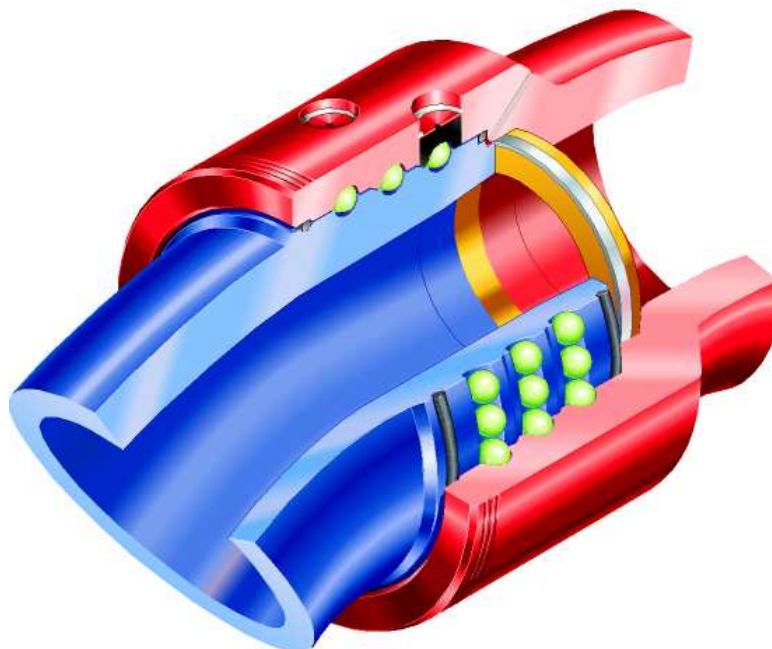


**FCD OPERATING AND MAINTENANCE MANUAL, TRIPLESTEP SWIVEL JOINT**

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**Summary:**

This document covers the safe operation, maintenance and repair of the TripleStep Swivel Joint (model designation TSi) product line.



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## Abbreviations

The following abbreviations are used throughout this procedure.

Abbreviation	Description
TSi	TripleStep Swivel Joint with instream packing
CWP	Cold Working Pressure
GPM	Gallons per minute
BBL	US Barrels (42 gallons)

## 1.0 Operating Instructions

### 1.1 Product Description

The FMC Technologies TripleStep Swivel Joint is a high performance swivel available in a variety of swivel style configurations (see Figure 1 below). It's long radius forged and bent elbows, high capacity bearings and instream primary seal are all specially designed to overcome many previous swivel joint limitations.

