SPM® Flow Control Product Safety, Usage and Maintenance Guide

DISCLAIMER

Only skilled professionals with a clear understanding of the equipment and safety protocols noted in this document should work with the equipment. These instructions are not intended to be a comprehensive procedural manual, do not cover all details or variations in the equipment, and do not provide for every possible contingency that may be encountered with the installation, operation, or maintenance of the equipment. Rather, these instructions serve as a guide for those who are specifically trained in installing, operating, maintaining and repairing similar equipment and who are familiar with appropriate safety and environmental protocols. All others should refrain from any involvement with this equipment.

S.P.M. Flow Control, Inc. ("SPM") is not liable for the user's failure to observe appropriate safety and environmental procedures. SPM does not make any representations, warranties or guarantees, express or implied, as to the accuracy or completeness of the instructions. If you have any questions, please contact SPM before proceeding.

CONTENTS

GENERAL INFORMATION

INTRODUCTION

The SPM® Flow Control Product Safety, Usage and Maintenance Guide is intended to provide readers with a general understanding and recommendations for the appropriate use and maintenance of SPM® flow control products. Additional information regarding the use and maintenance of each product family can be found in their corresponding operations and instructions manual. If the reader does not fully understand the information contained in this document, or has additional questions not covered in this document, contact Weir.

!!WARNING!!

WORKING IN THE OILFIELD, INCLUDING AT FRAC SITES, AND USING HIGH PRESSURE EQUIPMENT IS INHERENTLY DANGEROUS, AND CAN RESULT IN SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE. ALL INFORMATION CONTAINED IN THIS DOCUMENT IS GENERAL IN NATURE. WEIR DOES NOT MAKE ANY REPRESENTATIONS, WARRANTIES OR GUARANTEES, EXPRESS OR IMPLIED, AS TO THE ACCURACY OR COMPLETENESS OF THE INFORMATION CONTAINED IN THIS DOCUMENT. WEIR IS NOT LIABLE FOR THE USER'S FAILURE TO OBSERVE APPROPRIATE SAFETY PROCEDURES.

!!WARNING!!

WARNING: THE FOLLOWING INFORMATION IS GIVEN IN GOOD FAITH AND IS INTENDED TO AID IN THE SAFE USE OF SPM® PRODUCTS. THIS INFORMATION IS NOT MEANT TO REPLACE EXISTING COMPANY'S SAFETY POLICIES OR PRACTICES. ADDITIONAL SAFETY RECOMMENDATIONS CAN BE FOUND IN THE OPERATIONS & MAINTENANCE MANUALS FOR EACH PRODUCT FAMILY. FAILURE TO ADHERE TO THESE SAFE PRACTICE RECOMMENDATIONS CAN RESULT IN SERIOUS INJURY OR DEATH. YOU SHOULD NOT USE ANY SPM® PRODUCT UNLESS YOU HAVE KNOWLEDGE OF AND UNDERSTAND ITS SAFE USE, MAINTENANCE, AND PROPER HANDLING PROCEDURES.

PERSONAL RESPONSIBILITIES

- Do not hammer on any SPM® product when pressure is present.
- When using SPM® flow control products appropriate personal protective equipment (PPE) is required, including, at a minimum, safety glasses, approved safety shoes, gloves and hard hat.
- Hammering and lifting must be done with caution.
- Personnel should only hammer on union lugs and not strike the union nut or valve body. Fractures can occur from repeated misuse. Excessive hammering can damage components.
- Legs should be used for proper lifting. Avoid using your back when lifting objects.
- Technicians should be trained in proper application and safe handling of SPM® flow control products prior to using.

ON SITE CONSIDERATIONS

- Proper transportation of SPM® products is important. Racks that secure valves and other components, and protect against accidental unloading, are critical. Never transport any SPM® product in a fashion that would allow it to become loose and possibly cause an accident.
- End connections on SPM® products should be cleaned and oiled prior to each use. A visual inspection for damage should also be performed at this time. Union seals should be checked, and replaced when worn or damaged.
- Since SPM® products may be repainted in different colors for various applications, do not use factory color as the primary means of service identification. Operator should check end connection to confirm equipment pressure ratings.
- Due to the inherent risks of **SEVERE BODILY INJURY, DEATH, OR PROPERTY DAMAGE**, it is recommended that remote control actuators be used for actuating valves under pressure, and that personnel remain outside of the zone of danger.
- SPM® product usage should be monitored by a qualified supervisor or foreman. Supervisory personnel must approve proper placement, position, and handling of all equipment in the pumping system.

- Do not position any part of your body in the path of exit flow of SPM® flow line equipment.
- Each string of iron should be pressurized to its maximum planned working pressure prior to each use. The maximum working pressure of the lowest rated component must not be exceeded. All personnel must be at a safe distance or position when pressure is applied.
- Always consult the identification band or plate on the product for the correct cold working pressure rating.

!!WARNING!!

MOST SPM® PRODUCTS ARE PRESSURE VESSELS OR ARE INSTALLED AROUND PRESSURE VESSELS. THEY ARE ENGINEERED AND MANUFACTURED UNDER STRICT SPECIFICATIONS AND SHOULD BE INSPECTED ACCORDINGLY. EACH PRODUCT HAS A PUBLISHED WORKING PRESSURE THAT MUST NOT BE EXCEEDED. PROPER USE IS THE RESPONSIBILITY OF THE END USER. SPM® PROVIDES TECHNICAL LITERATURE FOR ITS PRODUCTS. CONSULT ENGINEERING IF TECHNICAL DATA BEYOND WHAT IS INCLUDED IN THIS DOCUMENT IS REQUIRED OR FOR CLARIFICATION ON ANY APPLICATION OR HANDLING PRACTICE COVERED BY THIS DOCUMENT.

GENERAL PRODUCT USE NOTES

GENERAL USAGE

- Personnel must take all appropriate steps to avoid being around pressure vessel products while pressure is present or being applied.
- Each treating iron component is clearly marked with a maximum pressure rating. Every string of iron should be pressure tested to its maximum planned working pressure prior to each use. Do not exceed the maximum rated pressure of any product in the flow line.
- Never tighten or hammer wing unions when flow line is under pressure.
- A complete visual inspection of flow control products must be made prior to each use. Prior to use, remedy or replace any leaking seals, broken bolts, leaking hoses, or improperly tightened parts.
- Treating iron connections should be properly cleaned and oiled before the downstream piping is attached. Replace any worn, damaged, or missing seals.
- Weir recommends that users designate specific treating iron strings by application, and that the designated iron remain in that service application throughout the product's life. These service strings should be marked or color coded in such a way as to be clearly identifiable, and **all personnel must be thoroughly trained in the use of these products.**

    - **All energized fluids and gases, such as CO2 and N2, are recommended to have a designated string of treating iron for that service**. This string must be clearly identified and must not be used for any other purpose. Pipe threaded components should never be used for energized service. Only integral union style components should be used.

    - Iron operating in applications using acids or other highly corrosive well fluids is recommended to have a designated string and should not be used for any other purpose.

- **H2S (Sour Gas) treating iron must also have a designated identification and always be used when H2S is apparent or could be encountered**. Pipe threaded components should never be used for H2S Service. Only integral union type components, designed for this service, should be used.

- Welding, brazing, or heating on high pressure components is prohibited.
- Flow rates above 42 feet per second are not recommended. Rates above 42 feet per second will cause accelerated wear. Certain abrasive media can also cause accelerated wear.
- After each job flush components with clean water and grease applicable equipment with the proper Weir approved grease.
- Pressure seal (line pipe) threads are not recommended for pulsating service above 10,000 psi or where side loading or erosion are suspected. Non-pressure seal (round tubing) threads or integral connections are recommended under these conditions.

SERVICE TYPES

- Standard Service
  - Alternative seals are available for harsh services (chemicals, acids, etc.)
  - **Warning: Certain acids and chemicals may not be compatible with standard elastomers used in SPM® flow control products. Contact engineering for guidelines regarding elastomer compatibility.**
  - Not intended for exposure to H2S.
- H2S (Sour Gas) Service
  - These assemblies are manufactured from tempered alloy (HSLA) steel and are in accordance with NACE MRO175 regarding allowable hardness and alloy concentration.

!!WARNING!!

