

DECLARATION OF NATHANIEL E FRANK-WHITE

1. I am a Records Request Processor at the Internet Archive. I make this declaration of my own personal knowledge.
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3. The Internet Archive has created a service known as the Wayback Machine. The Wayback Machine makes it possible to browse more than 450 billion pages stored in the Internet Archive's web archive. Visitors to the Wayback Machine can search archives by URL (i.e., a website address). If archived records for a URL are available, the visitor will be presented with a display of available dates. The visitor may select one of those dates, and begin browsing an archived version of the Web. Links on archived files in the Wayback Machine point to other archived files (whether HTML pages or other file types), if any are found for the URL indicated by a given link. For instance, the Wayback Machine is designed such that when a visitor clicks on a hyperlink on an archived page that points to another URL, the visitor will be served the archived file found for the hyperlink's URL with the closest available date to the initial file containing the hyperlink.
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5. The Internet Archive assigns a URL on its site to the archived files in the format `http://web.archive.org/web/[Year in yyyy][Month in mm][Day in dd][Time code in hh:mm:ss]/[Archived URL]` aka an "extended URL". Thus, the extended URL `http://web.archive.org/web/19970126045828/http://www.archive.org/` would be the URL for the record of the Internet Archive home page HTML file (`http://www.archive.org/`) archived on January 26, 1997 at 4:58 a.m. and 28 seconds (1997/01/26 at 04:58:28). The date indicated by an extended URL applies to a preserved instance of a file for a given URL, but not necessarily to any other files linked therein. Thus, in the case of a page constituted by a primary HTML file and other separate files (e.g., files with images, audio, multimedia, design elements, or other embedded content) linked within that primary HTML file, the primary HTML file and the other files will each have their own respective extended URLs and may not have been archived on the same dates.
6. Attached hereto as Exhibit A are true and accurate copies of screenshots of the Internet Archive's records of the archived files for the URLs and the dates specified in the attached coversheet of each printout.



7. Attached hereto as Exhibit B are true and accurate copies of the Internet Archive's records of the archived files for the URLs and the dates specified in the attached coversheet of each file.
8. I declare under penalty of perjury that the foregoing is true and correct.

DATE: September 20, 2022

Nathaniel E Frank-White
Nathaniel E Frank-White

EXHIBIT A

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Weir Oil & Gas Division provides superior solutions to Oil & Gas Companies in upstream, production, transportation, refining and related industries. Upstream products include well service & stimulation pressure pumping and flow control products from **Weir SPM** and **Weir Mesa**. Downstream products include API 610 centrifugal pumps and spare parts for refining and petrochemical industries from **Weir Gabbioneta**. Engineered mechanical and rotating equipment repairs and upgrades, oilfield and drilling equipment repair and certification, *Advanced Parts Solutions* (APS) including robust asset management and field engineering services are delivered globally by **Weir Oil & Gas Services**.

Drilling & well service »



Production & transportation »



Refining & petrochemical »



Power generation »



General industry »



Water and waste water »



Complete brand range

WEIR GABBIONETA Weir Gabbioneta



Weir Gabbioneta, established in 1897 as Pompe Gabbioneta, is a leading Italian company that has been manufacturing process pumps for the last three decades. Over the years our pumps have evolved from water wells to heavy duty (API 610) process applications and from single machines to complex packaged equipment, in line with the requirements of the Oil & Gas Refinery, petrochemical and power generation industries.

Learn more

WEIR MESA Weir Mesa



Weir Mesa has been providing reliable oilfield products to the industry for over 30 years. Recently acquired by The Weir Group, Weir Mesa expands the division's product portfolio through its offering of high quality cement heads, frac heads and flow control products. Weir Mesa also provides customers the chance to rework its worn or damaged pump plunger inventory through the company's plunger repair services.

Learn more

WEIR SPM Weir SPM



Weir SPM is a market leader in well service pumps and high pressure flow control equipment. Weir SPM's line of reciprocating plungers pumps are used in various applications including cementing, acidizing, and fracturing. The expanding flow control product line features products used to safely transport fluids at high pressure into the wellbore during various well service applications. Weir SPM also utilizes a global network of service facilities to provide superior post-sale services to our customers.

Learn more

WEIR OIL & GAS SERVICES Weir Oil & Gas Services



Weir Oil & Gas Services is the market leader in offering comprehensive engineering services to various industry segments including Oil & Gas, Power, Water and Petrochemical. Equipped with a wide range of modern machine tools and staffed with experienced personnel, Weir Oil & Gas Service division is capable to work on a wide variety of equipment, such as oilfield equipment, pumps, electric motors, turbines, compressors, valves and desalination plants.

Learn more

Service centre locations



Find your local service centre SELECT A REGION

Trade shows

Click to view the Weir Oil & Gas trade show calendar

News centre

28 Oct 2009 : Forth Worth, Texas
Weir SPM Wins Prestigious Award

26 Aug 2009 : New Zealand
Flow Line Safety Restraint training in New Zealand

26 Aug 2009 : Dubai
Major Oil Refinery contract in Dubai

26 Aug 2009 : Baku, Azerbaijan
Multiple awards for Weir SOS

26 Aug 2009 : Deer Park
Rapid repairs for vital pipeline

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Wesco Abu Dhabi
Amco Weir KSA
Weir Services Baku
Weir SOS Baku

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Product Spotlight

Weir SPM Flow Line Safety Restraint System

Weir SPM's Flow Line Safety Restraint System, or FSR, is the first engineered restraint system of its kind designed to increase safety by greatly reducing the area of danger around a high pressure flow line rupture.



Click here to learn more about the Flow Line Safety Restraint System



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- Oil & Gas Services

WEIR SPM

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Drilling Valves

Weir SPM Drilling Valves
Full Bore Unloading Valve



Weir SPM Services

Weir SPM Services
Iron Rental
Fluid End Repair
Mobile Recertification Units (MRU)
Iron Recertification
Pump Repair



Well Service Flow Line & Valve

Well Service Flow Line & Valves
Hammer Unions
Integral Connections
Choke Valve
Manifolds
Hose Loops
Plug Valves
Ball Injector
Swivels
Butterfly Valves
Gauge Kits
Relief Valves
Check Valves
Flow Line Pipe



Well Service Safety Products

Well Service Safety Products
Safety Iron™ Manifold Trailer
Flow Line Safety Clamps
Flow Line Safety Restraint System
Safety Iron™
Safety Hammer



Well Service-Stimulation Pumps

Well Service-Stimulation Pumps
Pump Monitoring Device (PMD)
Extended Duty Pumps
Other Intermittent Duty Pumps
QWS 1000S
TWS 2250
QWS 2500 Classic
TWS 600S
QWS 2500SD
Grooveless Fluid End
QWS 3500



Weir SPM contacts

Tel 817-246-2461
Fax 817-246-6324
Email Weir SPM

Regional emails

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Well Service Safety Products
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Production & transportation

Refining & petrochemical

Power generation

General industry

Water and waste water

Upstream drilling and well completion consists of the processes utilized to drill for and enhance the capture of hydrocarbons. This market segment is serviced through the Weir SPM, Weir Mesa, and Weir Oil & Gas Services brands.

Amco Weir Services KSA



Engineering Services
Weir offers a wide variety of diagnostic and analytical services to quickly and effectively get to the Root Cause of your rotating machinery problem



Tubulars, Pipe Threading & Premium Connections
Threading and repairs of Tubulars and pup joints Installation or removal of couplings. Fully licensed to recut & repair Premium Connections.



API Oilfield Components
Manufacturing, repair and refurbishment of Oilfield Equipment including DSA's, Crossovers, Weldneck Flange, Flange X WECO Adaptor & etc.



General Machining
Our workshop is equipped with a wide range of modern tools to undertake work on a wide variety of industrial equipment



BOP repair & certification
Weir is specialized in remanufacture, repair and recertification of Annular and Ram Type Blow Out Preventors



Wireline Tools
Our wireline tools are manufactured to suit our customers particular requirements and have been well proven in the field, especially with Aramco wireline departments.



Field Services
Weir offers a wide variety of engineering field services including: Field troubleshooting, Machinery diagnostics, Installation, Commissioning and start-up supervision

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Service centre locations



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Product Literature
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Drilling Valves



Full Bore Unloading Valve
The Unloading Valve provides over-pressure protection for pumps.

Frac & Cement Heads



Cement Head
Featuring single or double plug head designs and easy-to-attach landing joints, Weir Mesa cement heads perform with consistency and reliability in the field.



Frac Head
Weir Mesa manufactures two styles of high-pressure frac heads that can be tailored to meet customer preferred specifications.

Manifold Trailer



Safety Iron™ Manifold Trailer
Weir SPM Safety Iron™ Manifold Trailers provides the market with a unique trailer design that utilizes field proven, robust Safety Iron™ flow control products.

Power Transmission Drawworks



Drawworks
Weir Mesa offers a line of drawworks in various horsepower ratings designed for reliable service in multiple rig sizes.

Weir Dubai Services

Engineering Services
Weir offers a wide variety of diagnostic and analytical services to quickly and effectively get to the Root Cause of your rotating machinery problem



Wellhead Auxiliary Repair & Upgrade
Weir Services overhaul, repair and



and analytical services to quickly and effectively get to the Root Cause of your rotating machinery problem



Field Services
Weir offers a wide variety of engineering field services including: Field troubleshooting, Machinery diagnostics, Installation, Commissioning and start-up supervision



Customer Training
We deliver technical training programs to meet your specific educational requirements in various areas including Rotating equipment, Mechanical, hydraulic, process, materials, design studies & etc



BOP Repair & Certification
Weir is specialized in remanufacture, repair and recertification of Annular and Ram Type Blow Out Preventors



upgrade a wide range of Wellhead Equipment including BOP Control system & Choke & Kill & Cement Manifolds



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Threading and repairs of Tubulars and pup joints Installation or removal of couplings. Fully licensed to recut & repair Premium Connections.



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Weir Edmonton Services



General Machining
Our workshop is equipped with a wide range of modern tools to undertake work on a wide variety of industrial equipment



Reciprocating Pump Fluid End Repair
Now, all customers will have the opportunity to evaluate the status of their fluid cylinders and have options of whether to replace or refurbish.

Weir Houston Services



Recip Pump & Fluid End Repair
Reciprocating Pump Repair for well stimulation and well service applications



Customer Training
We deliver technical training programs to meet your specific educational requirements in various areas including Rotating equipment, Mechanical, hydraulic, process, materials, design studies & etc



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Engineering Services
Weir offers a wide variety of diagnostic and analytical services to quickly and effectively get to the Root Cause of your rotating machinery problem

Weir SPM Services



Mobile Recertification Units (MRU)
Weir SPM brings convenient and reliable iron recertification services to the customer's location through its fleet of Mobile Recertification Units.



Iron Recertification
Weir SPM offers reliable iron recertification services through its network of service facilities and Mobile Recertification Units.



Pump Repair
Weir SPM provides pump repair procedures designed to extend the life of customers' pumps and return their units to the field quickly.



Fluid End Repair
Weir SPM provides fluid end repair services designed to allow customers to extend the life of worn fluid ends instead of scrapping them.



Plunger Repair Services
Weir Mesa offers plunger repair services as a less expensive alternative to replacing damaged inventories.



Iron Rental
Weir SPM offers convenient iron rental packages for both onshore and offshore applications.

Well Service Flow Line & Valve



Butterfly Valves
Weir SPM Butterfly Valves utilize features that make them the most reliable products of their kind. Available in sizes ranging from 3 inches to 12 inches.



Check Valves
Weir SPM offers a wide range of high pressure check valves including top-load clapper, dart and CO2 styles.



Gauge Kits
Weir SPM Gauge Kits are ideal tools used in the recertification of flow control components.



Hose Loops
Hose loops are used in well service applications: discharge and water lines, cementing and circulating lines, well test lines and temporary flow lines.



Flow Line Pipe
Weir SPM offers high pressure flow line piping in various sizes and pressure ratings, as well as configurations including butt-weld, NPS, and integral.



Relief Valves
Weir SPM's line of relief valves are available in sizes ranging from 2" to 4" and are offered in spring actuated or nitrogen actuated models.



Ball Injector
Weir SPM's Sur-Drop Ball Injectors feature the "positive feed system" for reliable ball release, and availability in several ball sizes.



Plug Valves
Weir SPM offers a range of plug valves from 1" to 4" in various pressure ratings. The newest offering is a SP150 3" Manual Actuated Plug Valve.



Swivels
Weir SPM's improved 3" Fig. 1502 and 4" Fig. 1002 LR Swivel Joints are designed and manufactured to produce an extended life expectancy.



Manifolds
Weir SPM offers multiple designs of flow-thru manifolds, as well as pump discharge manifolds (including Safety Iron™ models).



Integral Connections
Weir SPM offers a wide range of high pressure integral connections including tees, wyes, eles, crosses, crossovers, integrals, and more.



Choke Valve
Weir SPM offers choke tees for use primarily in manifold configurations as well as in stand alone operation.



Hammer Unions
Weir SPM hammer unions are available in sizes and pressures to 20,000 psi. They provide positive sealing in standard service and sour gas models.

Well Service Safety Products



Flow Line Safety Restraint System
Weir SPM's Flow Line Safety Restraint System provides a safer environment in case of flow line rupture or disengagement of a flow line while under pressure.



Safety Iron™
Weir SPM Safety Iron™ is a unique and superior performing alternative to hammer union connections that is more resistant to vibration.



Safety Hammer
Weir SPM's Safety Hammer™ is a pneumatic tool used to quickly make up, or break out, hammer union connections on site.



Flow Line Safety Clamps
Weir SPM Flow Line Safety Clamps provide increased safety during flow line ruptures in lower pressure applications.

Well Service-Stimulation Pumps



Other Intermittent Duty Pumps
Weir SPM offers several intermittent duty pump models in addition to its more commonly sold line of pump models. Their applications vary from cementing and acidizing to fracturing.



QWS 1000S
1000hp well service pump. Applications: Acidizing, cementing, gravel packing, snubbing.



QWS 2500SD
2500hp well service pump. Application: Fracturing.



Pump Monitoring Device (PMD)
Weir SPM's Pump Monitoring Device is designed to give users detailed information on the operation of their pumps in real time.



QWS 3500
3,500hp well service pump. Applications: Fracturing.



TWS 600S
600hp well service pump. Applications: Acidizing, cementing, gravel packing, snubbing.



Extended Duty Pumps
Weir SPM also offers a wide range of extended duty pump for a variety of service applications.



QWS 2500 Classic
2500hp well service pump. Application: Fracturing.



TWS 2250
2250hp well service pump. Application: Fracturing.



Grooveless Fluid End
Weir SPM has developed the Grooveless Fluid End for increased fluid cylinder life expectancy during harsh environment pumping operations.

Wesco Abu Dhabi Services



Tubulars, Pipe Threading & Premium Connections
Threading and repairs of Tubulars and pup joints. Installation or removal of couplings. Fully licensed to recut & repair Premium Connections.



Valve Repair
Repair and remanufacture of High Pressure Gate Valves in full accordance with the requirements of API Specifications 6A.



Electric Motors
Weir Offers High Voltage, Medium Voltage



Wellhead Auxiliary Repair & Upgrade
Weir Services overhaul, repair and upgrade a wide range of Wellhead Equipment including BOP Control system & Choke & Kill & Cement Manifolds.



Engineering Services
Weir offers a wide variety of diagnostic and analytical services to quickly and effectively get to the Root Cause of your rotating machinery problem



BOP Repair & Certification
Weir is specialized in remanufacture, repair and recertification of Annular and Ram Type Blow Out Preventors



API Oilfield Components
Manufacturing, repair and refurbishment of Oilfield Equipment including DSA's, Crossovers, Weldneck Flange, Flange X WECCO Adaptor & etc.



General Machining
Equipped with a wide range of modern tools to undertake work on a wide variety of industrial equipment



Field Services
Weir offers a wide variety of engineering field services including: Field troubleshooting, Machinery diagnostics, Installation, Commissioning and start-up supervision



and Low voltage motor rewinding and overhaul with trained personnel and full rewinding and repair facilities.

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Weir SPM Services
Well Service Flow Line & Valve
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Amco Weir Services KSA



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Tubulars, Pipe Threading & Premium Connections
Threading and repairs of Tubulars and pup joints Installation or removal of couplings. Fully licensed to recut & repair Premium Connections.



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Wireline Tools
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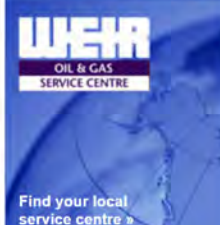


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Drilling Valves



Full Bore Unloading Valve
The Unloading Valve provides over-pressure protection for pumps.

Frac & Cement Heads



Cement Head
Featuring single or double plug head designs and easy-to-attach landing joints, Weir Mesa cement heads perform with consistency and reliability in the field.



Frac Head
Weir Mesa manufactures two styles of high-pressure frac heads that can be tailored to meet customer preferred specifications.

Manifold Trailer



Safety Iron™ Manifold Trailer
Weir SPM Safety Iron™ Manifold Trailers provides the market with a unique trailer design that utilizes field proven, robust Safety Iron™ flow control products.

Power Transmission Drawworks



Drawworks
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Weir Dubai Services

Engineering Services
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Wellhead Auxiliary Repair & Upgrade
Weir Services overhaul, repair and



and analytical services to quickly and effectively get to the Root Cause of your rotating machinery problem



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Weir Edmonton Services



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Reciprocating Pump Fluid End Repair
Now, all customers will have the opportunity to evaluate the status of their fluid cylinders and have options of whether to replace or refurbish.

