Technical Manual
for

Intermediate
FlexJoint® Assembly

5 June 2015
TM-0002, Rev. E

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Table of Contents

Tables

Figures

1 INTRODUCTION

1.1 GENERAL

This manual provides the operating and maintenance information necessary to use and maintain the Intermediate FlexJoint® Assembly (flexible joint) manufactured by Oil States Industries (OSI). OSI offers Intermediate flexible joints for 1,000, 2,000, and 3,000 kip axial tension applications in a variety of flanged configurations. This section provides a general description of the units and defines their operating parameters. Section 2 provides a list of tools and materials required for maintenance. Section 3 provides complete inspection and repair procedures. Information pertaining to storage and shipment is provided in Section 4 and Section 5 contains complete parts lists for the units.

1.2 DESCRIPTION

Intermediate flexible joints are flexible couplings designed for installation below the telescopic joint where the riser is subjected to extreme tension loads. Refer to Figure 1-1. All units share a common design comprising of two large diameter, spherical elastomeric bearings within a forged housing equipped with customer specified end connections. Materials used in the flexible joints consist of high-grade steels and various nitrile elastomers that offer a high resistance to oil well fluids. These elastomers also exhibit extremely long life under the conditions encountered during drilling and production operations. The OSI Intermediate FlexJoint® Assembly was designed so that the flex element acts as the primary seal. This technology was vital to the success of capping the Macondo well. The OSI FlexJoint®

Assembly was able to overcome an over-rotation load case, high well bore temperatures, and extreme well bore pressures for an extended duration. The OSI FlexJoint® Assembly successfully acted as the critical seal in the final capping stack arrangement, even though the wellbore temperatures and pressures exceeded the nominal requirements. This sealing technology is only available with an industry and field proven OSI FlexJoint® Assembly. The major components of the flexible joint are the two flex element assemblies.

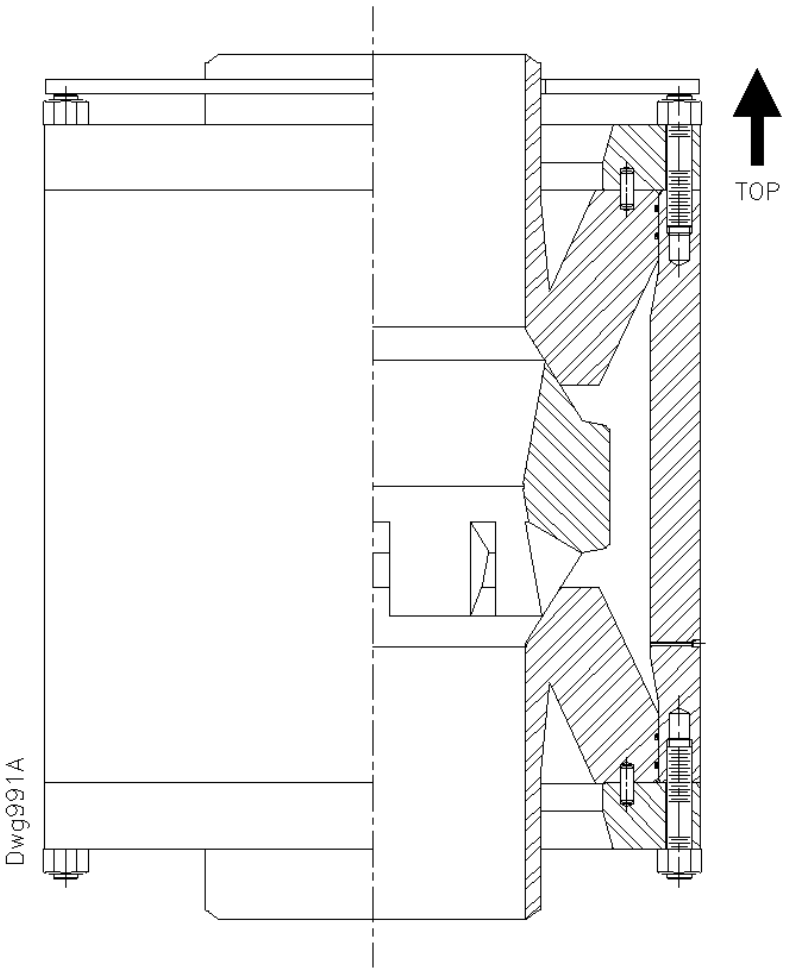


Figure 1-1
Typical Intermediate Flexible Joint

Each flex element assembly is constructed using alternating layers of elastomer pads and spherically shaped metal reinforcements. They are molded with an approximately 3/8 inch (1 cm) thick elastomer coating. The flex element assembly is integrally bonded during the molding process to the nipple and back flange so that it forms, in addition to a bearing, the seal between the housing and the nipple. Each flex element assembly is secured within the housing by a retainer flange fastened to one side of the housing using various retainer studs and nuts (with the size and quantity depending on the axial tension rating).

1.3 TECHNICAL CHARACTERISTICS

Each Intermediate flexible joint permits cocking displacements up to ±20 degrees. The flexible joints range from 47.0 to 48.5 inches (1.19 to 1.23 m) in diameter and weigh between 16,000 to 20,000 lbs (7,260 to 9,072 kg). The length of the unit depends on the end connections selected as well as the tension rating of the unit. Table 1.1 and Figure 1-2 illustrate typical envelope dimensions for the Intermediate –1, –2, –3, and –4 flexible joints. Table 1.2 provides the performance characteristics of the Intermediate –1, –2, –3, and –4 flexible joints.

NOTE:

Where differences exist between the US customary and metric values within this manual, the US customary value is the standard.