EXPOSING STANDARD SERVICE COMPONENTS TO H2S MAY RESULT IN RAPID CATASTROPHIC FAILURES, WHICH MAY LEAD TO SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE. DUE TO THIS RISK, ONLY USE H2S SERVICE COMPONENTS FOR APPLICATIONS INVOLVING ANY CONCENTRATION OF H2S.

END CONNECTIONS

- SPM® flow control products are available in hammer union or patented Safety Iron® end connections. Both end connection types are available in various sizes and pressure ratings. The most common include:
  - 2" 1502 hammer union or 15K Safety Iron® end connection
  - 3" 1502 hammer union or 15K Safety Iron® end connection
  - 4" 1002 hammer union or 10K Safety Iron® end connection
  - 4" 1502 hammer union or 15K Safety Iron® end connection
- Each hammer union is clearly marked with an identification code (e.g. "1502"). This code should be referenced when mating unions. Improper mating can result in failures. All union connections used must match (according to size, pressure rating, etc.). These connections must also match the service of the designated string in which they are installed. (Standard, H2S, etc.)
- All SPM® threaded components are right hand threaded unless specifically designated otherwise.

!!WARNING!!

IT IS CRITICAL THAT, SINCE MOST 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 MAINTENANCE

- General maintenance will assist in maximizing the life of flow control products.
    - Grease plug valves and swivel joints regularly. Reference specific greasing procedures and recommended intervals within each specific product's section of this document.
    - Replace worn or damaged seals to help prevent leaks and washouts of seal faces.
    - Clean all seal areas thoroughly.
- Flow lines should be flushed with clean water after each use. Care should be taken to avoid corrosive media from sitting stagnate in treating iron for extended periods of time.
- Use of proper tools is necessary when servicing SPM® flow control products. Service personnel must be knowledgeable and trained in the usage and handling of tools for all maintenance. Operating and maintenance manuals should be consulted before utilizing or performing maintenance on any product.

INSPECTION, REPAIR & TESTING

- Flow control components must have regular intervals of maintenance and inspection to help provide safe, reliable performance. Further information regarding maintenance of specific product categories can be found later in this document or in each product's corresponding operations and maintenance manual. Some users and particular operations may require more frequent maintenance and inspection intervals than

recommended in this document due to specific operating conditions. Weir Engineering can provide additional guidance to assist users in determining their inspection requirements.
- Only SPM® repair parts should be used for replacement in an SPM® product.
- Any unauthorized alteration of SPM® flow line equipment is prohibited.
- Use only repair methods as outlined by SPM® service literature. Use only the proper SPM® repair tools.
- Weir does not allow weld repair to be attempted on its flow control products. Replacing worn components is a more effective approach.

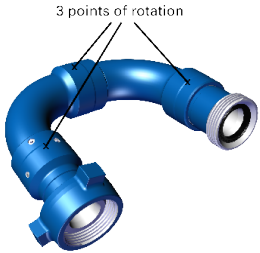
RECOMMENDED STORAGE

- Flow lines should be flushed with clean water prior to storage for extended periods of time.
- Plug valves and swivels should be greased prior to storage for extended periods of time.
- Plug valves should be stored in the open position.
- End connections and critical seal areas should be wiped dry prior to storage.
- Use a vapor phase corrosion inhibitor (VpCI) on the seal pocket, internal bores and thread connections.
- Thread protectors are recommended to be installed on end connections during general transport and storage.
- Flow control equipment should be stored in a controlled, clean, and dry environment when possible.
- Valves and swivels are recommended to be re-greased before being put into service if stored for an extended period of time.
- Valves and swivels are recommended to be pressure tested, including operational test, prior to being put in service if stored for an extended period of time.

SWIVELS

SWIVEL USE NOTES

- Do not use SPM® swivels for continuous rotation under pressure. Swivels are not designed for continuous rotation, even at very low pressure.
- Swivels are not designed for side loading. Loading that will induce a bending moment into the ball races is prohibited. To protect against the above, three points of rotation are recommended. This will allow the swivel to accommodate the free movement of the lines in all planes. This can be accomplished with one style-10 or two style-50 swivel assemblies.



- Monitor the condition of swivels used in an area where a permanent hookup is required. Frame flexing or structural movements must not place swivels in a side loaded condition.
- Do not restrain free movement of SPM® swivels. Damage will occur, which could result in injury or **SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE.**
- Swivel sections must be greased and free to rotate without binding. Any swivel that is excessively hard to rotate while hooking up or breaking down should be repaired. Swivels that leak should be removed, repaired or replaced.
- If the swivel leaks, it should be removed from service for immediate repair or replacement. Fluids may leak into the ball race cavity. This area is highly susceptible to problems caused by caustic or acid type fluids. If the ball races show indications of acid contamination, replace the unit.
- All SPM® long radius swivel joints are furnished with a vent port between the primary seal (packing) and the secondary seal

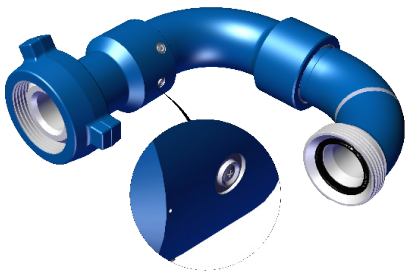
(backup). This design is intended to reduce the danger of high pressure fluid entering the ball race area if the primary seal fails. In addition, any visible leaking at this feature serves as a visible indicator that the primary packing requires replacement. It is extremely important to monitor the port for any venting of fluid. Immediately repair the assembly if leakage is detected.

- Swivel union connections should be clean and lightly oiled prior to each use. A visual inspection for damage should also be performed at this time. Union seals should be checked and replaced when worn or damaged.

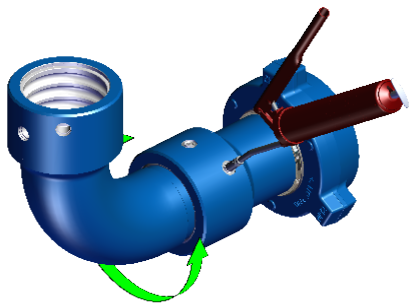
SWIVEL MAINTENANCE NOTES

- **Weir recommends that swivels be thoroughly inspected, serviced and/or repaired, at least every six (6) months.** While the swivel assembly is undergoing maintenance, a visual inspection for wear, corrosion, or erosion should be performed. Ultrasonic inspection should be performed on critical areas, including the swivel elbows. In areas of high use, this type of inspection should be more frequent.
- Visually inspect prior to each use and verify that swivels rotate smoothly and are greased properly. Use only SPM® repair kits when repairing swivel assemblies.

SWIVEL GREASE PROCEDURE



- Swivels should be greased before each job and prior to long periods of storage.
- Approved Grease: **Chevron Dura-Lith® Grease EP (SPM P/N P17301)**
- Procedure:
    - Remove lube plug and o-ring.
    - Using a hand-held grease gun and approved grease, apply two strokes of grease.
    - Do not use high pressure grease gun.
    - **Never grease swivel while under pressure.**
    - Rotate swivel elbow 90 degrees.
    - Apply two more strokes.
    - Rotate assembly 90 degrees two more times and apply two strokes of grease each time.
    - Rotate swivel 360 degrees to verify smoothness of rotation.
    - Reinstall lube plug and o-ring.
    - Repeat at all articulating joints of the swivel.



PLUG VALVES

PLUG VALVE USE NOTES

!!WARNING!!

AVOID ACTUATING VALVES UNDER PRESSURE DUE TO THE INHERENT RISKS OF SEVERE BODILY INJURY, DEATH, OR PROPERTY DAMAGE. IT IS RECOMMENDED THAT REMOTE CONTROL ACTUATORS BE USED FOR THIS PURPOSE.

- Only the proper actuator bar should be used to turn SPM® plug valves. Makeshift bars can become dislodged easily and cause an accident. Use only an SPM® actuator bar, part number 3P19958 for 1", 3P11542 for 2" and 2P40036 for 3" plug valves. It is a personal responsibility to become knowledgeable and trained in the proper use and handling of this tool.
- If valve is slow or difficult to open or close, remove it from service. Do not hammer on the valve's actuator cap.
- Valve unions should be clean and oiled prior to each use. A visual inspection for damage should also be performed at this time. Union seals should be checked, and replaced when worn or damaged.
- Prior to applying pressure, valves should be greased in the opened position. This should be done before each use. If valve is excessively hard to operate, it should be removed and not used until repairs are made.
- Do not position any part of your body in the path of exit flow of the valve.
- Do not position the exit of any plug valve, used for bleeding, where rocks or debris may be picked up by the exit stream.
- If any valve becomes plugged or does not operate properly, contact a supervisor immediately. **DO NOT** look into the end of the valve to check for debris, blockage, or for any other reason.