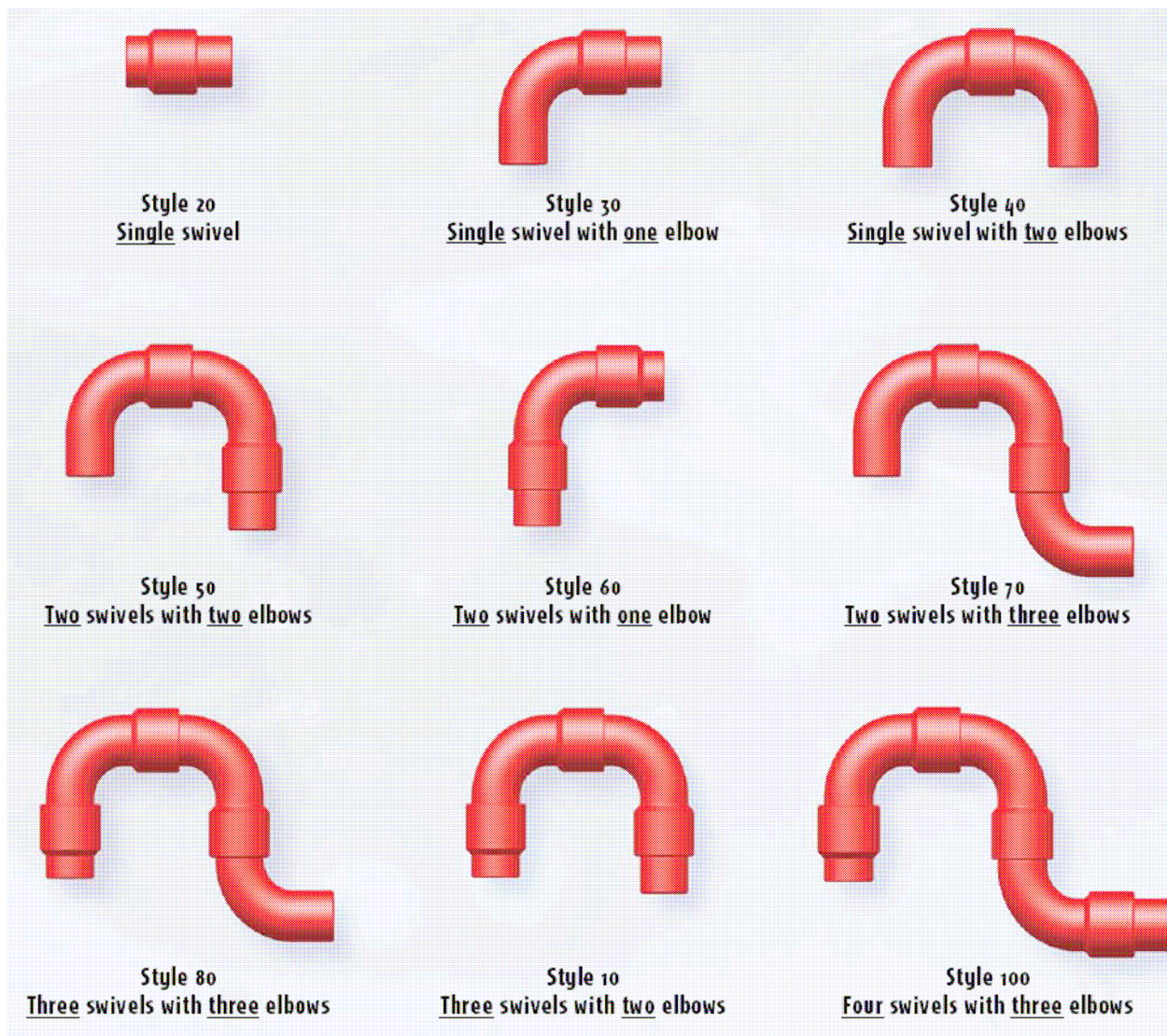


Figure 1: TripleStep Swivel Joint Styles

The Model designations covered in the manual are as listed in the table immediately below.

Table 1: Available models covered in this manual

Model	Color	Pressure Rating, CWP PSI (Bar)	End Connection	Bore Size Inches (mm)
3" TSi-6	Silver	6,000 (414)	3" Fig. 602	2.75 (70)
3" TSi-10	Black	10,000 (690)	3" Fig. 1002	2.75 (70)
3" TSi-15	Red	15,000 (1034)	3" Fig. 1502	2.75 (70)
3" TSi-20	Light Blue	20,000 (1380)	3" Fig. 2002	3.00 (76)
4" TSi-10	Black	10,000 (690)	4" Fig. 1002	3.75 (95)
4" TSi-15	Red	15,000 (1034)	4" Fig. 1502	3.50 (89)

## 1.2 Service Applications

The TripleStep Swivel Joint is made to handle a variety of oilfield fluids including cements, fracturing fluids, drilling muds, crude oil and other abrasive fluids. It is intended to facilitate the installation of temporary or permanent flow lines and to absorb movement caused by pressure pulsation and thermal expansion,

## 1.3 Pressure/Temperature Rating

The pressure ratings and corresponding color coding for the various models are shown in Table 1, above. The cold working pressure (CWP) is the maximum internal pressure that is anticipated by design to be applied in the working environment (field application). Assemblies consisting of components of different pressure ratings are always limited to the lowest rate given on any individual component.