Figure 1-2
Intermediate Flexible Joint
Envelope Dimensions

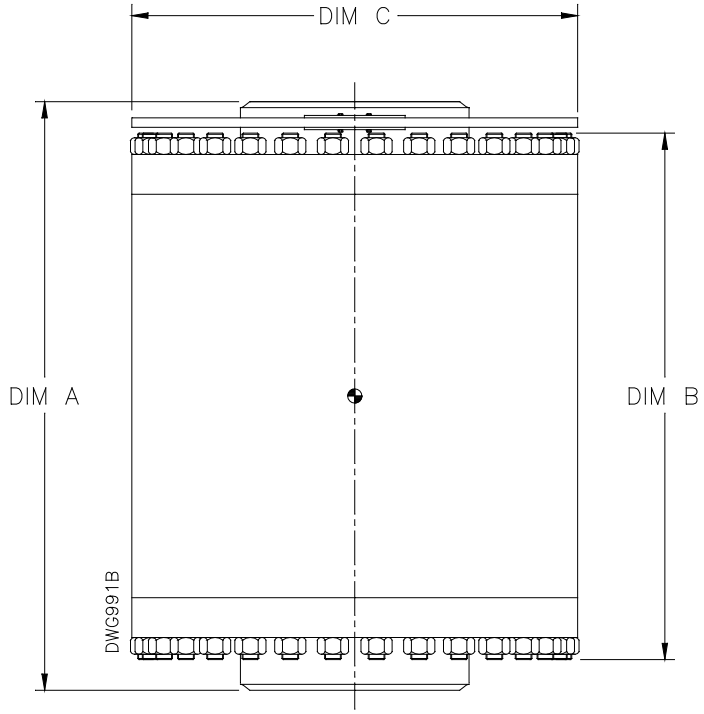


Table 1.1
Envelope Dimensions

	Dim. 'A'	Dim. 'B'	Dim. 'C'
Intermediate –1	62.00	55.88	47.00
Intermediate –2	62.00	57.00	47.00
Intermediate –3	62.00	58.50	48.50
Intermediate –4	62.00	58.50	48.50

Table 1.2
Performance Characteristics

Intermediate –1 Flexible Joint

Characteristic	Value
Bore Size:	22.00 in. (55.9 cm)
Normal Operating Pressure:	500 psi (34.5 bar)
Maximum Operating Pressure:	2,000 psi (137.9 bar)
Maximum Test Pressure:	3,000 psi (206.8 bar)
Normal Operating Tension:	1,000,000 lbs (4,448 kN)
Maximum Operating Tension:	2,000,000 lbs (8,896 kN)
Maximum Deflection:	±20 degrees
Angular Spring Rate:	17,100 ft-lb/deg (23.18 kNm/deg) @ 20 degrees rotation
Pivot Location:	Housing Center
Maximum Outer Diameter:	47.00 in. (119.4 cm)
Estimated Final Weight:	16,000 lbs (7,257 kg)

Intermediate –2 Flexible Joint

Characteristic	Value
Bore Size:	22.00 in. (55.9 cm)
Normal Operating Pressure:	500 psi (34.5 bar)
Maximum Operating Pressure:	2,500 psi (172.4 bar)
Maximum Test Pressure:	3,750 psi (258.6 bar)
Normal Operating Tension:	1,600,000 lbs (7,117 kN)
Maximum Operating Tension:	2,600,000 lbs (11,565 kN)
Maximum Deflection:	±20 degrees
Angular Spring Rate:	17,100 ft-lb/deg (23.18 kNm/deg) @ 20 degrees rotation
Pivot Location:	Housing Center
Maximum Outer Diameter:	47.00 in. (119.4 cm)
Estimated Final Weight:	18,000 lbs (8,165 kg)

Intermediate –3 Flexible Joint

Characteristic	Value
Bore Size:	22.00 in. (55.9 cm)
Normal Operating Pressure:	500 psi (34.5 bar)
Maximum Operating Pressure:	3,000 psi (206.8 bar)
Maximum Test Pressure:	4,500 psi (310.3 bar)
Normal Operating Tension:	1,000,000 lbs (4,448 kN)
Maximum Operating Tension:	2,000,000 lbs (8,896 kN)
Maximum Deflection:	±20 degrees
Angular Spring Rate:	17,100 ft-lb/deg (23.18 kNm/deg) @ 20 degrees rotation
Pivot Location:	Housing Center
Maximum Outer Diameter:	48.50 in. (123.2 cm)
Estimated Final Weight:	20,000 lbs (9,072 kg)

Intermediate –4 Flexible Joint

Characteristic	Value
Bore Size:	22.00 in. (55.9 cm)
Normal Operating Pressure:	500 psi (34.5 bar)
Maximum Operating Pressure:	3,000 psi (206.8 bar)
Maximum Test Pressure:	4,500 psi (310.3 bar)
Normal Operating Tension:	2,200,000 lbs (9,786 kN)
Maximum Operating Tension:	3,200,000 lbs (14,234 kN)
Maximum Deflection:	±20 degrees
Angular Spring Rate:	17,100 ft-lb/deg (23.18 kNm/deg) @ 20 degrees rotation
Pivot Location:	Housing Center
Maximum Outer Diameter:	48.50 in. (123.2 cm)
Estimated Final Weight:	20,000 lbs (9,072 kg)

2 TOOLS AND MATERIALS REQUIRED

2.1 GENERAL

This section provides detailed information on the tools and materials required for maintenance of an Intermediate flexible joint. In addition to the standard tools identified below, a crane is required for handling the unit and the various parts during inspection and maintenance. The minimum lift capacity of the crane should be checked against the estimated weights given in Table 1.2.

2.2 TOOLS AND MATERIALS

Table 2.1 lists the tools and materials required for maintenance of an Intermediate flexible joint, and explains the intended purpose of each.

NOTE:

Equivalent tools or materials may be substituted for those listed as long as the intended purpose is achieved.

Table 2.1
Tools and Materials Required for Flexible Joint Maintenance

Intermediate –1 and –2 Flexible Joints

Item	Purpose
Torque Wrench (2,000 ft-lb)	Torque Retainer Nuts
Torque Wrench (300 ft-lb)	Torque Ring Groove Insert Bolts
Capscrew Wrench (5/8 in.)	Remove Ring Groove Insert
2-3/4 Socket (hex)	Retainer Nuts
Eyebolt 1 in., 8-UNC	Lift Retainer Flange
Eye Nuts 1-1/4 in., 8-UN	Lift Flex Element Assembly and Housing
Eyebolts 3/4 in., 10-UNC	Lift Center Wear Ring
Sling for Crane	Connect to Eyebolts
Grease, API #SA2	Lube Bolts, Center Wear Ring
Grease, Alemite Multi-Purpose #2	Lube O-ring
Trichloroethylene	Clean Metal
Methyl Ethyl Ketone (MEK)	Clean Rubber
Emery Cloth (400 grit or finer)	Refinish O-ring Groove
Thread Lubricant	Lube Retainer Studs, Nuts

