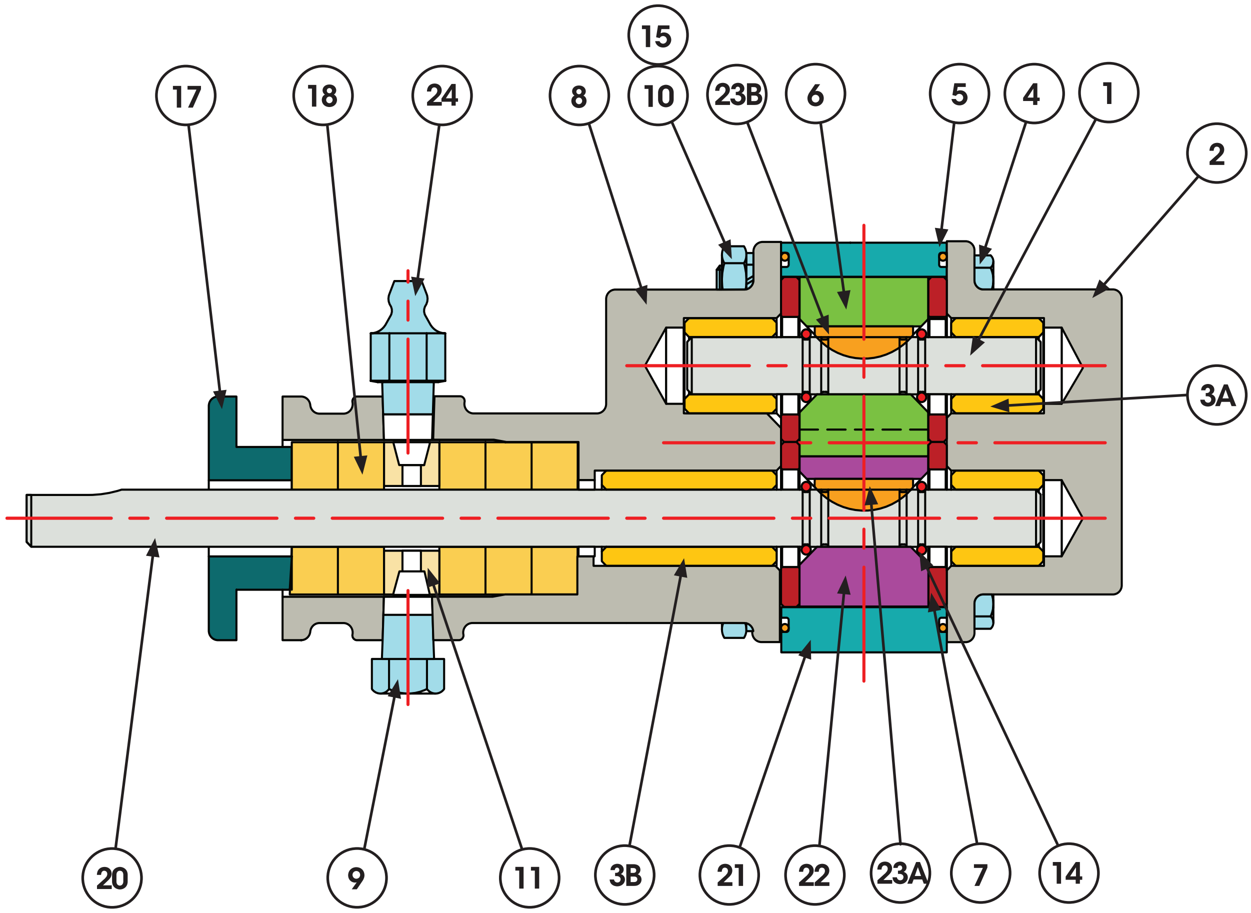
Ref. #	Description	Qty.	Ref. #	Description	Qty.
1	Idler Shaft	1	14	Pin, Bearing Lock (Not Shown)	4
2	Rear Housing	1	15	Lockwasher, Housing **	4
3A	Bearing, Short *	3	16	Screw, Gland (1/4-28 x 1 HHCS)	2
3B	Bearing, Long *	1	17	Gland Plate	1
4	Bolt, Housing (HHCS) **	4	18	Gasket, Seal Seat, Outer	2
5	O-ring, Housing	2	19	Lockwasher, Gland (1/4) (Not Shown)	2
6	Idler Gear	1	20	Drive Shaft	1
7	Wear Plate	4	21	Center Housing	1
8	Front Housing	1	22	Drive Gear	1
9	Plug, 1/8 NPT	1	23A	Key, Drive Gear	1
10	Nut, Housing **	4	23B	Key, Idler Gear	1
11	Lantern Ring	1	24	Seal Seat, Outer	1
12	Pin, Housing Alignment (Not Shown)	4	25	Seal Seat, Inner	1
13	Pin, Bearing Lock (Not Shown)	4	26	O-ring, Seal Seat, Inner	1

* Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size. ** See Page 35 for bolt size.

NOTE: For Liquiflo Part Numbers, refer to H-Series or 3-Series Consolidated Bill of Materials (BOM).

Appendix 6: Reference Drawings (Continued)

Sectional Drawing #3 – Pump with PACKING SEAL



Ref. #	Description	Qty.	Ref. #	Description	Qty.
1	Idler Shaft	1	13	Pin, Bearing Lock (Not Shown)	4
2	Rear Housing	1	14	Retaining Ring, Gear	4
3A	Bearing, Short *	3	15	Lockwasher, Housing * *	4
3B	Bearing, Long *	1	16	Screw, Gland (1/4-28 x 3/4 HHCS) (Not Shown)	1
4	Bolt, Housing (HHCS) * *	4	17	Gland Plate	1
5	O-ring, Housing	2	18	Packing Ring	5
6	Idler Gear	1	19	N/A	-
7	Wear Plate	4	20	Drive Shaft	1
8	Front Housing	1	21	Center Housing	1
9	Plug, 1/8 NPT	1	22	Drive Gear	1
10	Nut, Housing * *	4	23A	Key, Drive Gear	1
11	Lantern Ring	1	23B	Key, Idler Gear	1
12	Pin, Housing Alignment (Not Shown)	4	24	Grease Fitting	1

* Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size.

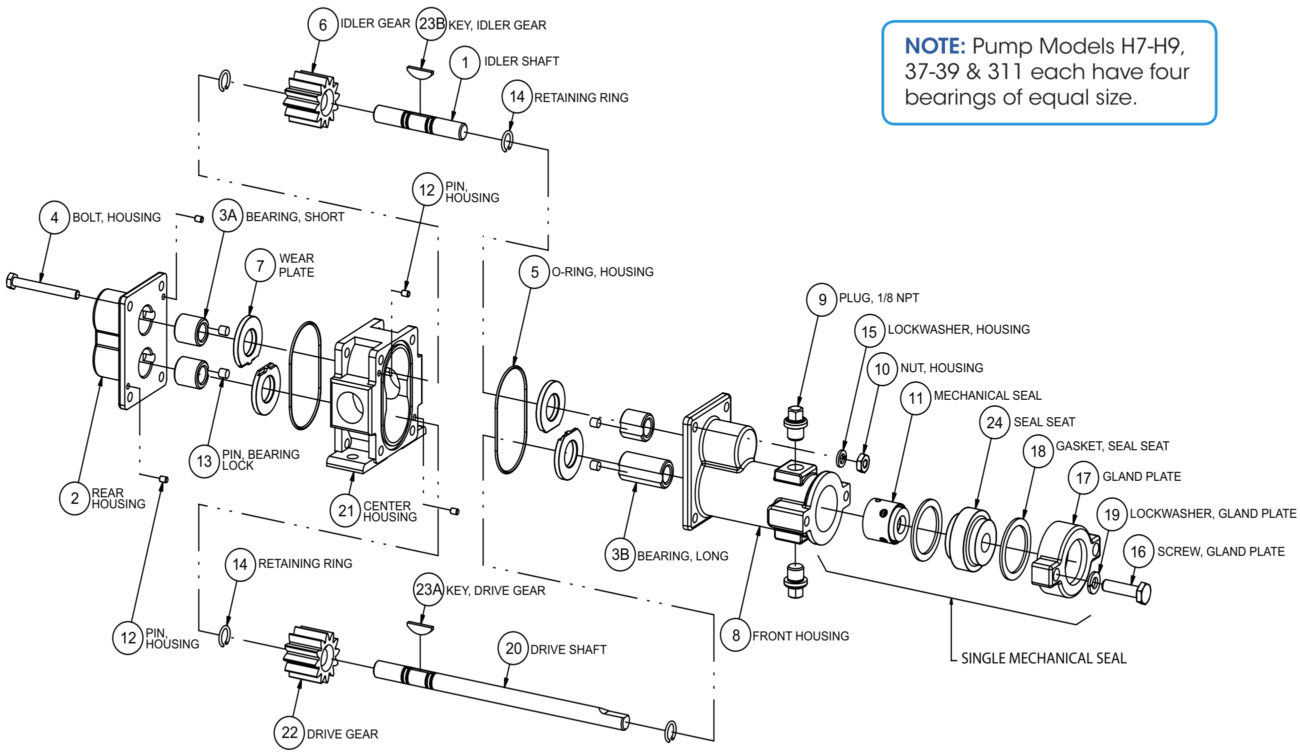
* * See Page 35 for bolt size.

