Standard
Distribution

BOLTED SBOP
USER'S MANUAL

NATIONAL OILWELL VARCO

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Shaffer Bolted Cover Spherical BOP User's Manual

Prepared For:

Standard Distribution

Doc. P/N: 29100101

NATIONAL OILWELL VARCO

USER'S MANUAL

Shaffer Spherical® BOP
Bolted Cover

Customer Name
Rig Name
Sales Order Number

Reference	Reference Description
Standard IOM	

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Document Number	Rev.
29100101	**B**

NATIONAL OILWELL VARCO

www.nov.com

Revision History

B	22-06-2007	Add BOM table			
A	20-10-2005	Issued for implementation			
Rev	**Date (dd.mm.yyyy)**	**Reason for issue**	**Prepared**	**Checked**	**Approved**

Change Description

Revision	Change Description
A	First issue
B	Add 7-5M “Snubber” Table on page 5-11

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General Information

Conventions

This manual is intended for use by field engineering, installation, operation, and repair personnel. Every effort has been made to ensure the accuracy of the information contained herein. National Oilwell Varco (NOV), will not be held liable for errors in this material, or for consequences arising from misuse of this material.

Notes, Cautions, and Warnings

Notes, cautions, and warnings provide readers with additional information, and to advise the reader to take specific action to protect personnel from potential injury or lethal conditions. They may also inform the reader of actions necessary to prevent equipment damage. Please pay close attention to these advisories.

Note:

The note symbol indicates that additional information is provided about the current topic.

Caution:

The caution symbol indicates that potential damage to equipment, or injury to personnel exists. Follow instructions explicitly. Extreme care should be taken when performing operations or procedures preceded by this caution symbol.

Warning:

The warning symbol indicates a definite risk of equipment damage or danger to personnel. Failure to follow safe work procedures could result in serious or fatal injury to personnel, significant equipment damage, or extended rig down time.

Illustrations

Illustrations (figures) provide a graphical representation of equipment components or screen snapshots for use in identifying parts, or establishing nomenclature, and may or may not be drawn to scale.

For component information specific to your rig configuration, see the technical drawings included with your equipment documentation.

Safety Requirements

The National Oilwell Varco equipment is installed and operated in a controlled drilling rig environment involving hazardous situations. Proper maintenance is important for safe and reliable operation. Procedures outlined in the equipment manuals are the recommended methods of performing operations and maintenance.

To avoid injury to personnel or equipment damage, carefully observe requirements outlined in this section.

Personnel Training

All personnel performing installation, operations, repair, or maintenance procedures on the equipment, or those in the vicinity of the equipment, should be trained on rig safety, tool operation, and maintenance to ensure their safety.

Personnel should wear protective gear during installation, maintenance, and certain operations.

Contact the National Oilwell Varco training department for more information about equipment operation and maintenance training.

Recommended Tools

Service operations may require the use of tools designed specifically for the purpose described. The equipment manufacturer recommends that only those tools specified be used when stated. Ensure that personnel and equipment safety are not jeopardized when following service procedures and that personnel are not using tools that were not specifically recommended by Manufacturer.

General System Safety Practices

The equipment discussed in this manual may require or contain one or more utilities such as electrical, hydraulic, pneumatic, or cooling water.

Read and follow the guidelines below before installing equipment or performing maintenance to avoid endangering exposed persons or damaging equipment.

- Isolate energy sources before beginning work.
- Avoid performing maintenance or repairs while the equipment is in operation.
- Wear proper protective equipment during equipment installation, maintenance, or repair.

Replacing Components

- Verify that all components (such as cables, hoses, etc.) are tagged and labeled during assembly and disassembly of equipment to ensure correct installment.
- Replace failed or damaged components with original equipment manufacturer certified parts. Failure to do so could result in equipment damage or injury to personnel.

Routine Maintenance

Equipment must be maintained on a routine basis. See product-specific service manuals for maintenance recommendations.

Failure to conduct routine maintenance could result in equipment damage or injury to personnel.

Proper Use of Equipment

National Oilwell Varco equipment is designed for specific functions and applications, and should be used only for its intended purpose.

Introduction

The Shaffer Spherical Blowout Preventer (BOP) has five major parts-upper housing, lower housing, sealing element, adapter ring, and piston (see Figure 2-1 and Figure 2-2).

This manual provides the installation, operation, and maintenance procedures for the bolted-cover Spherical BOP. Shaffer bolted-cover models are the smaller Sphericals which operate under lower working pressure for general land drilling operations. The wedge-cover models are the larger Sphericals with higher working pressures.

All pressure references are working pressures unless otherwise specified.

Bolted-cover models are rated for the working pressures and bore sizes shown in the table titled "Bolted-Cover Models" on page 2-2.

Shaffer bolted-cover Spherical BOPs will seal on almost any shape or size kelly, tool joint, drill pipe, drill collar, casing, or wireline as well as close on an open hole. The sealing element maintains a seal while expanding and contracting to allow each tool joint to pass. This capability permits stripping of drill pipe under well pressure.

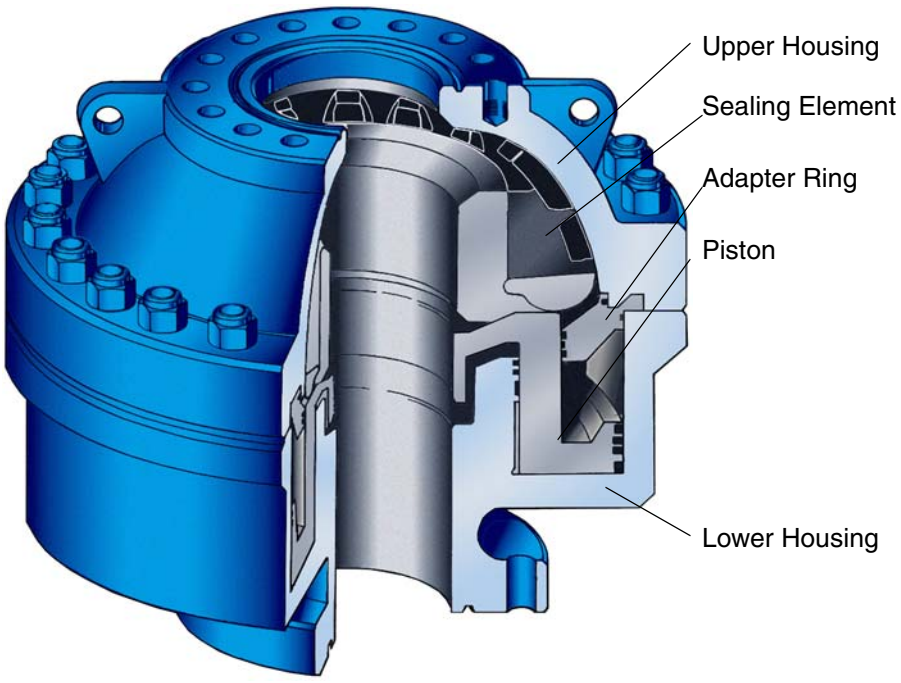


Figure 2-1. Bolted-Cover Spherical BOP

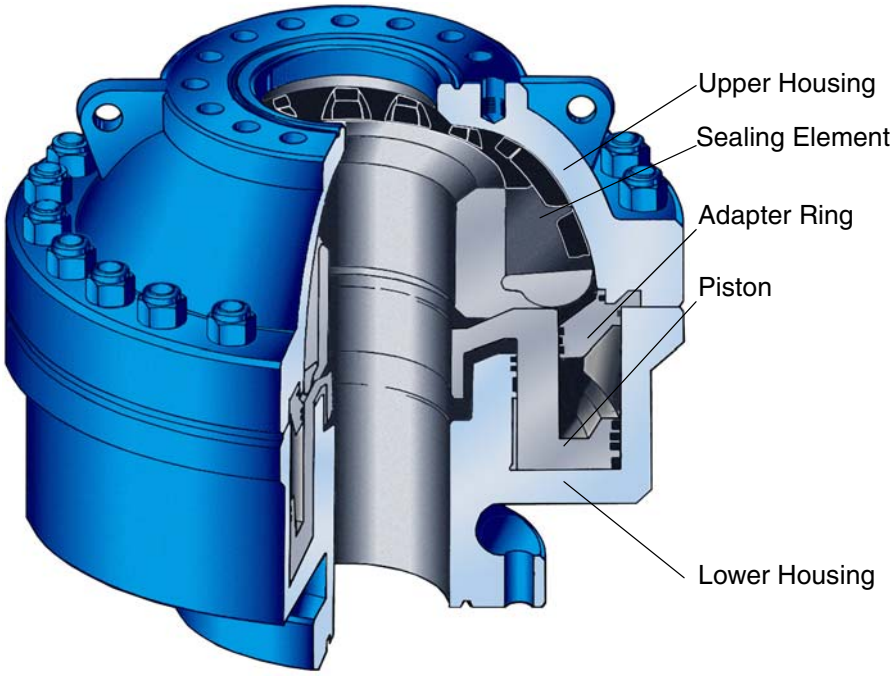


Figure 2-2. Hollow-Piston Bolted - Cover Spherical BOP

Bolted-Cover Models

Working Pressure psi	Bore Size
10,000 (690) psi	4 1/16"
	7 1/16"
5,000 (345) psi	13 5/8"
	13 5/8" *
	11"
	11" *
	9"
	7 1/16"
3,000 (207) psi	13 5/8"
	11"
	9"
	7 1/16"
2,000 (138) psi	21 1/4"
	21 1/4" *
1,000 (69) psi	30"

** Lightweight*

Features

The Spherical features the following advantages:

- Few parts, strong construction
- Rugged, reliable sealing element
- Steel segments to strengthen rubber sealing element
- Smooth, dependable action
- Compact, forged body saves space
- Easy servicing
- Wear bands to prevent metal-to-metal contact
- Simple operating requirements
- Lightweight models

A standard Spherical meets all applicable American Petroleum Institute (API) requirements. Current models are suited for internal H_2S service and meet National Association of Corrosion Engineers (NACE) Standard MR-01-75 (latest revision) requirements. If required, the Spherical can easily be fitted for external (full environmental) H_2S service as well. Field conversion for external H_2S service requires changing only the studs, nuts and lifting shackles.

Safety Precautions

During operation of the BOP and its control system, certain conditions may exist in which operators and technicians should heed potential hazards. Normally, most hazards are avoided by observing and exercising standard safety precautions.

Pneumatic Circuit Safety Precautions

Pneumatic source power is supplied to the control units at pressures and volumes high enough to warrant precautionary measures.

- Control line to the opening (upper) port (See the table titled "Recommended Hydraulic Closing Pressures on Casing" on page 3-12).
- Supply pneumatic source power at the correct pressure and volume to ensure proper operation of the equipment.
- Filter air to prevent any dirt or debris from entering the pneumatic circuit.
- Dry and lubricate air before it is used to pilot or operate any motor (hydraulic pump). Moisture can damage components and result in unit failure.
- Should a rupture or break occur in a pressurized pneumatic circuit, avoid contact with the escaping high-pressure stream of air.
- Before attempting any corrective action on the pneumatic circuit, verify that pneumatic source power is cut off and that all pneumatic pressure is completely vented. All pneumatic pressure gauges should read 0 psi (0 bar).

Hydraulic Circuit Safety Precautions

Hydraulic source power is produced by the control units at pressures and volumes high enough to warrant precautionary measures. Observing the precautions listed below will prevent damage to equipment and injury to personnel.

- Supply the recommended hydraulic fluid to ensure correct operation of the control system units (see the section titled "Recommended Hydraulic Closing Pressures on Casing" on page 3-12).
- Filter hydraulic fluid to prevent any dirt or debris from entering the hydraulic circuit.
- Ensure that the pressure relief valves are in working condition and are set to relieve at their designated pressure levels.
- Should a rupture or break occur in a pressurized hydraulic circuit, avoid contact with the escaping high pressure stream of hydraulic fluid.
- Before attempting any corrective action on the hydraulic circuit, verify the following:
  - Electric source power is turned off
  - Pneumatic source power is cut off
  - All hydraulic pressure is completely vented
  - All hydraulic pressure gauges should read 0 psi (0 bar)
- When precharging accumulators, use only nitrogen gas. The use of another gas may cause unit failure or explosion.

Cable and Hose Safety Precautions

The precautions listed below should be observed to prevent damage to equipment and injury to personnel.

- Protect electrical cables, pneumatic hoses, and hydraulic hoses from cutting, scraping, pinching, abrasion, or other physical damage.
- Route cables and hoses outside of traffic patterns and away from mechanical equipment.
- Comply with the prescribed minimum bend radius for cables and hoses. Twisting or bending of cables or hoses beyond the minimum bend radius can rupture the insulation and damage the conductors.

Welding and Cutting Safety Precautions

Observing the precautions listed below will prevent damage to equipment and injury to personnel.

- Do not weld or operate acetylene cutting torches near unprotected electrical cable, flexible hose, or hose bundles. Weld spatter can seriously damage the hose or cable.
- Prevent weld slag or spatter from entering the hydraulic system.

Do not heat, weld, or machine (hollow) pistons before contacting Shaffer for detailed instructions. (See Figure 2-1 on page 2-1 and Figure 2-2 on page 2-2). Hollow pistons may explode when heat is applied improperly. The following bolted-cover Spherical BOPs are available with hollow pistons:

11", 5,000 psi (279.40 mm, 345 bar)
13 $^{5}/_{8}$", 5,000 psi (346.07 mm, 345 bar)
21 $^{1}/_{4}$", 2,000 psi (539.75 mm, 138 bar)
All 30", 1,000 psi (762.00 mm, 69 bar) manufactured after January 1982

Work Area Safety Precautions

In order to prevent or reduce the severity of an injury, work should be performed in an area free of any dangerous obstructions, chemicals, or hazards of any kind. The precautions listed below should be observed in order to maintain a safe working environment.

- If any dangerous obstruction is located overhead, to the side, or on the surrounding floor of the work area, ensure that the hazard is removed.
- If any flammable materials are located or are spilled within or near the work area, ensure that the hazardous materials are removed and cleaned from the work area as safely and quickly as possible.

Flammable materials include but are not limited to the following:

Oily rags, paper products, or any combustible solid.
Kerosene, gasoline, or any combustible liquid.
Oxygen tanks, acetylene tanks, or any combustible gas.

Correct Replacement Parts

Many of Shaffer's BOP and system components are specially manufactured to system design specification. To avoid possible hazardous equipment failures, use only Shaffer replacement parts, components, and assemblies. See the section titled "Specifications and Parts Lists" on page 5-1 for spare parts lists.

Installation and Operation

Inspection

Prior to installing a Spherical, or before starting a new well, perform the tasks listed below.

1. Clean the Spherical in accordance with the table titled "Cleaning and Lubricating Instructions" on page 4-42.
2. Inspect the Spherical components for physical damage and excessive wear (see the section titled "Preventative Maintenance Program for Spherical BOPs" on page 4-4).
3. Look through the bore of the upper housing to check the piston and lower housing bores for excessive wear. The bore should not be worn more than $^{1}/_{8}$" (3.17 mm) oversize at any point around the bore.
4. Visually check the sealing element (top of the ID) for discrepancies such as cracking, gouging, chunking, or splitting. Replace the sealing element if necessary (see the section titled "Changing Sealing Element" on page 4-11 and the section titled "Low Temperature Service" on page 4-41).

Cleaning, inspection, and testing of the Spherical immediately after completion of drilling operations reduces installation time on the next well, or delays due to unexpected repairs.

Installation

The procedures listed below should be performed when installing the Spherical on flanged, studded, or hubbed connections.

Refer to the table titled "API Bolting Data" on page 3-4, to ensure that API studs are torqued in accordance with API specifications.

All torque data is based on the API 5A2 recommended lubricant which should be applied to threads and nut face.

Refer to the table titled "API Hub Data" on page 3-4 for API hub information.

Flanged and Studded Connections

(See Figure 3-1)

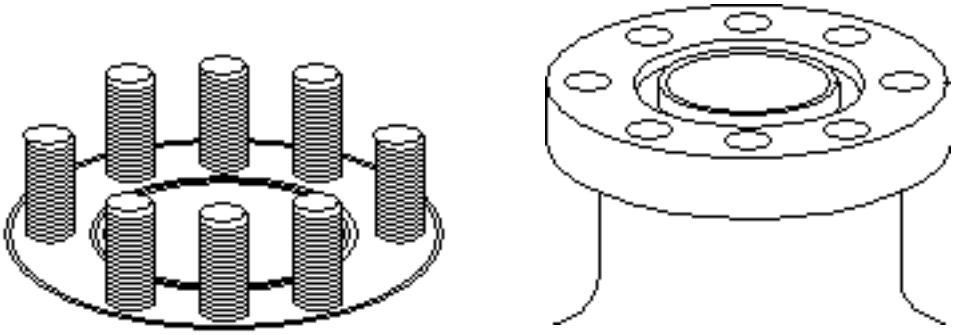
1. Install the ring gasket.

2. Install the Spherical on the mating flange.
3. Install the studs and/or nuts.

Use extreme care during the removal and installation of tapend studs. Inspect the threads of the stud and the stud hole for damage such as deformation, stripping, or burrs. Do not over torque studs when installing in studded flange.

Use specified lubricants.

Do not use Loctite or similar compounds.



Studded

Flanged

Figure 3-1. End Connections

4. Tighten all joints uniformly in a diametrically staggered pattern as shown in Figure 3-2.
5. Lubricate all studs and nuts with grease specified in API 5A2.

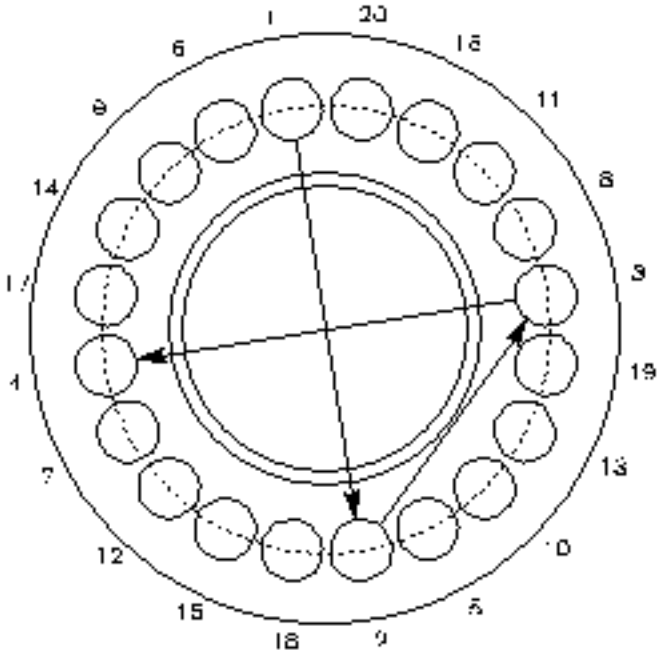


Figure 3-2. Torquing Pattern for Connections

Hubbed Connections

(See Figure 3-3)

1. When assembling the clamp joint, tighten the studs alternately from one side to the other.
2. Maintain the same distance between the two clamp halves.
3. the table titled "API Hub Data" on page 3-4 list clamp sizes for bolted-cover models with stud size, wrench size (across the nut flats), and recommended torques.

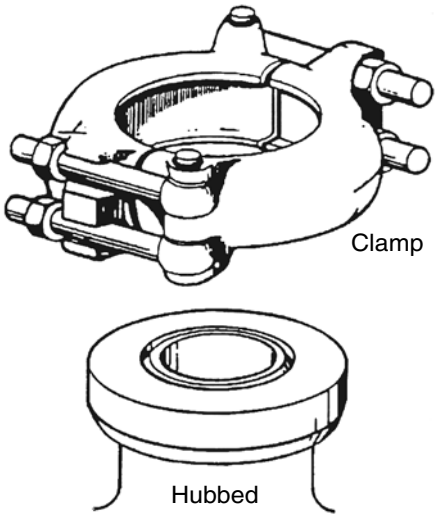


Figure 3-3. Hubbed Connections

API Hub Data

Working Pressure	10,000 psi					5,000 psi			
Hub Size	$13\frac{5}{8}$"	11"	9"	$7\frac{1}{16}$"	$4\frac{1}{16}$"	$13\frac{5}{8}$"	11"	9"	$7\frac{1}{16}$"
Clamp Number	12A	11A	8A	7A	5A	9A	8A	7A	6A
Bolt Size	$3\frac{1}{4}$"	$2\frac{3}{4}$"	$2\frac{1}{2}$"	2"	$1\frac{3}{8}$"	$2\frac{5}{8}$"	$2\frac{1}{2}$"	2"	$1\frac{5}{8}$"
Wrench Size, Nut Across Flats	5"	$4\frac{1}{4}$"	$3\frac{7}{8}$"	$3\frac{1}{8}$"	$2\frac{3}{16}$"	$4\frac{5}{8}$"	$3\frac{7}{8}$"	$3\frac{1}{8}$"	$2\frac{9}{16}$"
Recommended Torque (ft.-lb.)*	11,865	7,100	5,290	2,650	820	6,185	5,290	2,650	1,390
Ring Gasket	RX-57	RX-53	RX-49	RX-45	RX-35	RX-57	RX-53	RX-49	RX-45

**Torques calculated to produce stress of 40,000 psi in the clamp bolt when thread and nut bearing surfaces are well-lubricated with API 5A2 thread compound. Use of other compounds without proper change in torque can result in: 1) overstressing clamp and bolt; or 2) insufficient preload on connection.*

Annular Installation, Hookup, and Preparation

API BX and RX Ring Gaskets

Reference the table titled "API Bolting Data" on page 3-4 lists the API BX and RX ring gasket sizes used on bolted-cover models.

API Bolting Data

WP	15,000 psi		10,000 psi					5,000 psi			
Flange Size (Ins)	$7\frac{1}{16}$"	$4\frac{1}{16}$"	$13\frac{5}{8}$"	11"	9"	$7\frac{1}{16}$"	$4\frac{1}{16}$"	$13\frac{5}{8}$"	11"	9"	$7\frac{1}{16}$"
API Stud Nut Size (Ins)	$1\frac{1}{2}$"	$1\frac{3}{8}$"	$1\frac{7}{8}$"	$1\frac{3}{4}$"	$1\frac{1}{2}$"	$1\frac{1}{2}$"	$1\frac{1}{8}$"	$1\frac{5}{8}$"	$1\frac{7}{8}$"	$1\frac{5}{8}$"	$1\frac{3}{8}$"
Wrench Size, Nut Across Flats (Ins)	$2\frac{3}{8}$"	$2\frac{3}{16}$"	$2\frac{15}{16}$"	$2\frac{3}{4}$"	$2\frac{3}{8}$"	$2\frac{3}{8}$"	$1\frac{13}{16}$"	$2\frac{9}{16}$"	$2\frac{15}{16}$"	$2\frac{9}{16}$"	$2\frac{3}{16}$"
Recom-mended Torque (ft.-lb.)*	1,400	1,200	3,220	2,040	1,400	1,400	600	1,700	3,220	1,700	1,200
Number of Studs	16	8	20	16	16	12	8	16	12	12	12
Ring Gasket	BX-156	BX-155	BX-159	BX-158	BX-157	BX-156	BX-155	BX-160	RX-54	RX-50	RX-46

API Bolting Data

WP	3,000 psi					2,000 psi	1,000 psi
Flange Size	$20\frac{3}{4}$"	$13\frac{5}{8}$"	11"	9"	$7\frac{1}{16}$"	$21\frac{1}{4}$"	30"
API Stud, Nut Size	2"	$1\frac{3}{8}$"	$1\frac{3}{8}$"	$1\frac{3}{8}$"	$1\frac{1}{8}$"	$1\frac{5}{8}$"	2"
Wrench Size Nut Across Flats	$3\frac{1}{8}$"	$2\frac{3}{16}$"	$2\frac{3}{16}$"	$2\frac{3}{16}$"	$1\frac{13}{16}$"	$2\frac{9}{16}$"	$3\frac{1}{8}$"

API Bolting Data (Continued)

WP	3,000 psi					2,000 psi	1,000 psi
Recom-mended Torque (ft.-lb.)*	3,850	1,200	1,200	1,200	600	1,700	3,650
Number of Studs	20	20	16	12	12	24	28
Ring Gasket	RX-74	RX-57	RX-53	RX-49	RX-45	RX-73	RX-95

**Values are based on a stress equal to 50% of minimum yield. Lubricant API 5A is applied to face and threads of all nuts.*

Attachment and Lifting of Spherical BOP

All bolted-cover Sphericals have two lifting lugs and two lifting shackles located on the top of the upper housing. Removable eyebolts are used to lift internal components and lower housing (see the table titled "Eyebolt Sizes" and Figure 3-4 below).