Intermediate –3 and –4 Flexible Joints

Item	Purpose
Torque Wrench (3,500 ft-lb)	Torque Retainer Nuts
Torque Wrench (300 ft-lb)	Torque Ring Groove Insert Bolts
Capscrew Wrench (5/8 in.)	Remove Ring Groove Insert
3-1/8 Socket (hex)	Retainer Nuts
Eyebolt 1 in., 8-UNC	Lift Retainer Flange
Eye Nuts 1-1/4 in., 8-UN	Lift Flex Element Assembly and Housing
Eyebolts 3/4 in., 10-UNC	Lift Center Wear Ring
Sling for Crane	Connect to Eyebolts
Grease, API #SA2	Lube Bolts, Center Wear Ring
Grease, Alemite Multi-Purpose #2	Lube O-ring
Trichloroethylene	Clean Metal
Methyl Ethyl Ketone (MEK)	Clean Rubber
Emery Cloth (400 grit or finer)	Refinish O-ring Groove
Thread Lubricant	Lube Retainer Studs, Nuts

3 MAINTENANCE

3.1 GENERAL

This section presents complete procedures for installation and removal, disassembly, cleaning, inspection, and reassembly of each Intermediate flexible joint. The procedures are directed toward identification and replacement of worn or damaged parts, since field repair of these parts is impractical. Maintenance procedures are essentially the same for each flexible joint size. However, there are options that may be present on any size of flexible joint. The various options are summarized below and procedures for each are presented as part of the maintenance process. When performing maintenance, select the appropriate procedure for the unit being worked on.

3.1.1 End Connections. Various end connections are available for the flexible joints. Generally, no maintenance is required for these other than replacement of worn or damaged studs or seal rings. This manual assumes that typical end connections are used. If your unit uses a different end connection, it may be necessary to adjust the size of eyebolts used for lifting the end connection or to make other minor adjustments in the procedures. Where special end connections are provided as specified by the customer, maintenance procedures are provided as a supplement to this manual.

3.1.2 Debris Shield. Two different types of debris shields are used on the flexible joints, depending on whether splitting the shield is required to clear the upper end connector.

3.1.3 Parts. Due to the difference in tension ratings between the various models of flexible joints, certain parts are changed. When ordering replacements for worn or damaged parts, be sure you are referring to the parts list (Section 5) for your size unit or to the OSI unit serial number.

3.2 REMOVAL

The flexible joint should be removed from the riser following the operator's standard procedures. After the unit has been removed, it should be positioned upright in an area that is free of obstacles and permits easy access to all parts of the flexible joint.

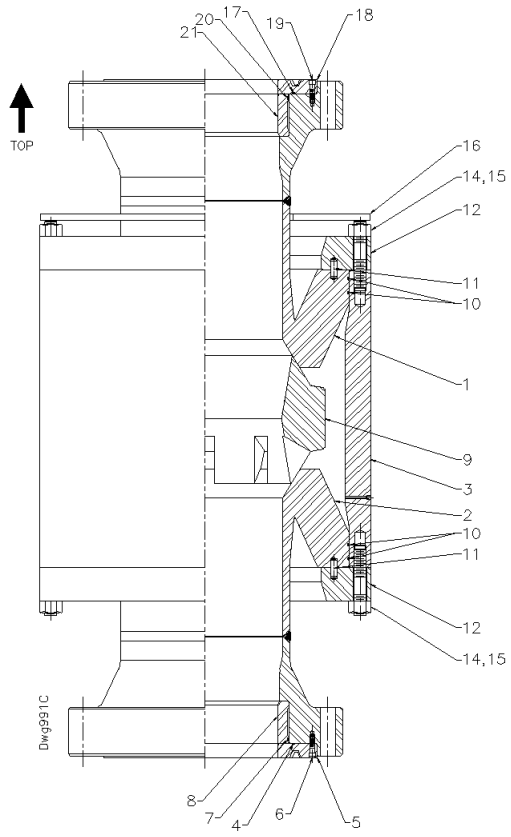
WARNING:

The flexible joint and its parts are extremely heavy. Never work in a position that places you under the unit or its parts when they are being lifted. Failure to follow the maintenance procedures or to observe this WARNING could result in injury or death.

3.3 FLEXIBLE JOINT DISASSEMBLY

Perform the following procedures, in sequence, to disassemble the flexible joint. The procedures are keyed (via the numbers in parenthesis) to the numerical list of components shown in Figure 3-1. It is recommended that, with the exception of the debris shield, if disassembly is started, the unit be completely disassembled and inspected for worn or damaged parts before reassembling.

Figure 3-1
Intermediate Flexible Joint Components



1.	Upper Flex Element Assembly	**12.**	Upper Retainer Flange
2.	Lower Flex Element Assembly	**13.**	Lower Retainer Flange
3.	Housing	**14.**	Retainer Nut
4.	O-ring (Lower Ring Groove Insert)	**15.**	Retainer Stud
5.	Lower Ring Groove Insert	**16.**	Debris Shield
6.	Bolts (Lower Ring Groove Insert)	**17.**	O-ring (Upper Ring Groove Insert)
7.	O-ring (Lower Wear Sleeve)	**18.**	Upper Ring Groove Insert
8.	Lower Wear Sleeve	**19.**	Bolts (Upper Ring Groove Insert)
9.	Center Wear Ring	**20.**	O-ring (Upper Wear Sleeve)
10.	O-Ring (Flex Element)	**21.**	Upper Wear Sleeve
11.	Anti-Rotation Pin		

3.3.1 Debris Shield. Remove the debris shield (16) as follows:

1. Remove the screws and plate that secure the break in the debris shield (16).
2. Bend the debris shield (16) to clear the upper end connector and remove it.

NOTE:

The upper and lower ring groove inserts and wear sleeves are an optional feature. If your unit does not have them, disregard these disassembly procedures.

3.3.2 Upper Ring Groove Insert and Wear Sleeve. Remove the upper ring groove insert (18) and the upper wear sleeve (21) as follows:

1. Remove the upper ring groove insert bolts, Item (19) Figure 3-1.
2. Screw 1/2-13 eyebolts into the holes provided in the upper ring groove insert (18) and connect the crane hook to them using the sling.
3. Lift the upper ring groove insert out and set on a wooden pallet.
4. Remove the O-ring (17) from the upper ring groove insert. Discard the O-ring.
5. Screw 1/2-13 eyebolts into the upper wear sleeve (21). Connect the crane hook to them using the sling.
6. Lift out the upper wear sleeve and set on a wooden pallet.
7. Remove the O-rings (20) from the upper wear sleeve. Discard the O-rings.

3.3.3 Upper Flex Element Assembly and Retainer Flange.

Remove the upper flex element assembly (1) and retainer flange (12) as follows:

CAUTION:

Be extremely careful when removing the assembly from the housing to avoid damage to the O-rings (10).