Weir Houston Services



Recip Pump & Fluid End Repair
Reciprocating Pump Repair for well stimulation and well service applications

Weir SOS Services



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Engineering Services
Weir offers a wide variety of diagnostic and analytical services to quickly and effectively get to the Root Cause of your rotating machinery problem

Weir SPM Services



Mobile Recertification Units (MRU)
Weir SPM brings convenient and reliable iron recertification services to the customer's location through its fleet of Mobile Recertification Units.



Iron Recertification
Weir SPM offers reliable iron recertification services through its network of service facilities and Mobile Recertification Units.



Pump Repair
Weir SPM provides pump repair procedures designed to extend the life of customers' pumps and return their units to the field quickly.



Fluid End Repair
Weir SPM provides fluid end repair services designed to allow customers to extend the life of worn fluid ends instead of scrapping them.



Plunger Repair Services
Weir Mesa offers plunger repair services as a less expensive alternative to replacing damaged inventories.



Iron Rental
Weir SPM offers convenient iron rental packages for both onshore and offshore applications.

Weir Service Flow Line & Valve



Butterfly Valves
Weir SPM Butterfly Valves utilize features that make them the most reliable products of their kind. Available in sizes ranging from 3 inches to 12 inches.



Check Valves
Weir SPM offers a wide range of high pressure check valves including top-load clapper, dart and CO2 styles.



Gauge Kits
Weir SPM Gauge Kits are ideal tools used in the recertification of flow control components.



Hose Loops
Hose loops are used in well service applications: discharge and water lines, cementing and circulating lines, well test lines and temporary flow lines.



Flow Line Pipe
Weir SPM offers high pressure flow line piping in various sizes and pressure ratings, as well as configurations including butt-weld, NPS, and integral.



Relief Valves
Weir SPM's line of relief valves are available in sizes ranging from 2" to 4" and are offered in spring actuated or nitrogen actuated models.



Ball Injector
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Plug Valves
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Swivels
Weir SPM's improved 3" Fig. 1502 and 4" Fig. 1002 LR Swivel Joints are designed and manufactured to produce an extended life expectancy.



Manifolds
Weir SPM offers multiple designs of flow-thru manifolds, as well as pump discharge manifolds (including Safety Iron™ models).



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Choke Valve
Weir SPM offers choke tees for use primarily in manifold configurations as well as in stand alone operation.



Hammer Unions
Weir SPM hammer unions are available in sizes and pressures to 20,000 psi. They provide positive sealing in standard service and sour gas models.

Well Service Safety Products



Flow Line Safety Restraint System
Weir SPM's Flow Line Safety Restraint System provides a safer environment in case of flow line rupture or disengagement of a flow line while under pressure.



Safety Iron™
Weir SPM Safety Iron™ is a unique and superior performing alternative to hammer union connections that is more resistant to vibration.



Safety Hammer
Weir SPM's Safety Hammer™ is a pneumatic tool used to quickly make up, or break out, hammer union connections on site.



Flow Line Safety Clamps
Weir SPM Flow Line Safety Clamps provide increased safety during flow line ruptures in lower pressure applications.

Well Service-Stimulation Pumps



Other Intermittent Duty Pumps
Weir SPM offers several intermittent duty pump models in addition to its more commonly sold line of pump models. Their applications vary from cementing and acidizing to fracturing.



QWS 1000S
1000hp well service pump. Applications: Acidizing, cementing, gravel packing, snubbing.



QWS 2500SD
2500hp well service pump. Application: Fracturing.



Pump Monitoring Device (PMD)
Weir SPM's Pump Monitoring Device is designed to give users detailed information on the operation of their pumps in real time.



QWS 3500
3,500hp well service pump. Applications: Fracturing.



TWS 600S
600hp well service pump. Applications: Acidizing, cementing, gravel packing, snubbing.



Extended Duty Pumps
Weir SPM also offers a wide range of extended duty pump for a variety of service applications.



QWS 2500 Classic
2500hp well service pump. Application: Fracturing.



TWS 2250
2250hp well service pump. Application: Fracturing.



Grooveless Fluid End
Weir SPM has developed the Grooveless Fluid End for increased fluid cylinder life expectancy during harsh environment pumping operations.

Wesco Abu Dhabi Services



Tubulars, Pipe Threading & Premium Connections
Threading and repairs of Tubulars and pup joints. Installation or removal of couplings. Fully licensed to recut & repair Premium Connections.



Valve Repair
Repair and remanufacture of High Pressure Gate Valves in full accordance with the requirements of API Specifications 6A.



Electric Motors
Weir Offers High Voltage, Medium Voltage



Wellhead Auxiliary Repair & Upgrade
Weir Services overhaul, repair and upgrade a wide range of Wellhead Equipment including BOP Control system & Choke & Kill & Cement Manifolds.



Engineering Services
Weir offers a wide variety of diagnostic and analytical services to quickly and effectively get to the Root Cause of your rotating machinery problem



BOP Repair & Certification
Weir is specialized in remanufacture, repair and recertification of Annular and Ram Type Blow Out Preventors



API Oilfield Components
Manufacturing, repair and refurbishment of Oilfield Equipment including DSA's, Crossovers, Weldneck Flange, Flange X WECCO Adaptor & etc.



General Machining
Equipped with a wide range of modern tools to undertake work on a wide variety of industrial equipment



Field Services
Weir offers a wide variety of engineering field services including: Field troubleshooting, Machinery diagnostics, Installation, Commissioning and start-up supervision



and Low voltage motor rewinding and overhaul with trained personnel and full rewinding and repair facilities.

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TWS 2250

The TWS 2250 is the most powerful triplex in Weir SPM's line of well service pumps. This staple of the Weir SPM line of well service pumps offers great pressure and flow ratings in a smaller package than the large quintuplex pumps offered by Weir SPM.



Applications: Fracturing

OTHER RELATED ITEMS

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TWS 2250

Rated Max Brake HP: 2,250 BHP (1,641 Kw)
Maximum Rod Load: 225,000 Lbs. (102,060 kg)
Stroke Length: 8" (203.2 mm)
Gear Ratio: 6.353:1
Length: 89-3/4" (2,280 mm)
Width: 59-3/4" (1,518 mm)
Height: 44-1/4" (1,124 mm)
Weight Dry (Approx.): 12,680# (5,751 kg)

Pump dimensions are approximate. For full detailed drawings, please contact Weir SPM Engineering.

Click an image to enlarge

TWS 2250

TWS 2250 Performance Curve

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Applications: Fracturing

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Drilling Motors - Sales, Service and Repair

AC and DC Top Drive Motors

Drawworks Motors

Rotary Table Motors

Mud Pump Motors

Anchor Windlass Motors

GE High-Torque 1130 HP Drilling Motors

Single or Double Shaft Extension Units

Converted Traction Frame or Original Factory Frame

Shunt or Series Wound

AC Motors for Pump, Mixers or Shakers

Dominator AC vector heavy duty motors.

Electric Motor Replacement Parts

Complete Armature Assemblies

Series Wound Field Coils

Shunt Wound Field Coils

Interpoles

Frameheads (Endbells)

Bearings

Bearing Caps

Oilfield Hubs

Brush Holders

Brushes

Shaft Assemblies

Standard and XP heaters

Cooling Blowers and Accessories

Custom-made cooling blowers are designed to meet or exceed factory specifications and to operate on all drilling motors as direct mounted units.

Available in Stainless Steel

Motor sizes ranging from 5-25HP

Remote-mounted units available.

Filters for traction motors.

Pressurized Junction Boxes

New junction boxes are custom made to your specifications.

Fabricated from carbon steel or stainless steel

Constructed to fit GE 752, EMD79, Reliance SDR13, Toshiba DR900 drilling motors.

Bolt-on bus bar or Pyle-National receptacle

XP lockout device

XP pressure switch

Pyle-National 20-pin connector (pre-wired)

Factory terminal strip

Cord grips

Bolt-on covers
Removable covers on front and top
Marine style available
Primer coated or painted to customer specifications.

DREDGING



AC/DC Motors and Controls

- Clutter Winch

- Main Pumps

- Booster Pumps

COMPRESSOR DRIVES



AC Synchronous Motors

Synchronous Motor Starters

Variable Frequency Drives

DC Variable Speed Drives up to 6000 HP

CEMENT PRODUCTION



I.D. Fan Drives

- AC/DC variable speed drive motor and controls

Kiln Drives

LIBERTY EXHIBIT 1061

• Booster Pumps

- Spud Hoists
- Propulsion Systems
- Bow Thruster Systems
- Z Drive Motors (horizontal, vertical)

Automated Systems & Control Consoles
Main Generators and Controls
Emergency Generators and Controls
Switch Gear
Transformers

- AC/DC variable speed drive motor and controls

Ball Mill Drives

- AC/DC variable speed drive motor and controls

AC/DC Motors

AC/DC Motor Repairs

Motor Control Centers

Transformers

Switchgears

MARINE WORK BOATS



Propulsion Motors and Controls
Thruster Motors and Controls
Control Stations
Main Generators and Controls Panels
Switch Gear
Transformers

- Equipment built to A.B.S. and U.S. Coast Guard specifications.

PLASTICS AND RUBBER



AC Motors and Controls up to 15,000 HP
Pump Drives
Fan Drives
Mixer Drives
Compressor Drives
DC Motors and Controls up to 6,000 HP
Co-Generators and Controls
Transformers
Switch Gear
Motor Control Centers

PETROCHEMICAL



DC Motors and SCR Controls to 3,000 HP

- Mixer Drive Systems
- Extruder Drive Systems

Switch Gear

- Low, Medium and High Voltages

Motor Control Centers

- Low, Medium and High Voltages

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- Any KVA, any type and any voltage
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AC Drilling Motors

Introducing the "DOMINATOR"

The "DOMINATOR" AC motor is rated for 3000 continuous horsepower and is designed for Vector Duty.

The "DOMINATOR" motor is designed to provide superior performance for industrial applications such as Oilwell Drilling, Marine Propulsion, Dredging, Petrochemical, Mining, etc.

The "DOMINATOR" is offered in horsepower ranges starting at 800HP through 3000HP.

Our 1750HP is the largest motor with a conventional drilling motor foot print in the drilling industry. Verticle motors for top drives are available.

Design Features

- ✓ Superior cooling system, utilizing the AmeriMex "ELIMINATOR" Stainless Steel Blower
- ✓ Center Mounted Stainless Steel Junction Box, allows cable entry from both left and right sides and provides connection points for the Lockout Switch, Pressure Switch and RTD's. The Junction Box is rated IP56
- ✓ The "DOMINATOR" shaft and mounting dimensions are interchangeable with the most common drilling motors in the industry
- ✓ Motor enclosure can be horizontally or vertically mounted and is rated IP44
- ✓ ATEX Certified EEXE by Sira
- ✓ ABS Certified
- ✓ Temperature rating 145°C (293°F) rise at 45°C (113°F) ambient (ATEX Rating)
- ✓ Form Wound 6-Pole Stator with vented laminations for superior cooling
- ✓ Copper Rotor Bars and End Rings
- ✓ V.P.I. System utilizing Class H insulation
- ✓ Windings are MICA Kapton wrapped
- ✓ Anti-friction Bearings for longer life
- ✓ Insulated Bearing Housing (no special bearing required)
- ✓ Drive End Bearing is designed for severe side loads
- ✓ Tapered and straight keyed shaft. Custom designs are available
- ✓ Single or double shaft extension available
- ✓ Six 100Ω platinum RTD's, two per phase, embedded in stator
- ✓ Anti-condensation space heater
- ✓ Encoder (optional)
- ✓ Closed loop cooling (optional)
- ✓ Spark Arrestor (optional)
- ✓ Weight approximately 8500 lbs for 1150HP.

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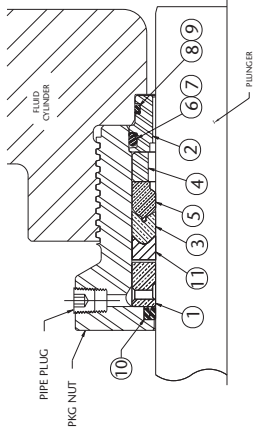
HIGH PERFORMANCE PACKING ASSEMBLY DRAWINGS AND PART NUMBERS

HIGH PERFORMANCE PACKING



ITEM	QTY	DESCRIPTION
11	1	PKG ADAPTER
10	1	WIPER RING
9	1	BACKLUP
8	1	O-RING
7	1	BACKLUP
6	1	O-RING
5	1	HEADER RING
4	1	SPACER RING
3	1	PRESSURE RING
2	1	SEAL RING
1	1	LANTERN RING

PACKING ASSEMBLIES WEIR SPM TWS 250



4"	3A10699ZHP
3 3/4"	3A106991HP
3 1/2"	3A106990HP
3"	3A106988HP
2 3/4"	3A106987HP
2 1/2"	3A106986HP
2"	3A106985HP
SIZE	COMPLETE ASSEMBLY

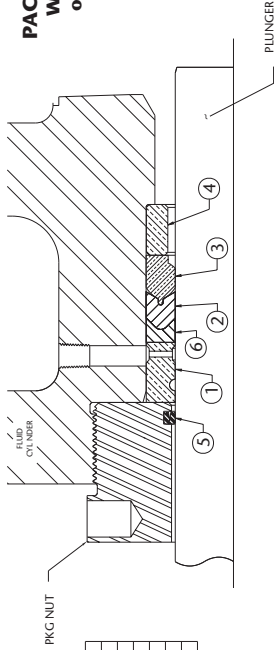
3A10699ZHP	SOFT PKG SET
3A106991HP	
3A106990HP	
3A106988HP	
3A106987HP	
3A106986HP	
3A106985HP	
COMPLETE ASSEMBLY	SOFT PKG SET

**SOFT PKG. SET INCLUDES
COMPONENTS #3, 5, 6, 7, 8, 9, 10 AND 11.
FOR CO2 SERVICE APPLICATIONS, SPECIFY
"CO2" AT THE END OF EACH PART NUMBER.**

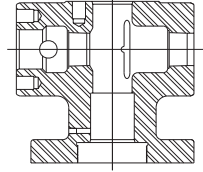
HIGH PERFORMANCE PACKING



6	1	PKG ADAPTER
5	1	WIPER RING
4	1	SPACER
3	1	HEADER RING
2	1	PRESSURE RING
1	1	LANTERN RING
ITEM	QTY	DESCRIPTION



PACKING ASSEMBLIES WEIR SPM TWS 400 or GEOQUIP LC350



**SOFT PKG. SET INCLUDES
COMPONENTS #2, 3, 5 AND 6.
FOR CO2 SERVICE APPLICATIONS, SPECIFY
"CO2" AT THE END OF EACH PART NUMBER.**

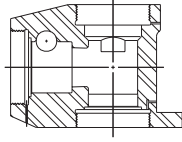
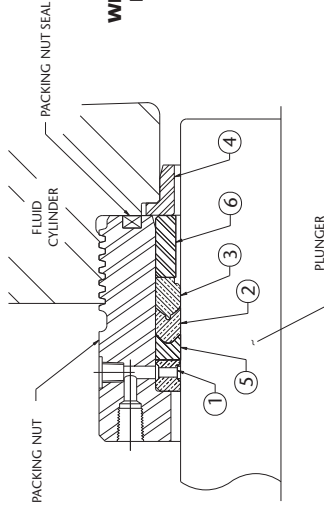
4 1/2"	3A10700ZHP
4"	3A107000HP
3 3/2"	3A107003HP
3"	3A106994HP
2 1/2"	3A106993HP
SIZE	COMPLETE ASSEMBLY

3A10700ZHP	SOFT PKG SET
3A107000HP	
3A107003HP	
3A106994HP	
3A106993HP	
COMPLETE ASSEMBLY	SOFT PKG SET

HIGH PERFORMANCE PACKING



PACKING ASSEMBLIES
WEIR SPM TWS 500LW (H/V)
ROUGH RIDER 500 (H/V)



SOFT PKG. SET INCLUDES COMPONENTS #2, 3 AND 5.