Eyebolt Sizes

Size	Working Pressure	Piston	Adapter Ring	Upper Housing	Lower Housing	Element
4 1/16"	10,000 psi (690 bar)	1/2"-13 NC	1/2"-13 NC	*	**	N/A
7 1/16"	3,000 psi (207 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
7 1/16"	5,000 psi (345 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
7 1/16"	10,000 psi (690 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
9"	3,000 psi (207 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
9"	5,000 psi (345 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
11"	3,000 psi (207 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
11"	5,000 psi (345 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
13 5/8"	3,000 psi (207 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
13 5/8"	5,000 psi (345 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
13 5/8"	5,000 psi (345 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC
21 1/4"	2,000 psi (138 bar)	5/8"-11 NC	5/8"-11 NC	*	**	5/8"-11 NC

Eyebolt Sizes (Continued)

Size	Working Pressure	Piston	Adapter Ring	Upper Housing	Lower Housing	Element
30"	1,000 psi (69 bar)	1"-8 UNC	$^{5}/_{8}$"-11 NC	*	**	1"-8 UNC
	—	$^{5}/_{8}$"-11 NC†	—	—	—	—

** When lifting the upper housing, use lifting shackles.*

*** When lifting the lower housing, use the bonnet studs.*

† Piston skirt

Figure 3-4. Lifting the Spherical BOP

Weights for each Spherical bore size, major components and the total lifting capacities of the shackles are listed in the table titled "Bolted-Cover Spherical BOP Specifications" on page 5-22 through the the table titled "Bolted-Cover Spherical BOP Specifications" on page 5-36.

Hydraulic Connections

Bolted-cover Spherical BOPs have opening and closing hydraulic ports which have female pipe threads. See the table titled "Recommended Hydraulic Closing Pressures on Casing" on page 3-12 for the thread sizes of each bolted-cover model. Hydraulic connections should be direct and free from restrictions to ensure quick BOP action.

Hydraulic Hookup

A BOP hydraulic control system is required to actuate the Spherical. The hookup required for basic operations is shown in Figure 3-5 below. A hydraulic regulator is required to prevent the operating pressure from exceeding the recommended closing pressure [1,500 psi (103 bar)] and allows application of lower operating pressures when stripping or when closing on large diameter casing.

This hookup should be used for all applications.

The Spherical can be used for stripping in subsea and land installation operations.

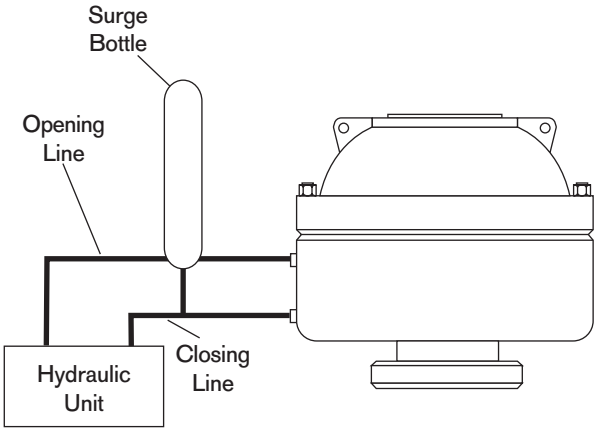


Figure 3-5. Spherical Installation Hookup

Subsea Installations

When installing the Spherical for subsea operations, the following items should be included in the hookup procedure:

- Control line to the opening (upper) port (see the "Hydraulic Connections" table below).

Precharge the accumulator bottle to 500 psi (34 bar) plus hydrostatic water depth (0.445 psi/feet).

- Hydraulic regulator for the accumulator system.

The purchase of spare accumulator bottles (in kit form) is optional. The the table titled "Accumulator Kits" on page 3-9 lists the accumulator bottle kit part number and the parts contained in each kit.

Hydraulic Connections

Working Pressure	10,000 psi			5,000 psi		
BOP Size (Inches)	7 1/16	4 1/16	13 5/8 *	11	9	7 1/6
NPT Size (Inches)	1 1/4	3/4	1 1/2	1 1/4	1 1/4	1
Quantity	2	2	2	2	2	2
Working Pressure	**3,000 psi**			**2,000 psi**	**1,000 psi**	
BOP Size (Inches)	13 5/8 *	11 *	9	7 1/6	21 1/4	30
NPT Size (Inches)	1 1/2	1	1	1	1 1/2	2
Quantity	2	2	2	2	2	4 (2 Open) (2 Close)

** Lightweight model has the same number of connections.*

Land Installations

When installing the Spherical for land operations, the following should be included in the hookup procedures:

- Accumulator surge bottle in the closing line adjacent to the Spherical during stripping (see Figure 3-5 on page 3-7).
- Control line to the opening (upper) port (see the "Hydraulic Connections" table above).
- Hydraulic regulator for the accumulator system.
- Surge bottle in the closing line to the Spherical to prevent excessive pressure surges when tool joints are stripped through the element.

Stripping is the only land operation that requires an accumulator bottle in the system. Accumulator bottle requirements for land hookup are identical to those required for subsea. Precharge the accumulator bottle to 500 psi (34 bar).

Hydraulic Circuits

Each Spherical BOP is equipped with at least one hydraulic port for the closing chamber and one hydraulic port for the opening chamber. The opening port is always the uppermost port. Refer to the "Accumulator Kits" table below for the quantity of hydraulic ports for each bore size. The location of the ports is shown in Figure 3-5 on page 3-7.

Accumulator Kits

Accumulator Bottle	10 Gallon	5 Gallon	1 Gallon		
Accumulator Kit Part Number	152720	152715	152716	152717	155157
Accumulator Bottle (Quantity)	150959(1)	150958(1)	150958(1)	150958(1)	155144(1)
Pipe Nipple (Quantity)	066196(1)	066193(1)	066194(1)	066195(1)	066192(1)
Pipe Tee (Quantity)	065041(1)	065038(1)	065039(1)	065040(1)	065037(1)
Pipe, Close Nipple (Quantity)	066110(1)	—	—	—	—
Pipe Swage (Quantity)	—	066050(1)	066049(1)	066048(1)	066044(1)

For the proper kit number to be used with a specific Spherical, refer to the parts list in the section titled "Specifications and Parts Lists" on page 5-1.

Hydraulic Operating Fluids

Hydraulic fluid should have the following characteristics:

- Non-freezing in cold climates
- Lubricity to reduce wear
- Chemical compatibility with elastomer seals
- Resistance to corrosion

Recommended Hydraulic Fluids

The following hydraulic fluids are listed in order of preference:

- Hydraulic oil with viscosity between 200-300 SSU at 100 ºF (38 ºC).
- Water with water soluble oil.
- Commercially available BOP pre-mixed fluid.

Do not use commercial antifreeze mixes.

Emergency Fluid Recommendations

In an emergency where hydraulic fluid is lost and the BOP must continue to operate, the fluids listed below can be substituted.

- When using hydraulic oil:
  - Add motor oil. SAE 10W is recommended, but heavier oils can be used.

- Add water if motor oil is not available. After the emergency, the hydraulic system must be flushed and refilled with hydraulic oil.

- When using a water/water soluble oil mixture, add more water. After the emergency, replace the fluid in the system with the proper mixture of water soluble oil and water.

Diesel fuel or kerosene-these flammable fluids cause the rubber goods to swell and deteriorate.

Drilling mud-the grit in this fluid will cause the pistons and cylinders to wear and gall rapidly.

Recommended Operating Pressures

In most applications, the Spherical opens and closes with 1,500 psi (103 bar) operating pressure. For stripping operations, see Figure 3-6.

The Spherical operates in three basic modes:

- Closing on stationary pipe or open hole (complete shutoff)
- Closing on casing
- Stripping operations

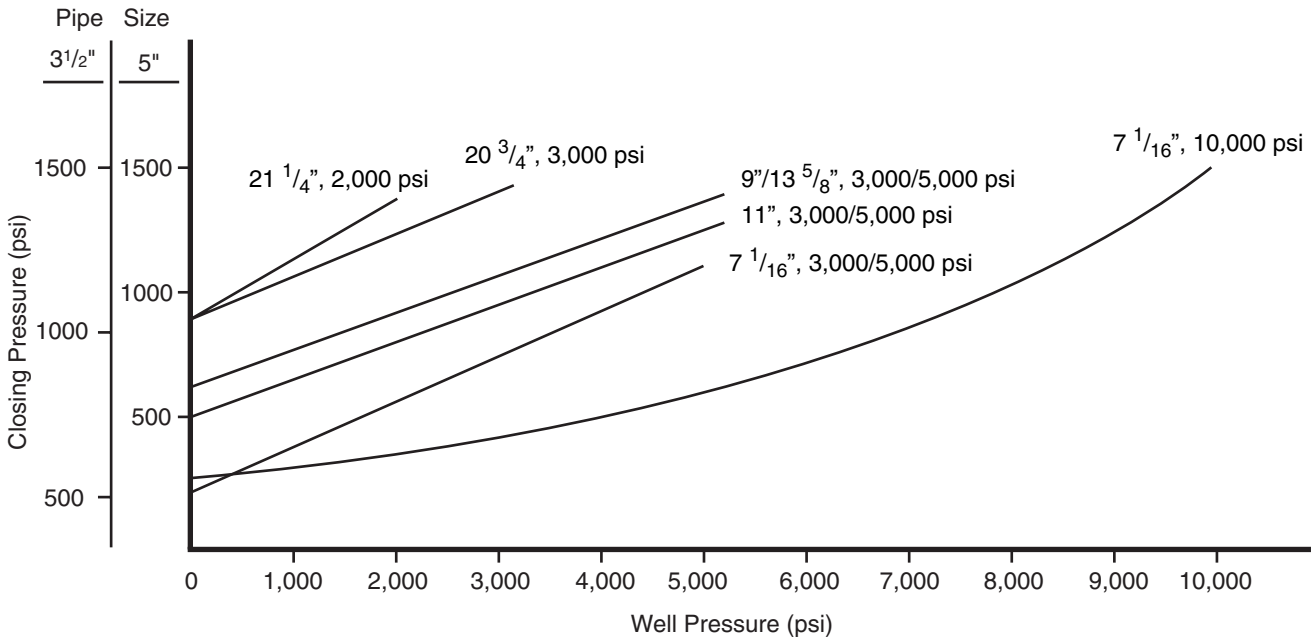


Figure 3-6. Guideline Closing Pressures for Stripping Operations

Closing on Stationary Pipe

To close the Spherical on stationary pipe with 7" (177.80 mm) OD or less, including open hole closure, apply 1,500 psi (103 bar).

A minimum of 1,200 psi (83 bar) is required to close the Spherical on an open hole.

Closing on Casing

To close the Spherical on casing, adjust the Spherical hydraulic operating pressure, if necessary, to avoid contact of the sealing element segments with the casing. See the "Recommended Hydraulic Closing Pressures on Casing" table below for the recommended closing pressures for pipe larger than 7" (177.80 mm). See Figure 3-7 for the recommended closing pressures on casing when operating the 30" (762.00 mm), 1,000 psi (69 bar) BOP.

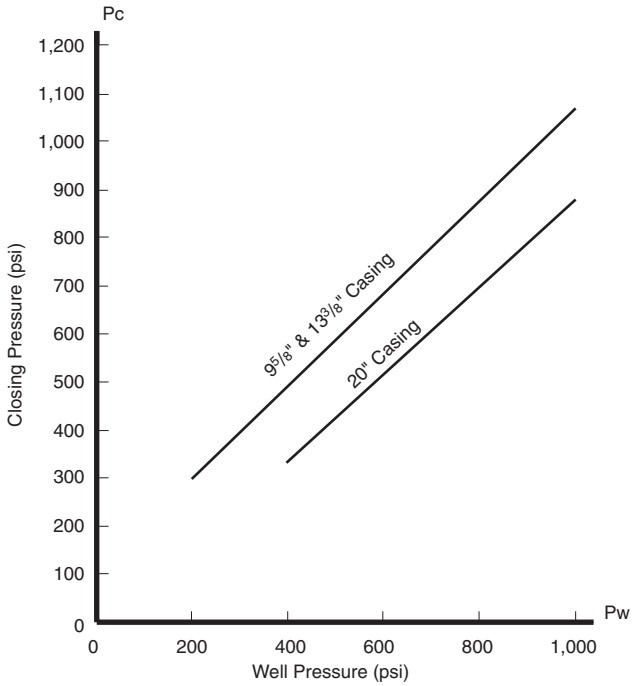


Figure 3-7. Recommended Closing Pressures on Casing (30"-1,000 psi BOP)

Excessive closing pressure may cause damage to large diameter casing due to the sealing element segments making contact with the casing. A special casing element Shaffer P/N 156450 is available for the 21 1/4" 2,000 psi (138 bar) (539.75 mm), Spherical.

Recommended Hydraulic Closing Pressures on Casing

Spherical Size*	Working Pressure (psi)	Casing Size									
		7"	7 5/8"	8 5/8"	9 5/8"	10 3/4"	11 3/8"	13 3/8"	16"	18 5/8"	20"
20 3/4"	3,000	1,500	1,400	1,175	975	790	640	480	300	190	150
21 1/4"	5,000	1,500	1,400	1,175	975	790	640	480	300	190	150
21 1/4"	2,000	1,500	1,400	1,175	975	790	640	480	300	190	150
18 3/4"	10,000	—	—	—	385	—	—	310	325	—	—
18 3/4"	5,000	1,500	1,400	1,175	975	790	640	480	300	—	—
16 3/4"	5,000	1,500	1,400	1,175	975	790	640	480	—	—	—
13 5/8"	3,000	1,500	1,265	890	615	415	280	—	—	—	—
13 5/8"	5,000	1,500	1,265	890	615	415	280	—	—	—	—
30"	1,000	—	—	—	1,100	—	—	1,100	—	—	900

** Spherical sizes not listed above require no pressure adjustments when closing on casing.*

Stripping Operations

Stripping operations are the most severe application for any Spherical. The sealing element is exposed to extreme wear as the drill string moves through the Spherical under pressure. The operating procedures listed below should be used to prolong the life of the sealing element when stripping.

1. Close the preventer with 1,500 psi (103 bar) pressure.
2. Before commencing stripping operations, reduce closing pressure sufficiently to allow a slight leak.
3. Strip with a slight leak to provide lubrication and to prevent excessive temperature buildup within the sealing element.
4. As the sealing element wears, increase closing pressure to prevent excessive leakage.

5. If conditions such as environmental protection requirements do not allow leakage during stripping operations, adjust the closing pressure sufficiently to maintain a seal.
6. As the closing pressure approaches 1,500 psi (103 bar) and wear on the sealing element is evident, switch to another Spherical to complete stripping operations.

The minimum pressure required to maintain a seal during stripping will vary, depending on the particular sealing element and its service history.

7. When stripping operations are completed, adjust the regulator to 1,500 psi (103 bar). Conservative closing pressure requirements for each Spherical are shown in Figure 3-6 on page 3-10. Use this chart as a starting point to determine required closing pressures. See Figure 3-8 for the closing pressure requirements for the 4 $^{1}/_{16}$", 10,000 psi (103.17 mm, 690 bar) Spherical.

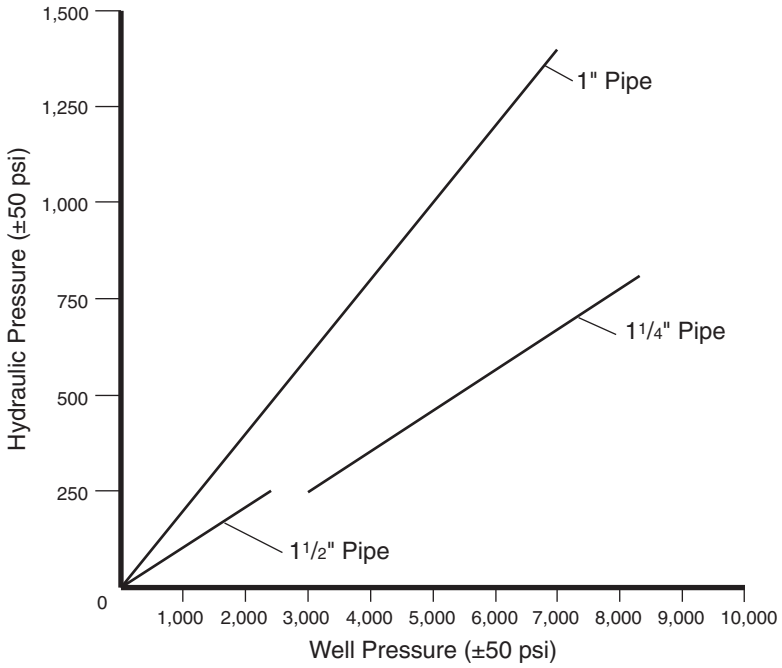


Figure 3-8. Guideline Closing Pressures for Stripping with 4 $^{1}/_{16}$", 10,000 psi BOP

The 4 $^{1}/_{16}$", 10,000 psi (103.17 mm, 690 bar) Spherical is designed for high pressure stripping operations and is capable of stripping in gas or mud medium. Observe general guidelines when stripping in a mud medium.

Wellbore Pressure Test

Test Seals A, B, C. The wellbore pressure test is a means of testing the Spherical BOP sealing element and piston ID upper seal. This test is performed prior to operating the Spherical BOP (see Figure 3-6 through Figure 3-9).

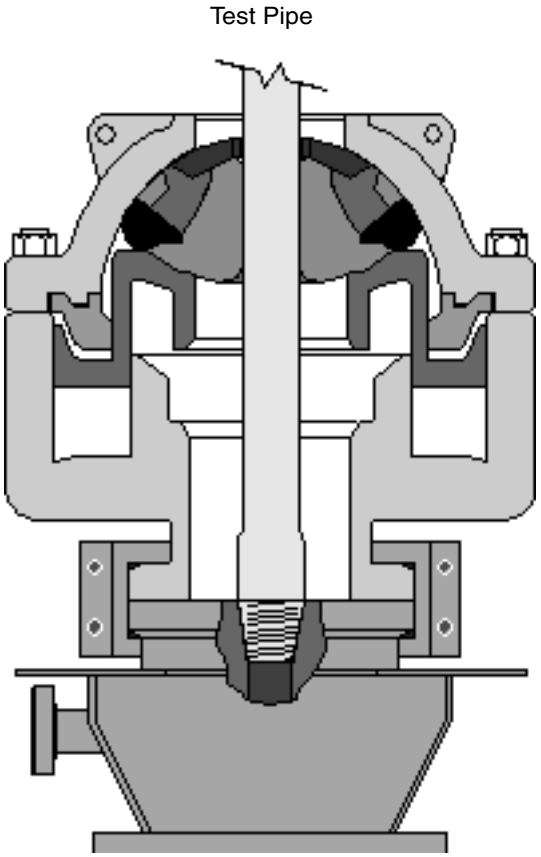


Figure 3-9. Anchoring Test Pipe to Blind Flange

Preparation (Rig Up)

The Spherical is tested according to the instruction listed below.

1. Place the Spherical on one of the following:
   - A stack
   - A test stump

- A blind flange

2. Install a valve between the test stump and the test pump.

Installation of Test Pipe

1. Install a test pipe or rod in the wellbore. The recommended pipe for a bolted-cover Spherical is 3 $^{1}/_{2}$" (88.90 mm) OD or 5" (127.00 mm) OD.
2. Anchor the test pipe at the bottom to prevent well pressure from forcing the pipe upward out of the Spherical (see Figure 3-9).

Do not use the sealing element to support the test pipe. This will damage the rubber in the bottom of the sealing element and cause excessive extrusion on top (see Figure 3-10).

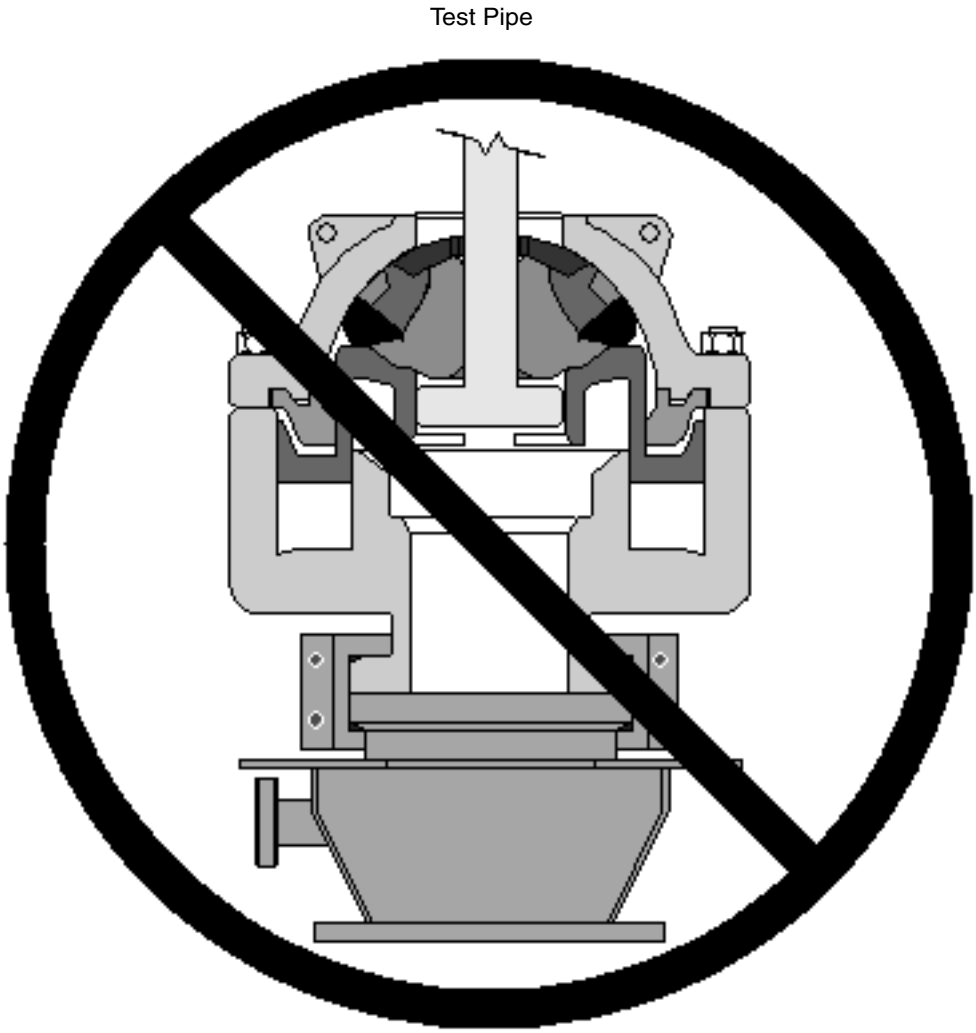


Figure 3-10. Improper Installation of Test Pipe

3. Seal the test pipe at the bottom so that well pressure cannot leak through it.

Pressure Gauge and Valves

Install a gauge and valve in both the closing and opening hydraulic lines (see Figure 3-11).

