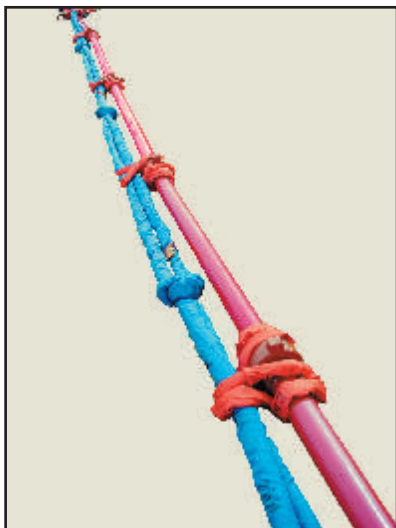


FLOW LINE SAFETY RESTRAINTS
INSTRUCTION GUIDE



FLOW LINE SAFETY RESTRAINTS (FSR)

INSTALLATION GUIDE



**For additional Information on
Safety Products, Contact
Weir SPM Engineering at
(817) 246-2461**

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(Important: Read before attempting to use)

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SAFETY INFORMATION

(Important: Read before attempting to use)

- It is critical that, since most Weir SPM products generate, control or direct pressurized fluids, those who work with these products be thoroughly trained in their proper application and safe handling. It is also critical that these products be used and maintained properly.
- Weir SPM Safety Restraint components are not rated for individual use. FSR Ribs and Spines are not lifting devices and should never be used as such. Any Ribs or Slings that have been subjected to any loads should be immediately taken out of service.
- FSRs are considered “single-use” items. This means that, while these components can be installed multiple times out in the field, if they are actually employed (that is, subjected to trauma as in the event of a union failing or a pipe rupturing), then the affected safety equipment needs to be replaced.
- Always keep ALL personnel away from flow line system while under pressure. This applies even when a safety restraint system such as FSR is in place.
- Installation of individual FSR components as well as the system itself should be done by Weir SPM personnel or persons qualified by Weir SPM to do so. Training is available on a regular basis from Weir SPM. Contact us as (817) 246-2461 for more information.
- Always make sure to only use ribs as ribs, and spines as spines.

Color Codes:

FSR Ribs - Always **RED**

FSR Spines - Always **BLUE**



WARNING



FAILURE TO READ, UNDERSTAND AND FOLLOW THE INSTRUCTION GUIDE MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

THE USE OF PRESSURIZED COMPONENTS IN OILFIELD OPERATIONS IS INHERENTLY DANGEROUS. PERSONNEL WORKING AROUND ENERGIZED EQUIPMENT AND FLOW LINES SHOULD USE EXTREME CARE AND OBSERVE ALL APPLICABLE SAFETY PRECAUTIONS. PROPER USE OF THIS DEVICE CAN REDUCE BUT NOT ELIMINATE THE RISK OF SEVERE PERSONAL INJURY OR DEATH. EVEN WITH FSRs, SEVERE PERSONNEL INJURY OR DEATH CAN RESULT FROM DEBRIS AND SHRAPNEL SHOULD A RUPTURE OCCUR.

THIS IS NOT A LIFTING DEVICE NOR SHOULD IT BE INSTALLED BY ANYONE OTHER THAN PERSONNEL SPECIFICALLY TRAINED IN WEIR SPM PROCEDURES.

CHEMICAL COMPATIBILITY CHART

Chemical	FSRs
Acids	*See note
Alcohols	OK
Strong Alkalis	OK
Ethers	OK
Hydro-Carbons	OK
Ketones	OK
Oils - Crude	OK
Oils - Lubricating	OK
Soaps/Seawater	OK
Water/Seawater	OK
Weak Alkalis	OK

***Acid Compatibility** – Hydrochloric Acid (HCl): Concentrations up to 36% acceptable for up to 8 hours. Hydrofluoric Acid (HF): Concentrations up to 10% acceptable for up to 8 hours. (Note that all chemical exposures are assumed to be at ambient temperature.)

For other acids or chemicals not stated, please contact Weir SPM Engineering at (817) 246-2461.

GENERAL INFORMATION

Note: It is critical that, since most Weir SPM products generate, control or direct pressurized fluids, those who work with these products be thoroughly trained in their proper application and safe handling. It is also critical that these products be used and maintained properly.

GENERAL:

FSRs are intended to help contain high-pressure piping and components in case of rupture or excessive impulse during the pumping process. When flow lines fail, whether it is due to excess pressure, faulty connections, worn components, trauma to the piping connection, or otherwise, the results can be devastating and catastrophic to both equipment and people. The metal components that were previously being subjected to up to 15,000 p.s.i. of internal pressure are suddenly and instantly forced to relieve themselves of the stored energy. In a failure there could be hundreds or even thousands of pounds of iron pipe flailing about in an unrestrained condition. In that scenario, there is a high likelihood of severe personal injury or death. FSRs reduce but do not eliminate that risk.

IDENTIFICATION:

Weir SPM Safety Restraints are permanently identified on each of the individual components. All metal components have full traceability. The Safety Restraints are identified with their VENDOR ID (Weir SPM), PART NUMBER, SIZE and SERIAL NUMBER recorded on the label permanently attached to each restraint.

