



# **Operations & Maintenance Manual**

## **Model MP-16 Triplex Pump**

### **Valve over Valve**

**Manual Part Number 1842861**

January 2014



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# Chapter 1: Introduction

This manual is designed to provide instruction in the use of the Weatherford MP-16 pump. All personnel tasked with pump operation and maintenance should study all relevant sections in order to ensure the pump continues to operate at peak efficiency.

## 1.1 Product Details

The Weatherford MP-16 Pump is a single acting triplex piston pump rated at 1,600 horsepower in continuous duty service. It is offered in a wide variety of design options, and as a result, some components may vary from unit to unit. Check the specifications sheet included with this manual to determine the exact configuration of your particular pump.

### 1.1.1 Specifications

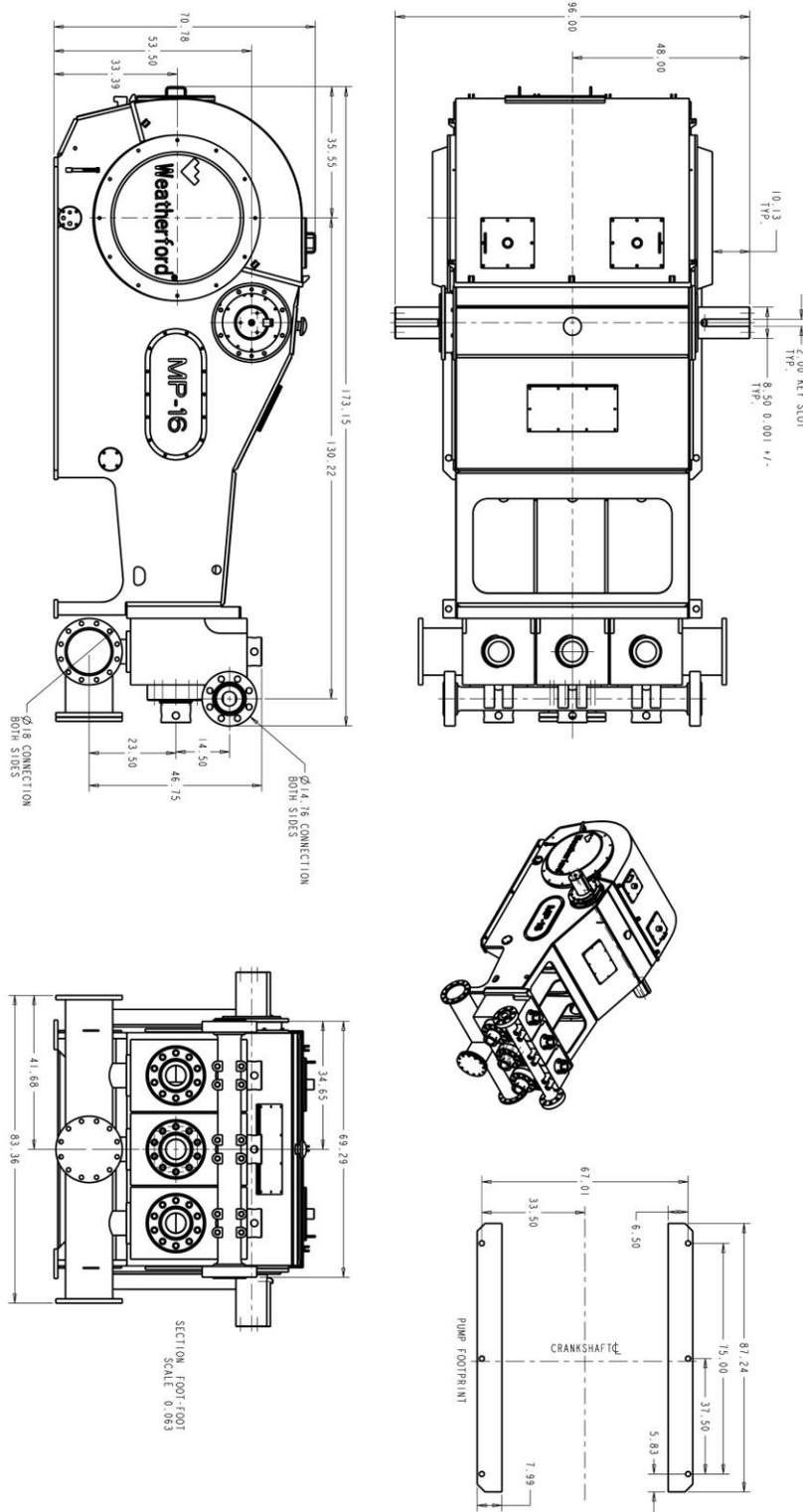
General Information		Operational Statistics	
<b>Pump Type</b>	Triplex	<b>Maximum Rated Power</b>	1,600 HP
<b>Pump Weight</b>	56,700 lbs.	<b>Maximum Discharge</b>	5,000 psi
<b>Oil Capacity</b>	100 gal	<b>Maximum Rated Speed</b>	120 RPM
<b>Max Fluid Temp.</b>	140° F	<b>Minimum Rated Speed</b>	90 RPM*
<b>Mechanical Efficiency</b>	90%	<b>Stroke Length</b>	12 IN

Liner Size (in/mm)	Rated Pressure (psi/Mpa)	Rated Capacity GPM (BPD)						
		120 RPM 1,600 HP	115 RPM 1,520 HP	110 RPM 1,454 HP	105 RPM 1,388 HP	100 RPM 1,322 HP	95 RPM 1,255 HP	90 RPM 1,189 HP
7.00	3,400	720	690	660	630	600	570	540
178	23.442	24,689	23,660	22,631	21,603	20,574	19,545	18,517
6.50	3,900	621	595	569	543	517	491	465
165	26.890	21,294	20,403	19,511	18,619	17,728	16,836	15,945
6.00	4,600	529	507	485	463	441	419	397
152	31.716	18,139	17,385	16,631	15,876	15,122	14,368	13,613
5.50	5,000	444	426	407	389	370	352	333
140	34.474	15,225	14,608	13,956	13,339	12,687	12,070	11,419
5.00	5,000	367	352	337	321	306	291	275
127	34.474	12,584	12,070	11,556	11,007	10,493	9,978	9,430

\* For operations below 40 RPM, an auxiliary power end lubrication system is required.



### 1.1.2 General Dimensions





## **1.2 Scope**

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This manual is intended to provide instruction and guidance on standard and frequently used procedures and processes regarding the MP-16 pump. These include the setup and installation of the system, basic operations, storage, routine maintenance and basic troubleshooting, as well as a parts list for the various components of this system.

The information contained in this document has been expanded to include not only the core systems and functions of the MP-16 pump, but also optional features that may be incorporated into the system. This information is included to ensure that the guidance provided remains applicable in most expected operating conditions and situations. As a result, some of the features described may not be present on a specific unit, and allowances should be made accordingly.

This document was designed for use by pump operators, maintenance personnel and other personnel familiar with the equipment and its expected use. As such, this document will not go very deeply into theory and basic processes, but will focus primarily on equipment-specific issues and procedures. Individuals without proper training or experience should always have experienced personnel supervising their use of this or any other powerful and potentially hazardous equipment.

This manual has been prepared with the system's expected uses in mind. For help with events, situations and uses not typical to this system, or for advanced troubleshooting issues, please contact your local Weatherford representative.

## **1.3 Manual Organization**

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This manual has been laid out in accordance with the expected need of its users. It is divided into seven sections, each of which is intended to cover one aspect of the equipment's use and functions.

**Chapter 2: Storage & Installation** covers the non-operational aspects of using and maintaining the system, from basic storage to installing the system on location.

**Chapter 3: Operations** covers the basic operating procedures, from the standard startup sequence to the general operations procedures and troubleshooting tips.

**Chapter 4: Maintenance** covers all aspects of the regular preventative maintenance that will help to ensure that the system operates at peak efficiency for as long as possible, including the tools used, operational guidelines and basic replacement procedures.

**Chapter 5: Assembly & Disassembly** covers the assembly and disassembly of the pump and its components, including advanced repair and replacement procedures.

**Chapter 6: Glossary** provides a list of standard terms and definitions regarding triplex pumps in general and the MP-16 pump in particular.

**Chapter 7: Parts Lists** provides a comprehensive inventory of all the standard components used in the MP-16 pump.

## 1.4 Safety Summary

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Every year, the United States Occupational Safety & Health Administration (OSHA) receives reports of millions of worker related injuries and deaths associated with the use and misuse of mechanical and industrial equipment. Many of these incidents occur due to either carelessness on the part of the operator or as a result of the operator not understanding the equipment and processes he or she was using. In many cases, such incidents could have been prevented through the use of basic, commonly-accepted safety procedures.

When working with industrial equipment, or indeed at any time you are working, it is important to employ all appropriate safety measures. These exist not only to protect the operator of the equipment, but also co-workers, supervisors, contract personnel and anyone else who happens to be in the area where the work is being performed.

Always use good, sound mechanical practices when working with industrial equipment, and as an absolute minimum, follow all of the safety guidelines outlined below. Failure to follow the established safety guidelines can result in damage to equipment, employee injury and/or death.

At the same time, it is important to remember that no set of procedures is perfect. While these guidelines should help to significantly reduce the chance of an incident, they are no match for an aware and reasoning human mind. Always use your best judgment, and if something seems unsafe or dangerous, do not do it.

### 1.4.1 Safety Symbols and Terms

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Throughout this document, you will regularly see a number of information boxes labeled with safety-specific terms. These are the standard terms and conventions that will help to ensure the safety and health of those working with or near this equipment. It is important to make sure that the operator and others know what each one means.

**WARNING** WARNING safety notes **MUST** be followed carefully. Failure to do so may result in catastrophic equipment failure, serious injury and/or death.

**CAUTION** CAUTION safety notes are very important and should be followed carefully. Failure to do so may result in equipment damage and/or personal injury.

**NOTE** NOTE safety notes are used to notify personnel of information that is important, but not hazard related.



### **1.4.2 General Safety**

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The following are general safety practices which should always be used when working.

#### **Qualified Personnel Only**

Personnel without a thorough understanding of all processes and procedures required to operate and maintain equipment can unintentionally create hazards for themselves and others. Only individuals with proper training should ever operate or perform maintenance on industrial equipment in a workplace environment. This includes not only the appropriate procedures for the equipment being used, but also requires an understanding of all attached systems, equipment in the area, and general safety and hazard recognition training.

#### **Equipment Ratings & Guidelines**

Always follow all of the manufacturer's instructions when using a piece of equipment or machinery. Never use any equipment or machines for any purpose for which they are not specifically designed without first receiving approval from the manufacturer. When using equipment and machinery, always ensure it is properly rated for the work performed, and never exceed the listed ratings and guidelines.

#### **Safety Systems & Countermeasures**

All equipment should have guards and other safety systems to protect personnel from exposed moving parts and other dangers. It is the responsibility of every employee on site to ensure that all safety systems and countermeasures are in place, secure and effective.

#### **Lock Out Tag Out**

Before performing repairs or maintenance on any industrial equipment, you should always follow standard "Lock Out/Tag Out" procedures. This includes not only shutting down the equipment, but also isolating it from any potential power sources (electric, hydraulic, mechanical etc...). In addition, be sure to lock controls and tag the equipment as under maintenance to ensure that it is not accidentally reconnected or activated by a third party. Never activate systems tagged out of service.

#### **Environmental Hazards**

Never attempt to perform work in an environment in which your senses are significantly impaired, that is, if you cannot adequately visualize the area you are working in, the work you are performing, or you cannot be adequately alerted to potential dangers and hazards.

#### **Appropriate Dress**

It is the responsibility of employees to ensure that their clothing, hair and accessories do not pose a potential safety hazard when on the job. In industrial environments, this includes, but is not limited to, wearing all appropriate clothing and PPE, keeping hair short or restrained, avoiding jewelry and loose clothing like skirts or ties. Consult with the site supervisor or safety coordinator to ensure you meet all safety requirements.

#### **Exercise Good Judgment**

Especially when working in an industrial environment, it is important to remain alert and aware to avoid causing or entering potentially hazardous situations. Always be alert for potentially unsafe activities and situations, and do not attempt to work or operate equipment when sick, taking certain medications or in any other circumstances in which your senses or your judgment is in any way impaired.



### **1.4.3 Common Hazards**

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The following are major risks and hazards that may occur in an industrial environment. Each of the following is a WARNING level hazard, meaning personnel should obey all regulations or risk serious injury or even death.

#### **Securing Equipment**

Unsecured equipment can shift and move during operation, not only causing damage to the components but serious injury or death to personnel. All truck, trailer or skid mounted equipment should be secured with blocks and/or moorings prior to use, which should be inspected for damage before equipment is activated.

#### **Hoisting and Lifting Equipment**

Equipment that swings or falls while being hoisted can crush body parts caught between the equipment and other objects, causing serious injury and death. Always use lifting equipment not only rated for load to be lifted, but also complying with all applicable regulations, both governmental and corporate.

Before lifting, check to ensure that all parts of the load are secure. Any time a piece of equipment is being hoisted or lifted; all personnel should clear all locations in which the equipment could swing, fall or any combination of the two.

#### **Drive Systems**

Body parts and loose clothing can become caught on moving and rotating parts of the pump drive systems, dragging personnel into the system and inflicting serious injury or death. When working with drive systems, keep all guards in place and in good condition, and keep hands and clothing clear of the drive system cavity at any time when the drive is in motion.

#### **Hydraulic & Pneumatic Systems**

Hydraulic and Pneumatic systems operate by means of high-pressure fluids that can cause serious injury or death if vented improperly. Avoid striking or puncturing any hydraulic or pneumatic components or connections. When performing any work on these systems, even tightening a leaking joint, fitting or connection, slowly drain to zero pressure before commencing work, and disconnect and tag systems as “Out of Service.”

#### **Electrical Systems**

Electrical systems contain high voltage current which can cause serious injury and death when improperly grounded. Avoid striking or puncturing any electrical components or connections, and ensure that the power is turned off, the system is disconnected and that it is tagged out of service before commencing work.

#### **Lubrication & Filtration Systems**

Failure to properly maintain lubrication and filtration systems can result in various types of catastrophic system failures which themselves can cause serious injury and death. Institute a complete lubrication program at regular intervals, and inspect all systems before operation.



### **1.4.4 Pump Specific Safety**

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The following are standard guidelines and practices which should be used when working with the MP-16 triplex pump.

#### **Disengage / Vent Pressure**

As per standard Lock Out/Tag Out procedures, be sure to completely shut down the pump and vent all pressure from the pump and piping before performing any work on the equipment, and tag all equipment being worked on as “Out of Service.” Failure to do so may result in electrical shocks, crushing injuries or the sudden release of potentially hot fluids at high pressure.

#### **Pressure Relief**

Never operate the pump without a pressure relief valve, rupture disk or other type of over-pressure safety device installed. All such equipment must be properly sized and fitted before use, and operators must ensure that there are no valves of any type between the pump and the safety device.

#### **Fluid, Lubricant & Solvent Use**

Only use fluids, lubricants or solvents approved for the equipment. Always exercise extreme care when using solvents to clean or degrease equipment. Many solvents are flammable or toxic, and some solvents may damage or deteriorate system components. Both of these conditions can lead to system failures and injury, so be sure to use only approved solvents, read all safety precautions before using and follow all appropriate procedures. Never mix fluids, lubricants or solvents.

#### **Fluid, Lubricant and Solvent Disposal**

Follow all normal health and environmental guidelines when disposing of fluids, lubricants or solvents. In the event of a spill, follow the appropriate steps and procedures to ensure the spill is cleaned up with minimal risk to fellow employees or the local environment.

#### **Polished Areas**

Never grip polished areas with tongs or other gripping devices, as it can result in equipment failure and potential injury.

#### **Shields and Covers**

When pumping hot fluids, it is important to always use shields and covers to protect service personnel from any accidental exposure.

#### **Guards**

Likewise, guards should always be used on belt drives, couplings and shafts to prevent personnel or objects from becoming entangled in rotating or reciprocating parts. Failure to do so can result in severe injury or death.

#### **Battery Connections**

Always ensure the battery connections are made correctly, with the positive (+) connector hooked up to the positive terminal and the negative connector (-) hooked up to the negative terminal. Failure to do so can result in equipment damage and potential injury.

#### **Zerk Fittings**

Do not leave Zerk fittings installed on this high-pressure equipment, as the extreme pressures handled by these systems can cause the Zerk check ball to blow out.



**Teflon Tape**

In general, it is better to use pipe sealant rather than Teflon Tape due to the chance of pieces of the tape coming loose and clogging the lube system. However, if the situation mandates the use of Teflon Tape, always start the wrap two (2) or more threads from the opening to prevent Teflon contamination of the hydraulic system.

**Do Not Modify**

Never modify the pump to perform beyond the rated specifications or use substitute parts or components without first consulting and receiving written consent from Weatherford. Failure to do so may put too much stress on certain components, which can result in catastrophic equipment failure, serious injury and/or death.

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# Chapter 2: Storage & Installation

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This section shall provide a basic guide to all of the non-operational aspects of utilizing the MP-16 triplex pump. It includes general guidelines and procedures for installing the pump, as well as a general guide to storing the equipment, including recommendations for dealing with severe environments.

## 2.1 Installation

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The proper installation of the MP-16 triplex pump is essential to ensuring optimal performance and a long service life, as well as significantly reducing required maintenance. This can require some precise values, and so it is important to plan ahead before the pump is brought to location and the rig-up is made. It is difficult, expensive and time consuming to correct errors in piping, pulsation dampener mounting and tie downs after they have been fabricated and welded in place.

### 2.1.1 Transport Skid

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The MP-16 comes mounted on a small I-beam style oilfield skid. This skid is designed to protect the pump during transport, but may be incorporated into the larger structural skid on site. However, this is not required, and users may remove the transport skid and mount the pump directly to a larger skid, usually one with power and inlet piping to reduce the overall size and weight of the equipment package.

### 2.1.2 Location and Orientation

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**CAUTION** Always make sure pumps are mounted on a level surface and are locked down evenly. Failure to do so can cause twisting, which places unnecessary strain on the frame and the pump, and can result in equipment damage and injury.

Pumps should be mounted on a flat, level surface in a clean, dry, well-illuminated and well-ventilated area for optimum performance. Ensure that the mounting surface is at least strong enough to withstand the forces and vibrations generated during pump operations.

### Temporary Installations

For temporary installations, the pump may be mounted on a mat of 3" x 12" boards laid crosswise to the skid. These boards should be a few feet wider than the width of the skid runners. Wet, marshy or otherwise unstable location may require a more stable foundation.

### Permanent Installations

The pump should be secured using clamps or the bolt holes provided in the skid base. If there are any gaps between the pump skid and the foundation, never draw the skid down to the foundation. Instead, apply shims to the skid until the pump sits solid with all bolts loose, then affix to the surface. Shims should extend the full width of the skid and must have a minimum length of 12 inches (305 mm).



### **2.1.3 The Prime Mover**

The Prime Mover should be installed with great care to ensure maximum operating life and minimal difficulties. Before locking the pump into position, check that the prime mover has been aligned properly in relation to the pump, and that all burrs, rough spots, grease and rust preventative has been removed from the drive shaft, bore, key and keyway.

When installing, check that the pump rotation is set to drive the top of the crankshaft towards the fluid end, as this will go a long way towards establishing proper splash lubrication and crosshead loading. Then verify that no damage has occurred to the components and systems, including all safety devices and guards, and fit keys into the keyways as appropriate. Finally, lightly coat the pinion shaft with an anti-seize compound or light oil and install the drive sheave or sprocket hub.

**CAUTION** Never operate the pump without proper guards in place.

#### **Belt Drives**

Before installing the sheaves, check to ensure that the sheave grooves are not worn or damaged, that the sheave side walls are straight and that the sheaves are free of rust, dirt or other extrusions, as all of these will cause the V-belts to deteriorate rapidly.

Belts should be tensioned as recommended by the supplier. Do not use worn or damaged belts or chains. Do not exceed the recommended tension rating, as it can result in damage to the shafts.

Once tensioned, perform a final alignment check and ensure all mounted bolts are secure. To do so, first verify that the sides of the sheaves are equidistant from the centerline of the groove. Then simply stretch two lengths of string or wire along one side of the sheaves, one above and one below the centerline. These wires should touch all four points on the sheave rims.

If it does not touch all four points, adjust move ONE of the sheaves until the string makes four-point contact. Leave the other sheave in place while performing this procedure.

#### **Chain Drives**

When installing chain drives, the chain alignment must be held as close to perfect as possible. Use the procedures listed under *Belt Drives* to help ensure a proper alignment, particularly the two-wire procedure, though the wires should be aligned with the sprockets, and one sprocket's position should be adjusted as needed.

Chain drives will utilize their own lubrication systems. Follow all manufacturer instructions when installing this system. If the ambient temperature is expected to drop below 0°F, consult the manufacturer or a reputable lubrication dealer for recommendations.

#### **Direct-Coupled Installations**

For direct coupled installations, ensure that the coupling is secure, then install all cages and guards and secure into position. Check the parts list sheet that came with this particular unit for recommended guards and cages used. Do not operate pump with loose cages or guards.



### **2.1.4 Suction System**

Single acting reciprocating pumps perform best when supplied with an appropriate level of fluid. Inadequate fluid supplies may lead to cavitations, which is one of the primary causes of premature pump failure. When setting up the pump, it is very important to ensure that there is sufficient fluid running through the pump at all times.

The fluid supply tank should be large enough to allow dissolved air and other gases to escape from the liquid, and allow suspended solids to settle out before entering the pump. For this reason, a system employing dams and settling chambers is desirable.

#### **Charging Pumps**

A centrifugal charging pump should be used to boost fluid supply and ensure proper operations. This pump should be sized to 150% of the main pump volume for the largest piston size expected to be used to allow for the varying flow demands of the triplex pump. The charging pump should be set to ensure the suction manifold pressure is between 20 and 30 PSI to ensure maximum volumetric efficiency and expendable parts life.

The charging pump may be driven using V-belts or chains off the mud pump input shaft, but this is not recommended as it makes mounting the pump and inlet system piping difficult, and may not provide sufficient RPMs to the charging pump for proper operation when the mud pump is operating at lower speeds. For this reason, it is recommended that a booster pump be used, powered by an electric AC motor.

The mud pump control panel should be configured so that the mud pump cannot be started until the charging pump is running and has developed at least 20 PSI. For full operating instructions and guidelines for using a particular charging pump, see the documentation provided by the manufacturer.

#### **Piping**

The suction piping can be connected to any of the available flanged connections on the suction manifold. The length of the suction piping should be minimized as much as possible to enhance pump efficiency, and utilize 45° long radius elbows to help reduce frictional pressure drops at the inlet. The suction piping should be supported to prevent unnecessary loads on the pump suction manifold.

#### **Common Suction Manifolds**

Two or more pumps can have their suction connections made to a common manifold provided that the manifold has a cross-sectional area greater than the sum of the individual pump inlet areas.

**NOTE** Never use a common manifold with a smaller cross-sectional area than the sum of the individual pump inlet areas, as this will significantly decrease the efficiency of all the pumps used.

#### **Gauges and Meters**

It is recommended that a pressure gauge be installed at the pump suction, and a low-suction pressure alarm be mounted in the suction line. However, do not install any metering device that causes a flow restriction on the suction piping. For full operating instructions and guidelines for this equipment, see the documentation provided by the manufacturer.



### **Suction Stabilizer**

A suction pulsation dampener should always be utilized, as it will significantly extend the pump's operational life and efficiency. This system will typically be installed directly inside the suction manifold, though external models are available. Pre-charge the pulsation dampener in accordance with the manufacturer's instructions before beginning operations, and ensure that no valves or turns are placed between the suction pulsation dampener and the suction manifold inlet.

**WARNING** The use of a high pressure source or nitrogen bottle to charge the suction line pulsation injury dampener can result in catastrophic equipment failure and serious injury to personnel.

For full operating instructions and guidelines for this equipment, see the documentation provided by the pulsation dampener manufacturer.

### **Line Valves**

Only full open valves should be used on the suction line to prevent any reduction or interruption of flow and thereby ensure the efficient operation of the pump. Drain valves should be installed at the lowest point in the piping, while vents should be located at the highest point available. Do not under any circumstances use any valve that has the potential to choke the flow of fluid through the line.

### **Suction Pressure Relief Valve**

It is recommended that a suction pressure relief valve be used in the suction line to prevent damage to either pump in the event of a high pressure surge occurring in the line. It is recommended that the valve be located on the suction manifold of the pump, but may be located elsewhere on the suction line at the customer's discretion. The outlet line from the relief valve should gradually slope down to the tank level, and should be supported to prevent any dips or low spots where mud could collect, harden and potentially block flow.

The relief valve should be set to 50% greater than the normal operating pressure (70 psi for normal operations, but this value may vary depending on the specifics of the job).

**WARNING** The pressure relief valve outlet must not connect back to the pump suction line. This can cause uncontrollable pressure surges, which can result in equipment damage and significant injury to personnel.



### **2.1.5 Discharge System**

The discharge piping is subject to damage due to the pulsations from the pump as well as loads imposed by thermal expansion of the pipe. Generally, a single pulsation dampener should be sufficient to handle such loads, but in cases of high output rates, two pulsation dampeners may be required. By correctly handling these issues, the user can improve the pump's overall performance and longevity.

#### **Strainer Cross**

The discharge piping setup can be simplified by using a Strainer Cross. This system provides two outlets for mud lines, a mounting for the discharge pulsation dampener and incorporates a side connector for mounting a pressure gauge. In addition, it provides easy access to the strainer, which should be checked and cleaned at least once a month.

Alternately, a standard discharge cross is available, which has many of the above benefits but does not include a strainer.

The complete assembly may be flanged directly to either side of the pump discharge manifold and is provided with an integral support mounted between the cross and the pump skid. For full operating instructions, see the documentation provided by the manufacturer.

#### **Piping**

All discharge piping should be the same size as the outlet on the pump. Gradual turns should be used to prevent unnecessary frictional pressure buildup and pipe erosion, and no immediate turns next to the pump discharge should be used. 45° long radius elbows should be used to minimize flow frictional pressure concerns. Furthermore, discharge piping should be supported, but allowed to move along the axis of the pipe to ensure that any thermal expansion will not unnecessarily load the fluid end connections.

#### **Discharge Pulsation Dampener**

A discharge pulsation dampener should always be utilized, as it will prevent harmonic vibration from damaging the discharge piping and significantly extend the pump's operational life. This system should be mounted on a discharge cross or strainer cross flanged directly to the discharge manifold, before any valves or turns are placed in the discharge line.

For full operating instructions and guidelines for this equipment, see the documentation provided by the pulsation dampener manufacturer.

**WARNING**

Always use a regulator in the line when charging the discharge pulsation dampener. An uncontrolled increase of pressure can result in catastrophic equipment failure and serious injury or death.

**WARNING**

Do not use air or oxygen to fill bladder, especially when pumping flammable fluids, as it may combust and cause catastrophic equipment failure and serious injury to personnel. In most cases, it is recommended that nitrogen is used to fill the bladder.

#### **Bypass Line**

It is highly recommended that a bypass line be utilized. It will help to ease the start up torque requirements on the primary driver, allow a low discharge of pressure to help pump priming and ensure that lubrication is established prior to the load being applied.

### Line Valves

When selecting valves for the piping, personnel should ensure that only full open valves are used. Plug type and full opening gate valves are good candidate types.

### Pressure Relief Valve

A pressure relief valve should be installed on the opposite side of the pump discharge manifold from the strainer cross, and incorporate a high pressure relief line. The valve should be a full-opening reset type valve, and set to a pressure no greater than 15% of the working pressure of the piston size that is being used.

The Pressure Relief Valve discharge line should be short, straight securely anchored and slope downwards at least ¼" per foot in order to prevent solids from settling in the line. The piping should be the same size as the valve discharge opening, and lead back to the supply tank, but not the pump suction.

**WARNING**

The Relief Valve must not be connected to the strainer cross, as the systems can interfere with one another, resulting in potentially life-threatening situations.

**WARNING**

Do not put any type of shut-off valve between the pressure relief valve and the discharge manifold, in order to protect the system against damage resulting from accidental or incorrect start-up

**WARNING**

The Relief Valve outlet must not be connected to the pump suction line. This can cause uncontrollable pressure surges in the suction line, which can result in equipment damage and significant injury to personnel.

For full operating instructions and guidelines for this equipment, see the documentation provided by the pressure relief valve manufacturer.

### Gauges and Meters

A pressure gauge should be installed on the pump discharge, and a high-low pressure alarm system should be utilized to address problem conditions that could lead to pump failure. For full operating instructions and guidelines for this equipment, see the documentation provided by the manufacturer.



### **2.1.6 Power End Preparation**

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The pump power end should arrive assembled and tested, but without expendables or lubrication. Before operating the pump, check the following.

#### **Lubrication**

Check the oil reservoir for the possible accumulation of condensation, and drain and flush by removing the pipe plugs on either side. Fill the power end with lubricant to the proper level with a clean EP gear oil of the proper viscosity (see 4.3: Lubrication on page 31). Make sure the oil is poured into the crosshead reservoir and worked into all of the bearings.

Recheck oil level after first 15 minutes of operation, and add more as needed.

#### **Extension Rod and Diaphragm Stuffing Box Seals**

Ensure the extension rod and diaphragm stuffing box seals are properly installed as per 5.3.7: Installing the Crossheads & Crosshead Guides (page 99).

### **2.1.7 Auxiliary or Ancillary Systems**

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Any Auxiliary or Ancillary systems, such as liner wash systems and jib cranes, should be installed in accordance with the manufacturer's guidelines. If those come into conflict with the regulations here, default to the manufacturer's specifications, unless those come into direct conflict with the safety and operational guidelines outlined here. When in doubt, contact a Weatherford professional or manufacturer agent for information regarding the systems used.



### **2.1.8 Installation Checklist**

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#### **Pump Checklist**

- Ensure the location for installation is clean, dry, well-ventilated and well-illuminated, and as close to the fluid source as possible.
- Check that the pump is level.
- Ensure the pump rotation is set to drive the top of the crankshaft towards the fluid end.
- Ensure that the prime mover drives are properly aligned and configured (see 2.1.3: The Prime Mover, on page 10)
- Ensure all guards on the drives are in place and secure.

#### **Suction Checklist**

- Check that any charge pumps used are of suitable size and are configured correctly.
- Check that the suction stabilizer is installed and inflated correctly.
- Ensure that the piping is as short as possible and properly supported.
- Ensure that vents and drain valves are installed at the proper locations and clear for use.
- Ensure a pressure gauge is installed at the suction point, preferably with a thermometer and a low-pressure alarm.
- Check that the suction piping is properly sized and that there are no components that may choke or disrupt flow (tight elbows, partial valves, metering devices, etc...)

#### **Discharge Checklist**

- Ensure the discharge piping is properly sized and supported.
- Ensure the pressure gauge is correctly installed at the pump discharge, along with the high-low pressure alarm (if used).
- Install a discharge pulsation dampener as close to fluid end as possible.
- Ensure the pressure relief valve is installed and set to the appropriate pressure.
- Ensure the line from the pressure relief valve directs back to a supply tank and not the pump suction.
- Ensure the bypass line is properly installed and functioning.
- Check that the discharge piping is properly sized and that there are no components that may choke or disrupt flow (tight elbows, partial valves, metering devices, etc...)