PLUG VALVE MAINTENANCE NOTES

!!WARNING!!

VERIFY ALL PRESSURE IS RELIEVED PRIOR TO PERFORMING ANY MAINTENANCE OR DISSASEMBLY. FAILURE TO DO SO COULD RESULT IN PERSONAL INJURY, DEATH, PROPERTY DAMAGE, AND/OR SEVERE DAMAGE TO THE VALVE.

- Flush, clean and grease after each job with water and the proper SPM® valve grease. Use only a Weir approved grease gun.
- **Weir recommends plug valves be fully disassembled, inspected, and pressure tested at least every 6 (six) months and always tested after each repair**. The valve should be tested in an opened and in a closed position. Personnel should be a safe distance during pressure cycles. They should never look into or position themselves in the exit flow path of the valve.
- Use only SPM® repair kits when repairing SPM® units.

PLUG VALVE GREASE PROCEDURE (LEGACY PLUG VALVES)

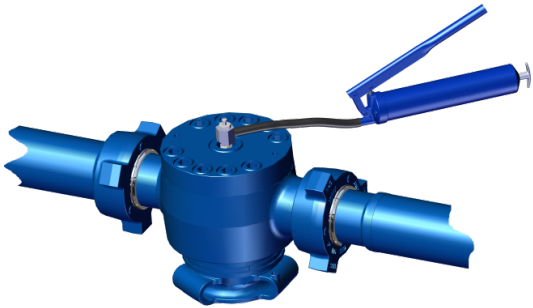
- Regular re-greasing will increase the performance and help maximize the life of the plug valve. Normal working operations will result in grease loss if the plug valve is not maintained. Insufficient grease can create voids within the assembly. These voids will quickly accumulate sand and/or proppant thus increasing the force required to open/close the valve. Frequent greasing of the valve will assist with easier operation and better sealing. Greasing also helps prevent corrosive fluid from becoming entrapped within voids in the valve, protecting against damage to critical sealing areas and maximizing product life.
- Weir Engineering has identified a grease compound to be used in conjunction with a specific greasing procedure on all existing plug valve assemblies. Val-Tex 972 grease (stick) has been identified to notably increase the performance in all sizes of SPM® plug valves. It is the responsibility, of the end user to implement the proper maintenance procedures. Failure to follow

these requirements can result in reduced valve performance and life.

- It is important to note the difference between Val-Tex 972 "stick" and "bulk" grease. While the bulk Val-Tex 972 grease bears a similar description, it offers a reduced viscosity to that of the stick grease, resulting in decreased performance and longevity of the valve. Also note that Val-Tex 1502 should be used to coat certain components during the rebuild process. Val-Tex 1502 is not to be used as operational grease.
- **Weir recommends operational re-greasing after every six stages or six valve turn operations.**

PROCEDURE

- Flush valve with clean water to wash away any contaminants in the valve.
- The valve must be in the open position prior to pumping the grease. Pump the operational grease, Val-Tex 972, into the valve using the grease gun.
- Cycle the valve and grease per the following criteria:
    - Pump to 2,000 psi
    - Close and open valve
    - Pump to 4,000 psi
    - Close and open valve
    - Pump to 6,000 ps
    - Close and open valve
    - NOTE: Air will be heard "popping" during opening and closing. This will allow for a more complete filling of grease in the valve.
- Visually inspect the inside of the valve to determine if the grease is extruding around the sides of the plug.
- **FOR RE-WORK ONLY:** Engineering specifies the use of Val-Tex 1502 assembly grease when disassembly and rebuild of the valve is required. Completely coat with grease the O.D. of the plug and seal segments. Reassemble valve using new seal components.
- NOTE: The mixing of operational grease types/brands is not recommended. Grease mixing can result in a decrease of valve performance and/or increase the required re-greasing frequency.



MATERIALS:

- Val-Tex 1502 (Temp Range -22F to 400F) SPM® P/N P36791
- Val-Tex 972- (Temp Range -22F to 600F), SPM® P/N P32553
- Do not mix Assembly Greases – This will increase the amount of friction between internal components of the valve. -- Contact Weir for other approved greases.

!!WARNING!!

USE EXTREME CAUTION WHEN INSPECTING THE INTERIOR PORTION OF THE VALVE AS THE GREASE COULD BE UNDER HIGH PRESSURE. FAILURE TO DO SO MAY LEAD TO SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE.

PLUG VALVE GREASE PROCEDURE (EXL PLUG VALVES)

- Regular re-greasing will increase the performance and extend the life of the plug valve. Normal operations will result in grease loss if the plug valve is not maintained. This can create voids within the assembly. These voids will quickly accumulate sand and/or proppant thus increasing the force required to open/close the valve. Frequent greasing of the valve will assist with easier operation and better sealing performance. Greasing also helps protect against corrosive fluid from becoming entrapped within voids in the valve, protecting against damage to critical sealing areas and maximizing product life.
- Weir Engineering has identified a grease compound to be used in conjunction with a specific greasing procedure on all existing plug valve assemblies. Val-Tex 972 grease (stick) has been identified to notably increase the performance in all sizes of SPM® plug valves. It is the responsibility, though, of the end user to implement the proper maintenance procedures. Failure to follow these requirements can result in reduced valve performance and life.
- It is important to note the difference between Val-Tex 972 "stick" and "bulk" grease. While the bulk Val-Tex 972 grease bears a similar description, it offers a reduced viscosity to that of the stick grease, resulting in decreased performance and longevity of the valve. Also note that Val-Tex 1502 should be used to coat certain components during the rebuild process. Val-Tex 1502 is not to be used as operational grease.

- **Weir recommends operational re-greasing after every fracturing job or 20 stages (whichever comes first)**.
- **The design of the EXL plug valve facilitates better grease retention resulting in a reduction in the recommended greasing interval compared to the legacy plug valve.**

RE-KITTING GREASE PROCEDURE

- During the rebuild of the EXL Plug Valve the following grease procedure should be followed to achieve proper grease distribution. A hydraulic grease machine that is capable of delivering grease at pressures above 2,000 PSI should be used:
    - Assemble valve and position on a secure table with the appropriate end connection (Hammer Union or Safety Iron®)
    - Verify that the plug valve is in the OPEN position
    - Position grease end connection onto grease fitting on Side 1 of the plug valve
    - Pump grease until the gauge reaches 2,000 PSI
    - Rotate valve to CLOSED position then back to the OPEN positon
    - Positon grease end connection onto grease fitting on Side 2 of the plug valve
    - Pump grease until the gauge reaches 2,000 PSI
    - Rotate valve to CLOSED position then back to the OPEN position
    - Valve is ready for service

PREVENTATIVE MAINTENANCE GREASE PROCEDURE

- After each job, flush valve with clean water to wash away any contaminants in the valve. Upon completion of the job, grease with approved SPM® valve grease to displace contaminants in between valve's internal components. To maximize the valve's performance and longevity, it is recommended that the lubrication maintenance procedure described below be followed:
    - Verify that the valve is in the OPEN position before pumping grease.
    - Using a hand pump grease gun (or grease

machine), pump the lever in order to push the grease into the valve. Val-tex 972 (SPM® PN P32553) stick grease is recommended.
- If using a pneumatic grease gun, SPM® PN P28682 grease can be used.
- Grease side of the valve to 2000 PSI
- Close and reopen valve
- Repeat process using grease insert on opposite side of the valve.