**DO NOT EXCEED THE RATED WORKING PRESSURE OF THE PRODUCT!**

**WARNING**

The TripleStep Swivel Joint has a basic operating temperature rating of -20°F (-29°C) to 240°F (116°C). When operating with fluids above 185°F for extended periods the life of the environmental o-ring seals and wing union seal ring may be reduced. Consult factory for non-standard seals.

## 1.4 Motion, Rotation and External Loads

The FMC Technologies TripleStep Swivel Joint is not designed for continuous rotation or oscillation.



**CONTINUOUS ROTATION OR OSCILLATION MAY REDUCE THE SWIVEL JOINT SEAL AND BEARING LIFE.**

**CAUTION**

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The swivel joint can absorb relative motion only if the styles and orientation of the swivels allow sufficient degrees of freedom. The swivels must be oriented to provide the required flexibility in each plane of motion and axis of rotation. When connecting swivels between fixed end connections, regardless of subsequent relative motion, enough freedom must exist to properly make the connection without loading or binding the swivel. Consult factory for additional information on recommended line layout.



**THE STYLES AND ORIENTATION OF SWIVELS DETERMINE THE DEGREES OF FREEDOM AND MAGNITUDE OF RELATIVE MOTION POSSIBLE. INCORRECT ORIENTATION AND SUBSEQUENT BINDING CAN CAUSE BEARING FAILURE.**

**WARNING**

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Externally applied binding or tensile loads are additive to the loads already induced by internal pressure. Externally applied loads can result in an over-stress condition and catastrophic failure. If externally applied loads are to be applied, consult factory for limitations. For guidance on line layout in well service pumping applications, refer to Engineering Bulletin Number 124C.



**DO NOT SUSPEND LOADS WITH A TRIPLESTEP SWIVEL JOINT**

**WARNING**

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## 2.0 Flow

The FMC Technologies TripleStep Swivel Joint is specially designed to minimize the erosive effects of abrasive fluids at high flow rates. Bore sizes should be selected to minimize the fluid velocity when handling abrasive fluids. Fluid flow velocities greater than 40 feet per second (12 m/sec) of abrasive fluid will result in accelerated erosion and premature failure. See chart below for maximum recommended flow rates.

Table 2: Flow Rates at Maximum Recommended Velocity of 40 Feet Per Second

Size and Model	GPM	BBL/Min.	Liter/Min.
3" TSi-6, TSi-10, TSi-15	741	17.6	2,803
3" TSi-20	881	20.9	3,336
4" TSi-10	1377	32.7	5,212
4" TSi-15	1200	28.5	4,540

Refer to FMC Technologies Engineering Bulletin Number 102 for minimum allowable wall thickness values for worn swivel joints.



**TRIPLESTEP SWIVEL JOINTS EXHIBITING WALL THICKNESS BELOW THE MINIMUM ALLOWABLE SHALL BE REMOVED FROM SERVICE.**

**WARNING**



**TO AVOID PITTING AND CORROSION, ALL WORKING FLUIDS, ESPECIALLY ACIDS AND OTHER CORROSIVES SHOULD BE FLUSHED THOROUGHLY AFTER EACH USE.**

**CAUTION**

## 2.1 Installation

Standard practices should be used when installing TripleStep Swivel Joints in a system. There include:

1. Check that the orientation allows for the required degrees of freedom and flexibility for the relative motion.
2. Check that the end connections are the same size, figure number and pressure rating.