CARE:

Maintenance & Storage –

Weir SPM Safety Restraints generally do not require any special maintenance to keep them in service. Even though they are water resistant, the safety restraints should NOT be used underwater or submersed in water. If they are in an environment where they get wet, it is recommended that they are wiped dry after each use.

The Safety Restraints can be wiped clean with a dry cloth. It is essential to store Weir SPM Safety Restraints and associated equipment in a dry place.

TEMPERATURE RATING (Standard*):

Minimum: -30° C

Maximum: 100° C

*For higher temperature applications contact Weir SPM Engineering.

APPLICATION:

Weir SPM Safety Restraint assemblies are designed to help reduce the effect of failures on frac jobs running energized fluid. This system has been tested at 15,000 p.s.i. with nitrogen, utilizing approximately 125 linear feet of 3"-1502 components.

For variations GREATER THAN any of the above values, before using Weir SPM Safety Restraints contact Weir SPM Engineering at (817) 246-2461. These variations include:

Pressures above 15,000 p.s.i.

Flow Line lengths greater than 125 ft.

Piping sizes greater than 3"-1502

Because non-energized systems are considerably less volatile, Weir SPM FSR will also work with any flow line running non-energized fluids provided they are within the

above guidelines.

INSPECTING FSR COMPONENTS:

Inspect each component before every use. Also, to ensure safety, qualified personnel should review the overall installation before every use.

a) Safety Restraints (Spines & Ribs) –

The FSRs are designed where failures are normally visible. If there are any signs of damage, the affected components should be replaced. Remove Safety Restraints from service if inspection indicates the following damage.

- 1) Any damage to the FSR cover where internal red-stripped white core yarns are exposed. (This includes cuts, holes, tears, snags, abrasions or other damage to cover).
- 2) The Safety Restraint ID tag is missing or has become illegible.
- 3) Knots or other modifications to any part of the FSR.
- 4) Melting, charring, or other indications of excessive heat to any part of the FSR.
- 5) Acid, caustic burns, or other signs of chemical deterioration to the FSR.
- 6) Any FSR that has been stretched beyond its original design length or deformed or otherwise misshapen.

7) Any other visible damage which causes doubt as to the strength of the FSR.

b) Anchor Crossover Assembly –

Remove Anchor Crossovers from service if inspection indicates the following damage:

- 1) Excessive rust or corrosion prevents the crossover from operating properly.
- 2) Excessive wear on the OD or ID of crossover.
- 3) Any damage to integral female threads that would prevent proper installation.

c) “Anchor”-type & “D”-type Shackles –

Remove shackles from service if inspection indicates the following damage:

- 1) Visible signs of damage or galling on screw threads that would prevent proper operation.
- 2) The metal shackles show excessive wear.
- 3) The shackle’s screw pin is damaged and cannot be fully installed into the mating threads.

General Installation Notes For Weir SPM Flow Line Safety Restraint System

Installation of individual FSR components as well as the system itself should be done by Weir SPM personnel or persons qualified by Weir SPM to do so. Training is available on a regular basis from Weir SPM. Contact us at (817) 246-2461 for more information.

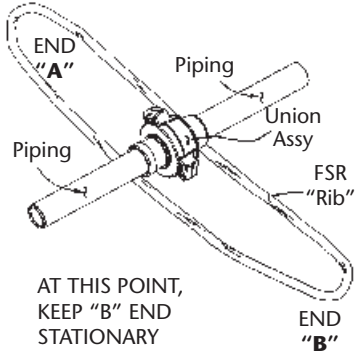
Any misuse of the FSRs such as lifting or towing or improper installation shall void any and all warranties and may cause injury or death. Further, any mishandling of the FSRs such as not following the maintenance and care instructions contained in this guide, such as exposing the FSRs to excessive heat, shall void all warranties.

- Install FSR system after entire flow line is setup. Hammering wing nuts can be clumsy with FSR equipment installed.
- When possible, pressure-test flow line system for leaks (at a very low pressure) before installing FSR system components.
- After FSR is installed, check every connection, every link, and every FSR component to ensure that there is a continuous connection from anchor point to anchor point.
- After FSR system is installed, make sure:
 - a) All FSR Ribs are installed as tight as possible around flow line components.
 - b) All main line and anchor line FSR Spines are as tight as possible from anchor point to anchor point.

Always keep ALL personnel away from flow line system while under pressure. This applies even when a safety Restraint System is installed.

INSTALLING COMPONENTS

FSR "Rib" Installation



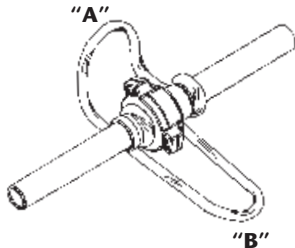
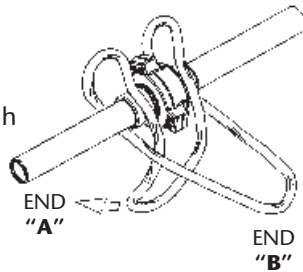
STEP 1

Begin by positioning Rib beneath flow line as shown. Rib profile should straddle union assy.

NOTE THAT PIPING MIGHT REQUIRE ELEVATION IN ORDER TO FIT RIB BENEATH - SEE PAGE 12 **ASSEMBLY AID** VIEW, FOR COMPLETE DETAILS.