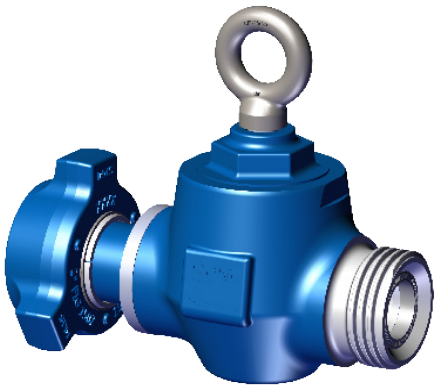
MATERIALS

- Val-Tex 1502 (Temp Range -22F to 400F) SPM® P/N P36791
- Val-Tex 972- (Temp Range -22F to 600F), SPM® P/N P32553
- Do not mix Assembly Greases – This will increase the amount of friction between internal components of the valve. – Contact Weir Oil & Gas Engineering for other approved greases.
- **NOTE:** Greasing from both sides is recommended for uniform fill, but not required for those instances where a valve is installed such that both sides are not accessible.

!!WARNING!!

USE EXTREME CAUTION WHEN INSPECTING THE INTERIOR PORTION OF THE VALVE AS THE GREASE COULD BE UNDER HIGH PRESSURE. FAILURE TO DO SO MAY LEAD TO SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE.

CLAPPER CHECK VALVES



CLAPPER CHECK VALVE USE NOTES

!!WARNING!!

BEFORE ASSEMBLY INTO A FLUID LINE, CHECK THE DIRECTION OF FLOW INDICATED BY THE ARROW ON THE BODY OF THE VALVE AND MAKE SURE THE VALVE IS PROPERLY ORIENTED IN THE FLOW LINE ACCORDING TO THE DIRECTION OF FLOW. IMPROPERLY ORIENTED CHECK VALVES WILL SHUT OFF FLUID FLOW, CAUSING AN OVER PRESSURE EVENT THAT CAN RESULT IN SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE.

- Weir recommends that clapper check valves be used in applications in which fluid being pumped contains solid materials, such as proppant. Dart check valves are recommended only for use in non-abrasive media applications, such as nitrogen pumping.
- The valve should be mounted in-line in a flat, horizontal position to allow for gravity to close the clapper when there is no flow. The clapper will close by itself, reseat, and seal when sufficient back pressure is encountered. The valve should be mounted such that the bottom plane of the valve (normal to the gravitational direction) does not exceed 22 degrees.
- SPM® clapper style check valves are intended to provide quick responding directional fluid control. For complete fluid shut-off, an isolation valve (i.e. a plug valve) should be installed in series with the clapper check valve. Do not attempt to work on or repair any equipment isolated by the clapper check valve while the check valve has pressurized fluid behind it.
- Any clapper check valve that has been exposed to high shock loads (i.e. overpressure, sandoffs, etc.) should be removed from service until ultrasonic checks and pressure testing can be performed.
- Valve unions should be clean and oiled prior to each use. A visual inspection for damage should also be performed at this time. Union seals should be checked and replaced when worn or damaged.

CLAPPER CHECK VALVE MAINTENANCE NOTES

- **Weir recommends clapper check valves be disassembled and inspected often (at least every 90 days)**. Any signs of pitting or washing on the body and components require replacement. **Clapper assemblies should be replaced regularly (approx. every 90 days or sooner depending the type and amount of use).** Clapper, hanger, pin and seat should be checked for wear. Clapper check valve caps should be inspected for damage, deterioration, or washing.
- Clapper check valve seats should be checked for washing or corrosion. If evidence exists, replace parts or valve.
- Valves used in applications with high acid concentrations require special attention related to inspection and maintenance.
- Use only SPM® repair kits when repairing units.

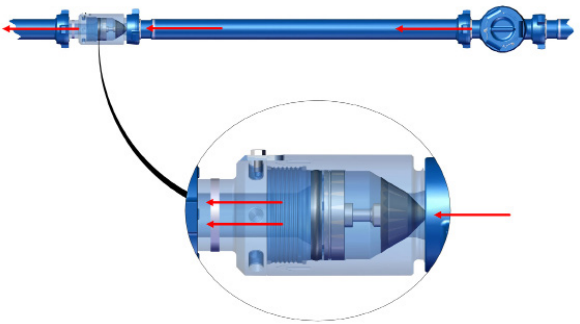
DART VALVES

DART VALVE USE NOTES

!!WARNING!!

BEFORE ASSEMBLY INTO A FLOW LINE, CHECK THE DIRECTION OF FLOW INDICATED BY THE ARROW ON THE BODY OF THE VALVE AND MAKE SURE THE VALVE IS PROPERLY ORIENTED IN THE FLOW LINE ACCORDING TO THE DIRECTION OF FLOW. IMPROPERLY ORIENTED CHECK VALVES WILL BLOCK FLOW, CAUSING AN OVER PRESSURE EVENT THAT CAN RESULT IN SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE.

- Any dart valve that has been exposed to high shock loads (i.e. overpressure, sandoffs, etc.) should be removed from service until ultrasonic checks and pressure testing can be performed.
- Dart valves are intended for use in services where the fluid media does not contain abrasive materials. For those applications, the clapper check valve will provide enhanced performance and extended life.
- The SPM® dart valve is not required to be mounted flat to function properly. The internal spring constantly applies positive pressure on the dart that prevents any effect gravity might have on the dart's operation.
- Dart valves should be installed in a branch where a flow control device is necessary to prevent flow in one direction. For complete fluid shut-off, an isolation valve (such as the SPM® plug valve) should be installed in series with the dart check valve.
- Valve unions should be clean and lightly oiled prior to each use. A visual inspection for damage should also be performed at this time. Union seals should be checked, and replaced when worn or damaged.



DART VALVE MAINTENANCE NOTES

- **Weir recommends dart valves be disassembled and inspected often (at least every 90 days)**. Any signs of pitting or washing on the body and components require replacement. **Dart assemblies should be replaced regularly (approx. every 90 days or sooner depending the type and amount of use)**. Dart valve seats should be checked for washing or corrosion. If such evidence exists, replace parts or valve.

SPRING RELIEF VALVES

SPRING RELIEF VALVE USE NOTES

!!WARNING!!

THIS DEVICE IS INTENDED TO DISCHARGE TO ATMOSPHERE WHEN IT RELIEVES. DO NOT BLOCK THE DISCHARGE PORT OR SUBJECT IT TO ANY BACK PRESSURE WHILE IN THE CLOSED POSITION. FAILURE TO COMPLY MAY LEAD TO SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE.

- SPM® spring relief valves should be installed in a branch on the high-pressure treating line. It is recommended that the valve be placed downstream away from the high pressure pumps. This increased distance will reduce the likelihood of the valve seat experiencing "chatter" as a result of pulsation in the treating line. However, localized protection for pumps on site is permissible.
- Reference the product's maintenance and operations manual for guidelines on the safe and accurate setting of the relief valve.
- It is a personal responsibility to use the proper wrench to adjust SPM® emergency relief valves. Direct acting valves require a substantial torque to adjust. Makeshift tools can become dislodged easily and cause an accident. It is a personal responsibility to become knowledgeable and trained in the proper use and handling of this product.
- It is recommended that SPM® emergency relief valves be preset to the required relieving pressure prior to installation and use. This should be done at the factory or a qualified field shop. When setting or adjustment is required on site, care should be exercised. Adjustments should be done only by specially trained personnel under direct supervisory instruction, and only then when necessary due to application.
- Make certain pressure is relieved before making any adjustments to pressure setting.
- The relief valve is designed for use in emergencies where an over-pressure situation occurs. The valve must not be the only safety device in the system. Over-pressure prime mover shutdowns are an important compliment to the relief valve. It is important that the cause for the over-pressure be corrected

immediately, since continued flow over the relief valve will damage its sealing capability.

- The discharge of the relief valve should be connected to a suitably sized discharge line that will direct relieved fluid to a safe area. This line must be of adequate size to minimize back pressure on the valve and have suitable pressure holding capacity in the event of a relief valve failure.
- Do not position any part of your body in the path of exit flow of the valve.
- Do not position the exit of any relief valve where rocks or debris may be picked up by the exit stream.
- Any relief valve that has been exposed to high shock loads (i.e. overpressure, sandoffs, etc.) should be removed from service until ultrasonic checks and pressure testing can be performed.