**WARNING**

**DO NOT CONNECT DIFFERENT SIZE, FIGURE NUMBER OR PRESSURED RATED WING UNIONS AS THIS MAY RESULT IN DEATH, SERIOUS PERSONAL INJURY AND/OR SEVERE PROPERTY DAMAGE.**

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3. Clean and lubricate the wing union threads and check that the seal ring is present and undamaged.
  4. Fully tighten with wing union connection before applying any pressure.
- 

**WARNING**

**WHEN TIGHTENING WING UNION NUTS, PERSONNEL MUST WEAR SUITABLE EYE PROTECTION TO PROTECT AGAINST METAL FRAGMENTS THAT MAY BE LOOSENED FROM THE SURFACE OF THE NUT OR HAMMER.**

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**WARNING**

**DO NOT STRIKE, TIGHTEN OR LOOSEN PRESSURIZED COMPONENTS OR CONNECTIONS.**

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### 3.0 Maintenance Instructions

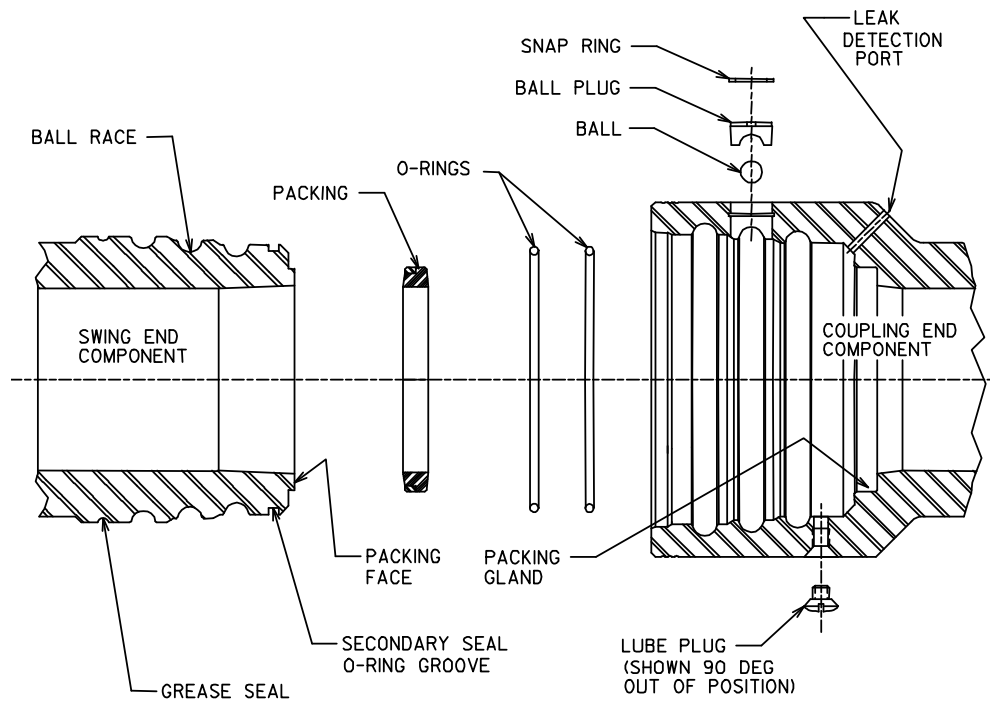


Figure 2: TripleStep Swivel Exploded View

#### 3.1 Identification

FMC Technologies TripleStep assemblies with instream packing are differentiated from other swivel joint models by the presence of three grooves machined in the couple end of each swivel connection. Other swivel joint models will have a different number of grooves or none at all.

#### 3.2 Preventive Maintenance

The TripleStep Swivel Joint is constructed with superior sealing and corrosion protection. Little preventive maintenance is therefore required, but should include the following:

Working fluids, especially acids, should be thoroughly flushed from the swivel after each use to avoid pitting, corrosion and exposure to personnel.

Leaks should be repaired immediately.