STEP 2

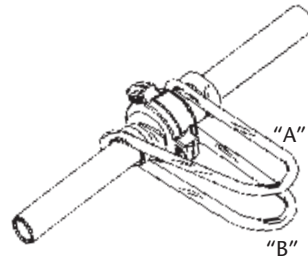
Next, bring end "A" up and over piping and union assy. Insert end "A" down through end "B" opening. Pull "A" back through to original side as shown.



STEP 3

Continue to bring end "A" back around to form a second loop. Rib profile should still evenly straddle union assembly as shown.

STEP 4



Draw End "A" even with "B" end as shown. Ensure that Rib profile fits snugly around union assy (or other applicable connection). This Rib is now ready for Spine installation. See Page 18 and 19 for correct spine installation/configuration.

At this point, it is recommended to complete installing remainder of FSR Ribs before Spine is installed.

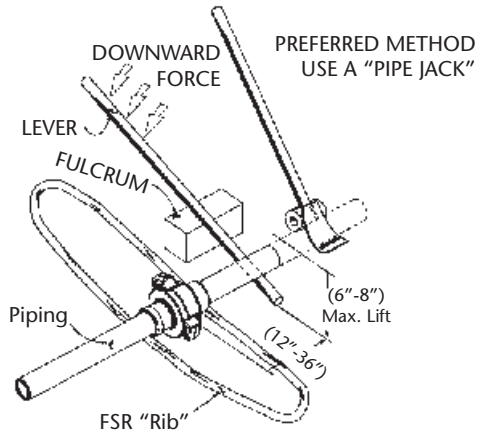
NOTES:

- a) Rib profiles must always STRADDLE each side of wing union connection. This configuration provides the most purchase to contain flow line components on either side if the union fails.
- b) FSR Ribs (always RED) can NEVER be substituted for FSR Spines (which are always BLUE).
- c) No FSR Ribs are required, or should be used, on anchor lines (Anchor lines are the separate FSR lines that secure the entire FSR system to separate anchor points).
- d) FSR Ribs should be installed as tightly as possible. Excessive play in the overall safety restraint system could allow components to release during line failure.
- e) In the limited instance where a single FSR Rib is not long enough to fit around a large component, FSR Ribs can be "linked" if necessary, but, never tied together. For complete information on linking, see spine installation instructions on pages 18 and 19 of this Instruction Guide.

RECOMMENDED ASSEMBLY AID

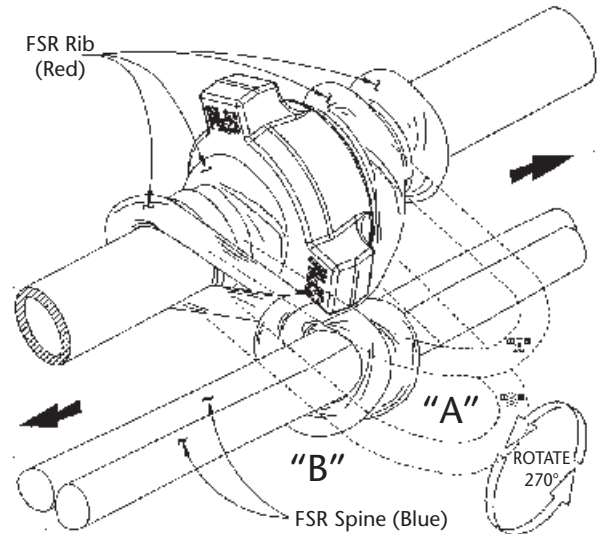
It is typically necessary to raise the flow line piping in order to insert Ribs between piping components and ground. Never attempt to lift piping manually. The suggested method is to use a "pipe jack". A secondary method is to use a lever and fulcrum. Place lever under flow line as shown and temporarily lift piping to a minimal height using the following guidelines for reference:

- Do not lift piping more than 6-8". More than this increases the potential of loosening the union seal connection.
- Never extend any part of your body underneath the piping while it is elevated.
- Sometimes an opposing force is required from the side opposite the lever. A second lever may be used.
- Make sure that piping is still in straight line after lowering back to ground. If piping or components are askew, there is potential of leakage through union assemblies.



INSTALLING COMPONENTS CORRECT RIB Configuration

(Shown with FSR Spine installed)



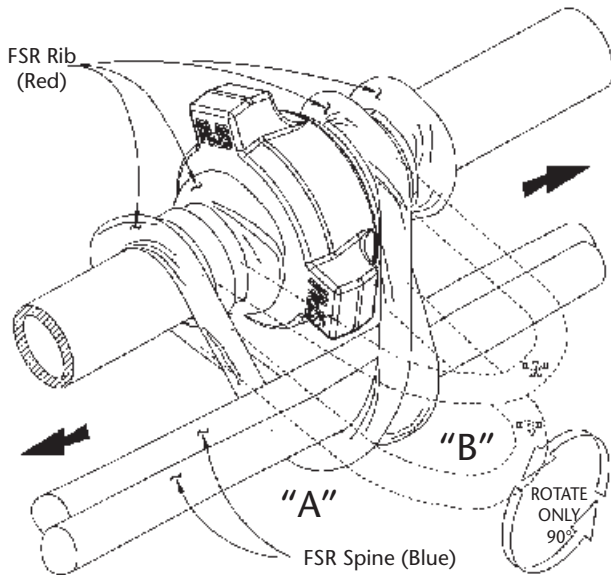
PRIMARY Method

This is the recommended method of installing Weir SPM FSR Ribs. ROTATE "A" and "B" ends 270° from flat before installing FSR spine.