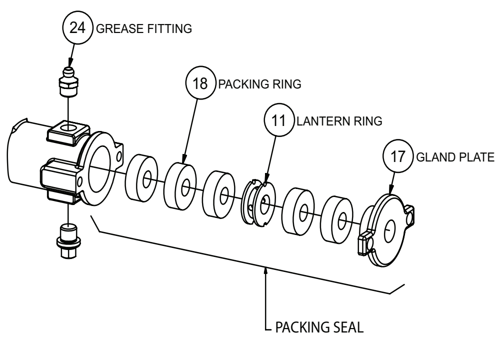
NOTE: For Liquiflo Part Numbers, refer to H-Series or 3-Series Consolidated Bill of Materials (BOM).

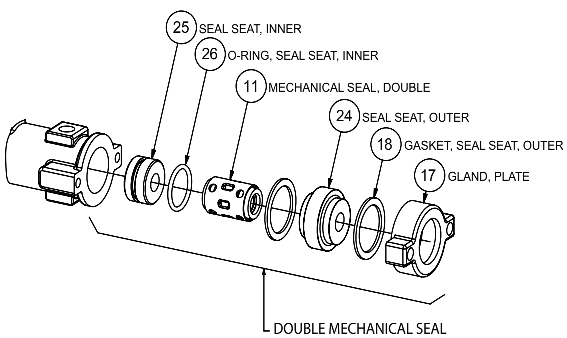
Appendix 6: Reference Drawings (Continued)

Exploded View Drawing #1 – Sealed Pump, Long-Coupled

NOTE: Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size.