1. Screw four eye nuts to studs at 90° intervals around the upper end connector or install four eyebolts, as applicable.
2. Position the crane and connect it to the eyebolts. Take up the slack in the crane cable, but do not apply tension yet.
3. Ensure that there is a locator mark on both the upper retainer flange (12) and the housing (3) to permit proper orientation when the assembly is reinstalled. If no marks are found, scribe opposing lines on the housing and upper retainer flange to serve as a locator.

CAUTION:

Be careful while moving the flex element assembly not to damage the elastomer or the elastomer-to-metal interfaces.

4. Remove the upper retainer nuts (14) from the upper retainer studs (15).
5. Use the crane to lift the upper flex element assembly (1) with the retainer flange (12) straight up out of the housing (3). Swing the assembly clear of the housing and carefully remove the O-rings (10) from the upper flex element assembly (1). Discard the O-rings. Set the upper flex element assembly and retainer flange down on a wooden pallet.
6. For those units with an end connector small enough to permit the upper retainer flange (12) to be removed, use four eyebolts

through the retainer flange to lift the flange away from the upper flex element assembly (1). Otherwise, use the eyebolts to lift the upper retainer flange while performing step 7 below and then set it back in place.

7. Remove the two anti-rotation pins (11) from the upper flex element assembly (1).

3.3.4 Center Wear Ring. Remove the center wear ring (9) from the housing (3) as follows:

1. Install two 3/4 inch eyebolts in the holes provided in the upper surface of the center wear ring (9).
2. Connect the crane sling to the eyebolts and lift the center wear ring (9) out of the housing (3).
3. Set the center wear ring (9) down on a wooden pallet and disconnect the crane from the eyebolts.

3.3.5 Retainer Studs. Damaged retainer studs (15) may be removed from an API flange or the housing (3) by installing two nuts on a stud and then applying a torque to the bottom nut.

NOTE:

Do not remove undamaged retainer studs. Retainer studs should be removed as directed in 3.3.5 above only if obvious damage to the stud is apparent or the stud is improperly installed.

3.3.6 Flipping the Flexible Joint Over.

1. To flip the housing (3), the lower flex element assembly (2), and the lower retainer flange (13) over, first install two eye nuts to two adjacent upper retainer studs (15) and attach a two point chain/cable to the eye nuts. After ensuring the area is clear of personnel, smoothly raise the assembly off the floor *making sure that the crane gantry is directly over the assembly at all times.* Lower the assembly onto its side on thick cardboard or a rubber mat and remove the eye nuts.
2. Install two eye nuts or eyebolts to the top of the lower end connector, attach the crane, and lift smoothly *keeping the crane gantry over the assembly at all times*. As the assembly becomes suspended and rotates towards the upright position, start lowering it until it sits on the mat. Remove the crane and eye nuts or eyebolts.

3.3.7 Lower Ring Groove Insert and Wear Sleeve. Remove the lower ring groove insert (5) and the lower wear sleeve (8) as follows:

1. Remove the lower ring groove insert bolts, Item (6) Figure 3-1.
2. Screw 1/2-13 eyebolts into the holes provided in the lower ring groove insert (5) and connect the crane hook to them using the sling.
3. Lift the lower ring groove insert out and set on a wooden pallet.
4. Remove the O-ring (4) from the lower ring groove insert. Discard the O-ring.
5. Screw 1/2-13 eyebolts into the lower wear sleeve (8). Connect the crane hook to them using the sling.
6. Lift out the lower wear sleeve and set on a wooden pallet.

7. Remove the O-rings (7) from the lower wear sleeve. Discard the O-rings.

3.3.8 Lower Flex Element Assembly and Retainer Flange.

Remove the lower flex element assembly (2) and retainer flange (13) by repeating the procedures outlined in Section 3.3.3.

3.4 CLEANING AND INSPECTION

Cleaning and inspection of the parts within the flexible joint are described in the following subparagraphs. Always clean the part before performing the inspection. Replace all worn or damaged parts with new parts before reassembling the flexible joint.

OSI recommends that under normal operating conditions, the flexible joint should be disassembled and inspected for damage / wear every 5 years. In order to issue a new OSI Certificate of Conformance, a disassembly and inspection of critical areas and dimensional checks to verify conformance must be completed by an OSI facility per SP2U-0247. See Section 5.3 to contact the nearest OSI facility.

3.4.1 Cleaning.

WARNING:

The solvents used for cleaning the parts within the flexible joint are toxic. Avoid getting the solvents on your skin or breathing the fumes. Cleaning operations should be performed in a well-ventilated area.

Methyl Ethyl Ketone (MEK) is extremely flammable. Do not smoke or allow welding or other operations involving open flames or sparks nearby when it is being used.

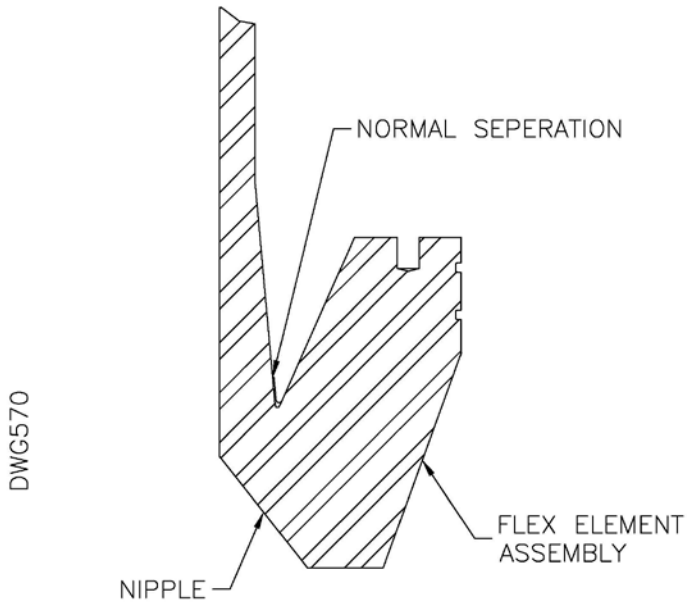
1. Clean all metal parts within the flexible joint with a clean rag soaked with Trichloroethylene or equivalent solvent. Be especially careful to remove all dirt and grease from the O-ring grooves, anti-rotation pins and their holes, mating surfaces, and threads of bolts, studs, and nuts.
2. Clean the elastomer of each flex element assembly (1, 2) with a clean rag soaked in MEK.

3.4.2 Inspection.

NOTE:

The elastomer flashing usually separates from the nipple at the points indicated by Figure 3-2. This is normal when the flexible joint is deflected and should not be cause for concern.