## **2.2 Storage**

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While the MP-16 pump is a sturdy piece of equipment, it is vulnerable to damage at certain times, especially when inactive. Over time, environmental forces can wear down even the strongest materials, and cause subtle but significant damage to vital components and systems. Unlike equipment that is in use, stored units generally do not receive regular maintenance, and even small problems can become significant if not caught.

By storing the pump in accordance with the following guidelines, users may protect it from environmental wear and tear.

### **2.2.1 General Storage Guidelines**

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If the MP-16 pump is to be idle for longer than a month, it should be prepared for storage. Pumps should always be stored in a dry, temperature controlled environment to minimize environmental effects and help to prevent equipment degradation. Pumps should never be stored directly on the floor or ground, but elevated to avoid potential problems.

#### **Fluid End**

Remove the fluid end valves, pistons & liners. Clean the inside of the fluid end, including all valves and parts, and coat all components in rust inhibiting oil. Then clean the liner wash system and settling tank, and put clean oil into the liner wash system to prevent rusting. Finally, coat the liner wash tank and inner spray parts with a rust inhibiting oil.

If the pump is expected to remain in storage for six (6) months or more, the fluid end should be cleaned and flushed with water which has had its pH raised to 10 or more in order to kill any sulfide reducing bacteria in the pump. Over time, these bacteria can create sufficient Hydrogen Sulfide to attack the hardened steel parts in the fluid end and harm or even kill personnel when the pump is reopened.

Once the fluid end has been cleaned, 1 quart of internal rust inhibitor should be poured into the suction and discharge ports of the fluid end, and pipe plugs should be installed in any openings. Cover the entire pump with a plastic or canvas tarp to prevent exposure.

#### **Power End**

Remove the power end covers. Drain and clean the main sump and settling tank. Then clean and coat all bearings and finished surfaces with rust inhibiting oil, rotating the driveshaft during coating to ensure even coverage. Then coat all exposed metallic surfaces and the entire inside surface of the power end with rust inhibiting oil, and replace all covers.

Raise the fluid end of the pump so the pump slopes downwards towards the power end and secure in place. Replace the main sump drain with a 90° elbow pointed down, and cover the opening with a wire mesh screen to permit air circulation and prevent condensation buildup. In addition, a 100 watt light bulb burning continuously will also help prevent atmospheric water condensation.

**WARNING**

A falling MP-16 pump can do significant damage to itself and has sufficient mass to crush most anything in its path, causing catastrophic equipment failures, severe injury and death. When raising a pump, be sure that it is firmly secured and supported, and all personnel should always give suspended units a wide berth.



### **2.2.2 Special Conditions & Procedures**

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#### **Corrosive Fluids**

If the fluids used in the pump are potentially corrosive, it is important to flush the fluid end with clean water or another non-corrosive cleaner, and then blow dry with compressed air. This will ensure that the majority of the flushing fluid residue has been removed.

#### **New Pumps**

Pumps come from the factory without any crankcase oil and are prepared for short term storage without any preparation. If users expect to store the unit for longer than this or in a severe environment, they should use the procedures as indicated below.

#### **Precautions for Freezing Weather**

Freezing weather can cause problems for equipment when pumping water-based fluids, or when water used to flush prior to storage is not properly dried. In environments with freezing or near-freezing temperatures, it is vital to ensure that a pump is dry prior to storage, and to thoroughly inspect the pump prior to use.

#### **Severe Environment Precautions**

In severe environments, take the following additional steps. The oil in the power end should be drained and the fill cap removed, and then refilled with 8 quarts of internal rust inhibitor vapor emitting oil. Replace the fill cap before storing.

In addition, pour 1 quart of internal rust inhibitor into both the suction and discharge ports of the fluid end, then install pipe plugs in any opening. Coat all exposed, unpainted metal surfaces with preservative oil, and cover the entire pump with a weather resistant coating, such as plastic or a canvas tarp.

### **2.2.3 Upkeep**

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Once per month, pumps in storage should be inspected and the gears rotated to ensure that there is no rust or corrosion. During the inspection, the crankshaft should be rotated by hand at least 4 turns. Then re-coat all surfaces and components with rust-inhibiting oil.

Drain and replace the rust inhibiting oil in the crankcase every six (6) months.



### **2.2.4 Returning to Service**

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The first step in returning to service is to remove all covers on both the power end and the fluid end and to clean and inspect all finished surfaces. Replace any significantly damaged, rusted or corroded components.

**CAUTION**

Any pump that has been in storage for any reason, including unused units shipped straight from the plant, should receive a full inspection to make sure it has not suffered damage and that all parts are properly set in place. Failure to do so can result in serious equipment damage and injury to personnel upon startup.

#### **Power End**

Check all bearings to ensure that they are clean and in good condition. Check the oil reservoir for the possible accumulation of condensation, and drain and flush by removing the pipe plugs on either side. Fill the power end with lubricant to the proper level with a clean EP gear oil of the proper viscosity (see 4.3: Lubrication on page 31). Make sure the oil is poured into the crosshead reservoir and worked into all of the bearings.

#### **Fluid End**

The valves, pistons, liners and all fluid end parts must be properly installed and in good working condition. Carefully tighten all of the bolts, nuts, studs, working connections and covers, and fill the liner wash system with fresh water containing either water-soluble oils or detergents in order to keep the pistons properly lubricated.

Local weather conditions may require varying concentrations of coolants for optimal operation. Some trial and error may be required to get the best concentration of coolants for local conditions.

# Chapter 3: Operations

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This section covers all standard procedures used to operate the MP-16 triplex pump. It includes all basic operational guidelines and recommendations, as well as pump startup and shutdown procedures.

## 3.1 Starting Procedure

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The following startup procedure will help to ensure that the pump operates at maximum efficiency and will reduce the potential for damage during start-up.

### 3.1.1 Initial Startup

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While all Weatherford pumps are shipped with the factory run tests complete, they should always be inspected before beginning startup procedures. Check that all components are correctly positioned and secured, and are not damaged or corroded. Drain and flush as necessary to remove any condensation that may have formed during shipment or storage.

**CAUTION**

New pumps should always receive a full inspection to make sure it has not suffered damage and that all parts are properly set in place. Failure to do so can result in serious equipment damage and injury to personnel upon startup.

Once the inspection is complete, fill the power end with new, high-quality oil to the recommended level. Then disconnect the drive system, and use the pinion rotation tool to rotate the pump by hand for several complete revolutions to ensure there are no unusual knocks, vibrations or tight spots. If the pump does not rotate smoothly, investigate the source of the problem and correct before attempting to operate the pump.



### **3.1.2 Pre-Start Checklist**

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#### **General Systems Checklist**

- Check the installation to ensure that the pump is securely mounted horizontally on a flat surface, and that no obvious damage to the pump has occurred.
- Verify that the prime mover is properly aligned.
- Check that the belts have the correct tension applied.
- Ensure that all guards and other safety devices are attached as required and functioning properly.
- Fill the liner wash system with coolant lubricant as per the situation and according to manufacturer guidelines.
- Check all valves in the suction and discharge lines to ensure they are functioning correctly.

#### **Fluid end Checklist**

- Remove any debris, and note any excessive rust on the system.
- Ensure liners are installed and torqued to the proper value.
- Ensure piping is attached and proper stud/bolt torque has been applied.
- Check that all valves have been installed and that the valve covers are tight.

#### **Power End Checklist**

- Check that the rods and pistons have been installed.
- Check that the crosshead extensions, connecting rods and liner clamps are tight and properly torqued.
- Check for any debris or signs of rust, remove if possible.
- Ensure the crankcase is filled with the recommended volume and type of oil based on the ambient temperature and environmental conditions.
- Check the rotation to ensure the prime mover has been connected properly. The correct rotation is when the connecting rods come over the top of the crankshaft and are driving towards the fluid end.
- Ensure the breather cap and covers are in place prior to starting the pump.



### **3.1.3 Start Up Procedure**

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The following is the recommended start up procedure for the MP-16 triplex pump.

- 1) Ensure that all guards and safety devices are in place.
- 2) If an external lubricating pump is used, engage it for 5 minutes prior to starting the prime mover.
- 3) Remove the access covers on the power end and fill reservoirs with oil to ensure lubrication will be in place when the pump starts. If starting a new pump or if the pump has recently been in storage, pour oil into the pinion bearing oil trough and crosshead oil reservoir as well to ensure immediate lubrication. Then replace the access covers.
- 4) Check the temperature of the lubricant in the crankcase and verify that the viscosity meets the minimum listed in the tables below.
  - If oil temperature is too low, use an external heat source to reduce viscosity.
  - If oil temperature is too high, provide a cooling loop to lower temperature.

**CAUTION** Do not operate the pump if the oil temperature is out of range.

- 5) Rotate the pump by hand to verify that there are no restrictions on its movement.
- 6) Open the bypass valve.
- 7) Open the valve at the suction tank
- 8) Start the charging pump. Ensure it is working properly before starting the MP-16.
- 9) Apply power slowly (jog), verifying that proper rotation is established.
- 10) Open the discharge line fully, increasing the power and closing the bypass line. Then allow to run for 15 minutes, and checking the following.
  - For external lubrication, ensure a constant supply of oil.
  - Check that the lubrication in the power end and stuffing boxes is adequate.
  - Check the suction pressure and temperature.
  - Check the discharge pressure and temperature.
  - Check that the charge pressure of the discharge dampener is stable.
  - Check for leaks of any kind and remediate.
- 11) If all observed levels are within range, then release for operation.



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## 3.2 General Operations

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The following are some general guidelines for operating the MP-16 triplex mud pump.

### Pump Speed

The pump should be brought up to full operational speed gradually. This allows the flow velocity of the fluid in the suction line to match the requirements of the triplex pump without causing cavitations in the line.

### Natural Suction Operation

The maximum pump speed when operating with a “natural suction” (suction unassisted by systems such as a charging pump) is limited only by the pump’s ability to fill completely during the suction stroke. This limiting speed will be different for every installation, depending on suction piping, the available head, and the weight, pressure, viscosity and aeration of the fluid being pumped.

Experienced operators should be able to determine the limiting speed by slowly bringing the pump up to speed and listening closely to its operation. As the limiting speed is approached, the pump will begin to knock and pound, indicating cavitations in the line and incomplete filling of the chamber. This is the point at which a charging pump should be utilized, and should remain in use until operating conditions change and a natural suction can again be used.

### Suction Stabilizer Charge & Adjustment

The suction line pulsation dampener should only be charged with a hand operated air pump. For full instructions in the safe operation of the low pressure suction line pulsation dampener, see the documentation provided by the manufacturer of that equipment.

**WARNING**

The use of a high pressure source or nitrogen bottle to charge the suction line pulsation dampener can result in catastrophic equipment failure and serious injury to personnel.

**WARNING**

Always use a regulator in the line when charging the discharge pulsation dampener. An uncontrolled increase of pressure can result in catastrophic equipment failure and serious injury to personnel.

**WARNING**

Do not use oxygen to fill the bladder in either the suction stabilizer or the discharge pulsation dampener, especially when pumping flammable fluids, as it may combust and cause catastrophic equipment failure and serious injury to personnel.

### Low Speed Operation

The MP-16 pump can be operated as slow as 5 strokes per minute and still achieve proper lubrication. However, it is recommended that any time the pump is operated at 30 strokes per minute or less, that the crosshead access covers be removed to check that the crossheads are being sufficiently supplied with oil.

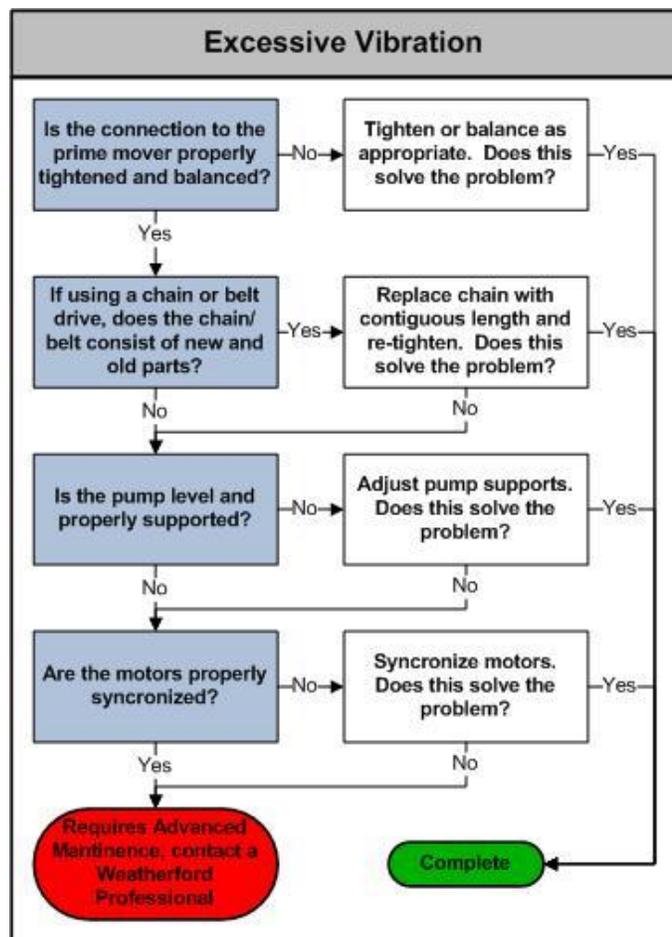
### 3.3 Basic Troubleshooting

The following section provides a basic guide to dealing with potential problems which may occur while using the MP-16 pump. This section is intended only as a basic problem solving tool, to help users ascertain the nature of the problem and allow for basic repairs should something go wrong. If problems do not match those outlined, or persist after all recommended solution options have been exhausted, do not attempt further work, but contact a Weatherford professional to examine the system and make a recommendation.

#### 3.3.1 Excessive Vibration

If there is excessive vibration coming from the pump, the most common cause is an unbalanced or loose connection between the prime mover and the pump itself. If using a direct connection, check that the sprockets and sheaves are properly balanced and aligned. If using a chain or belt drive, check that the chains/belts are not a mixture of new and old sections, and that they are taut on the sheaves and spacers.

If the drive connection seems normal, check that the pump is level and properly supported. Then check that the motors are properly synchronized on a dual shunt wound D.C. Motor Drive. To do so, isolate one motor by disconnecting one drive chain or belt and operating the pump with one motor. If the vibration ceases, then the motors will need to be properly synchronized before proceeding.



### 3.3.2 Knocking in the Fluid end

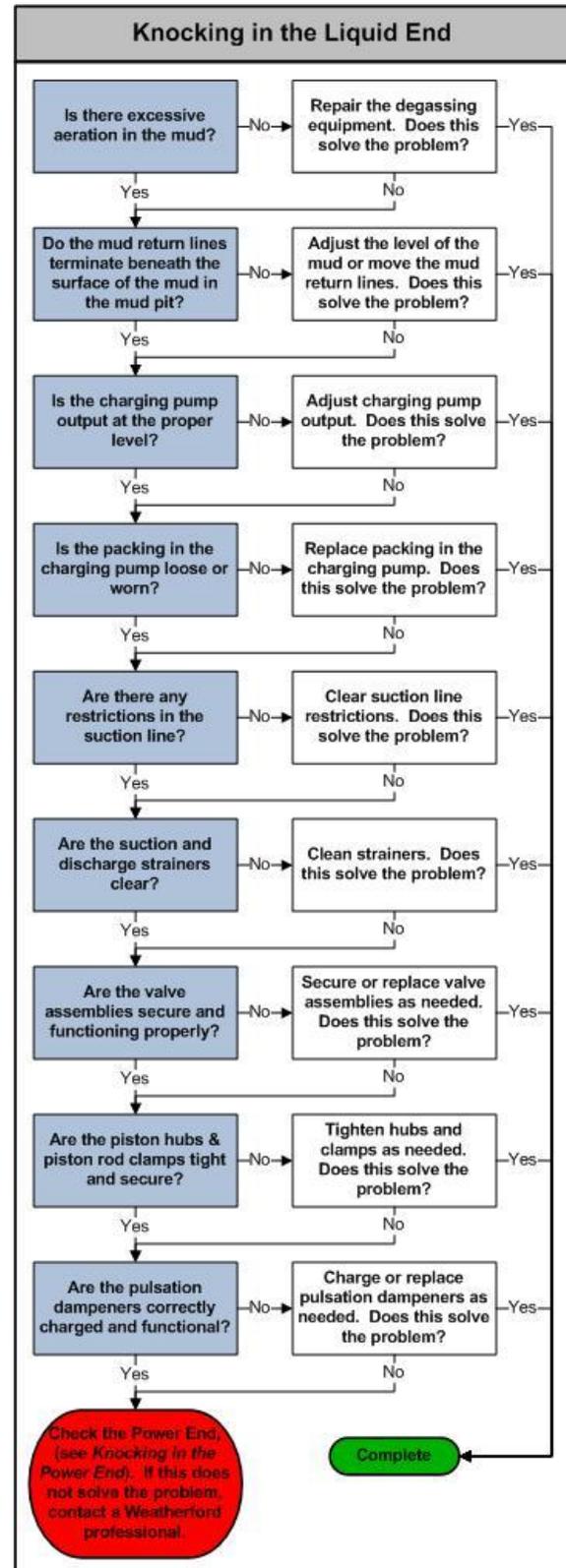
Most often, knocking is caused by aeration of the mud. Examine the mud pits for excessive bubbles, and check any degassing equipment used. Also check that the mud return lines terminate beneath the surface of the mud level in the pit.

Next, check that the charging pump output is at the proper levels (between 25 and 50 psi during operations). Run water over the packing. If this causes the knocking to stop, then the packing is loose or worn, and should be replaced. Also check that there are no restrictions in the suction line, and that both the suction and discharge strainers are sufficiently clear to allow fluid to pass through. If plugged, clean and reinstall.

If this does not solve the problem, then shut down the pump and check the valves. Ensure the valve seats are secured in the bore, and that neither they nor the valves are misaligned, washed out or damaged. Also check that the valve stem guide inserts have not swollen, as this will cause the valves to stick.

Finally, check the pistons for potential problems. The piston hubs and piston rod clamps should be tight and secure, and if not, adjust as appropriate. Also check that both the suction and discharge pulsation dampeners are properly charged and functional.

If none of these solutions help, contact a Weatherford professional.



### 3.3.3 Knocking in the Power End

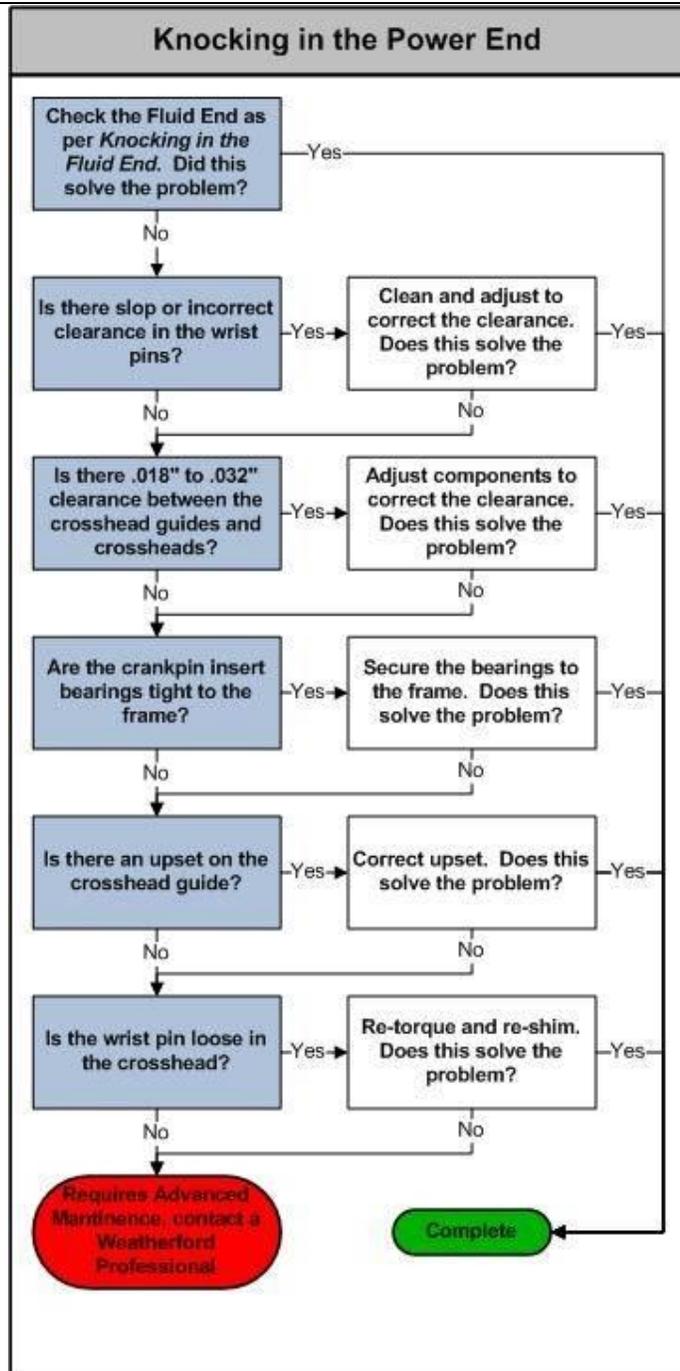
Even in cases where the knocking appears to be coming from the power end of the pump, it is much more likely that they are caused by conditions in the drilling fluid than by the actions of the power end equipment. Therefore, before checking the power end for potential causes, you should consult 3.3.2: Knocking in the Fluid end (page 25) and follow the procedure outlined there.

If the problem is not in the fluid end, then check for slop in the wrist pins. The wrist pins should have a clearance of no more than 0.002" between the wrist pin and the crosshead. Insert a 0.002" feeler gauge and see if it will fit through all 360.

Next, check the clearance of the crossheads, which should have between 0.014" and 0.030" between them and the guides. Also check the crankpin insert bearings, which should be tight in the frame, and can cause knocking when loose. Finally, check the crosshead guides for upsets, as these can also cause knocking.

If none of the above is the case, you will need to disassemble the power end so you can access the wrist pin (see 5.2: Power End Maintenance Procedures, page 67). Remove the outer screws in the retaining plate and bump the pin lightly. If it moves easily in the crosshead, then the pin and bearing should be removed and reinstalled or replaced if damaged (as per 5.3.5: Installing the Wrist Pin Bearing, page 95).

If none of these solutions help, contact a Weatherford professional.



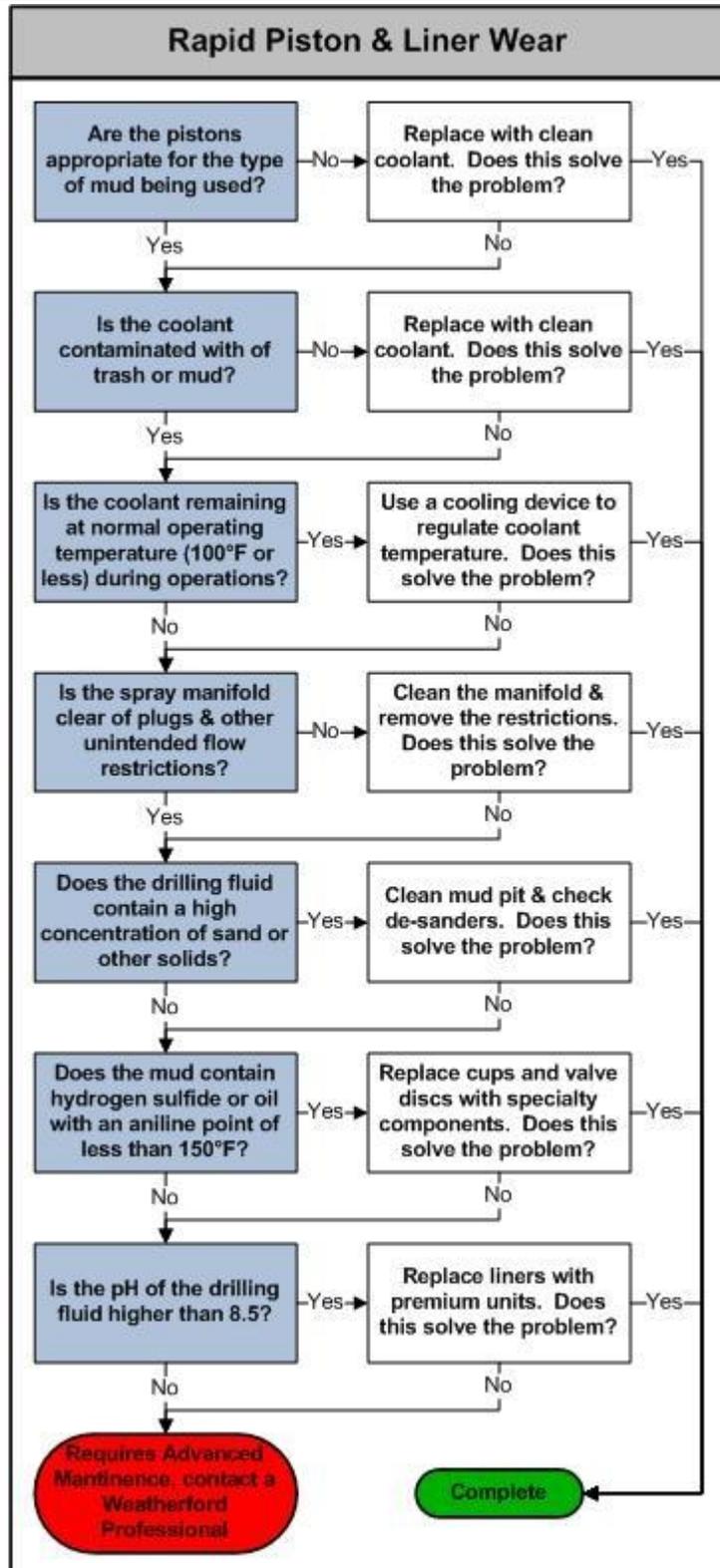
### 3.3.4 Rapid Piston & Liner Wear

In most cases, faster than normal wear of the pistons and/or liners is the result of either problems with the coolant or the mud. First, make sure the pistons being used are appropriate for the type of mud being run. Then check that the coolant is at a normal operating temperature (100°F or less), and is not contaminated with trash or mud. Then double check the spray manifold nozzles and holes drilled in the coolant rods to ensure that they are spraying sufficient coolant into the liner. Remove any plugs or restrictions on the coolant flow.

Drilling fluid that contains a high concentration of sand or other solids will rapidly degrade pump components, usually evidenced by streaks in the liner bores. In such cases, the mud tanks should be cleaned, and the de-sanders should be checked and replaced as needed.

If the drilling fluid has a pH above 8.5, then it is considered corrosive, and will cause excessive damage to normal liners. If the mud contains hydrogen sulfide, or if oil-based and the aniline point of the oil is less than 150°F, then it will attack and rapidly deteriorate the piston cups and valve discs. In all such cases, premium or specialty components should be used to reduce deterioration.

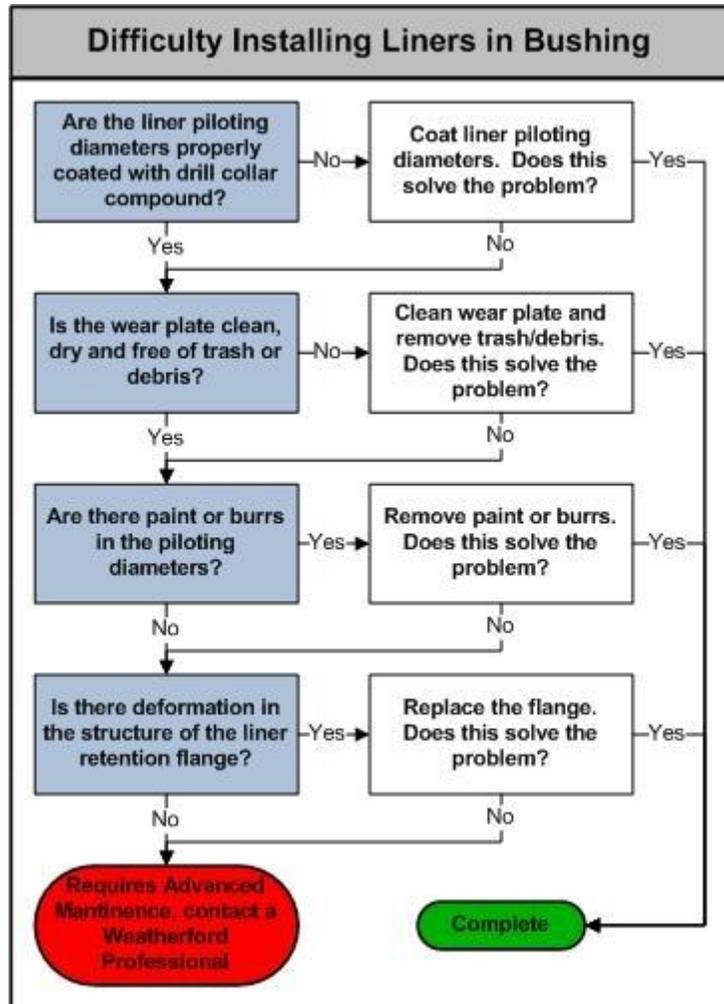
If none of these solutions help, contact a Weatherford professional.



### 3.3.5 Difficulty Installing Liners in Liner Retention Flanges

Be sure that the liner piloting diameters are lightly coated with drill collar compound before installation. Then check for trash on the wear plate, as it must be clean and dry for the liner to seal properly.

Check the piloting diameters for paint or burrs, and remove if discovered. Also check the liner retention flange, looking for an egg-shaped deformation in its structure. If found, remove and replace.



# Chapter 4: Maintenance

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## 4.1 Tools & Equipment

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### 4.1.1 Tools & Equipment Used

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The following list includes all of the standard tools and equipment used to perform basic maintenance on the MP-16 triplex pump. All are included in the basic maintenance kit, but the part numbers have been included here for easy replacement of lost or damaged items.

- One (1) pipe wrench
- One (1) torque wrench
- One (1) standard metric socket set
- One (1) liner puller
- One (1) hydraulic pump & four (4) hydraulic tools for valve housings
- One (1) valve cover puller assembly
- One (1) valve seat driver
- One (1) hook magnetic retriever tool
- One (1) dampener charging kit including three (3) charge hoses
- One (1) crankshaft / pinion rotating tool
- One (1) wear ring (plate) puller
- One (1) maintenance bar for valve closure
- One (1) standard set of push/pull adjustment tools

## 4.2 General Maintenance Guidelines

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Regular maintenance of the MP-16 triplex pump will help to ensure not only a long operational life, but will also enhance the efficiency and operational stability of the pump. The guidelines provided below offer general instructions for maintaining the systems and equipment, as well as standard maintenance schedules that will help to ensure optimal performance and lifespan.

All procedures outlined for the MP-16 triplex should be followed in accordance with their scheduled timelines. Any third-party equipment and systems should be maintained in accordance with the manufacturer's guidelines.