6	1	SPACER RING
5	1	PKG ADAPTER
4	1	SPACER
3	1	HEADER RING
2	1	PRESSURE RING
1	1	LANTERN RING
ITEM	QTY	DESCRIPTION

4 1/2"
4"
3 1/2"
2 3/4"
SIZE

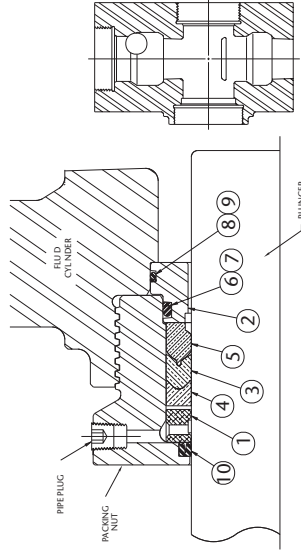
3A1 03794HP
3A1 03793HP
3A1 03792HP
3A1 05024HP
COMPLETE ASSEMBLY

3A107001HP
3A107000HP
3A106999HP
3A106998HP
SOFT PKG SET

HIGH PERFORMANCE PACKING



PACKING ASSEMBLIES
WEIR SPM TWS 600 SHORT
2-1/2" - 4-1/2"



**SOFT PKG. SET INCLUDES
COMPONENTS #3, 4, 5, 6, 7, 8, 9 AND 10.
FOR CO2 SERVICE APPLICATIONS, SPECIFY
"CO2" AT THE END OF EACH PART NUMBER.**

ITEM	QTY	DESCRIPTION
10	1	WIPER RING
9	1	BACK-UP
8	1	O-RING
7	7	BACK-UP
6	1	O-RING
5	1	HEADER RING
4	1	PKG ADAPTER
3	1	PRESSURE RING
2	1	SEAL RING
1	1	LANTERN RING

4 1/2"
4"
3 1/2"
3"
2 3/4"
2 1/2"
SIZE

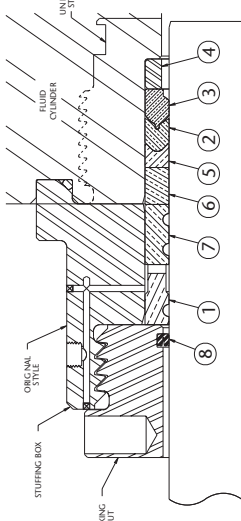
3A10S297HP
3A104227HP
3A105368HP
3A104769HP
3A105154HP
3A104731HP
COMPLETE ASSEMBLY

3A107012HP
3A107011HP
3A107010HP
3A107009HP
3A107008HP
3A107044HP
SOFT PKG SET

HIGH PERFORMANCE PACKING



PACKING ASSEMBLIES
 WEIR SPM TWS 600
 WEIR SPM TWS 500LW (V/V)



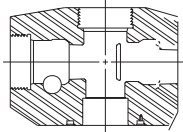
ITEM QTY	DESCRIPTION
8	1 WIPER RING
7	1 FLAT ADAPTER
6	1 SPACER LONG
5	1 PKG ADAPTER
4	1 SPACER SHORT
3	1 HEADER RING
2	1 PRESSURE RING
1	1 LANTERN RING

3A105263HP	4 1/2"
3A105262HP	4"
3A104586HP	3 1/2"
3A105225HP	3"
3A104703HP	2 3/4"
3A104744HP	2 1/2"
COMPLETE ASSEMBLY	SIZE

3A107007HP	SOFT PKG SET
3A107006HP	
3A107005HP	
3A107004HP	
3A107003HP	
3A107002HP	
SOFT PKG SET	

SOFT PKG. SET INCLUDES
 COMPONENTS #2, 3, 5 AND 8.

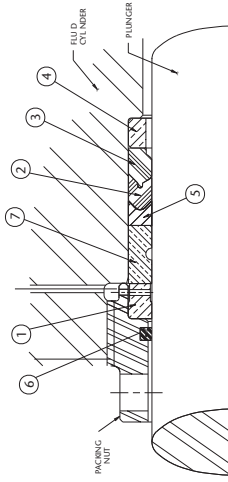
FOR CO2 SERVICE APPLICATIONS, SPECIFY
 "CO2" AT THE END OF EACH PART NUMBER.



HIGH PERFORMANCE PACKING



PACKING ASSEMBLIES
 WEIR SPM TWS 900-QWS 2500



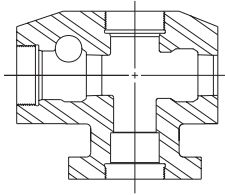
ITEM QTY	DESCRIPTION
7	1 FLAT ADAPTER
6	1 WIPER RING
5	1 PKG ADAPTER
4	1 SPACER
3	1 HEADER RING
2	1 PRESSURE RING
1	1 LANTERN RING

3A105377HP	6 3/4"
3A105312HP	6 1/2"
3A105372HP	6"
3A105371HP	5 3/4"
3A104758HP	5 1/2"
3A105180HP	5"
3A104367HP	4 1/2"
3A105348HP	4"
3A105168HP	3 3/4"
3A105207HP	3 1/2"
COMPLETE ASSEMBLY	SIZE

3A107000HP	SOFT PKG SET
3A107009HP	
3A107008HP	
3A107007HP	
3A107006HP	
3A107005HP	
3A107004HP	
3A107003HP	
3A107002HP	
SOFT PKG SET	

SOFT PKG. SET INCLUDES
 COMPONENTS #2, 3, 5, AND 6.

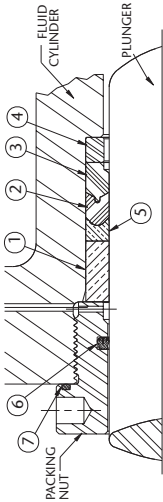
FOR CO2 SERVICE APPLICATIONS, SPECIFY
 "CO2" AT THE END OF EACH PART NUMBER.



HIGH PERFORMANCE PACKING



PACKING ASSEMBLIES
OPI,
GEOQUIP (GARDNER DENVER)
CMW (WEIR SPM)
OMEGA



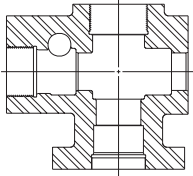
ITEM	QTY	DESCRIPTION
7	1	O-RING
6	1	WIPER RING
5	1	PKG ADAPTER
4	1	SPACER
3	1	HEADER RING
2	1	PRESSURE RING
1	1	FLAT ADAPTER

SIZE
7 1/2"
2"
6 3/4"
6 1/2"
6"
5 3/4"
5 1/2"
5"
4 1/2"
4"
3 3/4"
3 1/2"
3 1/4"
3"
2 3/4"

COMPLETE ASSEMBLY
3A102276HP
3A102254HP
3A101251HP
3A101250HP
3A101256HP
3A102274HP
3A101255HP
3A101159HP
3A101254HP
3A101253HP
3A101264HP
3A102273HP
3A102272HP
3A102271HP

SOFT PKG SET
3A107038HP
3A107028HP
3A107019HP
3A107018HP
3A107016HP
3A107015HP
3A107014HP
3A107009HP
3A107006HP
3A107013HP
3A107005HP
3A107004HP
3A107003HP

SOFT PKG. SET INCLUDES
COMPONENTS #2, 3, 5, 6 AND 7.
FOR CO2 SERVICE APPLICATIONS, SPECIFY
"CO2" AT THE END OF EACH PART NUMBER.



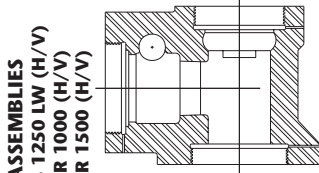
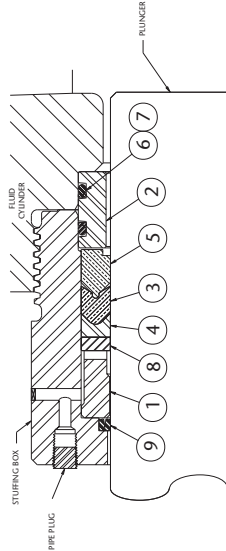
HIGH PERFORMANCE PACKING



PACKING ASSEMBLIES
WEIR SPM TWS 1250 LW (H/V)
ROUGH RIDER 1000 (H/V)
ROUGH RIDER 1500 (H/V)

SOFT PKG. SET INCLUDES
COMPONENTS #3, 4, 5, 6, 7 AND 9.
FOR CO2 SERVICE APPLICATIONS, SPECIFY
"CO2" AT THE END OF EACH PART NUMBER.

ITEM	QTY	DESCRIPTION
9	1	WIPER RING
8	1	SPACER
7	2	BACK-UP
6	2	O-RING
5	1	HEADER RING
4	1	PKG ADAPTER
3	1	PRESSURE RING
2	1	SEAL RING
1	1	LANTERN RING



SOFT PKG SET
3A107021HP

COMPLETE ASSEMBLY
3A106698HP

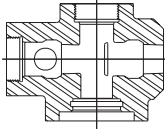
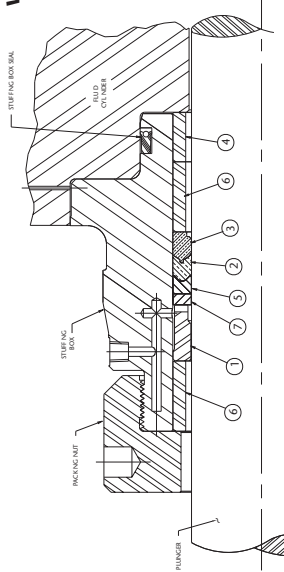
SIZE
5"

HIGH PERFORMANCE PACKING



PACKING ASSEMBLIES
WEIR SPM TWS 1250LW (V/V)
ROUGH RIDER 1000 (V/V)
ROUGH RIDER 1500 (V/V)

ITEM QTY	DESCRIPTION
7	1 SPACER
6	2 SPACER-LONG
5	1 PKG ADAPTER
4	1 SPACER-SHORT
3	1 HEADER RING
2	1 PRESSURE RING
1	1 LANTERN RING



SOFT PKG. SET INCLUDES
COMPONENTS #2, 3, AND 5.

FOR CO2 SERVICE APPLICATIONS, SPECIFY
"CO2" AT THE END OF EACH PART NUMBER.

3A107025HP
SOFT PKG SET

3A102136HP
COMPLETE ASSEMBLY

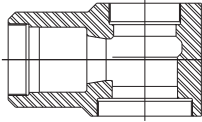
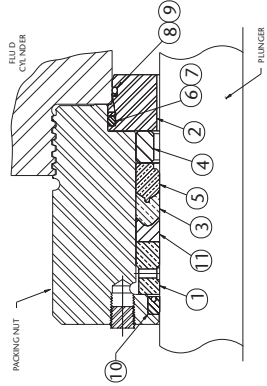
4"
3 3/4"
SIZE

HIGH PERFORMANCE PACKING



PACKING ASSEMBLIES
BJ PACEMAKER

ITEM QTY	DESCRIPTION
11	1 PKG ADAPTER
10	1 WIPER RING
9	1 BACK-UP
8	1 O-RING
7	1 BACK-UP
6	1 O-RING
5	1 HEADER RING
4	1 SPACER RING
3	1 PRESSURE RING
2	1 SEAL RING
1	1 LANTERN RING



SOFT PKG. SET INCLUDES
COMPONENTS #3, 5, 6, 7, 8, 9, 10 AND 11.

FOR CO2 SERVICE APPLICATIONS, SPECIFY
"CO2" AT THE END OF EACH PART NUMBER.

3A107025HP
SOFT PKG SET

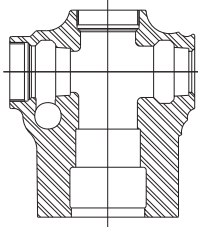
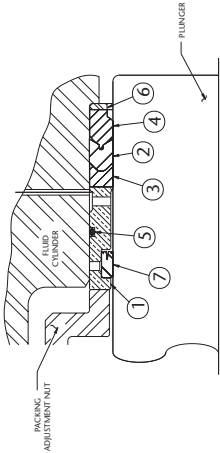
3A104390HP
COMPLETE ASSEMBLY

5"
4 1/2"
4"
3 1/2"
SIZE



PACKING ASSEMBLIES
HALLIBURTON HT-400

ITEM	QTY	DESCRIPTION
7	1	WIPER RING
6	1	SPACER
5	1	O-RING
4	1	HEADER RING
3	1	PKG ADAPTER
2	1	PRESSURE RING
1	1	LANTERN RING



SOFT PKG. SET INCLUDES
COMPONENTS #2, 3, 4, 5, AND 7.

FOR CO2 SERVICE APPLICATIONS, SPECIFY
"CO2" AT THE END OF EACH PART NUMBER.

5"
4 1/2"
SIZE

3A107581HP
3A105358HP
COMPLETE ASSEMBLY

3A108288HP
3A107032HP
SOFT PKG SET

STANDARD PACKING ASSEMBLY DRAWINGS AND PART NUMBERS

WELL SERVICE PUMP REFERENCE GUIDE

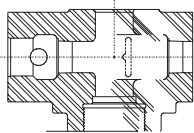


STANDARD PACKING

P PE PLUG

PACK NG NUT

WEIR SPM
PACKING ASSEMBLIES
WEIR SPM TWS 250



ITEM	QTY	DESCRIPTION
10	1	WIPE RING
9	1	BACK-UP
8	1	O-RING
7	1	BACK-UP
6	1	O-RING
5	1	HEADER RING
4	1	SPACER RING
3	2	PRESSURE RING
2	1	SEAL RING
1	1	LANTERN RING

RSU/ACID FRAC
CEMENT

4"
3 1/2"
3"
2 1/2"
2 3/4"
2 1/2"
2"

3A105324
3A105185
3A105322
3A105315
3A105321
3A106987
3A106986

3A109549
3A109547
3A109545
3A109547
3A106989
3A105315
3A106987
3A106986

SOFT PKG. SET INCLUDES
COMPONENTS #3, 5, 6, 7, 8 AND 9.

STANDARD PACKING

P PE PLUG

PACK NG NUT

WEIR SPM
PACKING ASSEMBLIES
WEIR SPM TWS 250
(CEMENT)

ITEM	QTY	DESCRIPTION
10	1	WIPE RING
9	1	BACK-UP
8	1	O-RING
7	1	BACK-UP
6	1	O-RING
5	1	HEADER RING
4	1	SPACER RING
3	2	PRESSURE RING
2	1	SEAL RING
1	1	LANTERN RING

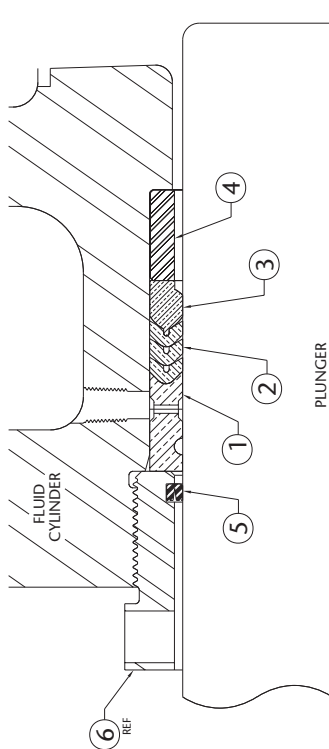
4"
3 1/2"
3"
2 1/2"
2"

3A105324
3A105185
3A105322
3A105315
3A107723

3A109549
3A109547
3A106989
3A106987
3A106986

SOFT PKG. SET INCLUDES
COMPONENTS #3, 5, 6, 7, 8 AND 9.

STANDARD PACKING



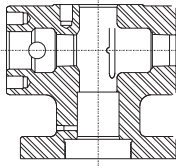
ITEM	QTY	DESCRIPTION
6	REF	PACKING NUT w/ WIPER GROOVE
5	1	WIPER RING
4	1	SPACER
3	1	HEADER RING
2	3	PRESSURE RING
1	1	LANTERN RING/FEMALE ADAPTER

RSJ/ACID FRAC	4 1/2"	4"	3 1/2"	3"	2 1/2"	SIZE
CEMENT	3A105294	3A106787	3A105228	3A105370	3A105369	COMPLETE ASSEMBLY
ACID/FRAC	3A106997	3A106996	3A106995	3A106994	3A106993	SOFT PKG SET

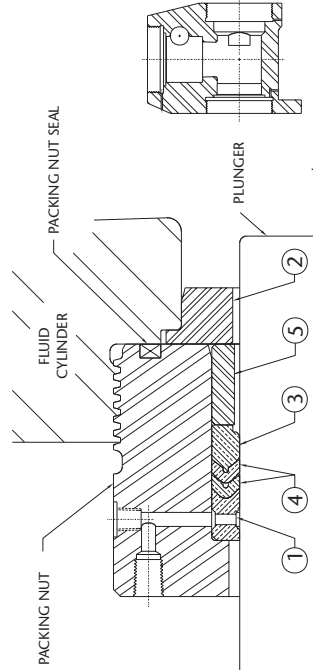
SOFT PKG. SET INCLUDES COMPONENTS #2, 3, AND 5.



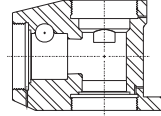
PACKING ASSEMBLIES
WEIR SPM TWS 400
OR
GEOQUIP LC350



STANDARD PACKING



PACKING ASSEMBLIES
WEIR SPM TWS 500LW (H/V) *
ROUGH RIDER 500 (H/V) *



HOR ZONTAL VALVE STYLE

ITEM	QTY	DESCRIPTION
5	1	SPACER RING
4	2	PRESSURE RING (SHORT)
3	1	HEADER RING
2	1	SPACER
1	1	LANTERN RING/FEMALE ADAPTER

CEMENT	4 1/2"	SIZE
3A105349	3A109550	COMPLETE ASSEMBLY
3A105349	3A109550	SOFT PKG SET

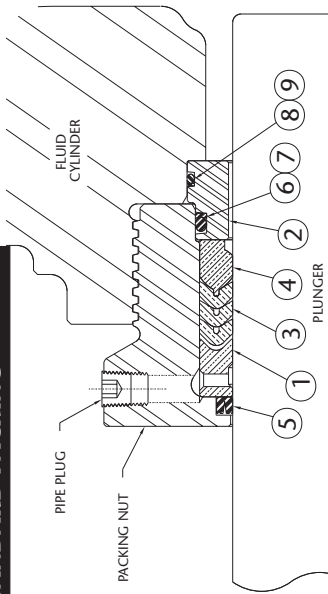
ACID/FRAC	4 1/2"	4"	3 1/2"	2 3/4"	SIZE
3A103794	3A103793	3A103792	3A106998	3A105024	COMPLETE ASSEMBLY
3A103794	3A107001	3A107000	3A106999	3A106998	SOFT PKG SET

SOFT PKG. SET INCLUDES COMPONENTS #3, AND 4.