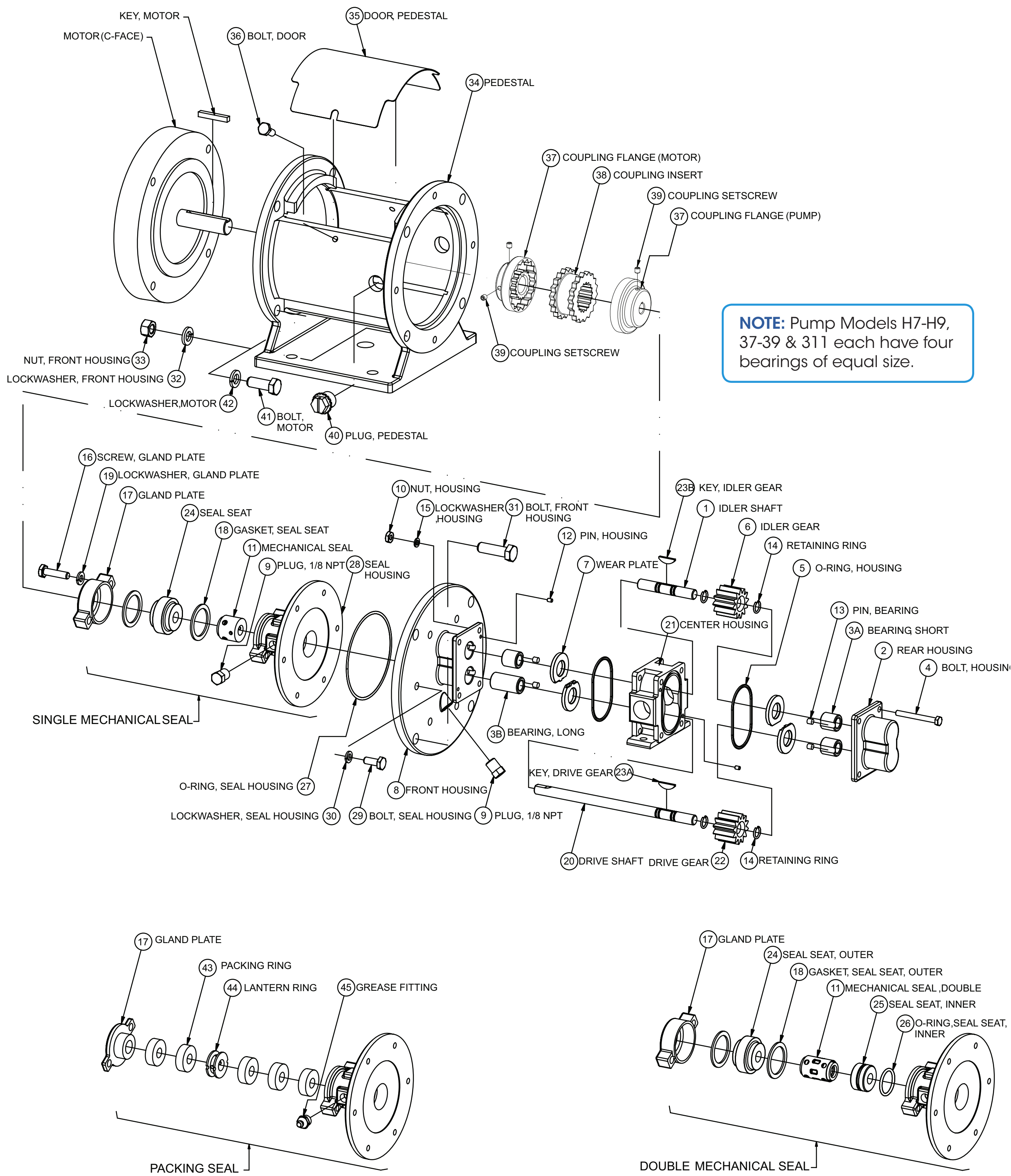






Appendix 6: Reference Drawings (Continued)

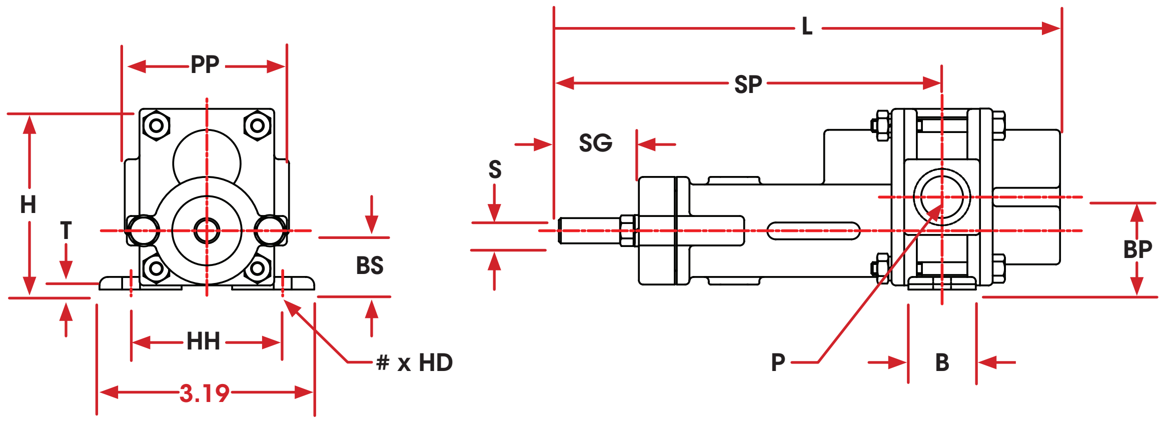
Exploded View Drawing #2 – Sealed Pump, Closed-Coupled



NOTE: Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size.