SPRING RELIEF VALVE MAINTENANCE NOTES

- **Any time the valve is sequenced in operation as a result of overpressure (other than routine calibration with clean water prior to pumping operations), it must undergo a teardown and the primary seal surfaces be inspected. If no over-pressure event occurs, the valve is recommended to be serviced after every 20 stages or 1 frac job, whichever comes first.**
- Relief valves require maintenance. It is impossible to visually inspect the internal components from the outside. **The valves are recommended to be disassembled and inspected often (at least every 90 days)**. If there are any signs of pitting or washing on the body, the valve should be replaced.
- When testing, the pressure should be applied only to inlet area.
- Use only SPM® repair kits for service and maintenance. Use only repair methods as outlined in SPM® relief valve service literature.

N2 RELIEF VALVES

N2 RELIEF VALVE USE NOTES

!!WARNING!!

THIS DEVICE IS INTENDED TO DISCHARGE TO ATMOSPHERIC PRESSURE WHEN IT RELIEVES. IT SHOULD NOT HAVE ITS DISCHARGE PORT BLOCKED OR BE SUBJECT TO ANY BACK PRESSURE WHILE IN THE CLOSED POSITION. FAILURE TO COMPLY MAY LEAD TO SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE.

N2 RELIEF VALVES SHOULD BE SET AT A MINIMUM OF 1,000 PSI ABOVE SYSTEM OPERATING PRESSURE.

- SPM® N2 relief valves should be installed in a branch on the high-pressure treating line. It is recommended that the valve be placed downstream away from the high pressure pumps. This increased distance will reduce the likelihood of the valve seat experiencing "chatter" as a result of pump pulsation in the treating line. However, localized protection for pumps on site is permissible.
- To reduce damage to critical seal surfaces as a result of "chatter", SPM® N2 valves should be set at no less than 1,000 psi over the system operating pressure. This will help facilitate longer life and better performance of the valve.
- The valve should be operated in the upright position no greater than 30 degrees from vertical. This will reduce the tendency for proppant to accumulate around the sealing area and potentially affect the sealing performance.
- **The approximate flow rate for SPM® N2 valves is 2,000 GPM.** This value is intended to be referenced for general sizing purposes. The actual discharge capacity is dependent on pressure differential and type of fluid media being discharged. Please contact Weir for additional information.
- The valve is intended to be used as an emergency pressure relief device only, and should not be subjected to continuous fluid flow except in emergency situations. If the valve is subjected to extended flow or abrasive fluids, it may not reseal completely once the pressure is relieved. If complete fluid shut-

off is desired, an isolation valve (such as a SPM® plug valve) should be installed in series with the relief valve, which can be closed once the over-pressure is relieved. See illustration below for valve position.

- Weir recommends that all N2 relief valve and isolation valve assemblies be supported by a self-enclosed portable structure that has been specifically engineered for the valve. Failure to comply with this recommendation may expose adjacent union connections to excessive loading, resulting in potential premature failure and line separation, which may cause **SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE.**

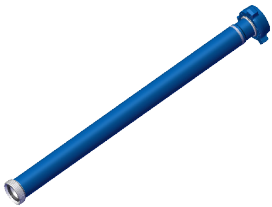
- The relief valve is designed for use in emergencies where an over-pressure situation occurs. The valve must not be the only safety device in the system. Over-pressure prime mover shutdowns are an important compliment to the relief valve. It is important that the cause for the over-pressure be corrected immediately, since continued flow over the relief valve will damage its sealing capability.
- The discharge of the relief valve should be connected to a suitably sized discharge line that will direct relieved fluid to a safe area. This line must be of adequate size to minimize

back pressure on the valve and have suitable pressure holding capacity in the event of a relief valve discharge.
- Do not position any part of your body in the path of exit flow of the valve.
- Do not position the exit of any relief valve where rocks or debris may be picked up by the exit stream.
- Any relief valve that has been exposed to high shock loads (i.e. overpressure, sandoffs, etc.) should be removed from service until ultrasonic checks and pressure testing can be performed.
- The gas regulator and gas back pressure relief valve should be installed as close to the relief valve as possible. The nitrogen filled high-pressure cylinder must be secured to either a skid or trailer or by staking it to the ground.
- Under no circumstance should the valve be allowed to continue operations with any visible external leak.
- Reference the product's maintenance and operations manual for guidelines on the accurate setting of the relief valve.

N2 RELIEF VALVE MAINTENANCE NOTES

- **Any time the valve is sequenced in operation as a result of overpressure (other than routine calibration with clean water prior to pumping operations), it must undergo a teardown and the primary seal surfaces be inspected. If no over-pressure event occurs, the valve is recommended to be serviced after every 20 stages or 1 frac job, whichever comes first.**
- Relief valves require maintenance. It is impossible to visually inspect the internal components from the outside. **The valves are recommended to be disassembled and inspected often (at least every 90 days). If there are any signs of pitting or washing on the body, the valve should be replaced.**
- **All fasteners should be replaced at the 90 day service interval for the valve**. Refer to Engineering Bulletin 1717 for more details.
- Use only SPM® repair kits for service and maintenance. Use only repair methods as outlined in SPM® relief valve service literature.
- When testing, the pressure should be applied only to inlet area.

INTEGRAL CONNECTIONS & PIPE



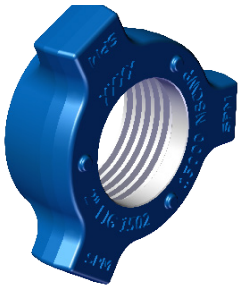
INTEGRAL CONNECTIONS & PIPE USE NOTES

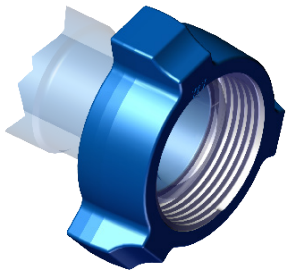
- In applications involving strong cyclic loading, Weir recommends the use of integral pipe over NPS pipe.
- It is a personal responsibility to visually inspect each union prior to each use for damage, unusual or excessive wear, excessive hammering, cracks, wash or erosion, corrosion or etching, thread or seal damage or other abnormalities. Any questionable component should be removed from service and submitted to a thorough inspection.
- Unions and treating pipe will stand some minor misalignment. However, placing piping where side loads are present is extremely dangerous and must be avoided.
- Treating pipe should not be used to vent gaseous fluids or gas to the atmosphere. Line whip can occur, which may lead to serious bodily injury, death, or property damage.
- Any SPM® union that is assembled to a crossover sub or other threaded connection will be limited to the working pressure of the lowest rated member.
- Pressure seal (line pipe) threads are not recommended for pulsating service above 10,000 psi or where side loading or erosion is suspected. Non-pressure seal (round tubing) threads or straight integral connections are recommended under these conditions.
- I.D. threads between the pressure seal (line pipe) and non-pressure seal (round tubing) are different. Do not mismatch these types. Failure may occur.

INTEGRAL CONNECTIONS & PIPE MAINTENANCE NOTES

- **SPM® recommends that integral connections and piping be thoroughly inspected, serviced and/or repaired, at least every six (6) months.** A visual inspection for wear, corrosion, or erosion should be performed. Ultrasonic inspection should be performed on critical areas.
- Use only SPM® parts to replace worn components.

HAMMER UNIONS





!!WARNING!!

PERSONNEL SHOULD NEVER HAMMER ON UNIONS OR TREATING PIPE WHEN PRESSURE IS PRESENT. PERSONNEL MUST TAKE ALL APPROPRIATE STEPS TO AVOID BEING AROUND PRESSURE VESSEL PRODUCTS WHILE PRESSURE IS PRESENT OR BEING APPLIED.

HAMMER UNIONS USE NOTES

- Each union connection is clearly marked with a pressure code (e.g. "1502"). This pressure must not be exceeded. This code should also be used with mating unions. Improper mating can result in failures, and may lead to **SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE.** All mating union connections must match (according to size, pressure rating, etc). These connections must also match the service of the designated string they are installed in.
- When using unions, safety glasses, approved safety shoes and hard hats must be worn. Hammering on unions may cause foreign material or steel slags to become airborne.
- Personnel should only hammer on makeup lugs and not strike union nut. Fractures can occur from repeated misuse. Excessive hammering on nut can damage hammer unions.
- It is an individual's personal responsibility to use the proper tools when working with hammer unions or treating pipe. Individuals should be knowledgeable and trained in the use of these tools.
- It is an individual's personal responsibility to visually inspect each union prior to use for damage, unusual or excessive wear, excessive hammering, cracks, wash or erosion, corrosion or etching, thread or seal damage or other abnormalities. Any questionable component should be removed from service and submitted to a thorough inspection.
- All threads on the wing nut and female union must be clean and free of any burrs and debris prior to installation. Cleaning of the threads may be accomplished by use of an abrasive wire wheel. Failure to implement this procedure may affect the initial hand tight starting location and impact the final assembly torque.
- Unions and treating pipe will stand some minor misalignment.