**IF ANY LEAKAGE IS DETECTED FROM A TRIPLESTEP SWIVEL JOINT, REMOVE IT FROM SERVICE IMMEDIATELY TO PREVENT POTENTIAL PERSONNEL INJURY AND/OR DAMAGE.**

**WARNING**

The sealed bearing construction does not normally require periodic greasing. A grease port is provided for extreme service conditions where periodic greasing may be desirable.

### 3.3 Periodic Inspection

Periodic inspection shall be undertaken to verify the condition of the swivel joint assembly. The frequency of inspection should be matched to the frequency of use and severity of the application. The periodic inspection should include:

- Visual inspection of end connections, looking for general corrosion, end connection thread wear and/or corrosion, and any damage or deformations.
- Wall thicknesses should be verified and compared to acceptable minimums.
- Determine if any leakage has occurred and if so, repair.
- Inspect free rotation of the swivel and that there are no missing parts.

### 3.4 Disassembly

Tools required: Truarc pliers, awl or similar pointed tool, vise, standard or locking pliers, rubber mallet, and large screwdriver.

1. Locate the TripleStep Swivel Joint in an appropriate position so that the female portion of the joint is secure and the male portion is free to rotate. An appropriately sized bench vise works well for this.
2. Remove the ball plug snap rings using Truarc pliers.
3. Remove ball plugs using an awl or pointed tool.
4. Remove lube port screw with screwdriver.
5. Secure female component in vise with ball plug holes positioned downward over a suitable container.
6. Rotate male component. Ball bearings should drop out.



**IT MAY BE NECESSARY TO THIN HARDENED LUBRICANT WITH PETROLEUM SOLVENT IN ORDER TO REMOVE BALLS.**

**NOTE**

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7. Separate male and female components after ball bearings have been removed.



**DO NOT DAMAGE MACHINED SURFACES WHEN SEPARATING COMPONENTS. PROTECT SEALING SURFACES AT ALL TIMES.**

**CAUTION**

8. Carefully remove old packing from packing gland using a screwdriver.



**USE EXTREME CARE IN REMOVING OLD PACKING TO PREVENT DAMAGE TO SEALING SURFACES OF SWIVEL JOINT COMPONENTS.**

**CAUTION**

9. Remove grease retainer O-ring and secondary O-ring seal from male component.
10. All components should be cleaned with solvent and inspected for wear and/or corrosion.

### **3.5 Repair**

1. Inspect parts for excessive wear, corrosion or other damage.
  - a. Inspect ball races for dents or grooves.
  - b. Check male and female components for excessive erosion or corrosion.
  - c. Carefully inspect the inside surfaces of elbows and male ball race bore for evidence of erosion or corrosion.



**TRIPLESTEP SWIVEL JOINTS EXHIBITING A WALL THICKNESS BELOW THE MINIMUM ALLOWABLE SHALL BE REMOVED FROM SERVICE. REPLACE ALL PARTS THAT SHOW EVIDENCE OF DAMAGE IN THE BALL RACES, SEALING SURFACES, OR OTHER AREAS.**

**WARNING**

2. Sealing surfaces must be completely smooth. Remove minor scratches or pitting by polishing with a fine abrasive or wire brush.
3. Reclean all parts after polishing to remove metal particles and foreign matter. Apply a thin coat of lubricant to ball races, sealing surfaces, and new packing.



**MAKE SURE CORRECT LUBRICANT IS USED FOR INTENDED SERVICE CONDITIONS.**

**CAUTION**

- 
4. Install new grease retainer O-ring on male component.
  5. Install new secondary O-ring on male component.



**THE GREASE RETAINER AND SECONDARY O-RINGS ARE IDENTICAL.**

**NOTE**

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6. Lightly coat the new packing with lubricant and install it in the coupling end component packing gland.



**ANTI-EXTRUSION RING MUST FACE OUTWARD, TOWARD BALL RACES.**

**CAUTION**

- 
7. Secure female component in vise with ball plug holes on top.
  8. Carefully insert the male component into the female component. Avoid damaging the packing. Hold the male piece in place and insert one ball into each ball plug hole. While pushing and rotating the male piece, pry one ball into each race with a large screwdriver.