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### 4.2.1 Initial Operations Maintenance

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#### Magnets in the Lube Oil Strainer/Filter

During the first 500 hours or so of new pump operation, special attention should be given to the magnets in strainer cage. After every 50 hours of operation, the strainer should be removed and the lubrication oil magnets inspected. Look for any particulate matter on the magnets, and clean them each time in accordance with standard procedures.

Repeat this process until such a time as the magnets cease accumulating particulate matter. At that point, simply apply normal regular maintenance procedures.

#### Pinion and Main Gear

Some corrective pitting of the main gear is expected during the initial operation period. These pits should be small, round or oval in shape and dispersed along the pitch line of the gear teeth. If they expand significantly, form single larger pits or do not slow down and halt during or after the initial operations period, the entire gear train should be thoroughly inspected and the cause of the problem rectified. Replace any components that are worn beyond the recommended clearance.

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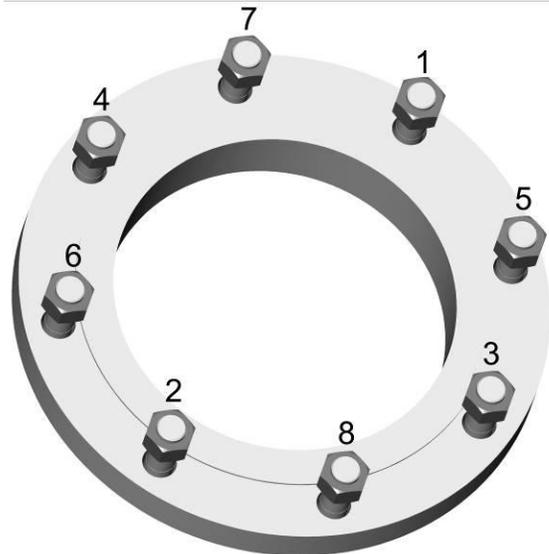
### 4.2.2 Fastener Torque Specifications

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When tightening multiple bolts on flanges, it is considered the best practice to tighten opposite bolts first, to ensure a tight flat seal. The diagram below provides a recommended order in which to tighten the bolts to best ensure a tight seal.

In addition, it is generally best to first tighten each bolt as far as possible by hand without inflicting pain or injury. Once all bolts are so tightened, tighten each bolt to one-half torque tightness, and then finish by tightening each to full torque tightness once all bolts are at the half-torque level of tightness.

For exact torque values for specific bolts, consult the Torque Chart on page 53.



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### 4.2.3 Biannual Inspection

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It is recommended that, in addition to the procedures and processes outlined below, the MP-16 triplex pump should receive a complete inspection about once every two years. This inspection should cover all components and systems, checking for wear and tear and ensuring that the pump is still in good operating condition. All damaged, defective or otherwise nonfunctional components should be repaired if possible or replaced.

## **4.3 Lubrication**

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Regular lubrication of the components is essential for pump longevity. By maintaining a regular lubrication schedule and using the correct lubricant for the type of service, the life of a pump can be extended markedly.

### **4.3.1 Prestart Lubrication**

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If the pump is idle for an extended period of time, rotate occasionally to avoid corrosion and prevent flat spots from forming on the rollers and races. Before restarting, the inspection covers should be removed and oil should be applied directly into the crosshead reservoirs to ensure immediate lubrication upon startup.

Regardless of the duration of inactivity, all drain plugs should be removed from the crankcase to allow any moisture or contaminants that have accumulated to be removed prior to startup. Likewise, any external lubrication pumps should be checked to ensure that it is operational and that oil is moving through all internal lube lines, and that the spray nozzles are properly positioned to fill the wrist pin bearing fill cups.

Any liner wash system used should be started before the mud pump to ensure that the liners are properly sprayed and lubricated in order to prevent damage to the pistons and liners.

### **4.3.2 Minimum Operating Speed**

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For most pumps, a speed of 40 RPM must be maintained in order to ensure proper lubrication of all components. However, pumps may be operated below this speed if an auxiliary power end lubrication system is used. Under no circumstances should the pump be run at speeds below 40 RPM without the use of auxiliary power end lubrication system.

### **4.3.3 Power End Lubrication Guidelines**

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During operation, significant loads will be placed on the crankshaft, connecting rods and crossheads, and so a heavy duty industrial gear lubricant rated for extreme pressure should be used. Consult the



Lubrication Chart on page 54 for recommended lubrication based on ambient temperature. At a minimum, AGMA specification 250.04 oil (that has passed a 60 lb load arm test) should be used.

Check oil level periodically (see 4.4: Maintenance Schedules on page 33). The oil level should be equal to the centerline of the lowest eccentric bearing roller, set so the connecting rod is at its lowest point during rotation. Oil should always pour freely at the operating temperature, and should be free of contaminants. The oil in the power end must be changed at minimum once every six months (2,000 hours of operation), and should be changed as often as necessary to maintain proper viscosity and keep the oil free of sludge.

Always replace the oil with an approved lubricant. When changing the oil, remove and clean the breather caps to help ensure pump longevity. When checking the oil level during operations, always allow the pump to remain idle for five minutes in order to ensure that the oil level stabilizes.

#### **4.3.4 Pistons & Crosshead Extension Lubrication**

The lubrication of the pistons and crosshead extensions is accomplished using an electric pump which directs a stream of lubricating fluid onto the pistons and liners in a regulated flow. Normally, this fluid is simply clean water, but it is recommended that a synthetic fluid (Castrol Syntilo 9954 or equivalent is recommended) or water-soluble oil be added, depending on the corrosiveness of the water and the drilling fluid. A mixture consisting primarily of clean water with 10-20% synthetic fluid or water-soluble oil is recommended, with precise values to depend on drilling conditions, size of the liner spray wash volume tank and the liner spray pump manufacturer's guidelines.

If only clean water is used, the operator must exercise greater than normal care and maintenance in order to prevent heat and corrosion damage in those parts in or adjacent to the liner piston chambers. Coating clamps and all exposed surfaces with a thread compound will minimize the effects of corrosion.

Used lubricant accumulates in compartmentalized sumps beneath the connecting rods, where it is re-circulated by the lubrication system. These sumps should be cleaned any time the oil is changed.

#### **4.3.5 Temperature Maintenance**

The oil temperature should be continuously monitored during operations, and it is recommended that a low-level alarm system is employed to warn of extreme temperature fluctuations. In extreme conditions, a heat exchanger may be needed to keep the crankcase temperature below 180°F (82°C).

<b>NOTE</b>	Effective cooling of the pistons and liners can only be accomplished if the temperature of the coolant is below that of the drilling fluid. Under certain circumstances, an external cooling system may be required to remove heat from the coolant fluid.
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## 4.4 Maintenance Schedules

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### 4.4.1 Daily Maintenance Checklist

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- Inspect the pump to ensure that all the exposed threads are coated with rust inhibitor.
- Check the oil in the power end, lubricator and chain case. If the oil is contaminated, replace. If not, ensure that the oil temperature is within range and add oil as needed. Always allow the pump to stand idle for approximately five minutes before checking oil level.
- Check the extension rod packing for proper alignment and lubrication. Adjust as needed.
- Ensure that the liner wash and charging pumps are properly lubricated.
- Lubricate the shaft and packing of the liner wash pump as instructed by manufacturer.
- Check the pressure gauges on the external lube oil filter (if utilized). If the differential between the gauges is greater than 15 psi when the pump is at operating temperature, clean the strainer and strainer magnets.
- During operation, examine the belt drive (if utilized). If slipping or squealing is noticed, disengage and turn off belt drive and adjust tension as necessary. Be sure to check the sheave alignment before returning to service.
- Observe the condition of the pistons and liners, and look for uneven wear or corrosion, or excessive bypass on each stroke (smooth wear and minor leakage is to be expected). If this occurs, replace pistons and/or liners as necessary.
- Check the pressure in the suction system, ensuring it is within range.
- Check the pressure in the discharge system, ensuring it is within range.
- Check that the pulsation dampener & suction stabilizer are set to the correct pressure.
- Check the entire pump for oil or fluid leaks, including the diaphragm and the oil seals in the power end.
- Check to ensure the pump is clean and ready for work.
- Check to ensure the work area around the pump is clean and free from hazards.
- Drain any piston leakage from the pump.



### **4.4.2 Biweekly Maintenance Checklist**

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- Flush the fluid in the cradle drain lines.
- Drain the water condensate from the frame by removing one of the lower ½” cap screws on the clean out cover.
- Check the valves and seats for wear, and replace any cut or worn inserts.
- Check the bushing in the valve stem guide and replace if visibly worn.
- Check over the piston/crosshead coupling for loose or damaged components, and correct the torque values as necessary.
- Ensure that the piston hub seal is properly mounted on the piston rod, correctly placed in the piston hub groove and has not been altered or damaged.
- Check the piston rod lock nut, and replace if it has been damaged or corroded, or if the locking nylon has lost its ability to effectively grip the threads. Any nut which has been used three (3) times should be replaced.
- Check over all guards, shields and other safety systems, ensuring that they are properly locked into position and in working order.

### **4.4.3 Monthly Maintenance Checklist**

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- Check over all tools used to work on the pump, ensuring that they are in good working order and readily available.
- If a strainer cross is used, ensure it contains a strainer sleeve. Clean the sleeve and check for damage or corrosion.
- Check all of the studs and nuts on the fluid cylinder for tightness, including the valve cover bolt on the rings, those affixing the fluid end blocks to the frame studs, those affixing the discharge to the suction studs and the liner retention flange.
- Inspect the power end for gaskets which leak excessively or loose cap screws, and replace as required.
- Check all of the bolting on the fluid and power ends of the pump, and make sure all are tight and secure.
- Remove both clean out covers and drain contaminated oil from settling chamber. Then replace covers and add oil to compensate for the amount drained out.
- Check the crosshead extension rods for wear and tear, and repair or replace as needed.
- Clean the liner wash pump strainer and the strainer in the strainer cross.
- Clean out the crankcase breather, replace as needed.
- Check all valves, seats and springs for wear and tear to ensure they are in good working order. Replace as needed.

#### **4.4.4 Semiannual Maintenance Checklist**

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- Drain and flush the oil reservoir and clean power end oil sump and the settling area under the crossheads. Then refill with fresh EP gear oil of the proper grade for the operation.
- Clean or replace filter element in breather cap and suction screen.
- Clean the magnet on the oil pump strainer area.
- Ensure that all lubrication lines are in position, continuous and free of obstructions.
- Clean the foundation and/or the hold down bolts, and ensure the pump is properly oriented and secure to the skid.
- Ensure that the bolting on suction and discharge flanges is secure.
- Check the pinion sheave and bushing for wear and tear. Replace as needed.
- Change the liner wash fluid. The fluid should also be flushed every time the pump is moved and refilled before the drilling resumes.

#### **4.4.5 Annual Maintenance Checklist**

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- Check the crosshead guides for grooves, which indicate improper lubrication or foreign matter in the lube oil. If found, check the lubrication system and the condition of the crosshead extension rod seals, and replace if severely worn or scarred.
- Check the clearance of the crossheads and the main gears, and record the data for future reference.
- Inspect the condition of the main gear and pinion gear teeth, as per the Pinion and Main Gear section under 4.2.1: Initial Operations Maintenance on page 30.
- Check the clearance of the bearings, and record the data for future reference. If bearing clearance exceeds two times the installed clearance, repairs should be made. If clearance has increased abnormally, a more thorough inspection should be made to locate the source of the wear.
- Check the tightness of the main frame mounting bolts and wristpin retainer bolts.
- Check all bolting safety wires. If broken, identify cause and correct before replacing.
- Check the tightness of the main bearing cap bolts and tighten as necessary. Units with “super bolts” will have the required torque stamped on top of the nut.



## **4.5 Routine Maintenance Procedures**

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### **4.5.1 Venting Pressure in the Fluid End**

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Before any maintenance is performed on the fluid modules, liners, pistons or valves, all pressure should be vented from the system. To do so, close the shut-off valves in both the suction and discharge lines and then open the by-pass line to the mud tanks. Allow all pressure to vent before performing maintenance on fluid end components.

**CAUTION**

Even while at rest, the fluid end of the system is under significant pressure, which if accidentally or inappropriately released can cause significant equipment damage and injury to nearby personnel. All pressure must be vented from the system before any maintenance on the fluid end is performed (see 4.5.1: Venting Pressure in the Fluid End, above).

### **4.5.2 Pre-Installation Procedure**

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Before installing any parts or components into the system, all parts should be gathered and checked to ensure they are ready for use before installation begins. This includes checking that all mountings, sealing faces and bores are clean and free of burrs, nicks and debris.



## **4.6 Expendable Components Maintenance & Repair**

The following are the standard procedures for safely removing and replacing the expendable components of the MP-16 Pump. Remember to always vent the pump pressure as per 4.5.1 (page 36) before beginning any maintenance procedures.

### **4.6.1 Removing the Discharge Valves**

The discharge valves of the MP-16 pump should only be removed in order to be replaced or during maintenance. The following procedure provides guidelines for this process.

- 1** Unscrew the upper valve cover from the fluid end module. This should also remove the valve stem guide, which is affixed to the cover by means of a retaining plate.



- 2** Remove the upper valve cover seal from the fluid bore.





- 3** Lift the valve spring and discharge valve out of the bore. This may require the use of a hook magnetic retrieval tool.



- 4** The discharge valve seat should only be removed if the valve is to be replaced. To remove, insert a hydraulic seat puller into the bore and extract, exercising care not to strike the seat directly.





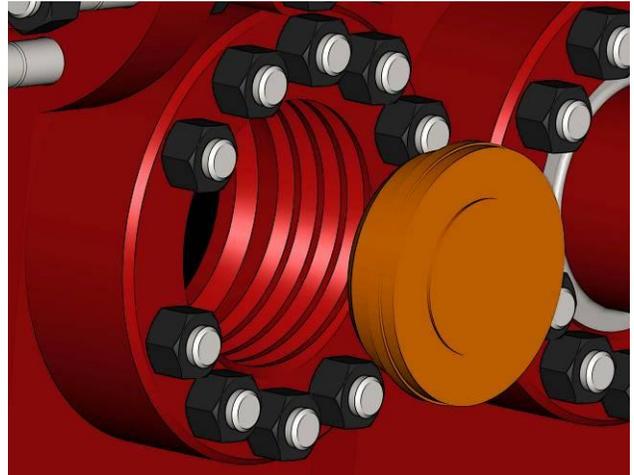
### 4.6.2 Removing the Suction Valves

The MP-16 suction may be removed for replacement or as part of a routine maintenance, but also will need to be removed in order to provide access to the liner and piston assemblies. Use the following procedure for each process, but if only seeking access to the pistons and liners, only Steps 1-6 below need be completed.

- 1** Unscrew the forward valve cover plugs from the fluid end module.

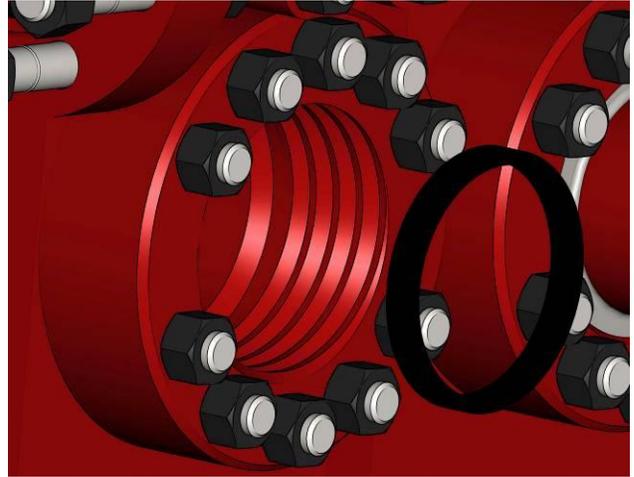


- 2** Remove the lower valve cover from the bore.





- 3** Remove the lower valve cover seal from the fluid bore.



- 4** Carefully remove the valve retainer from the valve bore.



- 5** Slide the valve cage out of the fluid bore, exercising care not to hit or damage the valves.

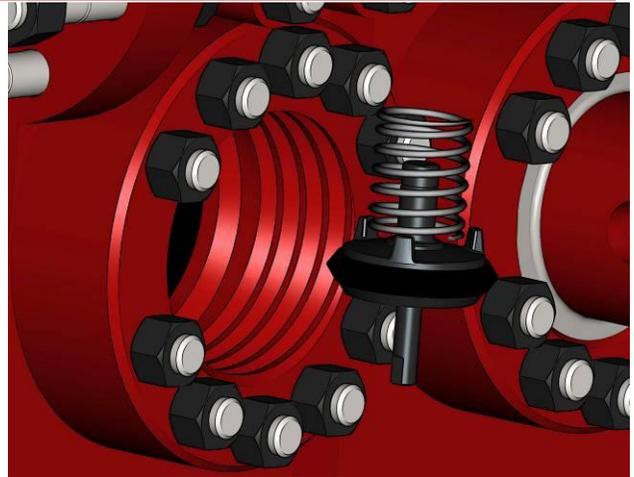
**NOTE**

While this is all that is required to gain access to the liner, it is recommended that Step 5-6 below be completed in order to avoid potential damage to the valve retainer or the valves themselves.

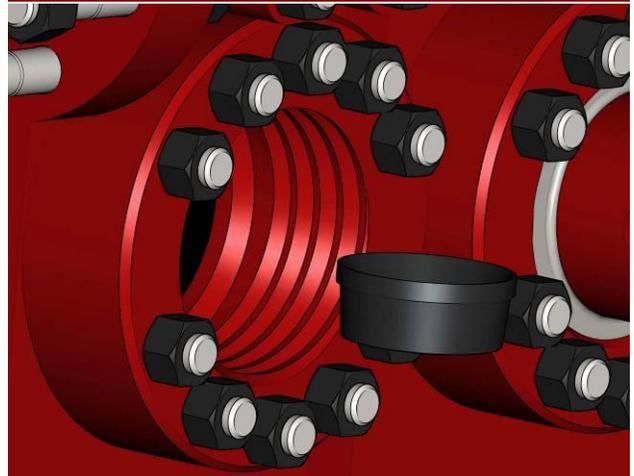




- 6** Carefully lift the valve spring and suction valve out of the bore. This will very likely require the use of the hook magnetic retrieval tool.



- 7** The valve seat should only be removed if the valve is to be replaced. To remove, first remove the discharge valve and then insert a hydraulic seat puller into the bore and extract, exercising care not to strike the seat directly.



**NOTE**

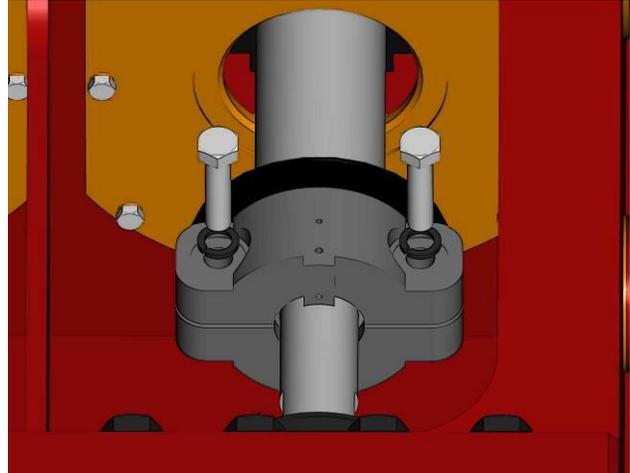
With center guided valves and seats it is mandatory to remove the discharge seat in order to be able to remove the suction seat.



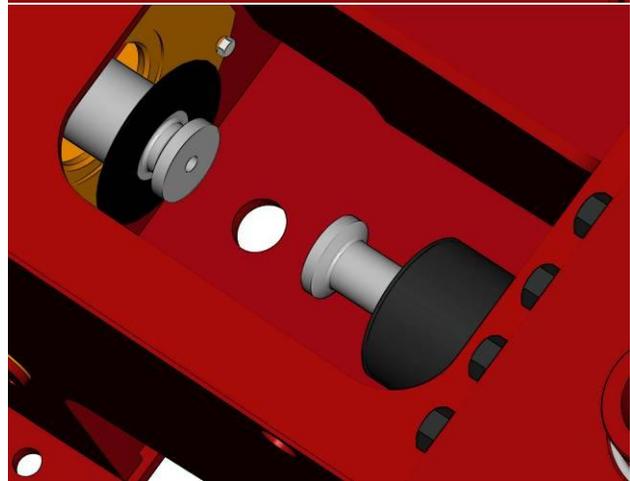
### 4.6.3 Removing the Pistons & Liners

The pistons and liners on the MP-16 should be removed from the pump frame at the same time using the following procedure.

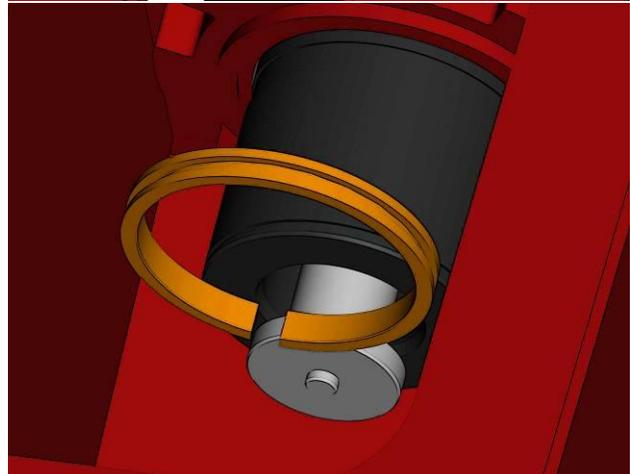
- 1** Unbolt and remove the clamps affixing the piston assemblies to the crosshead extension rods and remove the clamp, leaving the piston rod in the forward-most position.



- 2** Rotate the pump so the crosshead extension is at the end of its suction stroke (fully retracted towards the power end).



- 3** Remove the O-Ring from the split ring holding the liner lock in place, and slide the split ring free of the liner.





- 4 Unscrew the liner lock from the retainer flange and slide free of the liner, exercising care not to damage the liner or the liner lock threads.



- 5 Remove the liner and piston rod assembly from the power frame.



- 6 Remove the seal from the counter bore inside the liner retainer flange.



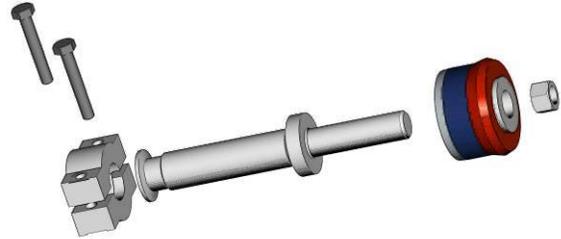


### 4.6.4 Piston Disassembly & Parts Replacement

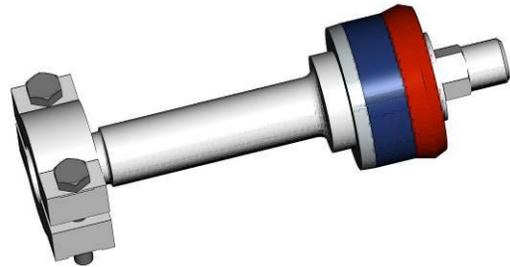
The following procedure is intended to be used to disassemble and replace the component parts for the pistons on the MP-16 pump.

- 1 Remove the piston rod nut and slide the piston hub off of the piston rod.

<b>NOTE</b>	Always replace seals which have been loosened or manipulated during maintenance procedures.
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- 2 Re-install the piston, ensuring that the seal remains properly aligned with the groove in the piston hub. Lock into position using the piston rod nut, and torque to 1,000 ft. lbs. torque (on a 1.5" piston rod nut).





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### 4.6.5 Piston Cup Replacement

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The standard pistons for the E-Series pumps come with a molded piston. Some operators choose to utilize older-style pistons which have replaceable cups or “rubbers.” Use the following procedure to replace the cups on this type of piston.

- 1** To remove, simply remove the snap ring from the front of the hub and slide the piston cup free.



- 2** To reinstall, simply slide the new cup onto the hub and secure in place with a snap ring.





### 4.6.6 Installing the Suction Valves

The MP-16 suction valves should be replaced using the following procedure.

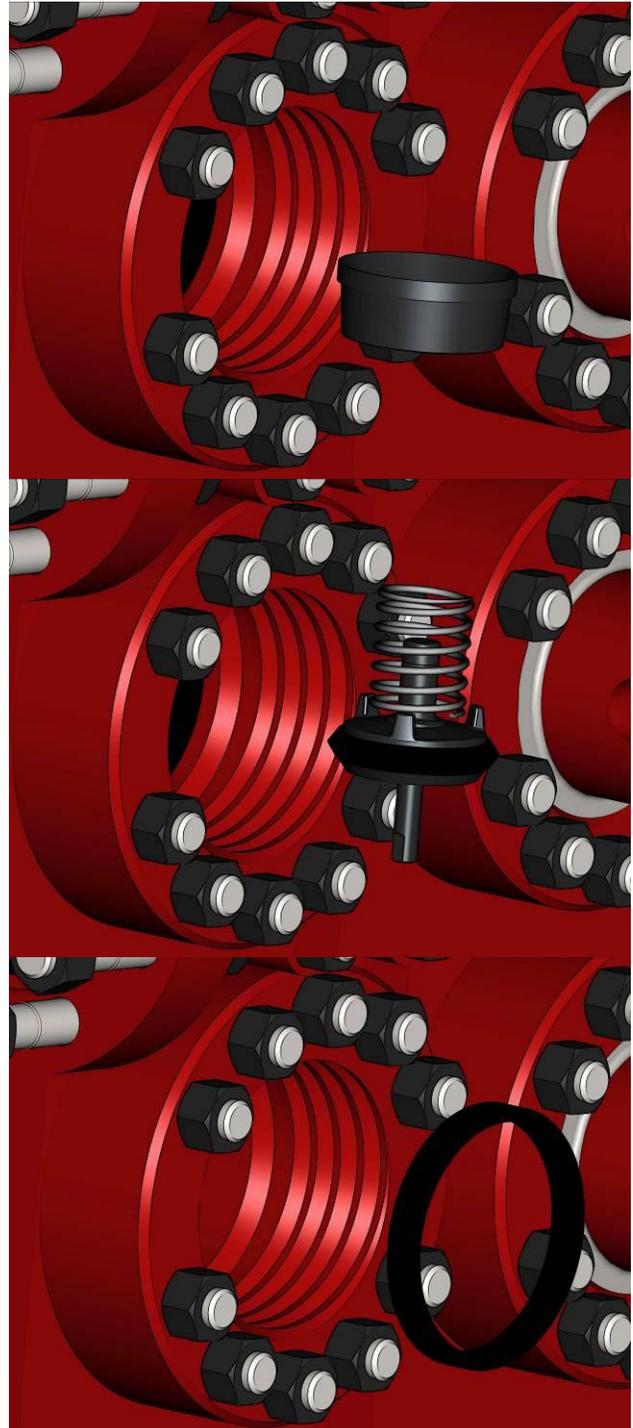
- 1 If it has been removed, slide the valve seat into the bore and press with a seat driver in order to obtain the initial seal. Exercise care not to strike the seat directly.

**NOTE**

Both valve seat and internal tapered seat deck bore should be clean, dry and free of all debris prior to installation of new valve seat

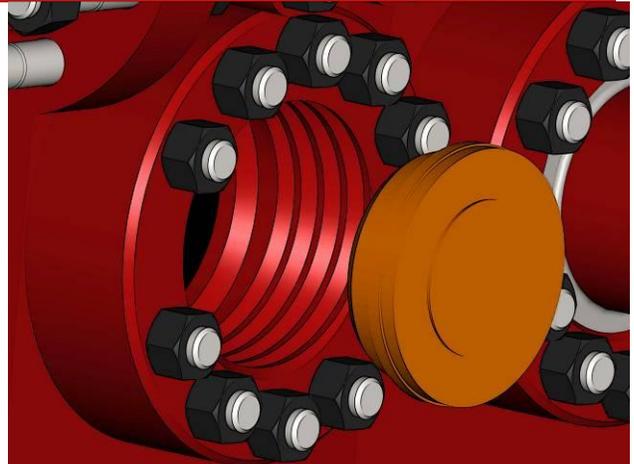
- 2 Slide the discharge valve into position atop the seat, then insert the spring atop the valve.

- 3 Lightly grease the new valve cover seals and insert into place in the counter bores.

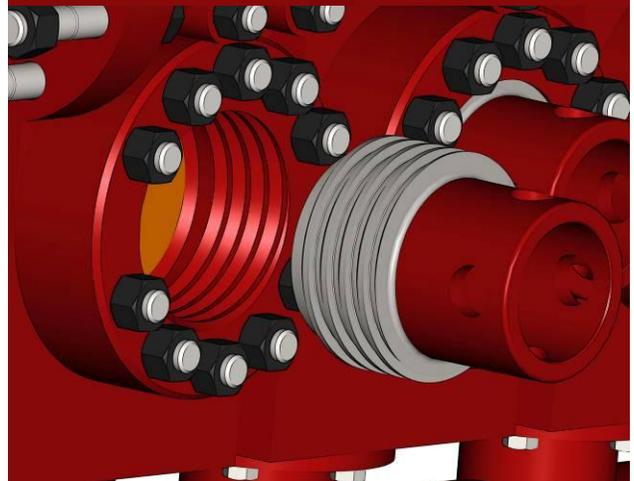




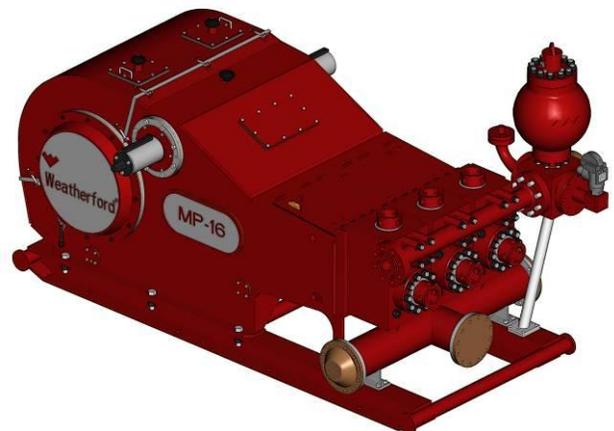
- 4** Coat the bottom seating surface and outside of the valve covers with grease and screw into place over the valve bores.



- 5** Coat the bottom seating surface and outside of the valve cover locks with grease and screw into place over the valve bores.



- 6** Once maintenance is complete and the pump is reassembled, run for approximately 15 minutes, then shut down the pump and release the pressure. Tighten the valve corner again with a sledgehammer and resume pumping.