Figure 3-2
Flashing Separation



1. Elastomer. Inspect the entire surface of the elastomer for abrasion or wear. Cuts or gouges in the elastomer that exceed 1/8 inch (3mm) in depth are cause for replacement of either flex element assembly (1, 2).
2. Center Wear Ring (9), Upper (21) and Lower (8) Wear Sleeves. Inspect the components for signs of uneven or excessive wear. Replace the components if they are sufficiently scored, galled, or worn such that wear is occurring to the housing (3) interior or either flex element assembly (1, 2).
3. Nipple. The extension protruding from the middle of the upper and lower flex element assemblies (1, 2) is referred to as the nipple. Check the bearing surfaces of the nipple for excessive or uneven wear. Return the entire flexible joint to the manufacturer for repair or replacement if severe scoring, galling, or wear in excess of 1/4 inch is found. Inspect the remainder of the nipple for cracks or other defects, paying particular attention to the weld area. Return the flexible joint to the manufacturer for repair or replacement if cracks or other defects occur for reasons other than normal wear.
4. Housing. Inspect the housing (3) for cracks, other defects, and particularly damage to the mating surfaces. Return the entire unit to the manufacturer if defects are found.
5. Flex Element Back Flange. The integrally bonded heavy metal ring surrounding the upper and lower flex element assemblies (and containing the O-rings) is referred to as the back flange. Inspect each flange for damage to the O-ring grooves and mechanical damage to the mating surfaces. Minor damage to the O-ring grooves may be repaired by smoothing out the surface with #400 grit or finer emery cloth. Ensure that the grooves are completely clean before installing new O-rings.
6. Threads. Inspect all threaded parts for damage to the thread. Minor thread damage may be repaired by using an appropriate tap

or die to renew the threads. Bolts, studs, or nuts with excessive damage to the threads should be replaced. If interior threads are badly damaged, return the flexible joint to the manufacturer for repair or replacement.

7. Ring Groove Inserts. Inspect the ring groove inserts for damage to the mating surfaces or the O-ring groove. Minor damage to the O-ring groove may be repaired by smoothing out the surface with #400 grit or finer emery cloth. Ensure that the groove is completely clean before installing a new O-ring.

3.5 FLEXIBLE JOINT ASSEMBLY

Assembly of the flexible joint is essentially a reversal of the disassembly procedures. Perform the procedures outlined in the following paragraphs, in sequence, being sure to observe the **WARNINGS** and **CAUTIONS** during reassembly of the flexible joint.

3.5.1 Lower Ring Groove Insert and Wear Sleeve. Install the lower ring groove insert (5) and the lower wear sleeve (8) as follows:

1. Lubricate a new O-ring (7) with Alemite Multi-Purpose #2 grease or equivalent and install in the O-ring groove within the lower wear sleeve (8). Coat entire outside surface of the wear sleeve with grease.
2. Attach the crane to the 1/2-13 eyebolts in the lower wear sleeve (8).
3. Lift the lower wear sleeve (8) and position within the API flange.
4. Lubricate a new O-ring (4) with Alemite Multi-Purpose #2 grease or equivalent and install in the O-ring groove within the lower ring groove insert (5).
5. Attach the crane to the 1/2-13 eyebolts in the lower ring groove insert (5). Lift the lower ring groove insert and lower into position

aligning the through holes with the threaded holes in the API flange.

6. Install the lower ring groove insert bolts (6) and torque to 150 ft-lbs.

3.5.2 Retainer Studs. Retainer studs (15) that have been removed should be installed as follows:

1. Ensure that both the retainer studs (15) and the threaded holes are clean.
2. Coat the threads of the retainer studs (15) liberally with Loctite 271 or equivalent adhesive.
3. Screw the retainer studs (15) into the housing (3), using the double-nut method, to a height of:

–1	–2	–3	–4
7.0 ±0.1 in. (18 cm)	7.0 ±0.1 in. (18 cm)	7.7 ±0.1 in. (20 cm)	7.7 ±0.1 in. (20 cm)

NOTE:

Refer to API standards to determine the proper installed height for studs in the end connectors.

3.5.3 Lower Flex Element Assembly and Retainer Flange. Install the lower flex element assembly (2) and retainer flange (13) as follows:

1. Install four eyebolts in the lower retainer flange (13) and connect the crane sling to them.

WARNING:

Be extremely careful when working under any heavy assembly to ensure that it is not lowered while you are working on it. One person should be assigned

2. Raise the lower retainer flange (13) to clear the top of the back flange and inspect the mating surfaces and anti-rotation pins (11) and holes.
3. Ensure that the holes for the anti-rotation pins (11) in both the lower retainer flange (13) and back flange are clean, then coat the anti-rotation pins with grease, and install them in the back flange holes.
4. Position the lower retainer flange (13) onto the anti-rotation pins (11), being sure it lines up and completely seats on the pins.
5. Remove the sling and eyebolts from the lower retainer flange (13).
6. Connect the crane sling to the eye nuts or eyebolts in the lower end connector and raise and position the lower flex element assembly (2) over the housing (3). Do not lower into place.
7. Lubricate the new O-rings (10) heavily with Alemite Multi-Purpose #2 grease or equivalent and install them in the O-ring grooves in the back flange. Apply additional lubricant to the O-rings and metal surface after they are installed.
8. Lubricate the lower retainer studs (15) in the housing (3) liberally with thread lubricant or equivalent.

NOTE:

The torque tables in steps 12 and 13 are a guide to torque application depending on the thread lubricant used by the technician. The torque values provided are based on the friction coefficient of various lubricants available.

CAUTION:

Be extremely careful while installing each flex element assembly and retainer flange into the housing, not to damage the O-rings or mar the mating surfaces. Damage to the housing or flange surfaces may require replacement of the entire unit.