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STANDARD PACKING



ITEM	QTY	DESCRIPTION
9	1	BACK-UP
8	1	O-RING
7	1	BACK-UP
6	1	O-RING
5	1	WIPER RING
4	1	HEADER RING
3	3	PRESSURE RING - SHORT
2	1	SEAL RING
1	1	LANTERN RING/FEMALE ADAPTER

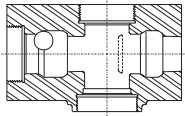
ACID/FRAC CEMENT	3"
SIZE	2 3/4"
	2 1/2"

3A104769	COMPLETE ASSEMBLY
3A105154	
3A104731	

3A107566	SOFT PKG SET
3A107008	
3A107044	

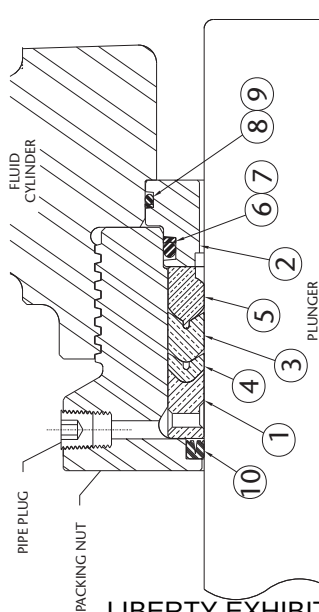


PACKING ASSEMBLIES
WEIR SPM TWS 600 SHORT
2-1/2" - 3"



SOFT PKG. SET INCLUDES
COMPONENTS #3, 4, 5, 6,
7, 8, AND 9.

STANDARD PACKING



ITEM	QTY	DESCRIPTION
10	1	WIPER RING
9	1	BACK-UP
8	1	O-RING
7	1	BACK-UP
6	1	O-RING
5	1	HEADER RING
4	1	PRESSURE RING - LONG
3	1	PRESSURE RING - SHORT
2	1	SEAL RING
1	1	LANTERN RING/FEMALE ADAPTER

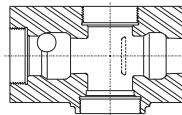
ACID/FRAC CEMENT	4 1/2"
SIZE	4"
	3 1/2"

3A105297	COMPLETE ASSEMBLY
3A104227	
3A105368	

3A109556	SOFT PKG SET
3A109555	
3A109554	

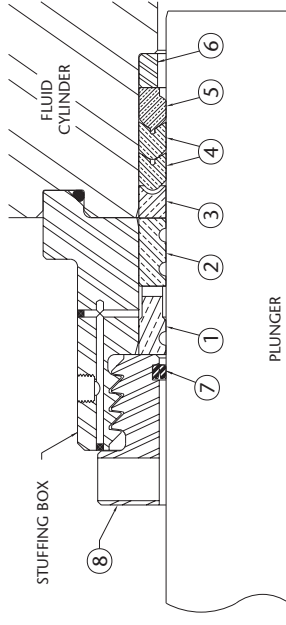


PACKING ASSEMBLIES
WEIR SPM TWS 600 SHORT
3-1/2" - 4-1/2"



SOFT PKG. SET INCLUDES
COMPONENTS #3, 4, 5, 6,
7, 8, 9 AND 10.

STANDARD PACKING



ITEM	QTY	DESCRIPTION
8	1	PACKING NUT w/ WIPER GROOVE
7	1	WIPER RING
6	1	SPACER
5	1	HEADER RING
4	2	PRESSURE RING
3	1	FEMALE ADAPTER
2	1	FLAT ADAPTER
1	1	LANTERN RING

CEMENT	SIZE
3A109552	3 1/2"

COMPLETE ASSEMBLY	SOFT PKG SET
3A106049	3A109552
3A106705	3A109551

ACID/FRAC	SIZE
3A105263	4 1/2"
3A105262	3 1/2"
3A105266	3"
3A105225	2 3/4"
3A104703	2 1/2"
3A104744	2 1/2"

COMPLETE ASSEMBLY	SOFT PKG SET
3A107869	3A107869
3A107866	3A107866
3A107865	3A107865
3A107864	3A107864
3A107863	3A107863
3A109553	3A109553



PACKING ASSEMBLIES
WEIR SPM TWS 600
WEIR SPM TWS 500LW (V/V)

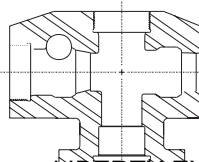
SOFT PKG. SET INCLUDES
COMPONENTS #4, 5, AND 7.



STANDARD PACKING

ITEM	QTY	DESCRIPTION
8	1	PACKING NUT w/ WIPER GROOVE
7	1	O-RING
6	1	WIPER RING
5	1	LANTERN RING
4	1	FEMALE ADAPTER
3	1	SPACER
2	2	PRESSURE RING
1	1	HEADER RING

** CEMENT SERVICE
* VITON SEALS



SIZE
6 3/4"
5"
4 1/2"
6 3/4"
6 1/2"
6"
5 3/4"
5 1/2"
5"
4 1/2"
4"
3 3/4"
3 1/2"

COMPLETE ASSEMBLY
** 3A105273
* 3A103180V
* 3A104367V
3A105377
3A105312
3A105373
3A105372
3A104755
3A105180
3A1053467
3A109558
3A105348
3A105166
3A107013
3A109557

SOFT PKG SET
** 3A109560
* 3A107014V
* 3A109559V
3A107020
3A107019
3A107018
3A107016
3A107015
3A107014
3A109559
3A109558
3A107013
3A109557

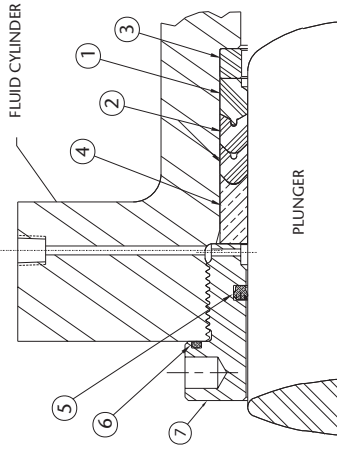
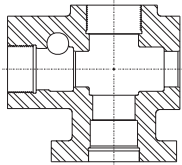
SOFT PKG. SET
INCLUDES
COMPONENTS #1,
2, AND 6.

PACKING ASSEMBLIES
WEIR SPM TWS 900, TWS 1000,
TWS 1200, TWS 1300,
TWS 1600, TWS 1800,
TWS 2000,
TWS 2250, QWS 2500



STANDARD PACKING

ITEM	QTY	DESCRIPTION
7	1	PACKING NUT w/ WIPER GROOVE
6	1	O-RING
5	1	WIPER RING
4	1	FEMALE ADAPTER
3	1	SPACER
2	2	PRESSURE RING
1	1	HEADER RING



PACKING ASSEMBLIES
OPI, GEOQUIP (GARDNER DENVER)
CMW (WEIR SPM)
OMEGA

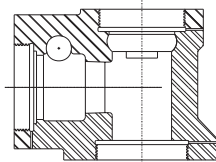
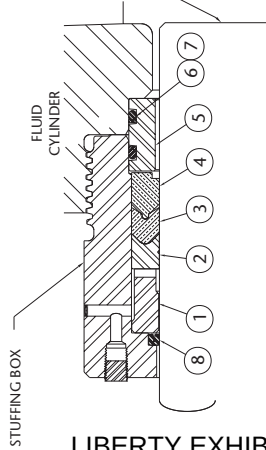
1300, 1800, 2000
BRAKE HORSE POWER SERIES

7 1/2"	7"	6 3/4"	6 1/2"	6"	5 3/4"	5 1/2"	5"	4 1/2"	4"	3 3/4"	3 1/2"	3"	2 3/4"	SIZE
3A102276	3A102275	3A101251	3A101250	3A101256	3A102274	3A101255	3A101159	3A101254	3A101253	3A101276	3A102275	3A102272	3A102271	COMPLETE ASSEMBLY
3A107039	3A107038	3A109573	3A109572	3A109571	3A109570	3A109569	3A109568	3A109567	3A109566	3A109565	3A109564	3A109563	3A109562	SOFT PKG SET

SOFT PKG. SET
INCLUDES
COMPONENTS #1, 2,
5, AND 6.

STANDARD PACKING

ITEM	QTY	DESCRIPTION
8	1	ROD WIPER
7	2	BACKUP RING
6	2	O-RING
5	1	SEAL RING
4	1	HEADER RING
3	1	PRESSURE RING
2	1	FEMALE ADAPTER
1	1	LANTERN RING



* HORIZONTAL VALVE STYLE

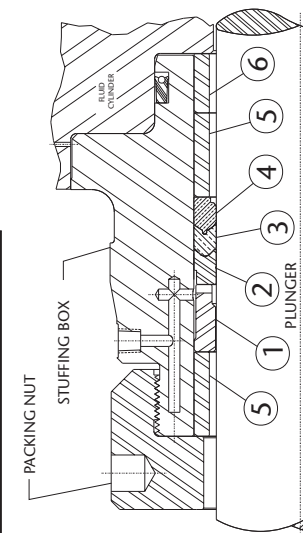
PACKING ASSEMBLIES
WEIR SPM TWS 1250LW (H/V) *
ROUGH RIDER 1000 (H/V) *
ROUGH RIDER 1500 (H/V) *



SOFT PKG. SET INCLUDES
COMPONENTS #3, 4, 6, 7, AND 8.

CEMENT	5"	SIZE	3A106698	COMPLETE ASSEMBLY	3A107021	SOFT PKG SET
ACID	5"	SIZE	3A106698	COMPLETE ASSEMBLY	3A107021	SOFT PKG SET

STANDARD PACKING



* VALVE OVER VALVE STYLE

ITEM	QTY	DESCRIPTION
6	1	SPACER - SHORT
5	2	SPACER - LONG
4	1	HEADER RING
3	1	PRESSURE RING
2	1	FEMALE ADAPTER
1	1	LANTERN RING

ACID/FRC	SIZE
4"	3 3/4"

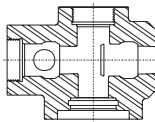
3A102136	COMPLETE SET
3A102499	

3A107025	SOFT PKG SET
3A107024	

3A107025
3A107024
SOFT PKG SET

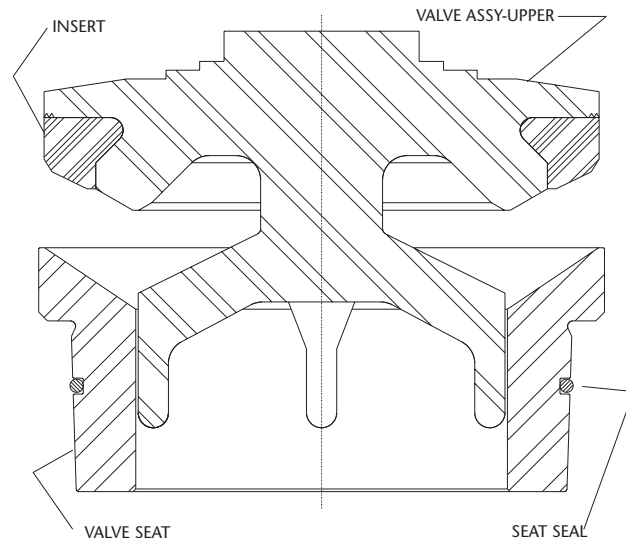


PACKING ASSEMBLIES
WEIR SPM TWS 1250LW (V/V) *
ROUGH RIDER 1000 (V/V) *
ROUGH RIDER 1500 (V/V) *



SOFT PKG. SET INCLUDES COMPONENTS #3, AND 4.

VALVE AND SEAT CROSS REFERENCE



SUCTION AND DISCHARGE VALVE ASSEMBLY

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VALVE AND SEAT CROSS REFERENCE

VALVE AND SEAT CROSS REFERENCE

Pump Mfr.	Pump Model	Plunger Size		Valve Part No.	Seat Part No.	Insert Part No.	Spring
BJ Services	Pacemaker, (Suction)	3"-5"		P105800	P105801	2P110363	*
	Pacemaker, (Discharge)	3"-5"		2A109538PP	2A109542	2P110357	*
CMW (WEIR SPM)	Clarksville, 1300HP	3.75"-4"		2A109538PP	2A109542	2P110357	*
		4.50"-5"		2A109539PP	2A109543	2P110363	*
		5.50"-6"		2A109540PP	2A109544	2P110359	*
		6.50"-7.50"		2A109627PP	2A109621	2P110360	*
Gardner Denver (Geoquip)	LC-350, H-600	3.50"-4.50"		2A109537PP	2A109541	2P110356	4P100198
	H-880	3.50"-4"		2A109538PP	2A109542	2P110357	*
	H-1600	4.50"-5"		2A109539PP	2A109543	2P110363	4P100348
	C-1300,1800	5.50"-6"		2A109540PP	2A109544	2P110359	4P106813
	J-2000	6.50"-7.50"		2A109627PP	2A109621	2P110360	4P100281
Gist	GT-78-1000	4"-5.25"		2A109538PP	2A109542	2P110363	*
		5.50"-7.50"		2A109540PP	2A109544	2P110359	*
Oilwell	346P, 46P, 326P			P105740	P105750	P105760	4P102383
	SA-625, -626,-630,-634-5			2A109608PP	2A109605	2P110355	4P102383
	SA-640-5,SA-650-L			2A109538PP	2A109542	2P110357	*
	SB-644-5,SA-644-5,-10 SA650-5,-10,SB-650-5			2A109539PP	P105802	2P110363	*
	Super 48,S-824,SA-824			2A109627PP	2A109621	2P110360	*
	W-350, W-500	3.50"-4" 4.50"-5"		2A109537PP 2A109539PP	2A109541 2A109541	2P110356 2P110363	* *
Omega	1000-1300HP	4"-5.25"		2A109539PP	2A109541	2P110363	*
		5.50"-7.50"		2A109540PP	2A109544	2P110359	*
	1300-1800HP MW/MWA Fluid End W-1300,-1800,-2000	3.75"-4"		2A109538PP	2A109542	2P110357	*
		4.50"-5"		2A109539PP	2A109543	2P110363	*
		5.50"-6"		2A109540PP	2A109544	2P110359	*
		6.50"-7.50"		2A109627PP	2A109621	2P110360	*
Gardner Denver (OPI)	350-500 AWS	2.75"-3"		2A109608PP	2A109605	2P110355	*
		3.50"-4"		2A109537PP	2A109541	2P110356	*
		4.50"-5"		2A109539PP	2A109543	2P110363	*
	880 AWS, 1600 BWS 1000-1300-1800 AWS 1300-1800-2000 CWS GD-2000	3.50"-4"		2A109538PP	2A109542	2P110357	*
		4.50"-5"		2A109539PP	2A109543	2P110363	4P100235
		5.50"-6"		2A109540PP	2A109544	2P110359	4P106813
		6.50"-7.50"		2A109627PP	2A109621	2P110360	4P100281
	1000-1300WS	4"-5.25"		2A109539PP	2A109621	2P110363	*
		5.50"-7.50"		2A109540PP	2A109541	2P110359	*
				2A109538PP	2A109542	2P110357	*
Pinion	RB-5, RB-6			2A109538PP	2A109542	2P110357	*

VALVE AND SEAT CROSS REFERENCE

VALVE AND SEAT CROSS REFERENCE

Pump Mfr.	Pump Model	Plunger Size		Valve Part No.	Seat Part No.	Insert Part No.	Spring
Weir SPM	TWS 250	1.75"-3"		2A109608PP	2A109605	2P110355	4P101362
		3.25"-4"		2A109537PP	2A109541	2P110356	4P100198
	TWS 400	2 .50"-3"		2A109608PP	2A109605	2P110355	4P101362
		3 .50"-4 .50"		2A109537PP	2A109541	2P110356	4P100198
	TWS 500LW-600	2 .75"		2A109608PP	2A109605	2P110355	4P101362
		3"-4 .75"		2A109537PP	2A109541	2P110356	4P100198
	TWS 600S	2 .50"-3"		2A109608PP	2A109605	2P110355	4P101634
		3.50"-4 .50"		2A109537PP	2A109541	2P110356	4P100198
	TWS 900	3.50"-4"		2A109538PP	2A109542	2P110357	4P100338
	TWS 1250LW	4"		P105740	P105750	P105760	4P101860
Western (Rough Rider)	TWS 1300-1600-1800-2000- 2250; QWS 2000-2500LW	4.50"-5"		2A109539PP	2A109543	2P110363	4P100348
	TWS 1600LW; QWS 2000- 2500LW	5.50"-6"		2A109539PP	2A109543	2P110363	4P100235
	QWS 2000-2500LW	6.50"-7.50"		2A109540PP	2A109544	2P110359	4P100116
				2A109627PP	2A109621	2P110360	4P10028
	RB-80, RB-81			P105740	2A109543	2P110363	*
	RR500 Mono Block F.E.			2A109537PP	2A109541	2P110356	*
	RR1000 Mono Block F.E. VDV	4"		P105740	P105750	P105760	4P102062
	Rough Rider (RR) 1500 VDV	4.50"-5"		2A109539PP	2A109543	2P110363	4P102062
	RR1000 MONOBLOCK HV	5"		2A109539PP	2A109543	2P110363	P101860