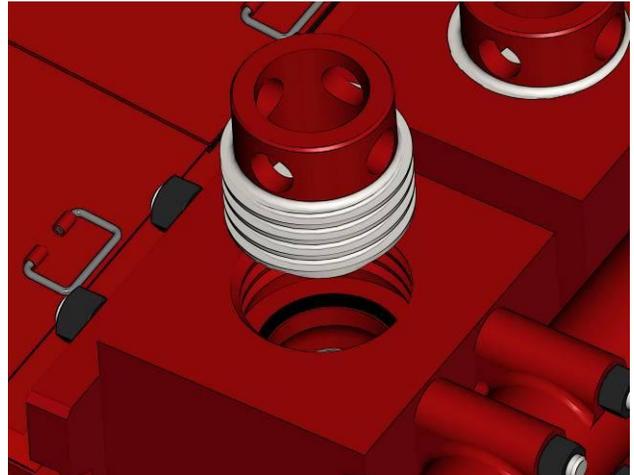




### 4.6.7 Installing the Discharge Valves

The following procedure provides guidelines for the installation of the MP-16 Discharge Valve.

- 1** If necessary, unscrew the upper valve cover from the fluid end module. This should also remove the valve stem guide, which is affixed to the cover by means of a retaining plate.



- 2** If replacing the valve stem guide, first unbolt and remove the retainer plate from the upper valve cover and remove.



- 3** Remove and replace the upper valve stem guide, then replace and bolt the retainer plate into position.





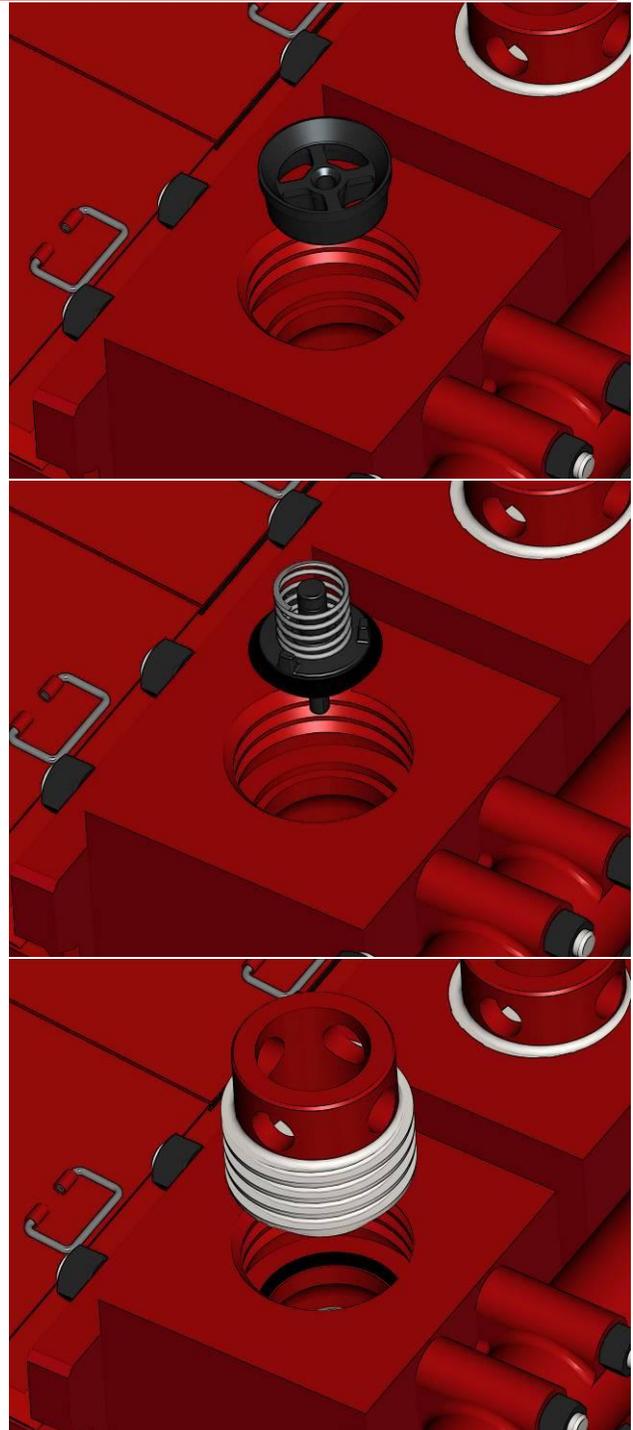
- 4 If it has been removed, slide the valve seat into the bore and press with a seat driver in order to obtain the initial seal. Exercise care not to strike the seat directly.

**NOTE**

Both valve seat and internal tapered seat deck bore should be clean, dry and free of all debris prior to installation of new valve seat

- 5 Slide the discharge valve into position atop the seat, then insert the spring atop the valve.

- 6 Set the covers atop the bore, ensuring that the valve stem guide lines up with the discharge valve.





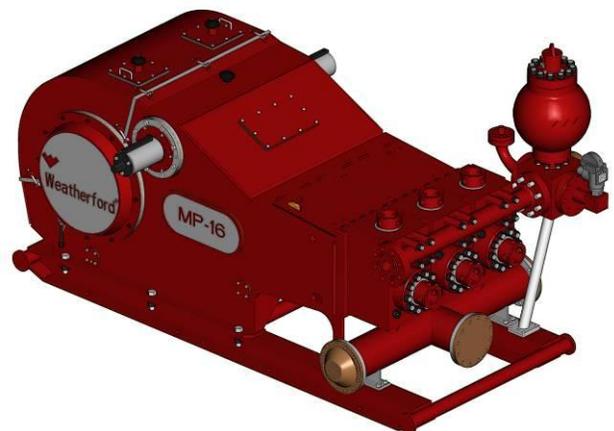
**7** Lightly grease the new valve cover seals and insert into place in the counter bores.



**8** Coat the bottom seating surface and outside of the valve covers with grease and screw into place over the valve bores.



**9** Once maintenance is complete and the pump is reassembled, run for approximately 15 minutes, then shut down the pump and release the pressure. Tighten the valve corner again with a sledgehammer and resume pumping.





### 4.6.8 Installing the Pistons & Liners

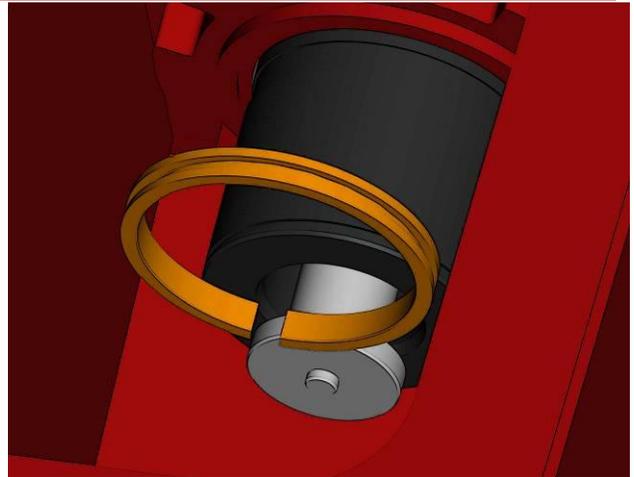
The pistons should be installed using the following procedure.

- 1** Install the O-Ring and wear plate into the counter bore of the fluid module inside the retainer flange.
  
- 2** Insert the piston rod assembly into the liner and attach both to the inside of the retainer flange.
  
- 3** Slide the liner lock into place around the liner, and screw into the retainer flange of the fluid module.

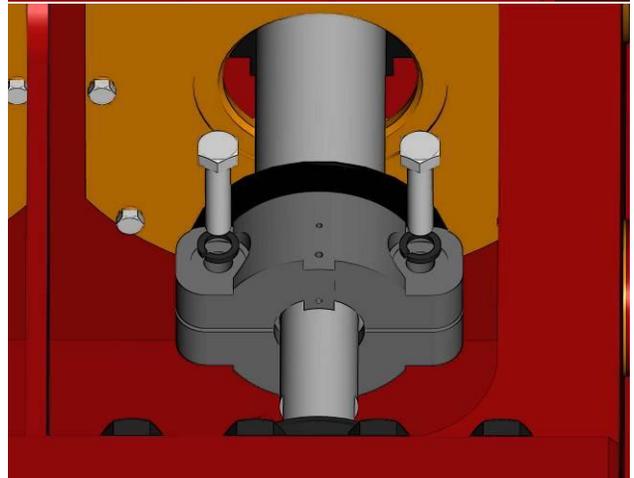




- 4** Slide on the split ring to hold the gland in place, and secure using a new O-Ring.



- 5** Rotate the pinion shaft bringing the extension rod and piston rod together and install the piston rod clamps.





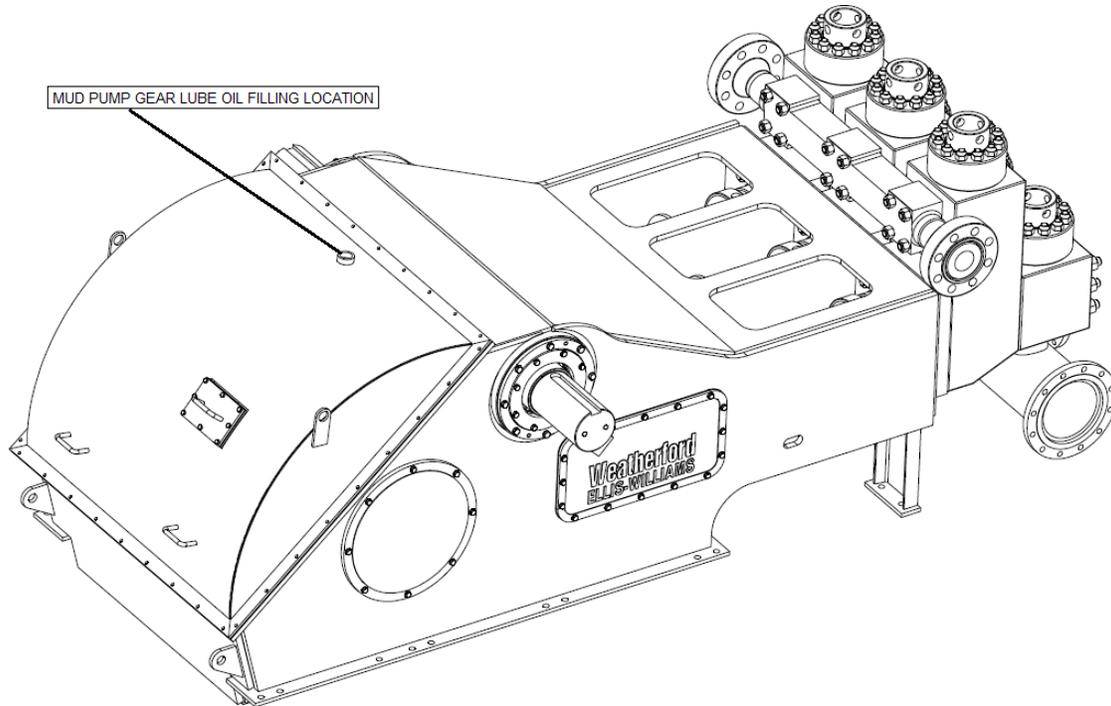
## 4.7 Charts & Diagrams

### 4.7.1 Torque Chart

Size	Tensile Stress Area AS Square Inch	SA193 and ASTM 193 B7 Studs with A194 2H Heavy Hex Nuts		
		Clamp Load Lbs.	Tightening Torque	
			Dry K=0.223	Lubed K=0.223
			Ft. Lbs.	Ft. Lbs.
1/2 - 13	0.138	10,350	96	72
9/16 - 12	0.177	13,275	139	104
5/8 - 11	0.22	16,500	192	143
3/4 - 10	0.327	24,525	342	256
7/8 - 9	0.452	33,900	551	413
1 - 8	0.594	44,550	828	620
1 1/8 - 8	0.776	58,200	1,217	911
1 1/4 - 8	0.984	73,800	1,714	1,284
1 3/8 - 8	1.215	91,125	2,328	1,744
1 1/2 - 8	1.471	110,325	3,076	2,303
1 5/8 - 8	1.769	132,675	4,006	3,000
1 3/4 - 8	2.06	154,500	5,024	3,763



**4.7.2 Lubrication Chart**



**Oil Quantity**

Approximately 75 U.S. Gallons (700L)

**Oil Cleanliness**

ISO 4406 Code 16/64 (NAS 1638 Class 8)

**Oil Change Period**

The pump should have its first oil change after 400 hours of operation.

Subsequent oil changes should occur every six months or 2,000 running hours, whichever comes first.

**Oil Change Procedure**

- 1 Shut down and lock out the pump as per standard procedure. The drain plug should be removed and the pump gear lube oil drained immediately after shutdown is complete.
- 2 Remove the pump gear inspection opening cover plate.
- 3 Visually inspect the gearing status, and report any damage, defects or other potential problems.
- 4 Reinstall drain plug and ensure it is secure.
- 5 Refill the crankcase with the correct oil type (see above) through the cover plate opening.

**NOTE** Oil may require pre-filtering to obtain an acceptable cleanliness level.

- 6 Replace the cover plate and gasket.

**Oil Type**

The recommended oils to be used in Weatherford mud pumps are directly related to the ambient operating temperature of the area in which the pump is to be operated. In order to extend the expected life of the gears within the mud pump, extreme pressure (EP) oils are to be used. These oils contain a sulfur compound which improves the lubrication value of the oil at high pressures and temperatures.

The following temperature ranges are used in determining which EP oil grade to use:

Air Temperature (°F)	Air Temperature (°C)	Industrial EP Gear Oil
0° to 50°	0° to 10°	AGMA EP5 / ISO 280 – EP220
50° to 80°	10° to 26°	AGMA EP6 / ISO 320 – EP320
80° to 110°	26° to 43°	AGMA EP7 / ISO 460 – EP460
110° to 135°	43° to 57°	SYNTHETIC BASED EP460

These oils should exhibit the following:

1. AGMA or ISO rated
2. Paraffin based mineral oils (except in the case of the synthetic extreme high ambient temperature requirements.
3. Rust and oxidation inhibited
4. Anti-foaming agents
5. Demulsifier agent for water separation
6. High viscosity index >90
7. Flash point in excess of 300° F
8. Pour point, 5° F (-15° C) or lower
9. Non-detergent, non-dispersant

Possible manufacturers without endorsement:

- Amoco AMOKON (syn.)
- Chevron Meropa / Delo
- CITGO CITGEAR Synthetic
- Conoco Hydroclear EP
- Exxon(Mobil) Spartan EP
- Gulf Gear EP
- Mobil Mobilgear SHC 364( syn.)
- Shell Omala / Omala S4 (syn.)
- BP/Castrol Castrol / Syntillo (syn.)
- Royal Purple(syn.) MAXGEAR / Synergy



# Chapter 5: Assembly/Disassembly

## 5.1 Fluid End Maintenance Procedures

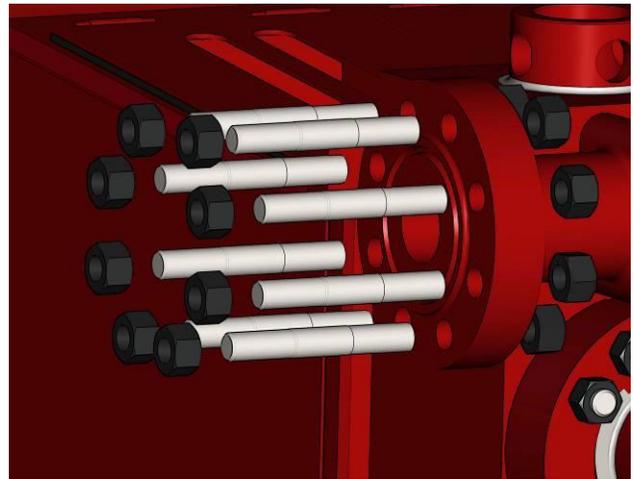
The following are the standard procedures for removing and replacing the components of the MP-16 pump fluid end. All personnel involved in these procedures should possess a thorough understanding of all steps in the process, especially any safety regulations involved.

**CAUTION** Even while at rest, the pump system is under significant pressure, which can cause significant equipment damage and injury to nearby personnel if vented inappropriately. All pressure must be properly vented from the system before any maintenance is performed (see 4.5.1: Venting Pressure in the Fluid End, page 36).

### 5.1.1 Discharge Cross Removal

The discharge cross must be removed before maintenance can be performed on the discharge manifold or the fluid modules. Use the following procedure.

- 1 Be sure to discharge all pressure from the system and then disconnect any piping connected to the discharge manifold.



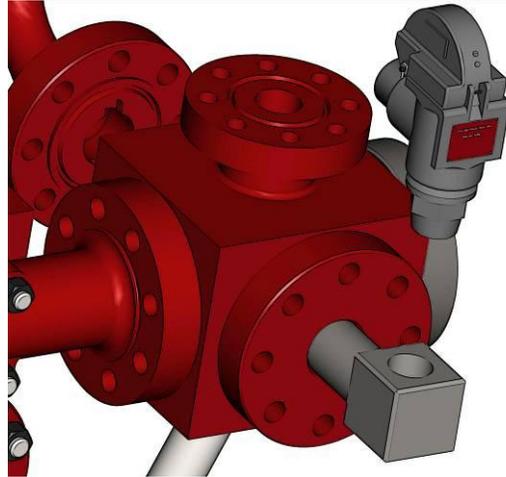
- 2 Unbolt the Discharge Pulsation dampener from the Discharge cross and carefully lift from the power frame.

**WARNING** The discharge pulsation dampener is a weighty piece of metal which can cause serious injury if dropped. Be sure it is sufficiently supported before unbolting.





- 3** Remove the pressure relief valve and any other components from the discharge cross in accordance with the manufacturer's instructions.



- 4** Unbolt the discharge cross from its support and the discharge manifold, and remove.

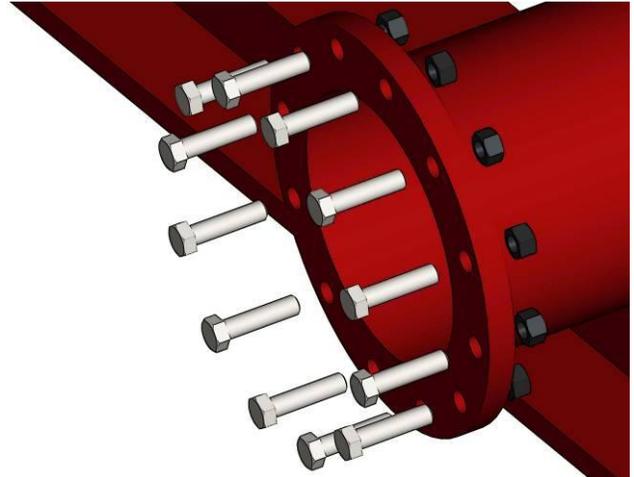




### 5.1.2 Suction Manifold Removal

The following outlines the proper procedure for removing the MP-16 suction manifold.

- 1 Be sure to discharge all pressure from the system, and then disconnect any piping connected to the suction manifold.



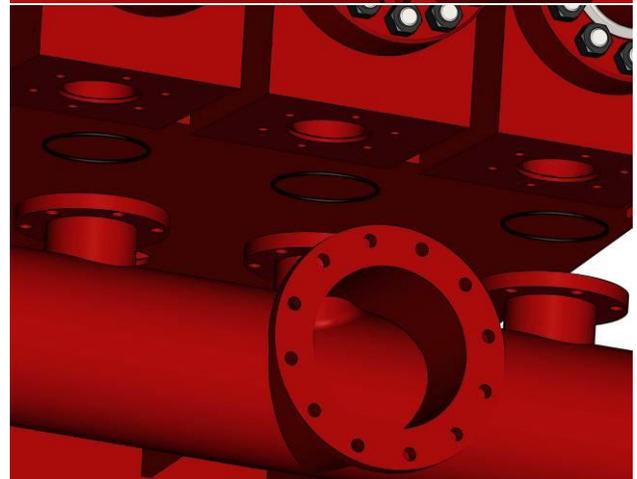
- 2 Remove the cap screws connecting the suction modules to the suction manifold.

**WARNING**

The suction manifold is a weighty piece of metal which can cause serious injury if dropped. Be sure the manifold is sufficiently supported before removing the cap screws.



- 3 Carefully remove the suction manifold and seals from the pump.

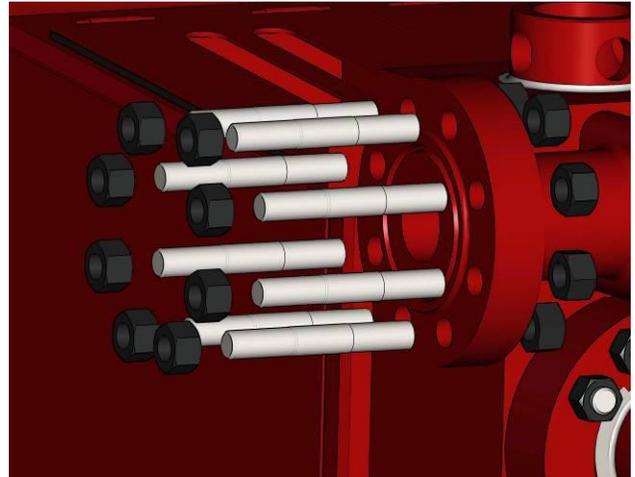




### 5.1.3 Discharge Manifold Removal

The following outlines the proper procedure for removing the MP-16 discharge manifold.

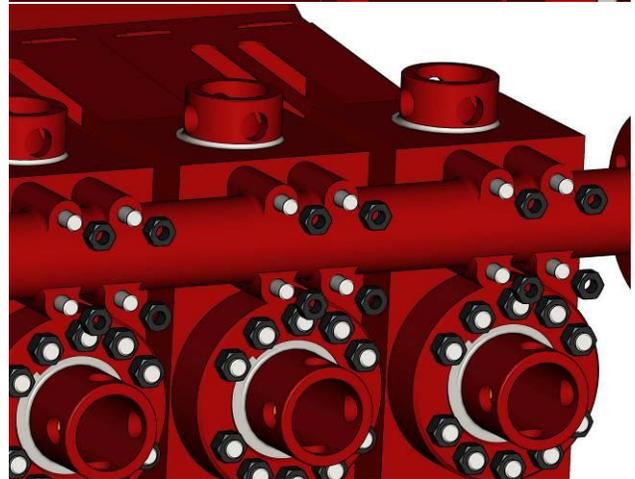
- 1 Remove the discharge cross page 56 and the section of the discharge piping connected to the discharge manifold.



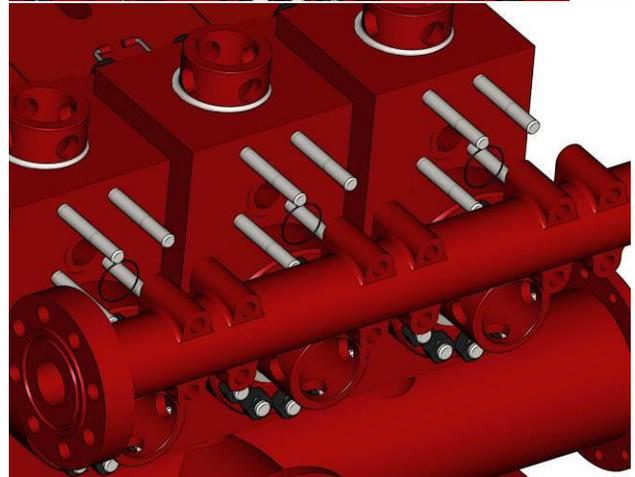
- 2 Remove the nuts connecting each of the discharge modules to the discharge manifold.

**WARNING**

The discharge manifold is a weighty piece of metal which can cause serious injury if dropped. Be sure the manifold is sufficiently supported before removing the fasteners.



- 3 Carefully remove the discharge manifold from the pump.

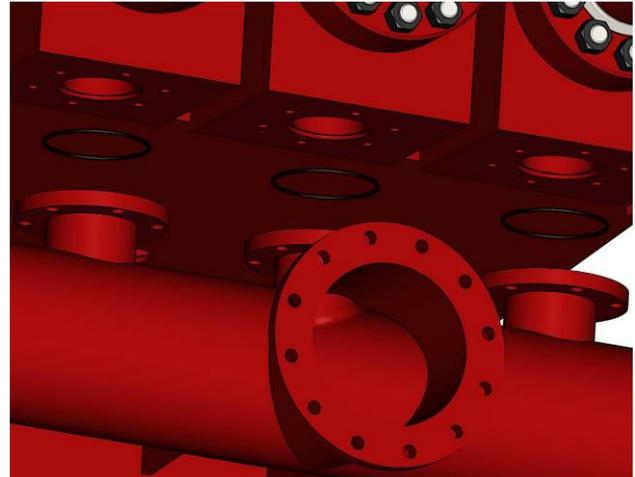




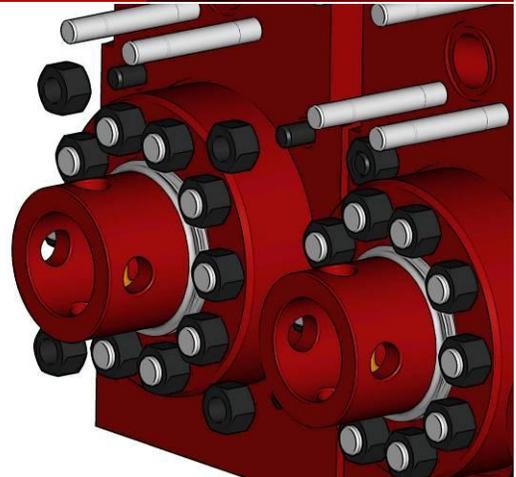
### 5.1.4 Fluid Module Removal

The fluid end consists of 3 modules; each may be maintained separately from the others.

- 1 Remove the Pistons and Liners as per 4.6.3, and then remove the suction and discharge manifolds as per 5.1.2 and 5.1.3.



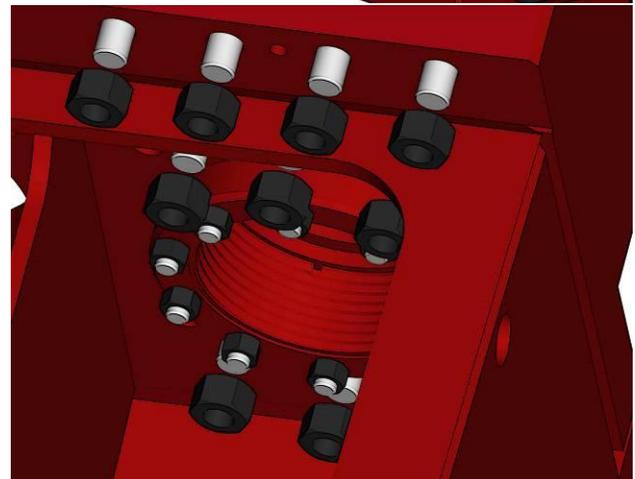
- 2 Remove the nuts from the retaining studs on the power frame.



- 3 Unbolt the inner retaining studs to free the fluid modules from the power frame.

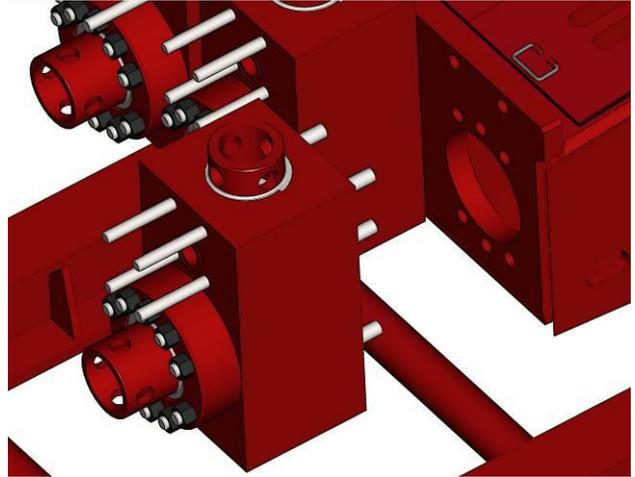
**WARNING**

The fluid modules are heavy pieces of equipment which can cause serious injury if handled improperly. Be sure the module is properly supported before unbolting.





- 4 Slide the fluid module off the power frame, taking care not to damage the mounting studs.





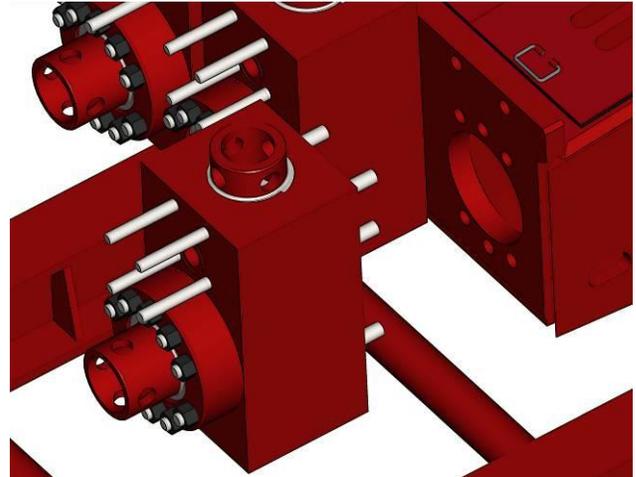
### 5.1.5 Fluid Module Installation

The following procedures should be used to install the fluid modules onto the pump.

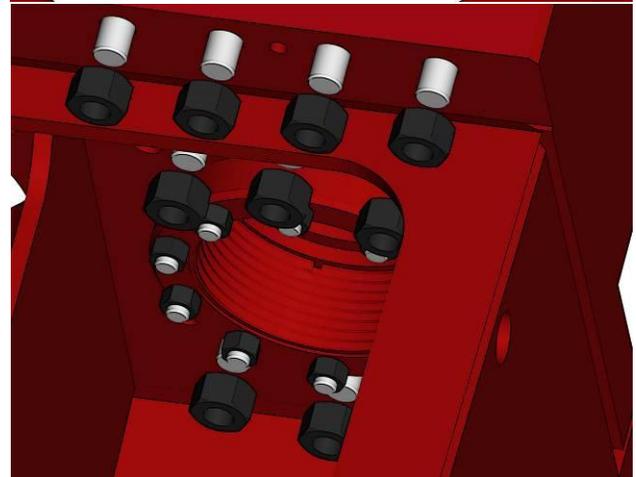
- 1 Slide the fluid module into position on the power frame.

**WARNING**

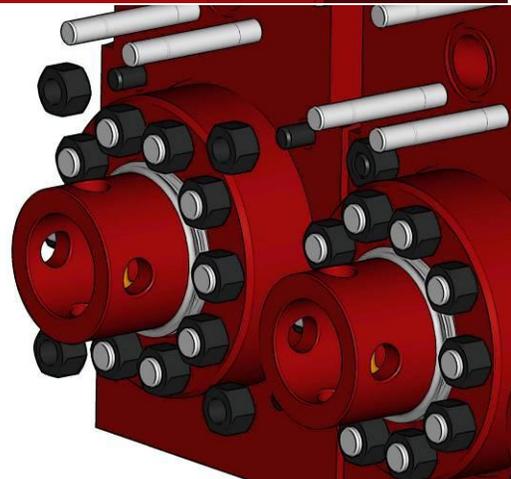
The fluid module is a heavy piece of equipment which can cause serious injury if dropped or mishandled. Be sure the module is properly supported and secure before continuing with this process.



- 2 Attach the nuts to the mounting studs to secure the fluid module on the power frame.



- 3 Reinstall and bolt the retaining studs to secure the pump into position on the power frame.