9. Drop balls into races. Rotate male component and add balls until all three races are filled with the correct number of balls.



**WARNING** COUNT THE NUMBER OF BALLS INSTALLED IN EACH RACE TO BE CERTAIN THAT THE PROPER NUMBER ARE INSTALLED. INCORRECT NUMBER MAY CAUSE BINDING OR EXCESSIVE WEAR AND REDUCED PRESSURE AND STRUCTURAL CAPACITY.

10. Insert ball plugs for races #1 and #2. Leave plug #3 out for greasing.



**NOTE**

**DUE TO THE NATURE OF THE STEPPED RACE, BALL PLUG ON RACE #1 WILL SITUATE DEEPER THAN ON RACE #2, WHICH IS DEEPER THAN RACE #3.**

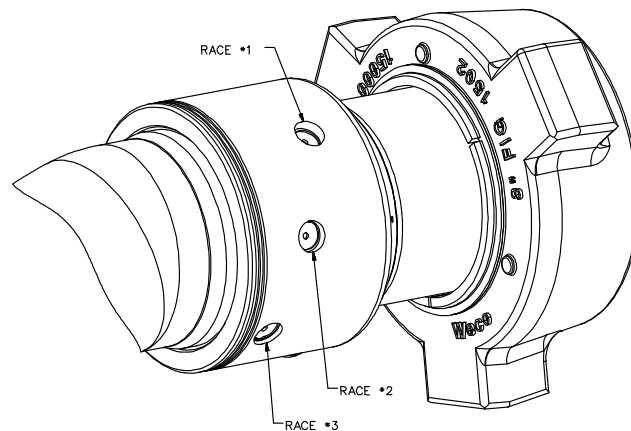


Figure 3: Stepped Ball Races Create Different Ball Retainer Plug Depths

11. Insert ball plug snap rings into plugs #1 and #2.
12. Lubricate bearings as follows:
  - a. Remove lube port plug screw and install grease fitting.
  - b. Using a small, hand-held grease gun with grease fitting adapter to force small amount of lubricant through the lube port.
  - c. Rotate male component 90 degrees (quarter turn) and add more grease.

- d. Repeat step c (above) two more times.
- e. Check smoothness of rotation.
- f. Install ball plug #3 and insert snap ring.
- g. Replace lube port screw.



**MAKE SURE CORRECT LUBRICANT IS USED FOR INTENDED SERVICE CONDITIONS.**

**CAUTION**



**EXCESSIVE LUBRICATION CAN CAUSE SWIVEL TO BIND. USE ONLY ENOUGH LUBRICANT TO OBTAIN SMOOTH ROTATION.**

**CAUTION**

13. After assembly, the swivel joint should be pressure tested to the full rated working pressure.

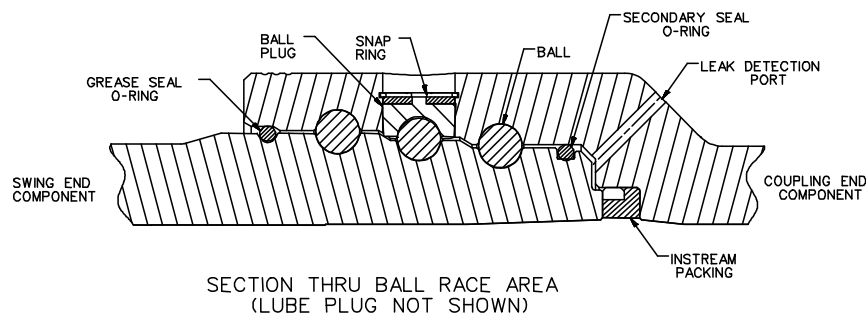


Figure 4: Cross-section of Assembled TripleStep Swivel

## 4.0 Hazardous Conditions



**FOLLOWING IS A LIST OF HAZARDOUS CONDITIONS SPECIFIC TO USE OF SWIVEL JOINTS WHICH, IF NOT AVOIDED AS INDICATED, MAY RESULT IN DEATH, SERIOUS PERSONAL INJURY OR SEVERE PROPERTY DAMAGE.**