* Call Weir SPM for information

PLUNGERS CROSS REFERENCE

PLUNGERS CROSS REFERENCE

Pump Manufacturer	Pump Model	Plunger Size	Plunger Part No.		Pump Manufacturer	Pump Model	Plunger Size	Plunger Part No.
CMW (Weir SPM)	1300	6.75" SHORT 6.75" STD.	2P102401 3P101432		Weir SPM	OPI880	3.75" 4.00" 4.50" 5.00" 5.50" 5.75" 6.00"	3P104144 3P100772 3P100725 3P100366 3P107060 3P107061 3P107062
GARDNER DENVER (OPI) OMEGA	1300 THRU 2000	4.00" 4.50" 5.00" 5.75" 6.50"	3P103963 3P103950 3P100233 3P108327 3P100258			TWS 1000 LW TWS 1300	3.75" 4.00" 4.50" 5.00" 5.50" 5.75" 6.00"	3P103887 3P100339 3P100654 3P100233 3P107060 3P107061 3P107062
OPI, OMEGA	500	2.75" 3.00" 3.50" 4.00" 4.50" 5.00"	3P107300 3P107301 3P107302 3P107303 3P107304 3P107305					
OILWELL	SA640	4.00"	2P102998					
Weir SPM	TWS 250	1.75" 2.00" 2.25" 2.50" 2.75" 3.00" 3.25" 3.50" 3.75" 4.00"	3P104545 3P104546 3P104547 3P103501 3P103502 3P103503 3P103504 3P103505 3P103506 3P103507			TWS 1600	3.75" 4.00" 4.50" 5.00" 5.50" 5.75" 6.00" 3.75"	3P104144 3P100339 3P100725 3P100366 3P101423 3P101652 3P101424 3P103887
	TWS 400	2.50" 2.75" 3.00" 3.50" 4.00" 4.50"	3P101397 3P101385 3P101384 3P100968 3P101334 3P100853			TWS 1800	4.00" 4.50" 5.00" 5.50" 5.75" 6.00" 6.50" 3.75"	3P100339 3P100654 3P100233 3P107060 3P107061 3P107062 3P100258 3P103887
	TWS 600	2.50" 2.75" 3.00" 3.50" 3P100293 4.00" 4.50"	3P104740 3P101733 3P100325 3P100293 3P100813 3P100181			TWS 2000	4.00" 4.50" 5.00" 5.50" 5.75" 6.00" 6.50" 3.75"	3P100339 3P100654 3P100233 3P107060 3P107061 3P107062 3P100258 3P103887
	TWS 600S	2.00" 2.50" 2.75" 3.00" 3.50" 4.00" 4.50"	2P106313 2P104716 2P104717 2P103345 2P103344 2P103313 2P103312			TWS2250	4.00" 4.50" 5.00" 5.50" 5.75" 6.00" 6.50" 3.75"	3P100339 3P100654 3P100233 3P107060 3P107061 3P107062 3P100258 3P103887
	TWS 900	3.50"	3P105202					

- Specify Standard 16" Length
- Specify Optional 18" Length
- Specify Optional 21" Length

- Specify Standard 16" Length
- Specify Optional 18" Length
- Specify Optional 21" Length

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PLUNGERS CROSS REFERENCE

Pump Manufacturer	Pump Model	Plunger Size	Plunger Part No.
Weir SPM	TWS 2250	5.50"	3P107060
		5.75"	3P107061
		6.00"	3P107062
		6.50"	3P100258
	QWS-2000-2500	3.75"	3P103887
		4.00"	3P100339
		4.50"	3P100654
		5.00"	3P100233
		5.50"	3P107060
		5.75"	3P107061
		6.00"	3P107062
		6.50"	3P100258
WESTERN ROUGH RIDER Weir SPM	500 HV MONO TWS 500LW	2.75"	2P105019
		3.00"	2P18196
		3.50"	1P101925
		4.00"	1P103772
	500 SECT	4.50"	1P101969
		4.50"	1P102014
	500 HV SEC* 1000 HV MONO TWS 1000/1250	3.75"	2P102527
		4.00"	1P102167
	1000 VOV MONO TWS 1000/1250	5.00"	1P102169
		5.75"	2P102728
	1500 VOV MONO	3.75"	2P102489
		4.00"	1P102037
		5.00"	2P102075
		5.75"	2P102602

* SEC Sectional Style

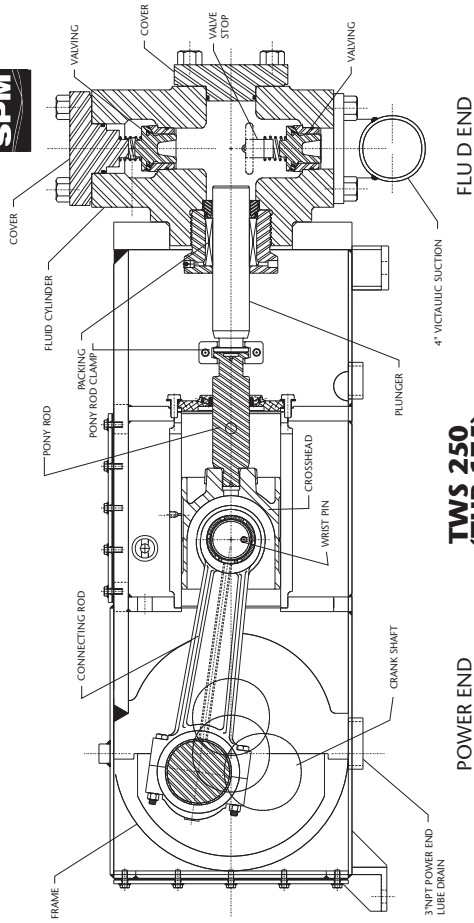


WELL SERVICE PUMP REFERENCE GUIDE

WELL SERVICE PUMP AND FLUID END DRAWINGS



COMPONENT PARTS CAN BE ORDERED BY CONTACT NG WE R SPM.



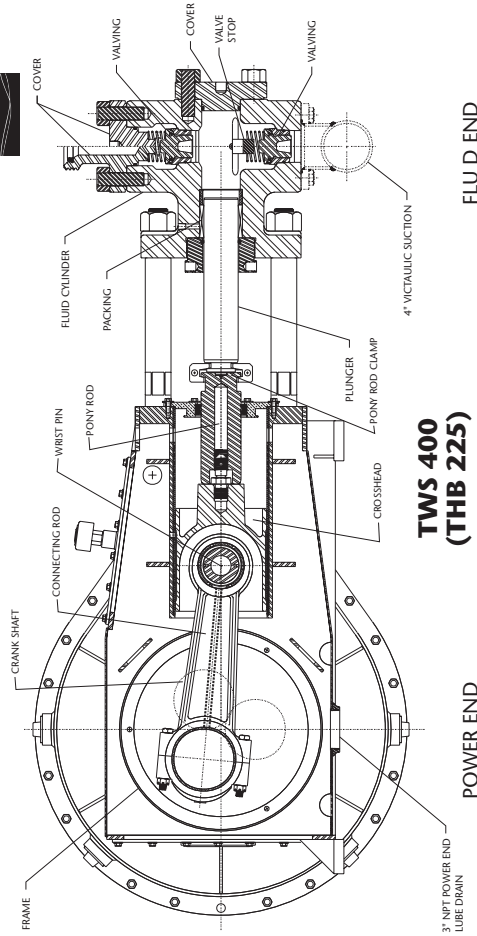
**TWS 250
(THB 175)**

POWER END

FLU D END



COMPONENT PARTS CAN BE ORDERED BY CONTACT NG WE R SPM.



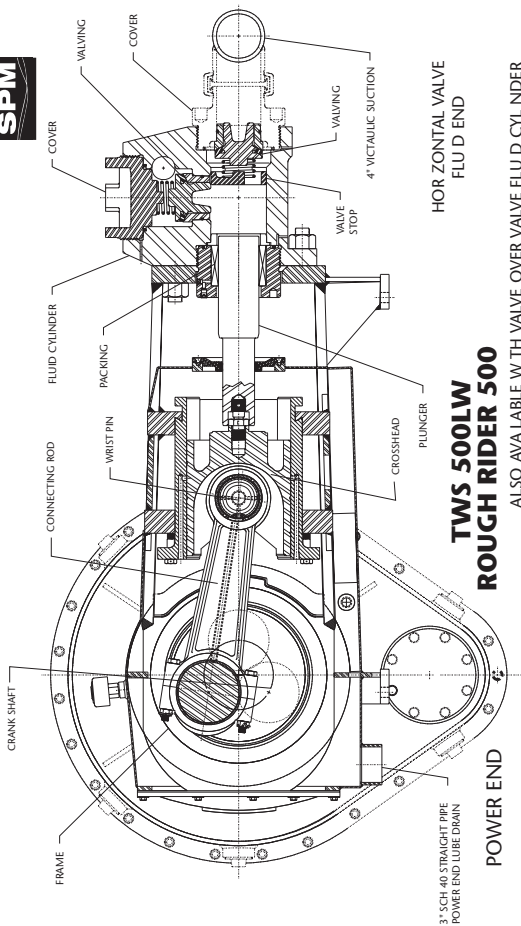
**TWS 400
(THB 225)**

POWER END

FLU D END



COMPONENT PARTS CAN BE ORDERED BY CONTACTING WEIR SPM.



HORIZONTAL VALVE
FLUID END

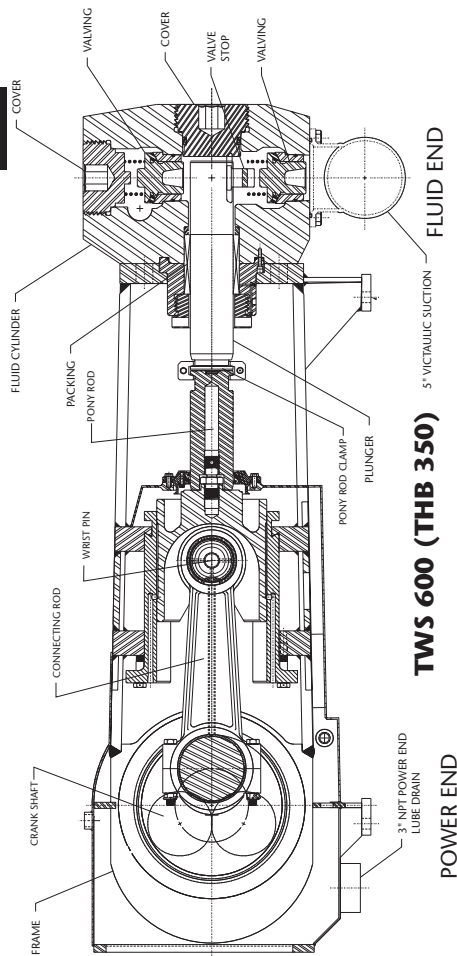
TWS 500LW ROUGH RIDER 500

ALSO AVAILABLE WITH VALVE OVER VALVE FLUID CYLINDER

POWER END



COMPONENT PARTS CAN BE ORDERED BY CONTACTING WEIR SPM.

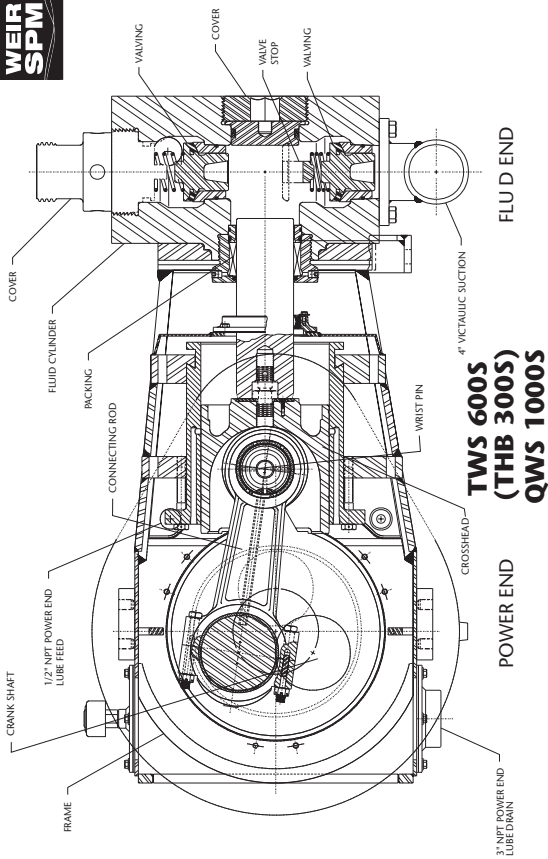


TWS 600 (THB 350)

POWER END

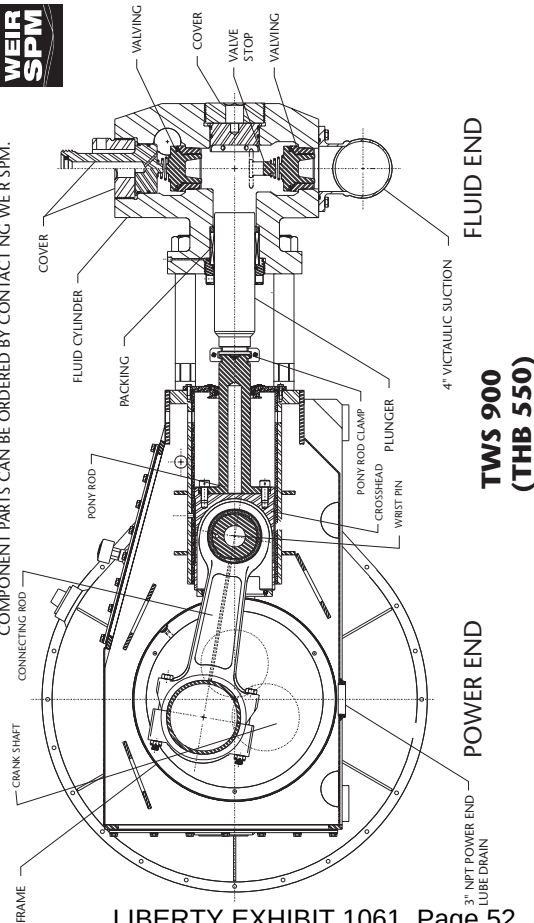
NATIONAL OILWELL SA640 Parts Also Available

COMPONENT PARTS CAN BE ORDERED BY CONTACT NG WE R SPM.



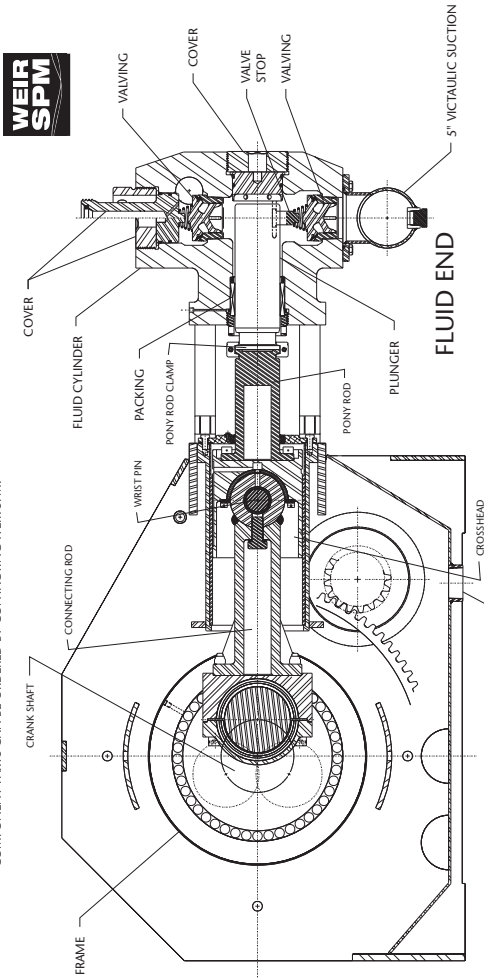
**TWS 600S
(THB 300S)
QWS 1000S**

COMPONENT PARTS CAN BE ORDERED BY CONTACT NG WE R SPM.



**TWS 900
(THB 550)**

COMPONENT PARTS CAN BE ORDERED BY CONTACTING WEIR SPM.

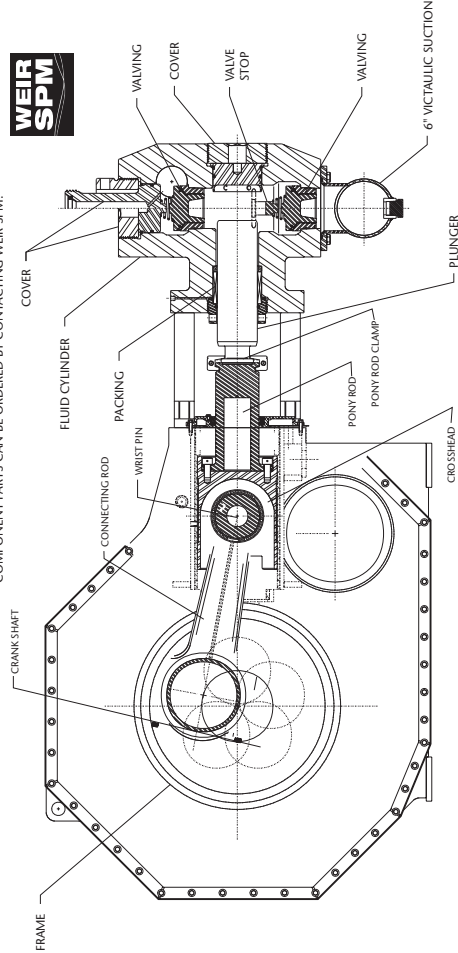


POWER END

TWS 1300 / 1600 / 1800 / 2000 / 2250 style pumps (THB 1050)

Material & sizes may vary. Parts for CMW, OPI, Gardner Denver, Geopquip, Omega Also Available

COMPONENT PARTS CAN BE ORDERED BY CONTACTING WEIR SPM.