- This takes up extra slack
- Makes connection more secure

INSTALLING COMPONENTS SECONDARY RIB Configuration

(Shown with FSR Spine installed)



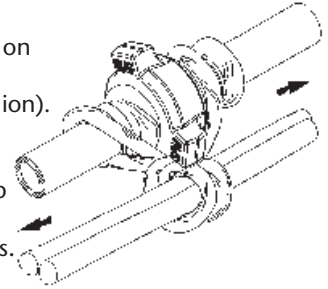
SECONDARY Method

Use this method only when there is not enough slack RIB material to allow for additional twist. ROTATE "A" and "B" ends only 90° from flat before installing FSR Spine.

INSTALLING COMPONENTS REQUIRED Rib Locations

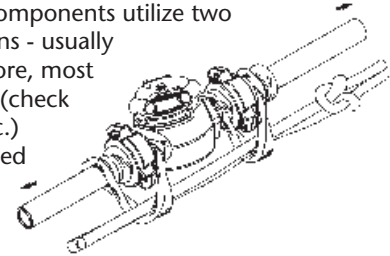
UNION CONNECTIONS

FSR Ribs should be installed on EVERY union connection on the flow line (one rib per union). The Rib envelope must always straddle both sides of the union in order to help contain each end of the adjoining pipes/components.



FLOW LINE COMPONENTS

Virtually all flow line components utilize two wing union connections - usually male x female. Therefore, most flow line components (check valves, plug valves, etc.) require FSR Ribs installed at each end as shown at right.



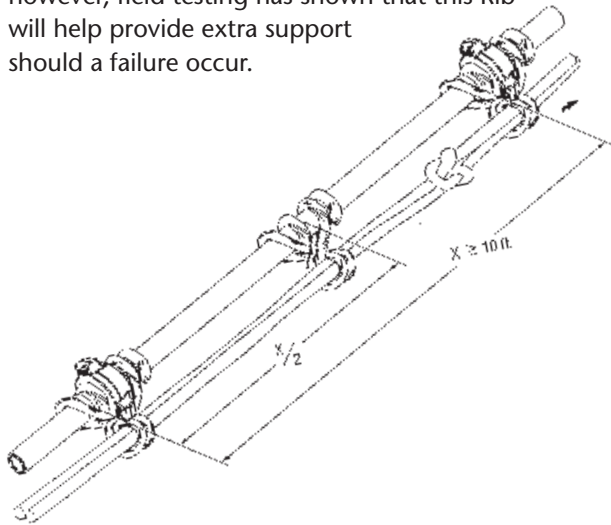
NOTES:

- There must be one FSR Rib installed at each union connection. The Rib envelope should always straddle both sides of the union. This is critical in order to help restrain each end of the flow line components.
- It is recommended that all Ribs are installed on the flow line prior to installing the Spine-mainline.
- Swivel assemblies should have additional FSR Ribs installed at "unsecured" swivel joint connections. Unsecured swivel connections are defined as male/female swivel connections that do not install directly into a straight run of piping.
- Each FSR Rib should be installed with minimum slack to ensure that the entire FSR system installation is as rigid as possible.

INSTALLING COMPONENTS REQUIRED Rib Locations

LONG PIPING ASSEMBLIES

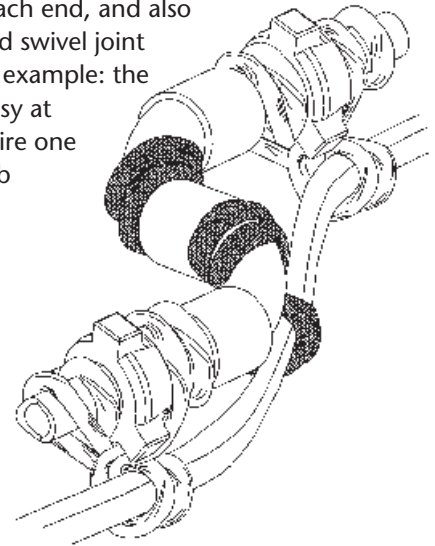
Most piping assemblies can be treated like other flow line components - with one FSR Rib installed on each union connection at each end. **However, on piping assemblies 10 feet or longer, Weir SPM requires that a third FSR Rib also be installed midway between the two union connections as shown at right.** This center Rib will not have the union connection to help prevent it from moving, however, field testing has shown that this Rib will help provide extra support should a failure occur.



INSTALLING COMPONENTS REQUIRED Rib Locations

SWIVEL ASSEMBLIES

Swivel assemblies should have FSR Ribs installed at the two wing union connections at each end, and also around unsecured swivel joint connections. For example: the style 10 swivel assy at right would require one additional FSR Rib (shown shaded).