Appendix 6: Reference Drawings (Continued)

Dimensional Drawing #1 – Sealed Pump with Threaded Ports, Long Coupled



Dimensional Data – Pump Ports

Pump Models		Port Size, Threaded[1] (P)	Port-to-Port, Threaded (PP)	Port Size, Flanged[2] (P)		Port-to-Port Flanged (PP)
				ANSI	DIN	
H-Series	3-Series	in	in	in	mm	in
H1F/H3F	31F/33F	1/4	2.68	1/2	10	10.00
H5R/H5F	35R/35F	1/2	2.44	1/2	15	10.00
H7N/H7R/H7F	37R/37F	3/4	3.32	3/4	20	10.00
H9R	39R	1	3.50	1	25	10.00
H9F	39F/311F	1 ¼	4.00	1 ¼	32	10.00

Dimensional Data (inches) – Not Dependent on Seal Arrangement

Pump Models		# x Hole Diameter (HD)	Pump height (H)	Base Height (T)	Base Length (B)	Hole-to-Hole (HH)	Base-to-shaft CL (BS)	Base-to-Port CL (BP)	Shaft Diameter (S)	
H-Series	3-Series								H-Series	3-Series
H1F/H3F	31F/33F	2 x 0.26	2.69	0.19	0.63	2.76	0.88	1.38	3/8	3/8
H5R/H5F	35R/35F	2 x 0.26	2.69	0.19	1.00	2.26	0.88	1.38	1/2	3/8
H7N/H7R/H7F	37R/37F	2 x 0.28	3.94	0.19	0.88	2.62	1.25	2.00	5/8	1/2
H9R	39R	2 x 0.28	4.06	0.28	1.50	2.62	1.38	2.13	5/8	5/8
H9F	39F	4 x 0.28	4.06	0.28	2.23	2.62	1.38	2.13	5/8	5/8
–	311F	4 x 0.28	4.06	0.28	2.23	2.62	1.38	2.13	–	1/2

Dimensional Data (inches) – Dependent on Seal Arrangement

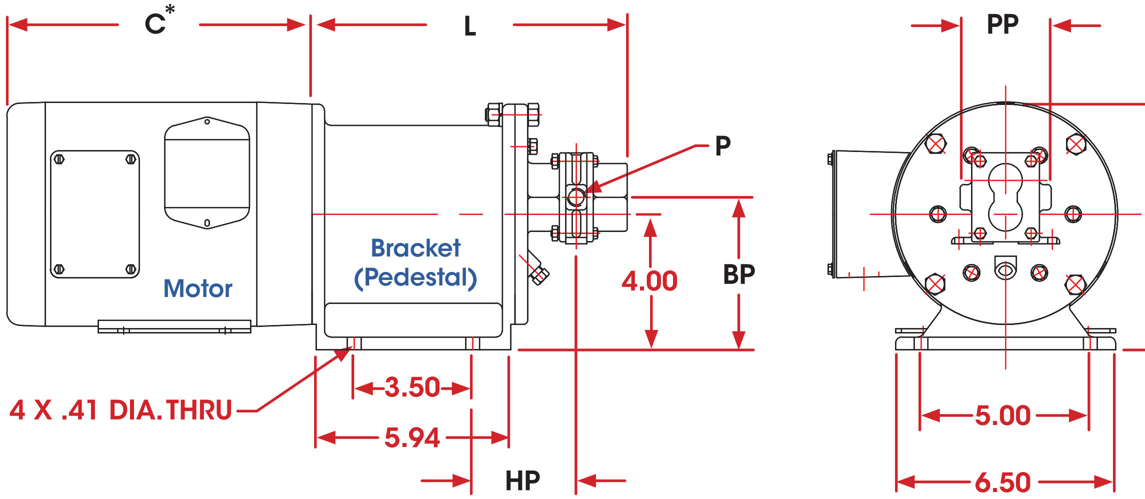
Pump Models		Packing Seal			Single & Double Mech. Seals		
H-Series	3-Series	SG[4]	SP	L[3]	SG	SP	L[3]
H1F/H3F	31F/33F	1.19	5.44	6.94	1.12	5.44	6.94
H5R/H5F	35R/35F	1.17	5.67	7.42	1.10	5.67	7.42
H7N/H7R	37R	1.20	5.98	8.20	1.26	5.98	8.20
H7F	37F	1.07	5.98	8.32	1.13	5.98	8.32
H9R	39R	1.93	7.09	9.68	1.99	7.09	9.68
H9F	39F/311F	1.94	7.47	10.44	2.00	7.47	10.44