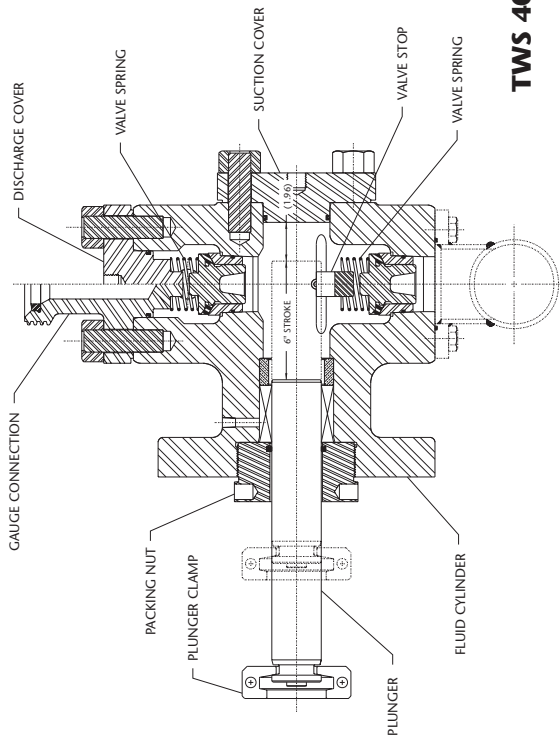


POWER END

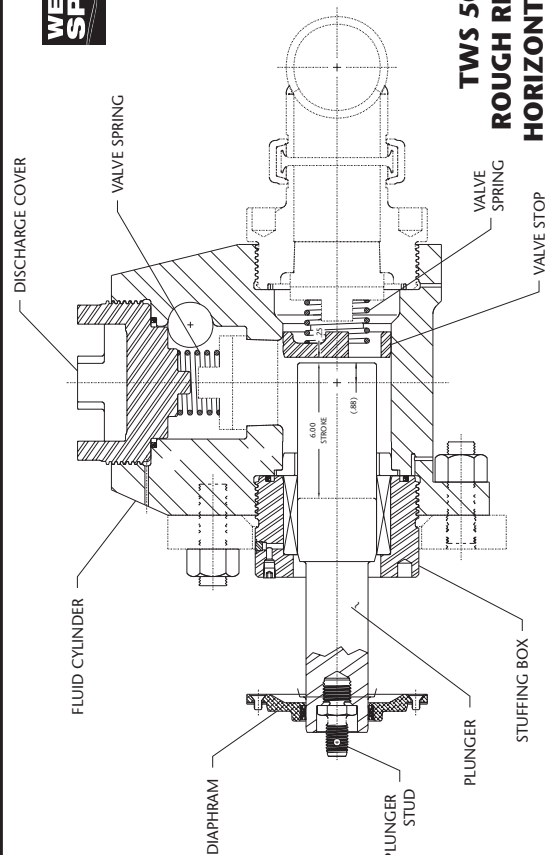
**QWS 2500 style pumps
(QHB 1575)**

Material & sizes may vary.

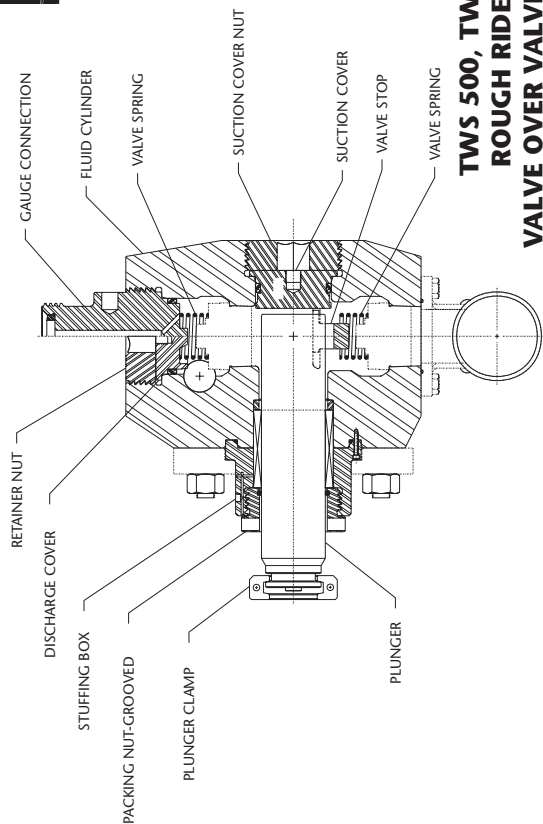
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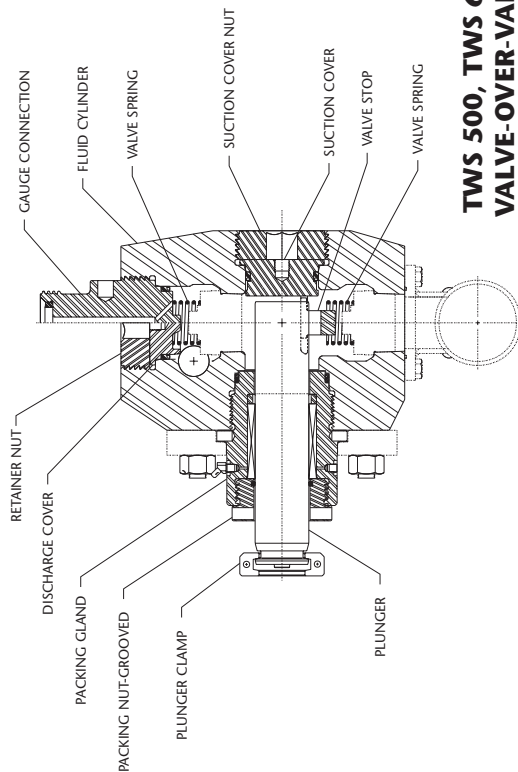
TWS 400 FLUID END



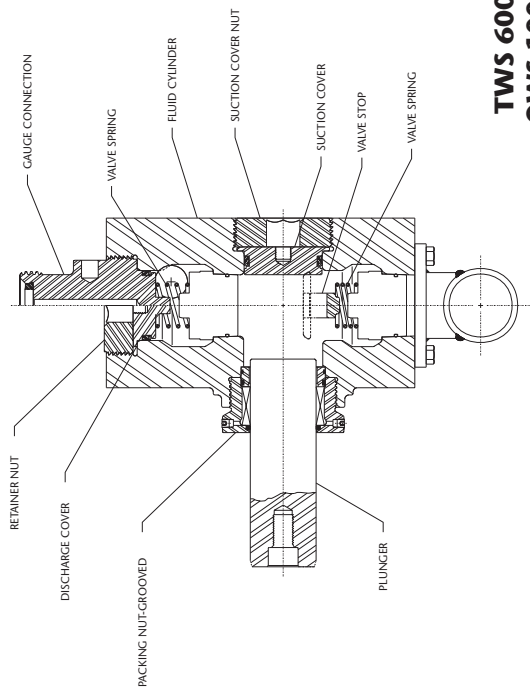
**TWS 500LW
ROUGH RIDER 500
HORIZONTAL VALVE
FLUID END**



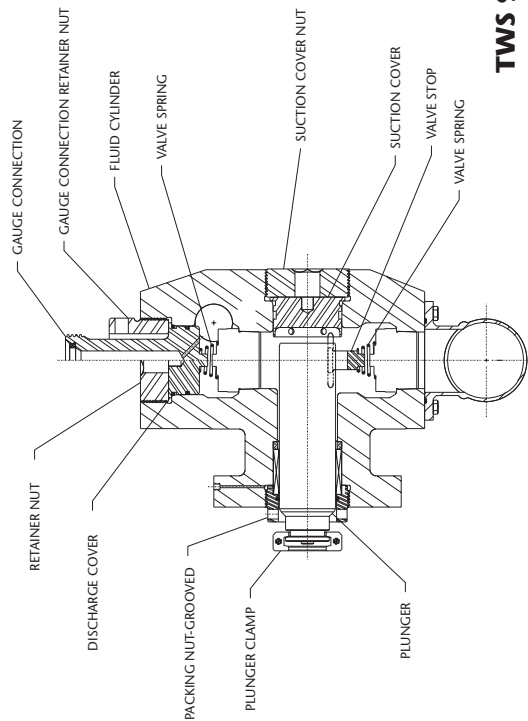
**TWS 500, TWS 600,
ROUGH RIDER 500
VALVE OVER VALVE FLUID END**



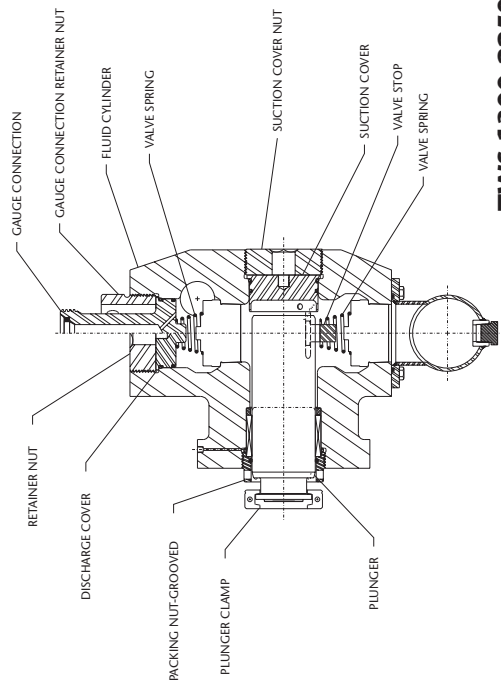
**TWS 500, TWS 600 UNIBLOCK
VALVE-OVER-VALVE FLUID END**



TWS 600S FLUID END
QWS 1000S FLUID END



TWS 900 FLUID END



QUINTUPLEX HAS FIVE CYLINDERS

**TWS 1300-2250, QWS 2000 - 2500
FLUID END**



WELL SERVICE PUMP REFERENCE GUIDE

PUMP MAINTENANCE RECORDS

LIBERTY EXHIBIT 1061, Page 57

Liberty Energy, Inc. and Liberty Oilfield Services LLC v. U.S. Well Services, LLC, IPR2024-01274

PUMP MAINTENANCE RECORD

MAINTENANCE LOGS ALSO AVAILABLE FROM WEIR SPM

PUMP DESCRIPTION:							UNIT NO.	
HORSEPOWER	PART NO.	REPLACEMENT			REPLACEMENT		REPLACEMENT	
SERIAL NO.		DATE	HOURS		DATE	HOURS	DATE	HOURS
PLUNGER								
HEADER RING								
PRESSURE RING								
WIPER RING								
SPACER								
ADAPTER								
LANTERN RING								
SUCTION VALVE								
DIS VALVE								
INSERT (SUC)								
INSERT (DIS)								
SEAT (SUCTION)								
SEAT (DISCHG.)								
VALVE SPRING								
COMMENTS:					COMMENTS:			



TROUBLESHOOTING GUIDE

PACKING, PLUNGERS, VALVES & SEATS, AND WELL SERVICE PUMPS

TROUBLESHOOTING GUIDE

PACKING

TROUBLE SYMPTOM:

- A. Significant leakage upon immediate startup with priming of the pump on individual or all plungers.**
Appearance of packing new or unused.

PROBABLE CAUSE & SOLUTION:

1. *Cause:* Packing in backward.
Solution: Remove packing. Make sure the seal rings and packing assembly are installed correctly with V of the seal rings facing the internal chamber of the cylinder.
2. *Cause:* Incorrect size packing.
Solution: Remove packing and check with plunger for fit. Packing should be snug to tight on the plunger. Verify that the packing size is correct. Contact Weir SPM for any possible size problems.
3. *Cause:* Incorrect adjustment.
Solution: Follow instructions for proper adjustment.
4. *Cause:* Incorrect length of packing assembly.
Solution: Remove packing. Review drawings and dimensions of packing assembly and stuffing box to assure that proper adjustment can be accomplished within the available envelope.

5. *Cause:* Packing very cold or frozen. Packing may be broken or deformed.
Solution: Remove and replace packing assemblies. Prime pump with warm fluid (water, oil etc.) and run pump until fluid cylinders are warm throughout. If possible, warm pump fluid cylinders with air blowers or heaters before commencing pumping operations.
6. *Cause:* Plunger settles on the side of the packing during transport and causes deformation.
Solution: Remove and replace packing assemblies.

B. Packing running very hot immediately upon start of pumping. Individual or all plungers.

1. *Cause:* Fluid cylinder not filled or pump not properly primed. Packing appears burned or scorched. Some deformation of seal rings and brass will have black or dark streaks across the I.D.
Solution: Remove and replace packing. Make sure that all cylinders are fully primed. Check all valves to make sure they are not stuck and operate properly. Run pump slowly until it is fully primed and operable.
2. *Cause:* Metal components in packing assembly incorrect size or eccentric. Some metal parts will have discolored or burned streaks across the I.D.

Solution: Remove packing assembly and check with

micrometer for proper size. If micrometer is not available check brass metal rings over the plunger for proper fit both for size and eccentricity (egg shaped). Never reuse eccentric metal or brass rings. Metal rings should slide freely over the full length of the plunger. Check the plunger for over-size dimension and for "roundness". Check plunger for possible tapering caused by improper grinding of surface.

C. Packing becomes very hot immediately after the pump reaches running pressure. Individual or all Plungers.

1. Cause: *Insufficient packing lubrication.*

Solution: Check lubrication reservoir to verify that it is full and the system is operating properly at all plungers. Make sure to use the proper and recommended lubricating oil in sufficient amounts. Larger plungers take more lubricant than small plungers.

2. Cause: *Discharge valve stuck open or washed out. This allows discharge pressure to stay on the packing at all times, limiting the packing's ability to relax and become lubricated. This can happen at any time during pumping.*

Solution: Replace with a good discharge valve. Replace packing assembly with new set.

3. Cause: *Misalignment due to "burrs" on the mating faces of the pony rod and/or plunger.*

Solution: Visually inspect whether the connection is

aligned. Remove plunger from pony rod and check both surfaces for irregularities. If plunger has been resurfaced, or refurbished, check for "squareness" or whether its mating surface is perpendicular to the barrel.

4. Cause: *Packing too loose, letting fluid into the voids of the packing causing hydrostatic pressures in excess of operating pressure. Prevalent in multiple ring sets.*

Solution: Check with Weir SPM for proper adjustment instructions.

5. Cause: *Very rough plunger surfaces.*

Solution: Remove plunger and check finish. Surface should be extremely smooth without grooves, nicks, or scratches. Some feel that an RMS finish of 4 to 5 will be too smooth for lubricant to provide a satisfactory film thus causing heat. A finish above 16 RMS will cause excessive packing wear and heat.

6. Cause: *Improper filling of the pump cylinders causing cavitation.*

Solution: Make sure the pump is operating properly with adequate supercharging. High viscosity fluids or high pump speeds can cause problems. It may be necessary to slow pump or to increase charge pump pressure.

7. Cause: *Hot fluids being pumped. Packing will appear hard and brittle. Potential for I.D. of packing rings to break and slough off.*

Solution: Check with Weir SPM on the high temperature limits of the packing components.

composition rings will deteriorate in fluids above 200°F. The temperature in the stuffing box will be much higher due to the additional sliding friction. It may be necessary to use a higher temperature elastomer such as HNBR; or a fluoroelastomer such as Viton, Fluorel or Aflas.

D. Packing running hot after 1 to 2 hours of operation. All or individual plungers.

1. Cause: *Fluid being pumped is corrosive and attacking the packing materials.*

Solution: Determine the exact makeup and composition of the fluid being pumped and the packing material. Contact Weir SPM for material compatibility. Some common fluids such as #1 diesel, toluene, zylene, over 15% HCL, synthetic gels, kerosene, and naphtha will present problems for low-to-medium acrylonitrile (Buna N) pressure rings. It may be necessary to replace packing rings with a ring molded from a more corrosion or heat resistant material.

E. Short or unacceptable life during normal operations. Individual or all plungers.

1. Cause: *Damaged header ring from lack of lubrication at startup. Insufficient lubrication at startup can cause the header ring to stick to the plunger causing tearing during the first stroke. This problem has the greatest potential when the pump has been idle and any residual plunger lube has drained from*

the surfaces.

Solution: Replace damaged packing and adjust packing lube. Lubrication should flow freely to plunger prior to stroking the pump. Although conditions will vary, generally twenty (20) drops per minute lube oil rate is recommended.

2. Cause: *Plunger lubrication system running out of oil.*

Solution: Keep lubrication reservoir supplied with oil at all times and fully operational. Put an alarm on the device to announce low lubrication supply.

3. Cause: *Low suction pressure or inadequate fluid volume to the pump during changeovers from one tank to another. This allows pump to run dry and cavitate.*

Solution: Plan pumping operations to allow for smooth changeovers during course of the job.

4. Cause: *Abrasives causing plunger scoring or excessive plunger wear.*

Solution: Review packing assembly. Consult with Weir SPM for best assembly for abrasive materials. Scoring can result from large dry particles of material from previous jobs breaking off the equipment and going through the pump. Attention should be given to cleaning the equipment "well" after each job.

5. Cause: *Oversized, egged, or worn brass of metal components.*

Solution: Replace all worn or oversized brass or metal components. Discard the old parts immediately.

6. Cause: Worn Plungers.

Solution: Remove and replace worn-out plungers.
Discard worn plungers.