**WARNING**

Table 3: Hazardous Condition Avoidance

Hazardous Conditions	Means to Avoid Hazard
Use of incompatible end connections on mating piping or equipment may result in catastrophic failure of the connection at pressures far below the rated working pressure of the TripleStep Swivel Joint.	Examine the end connections for identification marking to ensure that they are identical. If not identical, do not use; consult the factory.
Mating end components not manufactured by FMC or its licensees may result in catastrophic failure of the connections at pressures far below the rated working pressure of the FMC component.	Carefully examine all components for manufacturer's identification marking. FMC Technologies cannot assure compatibility or performance of components of other manufacturers.
Assembly of the TripleStep Swivel Joint into a system which inhibits the free rotation of the joint about its centerline will cause binding of the bearings and premature bearing failure under possible structure/pressure load combinations. This may result in catastrophic failure or structure collapse.	Do not assemble or fabricate the TripleStep Swivel Joint into a system which fixes the centerlines of both the male and female components of the joint. Precision tolerances will not alleviate the hazard described in left hand paragraph.
Use of TripleStep Swivel Joints in unsupported overhead applications is not recommended.	Refer to API and IADC Safety Bulletins.
Use of TripleStep Swivel Joints at pressures above the rated working pressure will result in rapid deterioration of the bearing races and possible catastrophic failure of the joint.	Include rated working pressure limitations in written operating procedures and train operators in the use of the procedures.
Uncontrollable hazardous conditions may result from the use of eroded, corroded, worn, or "second hand" joints, or the modification of TripleStep Swivel Joints by welding, machining, plating, heating or substitution of components not made by FMC Technologies or its licensees.	Used or worn TripleStep Swivel Joints must be destroyed to prevent inadvertent or intentional reuse and potential injury to subsequent users. An inspection program must be initiated.
Use of TripleStep Swivel Joints in handling acids and corrosive fluids may cause pitting of internal surfaces, localized wall section thinning, and seal deterioration. This may result in external leakage, structural weakening of the joint, and potential catastrophic failure.	The use of inhibitors in these fluids and thorough flushing of TripleStep Swivel Joints immediately after use is required to minimize damage.
Use of TripleStep Swivel Joints after initial leakage has been detected may result in contaminated bearings, binding of the joint, external leakage of hazardous fluids, and the introduction of mechanical loads beyond the capacity of the joint.	Inspect TripleStep Swivel Joints for signs of leakage. Immediately discontinue use, disassemble and repair if leakage is detected.
Impact loads, such as hammer blows, may cause failure of pressurized TripleStep Swivel Joints.	Avoid conditions which expose pressurized TripleStep Swivel Joints to impact loads.
Use of standard service TripleStep Swivel Joints in handling of fluids containing hydrogen sulfide (sour) gas may result in stress corrosion, cracking and catastrophic failure of the swivel joint.	Use only Chiksan® swivel joints specifically designated for Sour Gas Service. Consult FMC Technologies regarding swivel joints for Sour Gas Service.