(1) Threaded ports are NPT or BSPT.
(2) Flanges are ANSI 150# RF or DIN PN16 (not shown).
(3) Add 0.31 inches if pump has Bearing Flush Plugs installed.
(4) Minimum dimension.

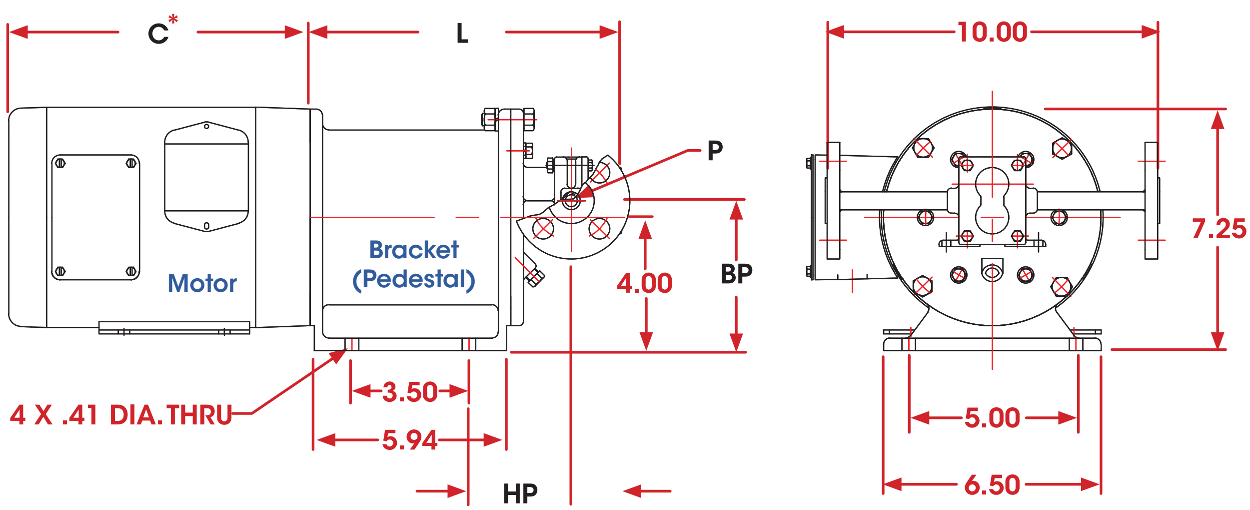
SG = End of Shaft-to-Gland
SP = End of Shaft-to-Port CL
L = Length of Pump

Appendix 6: Reference Drawings (Continued)

Dimensional Drawing #2 – Sealed Pump with Threaded Ports, Close-Coupled



Dimensional Drawing #3 – Sealed Pump with Flanged Ports, Close-Coupled



* See dimensional data from motor manufacturer for "**C**" Dimension.

Dimensional Data – Seal Pump, Close-Coupled

Pump Models		Port Size, Threaded(1) (P)	Port Size, Flanged(2) (P)		Port-to-Port Threaded (PP)	Length(3) (L)	Base-to-Port CL (BP)	Hole-to-Port CL (HP)
			ANSI	DIN				
H-Series	3-Series	in	in	mm	in	in	in	in
H1F/H3F	31F/33F	1/4	1/2	10	2.68	9.31	4.50	3.06
H5R/H5F	35R/35F	1/2	1/2	15	2.44	9.81	4.50	3.31
H7N/H7R	37R	3/4	3/4	20	3.32	10.72	4.75	3.75
H7F	37F	3/4	3/4	20	3.32	10.98	4.75	3.88
H9R	39R	1	1	25	3.50	11.47	4.75	4.12
H9F	39F/311F	1 ¼	1 ¼	32	4.00	12.22	4.75	4.50

(1) Threaded ports are NPT or BSPT.
(2) Flanges are ANSI 150# RF or DIN PN16.
(3) Length (L) is measured from C-face of bracket to end of pump's rear housing. Add 0.31 inches if pump has Bearing Flush Plugs installed.