- 
- 4** Once the fluid modules are secure on the power frame, reinstall the Pistons and Liners as per 4.6.8 and the manifolds as per 5.1.2 and 5.1.3.





### 5.1.6 Suction Manifold Installation

The following procedures should be used to install the suction manifold onto the MP-16.

- 1 Install the suction manifold seals into the counter bores and slide the Suction Manifold into position.

**NOTE** Always replace seals which have been loosened or manipulated with new seals.

- 2 Secure the manifold with cap screws. Tighten cap screws to the appropriate torque (413 ft. lbs. for a  $\frac{7}{8}$  inch cap screw).

- 3 If maintenance is complete, reattach the piping to the suction manifold. Check that all components are properly installed and secure, then reengage pressure to the system.

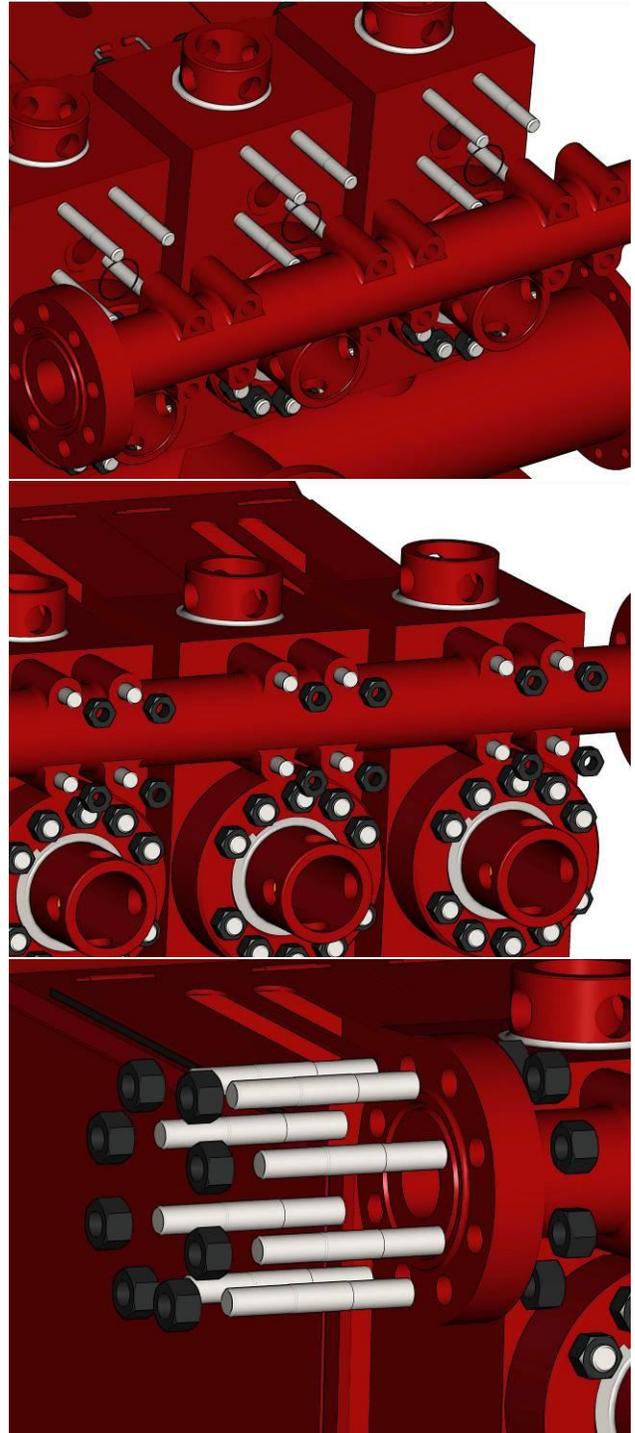




### 5.1.7 Discharge Manifold Installation

The following procedures should be used to install the discharge manifold onto the MP-16.

- 1** Replace all of the gaskets and seals connecting the discharge manifold to the discharge modules and slide the new manifold into position on the pump.
  
- 2** Reinstall the nuts and tighten to secure into place.
  
- 3** If maintenance is complete, reattach the piping to the suction manifold. Check that all components are properly installed and secure, then reengage pressure to the system.





### 5.1.8 Discharge Cross Installation

The following procedure is used to install the discharge cross on the MP-16.

- 1 Place the new discharge cross into position and bolt to secure to the discharge manifold and cross support.

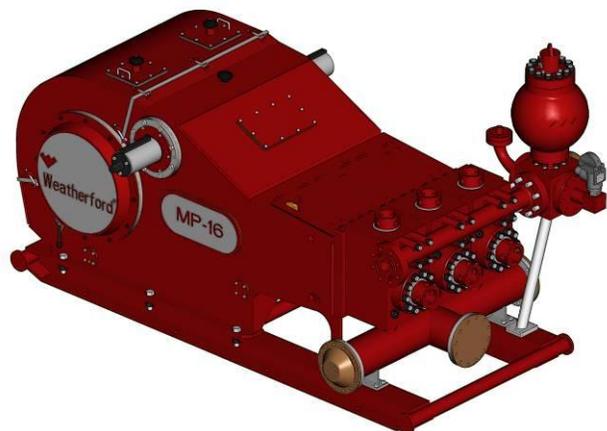


- 2 Reattach the Pressure Relief Valve, Pulsation Dampener and other components to the discharge cross.



### 5.1.9 Installing the Liner Wash System

Drop the liner spray manifold over the piston assemblies and slide at the bottom of the chamber. The hose may be connected at either side.





## 5.2 Power End Maintenance Procedures

The following are the standard procedures for disassembling the various components and systems of the power end of the MP-16 pump. All personnel involved in the disassembly of the power end must possess a thorough understanding of all of the following procedures, especially any and all safety regulations involved.

### 5.2.1 Removing the Wiper Box & Diaphragm Plate

The crosshead diaphragm plates are all line bored with the pump frame, and must not be interchanged. Take note of which cylinder and pump each plate was removed from so it can be reinstalled properly. Do not attempt to remove the diaphragm plate unless the outer diameter of the stub rod flange is greater than the inner diameter of the diaphragm plate itself.

- 1 Remove the Pistons as per 4.6.3: Removing the Pistons & Liners.

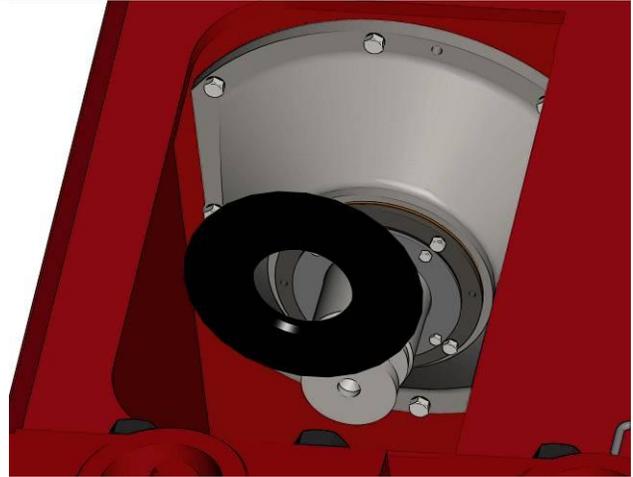


- 2 Mark the outer surfaces of the wiper box and diaphragm plates to indicate their orientation in the pump frame.

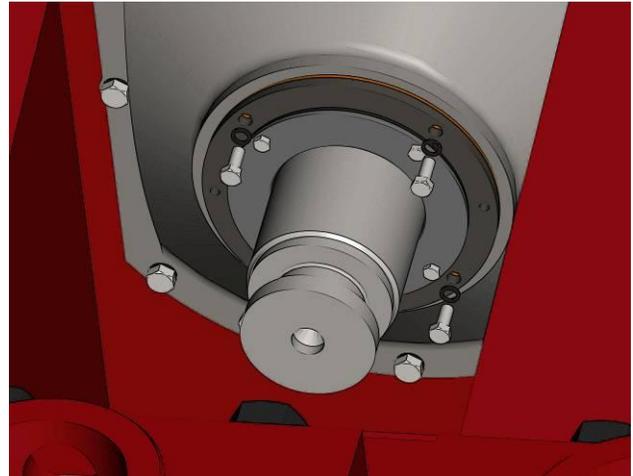




- 3** Rotate the pump so the crosshead extension rod is fully retracted towards the power end and remove the baffle.



- 4** Remove the bolts affixing the wiper box to the diaphragm plate.



- 5** Slide the wiper box off the crosshead extension and out of the pump frame.





- 6 Unbolt the diaphragm plate and gasket, and slide free of the frame. The resulting opening should be large enough to permit the removal of the crosshead.

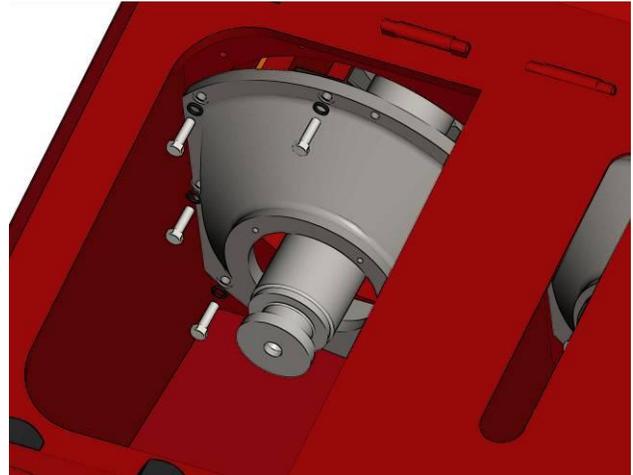




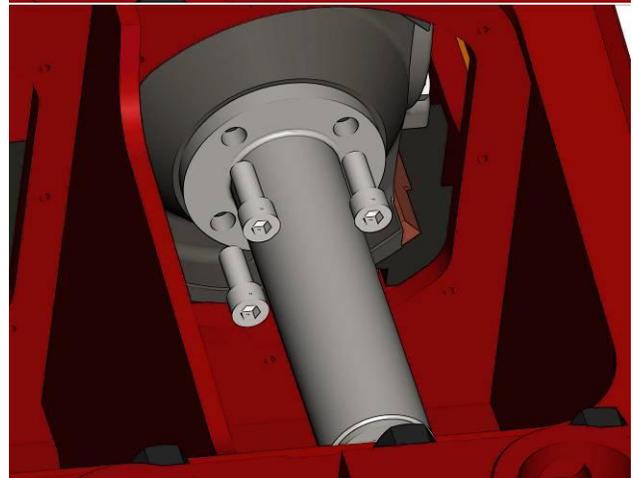
### 5.2.2 Removing the Crosshead

Each wrist pin corresponds to a specific crosshead, and must not be interchanged. It is best to mark each crosshead and wrist pin set to avoid confusion.

- 1 Remove the Wiper Box and Diaphragm Plate as per 5.2.1.



- 2 Rotate the pump so the crosshead extension rod is fully extended towards the fluid end. Unbolt the extension rod from the crosshead.



- 3 Carefully slide the extension rod free of the crosshead and remove.

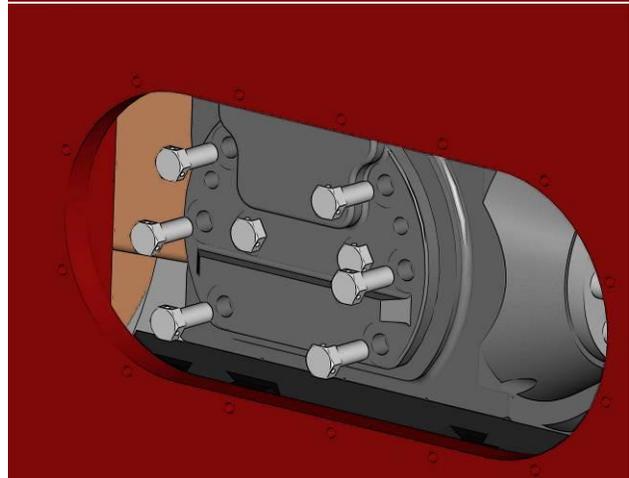




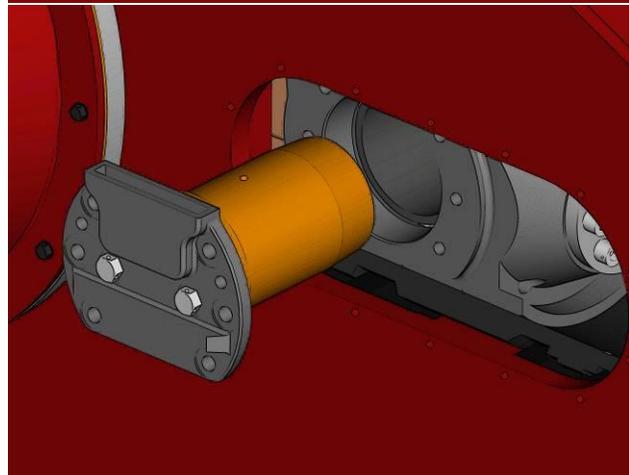
- 4 Remove the nameplates from the side of the pump to gain access to the crossheads.



- 5 Unbolt the wrist pin retainer plate from the crosshead.



- 6 Utilize the tapped holes in the retainer plate to jack the wrist pin from the crosshead and mark to indicate which crosshead they were removed from.





- 7 Remove the crossheads through the hole created by removing the diaphragm plates. Place wooden boards on the crosshead guides to prevent scoring by the connecting rod ends.





### 5.2.3 Removing the Crosshead Guides

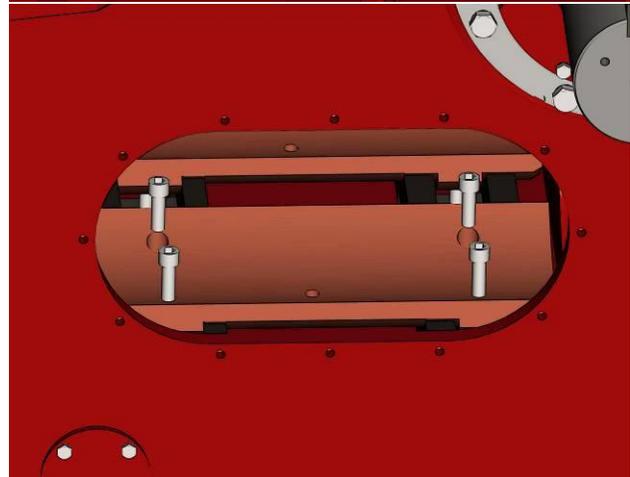
Use the following procedure to remove the crosshead guides.

- 1 Remove the Crossheads as per 5.2.2.



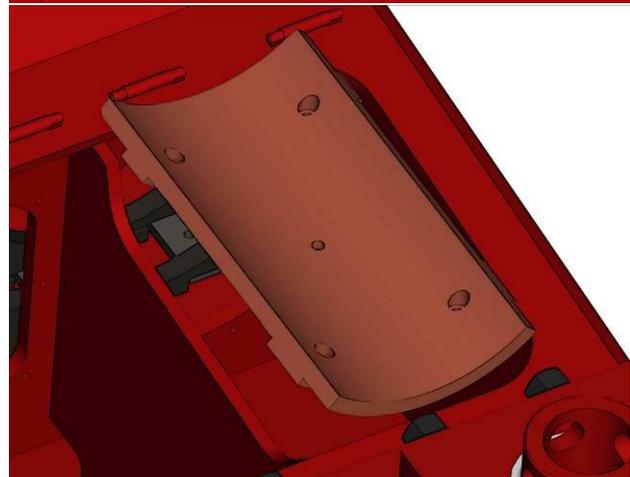
- 2 Remove the four (4) bolts which affix the crosshead guides to the frame.

<b>NOTE</b>	The upper guides are only affixed to the frame by the bolts, and so must either be secured or removed during the unbolting procedure.
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- 3 Remove the crosshead guides. Shims, if present, should be left in place if the guide is to be reinstalled. If not, a new shim package and realignment will be necessary.

<b>NOTE</b>	It is extremely important to make note of the size and placement of shims during removal. Failure to do so can result in excessive piston and liner wear due to misalignment.
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**5.2.4 Removing the Crankshaft Assembly**

The following procedure will remove the gear, crankshaft, main bearings and connecting rods as a single assembly.

- 1 Remove the crossheads as per 5.2.2. Make sure to support the connecting rods with come-a-longs and line the inner surfaces of the crosshead guides with wood or heavy cardboard to protect them from damage when removing the crankshaft assembly.

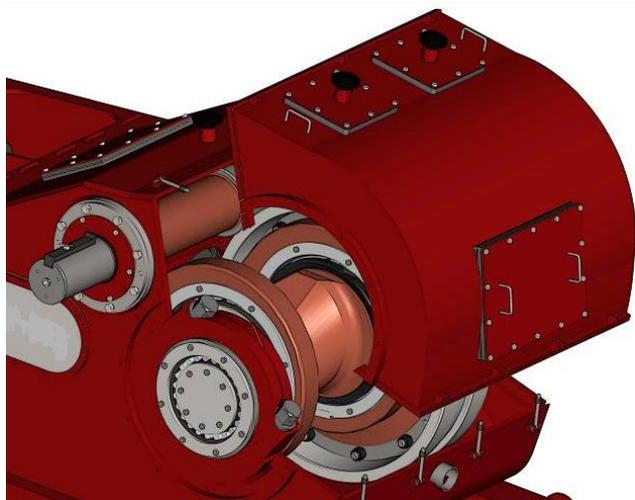


- 2 Unbolt and remove the main bearing cover.

<b>NOTE</b>	This will allow access to the main bearings for lubrication and basic maintenance. However, in order to perform full maintenance on the bearings, the crankshaft assembly will need to be removed.
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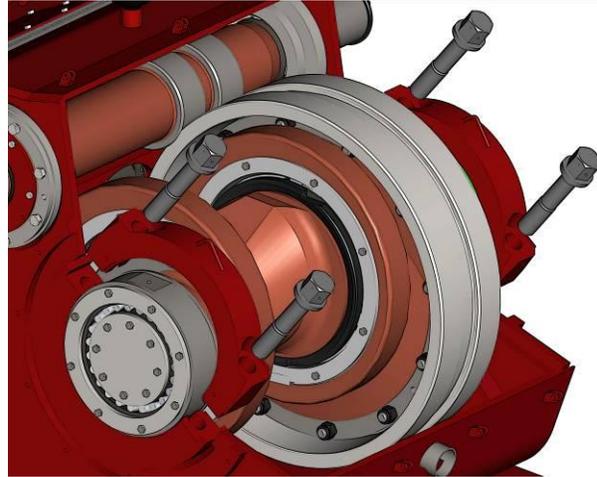


- 3 Remove the back cover of the power frame.





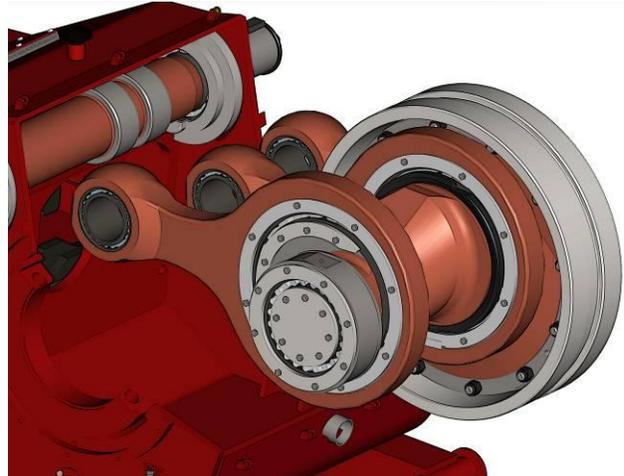
- 4 Disconnect the lube lines and the crankshaft main bearing housings.



- 5 Slowly lift the crankshaft assembly free of the pump frame.

**WARNING**

The crankshaft assembly is an extremely weighty system, and can cause damage, serious injury and death if dropped or if allowed to impact other objects or personnel. Handle with extreme care and follow all applicable safety procedures when lifting this system.

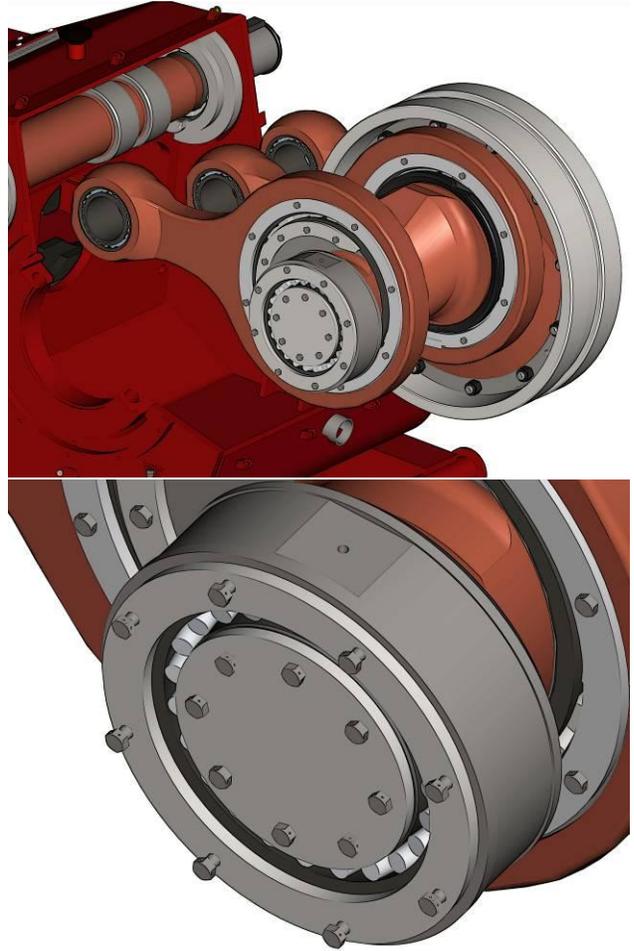




### 5.2.5 Removing the Main Bearing

Use this guide to remove the main bearing without removing the crankshaft from the floating carrier, or to remove the main bearing from a crankshaft that has already been removed from the power frame.

- 1** Remove the main crankshaft assembly as per 5.2.4 and support the crankshaft assembly so that the load is not resting on the main bearings.
- 2** Loosen the main bearing. To do so, loosen the bolts on the outer retainer 2 or 3 turns, and then inject grease into the grooves in the race until the bearing becomes loose on the shaft.

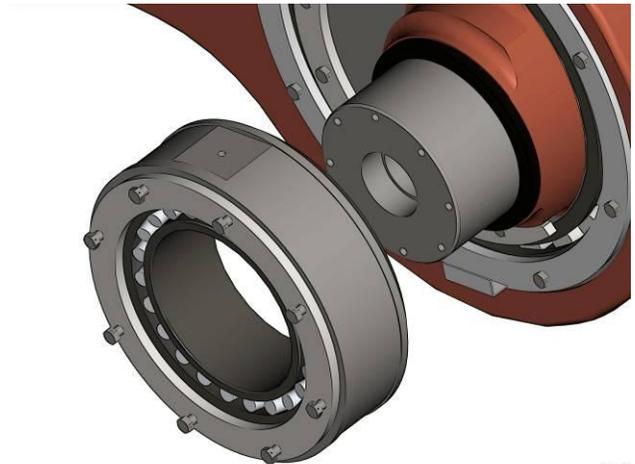




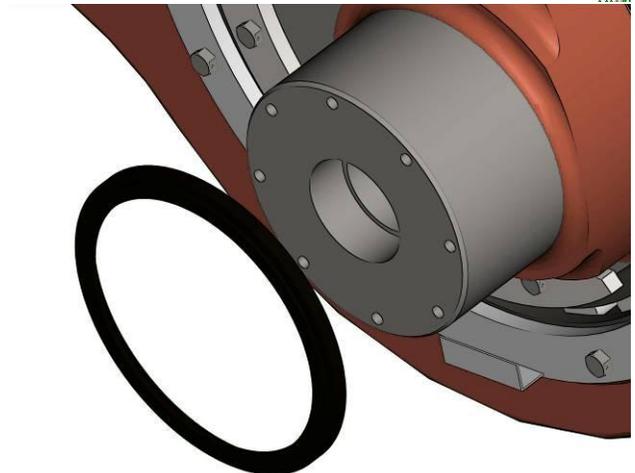
- 3** Remove the bolts and inner retainer from the main bearing.



- 4** Slide the main bearing and shims free of the crankshaft.



- 5** Remove the main bearing oil seals from the crankshaft.





### 5.2.6 Removing the Connecting Rods

The connecting rods should only be removed if absolutely necessary. If it is necessary to remove multiple connecting rods, each rod should be stored separately to avoid confusion.

- 1 Remove the main bearings as per 5.2.5 and support the crankshaft assembly so that the load is not resting on the connecting rods.



- 2 Unbolt and remove the outer bearing retainer from the crankshaft.



- 3 Carefully slide the connecting rod off of the crankshaft.

<p><b>NOTE</b></p>	<p>The outer race of the crankpin bearing will remain attached to the connecting rod, exposing the rollers, so care should be exercised to avoid potential damage to the crankpin bearing.</p>
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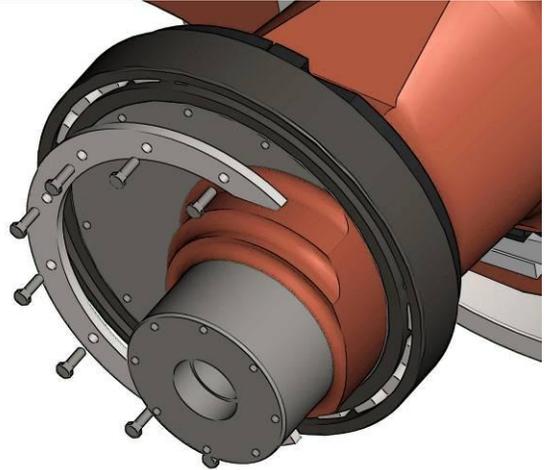




- 4 Unbolt and remove the inner bearing retainer from the crankshaft.

**WARNING**

Make sure that all bearing parts are kept with the same bearing. Do not mix parts between the bearings.



- 5 Slide the crankpin bearing inner race off of the crankshaft.



- 6 Remove the crankpin bearing shoulder.



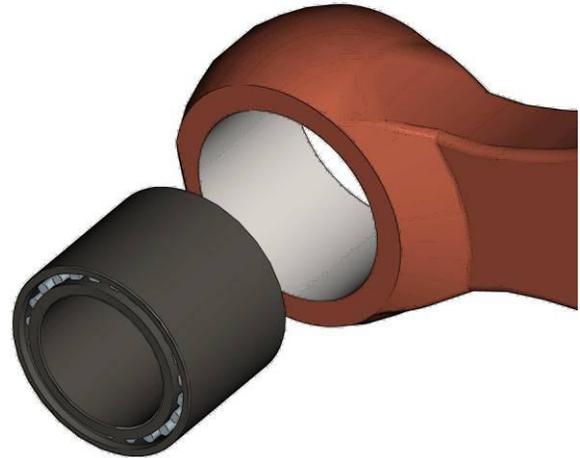


### 5.2.7 Removing the Wrist Pin Bearings

**CAUTION** If any part of a bearing needs to be replaced, then the entire bearing must be replaced. Do Not mix the parts of various bearings.

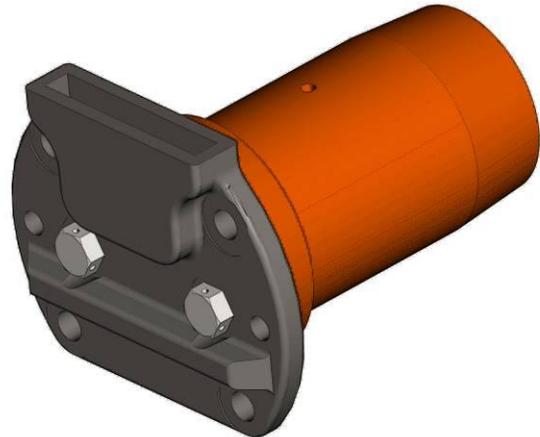
- 1 Use an adapter plate with a slightly smaller diameter than the bearing to push or pull the outer race of the wrist pin bearing from the connecting rod.

<b>NOTE</b>	Do not drive the bearing from the rod with a hammer, as this may damage the bearing.
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- 2 If the inner race of the wrist pin bearing needs to be replaced, it may be slipped off of the wrist pin by heating it with a torch. The bearing race should not have to be raised to over 200°F to press the wrist pin out of it.

<b>WARNING</b>	During this process, parts can become extremely hot. Allow a few minutes after heating for the races to stabilize, and handle with care.
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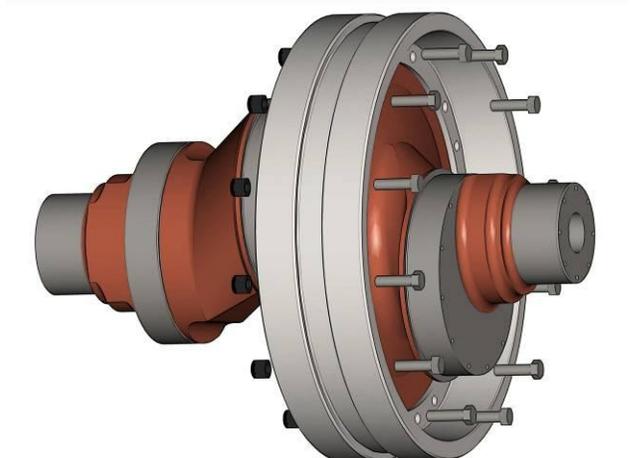
### 5.2.8 Removing the Main Gear

If it does become necessary to remove the Main Gear, use the following procedure.

- 1 Remove the connecting rods from the crankshaft as per 5.2.6.

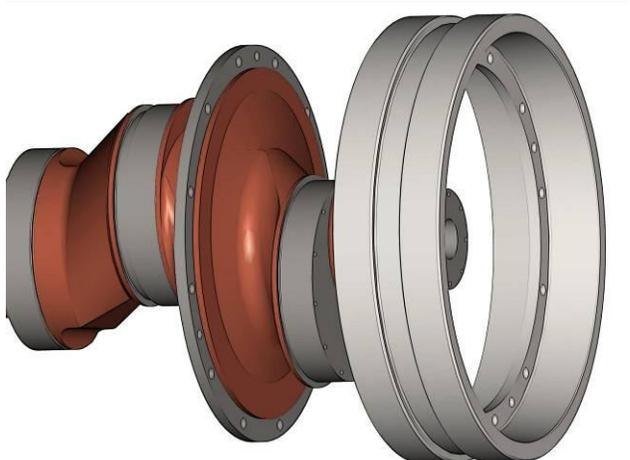


- 2 Unbolt the main gear from the crankshaft.



- 3 Slide the main gear from the crankshaft. The gear may have a slight shrink fit to the crankshaft, so exercise care not to warp or damage the gear during removal.