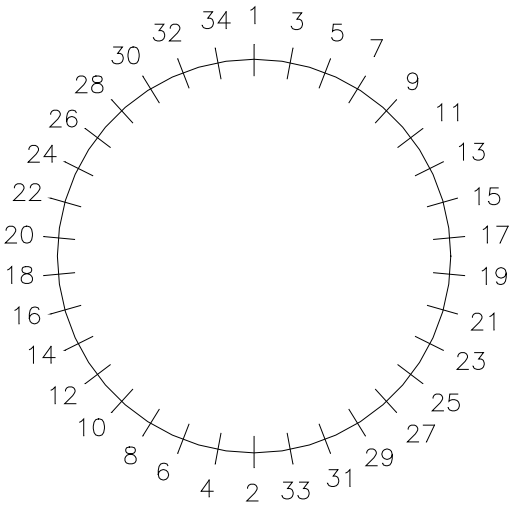


Figure 3-3
34 Bolt Torque Pattern

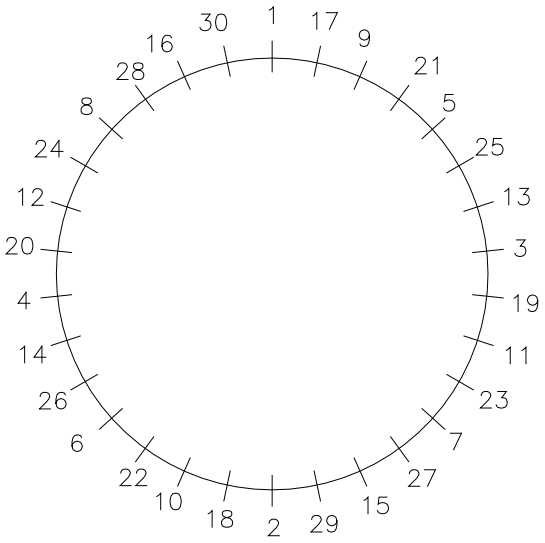


Figure 3-4
30 Bolt Torque Pattern

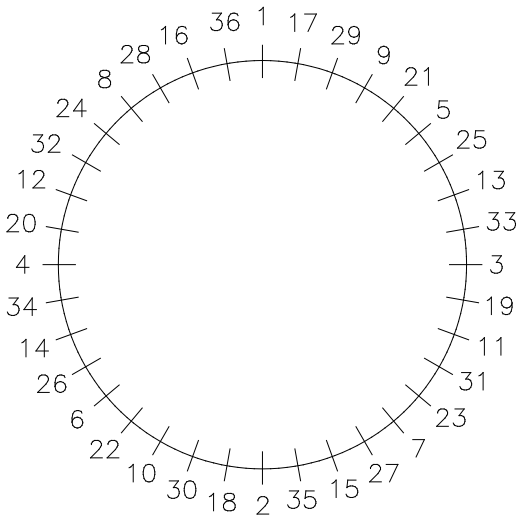


Figure 3-5
36 Bolt Torque Pattern

9. Ensure that the lower flex element assembly (2) is properly oriented by lining up the locator lines scribed on the housing (3) and lower retainer flange (13) and then lower the assembly into the housing until the retainer flange seats completely over the retainer studs (15).
10. Install the lower retainer nuts (14) on the lower retainer studs (15) and tighten them finger tight.
11. Refer to Figures 3-3 through 3-5 and torque each nut in the indicated order to the following tension:

–1	–2	–3	–4
150 ±50 ft-lbs	150 ±50 ft-lbs	150 ±50 ft-lbs	150 ±50 ft-lbs

12. Torque each nut to the applicable value in Table 3.1, based on the thread lubricant used, in the order indicated in Figures 3-3 through 3-5.

Table 3.1
50 Percent Torque Applied

Flexible Joint	Friction Coefficients (Fc) for Thread Lubricants				
	Dry 0.2 Fc (ft-lbs)	MIL-L-24479B 0.08 Fc (ft-lbs)	0.15 Fc (ft-lbs)	0.10 Fc (ft-lbs)	0.06 Fc (ft-lbs)
-1, -2	2,000	850	1,550	1,060	670
-3, -4	3,075	1,200	2,325	1,600	1,005

13. Torque each nut to the applicable value in Table 3.2, based on the thread lubricant used, in the order indicated in Figures 3-3 through 3-5. Repeat the torque sequence to ensure even torqueing.

Table 3.2
100 Percent Torque Applied

Flexible Joint	Friction Coefficients (Fc) for Thread Lubricants				
	Dry 0.2 Fc (ft-lbs)	MIL-L-24479B 0.08 Fc (ft-lbs)	0.15 Fc (ft-lbs)	0.10 Fc (ft-lbs)	0.06 Fc (ft-lbs)
-1, -2	4,000	1,700	3,100	2,120	1,340
-3, -4	6,150	2,400	4,650	3,200	2,010

14. Allow the unit to sit for at least one hour and then recheck the torque for the values given in Table 3.2. Torque any nuts that are below the specified value.
15. Inspect the unit to ensure that all mating surfaces are flush and for any other indications of improper assembly.

3.5.4 Flipping the Flexible Joint Over.

1. Lay the flexible joint on its side by installing two eye nuts or eyebolts to the top of the lower end connector, attach the crane, and lift smoothly *keeping the crane gantry over the assembly at all times*. As the assembly becomes suspended and rotates towards the horizontal position, start lowering it until it sits on the mat. Remove the crane and eye nuts or eyebolts.
2. Flip the housing (3), the lower flex element assembly (2), and the lower retainer flange (13) over by installing two eye nuts to two adjacent upper retainer studs (15) and attach a two point chain/cable to the eye nuts. After ensuring the area is clear of personnel, smoothly raise the assembly off the floor *making sure that the crane gantry is directly over the assembly at all times*. Lower the assembly onto its lower end connector on thick cardboard or a rubber mat and remove the eye nuts.

3.5.5 Center Wear Ring. Install the center wear ring (9) as outlined below:

CAUTION:

Be extremely careful when installing the center wear ring not to allow it to contact the O-ring mating surfaces at the top inside of the housing. Damage to this area may require that the entire flexible joint be replaced.

1. Lightly coat the entire center wear ring (9) with API #SA2 grease or equivalent. Install two 3/4 inch eyebolts in the threaded holes provided in the upper surface of the center wear ring and, with a crane, carefully lift over the housing (3) and insert.

2. Position the center wear ring (9) to sit within the palm end of the nipple within the lower flex element assembly (2).
3. Disconnect the crane from the eyebolts and remove the eyebolts.

3.5.6 Upper Flex Element Assembly and Retainer Flange. Install the upper flex element assembly (1) and retainer flange (12) by repeating the procedures outlined in Sections 3.5.2 and 3.5.3.