7. Cause: Worn or grooved stuffing boxes. Stuffing boxes will also wear out, although usually slower than plungers. With stuffing boxes, the wear appears as grooves in the I.D. The deepest groove will be adjacent to the last ring in the stuffing box (ring farthest from pressure).

Solution: Remove and replace stuffing box with a new or rebuilt unit. If stuffing boxes are to be rebuilt, they should be returned to the manufacturer. Extreme care and attention should be given to assuring the surfaces are smooth, parallel and perpendicular to the gland and bottom of the stuffing box.

8. Cause: Corrosive attack on metal or brass components in all cylinders. The metal will appear black, charred, blue, brittle or otherwise deformed.

Solution: Determine the exact composition and chemical makeup of the material being pumped. Higher or stronger concentrations of fluids being pumped will cause greater damage than lower strength materials. Check with Weir SPM and compatibility charts. Close attention should be given to strength and concentration of materials. Replace all components with a satisfactory material. Check with Weir SPM regarding the metal components. Determine the suitability of the material being used. Many brass

based metals look alike. Generally, the higher strength bronze should be used. Standard brass should not be used. It may be necessary to use stainless steel or other material.

9. Cause: Excessive plunger wear during a job. Plunger will appear dull gray in color or show excessive streaks and scoring. A dull gray rough appearance is generally caused by caustic material attack. Excessive streaks and scoring can occur on hardened steel plungers (not coated) due to oxidizing (rust) while sitting between jobs.

Solution: Check with Weir SPM regarding the plungers to determine the specifications on the matrix of the spray metal plunger. It may be necessary to change surface materials. Check with compatibility charts for suitable matrix materials. For standard hardened steel plungers, it will be necessary to remove them from the pump between jobs and coat them with a heavy grease or cosmoline to keep rust from attacking them.

10. Cause: Loose gland and subsequent loose packing.

Solution: When using a spring loaded or header ring packing assembly, the gland should be tightened as tight as possible since it is a metal-to-metal assembly. Occasionally due to vibration or other factors, the gland will loosen. It is a good practice to check the glands for tightness before each job. For adjustable packing assemblies, the adjustment should be made while the pump

is running. Tighten with spanner or bar furnished with the pump. **Use trained personnel only. Make sure to take all safety precautions and use complete safety gear.** Experience will govern how tight is correct. On adjustable assemblies, the gland has a tendency to loosen so the gland should be checked at least once an hour.

11. Cause: *Broken spring from a spring loaded packing assembly, causing plunger scoring.*

Solution: There is too much friction between the packing and plunger causing the packing to "stick" to the plunger, thus crushing or compressing the spring on every stroke. This chucking motion will fatigue the spring wire and cause it to break. There is then danger that the loose spring will score the plunger. Remove packing and plunger. Replace with new plunger and packing assembly. Determine the cause of the rough plunger and if there is any softening of the packing from the fluid being pumped. Also make sure lubricator is operating properly. If this happens often, check with Weir SPM regarding plunger surface material and packing selection.

F. Excessive leakage of packing oil between the plunger and the rod wiper.

1. Cause: *Worn or blown rod wiper. Excessive packing lube pressure.*

Solution: If it is worn, replace the rod wiper ring. If it is

blown, check the packing lube pressure. It should not exceed 30 psi. The packing lube system should have a 30 psi relief valve, if it is equipped with an air powered lube pump. If it is an air over oil system, the air regulator should not exceed 30 psi.

TROUBLESHOOTING GUIDE PLUNGER

TROUBLE SYMPTOM:

A. Extreme wear on stuffing brass, or brass worn eccentric, or egg shaped.

PROBABLE CAUSE & SOLUTION:

1. Cause: *Incorrect dimensions on brass. The brass I.D. is too large, letting the packing push the plunger to one side. This allows the packing to extrude through the open side. It also allows the plunger to rub against the brass, causing eccentric wear.*

Solution: Remove brass and discard immediately. Replace brass with correct dimensions.

2. Cause: *Incorrect "brass" materials.*

Solution: It is difficult to determine the difference in "brass" metals with a visual inspection. The correct material must be used for satisfactory service. Replace with higher grade bronze. Check with Weir SPM. Commercial brass, 660C brass or similar material will not

performs satisfactorily.

3. Cause: *Misalignment.*

Solution: Check alignment of crosshead to end of the plunger. Especially check connection between crosshead and pony rod. Inspect threads or clamp ends on the plunger (as it attaches to the pony rod) for burrs, cross-threading or any aggravating factors. Remove burrs or replace non-conforming component.

4. Cause: *Plunger ground eccentric or tapered.*

Solution: Remove plunger from pump and check for roundness and for taper. This can be done by rolling on a "flat" surface. If eccentric, the plunger will "jump" or not roll evenly on the surface. If the plunger is tapered it will roll in a circle with the small end toward the center of the circle. Replace with correct plunger.

5. Cause: *Plunger is hollow with insufficient barrel wall thickness to hold shape at pumping pressures. Indications will reflect an hourglass shape to the plunger and possible eccentric wear on the brass.*

Solution: Check on the maximum pressure allowed per plunger size.

6. Cause: *Large heavy plunger causing it to ride on the bottom of the packing/brass assembly.*

Solution: Check on an alternate packing with more metal support in the packing/brass or on a lighter weight hollow plunger.

7. Cause: *Brass O.D. too small or the stuffing box I.D. is worn or machined too large. This lets the I.D. of the brass rings ride on the plunger and*

does not support the plunger or packing.

Solution: Disassemble pump and measure the I.D. of the stuffing box. Check the O.D. of the brass rings for correct dimensions. Check with manufacturer for correct dimensions on the brass and stuffing box.

8. Cause: *Pump has been idle for a long period. The weight of the plunger has caused it to distort the packing and contact the brass.*

Solution: Replace packing and brass.

TROUBLESHOOTING GUIDE VALVES AND SEATS

TROUBLE SYMPTOM:

A. Eroded Insert

PROBABLE CAUSE & SOLUTION

1. Cause: *Chemical attack on the insert, usually acid.*

Solution: Determine the exact makeup of the fluid being pumped. Various elastomers are available that will perform in specific well service fluids. It may involve higher acrylonitrile rubber content or better polyurethane materials.

B. Swollen Valve Inserts

1. Cause: *Pumped fluid contains a high aromatic, low aniline solvent.*

Solution: Determine the exact makeup of the fluid

being pumped. Use high quality

polyurethane inserts. Use high temperature acrylonitrile rubber inserts for temperatures above 200°F operations. Check with Weir SPM.

C. Washout on the seat taper.

1. Cause: *Improper installation. The pump deck not cleaned and prepared properly. Probably a metal burr or some type of particle between seat and pump deck in the taper not allowing the seat to bottom properly.*

Solution: Hand deburr or polish where possible. If wash is severe check with Weir SPM to determine if the fluid cylinder can be repaired by welding. In some low-pressure fluid ends, it is possible to use some metal cast materials to repair the washout. This is only to temporary fix and a permanent repair or placement should be done as soon as possible.

D. Washout between the valve and seat. Many times the washing will erode away all or part of the valve guide leg.

1. Cause: *Seal failure of the valve insert. Continued running of the pump after the initial seal failure causes severe washing.*

Solution: Pay attention to gauges and smooth operation of the pump. A washed out valve will cause pressure fluctuations, a reduction in volumetric efficiency and rough pump operation.

E. Multiple small washes, uniformly distributed around the seating surface of the valve (below the insert).

1. Cause: *Insufficient valve lift due to stiff spring. Incorrect adjustment and/or installation of upper valve guide stop. Also incorrectly substituting seats.*

Solution: Use only correct seats and valves. Use appropriate spring with specified spring compression strength. Pay attention to installation and adjustment of valve stops. Check with Weir SPM for correct spring strength and adjustment of upper valve guide stop.

F. Excessive metal wear on the seating surface of the valve and seat. Also valve pounding.

1. Cause: *Excessive valve lift due to a weak spring. Incorrect adjustment and/or installation of upper valve guide stop. Also incorrectly substituting seats.*

Solution: Check with Weir SPM for correct spring compression and strength. Check also for adjustment on upper valve guide stop. Use correct valve and seat combinations.

G. Pitting on the sealing surface of the seat. Continued pumping leads to wash between the valve and the seat.

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1. Cause: *Pumping an extremely corrosive fluid; usually high concentrations of hydrochloric acid.*
- Solution: Determine the exact makeup of the fluid being pumped. Check with Weir SPM for metallurgy of valves and seats to determine compatibility. It may be necessary to use different materials.

H. Depressions in the seating surface of the seat; many times referred to as ball bearing indentions or marks.

1. Cause: *Entrapped air in pumped fluid, particularly viscous frac gels. Air bubbles trapped between the valve and seat during closure undergo explosive decompression when the valve opens, causing the damage.*
- Solution: Review the suction conditions of the pump and the fluids being pumped. It may be necessary to slow pump or increase suction pressure from auxiliary blender or feed pump.

I. Valve seat jumps out of the pump deck.

1. Cause: *Pump deck has not been properly cleaned and prepared when changing out old valve for new valve.*
- Solution: Remove old or worn valve seat using the valve seat puller available through Weir SPM. Clean the pump deck with solvent. Inspect for any nicks or burrs. Take a piece of steel wool and clean deck with circular motion.

Clean top to bottom. Take new seat and clean any oil or grease from the taper. Place seat in pump taper bore and drop in place. Take an old valve body and place in the newly installed seat. Strike firmly on top of valve to "seat" the new valve seat in place in the pump deck.

2. Cause: *Pump deck worn "egg shaped" or eccentric in the pump.*
- Solution: This is not a common occurrence but it does happen. It is possible it can be repaired. More than likely the cylinder will have to be replaced and discarded. Check with Weir SPM.

K. Insert jumps off the valve body.

1. Cause: *Can be caused by poor suction conditions and incorrect valve springs.*
- Solution: Check suction conditions to assure proper filling of the pump. Check the strength of the valve spring. A lighter or heavier spring may be needed. Check with Weir SPM.
2. Cause: *Material being pumped is too hot for the valve insert elastomer.*
- Solution: Check specifications on the elastomer. The standard polyurethane insert will perform up to 180°F. Above 180°F, the material will soften and depending on the material being pumped and job length, the insert will "dissolve" and disappear. Higher temperature materials are available for long and hot, high temperature jobs.

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3. *Cause: Material being pumped is corrosive to elastomer in valve insert.*

Solution: Determine the specifications of the material being pumped and the type of elastomer insert being used. Determine compatibility. Select the correct material to be used in the corrosive service.

L. Excessive wear on valve body and seat.

1. *Cause: Improper filling of pump causing valves to pound.*

Solution: Check the suction conditions of the pump with regard to viscosity of materials, abrasive index of the material being pumped and lifted. This wear can also be a function of pump speed in conjunction with these conditions. Check the valve spring strength.

TROUBLESHOOTING GUIDE PUMPS

TROUBLE SYMPTOM:

A. Abnormally high vacuum at power end lube pump suction inlet (may or may not be accompanied by abnormally low oil pressure).

PROBABLE CAUSE:

1. Extremely cold ambient temperature/dangerously high oil viscosity.
2. Clogged lube system suction strainer.
3. Kinked or collapsed lube system suction hose.

4. Clogged oil reservoir breather.

5. Erroneous gauge reading.

TROUBLE SYMPTOM:

B. Abnormally low power end lube oil pressure with normal to low vacuum reading at lube pump suction (may or may not be accompanied by high oil temperature.)

PROBABLE CAUSE:

1. Leak in lube pump suction piping which allows air to be drawn into the system.
2. Worn or damaged lube pump.
3. Leak in lube pump pressure piping.
4. Low oil level in reservoir.
5. Clogged oil filter element.
6. Faulty lube system relief valve.
7. Extremely hot lube oil temperature/dangerously low oil viscosity.
8. Erroneous gauge reading.

TROUBLE SYMPTOM:

C. Abnormally high power end and/or reduced lube oil temperature (may or may not be accompanied by low oil pressure).

PROBABLE CAUSE:

1. Extremely warm ambient temperature/dangerously low oil viscosity/incorrect grade of gear oil.
2. Gear oil contaminated with water, trash, or air bubbles.
3. Plunger pump has been operated continuously for too long a period of time at or near it's maximum horsepower or maximum torque rating.
4. Heat exchanger or oil cooler malfunction.
5. Excessive amount of lube oil around gearing.
6. Internal power end damage or power end wear.
7. Erroneous gauge reading.

TROUBLE SYMPTOM:

D. Leaking power end oil seals.

PROBABLE CAUSE:

1. Extremely cold ambient temperature/high oil viscosity.
2. Damaged seal surface on mating part.
3. Clogged oil breather/high crankcase pressure.
4. Worn or damaged seal.
5. Contaminated lube oil.

TROUBLE SYMPTOM:

E. Leaking fluid end seals.

PROBABLE CAUSE:

1. Seal installed improperly.
2. Seal cut or pinched on installation.
3. Mating seal surface not cleaned properly prior to seal installation.

4. Damaged or corroded mating seal surface.
5. Sealing part not properly tightened

TROUBLE SYMPTOM:

F. Fluid knock or hammer.

PROBABLE CAUSE:

1. Air entering supercharge system through loose, worn or damaged connections.
2. Air entering supercharge system through leaking charge pump seals.
3. Fluid being pumped contains gas or vapor.
4. Insufficient supercharge flow or pressure.
5. Valve cocked open/broken valve spring or valve stop.
6. Worn or damaged valve, valve insert, or valve seat.
7. Improperly charged or ineffective suction pulsation dampener.

TROUBLE SYMPTOM:

G. Low discharge pressure/rough running pump.

PROBABLE CAUSE:

1. Worn or damaged valve assembly.
2. Insufficient supercharge flow or pressure.
3. Air, gas, or vapor in fluid being pumped.
4. Improperly charged or ineffective suction pulsation dampener.
5. Two or more plunger pumps being supercharged by a

common charge pump and getting "in phase" with each other.

TROUBLE SYMPTOM:

H. Shavings or metal particles in power frame and/or reducer. Shavings or metal particles in pump lube strainer.

PROBABLE CAUSE:

1. Remnants of manufacturing process. A small amount after initial run-in is to be expected and should be considered benign.
2. Evidence of bearing or gearing deterioration.

TROUBLE SYMPTOM:

I. Leaking Covers

PROBABLE CAUSE:

1. Loose cover bolts.
2. Damaged cover gasket.
3. Inadequate cover sealant.
4. Cracked frame causing excessive flexing.

TROUBLE SYMPTOM:

J. Broken stay rods.

PROBABLE CAUSE:

1. Loose stay rod nuts, due to incorrect torque, causing remaining stay rods to support higher loads.
2. Incorrect stay rod design including thread profile and surface prep.

ROUTINE PREVENTATIVE MAINTENANCE WELL SERVICE PUMPS

Maximum service and trouble-free operation can be obtained from the Weir SPM plunger pump by establishing a thorough preventative maintenance program as follows. This is true for other pump brands as well.

!!WARNING!!

**MISUSE, SIDE LOADING, IMPROPER
MAINTENANCE, OR DISASSEMBLY WHILE
IN MOTION OR UNDER PRESSURE
CAN CAUSE SERIOUS INJURY OR DEATH!**

During the first 100 hours of new pump operation:

- Change power end lube oil filters every 25 hours or more often if required to prevent filter bypass.
- Change or thoroughly clean the power end lube oil suction strainer after 50 hours of operation and 100 hours of operation.
- Change the power end lube oil after the first 100 hours of operation and clean the lube oil reservoir.

Daily Preventative Maintenance:

- Check the oil level in the power end lube oil reservoir.
- Check the oil level in the plunger lube oil reservoir.
- Check the plunger pump for oil leaks and /or fluid leaks.
- Check the power end lube oil system for leaks.
- Check the plunger lube system for leaks.
- Check the supercharge piping for leaks.

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Weekly Preventative Maintenance:

- Check all items on "daily" list.
- Check all valves, inserts, valve seats, and springs.
- Check all discharge & suction cover seals.
- Check suction pulsation dampener for correct pre-charge.

Monthly (or every 100 hours)

Preventative Maintenance:

- Check all items on "daily" and "weekly" lists.
- Check all fluid cylinder mounting bolts to insure that they are tight.
- Check all plunger pump mounting bolts to insure that they are tight.
- Change power end lube oil filters.
- Check all supplies needed for routine maintenance such as O-rings, fluid seals, valves, valve inserts, valve seats, valve springs, packing, oil seals, filter elements, etc.

Quarterly (or every 250 hours)

Preventative Maintenance:

- Check all items on "daily", "weekly", and "monthly" lists.
- Change the power end lube oil and refill with the proper grade of gear oil for upcoming ambient conditions.
- Change or thoroughly clean the power end lube oil suction strainer.
- Remove and inspect the plungers and packing assembly components. Replace all packing pressure rings and header rings.
- Change or clean the plunger pump's oil breathers and the power end lube oil reservoir breather.

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Yearly (or as required) Preventative Maintenance:

- Replace worn plungers and packing brass.
- Replace worn or corroded valve covers, suction valve stops, packing nuts, discharge flanges, pump tools, etc.
- Replace the discharge flange seals and suction manifold seals.
- Replace any defective gauges and instruments. Inspect and repair the power end lube oil pump.