<b>NOTE</b>	It is helpful to place match marks on the crankshaft gear flange so that the main gear can be reinstalled in exactly the same position.
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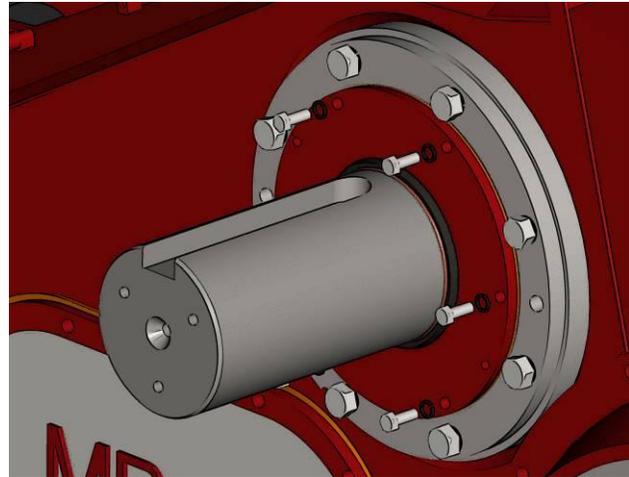
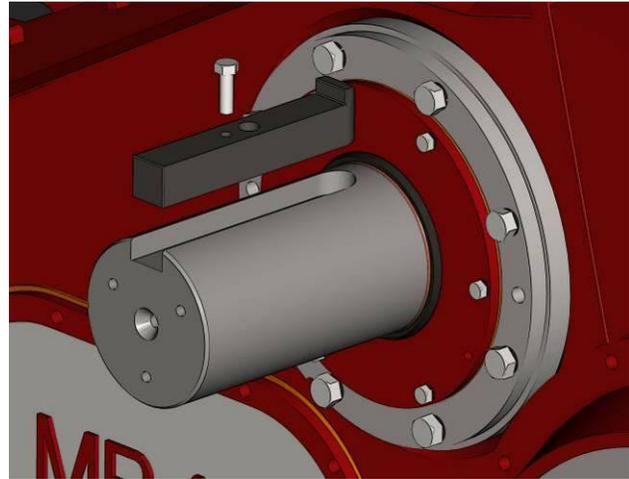




### 5.2.9 Removing the Pinion Shaft & Bearings

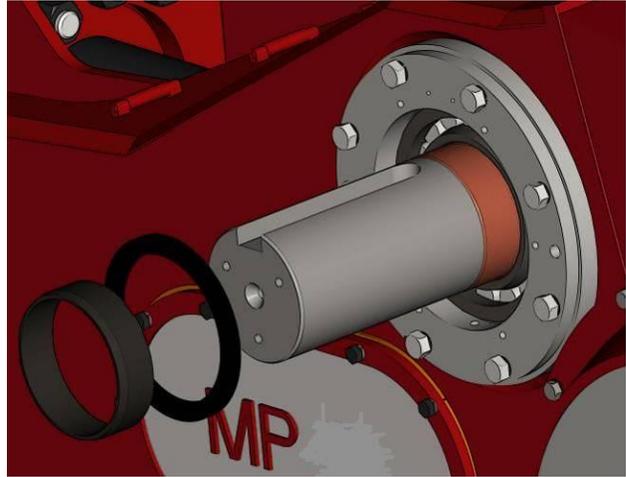
The following procedure outlines the removal of the pinion shaft bearings.

- 1** If necessary, unscrew and remove the key from the pinion shaft keyway.
- 2** Disconnect the oil lube lines and drain, then unbolt the pinion oil seal plate. Be sure to support the pinion shaft to prevent it from moving.
- 3** Slide the oil seal plate and spacer free of the pinion shaft.

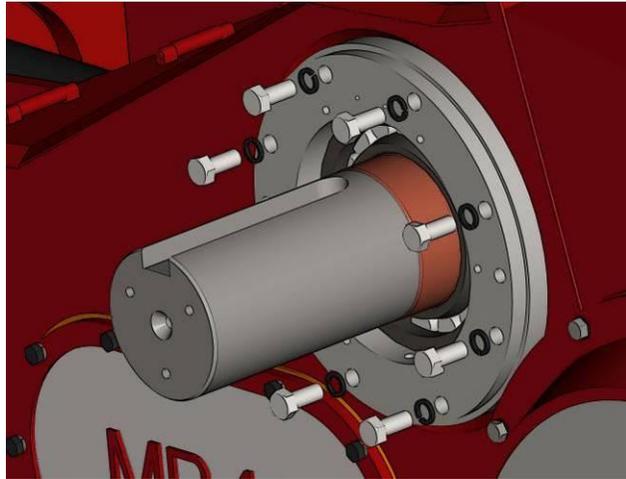




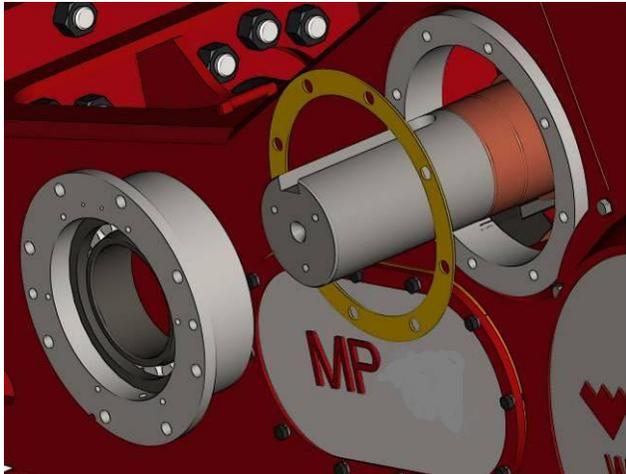
- 4** Remove the pinion oil seal and race from the pinion shaft.



- 5** Unscrew and remove the bolts and washers securing the pinion bearing carrier to the power frame.



- 6** Use the jackscrew holes in the pinion bearing carrier and remove it and the spacer from the power frame.

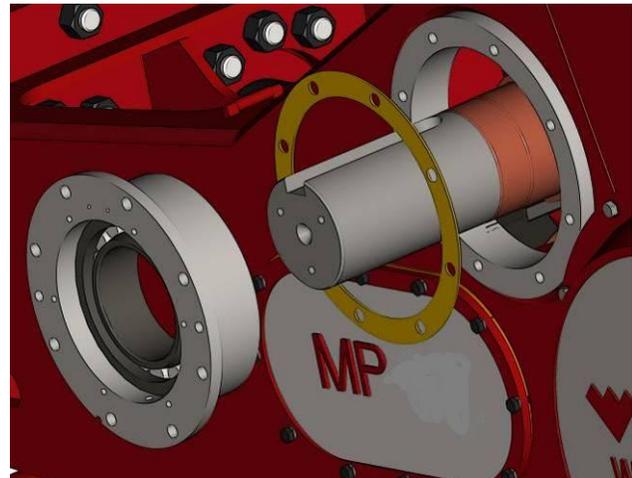




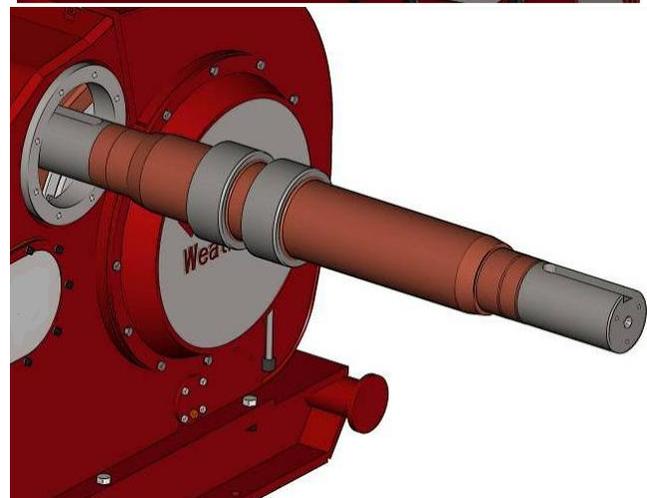
- 7** Remove the bearing outer race and rollers from the pinion bearing carrier. The bearing inner race will still be shrunk fit onto the pinion shaft, and it is important to protect the finish of the inner race if the bearing is to be reused.



- 8** Remove the Pinion Bearing Carriers as per 5.2.9.



- 9** Slide the shaft out of the pump frame. Since the bearings are carrier mounted, the shaft can be removed out of either side of the frame. However, be sure to note its original orientation, as it should be replaced facing the same direction.





## 5.3 Power End Assembly Procedures

The following are the standard procedures for assembling the various components and systems of the power end of the MP-16 pump. All personnel involved in the assembly of the power end must possess a thorough understanding of all of the following procedures, especially any and all safety regulations involved.

All nuts, bolts & studs referenced in this section should be tightened to the appropriate torque in accordance with 4.7.1: Torque Chart unless specifically noted otherwise. All nut and bolt connections located inside the pump should use lock nuts, and security washers should be used on all bolts in tapped holes inside the pump.

### 5.3.1 Installing the Pinion Shaft & Bearings

It is possible to install the pinion assembly with or without crankshaft and gear in place. Use the following guidelines to install the pinion shaft.

- 1 Install the pinion bearing inner races on the pinion shaft by heating to 300°F in an oil bath, electric oven or induction bearing heater. Wait for races to cool before proceeding.

**NOTE** Never apply direct flame to the bearings.

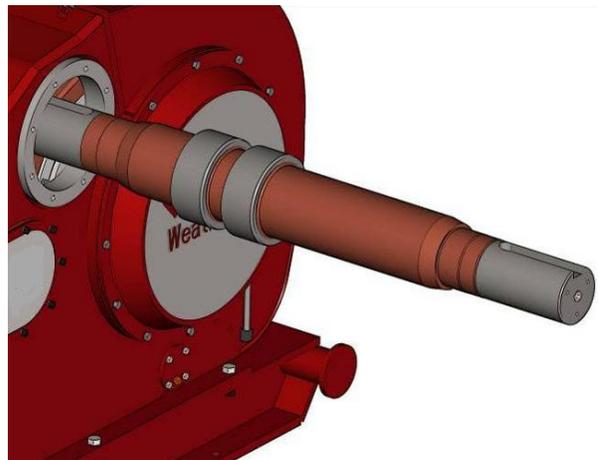
**WARNING**

During this process, parts can become extremely hot. Allow a few minutes after heating for the races to stabilize, and handle with care.

- 2 Install the pinion bearing outer races to the bearing carriers using a slip fit.

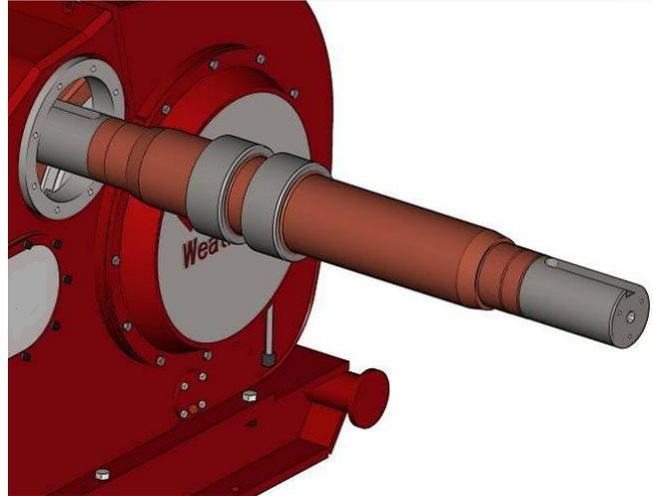
**WARNING**

During this process, parts can become extremely hot. Allow a few minutes after heating for the races to stabilize, and handle with care.

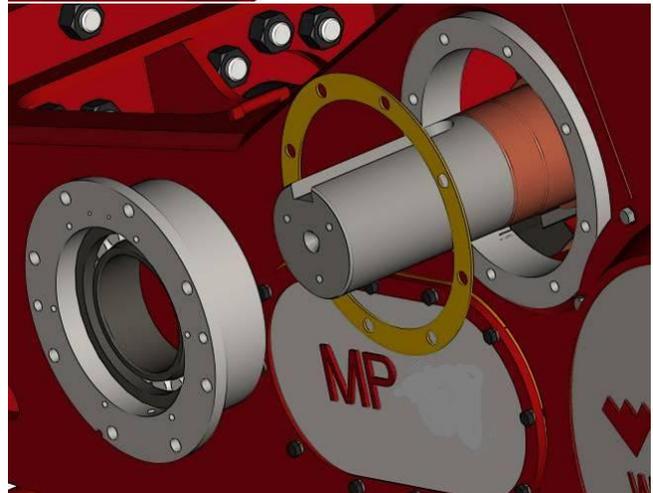




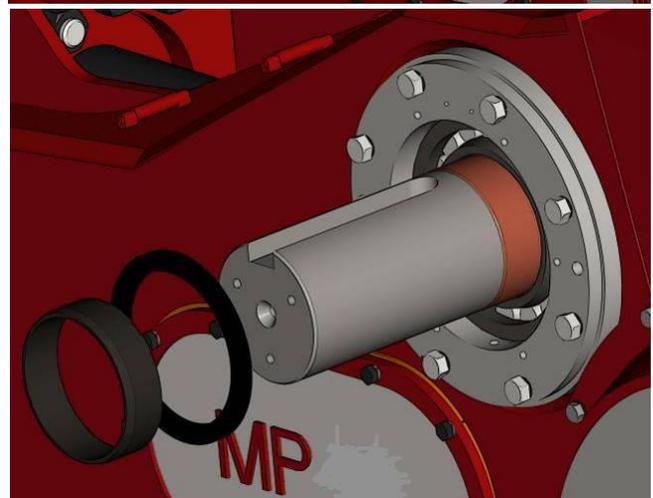
- 3** Place the pinion shaft into the pump before installing the bearing carrier assemblies. Make sure the pinion shaft is properly supported before proceeding.



- 4** Slide the bearing carrier assemblies and gaskets over the pinion shaft and into the pump frame, exercising caution as they meet the inner race.

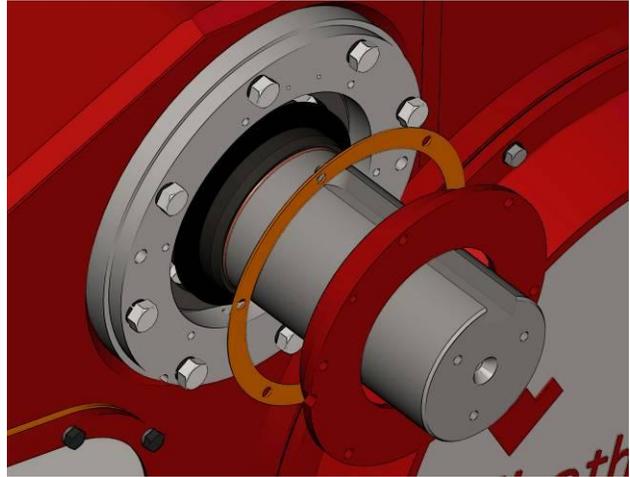


- 5** Install the pinion oil seal and race onto the pinion shaft.

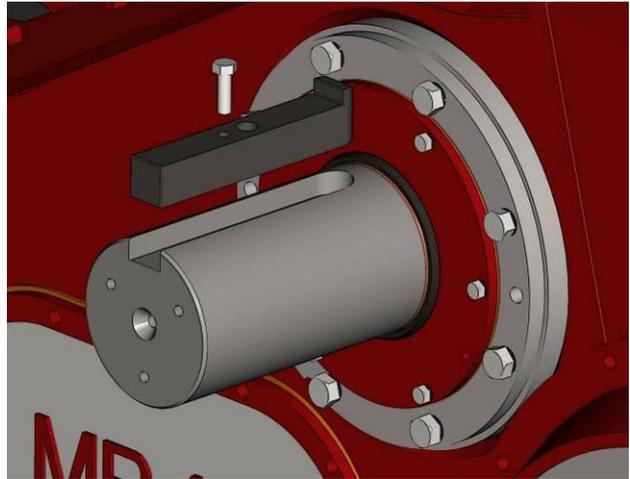




- 6 Reinstall the oil seal place and spacer on the pinion shaft.



- 7 Once all maintenance is complete, reconnect the oil lube lines and pressurize the system. Reattach key as required.





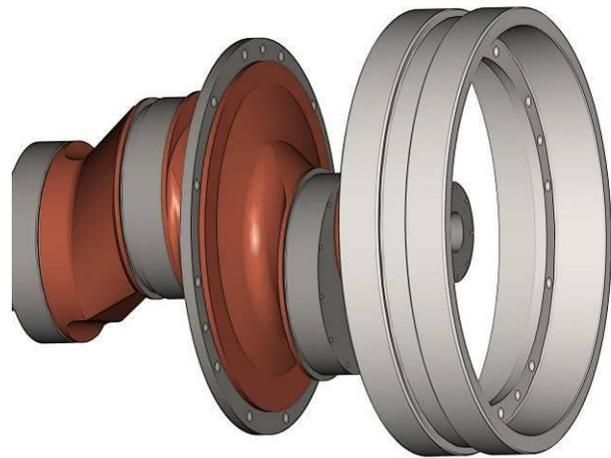
### 5.3.2 Mounting the Main Gear

The gear is held in place with bolts and locknuts, but the gear pilot diameter may utilize a light shrink fit onto the crankshaft.

- 1 Position the crankshaft vertically with the single eccentric side up, supporting it from beneath with the gear-mounting flange.

**WARNING**

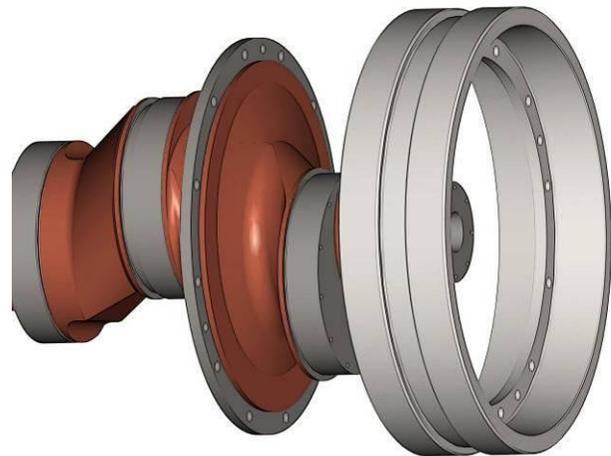
The crankshaft assembly is an extremely weighty system designed to withstand intense pressures, and can cause significant damage, serious injury and death if dropped or if allowed to impact other objects or personnel. Ensure it is properly supported and secure before taking any other steps.



- 2 Slide the gear over the pilot on the crank. This may require heating the gear. If that is the case, then be sure to uniformly heat all sides to approximately 200°F, and only heat as much as is necessary.

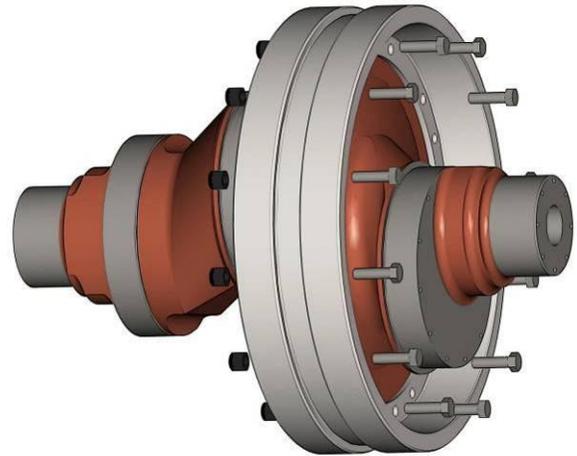
**WARNING**

During this process, parts can become extremely hot. Allow a few minutes after heating for the gear to stabilize, and handle with care.





- 3** Install and tighten the bolts on the gear as per the Torque Chart on page 53. Always use new bolts when mounting the main gear.



- 4** Reinstall the connecting rod between the right end of the crankshaft and the gear as per 5.3.3: Installing the Connecting Rods & Bearings.





### 5.3.3 Installing the Connecting Rods & Bearings

The connecting rods are precise systems designed for maximum pump effectiveness and longevity, and so should always be kept together as sets to avoid damage or confusion, and if possible, reinstalled in their original positions on the crankshaft.

When installing the connecting rods & bearings, be sure to install the inner bearing & connecting rod first, and then the outer bearings. All bearings must be placed against a stop, such as a shoulder or a set of bolt retainers, and should be placed so that the roller assembly may be removed by removing the retainer rings. Use the following procedure.

- 1 Heat the connecting rods & bearings in an electric oven or oil bath to 200°F. Each bearing consists of 3 parts (outer race, inner race and rollers), which must be kept together as sets.

**WARNING**

During this process, parts can become extremely hot. Allow a few minutes after heating for the gear to stabilize, and handle with care. Do not overheat or apply flame directly to the connecting rods.



- 2 Reinstall the bearing shoulder onto the crankshaft.

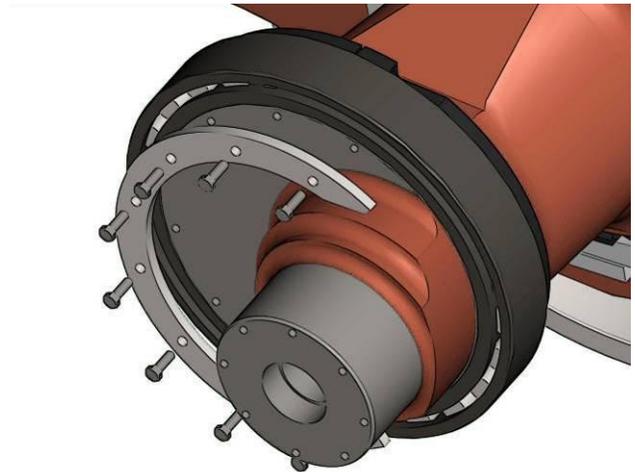




- 3** Slide the heated bearing onto the crankshaft with the loose ring leading.



- 4** Install the inner retainer to lock the bearing into place.

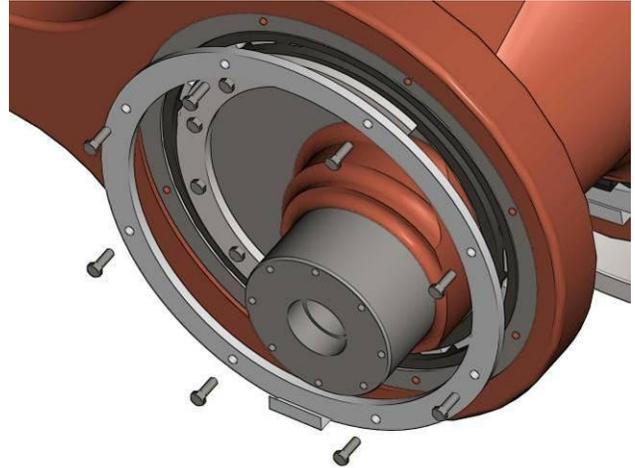


- 5** Slide the connecting rods back into position on the crankshaft, exercising care not to bump or damage the main gear.

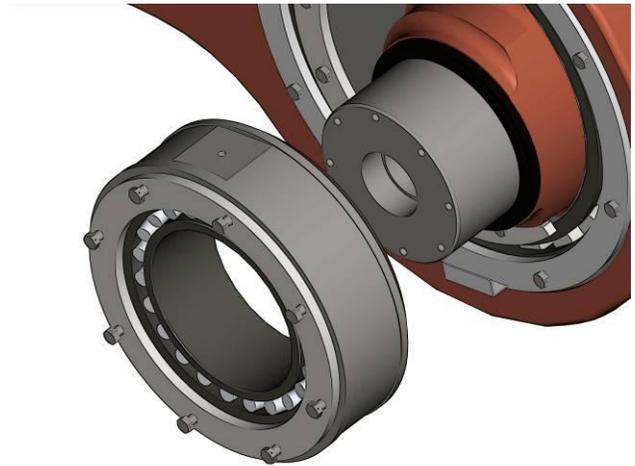




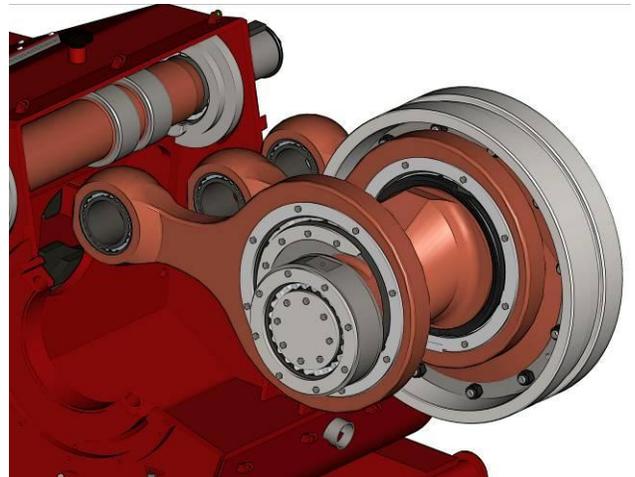
- 6** Secure the connecting rod into position by installing the outer bearing retainer.



- 7** Reinstall the main bearings as per 5.3.4.



- 8** Reinstall the crankshaft into the power frame as per 5.3.6.





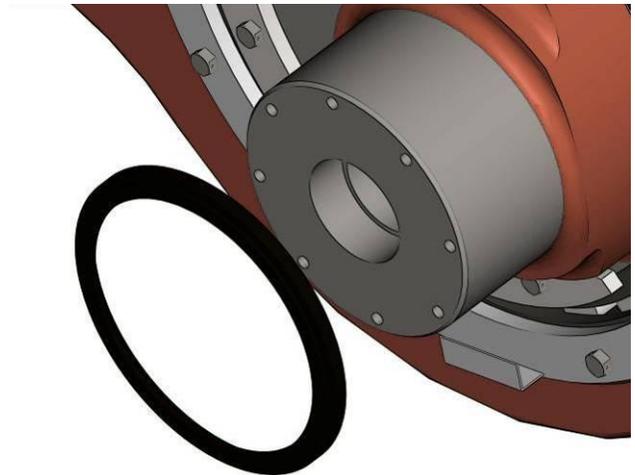
### 5.3.4 Installing the Main Bearing

Install the main bearings onto the crankshaft.

- 1 Reinstall the connecting rods as per 5.3.3 and check that the ends of the crankshaft and bearings are grease free.



- 2 Reinstall the main bearing seals.



- 3 Install the main bearings into the bearing carriers. Secure using the outer retainer ring.





- 4** Slide the main bearing and carrier onto the taper.



- 5** Install the inner retainer of the main bearing and bolt all retainers in accordance with the Torque Chart, page 53.





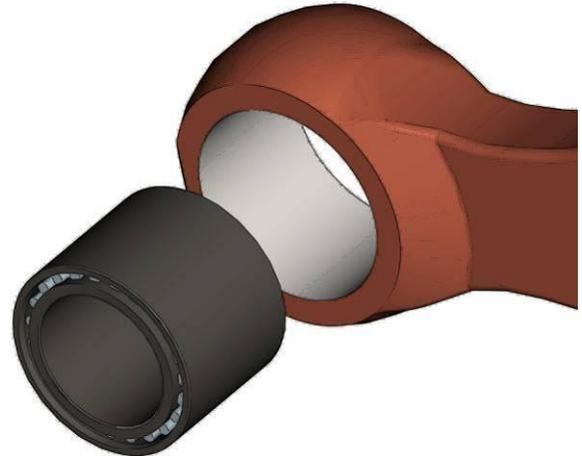
### 5.3.5 Installing the Wrist Pin Bearing

The following procedure is used to reinstall the wrist pin bearing.

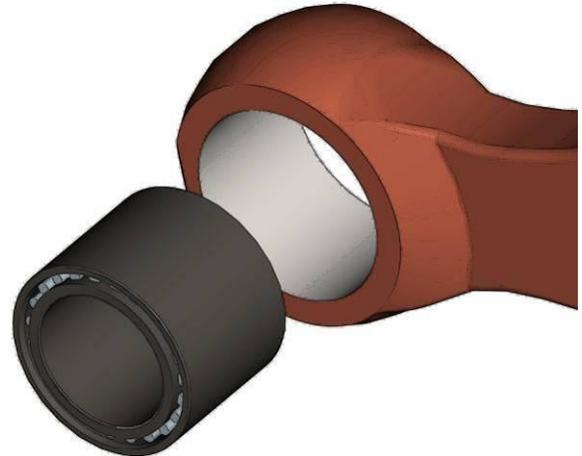
- 1 Heat the connecting rod to no more than 200°F, keeping the heat source moving to apply uniform heat.

**WARNING**

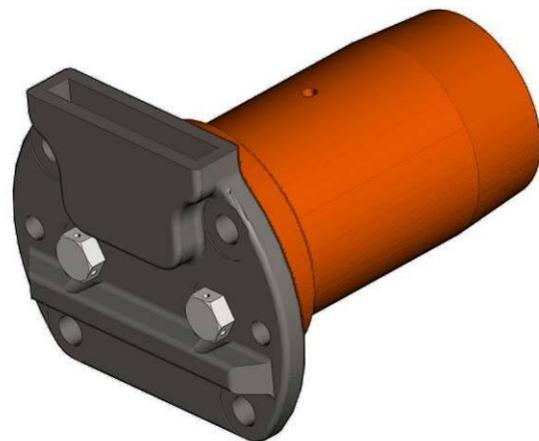
During this process, parts can become extremely hot. Allow a few minutes after heating for the gear to stabilize, and handle with care. Do not overheat or apply flame directly to the connecting rods.



- 2 Slide the outer race of the wrist pin bearing onto the connecting rod, ensuring that the ends of the bearing are flush with the sides.



- 3 Heat the inner race of the wrist pin bearing and then slide into position on the wrist pin. Allow to cool before going any further with the assembly procedures.





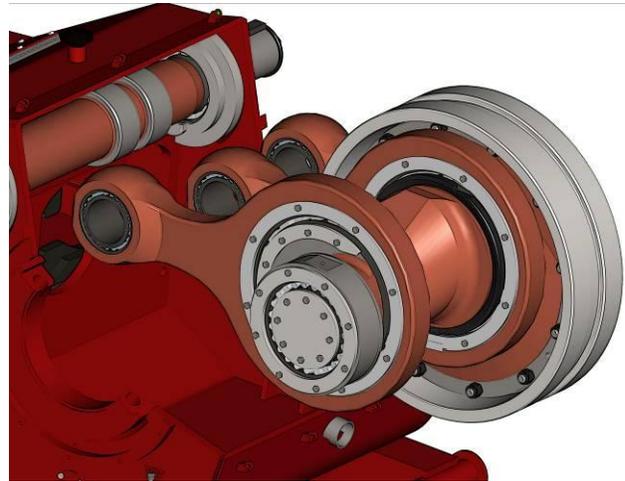
### 5.3.6 Installing the Crankshaft Assembly

When installing the crankshaft assembly be sure to secure pieces of wood to protect the guides from scoring or damage by the connecting rods during the installation process.