3.5.7 Upper Ring Groove Insert and Wear Sleeve. Install the upper ring groove insert (18) and the upper wear sleeve (21) as follows:

1. Lubricate a new O-ring (20) with Alemite Multi-Purpose #2 grease or equivalent and install in the O-ring groove within the upper wear sleeve (21). Coat entire outside surface of the wear sleeve with grease.
2. Attach the crane to the 1/2-13 eyebolts in the upper wear sleeve (21).
3. Lift the upper wear sleeve (21) and position within the API flange.
4. Lubricate a new O-ring (17) with Alemite Multi-Purpose #2 grease or equivalent and install in the O-ring groove within the upper ring groove insert (18).
5. Attach the crane to the 1/2-13 eyebolts in the upper ring groove insert (18). Lift the upper ring groove insert and lower into position aligning the through holes with the threaded holes in the API flange.
6. Install the upper ring groove insert bolts (19) and torque to 150 ft-lbs.

3.5.8 <u>Debris Shield</u>. Perform the following steps to reinstall the debris shield (16).

NOTE:

For debris shields that are not split, position the debris shield around the nipple and omit steps 1 and 2 below.

1. Bend the debris shield (16) so that it will clear the upper end connector and install it around the nipple.
2. Install the plate to the debris shield (16) and secure it with the 10 screws.

4 PREPARATION FOR STORAGE OR SHIPMENT

4.1 GENERAL

This section presents information on the packing and preservation required to prepare the flexible joint for storage or shipment.

4.2 PRESERVATION

Prior to storing or shipping the flexible joint, the following steps should be taken to ensure that no deterioration occurs in storage.

4.2.1 Clean Metals. Clean the metal surfaces of the unit completely inside and out with Trichloroethylene or an equivalent solvent.

4.2.2 Coat. Coat the metal surfaces with a liberal coat of API #SA2 grease or equivalent.

4.2.3 Clean Elastomer. Clean the elastomer surfaces inside and out with Methyl Ethyl Ketone. (MEK)

4.2.4 Install Shield. Place a shield over the exposed ends of the flexible joint and secure it in place.

4.2.5 Cover. If the unit will be exposed to direct sunlight, cover the entire unit to protect the elastomer from deterioration due to sunlight. The best option is an aluminum cover that completely protects the unit from sunlight and rain, but any cover that is waterproof and shields

the elastomer from the sun may be used.

4.3 PACKING

Packing of the flexible joint is limited to securing the unit to an appropriate pallet and ensuring that the steps required for preservation outlined in Section 4.2 have been accomplished.

4.4 STORAGE

The flexible joint should be stored in a cool, dry area where it is protected from moisture and sunlight. The temperature during storage should not be below -20°F (-29°C).

NOTE:

To protect the bottom sealing surfaces of the flexible joint, do not place the flexible joint on uneven surfaces such as rocks or steel as this may damage the sealing surfaces.

5 PARTS LIST

5.1 GENERAL

This section presents typical parts lists for each Intermediate flexible joint. Coverage is limited to those items that may be replaced by usual maintenance procedures.

5.2 USING PARTS LIST

NOTE:

If the top assembly drawings for your flexible joint are available, refer to them to verify part numbers before ordering. If not, the top assembly drawing number is stamped on the flexible joint housing. In addition, each individual part is stamped with the drawing number and serial number for that part.

To use the parts lists, first determine the model you have and turn to the parts list (Figures 5-1 through 5-4) for that model. Locate the part(s) you need and note the number of the part on the illustration. Find the corresponding part on the parts list and use the information provided to order parts. Each list provides the item number, name of the part, Oil States part number, and the quantity used in one flexible joint for all replacement parts.

5.3 ORDERING INFORMATION

Replacement parts for any member of the Intermediate FlexJoint® family may be ordered from Oil States Industries at the addresses given below. Always include all of the following information when ordering parts.

1. Rig Name
2. Unit Size
3. Unit Serial Number
4. Part Name
5. Part Number
6. Quantity Required
7. Your Company Name
8. Address and Phone Number
9. Shipping Instructions

CONTACT INFORMATION:

North America
Special Products
Oil States Industries, Inc.
P. O. Box 670
1031 Commercial Blvd. North
Arlington, Texas 76001
Tel.+1 817 548 4200
Fax.+1 817 804 7198
specprod@oilstates.com

South America
Macae, Brazil
Oil States Industries do Brasil Ltda.
Rua Professora Ivone Alves de Barcelos
No. 205
Novo Cavaleiros
CEP 27930-490
Macae, RJ Brazil
Tel.+55 22 2763 4300
Fax.+55 22 2773 5625

Europe
Oil States Heartlands
Broadfold Road
Bridge of Don
Aberdeen AB23 8EE
Scotland, UK
Tel. +44 1224 708 700
Fax. +44 1224 708 400

Asia
Oil States Industries (Asia) Pte Ltd.
42-H Penjuru Road
Singapore 609158
Tel.+65 6773 7555
Fax.+65 6773 7667
sales.singapore@oilstates.com

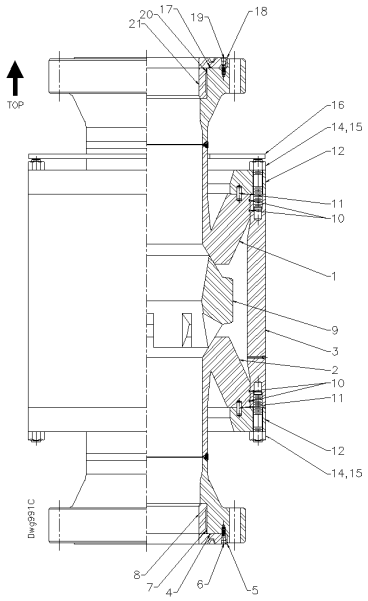


Figure 5-1
Intermediate –1 Flexible Joint
Parts List

Item	Description	Part Number	Quantity Required
1	Upper Flex Element Assembly	PD4773	1
2	Lower Flex Element Assembly	PD4773	1
3	Housing	PD4769	1
4	O-ring (Lower Ring Groove Insert)	PB2163-3	1
5	Lower Ring Groove Insert	Varies	1
6	Bolt (Lower Ring Groove Insert)	GR.8 S.H.C.S.	6
7	O-Ring (Lower Wear Sleeve)	PB2164-3	1
8	Lower Wear Sleeve	Varies	1
9	Center Wear Ring	PD4768	1
10	O-ring (Flex Element)	PB0977	2
11	Anti-Rotation Pin	PB0849	4
12	Upper Retainer Flange	PD4771	1
13	Lower Retainer Flange	PD4771	1
14	Retainer Nut	PB2265	60
15	Retainer Stud	PB2266	60
16	Debris Shield	PD3620-1	1
17	O-ring (Upper Ring Groove Insert)	PB2163-3	1
18	Upper Ring Groove Insert	Varies	1
19	Bolt (Upper Ring Groove Insert)	GR.8 S.H.C.S.	6
20	O-Ring (Upper Wear Sleeve)	PB2164-3	1
21	Upper Wear Sleeve	Varies	1