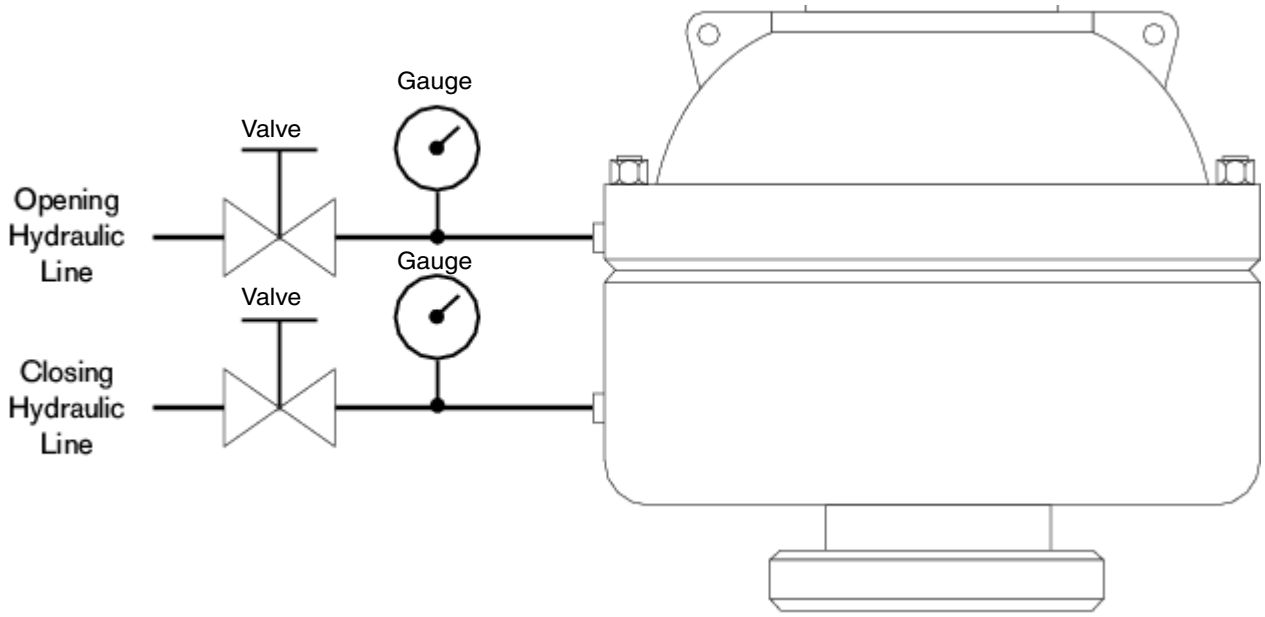


Figure 3-11. Hydraulic Hookup

Testing Seal A

Figure 4-9 on page 4-10

The following test procedures apply to all bolted-cover models.

Refer to Figure 4-6 on page 4-9 through Figure 4-10 on page 4-11 for the location of wellbore pressure seals A. In some models, seal C is mounted in the upper housing (see Figure 4-22 on page 4-26).

Shaffer recommends replacing all seals.

The wellbore pressure test is performed as described below.

1. Fill the Spherical with clean water.
2. Apply 1,500 psi (103 bar) hydraulic closing pressure to close the sealing element on the appropriate size test pipe.

Open and close the sealing element at least two times before closing the element on the test pipe in order to condition the rubber.

3. Apply wellbore pressure not to exceed the lowest rated working pressure as follows:
   - Control line to the opening (upper) port (see the table titled "Recommended Hydraulic Closing Pressures on Casing" on page 3-12)
   - Spherical body pressure rating
   - Spherical bottom connection pressure rating (stamped on the flange)
   - Spherical top connection pressure rating
   - Limiting pressure rating of any other component in the system
4. Maintain the wellbore pressure while observing the wellbore pressure gauge.

Due to the large rubber mass within the Spherical sealing element under pressure, there will be a movement (creeping) of rubber. This is not a leak. Maintain the test pressure for the time period specified by the operator. Refer to API 6A.

5. If there is no leak, reduce the wellbore pressure to 0 psi (0 bar). When wellbore pressure is zero, then reduce closing pressure to 0 psi (0 bar).
6. Apply 1,500 psi (103 bar) opening hydraulic pressure to open the Spherical.
7. If leaks occur while maintaining the wellbore pressure, check for leakage in the following locations:
   - Round the test pipe (water spillage over the top)
   - At the bottom connection of the Spherical to the test stump and in the well pressure piping system (visible leakage)

If no detectable leaks are found in these areas, seal A is leaking. To verify this leakage, follow the instructions listed below (see Figure 4-6 on page 4-9 thru Figure 4-9 on page 4-10).

- Maintain 1,500 psi (103 bar) closing hydraulic pressure.
- Pump slowly to maintain rated wellbore pressure.
- Close the valve in the hydraulic closing line.

The gauge in the hydraulic closing line will indicate a steady, constant increase in pressure if seal A is leaking. Open the valve in the hydraulic closing line before the gauge reaches 2,000 psi (138 bar).

- Reduce the wellbore pressure to 0 psi (0 bar). Open the valve in the hydraulic closing line.
- Apply hydraulic pressure to open the Spherical and bleed to 0 psi (0 bar) if disassembly is required.
- Check and replace damaged seal A in accordance with the section titled "Procedures for Disassembly and Assembly" on page 4-20 and the section titled "Replacing Seals" on page 4-29. Retest seal A for leakage.

Testing Seals B & C

The following test procedures apply to all bolted-cover models except the 30”, 1000 psi (762.00 mm, 69 bar) model (the section titled "Additional Testing for 30”, 1,000 psi (762.00 mm, 69 bar) Model" on page 3-20

Seals B and/or C can only be checked with the sealing element in the open position. If the sealing element is in the closed position, it will seal the area where the two seals are located from the wellbore pressure. If there is a need to check seals B and/or C, proceed according to the steps listed below.

1. Check seals B and/or C by flanging (or isolating by other means) the Spherical through bore, leaving the sealing element in the open position.
2. Apply wellbore pressure.
3. Check seal B by closing the valve in the opening line and observing the gauge in the opening line. This gauge should read 0 psi (0 bar). If the gauge does not indicate an increase in pressure, seal B is holding. If the gauge indicates a steady increase, seal B is leaking. To correct seal B leakage, proceed in accordance with the section titled "Disassembly" on page 4-20 (step 1 - 7) and the section titled "Replacing Seals" on page 4-29.
4. Maintain wellbore pressure and check seal C by inspecting for external leakage. In Spherical bolted-cover models, hydraulic fluid will flow out between the upper and lower housing flanges (see Figure 4-22 on page 4-26).
5. If seal C is leaking, perform step 1 - 5 in the section titled "Disassembly" on page 4-20. Replace seals in accordance with the section titled "Replacing Seals" on page 4-29.

6. After the Spherical has been reassembled, perform additional testing in accordance with the section titled "Closing Hydraulic Pressure Test (Seals 1 and 2)" on page 3-21 and the section titled "Opening Hydraulic Pressure Test" on page 3-24 to ensure that all seals were installed correctly.

Additional Testing for 30”, 1,000 psi (762.00 mm, 69 bar) Model

The modified wellbore pressure test procedures described below are used to test the piston ID upper seal A in the 30”, 1,000 psi (762.00 mm, 69 bar) spherical BOP.

1. Check seal A by flanging the spherical through bore on top and bottom, leaving the sealing element in the open position (Figure 4-10 on page 4-11).

Installation of a blind flange on top of the Spherical requires removal of the test pipe.

2. Apply wellbore pressure.
3. Check seal A by closing the valve in the hydraulic closing line and observing the gauge in the closing line. This gauge should read 0 psi (0 bar) initially. If the gauge does not indicate and increase in pressure, seal A is holding. If the gauge indicates a steady increase, seal A is leaking. Check and replace seal A (if damaged) in accordance with the section titled "Procedures for Disassembly and Assembly" on page 4-20 and the section titled "Replacing Seals" on page 4-29. After the spherical has been reassembled, retest to ensure that seal A was installed correctly.

Hydraulic System Pressure Test (Seals 1, 2, 3, 4 and 5)

The procedures described below are required to perform hydraulic pressure testing.

Warning

Observe appropriate safety precautions when working with hydraulic pressure. See Hydraulic Safety Precautions in the section titled "Hydraulic Circuit Safety Precautions" on page 2-3.

Equipment Hookup

Connect the opening and closing lines in the equipment as follows:

1. Install a gauge and valve in the opening and closing hydraulic lines in the Spherical (see Figure 3-11 on page 3-17).
2. Close and open the Spherical sealing element [1,500 psi (103 bar)] three or more times to clear all air from the hydraulic system.

Closing Hydraulic Pressure Test (Seals 1 and 2)

(Figure 3-12 and Figure 3-13)

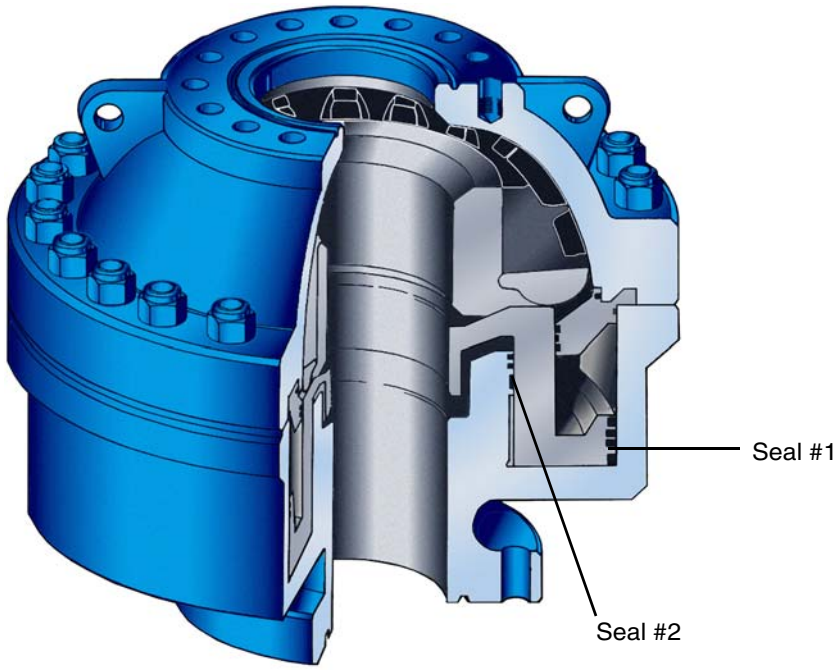


Figure 3-12. Seal #2 Leakage Check (Applicable To All Models)

1. Apply and maintain 1,500 psi (103 bar) closing hydraulic pressure. This will move the sealing element to the closed position.
2. Close the valve in the closing hydraulic line after waiting 2-3 minutes.

Due to the large amount of rubber in the sealing element, there will be some movement (creeping) of the rubber before it stabilizes. If the valve in the closing line is closed too early, this movement might be interpreted as a leak because the gauge pressure will drop as the element stabilizes.

3. Observe the gauge in the closing hydraulic line. If there is no pressure drops, seals #1 and #2 are holding. If there is a pressure drop, seals #1 and/or #2 are leaking.

Occasional air bubbles in the hydraulic fluid could cause a small pressure drop. If this occurs, it does not mean that the seals are leaking.

4. Open the valve in the closing hydraulic line to supply closing pressure to further identify the leak. Hold for 3-5 minutes.
5. Close the valve in the opening hydraulic line. The gauge in the opening line should read 0 psi (0 bar) initially. If there is a pressure increase on the gauge in the opening hydraulic line, seal #1 is leaking. If there is no pressure increase on the gauge in the opening hydraulic line, seal #2 is leaking.
6. To verify a leak at seal #2, reclose the valve in the closing hydraulic line.
7. Apply 1,500 psi (103 bar) opening pressure and inspect the lower housing bore area for the presence of hydraulic fluid (see Figure 3-14 on page 3-25). If seals #1 and/or #2 are leaking, proceed according to the section titled "Disassembly" on page 4-20 and the section titled "Replacing Seals" on page 4-29.

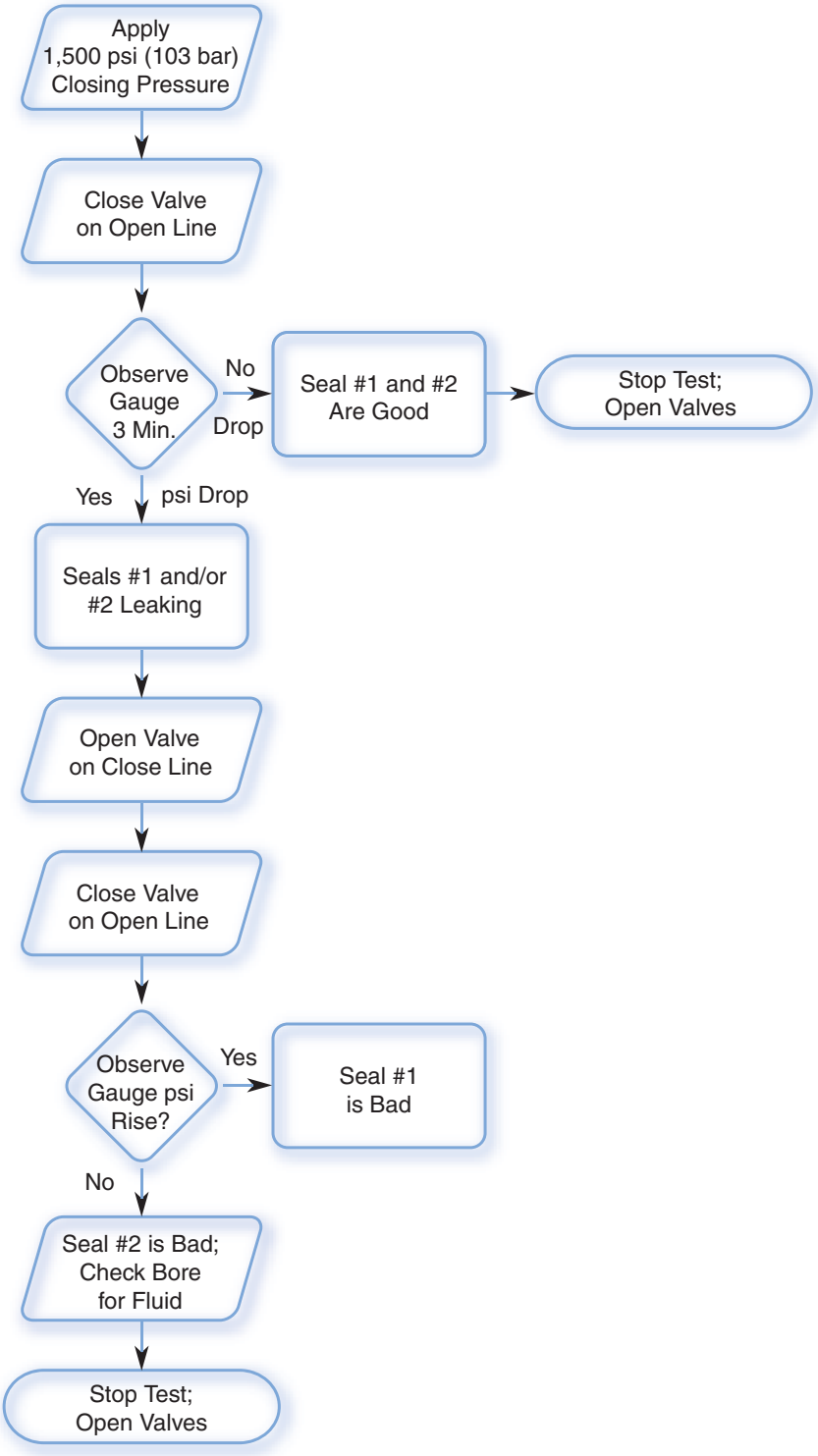


Figure 3-13. Closing Hydraulic Pressure Test Flowchart

Opening Hydraulic Pressure Test

(Figure 3-14 through Figure 3-16)

1. Apply and maintain 1,500 psi (103 bar) opening hydraulic pressure.
2. Close the valve in the opening hydraulic line.
3. Observe the opening hydraulic pressure gauge. If there is no pressure drop, seals #3, #4 and #5 are holding. If there is a pressure drop, one or more of the three seals are leaking

Occasional air bubbles in the hydraulic fluid could cause a small pressure drop. If this occurs, it does not mean that the seals are leaking.

4. Open the valve in the opening line to supply pressure to further identify the leak.
5. Check seal #5 by inspecting for external leakage. In Spherical bolted-cover models, hydraulic fluid will flow out between the upper and lower housing flanges (see Figure 3-15 on page 3-26).
6. Check seal #3 by closing the valve in the closing line, leaving the opening line open to pressure. The gauge in the closing line should read 0 psi (0 bar) initially. If pressure increases on the gauge in the closing line, seal #3 is leaking. If there is no pressure increase on the gauge in the closing line, seal #3 is holding.
7. To verify a leak at seal #4, visually inspect the top of the piston for the presence of hydraulic fluid (see Figure 3-16 on page 3-26).

The weight of the sealing equipment might cause a temporary seal between the sealing element and the top of the piston. Therefore, a leak in seal #4 might not show up immediately.

When abnormally large volumes of fluid are required to operate the Spherical, also check for a leak in the control system.

8. To replace seals #3, #4 or #5, proceed according to instructions in the section titled "Disassembly" on page 4-20, and the section titled "Replacing Seals" on page 4-29.

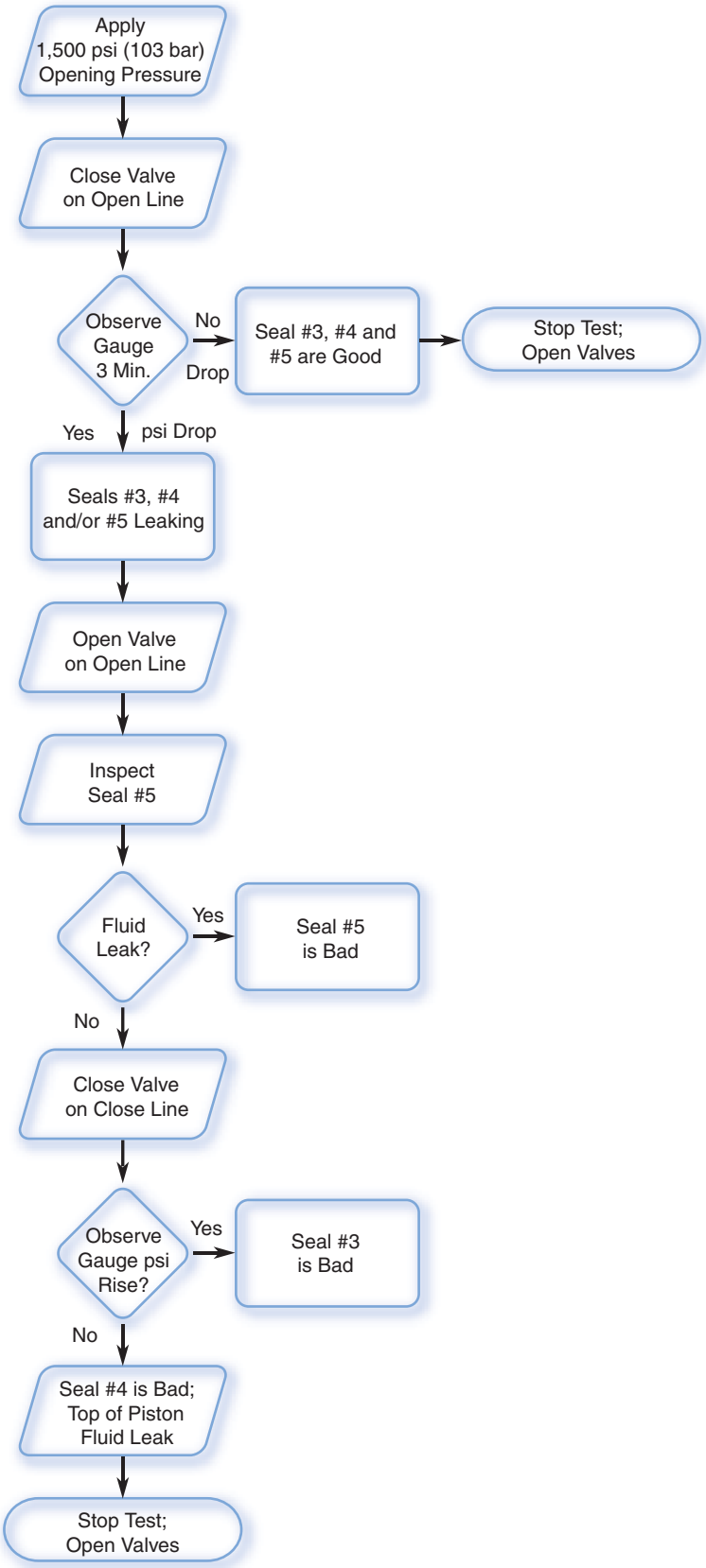


Figure 3-14. Opening Hydraulic Pressure Test Flowchart

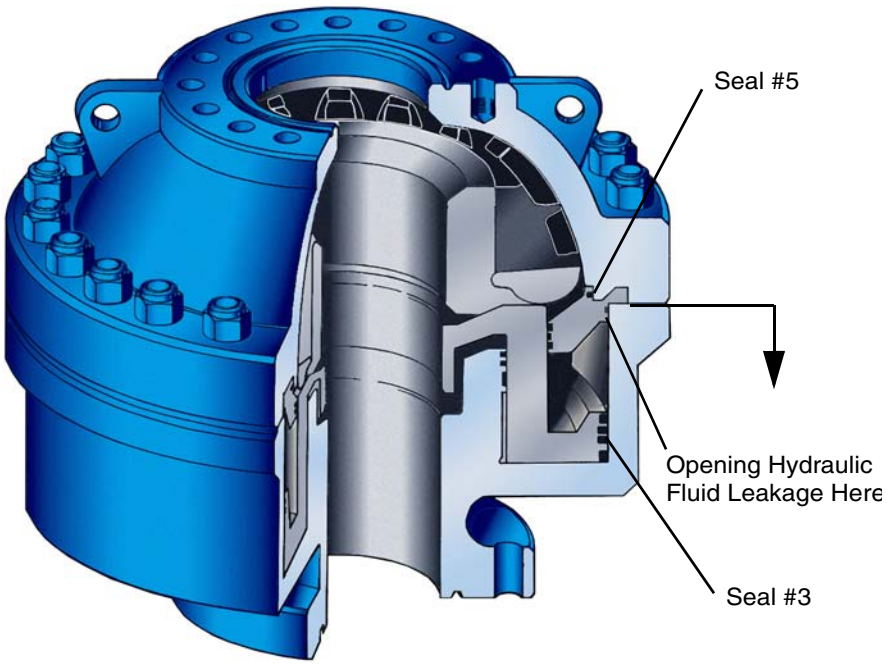


Figure 3-15. Seal #5 External Leakage Check (Applicable To All Models)