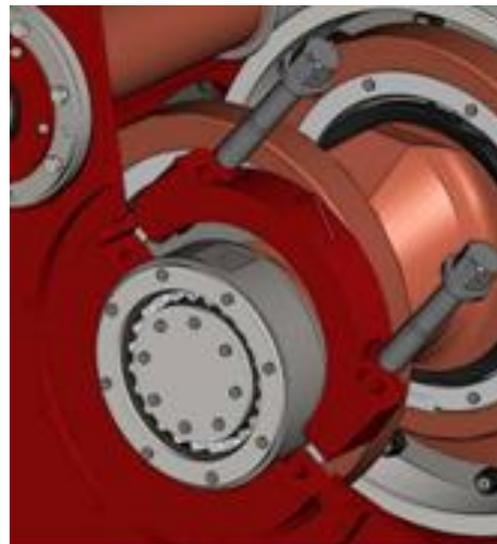
- 1 Reinsert the crankshaft assembly into the power frame, taking care that it is well supported throughout this process and avoiding sudden or jerky movements. Be sure to cover the crosshead guides with wood or cardboard to prevent damage.

**WARNING**

The crankshaft assembly is an extremely weighty system, and can cause damage, serious injury and death if dropped or if allowed to impact other objects or personnel. Handle with extreme care and follow all applicable safety procedures when lifting this system.



- 2 Place piece of wood between eye of eccentric strap and crosshead guide to protect guide from scoring or gouging as the straps are sliding into position. Rotate the main bearing carrier so that the two flat spots (180° apart) are parallel with the main bearing bolt holes, and slowly lower the crankshaft into position. (The flat spot provides clearance for the main bearing bolts). After placing crankshaft in the frame and before installing the main bearing caps, check the rollers in the main bearings to assure that each of the rollers in each bearing is equally loaded. Equal loading is obtained by positioning the floating bearing carrier so that the same numbers of inner and outer rollers supporting the weight of the crankshaft in each bearing are tight. Because of tolerances, etc., the total number of tight rollers could vary slightly between individual bearings. Install and shim main bearing caps to obtain .003" clamp or preload on the main bearing carrier. This preload is obtained by placing the correct amount of shims under the main bearing cap. The required amount of shims is determined as follows:



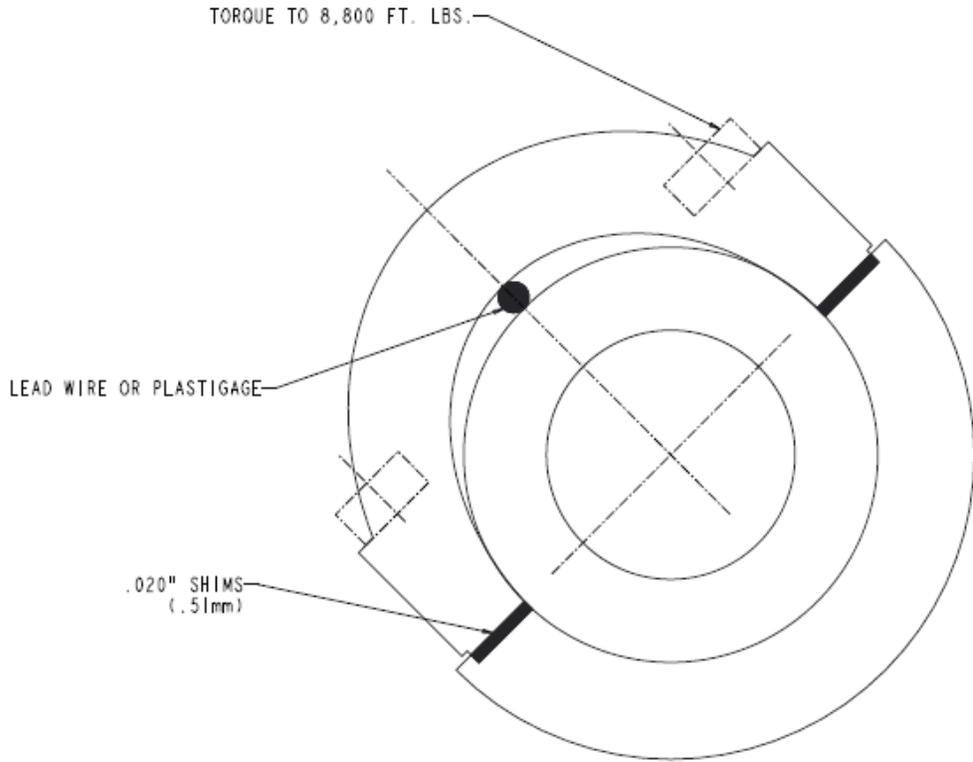


- Install .020" shims under both ends of the main bearing cap.
- Place a piece of lead wire (approximately 1/32" diameter) or Plastigage between OD of the bearing carrier and ID values shown in torque chart
- Remove main bearing cap and determine clearance between bore of cap and OD of bearing carrier by either micrometer or feeler gauge.
- Using this dimension, calculate the required thickness of shims as follows:

Subtract thickness of compressed lead or Plastigage from the original .020" shim thickness.  
Then subtract .003" for preload.  
The result is the correct shim thickness required

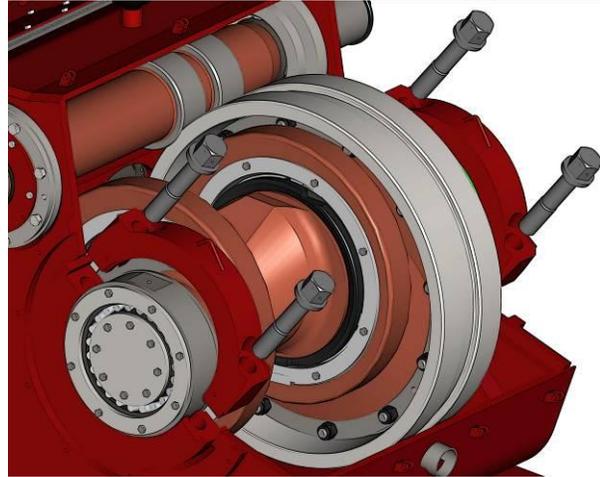
<b>NOTE</b>	Machining tolerances make it necessary to determine individual shim requirements for each (right hands and left hand) main bearing cap.
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- Install main bearing caps with the correct amount of shims as determined above and tighten main bearing bolts to torque.
- Again check inner and outer row of rollers on each bearing as previously outlined to assure equal loading is still present.

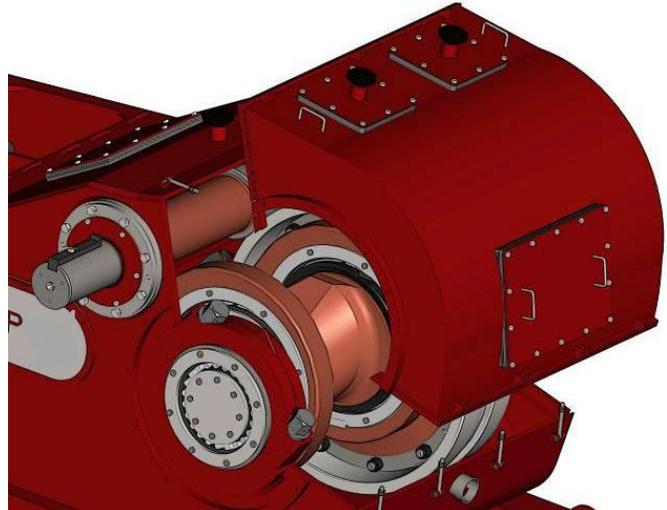




- 3** Bolt the main bearing housings into place to secure the crankshaft and reconnect the lube lines. Reinstall the main bearing clamp and torque nut into place using the torque valve stamped on the torque nut. Lubricate the bolt threads with a suitable thread compound such as KoprKote, Nev-Seez or even clean new motor oil.



- 4** Replace the rear cover of the power frame and secure into place.



- 5** Reattach the main bearing covers onto the power frame.



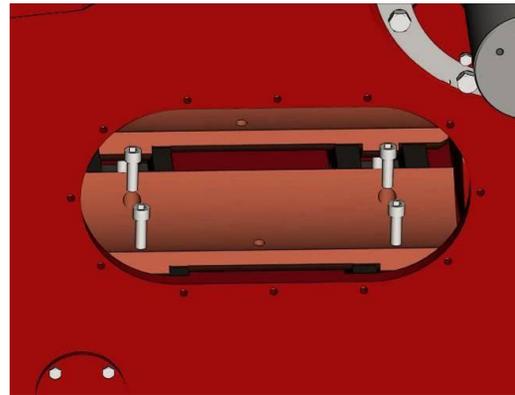


### 5.3.7 Installing the Crossheads & Crosshead Guides

The crosshead guides are bolted into the main frame with clamp bars and bolts. To install, use the following procedure.

<b>NOTE</b>	If the original crosshead guides are being reinstalled, it is vitally important to ensure that the guides and shims are reinstalled in the exact location that they were removed from. Failure to do so will result in excessive piston and liner wear.
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- 1 Insert and position the crosshead guides within the frame (see above note), then bolt to secure.



- 2 Install the outer race of the wrist pin bearing as per 5.3.5: Installing the Wrist Pin Bearing, then pack the wrist pin bearing rollers with grease to ensure that the rollers stay against the outer race during the wrist pin installation.



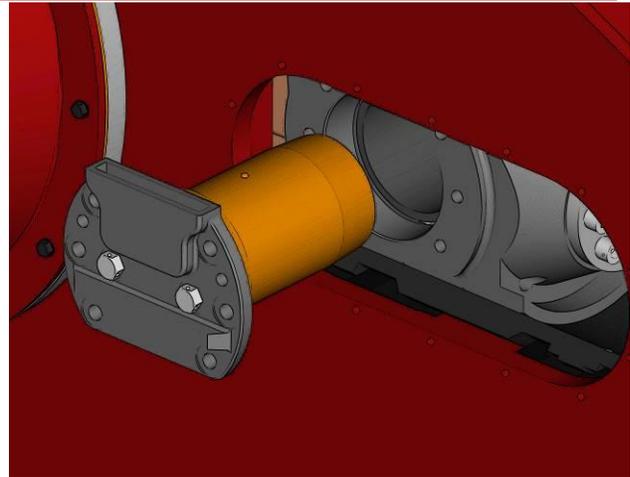
- 3 Insert the crosshead into the power frame, aligning the wrist pin slot in the center with the wrist pin slot in the connecting rod.





- 4 Insert the small end of the wrist pin into the wrist pin bearing and gently push into position.

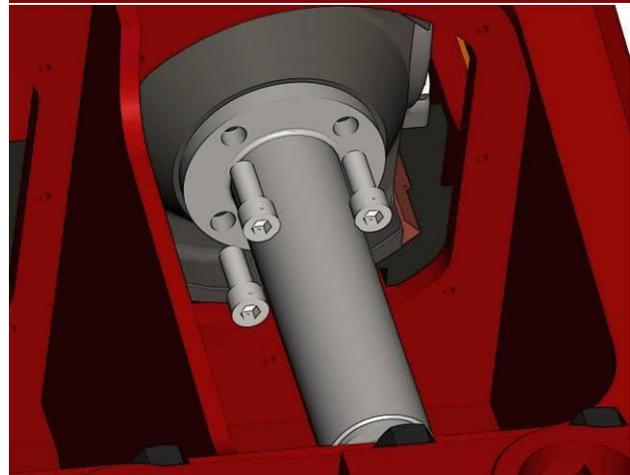
**NOTE** Do not force or drive the wrist pin. The pin should be a close, tight fit but it must not bind the bearing.



- 5 Bolt the wrist pin to secure into place, and the reinstall the name plates on the side of the pump.

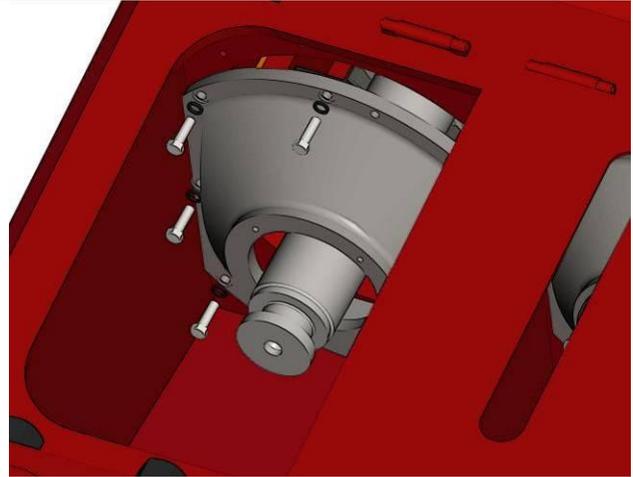


- 6 Slide the extension rod into position on the crosshead and bolt to secure.

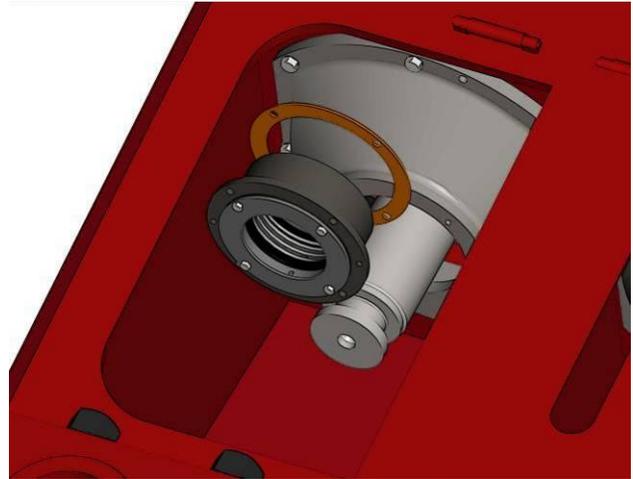




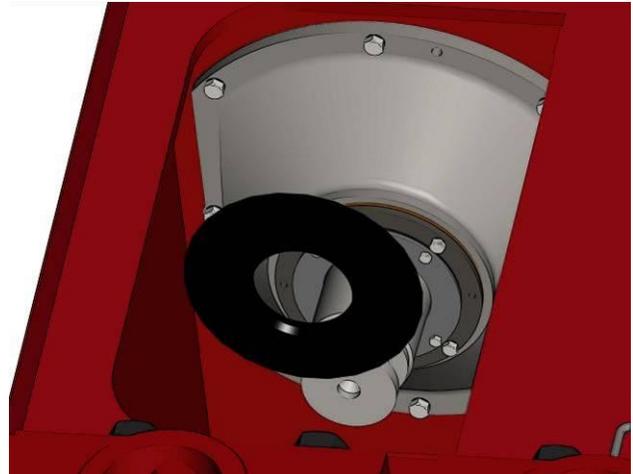
- 7** Replace the diaphragm plates and bolt into position in the power frame.



- 8** Check the wiper box for damaged or defective components, then reinsert into position on the diaphragm and bolt to secure.



- 9** Reinstall the baffle into position on the extension rod.



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## Chapter 6: Glossary

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**Adjusting Nut:** See Gland

**Aeration:** Air suspended in the fluid.

**AGMA:** The American Gear Manufacturers Association.

**Bearing:** A device that supports, guides, and reduces the friction of motion between fixed and moving machine parts.

**Bearing Carrier:** A device that fits around a bearing and allows for easy adjustment.

**Bearing Housing:** The outer shell of a bearing, designed to protect, support and contain the other elements.

**Bearing Roller:** Bearing elements which move along a fixed track inside of the housing, reducing friction, controlling movement and helping to absorb shocks and stresses.

**Bearing, Connecting Rod:** See Bearing, Crankpin.

**Bearing, Crankpin:** A bearing which transmits the oscillating reciprocating load transmitted by the connecting rod to the crankshaft. Also known as the connecting rod bearing.

**Bearing, Main:** The bearing which supports the crankshaft and absorb the liquid and inertia loads that are developed by the pistons as they displace the fluid. Also known as the main crankshaft bearing.

**Bearing, Main Crankshaft:** See Bearing, Main.

**Bearing, Wrist Pin:** The bearing which attaches the connecting rods to the crossheads and allows the circular motion of the crankshaft to be transformed into an oscillating force on the crossheads. Sometimes known as the Wrist Pin Bushing.

**Breather:** A vent which allows for pressure equalization between the inside and the outside of the pump.

**Bull Gear:** See Main Gear.

**Bypass Line:** A length of piping leading off the main line used to vent excess pressure from the pump.

**Bypass Valve:** See Valve, Bypass

**Cage (Guard):** A safety system consisting of a wire-mesh cage which surrounds and prevents access to potentially hazardous systems or components.

**Cavitations:** The sudden formation and collapse of low pressure bubbles in fluid.

**Chain Drive:** See Drive, Chain.

**Charging Pump:** See Pump, Charging.

**Come-A-Long:** A device for gripping and shortening the effective length of a cable, wire rope or chain by means of two jaws which close when one pulls on a ring.

**Connecting Rod:** A rod which articulates the motion of the crankshaft to the crosshead. Power is transmitted through the combination of compression and tension.

**Connecting Rod Bearing:** See Bearing, Crankpin.

**Cooling Loop:** A device designed to reduce fluid temperatures by pumping a coolant through a loop of hose or piping to absorb heat from the fluid, and then through a second loop to disperse the heat into the environment.

**Cradle:** The portion of the pump which connects the fluid end to the power frame. Also known as the Frame Extension.

**Crankcase:** See Power Frame

**Crankpin Bearing:** See Bearing, Crankpin.

**Crankshaft:** The stepped shaft which transmits power and motion to the connecting rods through eccentric rotation. Main bearings and connecting rods are fitted to this component.

**Crosshead:** A system which creates linear reciprocating motion derived from the crankshaft's rotary motion through the connecting rod. The reciprocating motion of the crosshead is applied to the piston via the extension rod.

**Crosshead Extension:** See Extension Rod.

**Crosshead Guide:** A track designed to control and direct the movement of the crosshead.

**Dampener Charging Kit:** A tool used to adjust the pressure in the pulsation dampeners.

**Degassing Equipment:** Systems designed to remove aeration from the fluid.

**De-sander:** Systems designed to remove sand and solid contaminants from the fluid.

**Diaphragm Plate:** A metal plate between the cradle and the power frame, designed to prevent environmental contamination of the oil in the crankcase.

**Direct Coupled Drive:** See Drive, Direct Coupled.

**Dirt Excluder:** An elastomeric guard designed to keep dirt out of the pump.

**Discharge Cross:** A flanged cross connected to the discharge manifold allowing for the addition of multiple lines and other systems.

**Discharge Dampener:** The pulsation dampener mounted in the discharge piping.

**Discharge Line:** See Discharge Piping.

**Discharge Manifold:** See Manifold, Discharge

**Discharge Module:** The portion of the fluid cylinder which discharges fluid from the pump.

**Discharge Piping:** The piping which carries fluid out from the discharge manifold. Also known as the Discharge Line.

**Discharge Pulsation Dampener:** See Discharge Dampener.

**Discharge Valve:** A valve assembly located in the fluid cylinder, designed to channel fluid from the cylinder to the discharge manifold and to prevent return flow.

**Drain Valve:** See Valve, Drain.

**Drilling Fluid:** The fluid used when drilling wells. Also known as Mud.

**Drilling Mud:** See Drilling Fluid.

**Drive System:** A system which provides power transmission and speed reduction from the prime mover to the pump power end. Usually includes a manual pump rotating device.

**Drive, Chain:** A drive system consisting of a multiple strand roller chain running on sprockets.

**Drive, Direct Coupled:** A drive system in which the prime mover is directly connected to the power end of the pump.

**Drive, V-Belt:** A drive system consisting of a set of V-Belts running on sheaves.

**Eccentric Bearing:** A bearing set so that its center is offset from a rotating axle, used to convert rotary motion into linear reciprocating motion via the connecting rods and crossheads.

**Extension Rod:** The rod which is bolted to the crosshead and passes through the stuffing box to connect to the piston. Also known as the piston extension, crosshead extension or pony rod.

**External Lube Oil Pump:** See Pump, External Lubricating.

**External Lubricating Pump:** See Pump, External Lubricating.

**Flange, Discharge Companion:** The main flange extending from the Discharge Manifold, used to attach the Discharge Piping and Cross.

**Flange, Suction Companion:** The main flange extending from the Suction Manifold, used to attach the Suction Piping.

**Fluid:** Any non-solid material. In this document, unless otherwise specified the term fluid will refer to the material being moved by the pump.

**Fluid Cylinder:** A chamber in which the motion of the pistons is imparted to the liquid, which may consist of separate suction and discharge modules. Also known as the Liquid Cylinder.

**Fluid End:** The portion of the pump which handles the fluid being moved. Includes the fluid cylinder, valves and other systems. Also known as the Liquid End.

**Fluid Module:** A portion of a multi-part fluid cylinder, usually designed to handle either suction or discharge.

**Frame Extension:** See Cradle.

**Gear End:** See Power End.

**Gland:** A threaded adjusting nut located at the atmospheric side of the stuffing box, used to compress the packing. Also known as the Adjusting Nut.

**Guard:** A portion of the pump designed to protect users by preventing access to potentially hazardous areas or blocking debris.

**Heat Exchanger:** A device designed to transfer heat from one medium to another.

**Hydrogen Sulfide:** A colorless gas with a rotten egg smell that often forms in crude oil, natural gas and hot springs. The gas is explosive and corrosive to machine parts, and exposure is extremely hazardous to humans and animals in small doses, and lethal at as low as 8 parts per million. Also known as Sour gas.

**Internal Lubricating Pump:** See Pump, Internal Lubricating.

**Jackscrew:** A mechanical lifting device driven by turning a lead screw.

**Jib Crane:** A light duty crane mounted atop the pump for handling heavy equipment when servicing the pump. Also known as the Service Crane.

**Knocking:** An arrhythmic pounding in the fluid end, usually the result of aeration of the fluid.

**Liner:** The hardened chamber through which the piston moves and applies its force to pumping the fluid.

**Liner Bushing:** The removable metal frame into which the liner is inserted. Also known as the Liner Retainer.

**Liner Lock Ring:** A ring which screws into place over the liner bushing to hold the liner in place. Also known as the Liner Retainer Nut.

**Liner Retainer:** See Liner Bushing.

**Liner Retainer Nut:** See Liner Lock Ring.

**Liner Spray System:** See Liner Wash System.

**Liner Wash Pump:** See Pump, Liner Wash.

**Liner Wash System:** A lubrication system consisting of a number of valves which spray lubricants onto the pistons and extension rods. Also known as the Liner Sprayer System.

**Liner Wash Tank:** Storage tank for the liner wash fluid, including a settling section and a reservoir section.

**Liquid Cylinder:** See Fluid Cylinder.

**Liquid End:** See Fluid End.

**Lubricant:** A liquid designed to reduce friction.

**Main Bearing:** See Bearing, Main.

**Main Crankshaft Bearing:** See Bearing, Main.

**Main Gear:** The heavy-duty gear affixed to the crankshaft which translates motion from the pinion rod.

**Manifold:** A chamber which accepts and directs the flow of fluid.

**Manifold, Discharge:** A manifold which accepts fluid from the individual discharge valves and directs it to the discharge valve assemblies.

**Manifold, Suction:** A manifold which accepts fluid from the suction ports and distributes it to the suction valve assemblies.

**Mud:** See Fluid, Drilling.

**Mud Pit:** A tank near the rig into which mud is circulated.

**Nose plate:** The vertical steel plate on the power end onto which the fluid ends are connected.

**Packing:** The material used to provide a seal around the plunger.

**pH:** The measure of the acidity or basicity of a solution.

**Pinion:** A gear with a small number of teeth designed to mesh with the main gear.

**Pinion Rod:** A rod containing the pinion designed to transfer motive power from the prime mover to the crankshaft via the pinion and main gear. Also known as the Pinion Shaft.

**Pinion Shaft:** See Pinion Rod.

**Piston:** A rod which is attached to the crosshead and is capable of exerting pressure upon the fluid within the fluid cylinder. The piston contains its own seals, and moves through a hardened cavity (see Liner).

**Piston Assembly:** The complete piston, including the cup, hub, rod and seal.

**Piston Cup:** The rubber cup on the end of the piston which transfers its motive power to the fluid.

**Piston Extension:** See Extension Rod.

**Piston Hub:** The metal retainer that screws onto the piston rod and holds the seal and cup in place.

**Piston Hub Seal:** An extended seal directly behind the piston hub, used to prevent leakage from the liner.

**Piston Rod:** The body of the piston which connects the hub to the extension rod.

**Pitch Line:** The line around the circumference of a gear along which its teeth are intended to operate.

**Pony Rod:** See Extension Rod.

**Power Crosshead:** See Crosshead.

**Power End:** The portion of the pump in which the rotating motion of the crankshaft is converted into reciprocating motion through the connecting rods and crossheads. Also known as Gear End.

**Power Frame:** The portion of the power end that contains the crankshaft, connecting rods, crossheads and bearings used to transmit power and motion to the fluid end.

**Pressure Relief Valve:** See Valve, Pressure Relief.

**Prime Mover:** The device which provides power to the drive system.

**Pulsation Dampener:** A liquid or gas charged, chambered device that minimizes periodic increases and decreases in the pressure of a fluid.

**Pump, Charging:** A pump that provides pressurized fluid flow to the suction of the main pump.

**Pump, External Lubricating:** An electrically powered pump located outside of the power frame which provides lubrication pressure to the pump crankcase.

**Pump, Internal Lubricating:** A crankshaft-powered pump located inside of the crankcase which provides it with lubrication pressure.

**Pump, Liner Wash:** An electric centrifugal pump circulating liner wash and cooling fluid from the liner wash tank to the liner spray nozzles.

**Pump, Triplex:** A reciprocating pump utilizing three plungers or pistons working in three separate cylinders, designed so that its power strokes are evenly distributed over the course of a crankshaft revolution.

**Race:** A groove in a machine through which a moving part slides or rolls.

**Retainer:** A device which affixes one component to another, usually mounting a component onto a frame.

**Rod Clamp:** The clamp which affixes the piston or plunger rod to the extension rod.

**Seal:** A device designed to prevent fluids from leaving a specific location.

**Seat Driver:** A driving tool used to move the seat into position in the cylinder, consisting primarily of a long, heavy rod with a seat adapter at the end.

**Seat Puller:** A system used to remove the valve seat from the cylinder. The system comes in many configurations, but most commonly consists of a valve seat adapter attached to a pulling rod, which itself is mounted on a heavy duty frame and driven by a manual hydraulic pump. The when the pump is used, the pulling rod exerts vertical pressure on the seat, eventually wrenching it free from the fluid cylinder.

**Service Crane:** See Jib Crane.

**Settling Tank:** A tank designed to filter solid contaminants from fluid by allowing them to settle in the base of the tank while the fluid flows over.

**Shield:** A type of guard designed to protect against flying debris or components.

**Shim:** A thin and often tapered or wedged piece of metal, used to ensure components remain properly aligned.

**Snap Ring:** An oblong metal ring which can be deformed and put into place, at which point it will snap back to its unstressed position in a groove or retainer.

**Sour gas:** See Hydrogen Sulfide.

**Spring Retainer:** The part of the Valve Assembly which guides and controls the movement of the spring.

**Stop:** A device that obstructs movement.

**Strainer Cross:** A discharge cross containing a strainer screen to remove debris from the pump discharge.

**Suction Depulser:** See Suction, Stabilizer.

**Suction Line:** The piping which carries fluid into the suction manifold. Also known as Suction Piping.

**Suction Manifold:** See Manifold, Suction.

**Suction Module:** The portion of a multi-part fluid cylinder which accepts fluid into the pump.

**Suction Piping:** See Suction Line

**Suction Stabilizer:** A low-pressure pulsation dampener mounted in the suction piping.

**Suction Valve:** A valve assembly located in the fluid cylinder, designed to channel fluid from the suction manifold to the fluid cylinder and prevent return flow.

**Sump:** A reservoir of oil, usually located in the crankcase.

**Teflon Tape:** A film cut to specified widths for use in sealing pipe threads.

**Thread Compound:** A paste for pipe joint threads that holds the pipes in place and prevents corrosion.

**Tie Wire:** A fine wire that is twisted around a bracket to keep the fastener from loosening.

**Torque:** A measure of twisting force, usually indicated in terms of foot-pounds.

**Triplex Pump:** See Pump, Triplex.

**Valve:** A structure which regulates the flow of fluid through a system by opening and closing under set conditions.

**Valve Assembly:** A configuration of parts including, but not limited to, the valve itself, a seat, spring, and spring retainer, all in normal operating positions relative to each other.

**Valve Cover:** The cover which holds the valve in place in the fluid cylinder.

**Valve Cover Seal:** The seal around the valve cover.

**Valve Puller Assembly:** See Seat Puller

**Valve Seat:** A surface against which a valve may rest in order to seal the aperture.

**Valve Seat Puller:** See Seat Puller.

**Valve Stem Guide:** A channel which supports the stem of a valve for maintenance of alignment.

**Valve, Bypass:** A specialized pressure relief valve hooked to the bypass line.

**Valve, Discharge:** The valve assembly through which fluid exits the pump into the discharge manifold.

**Valve, Line:** A valve designed to control flow through the piping.

**Valve, Pressure Relief:** A valve designed vent excess pressure from the system by opening at a set pressure value.

**Valve, Shut-Off:** A valve designed to completely stop the flow of fluid.

**Valve, Suction:** The valve assembly through which fluid enters the pump from the suction manifold.

**V-Belt:** A belt designed with a “V” shape to mate with a tracking groove in the sheave in order to enhance traction and prevent the belt from unintentionally slipping off.

**V-Belt Drive:** See Drive, V-Belt.

**Vent:** A system in the piping designed to remove aeration from the fluid.

**Wear Plate:** A component used to reduce wear and add support.

**Wiper Box:** A cylindrical cavity through which the extension rod reciprocates and in which liquid leakage is controlled by means of wipers.

**Wrist Pin:** The component which connects the connecting rod to the crosshead.

**Wrist Pin Bearing:** See Bearing, Wrist Pin.

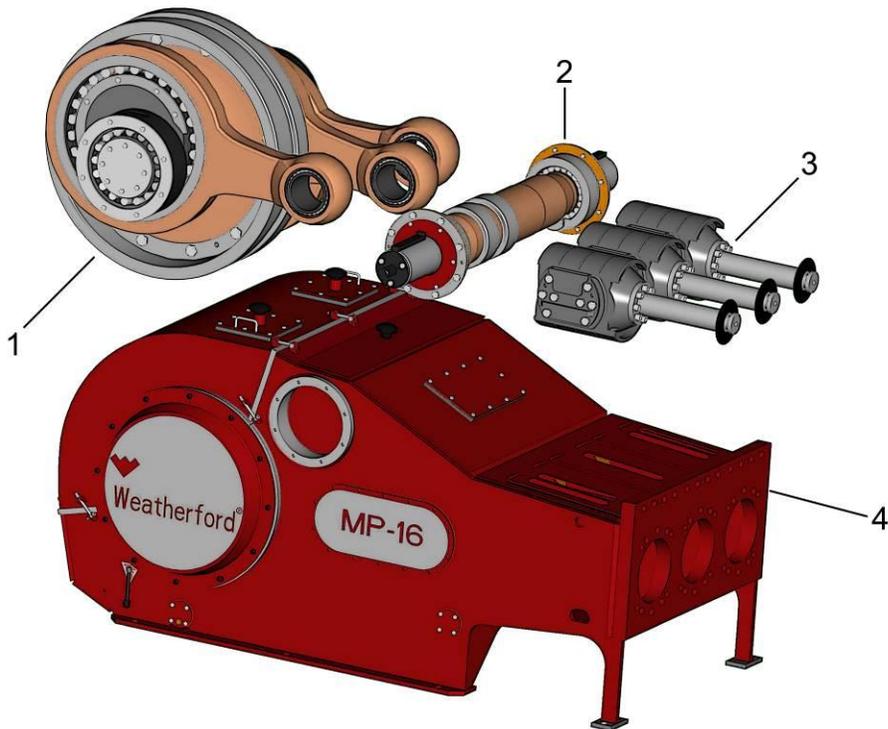
**Zerk Fitting:** A lubrication fitting in mechanical systems used to allow grease to be added with a grease gun.