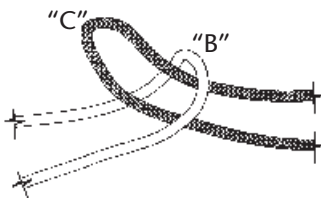
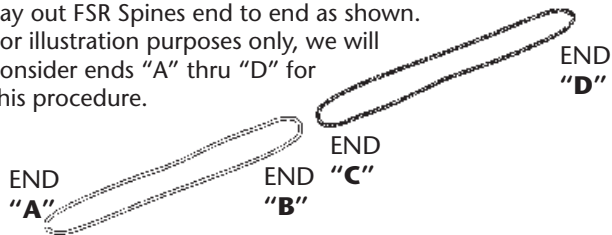
Note that, for clarity, FSR anchor crossover assemblies are not shown in view at right. For complete information on FSR crossover assy installation, refer to pages 20 and 21 of these installation instructions.

FSR "SPINE" INSTALLATION

USE THIS PROCEDURE TO LINK "SPINE" SAFETY RESTRAINTS TOGETHER TO CREATE ONE MAINLINE (OR LONG ANCHOR LINES)

STEP 1

Lay out FSR Spines end to end as shown. For illustration purposes only, we will consider ends "A" thru "D" for this procedure.

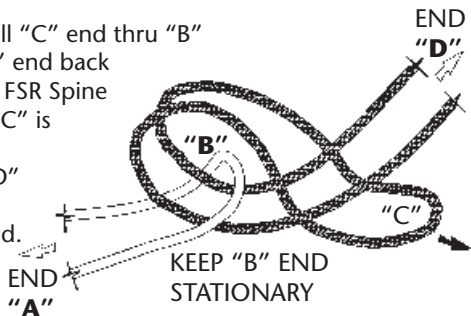


STEP 2

While keeping the "B" end stationary, draw "C" end thru as shown.

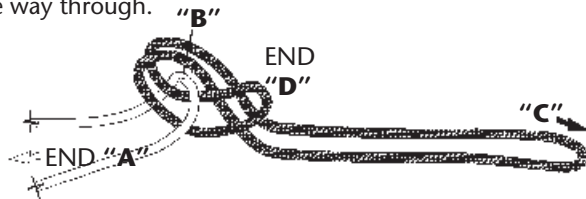
STEP 3

Continue to pull "C" end thru "B" end. Insert "C" end back thru the "C-D" FSR Spine as shown. As "C" is pulled further, unrestrained "D" end will move towards "B" end.



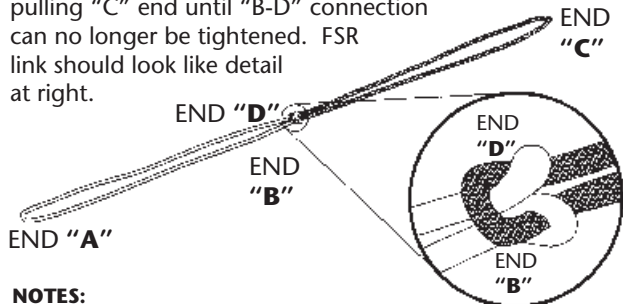
STEP 4

Pull the remainder of "C" end thru until "D" end draws close to "B" end as shown. While holding "B" end stationary, (using either a second person or placing a weight on the "A-B" FSR) pull "C" end the remainder of the way through.



STEP 5

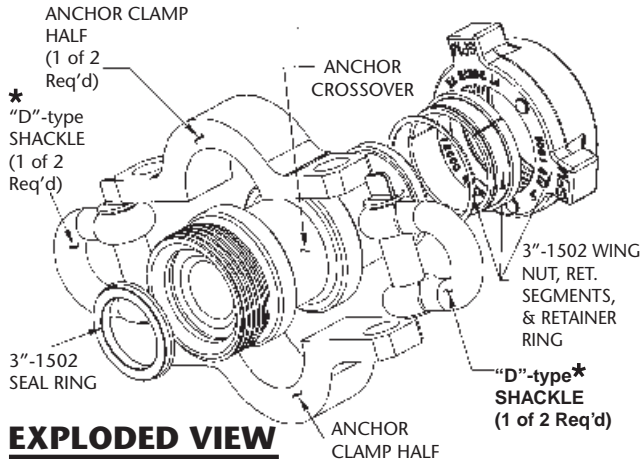
With "C" end pulled taut, notice how "D" and "C" ends have switched places. Keeping "A-B" FSR stationary, keep pulling "C" end until "B-D" connection can no longer be tightened. FSR link should look like detail at right.



NOTES:

- LINKING is described in the above procedure. NEVER tie knots in safety restraints. Use only the linking method to attach restraint ends to each other.
- Every Spine-to-Spine link must be tight. This is critical in establishing an overall tight FSR.
- This linking procedure generally applies only to FSR Spines. However, FSR Ribs can be linked in the same manner if a single Rib is too short to encircle a larger component.
- FSR Spines are rated at over twice the strength of FSR Ribs. BLUE Spines and RED Ribs should NEVER be linked together.
- As an extension of (d) above, RED FSR Ribs may NEVER be substituted for BLUE FSR Spines.