However, placing piping where side loads are present is extremely dangerous and must be avoided.

- Welding, brazing or heating unions or treating pipe is prohibited. Only butt weld unions and connections may be welded, and only then in accordance with specific approved processes.
- All SPM® threaded components are right hand threaded unless specifically designated otherwise. Any turning counterclockwise will unscrew the components.
- **Exposure to excessive vibrations may result in fatigue induced union failures. Care should be taken to optimize the iron layout to minimize side loads and vibration. See the section later in this document regarding flow line installation recommendations.**

HAMMER UNION ASSEMBLY NOTES

The chart below references the minimum assembly torque required to achieve a robust union connection, free of seal extrusion damage. Weir acknowledges that the ability to record the wing nut torque in the field is challenging. Due to this, the chart below includes the approximate rotation (after the wing nut is hand tight) required to achieve the minimum torque values. Be advised that debris on the thread may affect the initial hand tight position, resulting in an incorrect approximation of the torque. Due to this, it is recommended that the thread be cleaned prior to assembly.

HAMMER UNION SIZE (IN)	TORQUE (FT-LBS)	ROTATION
2-1502	700	15°
3-1502	275	45°
4-1002	575	105°
4-1502	650	60°

NOTE: Variations in the thread pitch and required “squeeze” on each of the union seals will affect the amount of rotation required after hand-tight is achieved. This explains the significant difference between the required rotation for the 2-1502 and 4-1002 union connections.

HAMMER UNIONS MAINTENANCE NOTES

!!WARNING!!

IT IS CRITICAL THAT SPM® HAMMER UNION COMPONENT PARTS BE REPLACED ONLY WITH SPM® PARTS OF THE SAME SIZE, PRESSURE RATING AND SERVICE TYPE. DO NOT MIX RETAINER SEGMENTS AND RINGS FROM OTHER MANUFACTURERS WITHIN SPM® UNION CONNECTIONS.

- Unions should be visually inspected each time they are used. Any severe dents in the wing nut or union half caused by misdirected hammer blows should be ultrasonic checked or replaced before use. Rolled or worn threads may be unsafe and should be replaced.
- Unions showing signs of internal washing, corrosion, acid pitting, cracks or rust should be replaced.
- Weld repair is prohibited for unions.
- Sharp edges on the wing nut lug with a width of less than 1/4" as shown below should be taken out of service and discarded. Any measurements more then 1/4" meet the lug width requirement.

Figure 1: Wing Nut Lug Width should be discarded

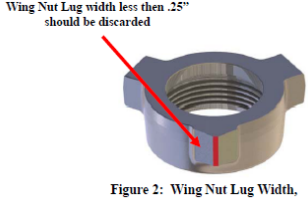
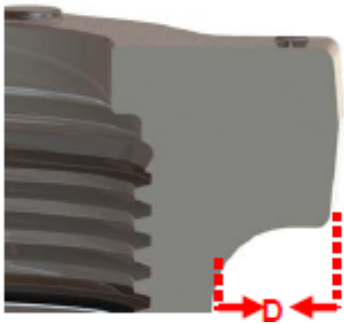


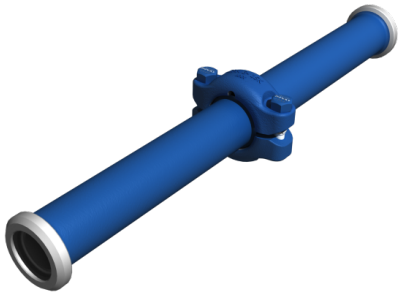
Figure 2: Wing Nut Lug Width, can be repaired

- On legacy (non-EXL) wing nuts, if the wing nut lugs measure less than half inch (1/2") as represented as "D" in Figure 3 it should be removed from service. If its height is greater than 1/2", then it has passed the lug height requirement.

Figure 3



SAFETY IRON®



SAFETY IRON® USE NOTES

- Weir recommends the use of a pneumatic impact wrench for primary assembly of all Safety Iron® connections. This wrench must be chosen to suit the torque requirements listed below and should have a minimum drive of 1/2". However, a 3/4" drive impact wrench is recommended for the larger 4" 15K Safety Iron® connection. If required, an adaptor can be incorporated to allow the use of larger size impact sockets.

SAFETY IRON® CONNECTION TORQUE VALUES

Size	Pressure Rating (psi)	Torque (ft-lbs)
2"	15K	180 +/- 50 ft lbs
3"	15K	350 +/- 50 ft lbs
4"	10K	350 +/- 50 ft lbs
4"	15K	700 +/- 50 ft lbs

- Weir recommends the use of a manual adjustable torque wrench to verify the proper torque has been applied. Also, while the iron is unpressurized, a visual inspection of the flow line should be performed to verify that all bolts are properly tightened. This can be achieved by performing a quick inspection of the line by feeling the underside of each clamp to verify the bolt is within 1/4" of the opening in the bottom threaded clamp.
- Always lubricate the threads before assembling the clamps. This will assist with proper torquing, and extend the life of the clamps and bolts.
- To help prevent unintentional impact damage to the clamp mating contact surfaces, Weir recommends that the upper and lower clamp halves be stored by threading the two halves together.
- The seal cavity on the flange must be protected from excessive wear or damage. This is no different than the requirements for hammer union seal pockets. To help maximize the life of the seal cavity, lubricate the seal ring during assembly and replace worn soft seals.

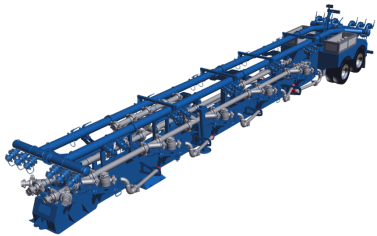
SAFETY IRON® MAINTENANCE NOTES

- Visually inspect the exterior of the clamp for deep gouges or cracks. If the gouge depth is greater than 1/8", the clamps must be discarded. If the gouge depth is less than 1/8" the clamp is acceptable to use. If any cracks are observed, the clamp must be discarded.
- Visually inspect mating contact surfaces on the clamp. Look for signs of impact damage that would obstruct the clamps from sliding over the flanges. If a raised surface exists due to a gouge, a grinder can be used to remove the excess material. The primary goal is to allow the mating clamp surface to freely slide over the bell of the flange. If the gouge depth is greater than 1/8", the clamps must be discarded. If the gouge depth is less than 1/8", the raised protrusion can be smoothed using a grinder. This will allow the product to be safely returned to service.
- Visually inspect the internal threads (located on the bottom threaded clamp) for broken or missing threads. If any obvious damage is observed, the clamp must be discarded.
- Visually inspect the backside of the flange for impact damage or gouges. To be a concern, the gouge must have created a protrusion of material, preventing the clamp from freely sliding over the flange. If the gouge depth is more than ¼", the component must be discarded. If the gouge depth is less than ¼", the raised protrusion can be smoothed using a grinder. This will allow the product to be safely returned to use. The main concern is that no "step" or obstruction exists on the flange that would cause the clamp to "hang-up" and not fully install.
- Visually inspect the front face of the flange for impact damage or gouges. To be a concern, the gouge must have created a protrusion, which would prevent the two mating flanges from being brought completely together. If the gouge depth is greater than ¼", the item must be discarded. If the gouge depth is less than ¼", the raised protrusion can be smoothed using a grinder. This will allow the product to be safely returned to use.
- Inspect the seal cavity for damage, including erosion, gouging, or deep scratches. If any damage is observed, the component must be discarded.
- Seal rings are considered consumable items and require

periodic inspection. Focus attention on the seal surfaces and through-bore. Common reasons for replacement include gouges, deep scratches, and erosion damage.