# Chapter 7: Parts Lists

The following sheets contain the master parts lists for the MP-16 triplex pump. These lists are designed to be comprehensive to every pump made, and so may include parts and systems that are not included on the particular unit this manual came with. For a specific list of exactly which parts and components are on a particular unit, consult the specifications sheet that came with the pump.

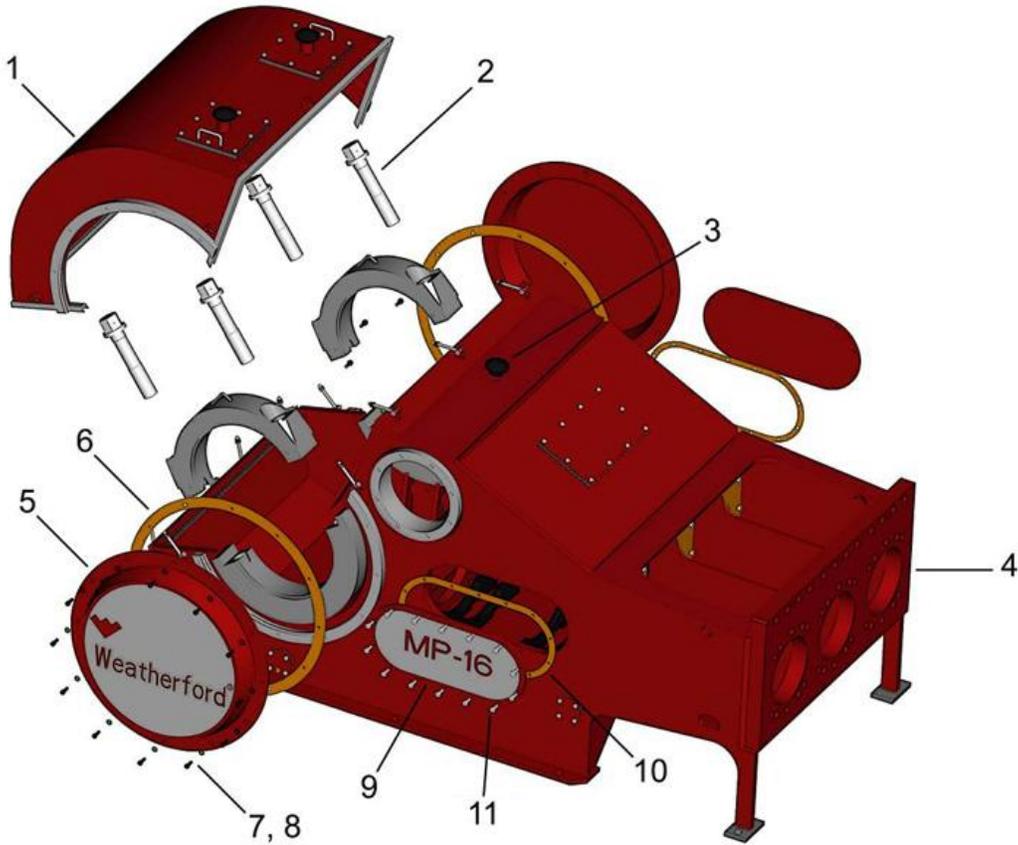
## 7.1 Power End Assembly



Item	Description	Part Number	Qty.
	Assembly, Power End	1138827	1
1	Assembly, Crankshaft	0908426	1
2	Assembly, Pinion	0908407	1
3	Assembly, Crosshead	1134258	1
4	Assembly, Power Frame	1815931	1



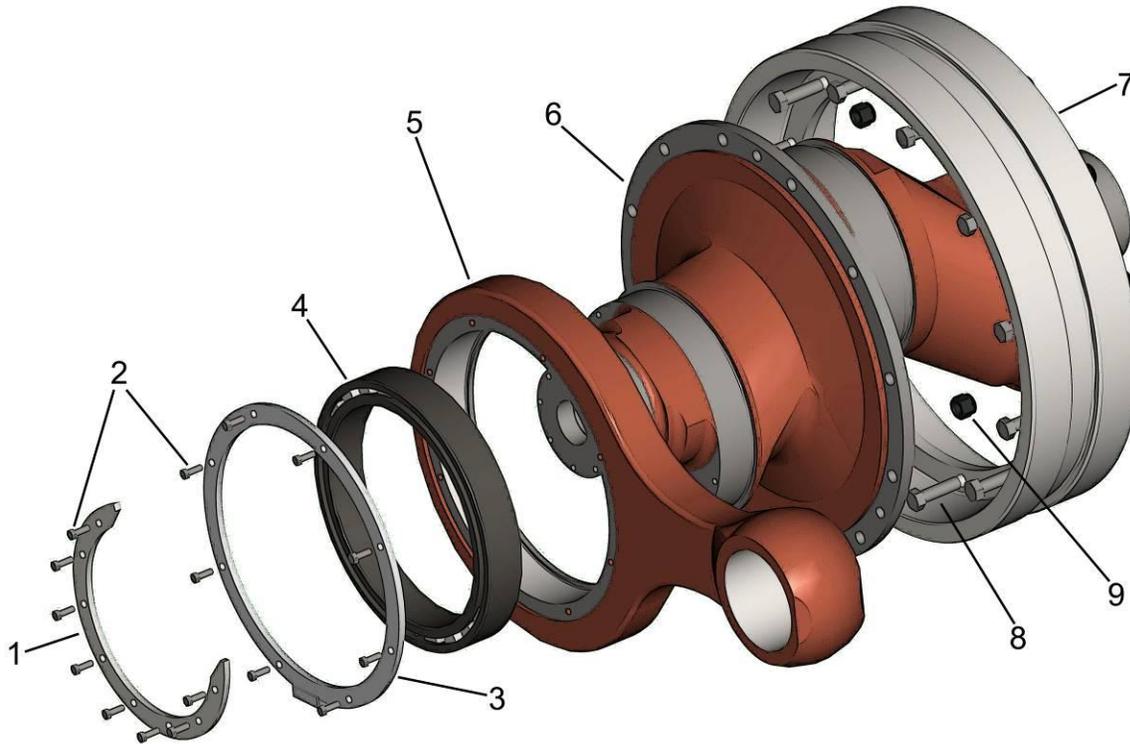
**7.1.1 Power Frame Assembly**



Item	Part Number	Description	Qty.
	1815931	Assembly, Power Frame	1
1	1134668	Cover, Power End Rear	1
2	1133853	Bolt, Main Bearing Housing	4
3	1128575	Cap, Breather	1
4	1814075	Power Frame	1
5	0908884	Cover, Main Bearing	2
6	1133830	Gasket, Main Bearing Cover	2
7	1124677	Bolt 5/8" – 11 UNC x 1 1/2"	24
8	0879134	Washer, Flat	24
9	1134280	Cover, Crosshead	2
10	1771957	Gasket, Crosshead Cover	2
11	1134670	Screw	28



**7.1.2 Crankshaft Assembly**



Item	Part Number	Description	Qty.
	0908426	Assembly, Crankshaft	1
1	1133837	Retainer, Inner Race	2
2	1124696	Bolt, Retainer	40
3	1133843	Retainer, Outer Race	3
4	1133857	Bearing, Eccentric	3
5	0908427	Rod, Connecting	3
6	0908384	Crankshaft	1
7	0908408	Gear, Main	1
8	1124662	Cap screw, 1½" – 8 UNC X 4½"	12
9	1133856	Nut, Lock, 1½" – 8 UNC	12



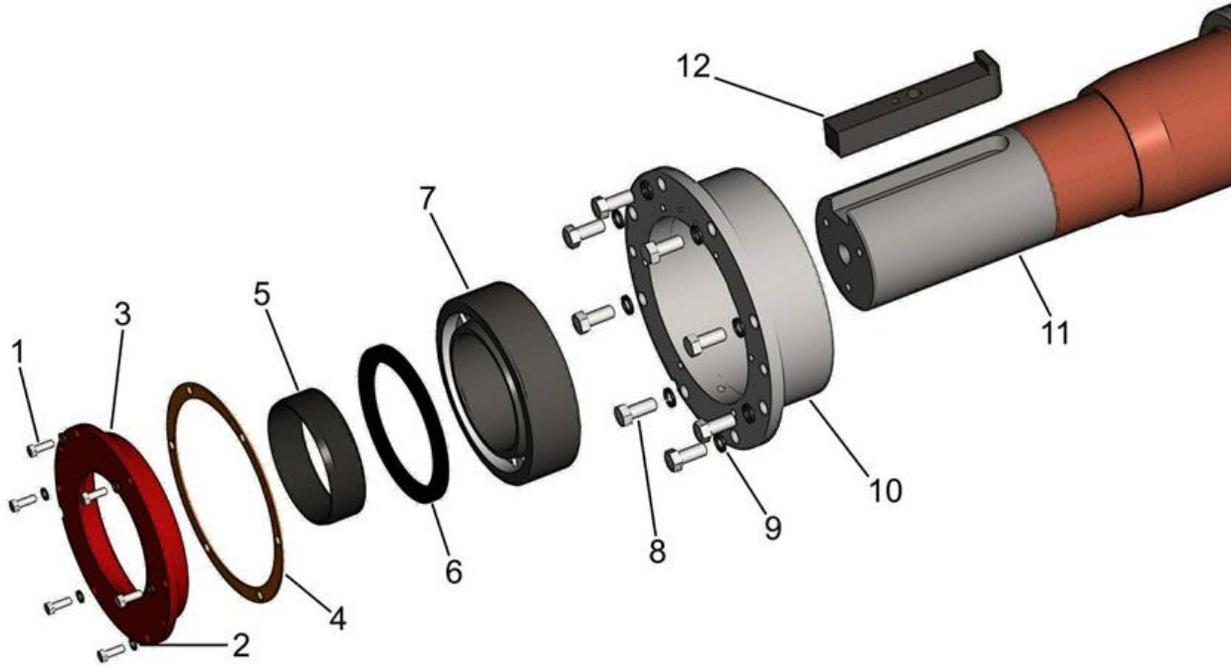
**7.1.3 Main Bearing Assembly**



Item	Part Number	Description	Qty.
1	1133852	Retainer, Main Bearing Inner	2
2	1124696	Cap screw, DH 5/8" – 11 UNC x 1 1/2"	32
3	1133851	Retainer, Main Bearing Outer	2
4	1133859	Bearing, Main	2
5	1133848	Carrier, Main Bearing, Left	1
	1133825	Carrier, Main Bearing, Right	1
6	1133846	Spacer, Main Bearing	2



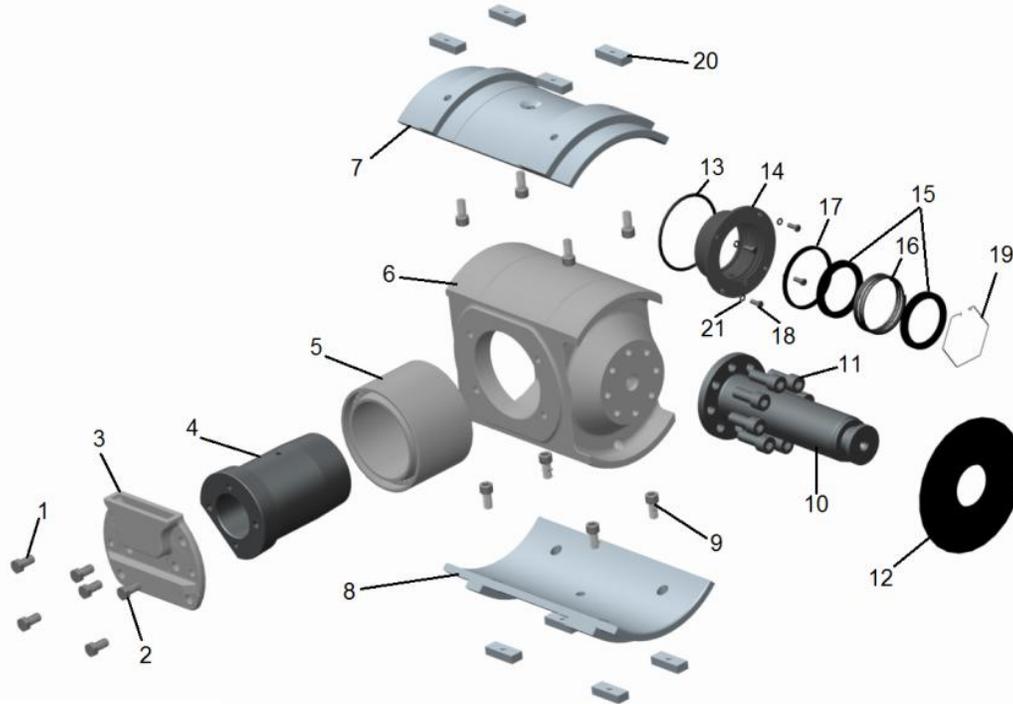
**7.1.4 Pinion Assembly**



Item	Part Number	Description	Qty.
	0908407	Assembly, Pinion Shaft	1
1	1124731	Cap screw, HH 1/2" – 13 UNC x 1 3/8"	12
2	1124735	Washer, Lock M14	12
3	1134036	Carrier, Oil Seal	2
4	1134037	Gasket, Oil Seal Carrier	2
5	1134027	Ring, Oil Seal Wear	2
6	1844173	Seal, Oil 9 1/8" x 10 3/8" x 5/8"	2
7	0908397	Bearing, Pinion Shaft	2
8	1124732	Cap screw, HH 7/8" – 9 UNC x 2"	16
9	0885578	Washers, Lock M22	16
10	1134040	Carrier, Pinion Bearing	2
NS	1134039	Gasket, Oil Seal Carrier	2
11	1134026	Shaft, Pinion	1
12	1124713	Key, 2" x 2" x 8"	2
NS	1134043	Turning Tool	1
NS	1124730	Bolt, 5/8" – 11 UNC x 2"	3



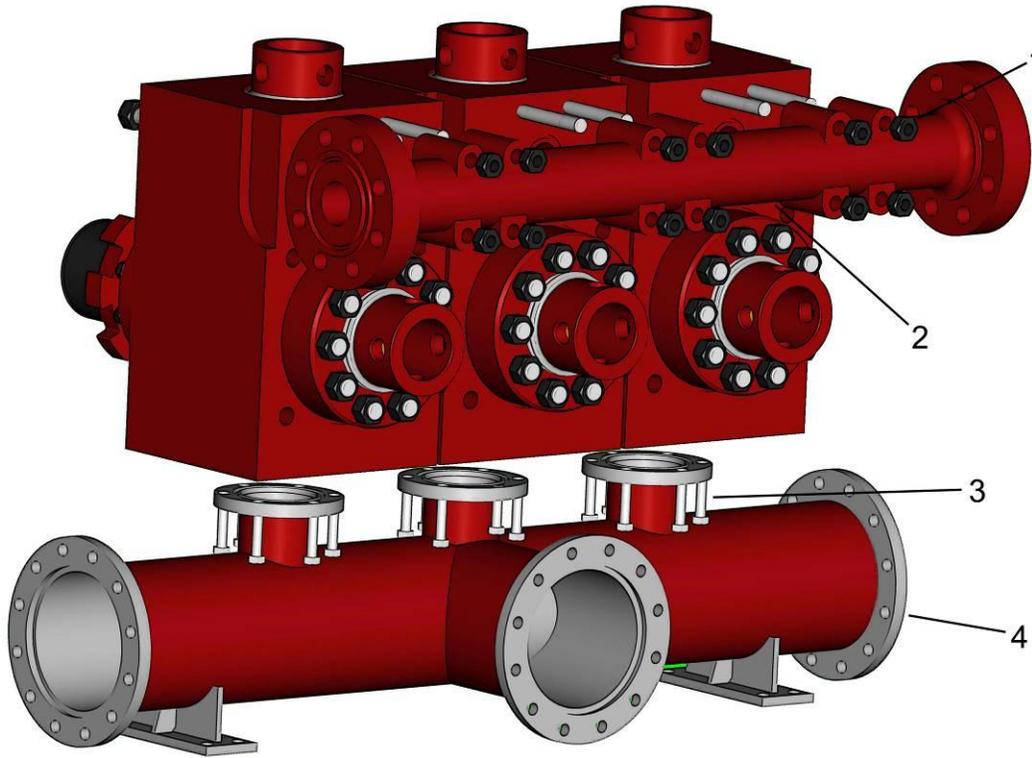
**7.1.5 Crosshead Assembly**



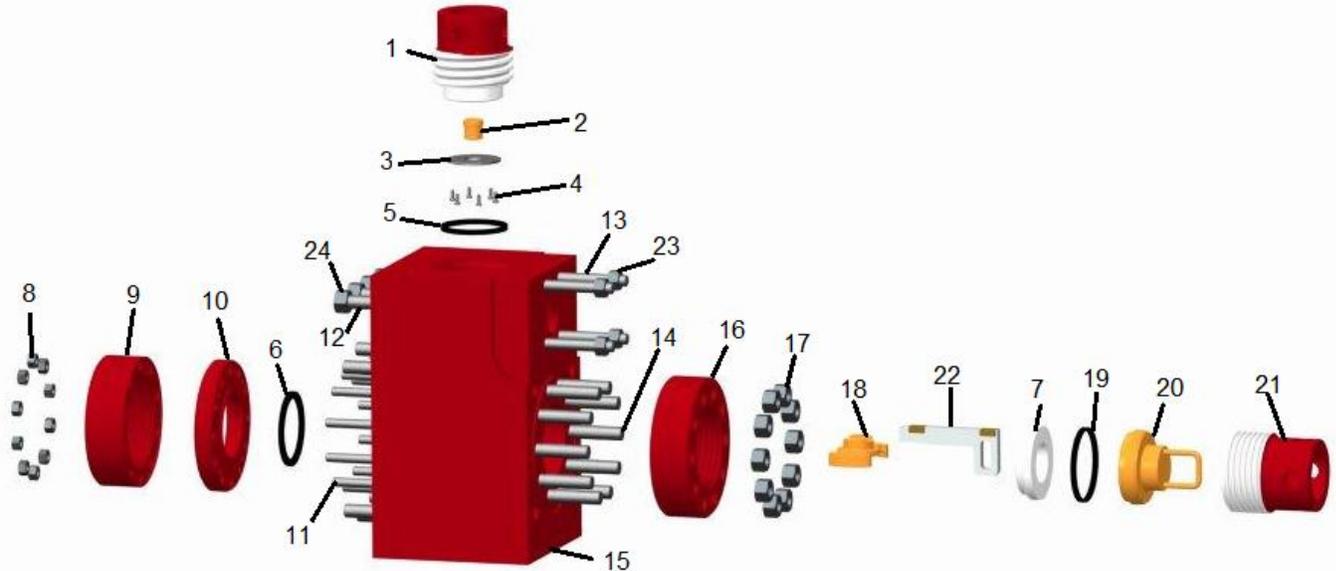
Item	Part Number	Description	Qty.
	1134258	Assembly, Crosshead	3
1	1134267	Bolt, Retainer Plate to Crosshead	4
2	1134261	Bolt, Retainer Plate to Wrist Pin	2
3	1134277	Plate, Wrist Pin Retainer	1
4	908404	Pin, Wrist	1
5	908429	Bearing, Wrist Pin	1
6	908399	Crosshead	1
7	1134260	Guide, Upper Crosshead	1
8	1134268	Guide, Lower Crosshead	1
9	1134273	Bolt, Crosshead Guide	8
10	908402	Rod, Crosshead Extension	1
11	1134267	Bolt, Extension Rod	8
12	1134266	Baffle	1
13	1134264	Gasket, Wiper Box	1
14	1134263	Box, Wiper	1
15	1317786	Seal, Double-Lip 4½" x 5½" x ½"	2
16	1123535	Spring, Wiper Box	1
17	1124898	O-ring, Wiper Box Front Plate	1
18	1124899	Screw, Cap ⅜" – 16 UNC x 1½"	4
19	1134271	Retainer Ring, Seal, Diaphragm, Wiper Box	1
20	1134269	Plate, Locking, Crosshead Guide	8
21	908042	Washer M10	4
NS	1124917	Tie-Wire	-
NS	509759	Loctite	-



## 7.2 Valve Over Valve 5000 psi Fluid End Assembly



Item	Part Number	Description	Qty.
	1134282	Assembly, Fluid End	1
1	1125015	Nut, Discharge Manifold	12
	1134315	Stud, 1¼" – 8 UNC x 2B	12
2	1134290	Manifold, Discharge	1
3	1248435	Cap screw, M22 x 65	18
4	1134306	Manifold, Suction	1
NS	0767106	O-Ring, Discharge Manifold	3
NS	0767109	O-Ring, Suction Manifold	3
NS	1125010	Dampener Suction	1
NS	1125009	Cover, Suction Dampener	1

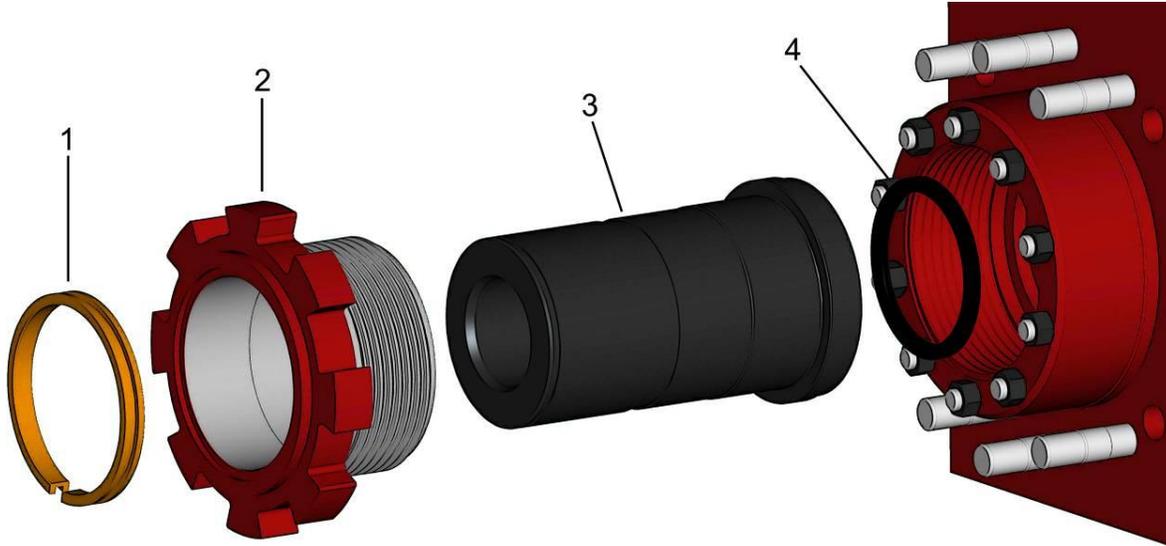
**7.2.1 Valve Over Valve Module Assembly**


Item	Part Number	Description	Qty
	2088480	Assembly, Module	
1	1134294	Cover, Discharge Valve	1
2	1134307	Guide, Upper	1
3	1134309	Retainer, Upper Valve Guide	1
4	1249115	Cap screw, HH 3/8" – 16 UNC x 1"	6
5	1317791	Seal, Cover, Discharge Valve	1
6	1317805	Seal, Liner/Wear Plate NBR	1
7	1134288	Spacer, Cylinder Head Plug	1
8	1134314	Nut, Liner Retainer Stud 1" -8UNC	10
9	1134296	Flange, Liner Retainer	1
10	0889432	Wear Plate	1
11	1134313	Stud, Liner Retainer, 1" – 8UNC	10
12	1125012	Stud, Power End 1½" – 8 UNC	10

Item	Part Number	Description	Qty
13	1134315	Stud, Discharge Manifold 1¼" – 8 UNC	4
14	1134312	Stud, Cylinder Head 1½" – 8 UNC	10
15	0889428	Module, Bare	1
NS	1823019	Module, Studded	1
16	1134283	Ring, Threaded	10
17	1125013	Nut, Cylinder Head Stud 1½" – 8 UNC	1
18	1134286	Guide, Lower Suction Valve	1
19	1317656	Seal, Plug Cylinder Head	1
20	1134287	Plug, Cylinder Head	1
21	1134284	Gland, Cylinder Head	4
22	1134285	Retainer, Lower Valve Guide	1
23	1125015	Nut, Discharge Manifold Stud 1¼" – 8 UNC	10
24	1125013	Nut, Power End Stud 1½" – 8 UNC	10



**7.2.2 Liners**

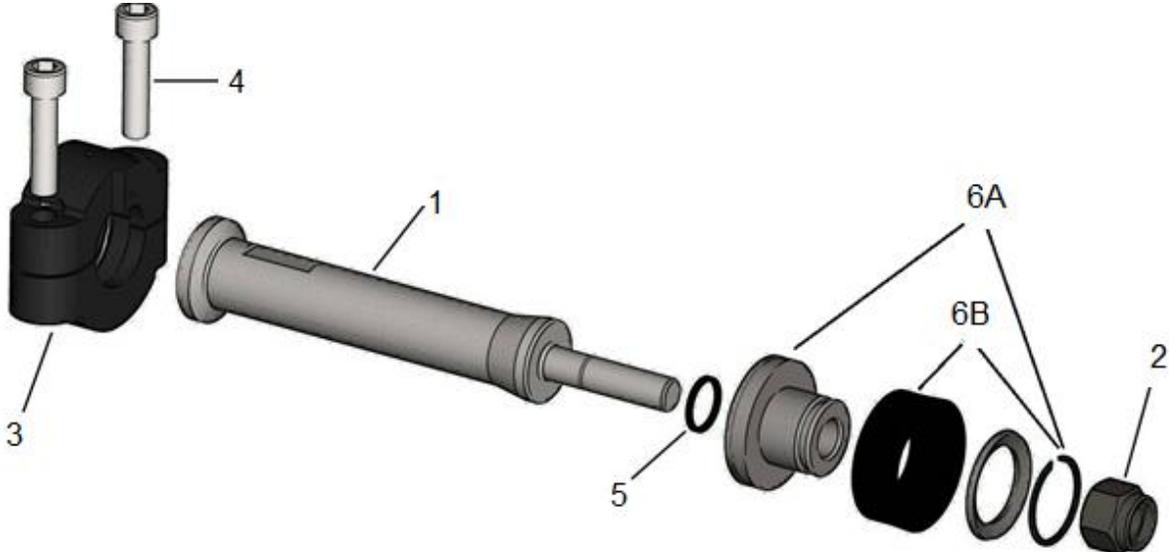


Item	Part Number	Description	Qty.
1	1317073	Split Ring Gland Retainer	3
NS	2285335	O-ring	3
2	1134297	Lock, Liner	3
3	See Below	Liner	3
4	See Below	Gasket, Liner	3

Liner Size	Liners		Liner Gaskets	
	Chrome Iron	Zirconia Ceramic	Rubber	Urethane
4.000"	1317099	1317116	1317805	1317807
4.500"	1317159	1317175	1317805	1317807
5.000"	1317213	1317225	1317805	1317807
5.500"	1317264	1317276	1317805	1317807
6.000"	1317313	1317324	1317805	1317807
6.500"	1317359	1317370	1317805	1317807
7.000"	1317396	1317406	1317805	1317807



**7.2.3 Piston Assembly**

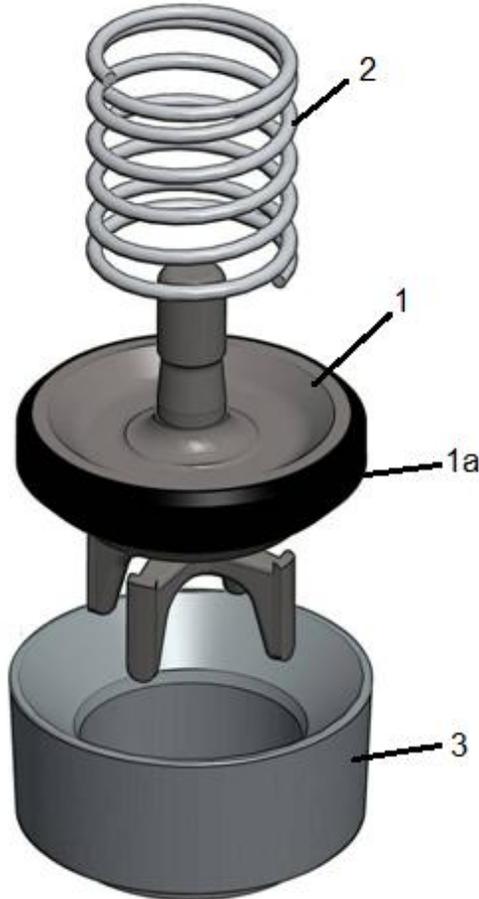


Item	Part Number	Description	Qty.
1	0889438	Piston Rod	3
2	1133856	Nut	3
3	1134301	Piston Rod Clamp	3
4	1323512	Bolt Piston Rod Clamp	6
5	0766945	Seal Piston Head	3
NS	1878015	Liner Baffle	3

Item	Description	Bonded DD Urethane	Bonded DD HT Urethane	Bonded Nitrile	Replaceable Nitrile Complete 5A	Replaceable Nitrile Rubber 6B	Qty.
8	Piston, 4.00 inch	1317542	1317541	1317543	1317544	1317520	3
	Piston, 4.50 inch	1317550	1317549	1317551	1317552	1317522	3
	Piston, 5.00 inch	1317558	1317557	1317559	1317560	1317524	3
	Piston, 5.50 inch	1317566	1317565	1317567	1317568	1317526	3
	Piston, 6.00 inch	1317574	1317573	1317575	1317576	1317528	3
	Piston, 6.50 inch	1317582	1317581	1317584	1317585	1317530	3
	Piston, 7.00 inch	1317591	1317590	1317592	1317593	1317532	3



**7.2.4 Valve Assembly**



Item	Description	Full Open	Full Open HT	3 Web CG	3 Web CG HT	4 Web CG	4 Web CG HT	Qty.
1	Valve with Bonded Insert	1318059	1318060	-	-	-	-	6
	Valve with Insert	1318061	-	1318056	1318055	1318058	1318057	6
1a	Replaceable Insert	1317998	-	1317994	1317995	1317996	1317997	6
2	Valve Spring CS	1318029	1318029	-	-	1318027	1318027	6
	Valve Spring SS	1318037	1318037	1318031	1318031	1318035	1318035	6
3	Valve Seat	1318014	1318014	1318012	1318012	1318013	1318013	6
NS	Puller Head	1317878	1317878	1317876	1317876	1317877	1317877	1
NS	Valve Seat Puller Kit*	1241141	1241141	1241141	1241141	1241141	1241141	1

\*Valve puller kits do not contain the puller head.