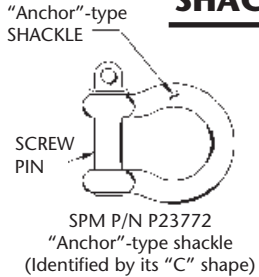
INSTALLING COMPONENTS FSR Anchor Crossover Assy.



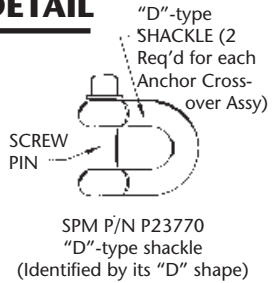
EXPLODED VIEW

3\"/>

SHACKLE DETAIL

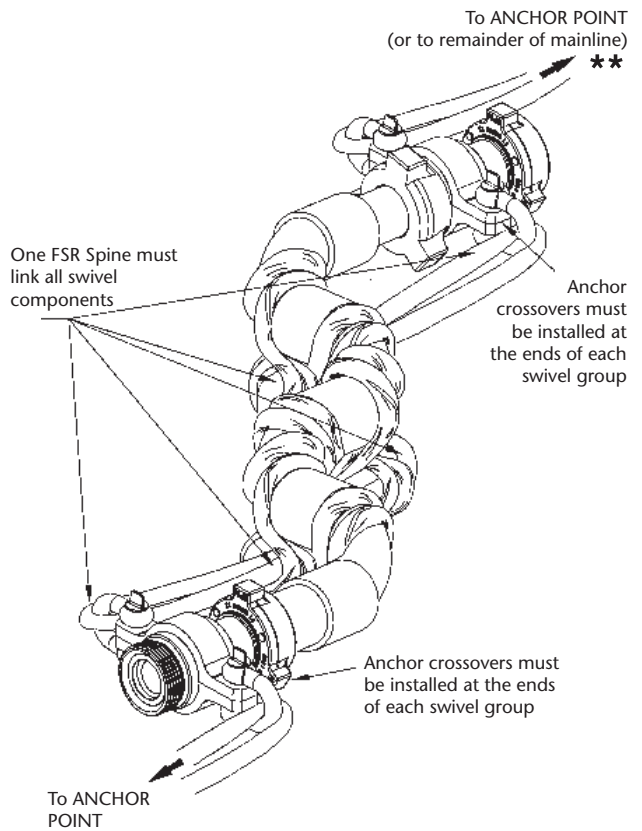


- DO NOT use these in Anchor Crossover assemblies
- Use this type of shackle throughout the remainder of the FSR system



- Use these only in Anchor Crossover assemblies
- DO NOT use this type of shackle throughout the remainder of the FSR system

INSTALLING COMPONENTS FSR Anchor Crossover Assy.



SEE "NOTES" ON NEXT PAGE

NOTES:

- a) Anchor Crossover Assys must be installed as illustrated on page 21. Generally, two Anchor Crossover Assys are required for each swivel assy (or group of swivel assys), ONE crossover assy on each end.
- b) Anchor Crossovers must be installed in this configuration because swivels and swivel assys are designed to provide flexibility in a flow line. While this is necessary for simplifying installations, this flexibility allows forces to build up in the event of a flow line failure. By "linking" FSR Spines to anchor crossover assys, the slack in the system can be reduced.
- ★★ See page 21.
- c) FSR mainlines must always be continuous from anchor point (at frac trailer for example) to anchor point at wellhead. Any time that there is a break in the mainline, such as where the mainline is shackled to the anchor crossover, a second FSR Spine mainline must continue from that point and make up the continuous mainline.
- ★ See page 20.
- d) NOTE: There are two types of shackles used on a typical Weir SPM FSR. Never substitute the incorrect type of shackle for the non-specified application. See SHACKLE DETAIL on page 20 for complete details.

SECURING FSR SYSTEM ENDS

(This includes both FSR main lines and FSR anchor lines)

THERE ARE TWO PRIMARY METHODS FOR SECURING the FSR MAIN LINES AND FSR ANCHOR LINES:



LOOPING

Looping the FSR Spine around the anchor, then back through itself (tying to an anchor point is never acceptable)



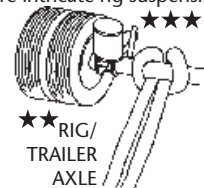
SHACKLE

Looping the FSR Spine around the anchor, then utilizing an anchor shackle to secure the end back to the FSR Spine

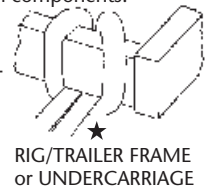
- ★ CAUTION: Sharp edges should always be avoided in all FSR installations. When connecting to a rig/trailer frame or undercarriage, make certain that these surfaces are smooth and do not have sharp edges.
- ★★ While large rig axles can be an excellent source to anchor an FSR line, if the axle is too oily or greasy, it is generally preferable to select an alternate anchor point to save cleaning time later.
- ★★★ When securing an FSR system to an axle, make sure the anchor point is a substantial member. Also, take care to avoid damaging more intricate rig suspension components.