- Soft seals are considered expendable items and should be inspected during each assembly of the iron. If the seal appears questionable, it should be replaced. The maintenance for soft seals will be similar to hammer union seals.
- Potential bolt issues include galling of bolt threads due to over torquing or insufficient lubricant, crossing of threads which can be prevented by hand rotating the bolts one (1) full turn before applying pneumatic tool, and impact damage to the threads caused by misuse or improper storage.

SPM® MANIFOLD TRAILERS



Note: This document covers only the guidelines recommended for the operation and maintenance of manifold trailers manufactured by Weir.

SPM® MANIFOLD TRAILERS USE NOTES

- All SPM® Safety Iron® bolts should be assembled to the required torque settings. An application of torque seal on the head of each bolt will indicate that the correct torque was applied during the factory assembly process. It is recommended that the torque of each bolt be verified prior to each job.
- After the trailer is decoupled from the truck and prior to starting a job, the trailer's landing gear and suspension system MUST be adjusted. If an air suspension system is utilized, the suspension airbags must first be dumped of air pressure prior to operating the manifold trailer. The airbag dump and load button is typically located on the roadside rear or very rear of trailer and will be clearly labeled.
- After the airbags have been dumped, the landing gear can now be retracted. The landing gear must be fully retracted so that the bottom of each cylinder disc is approximately one to three inches OFF THE GROUND. The trailer must be fully supported by the foot pad during operation.
- **Caution: The landing gear system must only be used for loading and unloading the manifold trailer.**

!!WARNING!!

UTILIZING A MANIFOLD TRAILER DURING PUMPING OPERATIONS WHILE IT IS SUPPORTED ONLY BY THE LANDING GEAR MAY RESULT IN FAILURE OF THE LANDING GEAR, WHICH COULD RESULT IN SERIOUS BODILY INJURY, DEATH, OR PROPERTY DAMAGE..

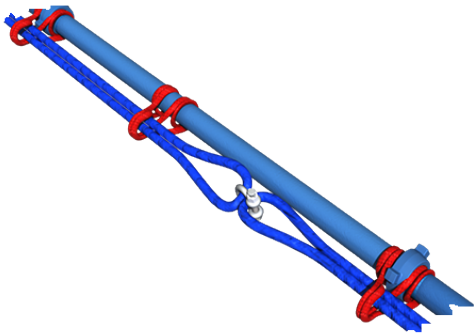
SPM® MANIFOLD TRAILERS MAINTENANCE NOTES

- The high pressure and low pressure components should be properly restrained by the U-bolts, or an approved alternative method, to the trailer frame and mounting brackets. Inspect and

confirm, that all U-bolts are tightened so the components are secured adequately.

- It is the recommendation of Weir that all customers flush out the suction assembly and discharge assembly with fresh water after each operation. This practice will help facilitate longer lasting performance of the manifold trailer and all iron components.
- It is recommended that a quarterly visual inspection be performed on the coiled springs to verify the versatility, performance, and multi-function characteristics of the isolator springs. Circumstances such as broken cable strands and/or badly separated strands may indicate the beginning failures of an isolator spring. In the event that broken cable strands and/or extreme separated strands are found at any time, that isolator spring should be replaced immediately.
- **Weir recommends biannual replacement of all isolator springs.** Refer to Engineering Bulletin 1662 for more information. This biannual (every two year) replacement program is to be performed on SPM® manifold trailers with wing mount designs only.
- For recommendations on replacement for trailers using other mounting configurations, contact SPM® Engineering.
- To easily identify when the biannual replacement of the springs has been performed at a Weir service facility, a new tag will be placed near the VIN plate. This will notify the end user when the next biannual replacement of the isolator springs is due. All springs should be replaced biannually, regardless if individual springs were replaced as a result of a prior quarterly inspection.

FSR



FSR USE NOTES

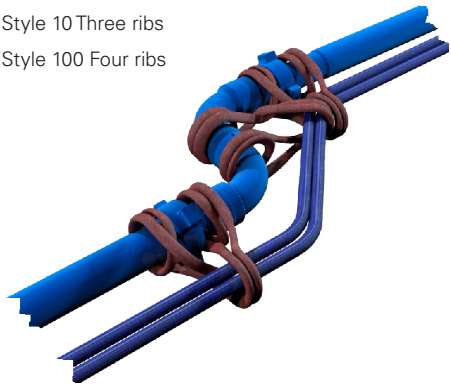
!!WARNING!!

DO NOT USE OR SUBSTITUTE NON-SPM® COMPONENTS AS REPLACEMENTS OR IN ADDITION TO SPM® FLOW LINE SAFETY RESTRAINT COMPONENTS. ONLY SPM® COMPONENTS MAY BE USED IN A SPM® FLOW LINE SAFETY RESTRAINT SYSTEM INSTALLATION.

- For specific information regarding the correct installation of an FSR system, please refer to the latest revision of the product's operations and maintenance manual.
- SPM® Flow Line Safety Restraint (FSR) components are not intended for individual use. SPM® FSR Ribs and Spines are not lifting devices and should never be used as such. Any Ribs or Spines that have been subjected to any loads should be immediately removed from service.
- SPM® FSR components 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 components need to be replaced immediately.
- Installation of individual SPM® FSR components as well as the system itself should be done by Weir personnel or persons qualified by Weir to do so.
- Prior to installation, confirm that the tag indicates the component has undergone inspection within the last year.
- After the complete SPM® FSR system is installed, confirm all SPM® FSR Ribs are securely installed around flow line components and that all main lines are secure around anchor points.
- SPM® FSR Ribs can NEVER be substituted for SPM® FSR Spines. SPM® Ribs are available in two lengths to allow for optimal fit during installation. SPM® Ribs may be linked together using a hitch knot to allow for attachment to larger, non-standard components.
- SPM® 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. The maximum rib spacing cannot exceed 10 ft.

- Most piping assemblies can be treated like other flow line components - with one SPM® FSR Rib installed on each union connection at each end. However, on piping assemblies 20 feet or longer, Weir requires that a third SPM® FSR Rib also be installed midway between the two union connections. This center Rib will not have the union connection to help prevent it from sliding, however, field testing has shown that this Rib will help provide extra support should a failure occur.
- Swivel assemblies should have SPM® FSR Ribs installed at each union connection and one additional Rib for each additional articulating joint (excluding the joint adjacent to each union connection). This will result in the following arrangement:
    - Style 50 Three ribs
    - Style 10 Three ribs
    - Style 100 Four ribs



- Every Spine-to-Spine link must be tight to establish an overall tight SPM® FSR main line installation. This linking procedure generally applies only to SPM® FSR Spines. However, SPM® FSR Ribs can be linked in the same manner if a single Rib is too short to encircle a larger component.
- SPM® FSR Spines are rated at over twice the strength of SPM® FSR Ribs. Spines and Ribs should NEVER be linked together. SPM® FSR Ribs are NEVER to be substituted for SPM® FSR Spines.
- Run linked Spines parallel down the main line and not twist or be wrapped around the flow line.
- Weir requires that the anchor location selected for terminating the FSR be capable of resisting the maximum shock load generated by the iron separation. This value is a function of the inner diameter of the flow iron, the length of the continuous spine, and the maximum fluid pressure. Review the FSR operations and maintenance manual for appropriate anchor load ratings.

FSR MAINTENANCE NOTES

- Over time, due to the nature of their handling and use in the field, SPM® Flow Line Safety Restraint Ribs and Spines may become worn or damaged. Therefore, it is critical that they are regularly inspected for noticeable damage, and are required to undergo an annual inspection performed by SPM® personnel. In addition, the regular inspection process includes a visual inspection of the restraints prior to installation on every job.
- Finalization of the annual inspection process requires "punching" the identification tag to indicate the quarter and year in which the inspection was completed.
- SPM® FSR components generally do not require any special maintenance to keep them in service. Even though they are water resistant, the components 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 with a clean, dry cloth.
- It is recommended to store SPM® FSR components and associated equipment in a dry place. However, exposure to water will not reduce the load capacity of the components; it

will only make them slightly heavier.