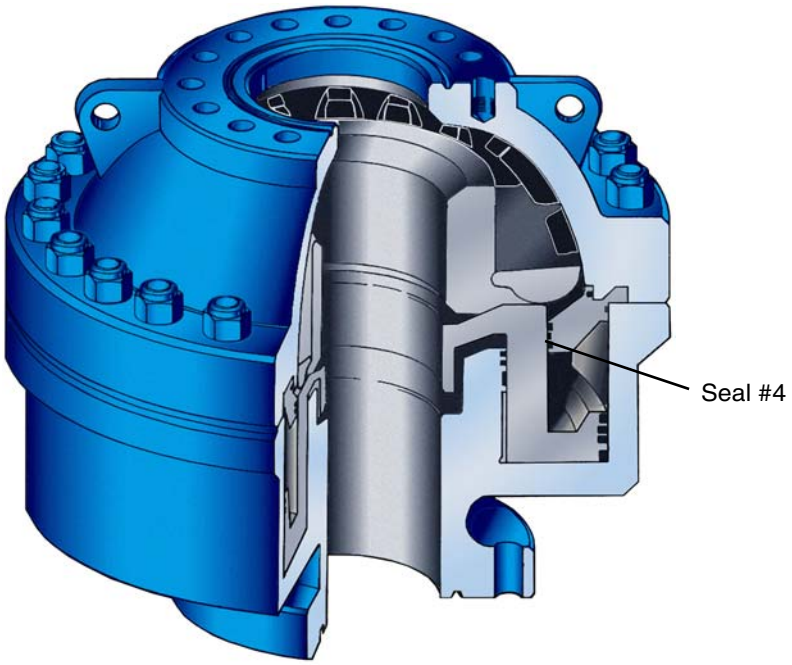
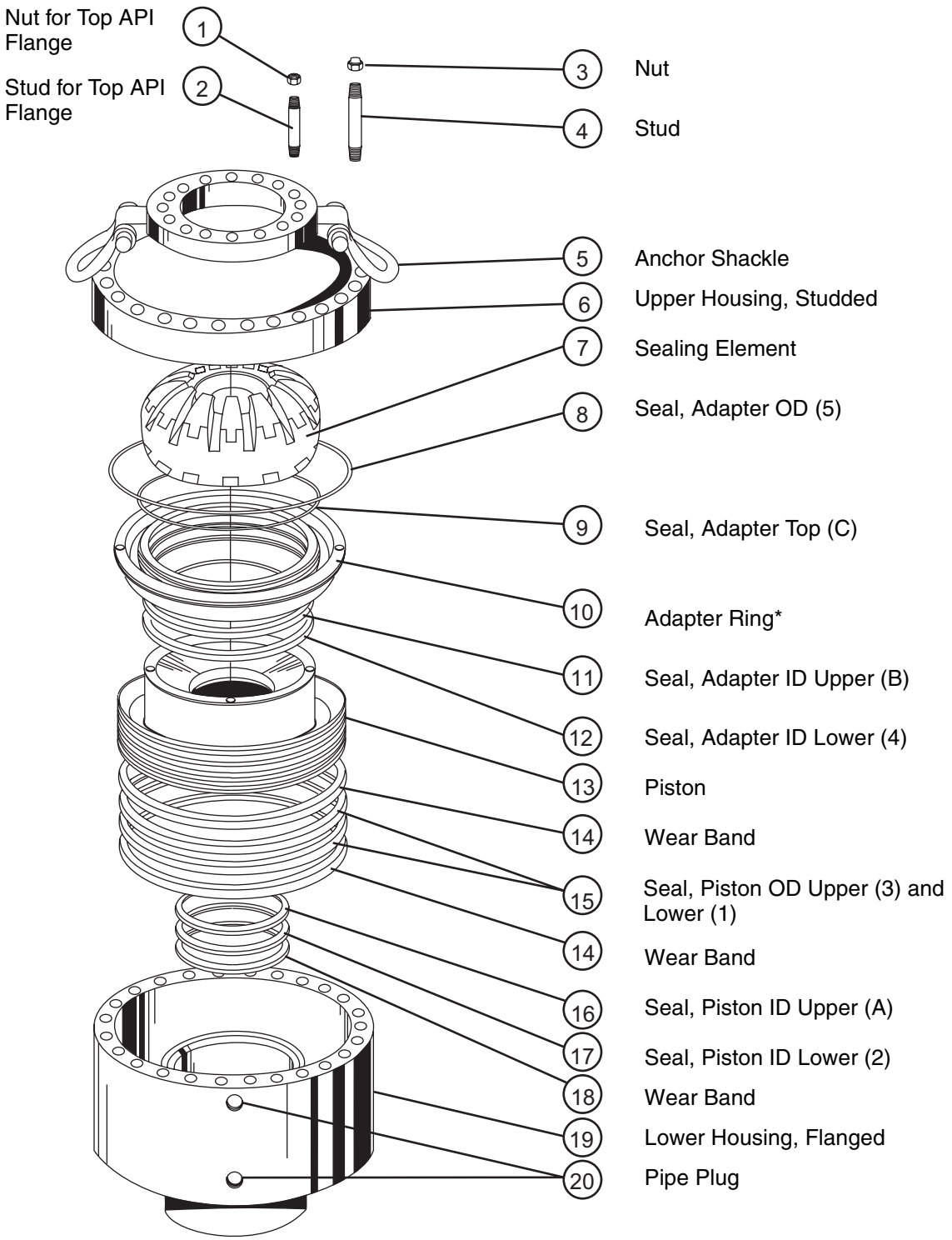


Figure 3-16. Seal #4 Leakage Check (Applicable To All Models)

Maintenance

Early detection and repair of irregularities in a Spherical BOP can prevent failure during a drilling emergency. A preventive maintenance program provides testing and inspection guidelines to ensure safe rig operation. All item numbers in parentheses correspond to the exploded views in Figure 4-1 and Figure 4-2. The the table titled "Preventative Maintenance Program for Spherical BOPs" on page 4-4 outlines the suggested testing and inspection schedule.



** Some bolted-cover sphericals have a wear band on the adapter ring. This wear band is not shown.*

Figure 4-1. Bolted-Cover Exploded View

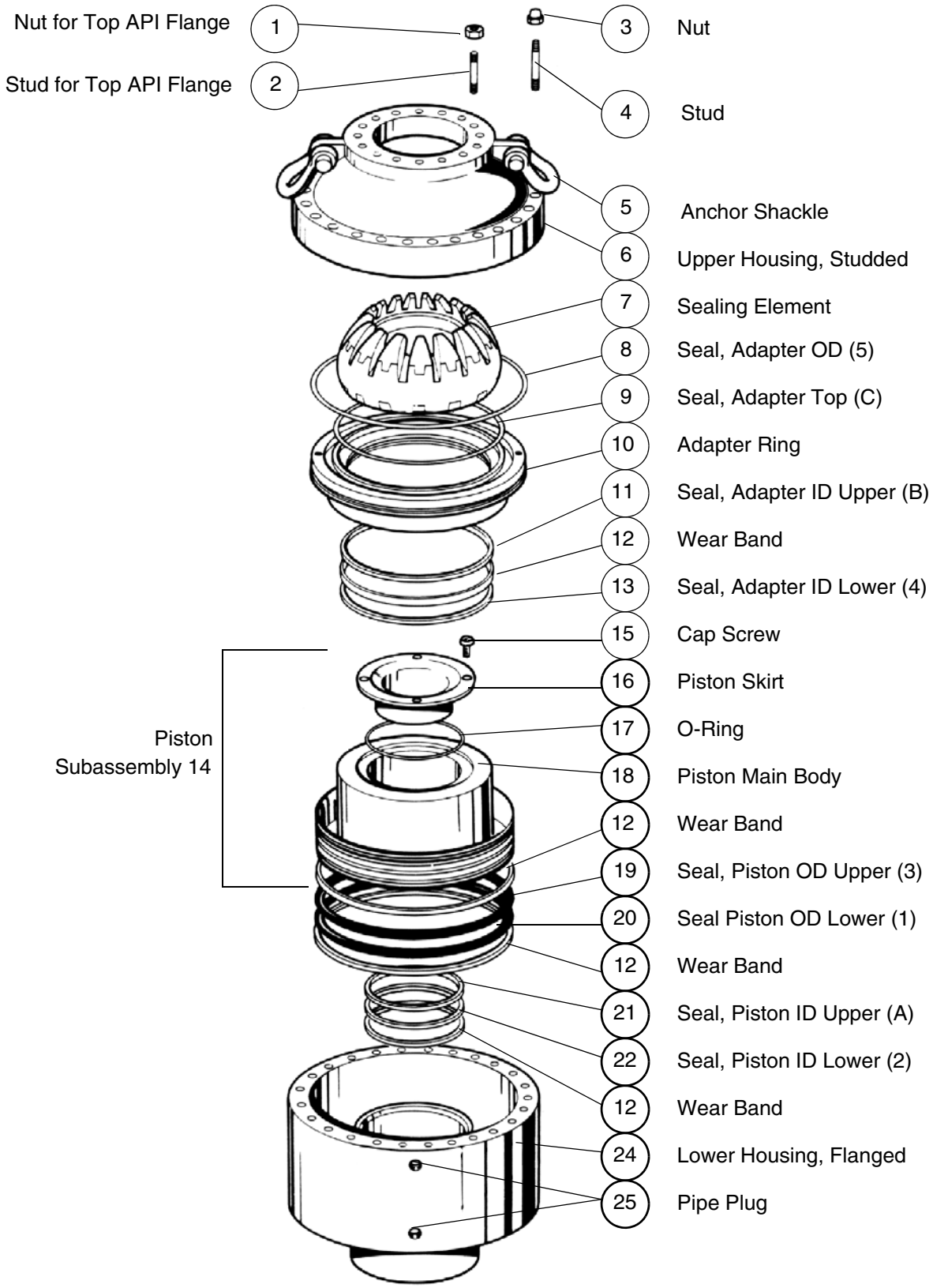


Figure 4-2. 30", 1,000 psi (762.00 mm, 69 bar) Bolted-Cover Spherical BOP

Preventative Maintenance Program for Spherical BOPs

	Performed		
Interval	**Where**	**By**	**Procedure**
Monthly or after each well	Rig	Rig personnel	Thoroughly clean the BOP and inspect for damage. Wellbore pressure test.
Yearly	Rig	Rig personnel or Shaffer Serviceman	Remove upper housing and sealing element. Inspect visually. Field repairs as needed. Hydraulic pressure test and wellbore pressure test.
Three years	Shaffer service facility or an adequate facility	Shaffer personnel or under Shaffer supervision	Completely disassemble. Repair or replace all parts as required. Replace all seals. Hydraulic pressure test and wellbore pressure test.

Monthly Preventative Maintenance

The Spherical BOP should be inspected for abnormal wear and accumulation of mud and gravel deposits on a routine basis using the procedures described below.

1. Function test the sealing element (7) daily. The sealing element is designed to clean the sphere as it closes. The wellbore pressure seals wipe the piston clean as it passes through them.

The interior of the spherical should be rinsed frequently with clean water. Frequent washings prolong seals and sealing elements and eliminate scoring of sealing surfaces caused by excessive buildup of solids or dried mud.

2. If cement reaches the Spherical during cementing operations, flush with fresh water to remove the cement before it sets.

   To remove accumulations of material deposits, follow the instructions listed below.

   - Before cement or other material deposits dry, function test the sealing element several times to squeeze out wet cement, and rinse with water.
   - In extreme cases, remove the upper housing and sealing element for thorough cleaning.

   Monthly maintenance does not normally require removal of any components.

3. Check all nuts and studs for damaged threads.

4. Visually check the upper housing (6), piston (13), and lower housing bores (19) for excessive wear.

Do not permit the bore to wear more than $^{1}/_{8}$" (3.17 mm) oversize at any point.

5. Visually check the sealing element for irregularities such as cracking, gouging, chunking, or splitting (see Figure 4-3).

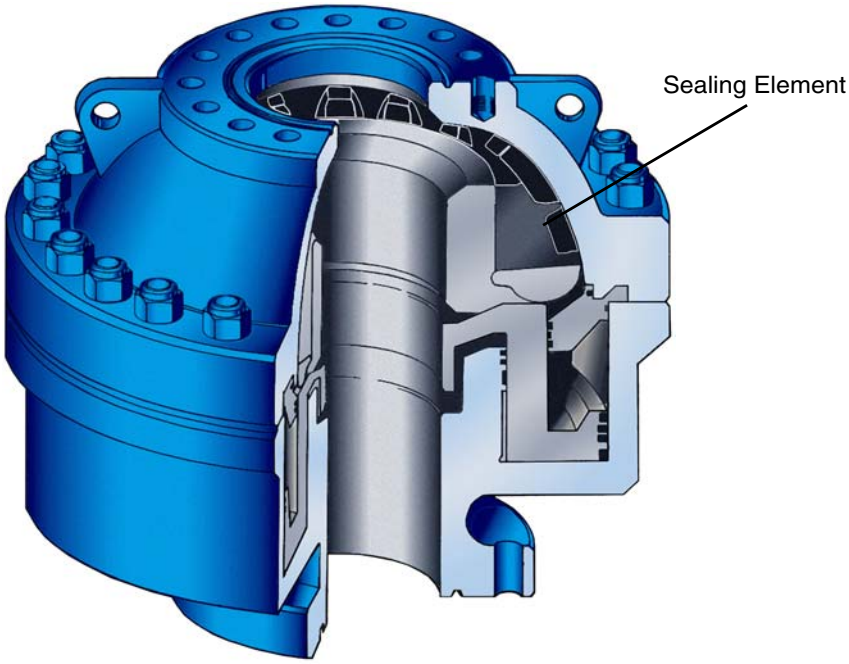


Figure 4-3. Sealing Element Check (Applicable to All Models)

6. Replace the sealing element if required (see the section titled "Changing Sealing Element" on page 4-11).

Yearly Preventive Maintenance

The purpose of the yearly maintenance operation is to evaluate wear in the BOP so that a major overhaul (3-year maintenance) can be scheduled at a convenient time before failure occurs.

Yearly preventive maintenance requires removal of the upper housing (6) and sealing element (7) for inspection and cleaning.

Check to ensure replacement parts are available (see the section titled "Specifications and Parts Lists" on page 5-1). For cleaning and lubricating instructions, refer to the table titled "Cleaning and Lubricating Instructions" on page 4-42.

Records should be maintained on inspections and test results.

The yearly inspection should consist of checking the general condition of all exposed areas. Only the adapter ring top seal C (9) is disturbed when the upper housing is removed. This seal should be inspected and replaced, if required. See Figure 4-6 through Figure 4-10 for position of seal C.

1. Clean ring groove and inspect for nicks and scratches in accordance with the table titled "Cleaning and Lubricating Instructions" on page 4-42.

Do not use a metal tool or wire brush to clean the ring groove as it may damage the groove. Remove light surface corrosion and scratches with an emery cloth.

2. Remove the upper housing. Refer to the section titled "Procedures for Disassembly and Assembly" on page 4-20 for disassembly instructions.
3. Clean the inside sphere surface thoroughly. Remove all dirt with clean water. Remove light surface corrosion and scratches with an emery cloth.
4. Inspect the sphere surface for deep nicks or scratches (see Figure 4-4). If deep nicks or scratches are present, contact your Shaffer representative.

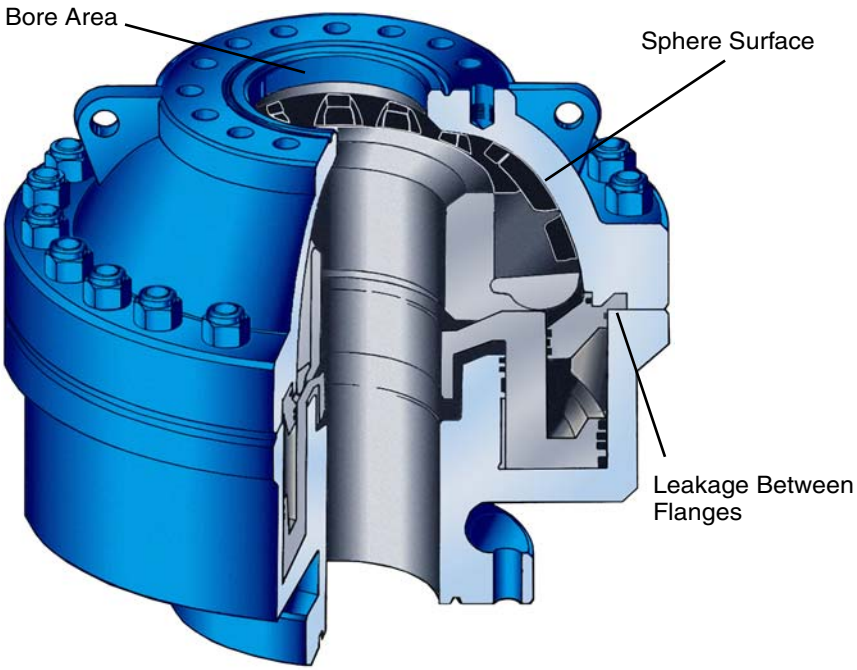


Figure 4-4. Sphere Surface Check (Applicable to All Models)

5. Inspect the sealing area of seal C for corrosion, pits, or scratches. Remove with an emery cloth (see Figure 4-4).
6. Visually check the bore area for excessive wear (see Figure 4-4). In case of major scoring, contact your Shaffer representative.

Do not permit the bore to wear more than $^{1}/_{8}$" (3.17 mm) oversize at any point.

7. Lubricate the sphere surface of the upper housing with grease.
8. Remove the sealing element. Refer to the section titled "Disassembly" on page 4-20 for disassembly instructions.
9. Clean the sealing element in accordance with the table titled "Cleaning and Lubricating Instructions" on page 4-42.
10. Inspect the sealing element for the following flaws (see Figure 4-5):
    - Excessive wear on the ID at the top
    - Cracks on the bottom around the bore area
    - Irregularities such as excessive splitting and gouging

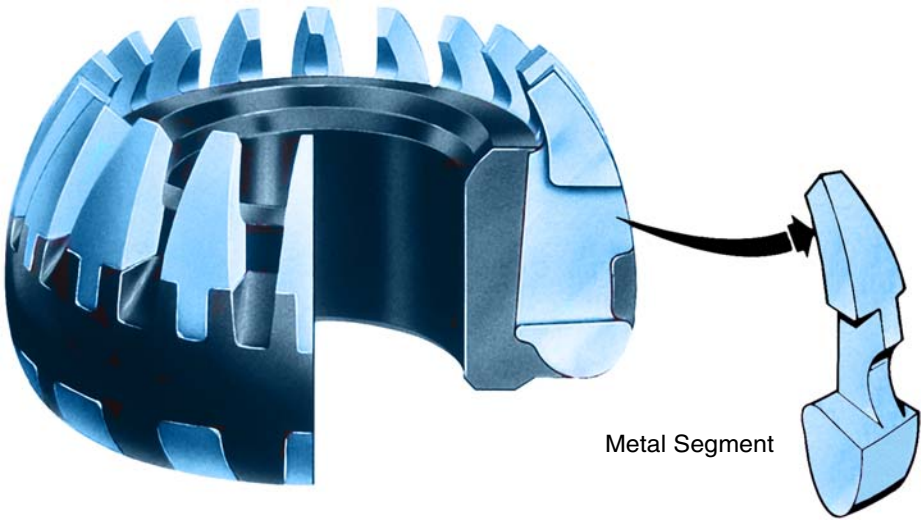


Figure 4-5. Sealing Element

11. Replace the sealing element, if required.
12. If the sealing element is replaced, inspect the condition of the rubber in the new sealing element before installation (see the section titled "Storage and Inspection of Rubber Parts" on page 4-40).
13. Reassemble the Spherical in accordance with the section titled "Assembly" on page 4-24.
14. Perform hydraulic pressure test in accordance with the section titled "Hydraulic System Pressure Test (Seals 1, 2, 3, 4 and 5)" on page 3-20.
15. If the hydraulic pressure test indicates a leak, perform the steps listed below.
    - Identify the leak. Refer to the section titled "Procedures for Disassembly and Assembly" on page 4-20 for disassembly instructions.
    - Make necessary repairs and/or replace the appropriate seal (see the section titled "Replacing Seals" on page 4-29).
    - Repeat the hydraulic pressure test.