RIG/TRAILER TOW EYE HOOK



★★ RIG/TRAILER AXLE



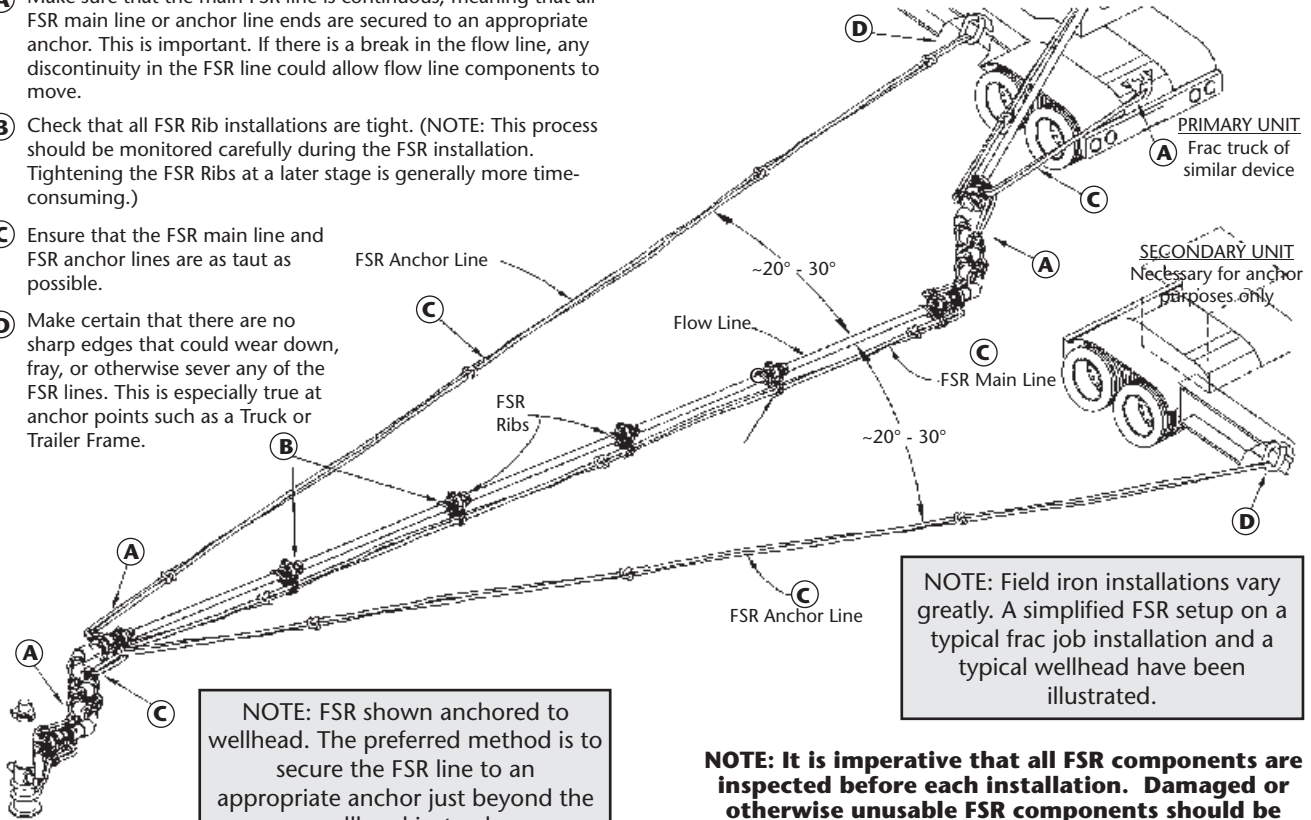
★ RIG/TRAILER FRAME or UNDERCARRIAGE

IMPORTANT NOTE: IT IS CRITICAL THAT ANY DEVICE USED TO ANCHOR THE FSR LINES MUST BE CAPABLE OF WITHSTANDING A MINIMUM 30,000# PULL TEST.

FINAL FSR SYSTEM INSPECTION

Always done before energizing the flow line

- (A)** Make sure that the main FSR line is continuous, meaning that all FSR main line or anchor line ends are secured to an appropriate anchor. This is important. If there is a break in the flow line, any discontinuity in the FSR line could allow flow line components to move.
- (B)** Check that all FSR Rib installations are tight. (NOTE: This process should be monitored carefully during the FSR installation. Tightening the FSR Ribs at a later stage is generally more time-consuming.)
- (C)** Ensure that the FSR main line and FSR anchor lines are as taut as possible.
- (D)** Make certain that there are no sharp edges that could wear down, fray, or otherwise sever any of the FSR lines. This is especially true at anchor points such as a Truck or Trailer Frame.



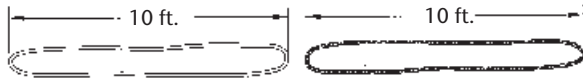
NOTES:

- Bleed-off (or blowback) line is not shown. It should be secured with the FSR system in the same manner as the main flow line.
- For clarity, some FSR Ribs have not been illustrated at some of the union connections.

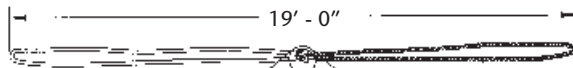
NOTE: It is imperative that all FSR components are inspected before each installation. Damaged or otherwise unusable FSR components should be discarded and replaced.