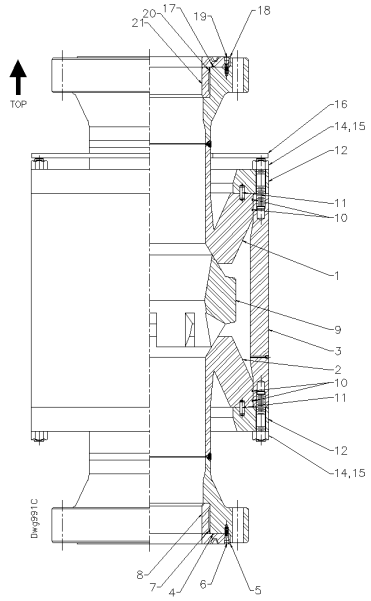
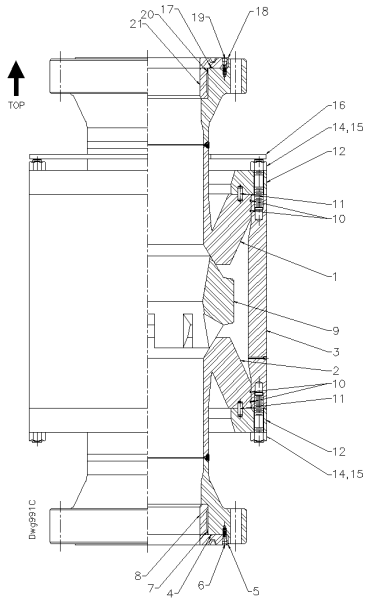


Figure 5-2
Intermediate –2 Flexible Joint
Parts List

Item	Description	Part Number	Quantity Required
1	Upper Flex Element Assembly	PD7896	1
2	Lower Flex Element Assembly	PD7896	1
3	Housing	PD7894	1
4	O-ring (Lower Ring Groove Insert)	PB2163-3	1
5	Lower Ring Groove Insert	Varies	1
6	Bolt (Lower Ring Groove Insert)	GR.8 S.H.C.S.	6
7	O-Ring (Lower Wear Sleeve)	PB2164-3	1
8	Lower Wear Sleeve	Varies	1
9	Center Wear Ring	PD4768	1
10	O-ring (Flex Element)	PB0977	2
11	Anti-Rotation Pin	PB0849	4
12	Upper Retainer Flange	PD4270-1	1
13	Lower Retainer Flange	PD4270-1	1
14	Retainer Nut	PB2265	72
15	Retainer Stud	PB2266	72
16	Debris Shield	PD3620-1	1
17	O-ring (Upper Ring Groove Insert)	PB2163-3	1
18	Upper Ring Groove Insert	Varies	1
19	Bolt (Upper Ring Groove Insert)	GR.8 S.H.C.S.	6
20	O-Ring (Upper Wear Sleeve)	PB2164-3	1
21	Upper Wear Sleeve	Varies	1

Figure 5-3
Intermediate –3 Flexible Joint
Parts List



Item	Description	Part Number	Quantity Required
1	Upper Flex Element Assembly	PD7970	1
2	Lower Flex Element Assembly	PD7970	1
3	Housing	PD7969	1
4	O-ring (Lower Ring Groove Insert)	PB2163-3	1
5	Lower Ring Groove Insert	Varies	1
6	Bolt (Lower Ring Groove Insert)	GR.8 S.H.C.S.	6
7	O-Ring (Lower Wear Sleeve)	PB2164-3	1
8	Lower Wear Sleeve	Varies	1
9	Center Wear Ring	PD4768	1
10	O-ring (Flex Element)	PB0977	2
11	Anti-Rotation Pin	PB0849	4
12	Upper Retainer Flange	PD7374	1
13	Lower Retainer Flange	PD7374	1
14	Retainer Nut	PB7380	68
15	Retainer Stud	PB7379	68
16	Debris Shield	PD3620-1	1
17	O-ring (Upper Ring Groove Insert)	PB2163-3	1
18	Upper Ring Groove Insert	Varies	1
19	Bolt (Upper Ring Groove Insert)	GR.8 S.H.C.S.	6
20	O-Ring (Upper Wear Sleeve)	PB2164-3	1
21	Upper Wear Sleeve	Varies	1

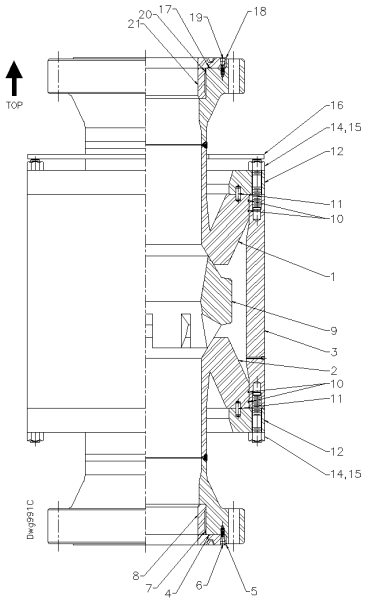


Figure 5-4
Intermediate –4 Flexible Joint
Parts List

Item	Description	Part Number	Quantity Required
1	Upper Flex Element Assembly	PD7971	1
2	Lower Flex Element Assembly	PD7971	1
3	Housing	PD7976	1
4	O-ring (Lower Ring Groove Insert)	PB2163-3	1
5	Lower Ring Groove Insert	Varies	1
6	Bolt (Lower Ring Groove Insert)	GR.8 S.H.C.S.	6
7	O-Ring (Lower Wear Sleeve)	PB2164-3	1
8	Lower Wear Sleeve	Varies	1
9	Center Wear Ring	PD4768	1
10	O-ring (Flex Element)	PB0977	2
11	Anti-Rotation Pin	PB0849	4
12	Upper Retainer Flange	PD7374	1
13	Lower Retainer Flange	PD7374	1
14	Retainer Nut	PB7380	68
15	Retainer Stud	PB7379	68
16	Debris Shield	PD3620-1	1
17	O-ring (Upper Ring Groove Insert)	PB2163-3	1
18	Upper Ring Groove Insert	Varies	1
19	Bolt (Upper Ring Groove Insert)	GR.8 S.H.C.S.	6
20	O-Ring (Upper Wear Sleeve)	PB2164-3	1
21	Upper Wear Sleeve	Varies	1