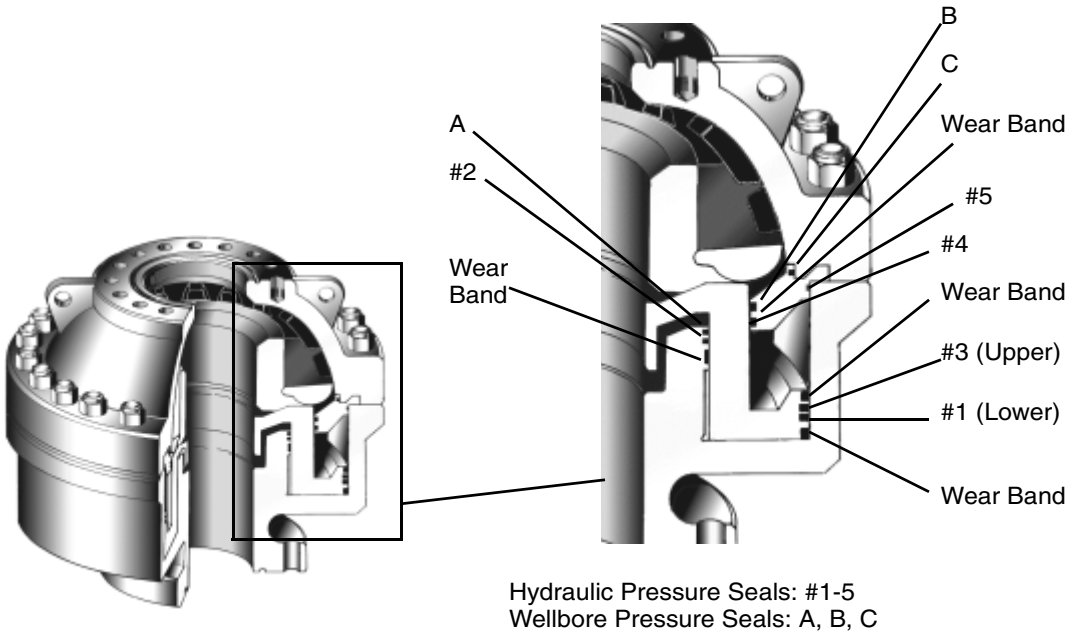


Figure 4-6. Seal Positions - 10,000 psi (690 bar) Model

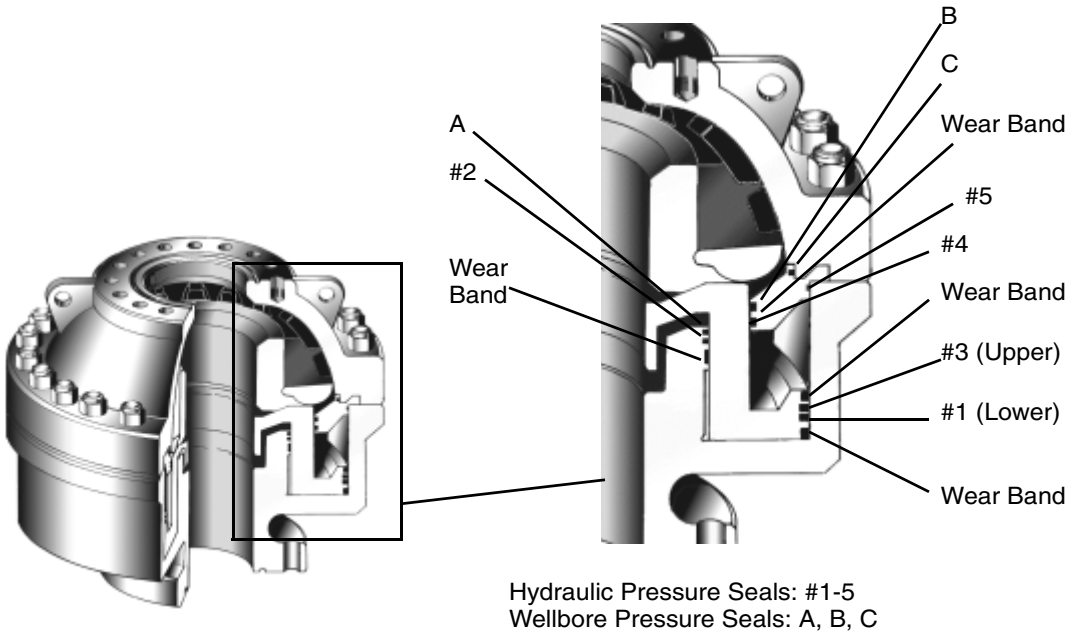


Figure 4-7. Seal Positions - 5,000 psi (345 bar) Model

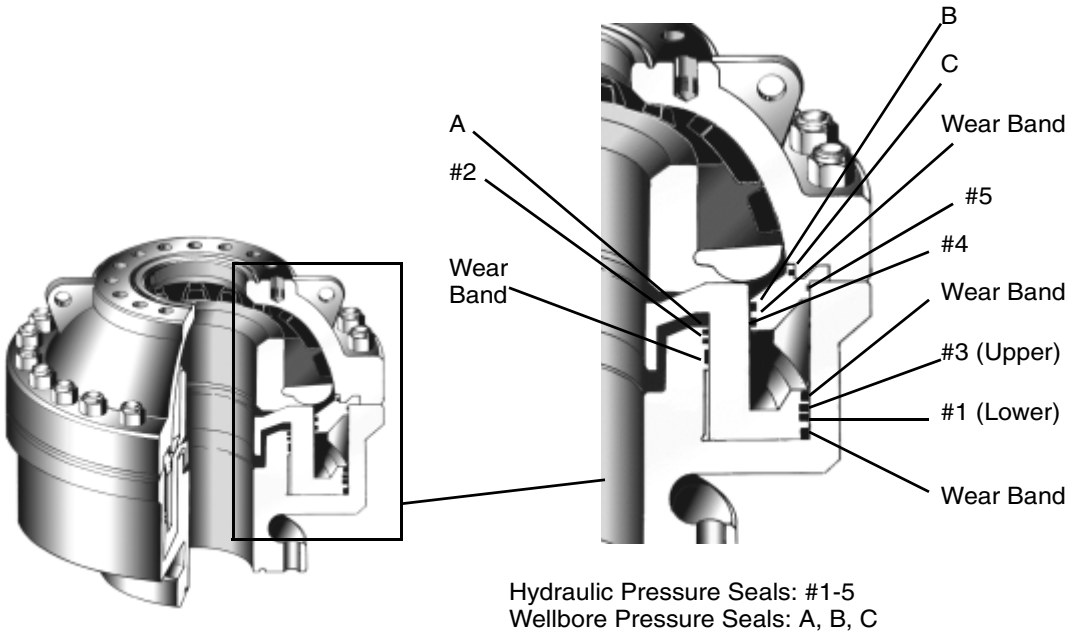


Figure 4-8. Seal Positions - 3,000 psi (207 bar) Model

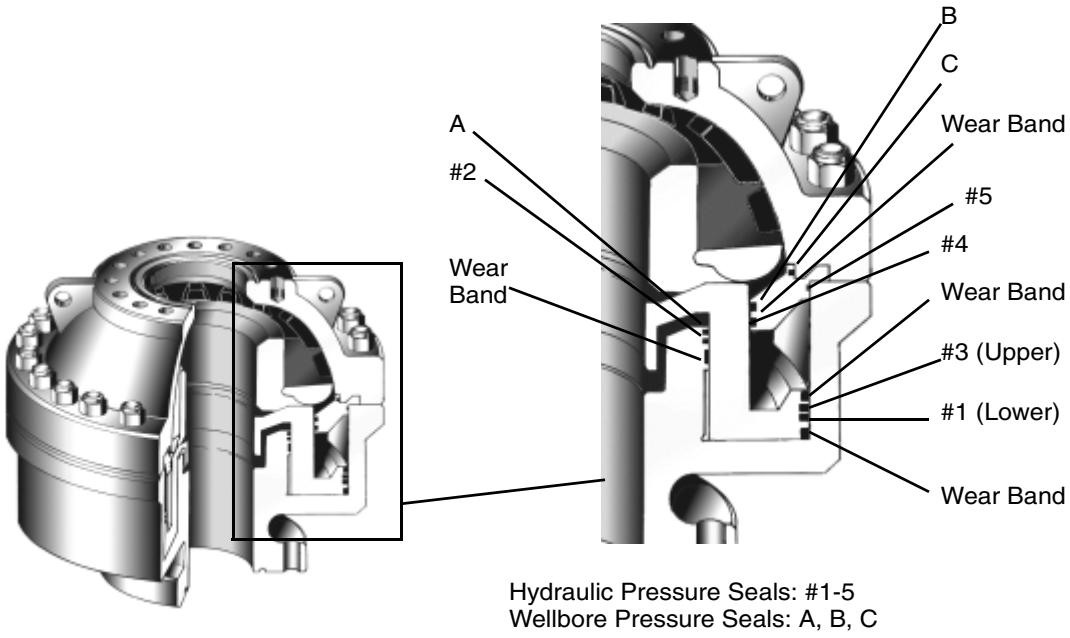


Figure 4-9. Seal Positions - 2,000 psi (138 bar) Model

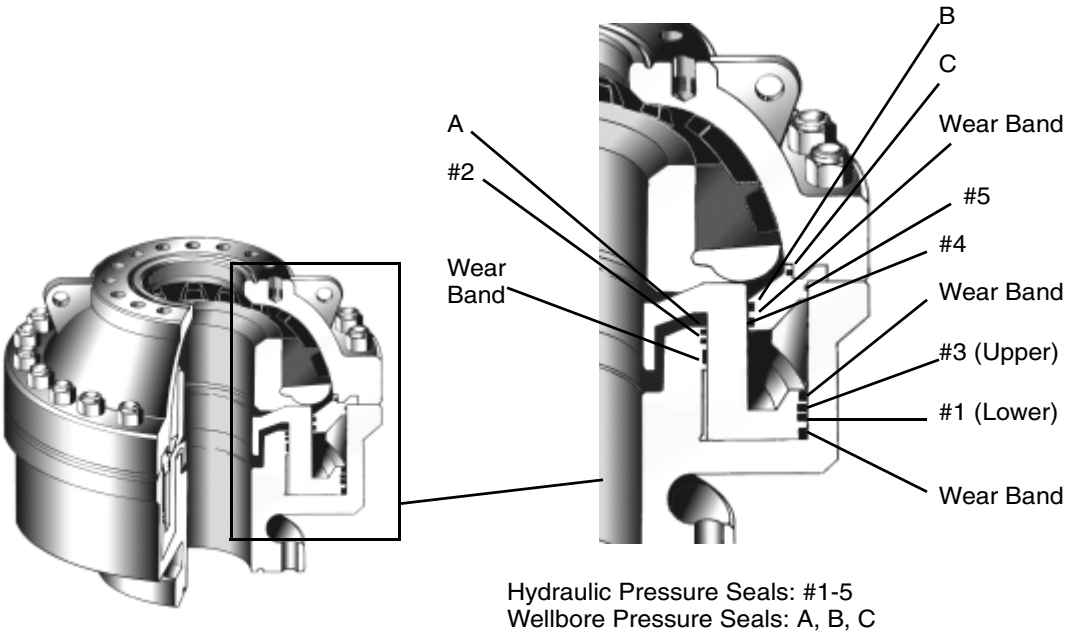


Figure 4-10. Seal Positions-1,000 psi (69 bar) Model

Three-Year Maintenance

Three-year maintenance is performed at a Shaffer service facility. The BOP is completely disassembled, cleaned, and inspected. All elastomer seals are replaced and all parts are repaired or replaced as required. Complete dimensional check. Hydraulic and wellbore pressure tests are performed prior to returning the BOP to service.

Changing Sealing Element

Check to ensure replacement parts are available (see the section titled "Specifications and Parts Lists" on page 5-1). See Figure 4-13 for a parts description. For cleaning and lubricating instructions refer to the table titled "Cleaning and Lubricating Instructions" on page 4-42.

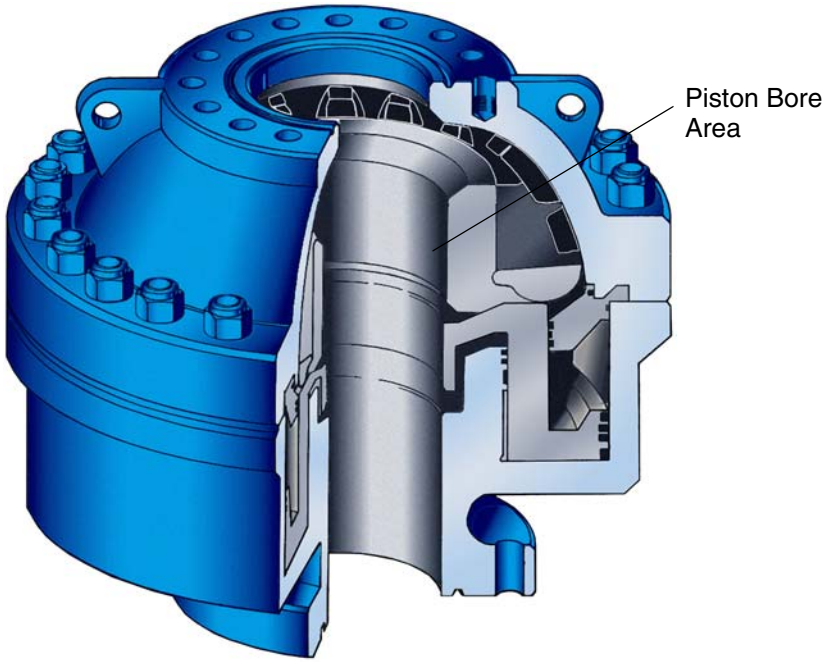


Figure 4-11. Piston Bore Check (Applicable to All Models)

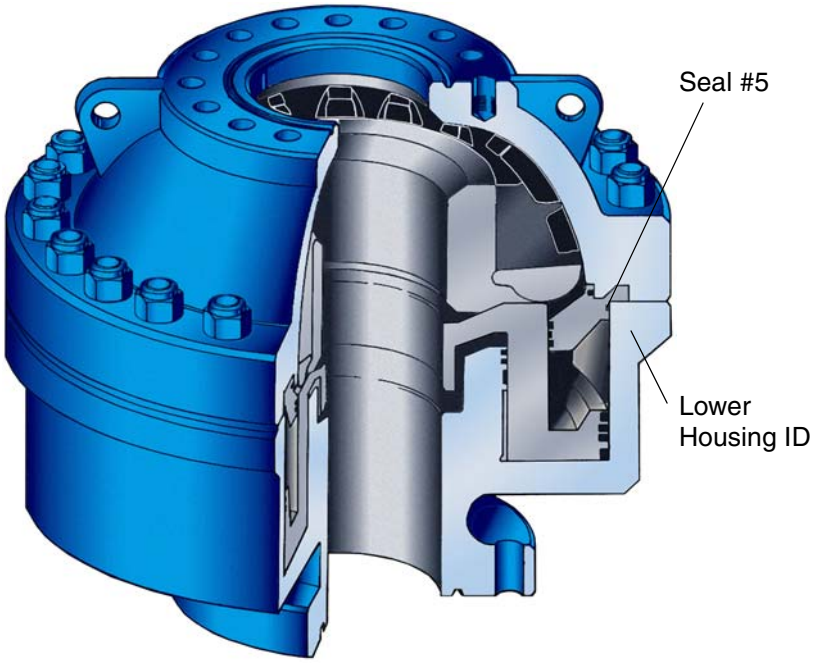
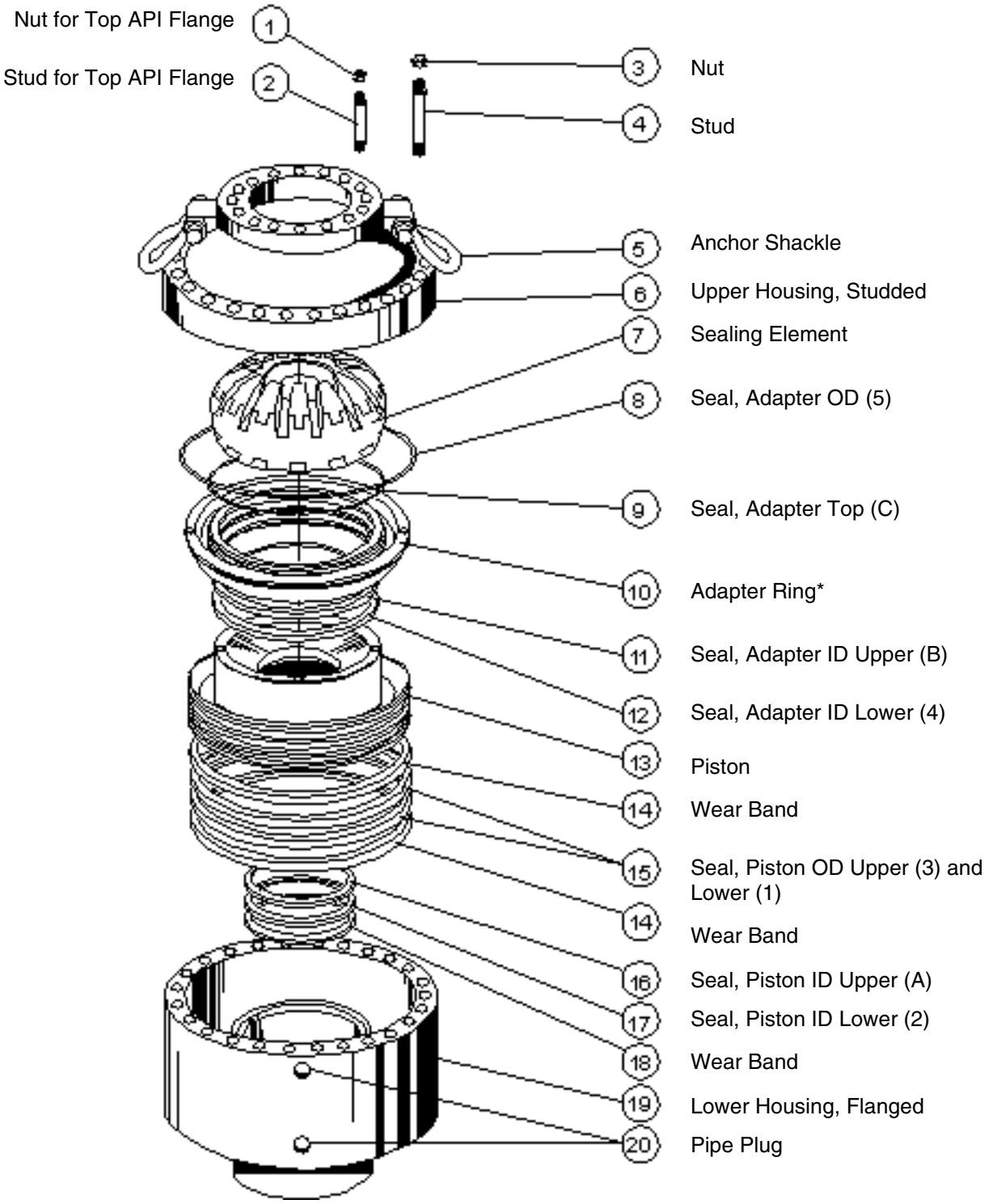


Figure 4-12. Lower Housing ID and Seal #5 Check



** Some bolted-cover sphericals have a wear band on the adapter ring. This wear band is not shown*

Figure 4-13. Bolted-Cover Exploded View

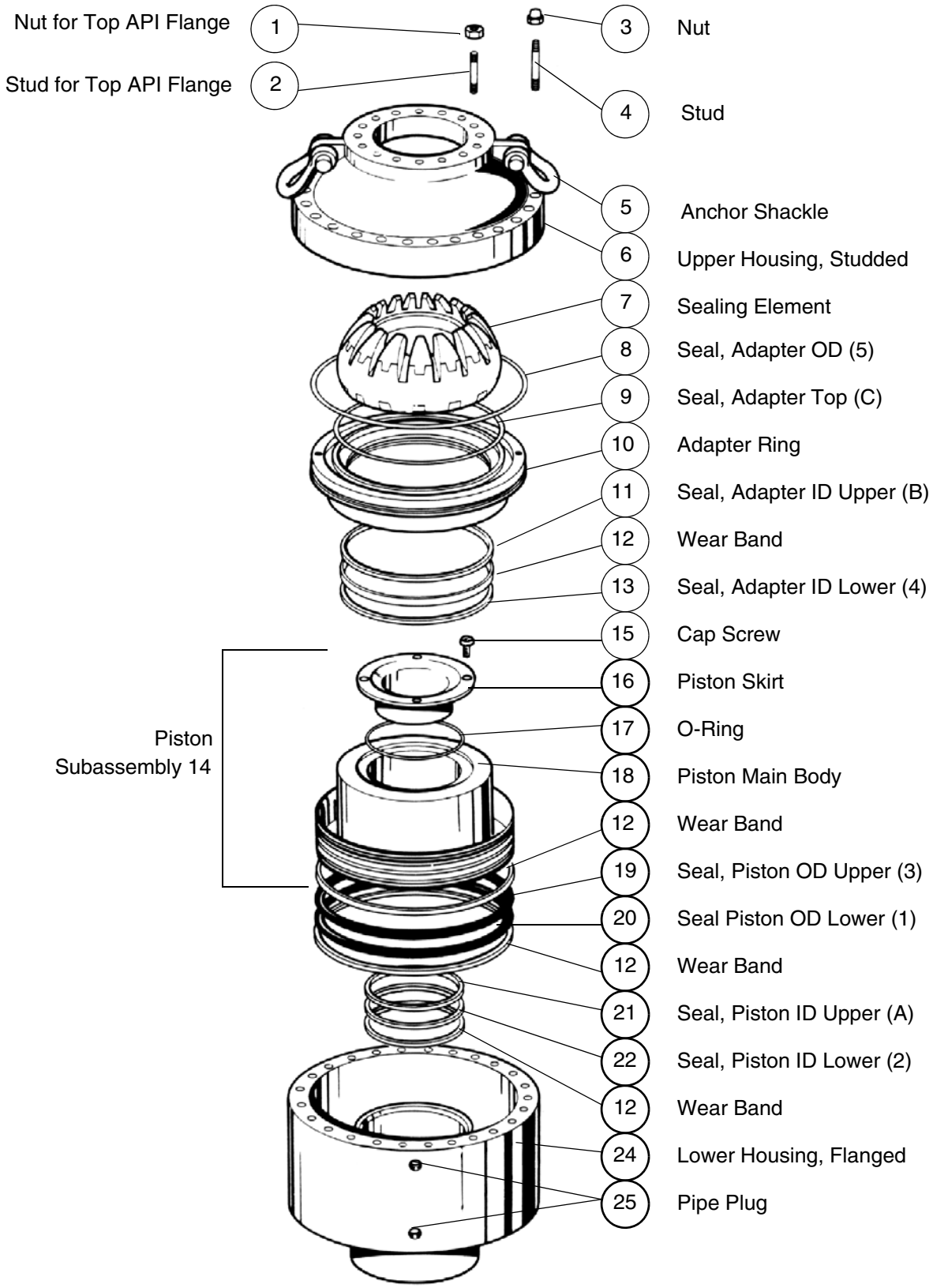


Figure 4-14. 30", 1,000 psi (762.00 mm, 69 bar) Bolted-Cover Spherical BOP

Disassembly

1. Remove the bonnet stud nuts (3) which retain the upper housing (6) (see Figure 4-15).

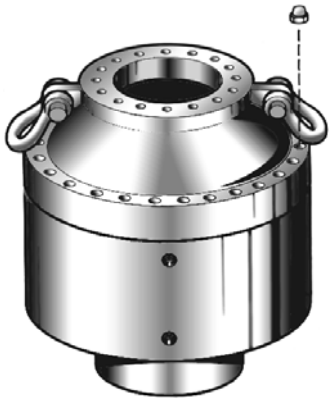


Figure 4-15. Removing the Bonnet Nuts (Applicable to All Models)

2. Remove the upper housing (6) by lifting with the anchor shackles (see Figure 4-16).

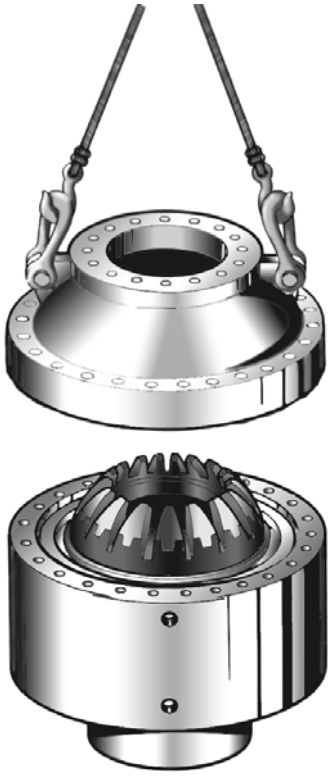


Figure 4-16. Removing the Upper Housing (Applicable to All Models)

3. Check the bonnet studs and nuts to ensure that the threads are not damaged by overtreating.
4. If a stud is damaged, replace according to the steps described below.

- Break the adhesive bond before the stud is removed to prevent galling the threads in the hole.
- Heat the upper housing where the stud is located to 700-800 ºF (371 - 427 ºC) for 15 to 20 minutes at temperature. This will destroy the adhesive bond. Do not exceed 900 ºF (482 ºC).

The bonnet studs are installed with an adhesive applied to the tap end threads to prevent the studs from backing out during routine removal of the nuts.

Do not allow the part to heat until "red" hot.

- Back out the stud.
- Clean and chase the threaded hole.
- Install new stud using Loctite (or equivalent) adhesive.

5. Install the eyebolts in the sealing element (7) (see Figure 4-17 on page 4-17). Remove the sealing element. Further disassembly is not required when only the sealing element is changed.

Serial numbers are steel-stamped into one of the four metal segments in the sealing element for lifting bolts. (see Figure 4-19 on page 4-19). Refer to this number when returning the sealing element for segment credit.

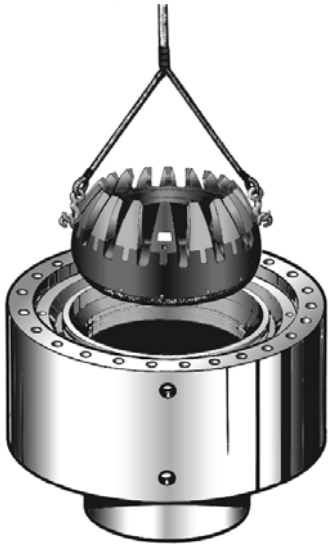


Figure 4-17. Removing the Sealing Element (Applicable to All Models)

Assembly

1. Grease the exterior (including the bottom) of the sealing element.
2. Install the sealing element on top of the piston (13) (see Figure 4-17). Remove the eyebolts.
3. Grease the sphere surface of the upper housing.
4. Install the upper housing onto the lower housing (19) (see Figure 4-16 on page 4-15).
5. Install the bonnet stud nuts, and torque in accordance with recommendations in Section 2, Table 2-1 through the table titled "Eyebolt Sizes" on page 3-5.

The upper housing (6) will stand off slightly, because there is an interference between it and the sealing element. Eliminate this standoff by making up the studs and nuts.

Emergency Replacement of Sealing Element

Warning

In extreme emergencies and when no other alternatives are available, sealing elements can be replaced while drill pipe is in the hole. However, this potentially hazardous procedure involves a high degree of risk unacceptable in any circumstances other than an emergency. Shaffer assumes no responsibility for sealing elements prepared in this manner.

Disassembly

1. Remove the worn sealing element from around the drill pipe by cutting the element with a handsaw or sharp blade (see Figure 4-18).

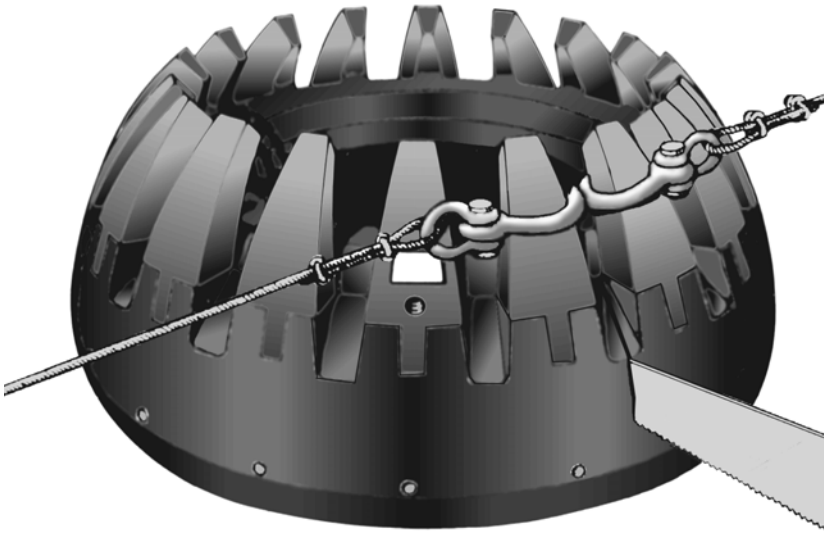


Figure 4-18. Emergency Element Replacement (Applicable to All Models)

Assembly

Warning

Cutting of the sealing element is not recommended and should be done only in extreme emergencies. Shaffer will not be responsible for elements prepared in this manner.