## 5.0 Replacement Parts

Table 4: Ball Bearing and Ball Retainer Plug Sets

Size and Model	Ball Bearings Required			Total Balls Req'd	Ball Set	Ball Plug Set	Single Ball Plug Set
	Race #1	Race #2	Race #3				
3" TSi-6, TSi-10, TSi-15	34	35	36	105	3267882	3144007	3139418
3" TSi-20	26	27	28	81	P530012	P530013	P530018
4" TSi-10	31	32	33	96	P516999	P516998	P516997
4" TSi-15	26	27	28	81	P530012	P530013	P530018

Table 5: Repair Sets and Packing Sets

Size and Model	Packing Material	Repair Kit <sup>(1)</sup>	Instream Packing Set
3" TSi-6, TSi-10, TSi-15	00/Brs	P505433	P505432
3" TSi-20	00/Brs	P530020	P530022
4" TSi-10	00/Brs	P516116	P516117
4" TSi-15	00/Brs	P530019	P530021

Note 1: Repair kits include (1) ball set; (1) instream packing; (1) ball plug set – includes 3 ball plugs and snap rings; (2) O-ring seals; and (1) lube port plug screw

Table 6: Lubrication Data

Lubricant	Temperature Range	Container	Part Number
TS-115 Corrosion Resistant Grease	-50 °F (-46 °C) to 400 °F (204 °C)	14½ oz. tube	3267513
		2-lb can	3267515

For special service conditions, consult factory for lubrication recommendations.

## 6.0 Warnings and Safety Instructions

FMC Technologies cannot anticipate all of the situations a user may encounter while installing and using FMC products. Therefore, the user of FMC products **MUST** know and follow all applicable industry specifications and practices on the safe installation and use of these products. For additional safety information, refer to FMC Technologies product catalogs, product brochures and installation, operating and maintenance manuals, which can be accessed at [www.fmcfuidcontrol.com](http://www.fmcfuidcontrol.com), or contact FMC Technologies at 800/772-8582.



**FAILURE TO FOLLOW THESE SAFETY WARNINGS COULD RESULT IN DEATH, SERIOUS PERSONAL INJURY, AND/OR SEVERE PROPERTY DAMAGE.**

### **WARNING**

1. Never mix or assemble components, parts or end connections with different pressure ratings. Mismatched conditions, including but not limited to that of a 2" Figure 1502 male sub end connected to a 2" Figure 602 female sub, may fail under pressure resulting in death, serious personal injury or severe property damage.
2. Never use or substitute non FMC components or parts in FMC products or assemblies.
3. Never modify or repair FMC products in a manner not specifically directed in instructions published by FMC Technologies.
4. Never strike, tighten, loosen or attempt repairs on pressurized components or connections.
5. Never exceed the rated working pressure of the product.
6. Complete and proper make-up of components and connections is required to attain rated working pressure. Always apply essential care, attention, handling and inspection to threaded components before, during and after make-up.
7. Never use severely worn, eroded or corroded products. Contact FMC Technologies for more information on how to identify the limits of erosion and corrosion.
8. Never strike wing union nuts having severely flattened and extruded ears. This condition can result in flying debris leading to serious personal injury and must immediately be addressed by either grinding off extruded material or removing the nut from service.

9. Always follow safe practices when using products in overhead applications. Products not properly secured could fall.
  - Never exceed the load rating of lifting devices on products or lifting equipment.
  - Use of FMC products in suspension applications can result in over-stress conditions leading to catastrophic failure. If externally applied loads are anticipated, consult factory.
10. Always follow safe practices when manually lifting and carrying products.
11. Always select only appropriate product and materials for the intended service:
  - Never expose standard service products to sour gas fluids. (Refer to NACE MR0175). Do not interchange sour gas with standard service components.
  - Always use appropriate safety precautions when working with ferrous products in below freezing temperatures. Freezing temperatures lower the impact strength of ferrous materials.
12. Always follow manufacturer's instructions and Material Safety Data Sheet directions when using solvents.
13. Always make certain that personnel and facilities are protected from residual hazardous fluids before disassembly of any product.
14. Whenever leakage is detected from FMC Technologies products, remove them from service immediately to prevent death, serious personal injury, and/or property damage.

**SAFETY INSTRUCTIONS:** The applications of FMC products are in working environments and systems which must be properly designed and controlled. Safety procedures and policies **MUST** be clearly established by the user and followed. Always use appropriate protective equipment