LINKED FSR MEASUREMENTS

USE THIS PROCEDURE TO DETERMINE APPROXIMATE AMOUNT OF OVERLAP WHEN LINKING FSRs TOGETHER



SEPARATE SPINES



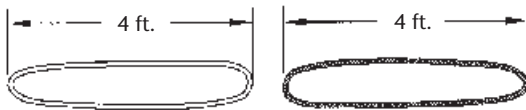
LINKED SPINES

FSR SPINES

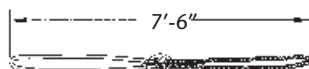
Note that linking the FSR Spines together results in a slight reduction in the combined length.



(10 ft. Spines shown but all Spines would show similar reduction)



SEPARATE RIBS



LINKED RIBS

FSR RIBS

Note that linking the FSR Ribs together results in a slight reduction in the combined length.



NOTE: ALL LENGTHS ARE APPROXIMATE & SHOULD BE USED FOR REFERENCE ONLY

Recommended Sequence When Installing FSR Components

Different situations require different installation sequences. The possibilities are myriad and each scenario cannot be discussed in this manual. Should you have anything other than a standard installation, it is strongly recommended you contact Weir SPM Engineering before proceeding. A standard installation sequence is as follows:

FIRST

Install FSR Anchor Crossover Assemblies. See pages 20 and 21 for more information. This is critical because they require installation into the flow line. If these are not included, the flow line must be disassembled and these components installed.

SECOND

Install the FSR Ribs next. See pages 10 - 17 of this guide for more information.

TIP - It is most efficient to have one person lay out all the FSR Ribs at appropriate locations along the flow line prior to installing them.

TIP - It is recommended that one person lift the flow line with the pipe jack (or similar leverage) while another individual installs the Rib at each union connection.

THIRD

Install the FSR mainline Spines next. These Spines should be threaded through the Ribs already installed on the flow line. See pages 18 and 19 of this guide for reference.

TIP - It is recommended to start at one end and work toward the other end.

TIP - Installers should remember to twist FSR Ribs prior to installing the FSR Spine main line through. This helps ensure a tight installation

FOURTH

Install the FSR anchor line Spines. See pages 24 and 25 of this guide for reference.

DEFINITIONS

For Weir SPM Flow Line Safety Restraints

Anchor Line – Comprised of multiple Weir SPM Spines. Only BLUE Spine FSRs should ever be use to make up anchor lines. Anchor lines are similar to main lines however, instead of being continuously installed on the flow line like main lines, anchor lines are attached to a single point on the flow line and to an immovable object away from the flow line.

Anchor Crossover Assy – Special crossover, similar to standard integral crossover, but designed with special anchor clamps/shackles that link FSR mainlines together. Anchor crossover assemblies should always be installed on either end of a group of swivels/swivel assemblies. They are designed to reduce the movement of the swivel assemblies in the event of a failure.

FSR – Abbreviation for Flow Line Safety Restraints.

FSR “Rib” – (Color code: RED) FSR Ribs are always 4’ long. They are designed to be installed at each union connection on a flow line. They are looped around the union connection, and then the main FSR line (comprised of BLUE Spine FSRs) is threaded through the Ribs in order to create a continuous safety line. Red Ribs can NEVER be substituted for blue FSR Spines.

FSR “Spine” – (Color code: BLUE) FSR Spines can range from 4’ to 20’ in length. They make up the main line of the safety restraint system. Spines are linked together to create the mainline, and then both ends should always be secured to immovable anchor points at each end of the FSR installation.

Mainline – Comprised of multiple Weir SPM Spine. Only BLUE Spine FSRs should ever be use to make up a mainline. This is the safety restraint line that is installed on the flow line.

RE-CERTIFICATION

In order to ensure the continued safe operation of the Flow Line Restraint System, Weir SPM requires annual FSR re-certification. Contact your Weir SPM sales representative at (817) 246-2461 to schedule the annual re-certification.

Reference Documents for Annual FSR Re-certification:

Weir SPM Engineering Bulletin 1024

This bulletin briefly explains the annual FSR procedure and details which documentation is required.

Weir SPM Specification 4S24036

Flow Line Safety Restraint Annual Re-Certification Procedure

Weir SPM SP-2002

Sampling Plan

MIL-STD-105-E: Sampling

Table 1 General Inspection Level 1 AQL 4.0, Table II-A

Weir SPM PWI-1057RD

Weir SPM Refurbished Procedures Manual

NOTES

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NOTES

Weir SPM Locations:

United States

Alice, Texas - Service Center
Brighton, Colorado - Service Center
Elk City, Oklahoma - Service Center
Fort Worth, Texas - HQ and Service Center
Grand Junction, Colorado - Service Center
Houston, Texas - Sales Office
Jane Lew, West Virginia - Service Center
Lafayette, Louisiana - Service Center
Longview, Texas - Service Center
Odessa, Texas - Service Center
Searcy, Arkansas - Service Center
Willison, North Dakota - Service Center

Canada

Grande Prairie, AB, Canada -Service Center
Medicine Hat, AB, Canada -Service Center
Red Deer, AB, Canada - Service Center

Mexico

Villahermosa, Mexico - Service Center

Europe

Aberdeen, Scotland -Service Center

Middle East

Dubai, UAE -Service Center

Australasia

Australia - Service Center
Singapore - Sales Office