1. Pry two adjacent metal segments of the new sealing element apart for ease in cutting.
2. Use a handsaw or sharp blade to cut completely through the rubber between these segments.
3. Pry the cut ends of the new sealing element open.
4. Use a lubricant such as soap and water or grease on the cut sealing element ends to reduce friction. Pass the cut sealing around the drill pipe.
5. Drop the sealing element in place. Reassemble the Spherical per instructions in the section titled "Assembly" on page 4-24.

Spherical Sealing Element Serial Number and Color Codes

A serial number, which contains information concerning type of elastomer and date of manufacture, is stamped into the steel segments of a Spherical sealing element. The serial number is located above one of the four lifting eye holes (see Figure 4-19). The following information is used to identify the type of rubber in a Spherical sealing element.

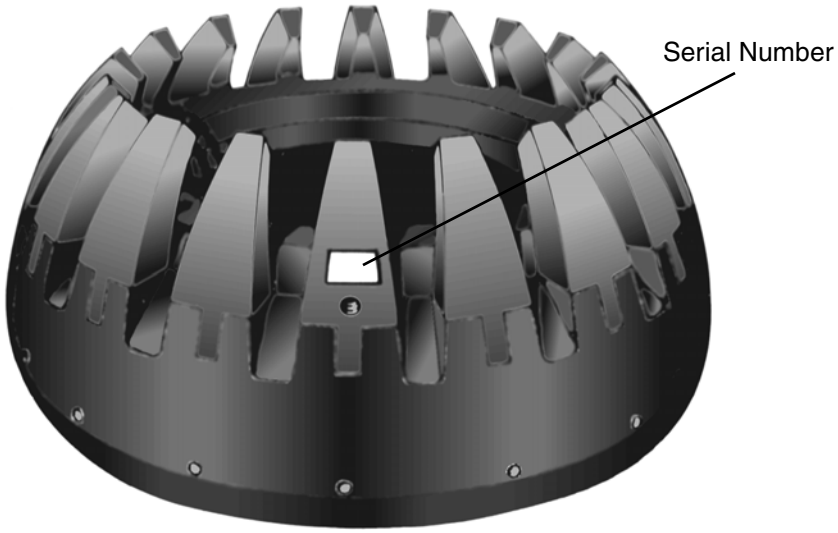


Figure 4-19. Sealing Element Serial Number Location (Applicable to All Models)

Serial Number (S/N)

XXXX-XX-X (Type of Elastomer)

- 0200 Series-Natural rubber
- 0600 Series-Nitrile rubber
- 0700 Series-Nitrile rubber
- 0800 Series-Natural rubber
- 1200 Series-Nitrile rubber
- 1400 Series-Natural rubber
- 2000 Series-Natural rubber
- 6000 Series-Nitrile rubber
- 7000 Series-Nitrile rubber
- 8000 Series-Natural rubber

Color Code

The metal segment tips in new sealing elements are color-coded for instant identification of rubber types.

- Nitrile rubber (blue)
- Natural rubber (red)

Sealing elements made of neoprene were discontinued in October 1978. Those neoprene elements still in existence maintain their original color code (black).

Procedures for Disassembly and Assembly

The following procedures for disassembly and assembly of the bolted-cover Spherical are applicable to all bolted-cover models. Procedures for the 30", 1,000 psi (762.00 mm, 69 bar) Spherical differ only in the disassembly of the piston subassembly, which is described in the section titled "Disassembly of 30", 1,000 psi (762.00 mm, 69 bar) Piston Subassembly" on page 4-27. All item numbers in parentheses correspond to Figure 4-13 on page 4-13. (To identify item numbers for the 30", 1,000 psi (762.00 mm, 69 bar) Spherical, see Figure 4-14 on page 4-14.) Check to ensure replacement parts are available (see the section titled "Specifications and Parts Lists" on page 5-1). For cleaning and lubricating instructions, refer to the table titled "Cleaning and Lubricating Instructions" on page 4-42.

Warning

Bleed, disconnect, and vent hydraulic chambers before disassembly to avoid injury to personnel.

No special tools are required for the disassembly and assembly of the Spherical BOP.

Disassembly

The procedures described below are used to disassemble the Spherical.

1. Remove the bonnet stud nuts (3) which retain the upper housing (6) (see Figure 4-15 on page 4-15).

2. Remove the upper housing (6) by lifting with the anchor shackles (see Figure 4-16 on page 4-15).
3. Check the bonnet studs and nuts to ensure that the threads are not damaged due to over torquing.
4. If a stud is damaged, replace according to the steps outlined below.
   - Break the adhesive bond before the stud is removed to prevent galling the threads in the hole. Heat the upper housing where the stud is located to 700-800 ºF (371-427 ºC) for 15-20 minutes at temperature. This will destroy the adhesive bond. Do not exceed 900 ºF (482 ºC).

The bonnet studs are installed with an adhesive to prevent the studs from backing out during routine removal of the nuts.

Do not allow the part to heat until "red" hot.

   - Back out the stud.
   - Clean and chase the threaded hole.
   - Install new stud using Loctite (or equivalent) adhesive.
5. Install the eyebolts in the sealing element (7) (see Figure 4-17 on page 4-17). Remove the sealing element.

If only the sealing element is to be changed, further disassembly is not required. See step 10 of the assembly procedure.

6. Install the eyebolts in the adapter ring (10). Refer to the table titled "Eyebolt Sizes" on page 3-5, and Figure 4-20. Remove the adapter ring.

Figure 4-20. Removing the Adapter Ring (Applicable to All Models)

Vent the opening hydraulic port to prevent suction as the adapter ring is lifted.

If the adapter ring is difficult to remove, apply low pressure (rig or city water pressure) to the opening side of the hydraulic port and pump the adapter ring loose. Do not use compressed air under any circumstances.

Do not bump the sealing areas on the adapter ring OD and ID against other surfaces.

7. Install the eyebolts in the piston (13). Refer to the table titled "Eyebolt Sizes" on page 3-5 and Figure 4-21. Remove the piston.

Figure 4-21. Removing the Piston (Applicable to All Models)

Vent the closing hydraulic port to prevent suction as the piston is lifted.

If the piston is difficult to remove, apply low pressure (rig or city water pressure) to the closing side of the hydraulic port and pump the piston loose. Do not use compressed air under any circumstances.

Do not bump the sealing areas on the piston against other surfaces.

Assembly

During assembly of the spherical BOP, avoid cutting or pinching o-rings and seals. Such damage will cause leakage of hydraulic fluid and loss of pressure.

While assembling the Spherical BOP, all hydraulic ports must be open.

All internal surfaces (including seals) should be thoroughly lubricated according to assembly instructions. Use four parts hydraulic oil and one part STP or equivalent. Refer to the table titled "Cleaning and Lubricating Instructions" on page 4-42 for cleaning and lubricating instructions.

The procedures described below are used to assemble the Spherical.

1. Replace piston ID upper seal A (16) and ID lower seal #2 (17) in the lower housing (19) (if damaged) in accordance with the section titled "Replacing Seals" on page 4-29. See Figure 4-6 through Figure 4-10, for the location of wellbore and hydraulic pressure seals.
2. Replace the damaged wear band (18) on the lower housing in accordance with the section titled "Replacing Wear Bands" on page 4-34.

The wear bands (14, 18) extend the life of the piston and lower housing by eliminating metal-to-metal contact between the moving parts.

Clean the lower housing wear band groove in accordance with the table titled "Cleaning and Lubricating Instructions" on page 4-42. Replace old wear band with snap-on wear band (see the section titled "Replacing Wear Bands" on page 4-34).

3. Replace damaged piston OD upper and lower seals #3 and #1 (15).

4. Replace damaged piston OD wear bands (14) in accordance with the section titled "Replacing Wear Bands" on page 4-34. The above notes for the wear band on the lower housing also apply to the piston OD wear bands.

Should the piston and lower housing show excessive wear, contact your Shaffer representative to determine whether the Spherical should be sent to a machine shop for reconditioning.

Check and replace damaged wear bands at that time.

5. Oil the major ID areas of the lower housing which come in contact with piston seals. Use four parts hydraulic oil and one part STP or equivalent.
6. Oil the piston ID and OD.

Do not use grease because it produces a thick film which prevents the piston from dropping in place easily.

7. Install the piston in the lower housing (see Figure 4-21 on page 4-23). If the piston is difficult to seat, use a rubber mallet to hammer it in. Remove the eyebolts.
8. Replace seals #5 (8), C (9), B (11), and #4 (12) on the adapter ring (10), if damaged.

In some models, seal C (9) is mounted in the upper housing (see Figure 4-22).

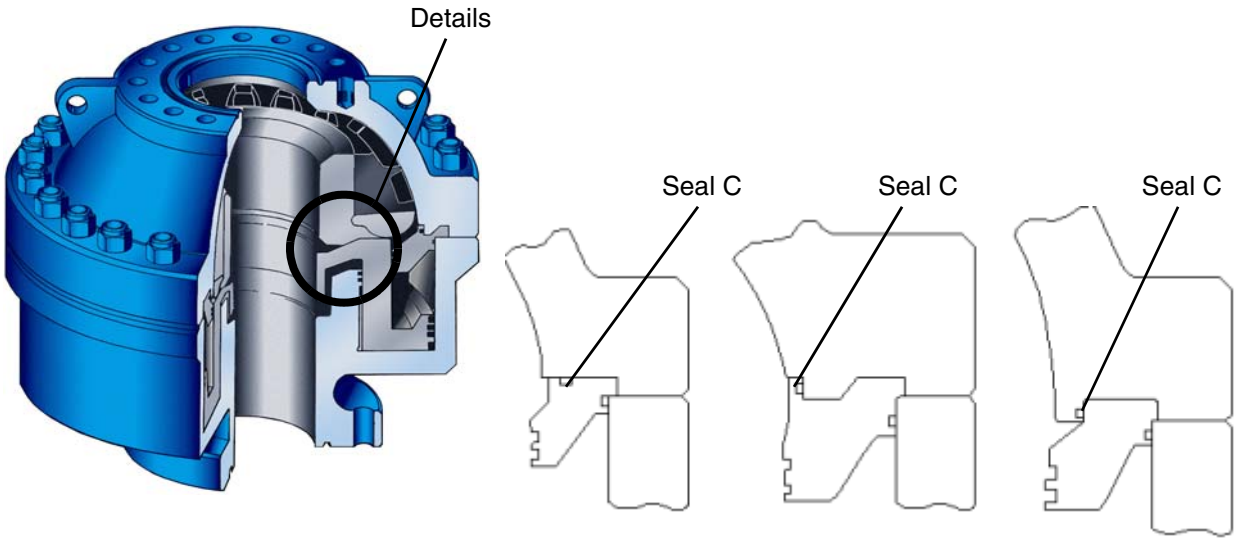


Figure 4-22. Bolted-Cover Upper Housing and Adapter Ring Configurations

9. Install the adapter ring in the lower housing (see Figure 4-20 on page 4-22). Remove the eyebolts.
10. Grease the exterior and bottom of the sealing element and install it on top of the piston (see Figure 4-17 on page 4-17). Remove the eyebolts.

Apply grease to the upper and lower housings. Refer to the table titled "Cleaning and Lubricating Instructions" on page 4-42 for cleaning and lubricating instructions.

11. Install the upper housing onto the lower housing (see Figure 4-16 on page 4-15). Remove the eyebolts.

The upper housing will stand off slightly, as there is an interference between it and sealing element.

12. Install the bonnet stud nuts and torque in accordance with recommendations in Section 3, table titled "API Hub Data" and the table titled "API Bolting Data" on page 3-4. This will eliminate the standoff between the upper housing and sealing element.

Disassembly of 30", 1,000 psi (762.00 mm, 69 bar) Piston Subassembly

Do not heat, weld, or machine (hollow) pistons before contacting Shaffer for detailed instructions. Hollow pistons may explode when heat is applied improperly. The following bolted-cover spherical BOPs are available with piston:

- **11", 5,000 psi (279.40 mm, 345 bar**
- **13 $^{5}/_{8}$", 5,000 psi (346.07 mm, 345 bar)**
- **21 $^{1}/_{4}$", 2,000 psi (539.75 mm, 138 bar)**
- **All 30", 1,000 psi (762.00 mm, 69 bar) manufactured after January 1982**

The procedures described below are used to remove the piston skirt from the piston main body (see Figure 4-14 on page 4-14).

1. Remove the four socket head cap screws (15) from the piston skirt (16).
2. Install two $^{5}/_{8}$" lifting eyes in the holes provided for this purpose in the piston skirt (16).
3. Connect a double leg sling to the lifting eyes and remove the skirt (16) from the piston main body (18).
4. Rest the piston skirt (16) on the floor or other desirable work surface.

Use of sharp metal instruments may damage the seal and /or the seal groove. Avoid tearing the seal or damaging the seal groove.

5. Remove the o-ring (17) from the piston skirt (16). Inspect the seal groove for corrosion and dimensional tolerances.
6. Install eyebolts in the piston main body (18) and remove the piston.

Assembly of 30", 1,000 psi (762.00 mm, 69 bar) Piston Subassembly

The procedures described below are used to install the piston skirt in the piston main body (see Figure 4-14 on page 4-14).

1. After the seal groove in the piston skirt (16) has been cleaned and inspected, install a new o-ring (17) in the seal groove. Ensure that the o-ring is free from twists and kinks.

If the lifting eyes were removed from the piston skirt after disassembly, re-install and connect the double leg sling.

2. Lubricate the piston skirt (16) and piston main body (18) with oil.
3. Install the piston skirt (16) in the piston main body (18). Align the socket head cap screw holes.
4. Install and tighten the four socket head cap screws (15) in the piston skirt (16). Remove the eyebolts.

During assembly of the piston skirt (16), avoid cutting or pinching the o-ring. Such damage to the o-ring will cause leakage of hydraulic fluid.

5. Install the piston main body (18) in the lower housing. (See Figure 4-21 on page 4-23) Remove eyebolts.
6. Replace seals #5 (8), C (9), B (11), and #4 (13) on the adapter ring (10), if damaged.

In some models, seal C (9) is mounted in the upper housing (see Figure 4-22 on page 4-26).

7. Install the adapter ring in the lower housing (see Figure 4-20 on page 4-22). Remove the eyebolts.
8. Grease the exterior and bottom of the sealing element and install it on top of the piston (see Figure 4-17 on page 4-17). Remove the eyebolts.

Apply grease to the upper and lower housings. Refer to the table titled "Cleaning and Lubricating Instructions" on page 4-42 for cleaning and lubricating instructions.

9. Install the upper housing onto the lower housing (see Figure 4-16 on page 4-15). Remove the eyebolts.

The upper housing will stand off slightly, as there is an interference between it and sealing element.

10. Install the bonnet stud nuts and torque in accordance with recommendations in Section 3 table titled "API Bolting Data" and the table titled "API Hub Data" on page 3-4. This will eliminate the standoff between the upper housing and sealing element.

Replacing Seals

All seals and o-rings should be inspected and replaced each time the Spherical is disassembled. Check to ensure replacement parts are available (see the section titled "Specifications and Parts Lists" on page 5-1). The item number for each part is identified in parentheses (see Figure 4-13 on page 4-13 and Figure 4-14 on page 4-14).

Adapter Ring Seals

See Figure 4-6 on page 4-9 through Figure 4-10 on page 4-11 for correct positioning of the seals. The procedures described below should be used when replacing adapter ring seals in the Spherical.

1. Remove the upper housing and sealing element in accordance with the section titled "Disassembly" on page 4-20.
2. Install eyebolts and remove the adapter ring in accordance with the section titled "Disassembly" on page 4-20.

Vent the opening hydraulic port to prevent suction as the adapter ring is lifted.

If the adapter ring is difficult to remove, apply low pressure (rig or city water pressure) to the opening side of the hydraulic port and pump the adapter ring loose. Do not use compressed air under any circumstances.

Do not bump the sealing areas on the adapter ring OD and ID against other surfaces.

3. Remove the adapter ring top seal C (9), the adapter ring OD seal #5 (8), and the adapter ring upper ID seal B (11) and lower ID seal #4 (12 or 13) with a flat, blunt instrument such as a screwdriver (see Figure 4-23).

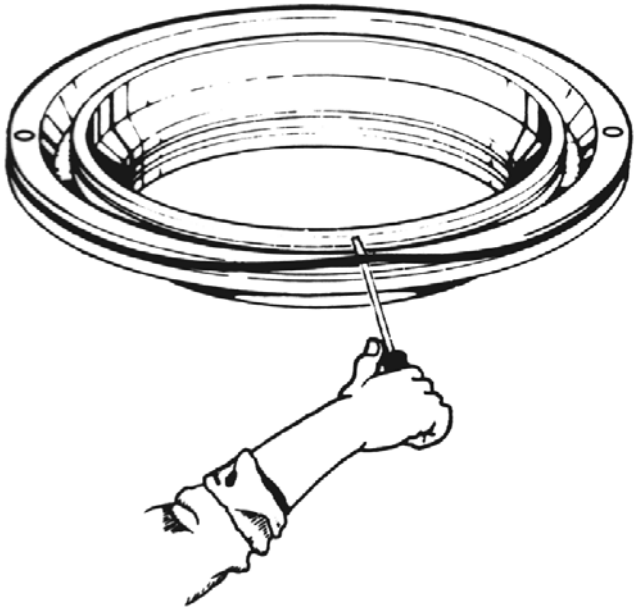


Figure 4-23. Removing Adapter Ring Seals

Use of sharp metal instruments may damage the seal and/ or the seal groove.

4. Pry the seal loose with the screwdriver until the seal pops out of its groove.

During assembly of the spherical, avoid cutting or pinching the o-ring and seals. This will cause leakage of hydraulic fluid and loss of pressure.

5. Install seals so that the seal lips point toward the pressure sources they are sealing against (see Figure 4-6 through Figure 4-10).

Wellbore pressure seals prevent leakage of wellbore pressure. Hydraulic pressure seals prevent leakage of hydraulic fluid.

6. Replace the adapter ring ID seal B (11) and seal #4 (12 or 13), OD seal #5 (8), top seal C (9) by carefully working the seals into the seal grooves with a rubber mallet.

Avoid tearing the seal or damaging the seal groove.

7. Assemble the Spherical in accordance with the section titled "Assembly" on page 4-24.

Piston Seals

See Figure 4-6 through Figure 4-10 for correct positioning of the seals. The procedures described below should be used when replacing piston seals in the Spherical.

1. Remove the upper housing, sealing element, and adapter ring in accordance with the section titled "Disassembly" on page 4-20.
2. Install eyebolts in the piston and lift out carefully in accordance with the section titled "Assembly" on page 4-24.

Vent the closing hydraulic port to prevent suction as the piston is lifted.

If the piston is difficult to remove, apply low pressure (rig or city water pressure) to the closing side of the hydraulic port and pump the piston loose. Do not use compressed air under any circumstances.

Do not bump the sealing areas on the piston against other surfaces.

3. Remove the piston ID upper seal A (16) and lower seal #2 (17), and piston OD upper seal #3 (15) and lower seal #1 (15) with a flat, blunt instrument such as a screwdriver (see Figure 4-24).

Use of sharp metal instruments may damage the seal and/or the seal groove.

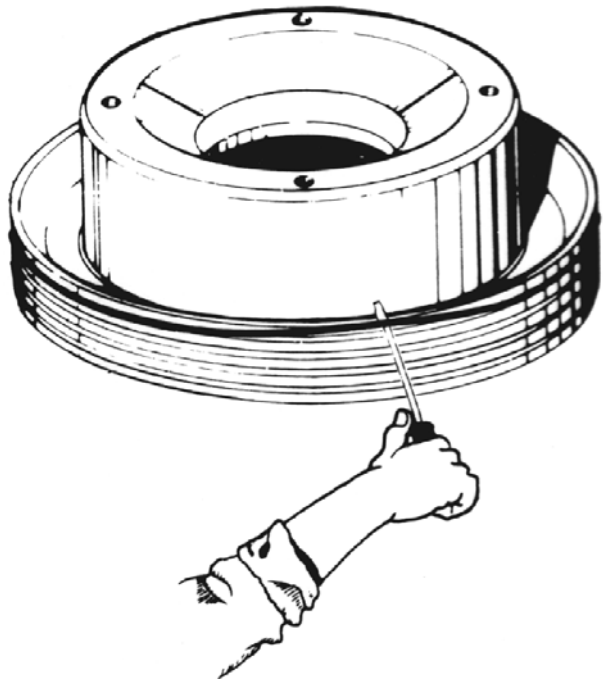


Figure 4-24. Removing Piston Seals

Piston ID seals A (16) and #2 (17) are located on the OD of the lower housing, and the piston OD seals #3 (15) and #1 (15) are located on the piston OD (see Figure 4-6 on page 4-9 through Figure 4-13 on page 4-13).

4. Pry the seal loose with a screwdriver until the seal pops out of its groove.
5. Install seals so that the seal lips point toward the pressure sources they are sealing against (see Figure 4-6 on page 4-9 through Figure 4-10 on page 4-11).

Wellbore pressure seals prevent leakage of wellbore pressure. Hydraulic pressure seals prevent leakage of hydraulic fluid.

6. Replace the piston ID upper seal A (16) and lower seal #2 (17), and the piston OD upper seal #3 (15) and lower seal #1 (15) by carefully working the seals into the seal grooves with a rubber mallet.

Piston OD seals #1 (15) and #3 (15) are hydraulic seals that hold pressure from opposite directions. These seals must be installed as shown in Figure 4-6 on page 4-9 through Figure 4-10 on page 4-11.

Avoid tearing the seal or damaging the seal groove.

7. Reassemble the Spherical in accordance with the section titled "Assembly" on page 4-24.

Replacing Wear Bands

Description

Shaffer provides flexible wear bands made of nylon material (Nylatron GSM) that are precut and pre-dimensioned to fit the wear band grooves in the Spherical BOP pistons and lower housings (see Figure 4-25 and the "Bolted-Cover Spherical BOP Wear Band Dimensions" table below).

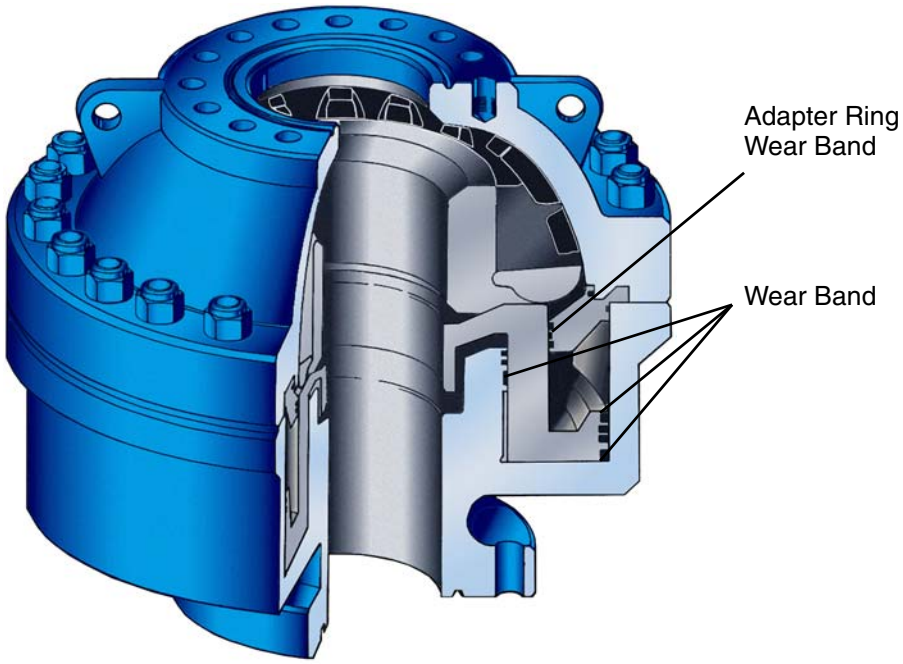


Figure 4-25. Location of Wear Bands

Bolted-Cover Spherical BOP Wear Band Dimensions

		Piston			Lower Housing			
Size	**Working Pressure**	**Width**	**Length***	**Qty.**	**Width**	**Length***	**Qty.**	**Total Length**
4 1/16"	10,000 psi	1/2"	54"	2	1"	25"	1	133"
7 1/16"	3,000 psi	1"	74"	2	1"	45"	1	193"
7 1/16"	5,000 psi	1	74"	2	1"	45"	1	193"
7 1/16"	10,000 psi	1"	107"	2	1"	57"	1	271"
9"	3,000 psi	1"	93"	2	1"	61"	1	247"
9"	5,000 psi	1"	104"	2	1"	61"	1	269"
11"	3,000 psi	1"	104"	2	1"	64"	1	272"

Bolted-Cover Spherical BOP Wear Band Dimensions (Continued)

		Piston			Lower Housing			
Size	**Working Pressure**	**Width**	**Length***	**Qty.**	**Width**	**Length***	**Qty.**	**Total Length**
11"	5,000 psi	1"	118"	2	1"	71"	1	307"
13 5/8"	3,000 psi	1"	124"	2	1"	74"	1	322"
13 5/8"	5,000 psi†	1"	124"	2	1"	74"	1	322"
13 5/8"	5,000 psi	1"	130"	2	1"	80"	1	340"
21 1/4"	2,000 psi	1"	134"	2	1"	86"	1	354"
30"	1,000 psi	1"	193"	2	1"	112"	1	660"

** Length must be specified when ordering a wear band.*

† Lightweight

Several bolted-cover Spherical BOPs have an additional wear band on the adapter ring (see the "Bolted-Cover Spherical BOP Wear Band Dimensions" table above). Location of wear band on the adapter ring is shown in Figure 4-25.