- The sheath plays an important role in protecting the critical load bearing core from degradation. Any visible sign of physical damage or wear may indicate that the integrity of the load bearing core has been compromised. In addition, the outer sheath is designed to tear if the restraint has been exposed to any significant loading. Therefore, any overload of the restraint will result in a damaged outer sheath.
- The following is a list of visual criteria used to assess the suitability of the FSR component for additional use:
    - Any damage to the SPM® FSR cover where internal red-striped white core yarns are exposed (This includes cuts, holes, tears, snags, abrasions or other damage to cover).
    - The FSR tag is missing or has become illegible.
    - Knots or other modifications to any part of the FSR.
    - Melting, charring, or other indications of excessive heat to any part of the SPM® FSR.
    - Acid, caustic burns or other signs of chemical deterioration to the SPM® FSR.
    - Any SPM® FSR that has been stretched beyond its original design length or deformed or otherwise misshapen.
    - Any other visible damage which causes doubt as to the strength of the SPM® FSR.


Examples of damaged FSR components

- Ribs and Spines cannot be repaired and any SPM® FSR component that exhibits a damaged or worn outer sheath is considered unacceptable and should be discarded immediately. Failure to follow this policy may result in the component failing prematurely and not meeting design intent.
- SPM® FSR 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), the affected equipment needs to be replaced immediately.
- The SPM® FSR Spines and Ribs are designed so failures are normally visible. If there are any signs of damage, the affected components must be replaced.
- Upon removal, note the serial number for your records, cut the restraint in half, remove the tag, and discard.
- Any FSR component should be removed from service five (5) years after commission.

GENERAL FLOW LINE INSTALLATION RECOMMENDATIONS

!!WARNING!!

THE FOLLOWING INFORMATION IS GIVEN IN GOOD FAITH AND SHOULD AID IN THE SAFE USE OF YOUR SPM® PRODUCTS. THIS INFORMATION IS NOT MEANT TO REPLACE EXISTING COMPANY'S SAFETY POLICIES OR INSTALLATION PRACTICES. YOU SHOULD NOT USE ANY SPM® PRODUCT UNLESS YOU HAVE KNOWLEDGE OF AND UNDERSTAND ITS SAFE USE, MAINTENANCE, AND PROPER HANDLING PROCEDURES. FOR ADDITIONAL INFORMATION NOT COVERED IN THIS DOCUMENT, PLEASE CONTACT SPM® ENGINEERING.

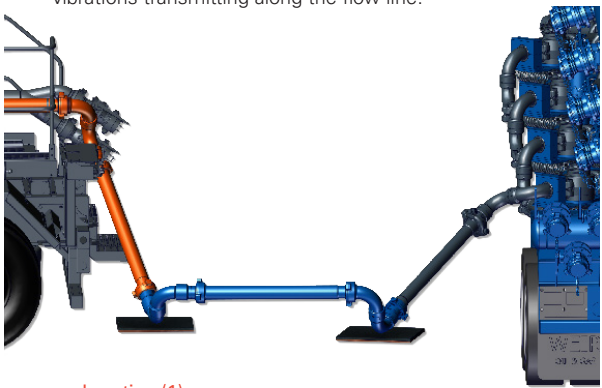
PUMP UNIT TO MANIFOLD TRAILER HIGH PRESSURE INLET

During fracturing operations, there is a significant amount of vibration that occurs between the manifold trailer and connected fracturing pumps. This large amount of vibration can harm the connected flow iron over time, leading to fatigue cracking, leaks and potential flow iron rupture.

To minimize the effects of vibration, Weir recommends the following installation configurations:

1. Make certain the flow iron between the pump truck and manifold trailer is positioned on the ground. This will result in the following benefits:
    - Iron in contact with the ground provides additional dampening effects
    - Protecting against additional side loading due to additional weight of un-supported iron

2. Weir suggests that one style 50 swivel (location 1) and one style 10 (location 2) swivel are employed to connect a manifold trailer to a frac pump trailer. It is also recommended that pads are placed underneath each swivel, where it may touch the ground, to reduce the chance of wear. This configuration will maximize the degrees of freedom during operations; therefore allowing the swivel to dampen vibrations transmitting along the flow line.



Location (1)

Location (2)

Note: Images are for illustrative purposes only. End user is responsible for determining the appropriate configuration for its own application.

IRON MOUNTING ON FIXED APPLICATIONS

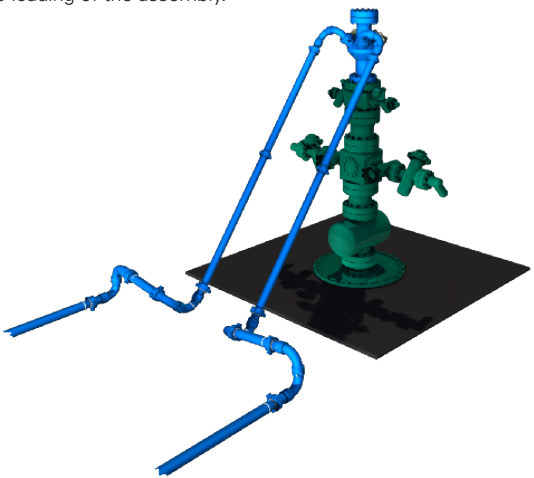
- One of the primary causes of hammer union failures are fatigue cracks which develop from excessive vibration and side loading. This phenomenon may occur in harsh operating environments if not properly addressed. Continual side loads paired with the pulsations produced during pumping operations can create significant levels of stress on these connections. Consequently, fatigue crack formations may develop at either the male or female end connections, which can propagate axially and lead

to an unexpected separation. Weir has identified some best assembly practices to reduce the likelihood of fatigue cracks.

- Iron mounted on fixed applications should be supported to protect against side loads. Swivels can assist with getting the high pressure piping to the ground to maximize the dampening effect the ground will offer.
- Swivel joints should be used in areas of high vibration so that the planes of articulation (degrees of freedom) are aligned with the plane of vibration. This helps vibration to be dampened by the movement of the swivel joint.
- Avoid hanging heavy weight off of hard mounted connections. The pulsations of the system could create vibrations which may lead to cyclical loading.
- The use of vibration dampening springs is beneficial to reduce stress on iron components and should be used to support fabricated features on fixed applications.

WELLHEAD TO GROUND IRON

Weir suggests the use of a Style 50 swivel at the wellhead connection, and a style 10 swivel on the ground connected to the piping coming off the wellhead. The line from swivel to ground should be placed at an angle of 35° (+/- 5°). This will help reduce side loading of the assembly.



Note: Images are for illustrative purposes only. End user is responsible for determining the appropriate configuration for its own application.

GROUND IRON

- Straight piping can be run for the appropriate length from the manifold trailer to the zipper manifold or riser to the wellhead.

- Additional swivels can be used to change direction of the flow lines, though when laying out the well site, straight runs of pipe are best practice. Swivels should primarily be used for dropping iron from manifold trailer outlet to ground and from the bottom of the risers to the top of the wellhead.

SERVICE AND SUPPORT

SERVICE CENTER ORDER INFORMATION

Weir stocks a large inventory of genuine original SPM® equipment replacement parts. In order to expedite a parts order and minimize any delays, please provide the following information with your order:

- The part number and description (refer to drawings and parts lists in this section) of each item ordered.
- The quantity of each part, kit, or assembly ordered.
- The model number and serial number.
- Your purchase order number.
- Specify method of shipment, complete shipping address, complete billing address and telephone number at the destination of the shipment.

HEADQUARTERS

601 Weir Way, Fort Worth, TX 76108
Ph: +1-800-342-7458 | Fax: +1-817-977-2508

Please refer to the Weir Oil & Gas website for global locations

www.global.weir

NOTES

Oil & Gas

www.global.weir
1.800.342.7458

Document P/N:2P42611
Release Date: 10/18/2016
Revision: A | Date: 10/18/2016

Copyright © 2016, S.P.M. Flow Control, Inc.. All rights reserved. S.P.M. Flow Control, Inc. is the owner of the copyright and all confidential information in this document, which must not be copied in whole or in part, in any form or by any means, and the information in it must not be used for any purpose other than the specific purpose for which it has been provided without the prior written consent of the copyright owner. SPM, SAFETY IRON, SAFETY HAMMER, SUR-DROP, DESTINY, STAMPEDE, DURALAST and GLADIATOR are trademarks and/or registered trademarks of S.P.M. Flow Control, Inc.. WEIR and WEIR (logo) are trademarks and/or registered trademarks of Weir Engineering Services Limited. Certain features of some of the products disclosed in this document may be protected worldwide by patents pending and registered in the name of S.P.M. Flow Control, Inc..