Appendix 7: Troubleshooting Guide

Troubleshooting Guide - Part 1

Problem	Possible Cause	Corrective Action
No discharge	Pump not primed	Verify suction pipe is submerged. Increase suction pressure. Open suction valve.
	Wrong direction of rotation	Reverse motor leads or reverse suction and discharge piping.
	Valves closed	Open all suction and discharge valves.
	Bypass valve open	Close bypass valve.
	Air leak in suction line	Tighten connections. Apply sealant to all threads. Verify suction pipe is submerged.
	Clogged strainer	Clean strainer.
	Pump worn or damaged	Rebuild pump.
Insuffiecient discharge	Suction pressure too low	Increase suction pressure. Verify suction piping is not too long. Fully open any suction valves.
	Bypass valve open	Close bypass valve.
	Partly clogged strainer	Clean strainer.
	Speed too low	Increase driver speed, if possible. Use larger size pump, if required.
	Pump worn or damaged	Rebuild pump.
Loss of suction after satisfactory operation	Pump not properly primed	Reprime pump.
	Air leaks in suction line	Tighten connections. Apply sealant to all threads. Inspect gaskets, if applicable. Verify suction pipe is submerged.
	Air or vapor pockets in suction line	Rearrange piping as necessary.
	Increase in fluid viscosity	Heat fluid to reduce viscosity. Reduce pump speed.
Excessive power consumption	Fluid viscosity higher than specified	Heat fluid to reduce viscosity. Reduce pump speed. Increase driver horsepower.
	Differential pressure greater than specified	Increase pipe diameter. Decrease pipe run.
	Gear clearances insufficient for fluid viscosity	Purchase gears trimmed for the correct viscosity.
	Plastic gear clearance insufficient for fluid temperature	Purchase plastic gear trimmed for the correct temperature.
	Rotating parts binding or severely worn	Disassemble pump and replace worn parts.

Appendix 7: Troubleshoot Guide (Continued)

Troubleshooting Guide - Part 2

Problem	Possible Cause	Corrective Action
Rapid pump wear	Abrasives in fluid	Install suction strainer. Limit solids concentration. Reduce pump speed or use larger pump running at lower speed.
	Corrosion wear	Use materials of construction that are acceptable for fluid being pumped.
	Extended dry running	Install power sensor to stop pump.
	Discharge pressure too high	Increase pipe diameter. Decrease pipe run.
	Housing stress from piping	Align piping with pump ports. Support piping independently of pump.
	Misalignment (long-coupled pump)	Align pump and motor.
Excessive noise and vibration	Suction and/or discharge piping not anchored or properly supported	Anchor per Hydraulic Institute Standards.
	Base not rigid enough	Tighten hold-down bolts on pump and motor or adjust stilts. Inspect grout and regrout if necessary.
	Worn pump bearings	Replace bearings.
	Worn motor bearings	Replace bearings or motor.
	Pump cavitation	Increase NPSH available.
	Misalignment (long-coupled pump)	Align pump and motor.
Excessive product leakage	Static seal failure caused by chemical incompatibility or thermal breakdown	Use O-rings or gaskets made of material compatible with fluid and temperature of the application.
	Static seal failure caused by improper installation	Install O-rings or gaskets without twisting or bending. Use star-pattern torque sequence on housing bolts during assembly. Allow Teflon O-rings to cold flow and seat during tightening. Torque bolts to specification.
	Dynamic seal worn or damaged	Disassemble and replace seal. Prime pump and avoid dry running.
	Pump port connections not properly sealed	Use Teflon tape or other suitable sealant. Use gaskets compatible with fluid and temperature of the application.
	Crevice corrosion of pump housing material	Only pump chemicals that are compatible with the pump housing material. Decrease temperature to reduce corrosion rate to acceptable value. Flush idle pumps that are used to pump corrosive chemicals. Eliminate contaminants in the fluid that can accelerate corrosion wear.