The wear band is designed to protrude 0.003-0.008 inches out from the matching machined surface (see Figure 4-26). Wear bands extend piston and piston seal life by eliminating metal-to-metal contact between the piston and lower housing.

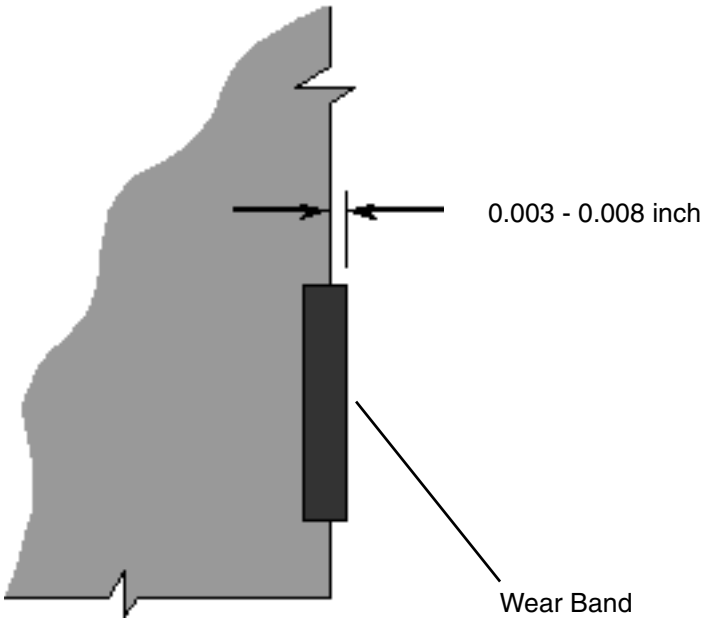


Figure 4-26. Wear Band Protrusion Dimensions (0.003-0.008 inch)

When the Shaffer representative determines that the piston and/on lower housing should be sent to a machine shop for reconditioning, the wear bands should be replaced at that time.

Disassembly

The procedures described below should be used when removing damaged wear bands.

1. Disassemble the Spherical BOP, exposing the piston and lower housing wear band grooves in accordance with the section titled "Disassembly" on page 4-20.
2. Remove the old wear band. Remove all adhesive buildup in the wear band groove. Clean thoroughly.

Assembly

The procedures described below should be used to install wear bands in the Spherical.

1. Tap the new wear band lightly into the groove, starting at one end.

There is a slight interference designed into the wear band to keep it in place. Should the wear band fail to snap into place, see the section titled "Adjustment of Wear Band Fit" on page 4-36.

2. Ensure that the wear band protrudes 0.003-0.008 inches from the surface (see Figure 4-26). Measure the protrusion for accuracy using a straightedge and a feeler gauge.
3. Install the piston and assemble the other components in accordance with the section titled "Assembly" on page 4-24.

Adjustment of Wear Band Fit

Loose Fit (Groove Width Too Wide)

Use a pair of pliers and squeeze the two ends of the wear band to make wider as shown in Figure 4-27. Snap the two ends in place, then proceed as in the "Assembly section above, step 3.

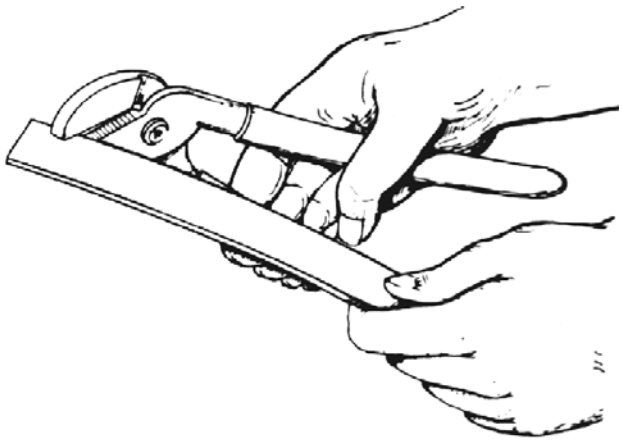


Figure 4-27. Correcting Loose Fit of Wear Bands

Tight Fit (Groove Width Too Narrow)

Reduce width of wear band by sanding along edge, then proceed as in the "Assembly section above, step 3. Corners should have $^{1}/_{32}$" by 45° bevels on one side of the wear band. The bevel can be formed with a knife.

Insufficient Protrusion (Groove Depth Too Deep)

Use adhesive tape such as electrical, duct, or teflon tape as a shim material on the entire circumference of the groove.

Difficulty Installing Mating Parts (Groove Depth Too Shallow)

When the piston will not fit into the lower housing and/or the adapter ring will not fit on the piston, proceed as follows:

- If a wear band is not beveled, form bevels measuring $^{1}/_{32}$" by 45º with a knife.
- Mill or sand the wear band to allow a protrusion of 0.003-0.008 inches from the surface (see Figure 4-26 on page 4-35).

The condition and/or depth of the groove may be such that the component must be machined at a Shaffer repair center.

Additional Procedures for Adjusting Wear Bands

When the procedures in described above are not applicable, roughen the sides of the two ends (2-3" per end) with sandpaper. Apply an epoxy adhesive to the two roughened ends and clamp the wear band in place. A cyanoacrylate ester adhesive such as Loctite 404 is also acceptable.

Use a 1" (25.40 mm) wide steel stripping band as a clamp. Dry for 2-3 hours, then proceed as in the "Assembly section above, step 3.

Do not use adhesive on the entire circumference of the groove because after drying, the wear band protrusion may be too great to allow assembly of components.

Troubleshooting

This troubleshooting guide contains the most common problems that may be encountered with the bolted-cover Spherical (see the "Troubleshooting" table below).

Troubleshooting

Problem	Possible Cause	Corrective Action
Will not hold wellbore test pressure	Element not sealing properly	Check sealing element for wear. Replace element, if necessary (see the section titled "Changing Sealing Element" on page 4-11).
	Piping system leaking (including ring gasket	Check fittings and/or valves for leakage in piping system.
	Wellbore pressure seal leaking	Check wellbore pressure seal. Replace seals, if damaged (see the section titled "Replacing Seals" on page 4-29).
	Pump malfunction	Repair or replace pump.
Will not hold hydraulic pressure	Leaking hydraulic hoses	Replace hoses or connections.
	Hydraulic pressure seals leaking	Check hydraulic seals. Replace, if damaged (see the section titled "Replacing Seals" on page 4-29).
Existing element will not seal	Buildup of dried cement or mud between the element segments	For dried cement, remove the element and clean thoroughly. For dried mud, flush out clean thoroughly and flex the element.

Troubleshooting (Continued)

Problem	Possible Cause	Corrective Action
	Inadequate hydraulic pressure applied	Apply recommended operating pressure for stationary pipe.
	Leakage in hydraulic system	Check hydraulic seals (see the section titled "Replacing Seals" on page 4-29).
New element not sealing	Inadequate hydraulic pressure applied.	Apply recommended operating pressure for stationary pipe.
	Leakage in hydraulic system	Check hydraulic seals (see the section titled "Replacing Seals" on page 4-29).

Storing the Spherical BOP

Short-Term Storage (6 Months or Less)

1. Remove element.
2. Clean unit and grease element.
3. Store the sealing element in accordance with the "Storage and Inspection of Rubber Parts section below.
4. Coat all internal components with oil (engine oil or equivalent).
5. Fill spaces between the upper housing and lower housing with heavy grease.
6. Pack the API ring grooves with heavy grease, and cover with connection protectors which are furnished with the unit.
7. Completely fill the hydraulic closing and opening chambers with petroleum-based hydraulic fluid.

Ensure the Spherical is in the open position and filled with hydraulic fluid before plugging the hydraulic ports.

8. Plug all hydraulic ports with pipe plugs which are furnished with the unit.
9. Cover the Spherical bore.
10. Elevate the Spherical so it does not rest in standing water, and store in a dry room.

Long-Term Storage (Longer than 6 Months)

1. Disassemble the Spherical.
2. Steam clean all parts and dry.
3. Coat all parts with heavy grease.
4. Wrap all OD sealing surfaces with wax cloth, if possible.
5. Plug all hydraulic ports with pipe plugs, which are furnished with the unit.
6. Elevate the Spherical so it does not rest in standing water, and store in a dry room.

Prior to assembly, steam clean and coat with light oil.

Storage and Inspection of Rubber Parts

Shaffer rubber parts are specially compounded to ensure maximum storage life under normal oilfield conditions. Proper storage minimizes deterioration and increases the service life of these items.

Aging of rubber parts is based on several factors including light, atmosphere, temperature, and size.

Direct light, especially sunlight which contains ultraviolet rays, is harmful and should be avoided.

Ozone in the atmosphere reacts with rubber parts and hastens deterioration. Rubber parts should never be stored near electrical equipment because of the occurrence of ozone.

Heat causes a gradual hardening of the rubber, especially when ozone or oxygen is present. In warm humid climates, particularly the tropics, fungi and bacteria attack the organic content in reinforced rubber parts. Rubber parts undergo several kinds of change when they are exposed to low temperatures. In temperatures of -40 ºF (-40 ºC), the rubber becomes brittle and will shatter when dropped or handled roughly. Some changes occur immediately, others after prolonged exposure. All are reversible; the rubber regains its original properties when it is returned to 65 ºF (18 ºC) or room temperature.

The variations in size, composition, and function of rubber parts prevent defining a precise shelf life. Large rubber parts might suffer the same amount of deterioration as small parts and still be usable, whereas small parts become useless and should be thrown away. Both natural and synthetic rubber parts are susceptible to deterioration from various solvents such as oilfield liquid hydrocarbons, which causes swelling or shrinkage.

In the final analysis, personal judgement determines whether a rubber part should be used. If there is doubt, replace the part.

Storage of Rubber Parts

Rubber parts should be stored under the conditions described below.

- Store rubber parts in a dark place, preferably indoors, away from sunlight, windows, and direct artificial lighting.
- Store rubber parts in a cool location (approximately 65 ºF or 18 ºC) away from heaters, electrical machinery, or any high voltage equipment producing corona.
- Store rubber parts in their natural shape. Do not hang o-rings on nails or hooks.
- Maintain storage areas as dry as possible. Oil, grease, or other fluids should be stored elsewhere to avoid spillage.
- Store rubber parts in sealed containers, or cover with a protective shield impervious to temperature or light when storing for a long duration.
- Use rubber parts on a first-in, first-out basis.

Inspection of Rubber Parts

Prior to installing rubber parts, inspect the rubber for signs of aging such as cracks, brittle surfaces, or other signs of deterioration. Replace rubber parts that have deteriorated.

- Bend, stretch, or compress each part and look for cracks.

Some cracks are obvious, but when the rubber part is bent, stretched, or compressed, minute cracks will become apparent.

- Observe whether the rubber surface is hard, chalky, or bark like in appearance.

Low Temperature Service

The following elastomers vary in their applicability for low temperature service.

Nitriles (Buna N, NBR, etc.)

Nitrile (synthetic rubber) compounds have a base polymer, acrylonitrile, which ranges in content from 20-50% and influences the performance of the compound. Increasing the acrylonitrile content decreases oil swell, which is the measure of oil resistance. However, low temperature properties are deteriorating at the same time.

This conflict of properties makes Nitrile compounds unsuitable for most applications in arctic service. Satisfactory low temperature Nitrile compounds have NOT been developed for seals under high stress with large, highly elastic deformation such as required for sealing elements in Spherical BOPS.

Nitrile compounds with low temperature properties have been developed for static seals such as o-rings, which are not subject to high elongations under stress. These compounds perform well in arctic service.

Natural Rubber

The most commonly used material for seal applications in low temperature service is natural rubber, which retains flexibility as well as other physical properties required for proper functioning of the seal. However, natural rubber has poor oil resistance.

Never expose rubber elements or seals to diesel oils, which cause rubber to swell and deteriorate. Natural rubber elements require water base drilling fluids.

Cleaning and Lubricating Instructions

Part	How to Clean	Lubricants
Spherical Exterior (surfaces)	Steam, high pressure water, diesel fuel[1]	N/A
Spherical Interior	Steam, high pressure water	SAE-10W hydraulic oil and *STPÆ or equivalent.
Studs/Nuts	Water, wire brush	Grease specified in API 5A2.
Ring Groove	Emery cloth	Grease (if not immediately in service).
Upper Housing	Steam, high pressure water, diesel fuel[1]	Grease
Sphere Surface of Upper Housing	Sand paper, emery cloth	Grease
Locking Ring	Steam, high pressure water, diesel fuel[1]	Grease
Lifting Eye Threads	Water, wire brush	Pack heavy grease to prevent corrosion.
Jackscrew Threads	Water, wire brush	Pack heavy grease to prevent corrosion.
Sealing Areas	Emery cloth	SAE-10W hydraulic oil or equivalent.
Seals	Wipe with damp cloth	SAE-10W hydraulic oil or equivalent.
Sealing Element	High pressure water	Grease exterior, including bottom and tips of metal segments.
Intermediate Housing	Steam, high pressure water, diesel fuel[1]	Grease
Sphere Surface of Intermediate Housing	Sand paper, emery cloth	Grease
Bore Areas (upper housing, pistons, intermediate housing, lower housing)	Steam, high pressure water	SAE-10W hydraulic oil or equivalent.
Adapter Ring	Steam, high pressure water, diesel fuel[1]	SAE-10W hydraulic oil or equivalent.
Piston	Sand paper, emery cloth	SAE-10W hydraulic oil or equivalent.[2]
Lower Housing	Sand paper, emery cloth	Grease
Wear Band Grooves	Wipe with cleaning solvent	SAE-10W hydraulic oil or equivalent.

1 Diesel fuel is a flammable liquid. It will cause rubber goods to swell and deteriorate.

2 Do not use grease as it produces a thick film which prevents the piston from dropping into place easily.

Specifications and Parts Lists

Parts Identification

All parts required for maintenance or repair are available from Shaffer. Assembly drawings and exploded views correspond to the parts list which identifies each part by number. Using this part number and part name will ensure procurement of the proper part when ordering spare parts.

Correspondence

Direct all correspondence to the appropriate address listed below.

Mailing Address

National Oilwell Varco
P.O. Box 1473
Houston, Texas 77251, U.S.A.

Shipping Address

12950 West Little York
Houston, Texas 77041
Tel. (713) 937-5000
Fax (713) 937-5779

National Oilwell Varco Repair Center Address

5900 Brittmoore
Houston, Texas 77041
Tel. (281) 847-9990
Fax (281) 847-9993

Ordering Replacement Parts

All parts required for maintenance or repair are available from Shaffer. When ordering replacement parts, please specify the following information:

- Part name-list part name as called out on the applicable drawing
- Part number-list part number as called out on the applicable drawing
- Drawing number-list engineering drawing number and the item number for the drawing
- Quantity-list the quantity required
- Serial number-list the serial number (if applicable) as shown on the nameplate

Parts Lists

All tables from "7 1/16", 10M psi, Bolted-Cover Spherical BOP (typical)" on page 5-2 through "30", 1M psi, Bolted-Cover Spherical BOP (typical)" on page 5-21 provide a parts list for the bolted-cover Spherical BOP.

Specifications

All tables from "Bolted-Cover Spherical BOP Specifications" on page 5-22 through "Bolted-Cover Spherical BOP Specifications" on page 5-36 provide specifications for the Bolted-Cover Spherical BOP.

Spare Parts Kits-BOP

7 $^{1}/_{16}$", 10M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	150982	1
Upper Housing-Studded	150983	1
Piston	150984	1
Adapter Ring	150985	1
Nitrile (Blue)	150987	1
Natural (Red)	150988	1
Stud	150989	1 Set**
Nut	020111	1 Set**
Seal-Piston I.D.-Upper	031102	1
Seal-Piston I.D.-Lower	031102	1
Seal-Piston O.D.	030765	2
Seal-Adapter I.D.-Upper	031100	1
Seal-Adapter I.D.-Lower	031100	1
Seal-Adapter O.D.	030773	1
Seal-Adapter Top	031035	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066328	2
Anchor Shackle	060498	2
Stud for API Flange	011020	1 Set**
Nut for API Flange	020000	1 Set**
Wear Ring-Adapter Ring	152344	1
Eye Bolts	050243	2
Hammer Wrench	050713	1

7 1/16", 10M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Size (Inches)	2 1/2	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155050	1
Accumulator Kit †	152716	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

4 1/16", 10M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	155238	1
Upper Housing-Studded	152315	1
Piston	155241	1
Adapter Ring	152313	1
Nitrile (Blue)	152376	1
Natural (Red)	152377	1
Stud	152854	1 Set**
Nut	020359	1 Set**
Seal-Piston I.D.-Upper	031121	1
Seal-Piston I.D.-Lower	031121	1
Seal-Piston O.D.	031123	2
Seal-Adapter I.D.-Upper	031122	1
Seal-Adapter I.D.-Lower	031122	1
Seal-Adapter O.D.	031124	1
Seal-Adapter Top	031125	1
Wear Ring-Piston	152344	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066327	2

4 1/16", 10M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Anchor Shackle	150818	2
Stud for API Flange	012102	1 Set**
Nut for API Flange	020345	1 Set**
Wear Ring-Adapter Ring	152344	1
Eye Bolts	060246	2
Hammer Wrench	050821	1
Size (Inches)	2 3/8	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155092	1
Accumulator Kit †	155157	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

13 5/8", 5M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152451	1
Upper Housing-Studded	152453	1
Piston	152148	1
Adapter Ring	151933	1
Nitrile (Blue)	150576	1
Natural (Red)	150577	1
Stud	150659	1 Set**
Nut	020111	1 Set**
Seal-Piston I.D.-Upper	031097	1
Seal-Piston I.D.-Lower	030770	1
Seal-Piston O.D.	031029	2
Seal-Adapter I.D.-Upper	031096	1

13 5/8", 5M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Seal-Adapter I.D.-Lower	030771	1
Seal-Adapter O.D.	030772	1
Seal-Adapter Top	031094	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066329	2
Anchor Shackle	060498	2
Stud for API Flange	011023	1 Set**
Nut for API Flange	020012	1 Set**
Wear Ring-Adapter Ring	152344	1
Eye Bolts	050243	2
Hammer Wrench	050713	1
Size (Inches)	2 1/4	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155070	1
Accumulator Kit †	152717	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

13 5/8", 5M psi, Light Weight Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152253	1
Upper Housing-Studded	151059	1
Piston	150736	1
Adapter Ring	151964	1
Nitrile (Blue)	150576	1
Natural (Red)	150577	1

13 5/8", 5M psi, Light Weight Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Stud	151060	1 Set**
Nut	020110	1 Set**
Seal-Piston I.D.-Upper	031111	1
Seal-Piston I.D.-Lower	030780	1
Seal-Piston O.D.	030782	2
Seal-Adapter I.D.-Upper	031096	1
Seal-Adapter I.D.-Lower	030771	1
Seal-Adapter O.D.	031011	1
Seal-Adapter Top	030773	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066329	2
Anchor Shackle	060498	2
Stud for API Flange	011024	1 Set**
Nut for API Flange	020012	1 Set**
Wear Ring-Adapter Ring	—	1
Eye Bolts	050243	2
Hammer Wrench	050825	1
Size (Inches)	2	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155073	1
Accumulator Kit †	152717	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

11", 5M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152406	1
Upper Housing-Studded	152328	1
Piston	152326	1
Adapter Ring	152323	1
Nitrile (Blue)	150810	1
Natural (Red)	150809	1
Stud	155661	1 Set**
Nut	020110	1 Set**
Seal-Piston I.D.-Upper	031113	1
Seal-Piston I.D.-Lower	031152	1
Seal-Piston O.D.	031018	2
Seal-Adapter I.D.-Upper	031114	1
Seal-Adapter I.D.-Lower	030781	1
Seal-Adapter O.D.	030783	1
Seal-Adapter Top	031115	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066328	2
Anchor Shackle	060497	2
Stud for API Flange	011026	1 Set**
Nut for API Flange	020014	1 Set**
Wear Ring-Adapter Ring	152344	1
Eye Bolts	050243	2
Hammer Wrench	050825	1
Size (Inches)	$3\ ^{1}/_{8}$	
Pipe Plug $^{1}/_{2}$" NPT	066326	1
Pipe Plug $^{1}/_{4}$" NPT	065008	1

11", 5M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Seal Kit*	155030	1
Accumulator Kit †	152716	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

11", 5M psi, Light Weight Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152410	1
Upper Housing-Studded	152413	1
Piston	152326	1
Adapter Ring	152323	1
Nitrile (Blue)	150810	1
Natural (Red)	150809	1
Stud	011033	1 Set**
Nut	020109	1 Set**
Seal-Piston I.D.-Upper	031113	1
Seal-Piston I.D.-Lower	030780	1
Seal-Piston O.D.	031018	2
Seal-Adapter I.D.-Upper	031114	1
Seal-Adapter I.D.-Lower	030781	1
Seal-Adapter O.D.	030783	1
Seal-Adapter Top	031115	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066328	2
Anchor Shackle	060497	2
Stud for API Flange	011026	1 Set**
Nut for API Flange	020014	1 Set**

11", 5M psi, Light Weight Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Wear Ring-Adapter Ring	152344	1
Eye Bolts	050243	2
Hammer Wrench	050824	1
Size (Inches)	21 $^{5}/_{16}$	
Pipe Plug $^{1}/_{2}$" NPT	066326	1
Pipe Plug $^{1}/_{4}$" NPT	065008	1
Seal Kit*	155030	1
Accumulator Kit †	152716	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

9", 5M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152232	1
Upper Housing-Studded	151002	1
Piston	151003	1
Adapter Ring	152236	1
Nitrile (Blue)	150996	1
Natural (Red)	152272	1
Stud	150999	1 Set**
Nut	020108	1 Set**
Seal-Piston I.D.-Upper	031110	1
Seal-Piston I.D.-Lower	031002	1
Seal-Piston O.D.	030765	2
Seal-Adapter I.D.-Upper	031109	1
Seal-Adapter I.D.-Lower	031037	1
Seal-Adapter O.D.	031126	1
Seal-Adapter Top	031036	1

9", 5M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066328	2
Anchor Shackle	060494	2
Stud for API Flange	011023	1 Set**
Nut for API Flange	020012	1 Set**
Wear Ring-Adapter Ring	—	1
Eye Bolts	050243	2
Hammer Wrench	050823	1
Size (Inches)	$2\ ^{3}/_{4}$	
Pipe Plug $^{1}/_{2}$" NPT	066326	1
Pipe Plug $^{1}/_{4}$" NPT	065008	1
Seal Kit*	155076	1
Accumulator Kit †	152716	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

7 $^{1}/_{16}$", 5M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152171	1
Upper Housing-Studded	150726	1
Piston	150718	1
Adapter Ring	152163	1
Nitrile (Blue)	150847	1
Natural (Red)	150848	1
Stud	150730	1 Set**
Nut	020106	1 Set**
Seal-Piston I.D.-Upper	031105	1
Seal-Piston I.D.-Lower	031000	1

7 1/16", 5M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Seal-Piston O.D.	030780	2
Seal-Adapter I.D.-Upper	031104	1
Seal-Adapter I.D.-Lower	031002	1
Seal-Adapter O.D.	030408	1
Seal-Adapter Top	030405	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066335	2
Anchor Shackle	060496	2
Stud for API Flange	012262	1 Set**
Nut for API Flange	020011	1 Set**
Wear Ring-Adapter Ring	152344	1
Eye Bolts	050243	2
Hammer Wrench	050821	1
Size (Inches)	2 3/8	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155076	1
Accumulator Kit †	152715	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

7 1/16", 5M psi, Bolted-Cover "Snubber" Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing, Large Stump Seal/Clamp Prep	20021881	1
Upper Housing with Adapter Clam Pockets	20021882	1
Piston	150718	1
Adapter Ring	152163	1

7 1/16", 5M psi, Bolted-Cover "Snubber" Spherical BOP (typical)

Description	P/N	Qty.
Nitrile (Blue)	150847	1
Natural (Red)	150848	1
Stud	150730	1 Set**
Nut	020106	1 Set**
Stud for API Flange	011016	1 Set**
Nut for API Flange	020011	1 Set**
Seal-Piston I.D.-Upper	031000	1
Seal-Piston I.D.-Lower	030780	2
Seal-Piston O.D.	031002	1
Pipe Plug	066335	2
Pipe Plug	065008	1
Seal-Adapter O.D.	030408	1
Seal-Adapter Top	030405	1
Standard Accessories	20004342	1
Seal-Adapter I.D.-Upper	031104	1
Seal-Polypak	031363	1
Wearband, 1" Wide	150613	150
Wearband 1/2" Wide	152344	103
Seal Kit	20021935	1
Accumulator Kit	152715	1
Screw	010693	2
Clamp, Hold Down Ring Adapter	20021884	2

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

20 3/4", 3M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	156512	1
Upper Housing-Studded	156513	1

20 3/4", 3M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Piston	156523	1
Adapter Ring	156521	1
Nitrile (Blue)	150799	1
Natural (Red)	150800	1
Stud	156528	1 Set**
Nut	020110	1 Set**
Seal-Piston I.D.-Upper	031108	1
Seal-Piston I.D.-Lower	030761	1
Seal-Piston O.D.	031013	2
Seal-Adapter I.D.-Upper	031107	1
Seal-Adapter I.D.-Lower	031018	1
Seal-Adapter O.D.	031031	1
Seal-Adapter Top	031027	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066329	2
Anchor Shackle	060498	2
Stud for API Flange	011028	1 Set**
Nut for API Flange	020015	1 Set**
Wear Ring-Adapter Ring	152344	1
Eye Bolts	050243	2
Hammer Wrench	050825	1
Size (Inches)	3 1/8	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	156527	1
Accumulator Kit †	152717	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

13 5/8", 3M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	151974	1
Upper Housing-Studded	150735	1
Piston	156400	1
Adapter Ring	151964	1
Nitrile (Blue)	150576	1
Natural (Red)	150577	1
Stud	155661	1 Set**
Nut	020109	1 Set**
Seal-Piston I.D.-Upper	031111	1
Seal-Piston I.D.-Lower	030780	1
Seal-Piston O.D.	030782	2
Seal-Adapter I.D.-Upper	031096	1
Seal-Adapter I.D.-Lower	030771	1
Seal-Adapter O.D.	031011	1
Seal-Adapter Top	030773	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066329	2
Anchor Shackle	060497	2
Stud for API Flange	011016	1 Set**
Nut for API Flange	020011	1 Set**
Wear Ring-Adapter Ring	—	1
Eye Bolts	050243	2
Hammer Wrench	050824	1
Size (Inches)	21 5/16	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155073	1

13 5/8", 3M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Accumulator Kit †	152717	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

11", 3M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152019	1
Upper Housing-Studded	150486	1
Piston	150498	1
Adapter Ring	152026	1
Nitrile (Blue)	150578	1
Natural (Red)	150579	1
Stud	150487	1 Set**
Nut	020108	1 Set**
Seal-Piston I.D.-Upper	031099	1
Seal-Piston I.D.-Lower	031101	1
Seal-Piston O.D.	030765	2
Seal-Adapter I.D.-Upper	031098	1
Seal-Adapter I.D.-Lower	030761	1
Seal-Adapter O.D.	030760	1
Seal-Adapter Top	131095	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066335	2
Anchor Shackle	060499	2
Stud for API Flange	011015	1 Set**
Nut for API Flange	020011	1 Set**
Wear Ring-Adapter Ring	—	1
Eye Bolts	050243	2

11", 3M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Hammer Wrench	050823	1
Size (Inches)	2 3/4	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155075	1
Accumulator Kit †	152715	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

9", 3M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152178	1
Upper Housing-Studded	150992	1
Piston	152837	1
Adapter Ring	152827	1
Nitrile (Blue)	150996	1
Natural (Red)	152272	1
Stud	155663	1 Set**
Nut	020106	1 Set**
Seal-Piston I.D.-Upper	031110	1
Seal-Piston I.D.-Lower	031002	1
Seal-Piston O.D.	0310012	2
Seal-Adapter I.D.-Upper	031109	1
Seal-Adapter I.D.-Lower	031037	1
Seal-Adapter O.D.	030784	1
Seal-Adapter Top	031145	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066335	2

9", 3M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Anchor Shackle	060499	2
Stud for API Flange	011014	1 Set**
Nut for API Flange	020011	1 Set**
Wear Ring-Adapter Ring	—	1
Eye Bolts	050243	2
Hammer Wrench	050821	1
Size (Inches)	1 1/2	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155077	1
Accumulator Kit †	152715	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

7 1/16", 3M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152420	1
Upper Housing-Studded	150717	1
Piston	150718	1
Adapter Ring	151831	1
Nitrile (Blue)	150847	1
Natural (Red)	150848	1
Stud	150721	1 Set**
Nut	020104	1 Set**
Seal-Piston I.D.-Upper	031105	1
Seal-Piston I.D.-Lower	031000	1
Seal-Piston O.D.	030780	2
Seal-Adapter I.D.-Upper	031104	1
Seal-Adapter I.D.-Lower	031002	1

7 1/16", 3M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Seal-Adapter O.D.	030408	1
Seal-Adapter Top	030244	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066335	2
Anchor Shackle	060500	2
Stud for API Flange	011011	1 Set**
Nut for API Flange	020003	1 Set**
Wear Ring-Adapter Ring	152344	1
Eye Bolts	050243	2
Hammer Wrench	050819	1
Size (Inches)	2	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155078	1
Accumulator Kit †	152715	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

21 1/4" 2M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152204	1
Upper Housing-Studded	150749	1
Piston	155623	1
Adapter Ring	152183	1
Nitrile (Blue)	150799	1
Natural (Red)	150800	1
Stud	150832	1 Set**
Nut	020107	1 Set**

21 1/4" 2M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Seal-Piston I.D.-Upper	031108	1
Seal-Piston I.D.-Lower	030761	1
Seal-Piston O.D.	030767	2
Seal-Adapter I.D.-Upper	031107	1
Seal-Adapter I.D.-Lower	031018	1
Seal-Adapter O.D.	031019	1
Seal-Adapter Top	031027	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066329	2
Anchor Shackle	060498	2
Stud for API Flange	011023	1 Set**
Nut for API Flange	020012	1 Set**
Wear Ring-Adapter Ring	152344	1
Eye Bolts	050243	2
Hammer Wrench	050822	1
Size (Inches)	2 9/16	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155067	1
Accumulator Kit †	152717	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

21 1/4", 2M psi, Light Weight Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	152195	1
Upper Housing-Studded	151690	1

21 1/4", 2M psi, Light Weight Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Piston	150750	1
Adapter Ring	152183	1
Nitrile (Blue)	150799	1
Natural (Red)	150800	1
Stud	150832	1 Set**
Nut	020107	1 Set**
Seal-Piston I.D.-Upper	031108	1
Seal-Piston I.D.-Lower	030761	1
Seal-Piston O.D.	030767	2
Seal-Adapter I.D.-Upper	031107	1
Seal-Adapter I.D.-Lower	031018	1
Seal-Adapter O.D.	031019	1
Seal-Adapter Top	031027	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066329	2
Anchor Shackle	060498	2
Stud for API Flange	011023	1 Set**
Nut for API Flange	020012	1 Set**
Wear Ring-Adapter Ring	152344	1
Eye Bolts	050243	2
Hammer Wrench	050822	1
Size (Inches)	2 9/16	
Pipe Plug 1/2" NPT	066326	1
Pipe Plug 1/4" NPT	065008	1
Seal Kit*	155067	1
Accumulator Kit †	152717	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

30", 1M psi, Bolted-Cover Spherical BOP (typical)

Description	P/N	Qty.
Lower Housing-Flanged	155274	1
Upper Housing-Studded	155272	1
Piston	155983	1
Adapter Ring	155984	1
Nitrile (Blue)	155393	1
Natural (Red)	155392	1
Stud	155408	1 Set**
Nut	020111	1 Set**
Seal-Piston I.D.-Upper	031225	1
Seal-Piston I.D.-Lower	031225	1
Seal-Piston O.D.	031226	2
Seal-Adapter I.D.-Upper	031224	1
Seal-Adapter I.D.-Lower	031224	1
Seal-Adapter O.D.	031020	1
Seal-Adapter Top	031021	1
Wear Ring-Piston	150613	2
Wear Ring-Lower Housing	150613	1
Pipe Plug	066330	2
Anchor Shackle	060498	2
Stud for API Flange	011035	1 Set**
Nut for API Flange	020015	1 Set**
Wear Ring-Adapter Ring	150613	1
Eye Bolts	150912	2
Hammer Wrench	050713	1
Size (Inches)	$3\ ^{1}/_{2}$	
Pipe Plug $^{1}/_{2}$" NPT	066326	1
Pipe Plug $^{1}/_{4}$" NPT	065008	1

30", 1M psi, Bolted-Cover Spherical BOP (typical) (Continued)

Description	P/N	Qty.
Seal Kit*	155412	1
Accumulator Kit †	155970	1

** Not a standard accessory. Includes all recommended spare seals.*

*** Part numbers are for each one. Quantity varies with size of spherical.*

† Not a standard accessory.

Bolted-Cover Spherical BOP Specifications

Bore Size	**7 1/16"**
Working Pressure	**10,000 psi**
Outside Diameter	43"
Height (Flange Face to Face)	42 1/4"
Operating Pressure	1,500 psi
Gallons to Close	17.20
Gallons to Open	13.95
Weights: Total	10,600 lbs.
15M Flanged Bottom	10,675 lbs.
15M psi Studded Bottom*	10,275 lbs.
15M psi Hubbed Bottom	10,425 lbs.
10M psi Flanged Bottom	10,600 lbs.
10M psi Studded Bottom*	10,275 lbs.
10M psi Hubbed Bottom	10,400 lbs.
Element	250 lbs.
Piston	1,100 lbs.
Adapter Ring	700 lbs.
Upper Housing	3,550 lbs.
Lower Housing	4,550 lbs.
Miscellaneous	450 lbs.
Test Pressure	12,500 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	100,000 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**7 1/16"**
Working Pressure	**10,000 psi**
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1 1/2" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**4 1/16"**
Working Pressure	**10,000 psi**
Outside Diameter	23"
Height (Flange Face to Face)	25 1/2"
Operating Pressure	1,500 psi
Gallons to Close	2.38
Gallons to Open	1.95
Weights: Total	1,850 lbs.
15M Flanged Bottom	1,925 lbs.
15M psi Studded Bottom*	1,800 lbs.
10M psi Flanged Bottom	1,850 lbs.
10M psi Studded Bottom*	1,800 lbs.
10M psi Hubbed Bottom	1,800 lbs.
Element	35 lbs.
Piston	150 lbs.
Adapter Ring	125 lbs.
Upper Housing	650 lbs.
Lower Housing	800 lbs.
Miscellaneous	90 lbs.
Test Pressure	12,500 psi
Lifting Shackle Quantity	2

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**4 1/16"**
Working Pressure	**10,000 psi**
Lifting Shackle Total Capacity**	19,000 lbs.
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	3/4" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**13 5/8"**
Working Pressure	**5,000 psi**
Outside Diameter	50"
Height (Flange Face to Face)	44 15/16"
Operating Pressure	1,500 psi
Gallons to Close	23.58
Gallons to Open	17.41
Weights: Total	13,650 lbs.
10M psi Flanged Bottom	14,250 lbs.
10M psi Studded Bottom*	13,100 lbs.
10M psi Hubbed Bottom	13,325 lbs.
5M psi Flanged Bottom	13,650 lbs.
5M psi Studded Bottom*	13,100 lbs.
5M psi Hubbed Bottom	13,250 lbs.
Element	550 lbs.
Piston	1,675 lbs.
Adapter Ring	800 lbs.
Upper Housing	3,800 lbs.
Lower Housing	6,350 lbs.
Miscellaneous	475 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**13 5/8"**
Working Pressure	**5,000 psi**
Test Pressure	10,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	100,000 lbs.
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1 1/2" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**11"**
Working Pressure	**5,000 psi**
Outside Diameter	44 3/4"
Height (Flange Face to Face)	41 1/2"
Operating Pressure	1,500 psi
Gallons to Close	18.67
Gallons to Open	14.59
Weights: Total	9,550 lbs.
10M psi Flanged Bottom	9,950 lbs.
10M psi Studded Bottom*	9,475 lbs.
10M psi Hubbed Bottom	9,450 lbs.
5M psi Flanged Bottom	9,550 lbs.
5M psi Studded Bottom*	9,300 lbs.
5M psi Hubbed Bottom	9,275 lbs.
Element	450 lbs.
Piston	1,150 lbs.
Adapter Ring	600 lbs.
Upper Housing	2,600 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**11"**
Working Pressure	**5,000 psi**
Lower Housing	4,425 lbs.
Miscellaneous	325 lbs.
Test Pressure	10,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	68,000 lbs.
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1 1/4" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**9"**
Working Pressure	**5,000 psi**
Outside Diameter	40"
Height (Flange Face to Face)	36 1/2"
Operating Pressure	1,500 psi
Gallons to Close	11.05
Gallons to Open	8.72
Weights: Total	6,800 lbs.
10M psi Flanged Bottom	7,075 lbs.
10M psi Studded Bottom*	6,500 lbs.
10M psi Hubbed Bottom	6,700 lbs.
5M psi Flanged Bottom	6,800 lbs.
5M psi Studded Bottom*	6,500 lbs.
5M psi Hubbed Bottom	6,625 lbs.
Element	275 lbs.
Piston	900 lbs.
Adapter Ring	450 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**9"**
Working Pressure	**5,000 psi**
Upper Housing	2,000 lbs.
Lower Housing	2,900 lbs.
Miscellaneous	275 lbs.
Test Pressure	10,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	48,000 lbs.
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1 1/4" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**7 1/16"**
Working Pressure	**5,000 psi**
Outside Diameter	29"
Height (Flange Face to Face)	30 7/8"
Operating Pressure	1,500 psi
Gallons to Close	4.57
Gallons to Open	3.21
Weights: Total	3,175 lbs.
10M psi Flanged Bottom	3,350 lbs.
10M psi Studded Bottom*	3,100 lbs.
10M psi Hubbed Bottom	3,200 lbs.
5M psi Flanged Bottom	3,175 lbs.
5M psi Studded Bottom*	3,100 lbs.
5M psi Hubbed Bottom	3,125 lbs.
Element	125 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	7 1/16"
Working Pressure	**5,000 psi**
Piston	425 lbs.
Adapter Ring	135 lbs.
Upper Housing	975 lbs.
Lower Housing	1,375 lbs.
Miscellaneous	140 lbs.
Test Pressure	10,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	26,000 lbs.
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1 1/4" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	20 3/4 "
Working Pressure	**3,000 psi**
Outside Diameter	54 1/8"
Height (Flange Face to Face)	48 7/16"
Operating Pressure	1,500 psi
Gallons to Close	43.4
Gallons to Open	26.9
Weights: Total	14,600 lbs.
Element	950 lbs.
Piston	2,485 lbs.
Adapter Ring	840 lbs.
Upper Housing	3,660 lbs.
Lower Housing	6,745 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**20 3/4 "**
Working Pressure	**3,000 psi**
Miscellaneous	400 lbs.
Test Pressure	6,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	100,000
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1 1/2" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**13 5/8 "**
Working Pressure	**3,000 psi**
Outside Diameter	46 3/8"
Height (Flange Face to Face)	40 11/16"
Operating Pressure	1,500 psi
Gallons to Close	23.50
Gallons to Open	14.67
Weights: Total	9100 lbs.
5M psi Flanged Bottom	9,475 lbs.
5M psi Studded Bottom*	8,850 lbs.
5M psi Hubbed Bottom	9,100 lbs.
3M psi Flanged Bottom	9,100 lbs.
3M psi Studded Bottom*	8,850 lbs.
3M psi Hubbed Bottom	8,925 lbs.
Element	550 lbs.
Piston	1,225 lbs.
Adapter Ring	425 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	13 5/8 "
Working Pressure	**3,000 psi**
Upper Housing	2,850 lbs.
Lower Housing	3,775 lbs.
Miscellaneous	275 lbs.
Test Pressure	6,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	68,000 lbs.
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1 1/2" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	11"
Working Pressure	**3,000 psi**
Outside Diameter	39 7/8"
Height (Flange Face to Face)	32 7/8"
Operating Pressure	1,500 psi
Gallons to Close	11.00
Gallons to Open	6.78
Weights: Total	5,825 lbs.
5M psi Flanged Bottom	6,000 lbs.
5M psi Studded Bottom*	5,700 lbs.
5M psi Hubbed Bottom	5,725 lbs.
3M psi Flanged Bottom	5,825 lbs.
3M psi Studded Bottom*	5,700 lbs.
3M psi Hubbed Bottom	5,700 lbs.
Element	325 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**11"**
Working Pressure	**3,000 psi**
Piston	950 lbs.
Adapter Ring	250 lbs.
Upper Housing	1,575 lbs.
Lower Housing	2,475 lbs.
Miscellaneous	250 lbs.
Test Pressure	6,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	34,000 lbs.
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**9"**
Working Pressure	**3,000 psi**
Outside Diameter	35 $^{1}/_{2}$"
Height (Flange Face to Face)	32 $^{1}/_{2}$"
Operating Pressure	1,500 psi
Gallons to Close	7.23
Gallons to Open	5.03
Weights: Total	4,775 lbs.
5M psi Flanged Bottom	4,850 lbs.
5M psi Studded Bottom*	4,675 lbs.
5M psi Hubbed Bottom	4,700 lbs.
3M psi Flanged Bottom	4,775 lbs.
3M psi Studded Bottom*	4,675 lbs.
Element	275 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**9"**
Working Pressure	**3,000 psi**
Piston	625 lbs.
Adapter Ring	275 lbs.
Upper Housing	1,350 lbs.
Lower Housing	2,125 lbs.
Miscellaneous	125 lbs.
Test Pressure	6,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	34,000
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**7 1/16"**
Working Pressure	**3,000 psi**
Outside Diameter	29"
Height (Flange Face to Face)	29 1/8"
Operating Pressure	1,500 psi
Gallons to Close	4.92
Gallons to Open	3.43
Weights: Total	2,900 lbs.
5M psi Flanged Bottom	2,925 lbs.
5M psi Studded Bottom*	2,825 lbs.
5M psi Hubbed Bottom	2,875 lbs.
3M psi Flanged Bottom	2,900 lbs.
3M psi Studded Bottom*	2,825 lbs.
Element	125 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**7 1/16"**
Working Pressure	**3,000 psi**
Piston	425 lbs.
Adapter Ring	125 lbs.
Upper Housing	775 lbs.
Lower Housing	1,325 lbs.
Miscellaneous	125 lbs.
Test Pressure	6,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	19,000
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**21 1/4"**
Working Pressure	**2,000 psi**
Outside Diameter	49"
Height (Flange Face to Face)	46 1/8"
Operating Pressure	1,500 psi
Gallons to Close	32.59
Gallons to Open	16.92
Weights: Total	10,850 lbs.
5M psi Flanged Bottom	12,800 lbs.
3M psi Flanged Bottom	11,200 lbs.
3M psi Studded Bottom*	10,400 lbs.
3M psi Hubbed Bottom	10,650 lbs.
2M psi Flanged Bottom	10,850 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**21 1/4"**
Working Pressure	**2,000 psi**
2M psi Studded Bottom*	10,400 lbs.
2M psi Hubbed Bottom	10,650 lbs.
Element	950 lbs.
Piston	2,485 lbs.
Adapter Ring	475 lbs.
Upper Housing	3,050 lbs.
Lower Housing	4,725 lbs.
Miscellaneous	275 lbs.
Test Pressure	4,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	100,000
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1 1/2" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**30"**
Working Pressure	**1,000 psi**
Outside Diameter	71"
Height (Flange Face to Face)	65 5/8"
Operating Pressure	1,500 psi
Gallons to Close	122.00
Gallons to Open	55
Weights: Total	28,750 lbs.
1M psi Flanged Bottom	26,275 lbs.
1M psi Studded Bottom*	25,555 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**30"**
Working Pressure	**1,000 psi**
Element	2,875 lbs.
Piston	5,025 lbs.
Adapter Ring	1,050 lbs.
Upper Housing	6,575 lbs.
Lower Housing	9,850 lbs.
Miscellaneous	900 lbs.
Test Pressure	2,000 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	100,000
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	2" NPT (4)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	**13 5/8"**
Working Pressure	**5,000 psi Light Weight**
Outside Diameter	50"
Height (Flange Face to Face)	42 1/4"
Operating Pressure	1,500 psi
Gallons to Close	23.58
Gallons to Open	17.41
Weights: Total	10,000 lbs.
5M psi Flanged Bottom	10,000 lbs.
5M psi Studded Bottom*	9,500 lbs.
5M psi Hubbed Bottom	9,625 lbs.
Element	550 lbs.
Piston	1,625 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	13 5/8"
Working Pressure	**5,000 psi Light Weight**
Adapter Ring	425 lbs.
Upper Housing	3,025 lbs.
Lower Housing	4,000 lbs.
Miscellaneous	375 lbs.
Test Pressure	7,500 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	100,000 lbs.
Hydraulic Fluid	SAE 20W
Hydraulic Connections	1 1/2" NPT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.

Bolted-Cover Spherical BOP Specifications

Bore Size	11"
Working Pressure	**5,000 psi Light Weight**
Outside Diameter	44 3/4"
Height (Flange Face to Face)	40 7/8"
Operating Pressure	1,500 psi
Gallons to Close	18.67
Gallons to Open	14.59
Weights: Total	8,725 lbs.
Element	450 lbs.
Piston	1,150 lbs.
Adapter Ring	525 lbs.
Upper Housing	2,475 lbs.
Lower Housing	3,800 lbs.
Miscellaneous	325 lbs.

Bolted-Cover Spherical BOP Specifications (Continued)

Bore Size	**11"**
Working Pressure	**5,000 psi Light Weight**
Test Pressure	7,500 psi
Lifting Shackle Quantity	2
Lifting Shackle Total Capacity**	68,000 lbs.
Hydraulic Fluid	SAE 20W Non-Detergent
Hydraulic Connections	1 $^{1}/_{4}$" PT (2)

** Includes studs and nuts.*

*** Individual capacity is one-half of the total.*

† Lightweight.