FLUID END MAINTENANCE PROCEDURES

Note: Always verify that the system is not under pressure and no pressure is retained in the system. Always be attentive to components and safe handling procedures. Improper handling or working on equipment under pressure can cause serious injury or death. Always use proper safety gear including hand and eye protection and be careful of gears and moving parts.

A. Replacement of Valves and Seats:

1. Remove and inspect the suction covers and discharge covers from the fluid cylinder. *(Use the Weir SPM 2" hex cover wrench and a 10 lb hammer if you are working on a Weir SPM or similar product or when refurbishing a TWS 250 or TWS 400. You will remove the six nuts from the studs that hold the suction and discharge covers on).* Also inspect the threads and seal surfaces of the fluid cylinder.

2. During the replacement of valves and seats, removal of the plungers is not necessary. However, be sure to rotate the pump until the plunger in the cylinder is clear of the valve stop and seat prior to removal.

3. Turn the suction valve stops approximately 90 degrees and remove them from the fluid cylinder along with the valve springs underneath them.

4. Cock each suction valve to one side in order to drain any fluid standing over it, and remove the valve from the fluid cylinder *(the Weir SPM hydraulic seat puller and the*

Weir SPM valve removal tool can be used). Follow the valve manufacturer's recommendation for removing the insert from the valve.

5. Remove the discharge valve springs and discharge valves from the fluid cylinder.

6. Remove each of the discharge valve seats and suction valve seats *(Use the Weir SPM hydraulic seat puller if you are working on a Weir SPM product).* Inspect the taper and seat deck.

7. The tapered valve seat bore in the fluid cylinder must be thoroughly cleaned and lightly hand polished with a 220 to 240 grit emory cloth prior to installing new valve seats.

8. Always install a new o-ring seal when reinstalling a valve seat. Do not use any type of grease, sealer, etc. The valve seat must be installed dry. Upon installing the valve seat hand tight, install the valve in the seat and place a heavy steel bar on top of the valve. Tap the hammer on the top of the bar to push the valve seat into the taper.

9. When reinstalling the valves, do not mix one manufacturer's valve with another manufacturer's valve seat. Likewise, do not mix one manufacturer's valve insert with another's valve.

10. When reinstalling the suction valve stop, make certain it is turned perpendicular to the plunger and securely seated. For Weir SPM Fluid Ends, the stop must securely seat in the groove.

11. Before reinstalling the discharge and suction covers,

remove the seals from each, clean the covers thoroughly, and install new seals. Make sure that the seals are replaced in the proper position. Each cover bore in the fluid cylinder must be cleaned thoroughly and lightly hand polished with a 220 to 240 grit emory cloth prior to cover installation.

12. Apply a coating of oil or very light grease to the suction and discharge covers before installation. Be sure to tighten them securely.

B. Replacement of Plungers and Packing:

Note: On Weir SPM pumps, If you are replacing plungers or packing on a TWS 250, TWS 500LW, TWS 600S, or the TWS 1250LW, remove the plunger lube fitting from each packing nut. It is unnecessary to remove the lube fitting on other Weir SPM pumps. Always verify each seal, bolt, stud, nut, insert, etc, for wear or damage prior to reinstallation.

1. Loosen each of the packing nuts at least one full turn (Use the Weir SPM packing nut tool if you are working on a Weir SPM product).

2. Remove the suction covers as outlined earlier.

3. Unscrew the plunger from the crosshead and pull each plunger out of the fluid cylinder through the suction cover bore (Use the Weir SPM plunger wrench if you are working on TWS 500LW, TWS 600S, and TWS 1250LW pumps). Other Weir SPM pump models require the removal of the plunger clamps by using a 3/8" allen wrench to remove the two 1/2" SHCS. Care must be taken to keep contaminants from entering the power end section once the plunger is removed.

4. Secure the seal rings with the Weir SPM seal ring retainer or another suitable tool (*The seal rings are only present on the TWS 250 and TWS 600S pumps in the Weir SPM product line*). Completely remove each packing nut from the packing gland thread bore. The seal ring must remain in the cylinder while the packing nut is being removed. Once the packing nut is removed, the seal ring may then be removed from the cylinder. Label each packing nut on removal to ensure that they are installed back into the same bore. Inspect the cylinder and nut, including the threads and seal areas.

5. Inspect each plunger for wear, scoring, and corrosion on the hard surface area and damage to the face which mates with the crosshead.

6. Inspect each ring of packing brass for excessive wear, damage, egging, and scoring. Never reuse any packing brass that is egged, scored or damaged.

7. Blow air through the lube port on each packing nut to ensure that the lube passage is unobstructed.

8. Each packing bore, both inside the packing nut and inside the fluid cylinder, must be thoroughly cleaned and lightly hand polished with a 220 to 240 grit emory cloth prior to packing reinstallation.

9. Using new packing header rings and new packing pressure rings, reinstall the packing assembly one piece at a time. Each ring should be installed with a coating of light oil only. Care must be taken to avoid damaging the internal and external sealing lips of each packing ring. (*Refer to the packing diagram for the proper sequence and direction of installation.*)

10. On Weir SPM TWS 250 and TWS 600S pumps, replace the O-rings and back-up rings in the steel seal rings and dress the seal areas in both the fluid cylinder and packing nut with 220 to 240 grit emory cloth. Reinstall the seal ring as shown in the packing assembly diagram. If the seals are installed backwards, a leak will occur.

11. Reinstall each packing nut into its proper cylinder, screwing it all the way in until tight, then backing it off one to two turns.

12. Coat the hard surface area of each plunger with a light oil and insert it into the packing. Using a short 4" x 4" piece of wood and a 12 lb. hammer, bump the plunger into the packing while holding it as straight as possible with the packing bore centerline. Continue bumping the plunger through the packing until the threaded bore approaches the crosshead threads or the pony rod depending on the Weir SPM pump model (See section B3.) Carefully align the plunger to the crosshead or pony rod and gently bump the plunger up against it.

13. Tighten the plunger to the proper torque specifications. Refer to the torque table on page 93. *(Use the Weir SPM plunger wrench if you are working on a Weir SPM product).*

14. Tighten each packing nut as tight as possible *(Use the Weir SPM packing nut wrench if you are working on a Weir SPM product).* Note: The packing nut will need to be retightened only once after the pump is reassembled and run under pressure for a short period of time. After that, the packing is completely self-adjusting.

15. Reinstall the packing lube fitting into the packing nut.

16. Reinstall the suction covers as outlined earlier.

INSTALLATION SUMMARY

Valves and Seats (All Weir SPM Pumps and Similar Pumps):

- Replace the O-Rings on the valve seat. (Install O-Ring Dry).
- Hand tighten the valve seat into the taper. (Do not use any grease).
- Place the valve into the seat. Using a steel bar, lightly tap on the bar with a hammer to push the valve seat into the taper.
- Do not mix one manufacturers valve with another manufacturers valve seat. Likewise, do not mix valve inserts with another manufacturers valve.
- Place the spring on top of the valve.
- Place the valve stop on top of the spring.
- Push the suction valve stop down and turn until it is secure and perpendicular to the plunger.
- Remove the seals from each of the discharge and suction covers.
- Clean the covers thoroughly and hand polish with 220 to 240 grit emory cloth.
- Replace each seal.
- Coat with oil or light grease and secure them with a 2 inch hex cover wrench and a 10 lb hammer.

Plungers and Packing (THB 175, THB 350, TWS 250, TWS 600S, and Similar Pumps):

- Using new header rings and new packing pressure rings,

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reinstall the packing assembly one piece at a time.
(Coat with a light oil)

- Replace all o-rings and back-up rings in the steel seal rings and dress the seal areas in both the fluid cylinder and the packing nut using 220 to 240 grit emory cloth.
- Install each packing nut into its proper cylinder, screwing it all the way until tight, then back it off one to two turns.
- Coat the hard surface area of each plunger with a light oil and insert it into the packing.
- Using a short 4x4 wooden block and a 12 lb. hammer, bump the plunger into the packing while holding it as straight as possible.
- Continue bumping the plunger through the packing until the threaded bore approaches the crosshead threads.
- Tighten the plunger to the crosshead. (*Use the Weir SPM plunger wrench if you are working on a Weir SPM product.*)
- Tighten each packing nut as tight as possible (*Use the Weir SPM packing nut wrench if you are working on a Weir SPM product*). The packing nut will need to be retightened only once after the pump is reassembled and run under pressure for a few revolutions.
- Reinstall the packing lube fitting into the packing nut.
- Reinstall the suction covers as outlined in the fluid end maintenance procedures.

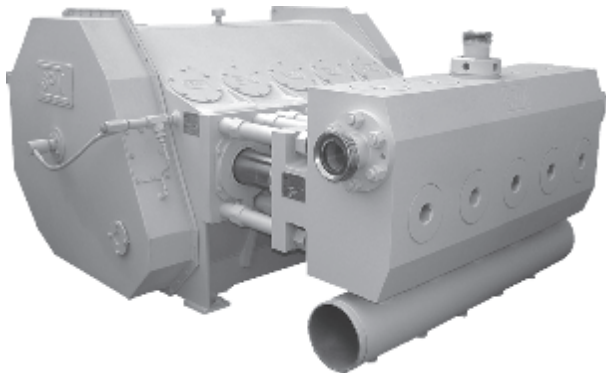
Plungers and Packing (All Other Weir SPM and Similar Pumps):

- Using new header rings and new packing pressure rings, reinstall the packing assembly one piece at a time.
(Coat with a light oil)
- Install each packing nut into its proper cylinder, screwing it all the way until tight, then back it off one to two turns.
- Coat the hard surface area of each plunger with a light

oil and insert it into the packing.

- Using a short 4x4 wooden block and a 12 lb. hammer, bump the plunger into the packing while holding it as straight as possible.
- Continue bumping the plunger through the packing until the plunger makes contact with the pony rod.
- Using a 3/8" hex key or socket, install and tighten the plunger clamp screws.
- *Tighten each packing nut as tight as possible (Use the Weir SPM packing nut wrench if you are working on a Weir SPM product).* The packing nut will need to be retightened only once after the pump is reassembled and run under pressure for a few revolutions.
- Reinstall the packing lube fitting into the packing nut.
- Reinstall the suction covers as outlined in the fluid end maintenance procedures.

WEIR SPM PRODUCT SAFETY GUIDE FOR WELL SERVICE PUMPS



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.

!!WARNING!!

MISUSE, SIDE LOADING, IMPROPER MAINTENANCE, OR DISASSEMBLY WHILE IN MOTION OR UNDER PRESSURE CAN CAUSE SERIOUS INJURY OR DEATH! ALWAYS USE PROPER SAFETY GEAR INCLUDING HAND AND EYE PROTECTION AND BE CAREFUL OF GEARS AND MOVING PARTS.

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The following information is given in good faith and should aid in the safe use of your Weir SPM products. This information is not meant to replace existing Company's safety policies or practices.

Personal Responsibilities:

Only properly trained personnel should be allowed to maintain and repair well service pumps.

A-1 When working on the pump, safety glasses, approved safety shoes and hard hat must be worn. Hammering on any part or component may cause foreign material or steel slugs to become airborne.

A-2 Personnel should only hammer on the Weir SPM hammer wrench provided and never directly on the pump itself. Fractures can occur from repeated misuse. Only soft-type hammers should be used.

A-3 Personnel should never hammer on one of the valve retainer nuts or any other pump components when pressure is present. Personnel should never be around the pump when the input shaft is turning under power or the unit is under pressure.

A-4 When servicing the pump, do not lift any part in excess of 40 lbs. A lift device must be used in these cases. For parts weighting 40 lbs. or less, proper leg type lifts are essential. Do not lift with a back type lift.

A-5 It is a personal responsibility to use the proper tool when servicing the pump. Any special tools required are furnished with the pump when new, and should be kept with the pump for its routine maintenance. It is a personal responsibility to be knowledgeable and trained in the use and handling

of these tools for all maintenance of the pump. A pump is made up of internal and external moving parts. All personnel should be located away from the pump while in operation. Only trained personnel should be around the pump, especially during service or operation.

On Location:

B-1 Each pump is clearly marked with a maximum pressure rating. This pressure must not be exceeded or **SERIOUS INJURY OR DEATH CAN OCCUR!**

B-2 Each pump is clearly marked with a maximum horsepower rating. This horsepower rating should not be exceeded or mechanical damage can occur leading to **SERIOUS INJURY OR DEATH!**

B-3 The pump's discharge connections should be properly cleaned and lightly oiled before the downstream piping is attached. Any worn, damaged or missing seals should be replaced before engaging the pump's drive.

B-4 The pump's suction connections should be properly cleaned and lightly oiled before the supercharge hoses are attached. Any worn, damaged or missing seals should be replaced prior to pumping. Leaking connections can cause pump cavitation leading to equipment failure and subsequent injury or death.

B-5 A relief valve system must always be in place during pump maintenance and/or repair.

B-6 Any fluid cylinder which has been pressured beyond its specified working pressure should be

returned to Weir SPM for disassembly, inspection and recertification.

B-7 Welding, brazing or heating any part of the pump is prohibited. If accessories are to be used, they are to be bolted or clamped on. Consult factory.

B-8 The use of any Weir SPM well service pump in conjunction with the centrifugal supercharge pump feeding it will limit the maximum flow rating to that of the centrifugal or the well service pump; whichever is lower.

B-9 A complete visual inspection of the pump's power end and fluid end must be made prior to each use. Any leaking seals, broken bolts, leaking hoses or improperly tightened parts must be remedied prior to rotating the pump.

B-10 If a pump is used in a place where permanent piping is to be attached, frame flexing or structure movements must be considered. Do not place the discharge or suction connections in a bind. Inspect all components of such piping structure, including any valves, every 90 days for wash, erosion, corrosion, etc. Replace if worn.

B-11 Weir SPM well service pumps are to be installed and operated in a horizontal position only, as shown in the pump's service manual. Operation in an extreme inclined position could cause equipment failure, leading to injuries due to improper oil flow and/or improperly sealing valves.

B-12 All personnel should maintain a safe distance from the pump when it is rotating as well

as when pressure is present. Keep hands and clothing clear of unit at all times.

B-14 Any repairs or service (even routine maintenance) performed on the pump must be performed by a technician who is qualified to work on high pressure reciprocating plunger pumps. All such service and repairs must be supervised by qualified personnel or returned to Weir SPM for service. Only qualified replacement parts should be utilized. Failure to do so may result in loss of warranty as well as serious injury or death. Weir SPM provides a Pump Maintenance Mechanic Training School to qualify pump service mechanics.

B-15 Weir SPM well service pumps should never be used to pump gaseous, explosive or uninhibited corrosive fluids. These may result in equipment failure, leading to injury or death.

B-16 Never place hands in the area of reciprocating pony rod or plunger path. If work must be done in this area, make sure pump is disengaged from driver prior to initiating activity.

Special Precautions:

C-1 The modifications to or improper repair of components, can lead to pump damage or failure, and serious injury or death!

C-2 The pump's fluid end and related piping must always be flushed with clean water after every job. If freezing temperatures are anticipated, the fluid cylinder must be completely drained of any fluid. Failure to do this may result in fluid cylinder damage from fluids which have hardened or frozen.

C-3 Personnel must clear all pumps during operation. There is a clear and ever present danger from gears and other moving parts to loose clothing, hand, etc., that could lead to serious injury or death. Keep clear of moving or pressurized components.

C-4 All Weir SPM threaded components are right hand threaded unless specifically designated otherwise. Any turning counterclockwise will unscrew the assembly. Always make sure any threaded component is made up properly with the proper power torque make-up.

C-5 All products should be properly cleaned, greased or oiled after each use and inspected prior to each use.

C-6 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 straight integral connections are recommended under these conditions. In order to achieve the recommended Non-Shock Cold Working Pressure, power-tight make-up is required on threaded connections. Consult the factory for any usage other than normal constant flow working conditions. Integral connections are recommended in lieu of pipe threaded connections for pump applications.

C-7 Each integral union connection is clearly marked with a pressure code (i.e. "1502", 15,000 psi). This pressure must not be exceeded. This code should also be used with mating unions. Improper mating can result in failures. All integral union connections used must match according to

size, pressure rating, etc.). These connections must also match the service of the designated string they are installed in.

Inspection & Testing:

D-1 Each pump, its drive system, and its fluid piping should be visually checked each time before operating. All worn, damaged or missing parts should be remedied before starting the pump.

D-2 All fluid cylinder mounting nuts must be checked routinely with a certified torque wrench. Loose fluid cylinder mounting nuts can cause the fluid end to separate from the power end resulting in extreme injury or death.

D-3 All studs and stay rods require tightening to the proper torque. Without proper torque, the fluid end will "breathe" against the power end resulting in stud failure, stay rod failure and/or even premature fatigue failure in the power or fluid end. Consult Weir SPM for torque information.

D-4 All covers must be tight and properly torqued. Otherwise, premature fatigue and possible fluid end or component failure can result.

D-5 All fluid cylinders must be disassembled and dimensionally inspected routinely. Any fluid cylinder which exhibits any loss in wall thickness due to washing or corrosion pitting in any area must be returned to Weir SPM for repair and recertification prior to operating again.

D-6 All fluid cylinders must be disassembled and inspected for cracks with a suitable ultraviolet/light/magnetic particle inspection device on a routine basis. The operation of any pump with even small surface cracks in any area of the fluid cylinder can result in serious injury or death.

WEIR SPM PUMP AND FLOW CONTROL APPLICATION FORMULAE

1. Horsepower Formulae:

$$\text{Hydraulic Horsepower} = \frac{\text{GPM} \times \text{PSI}}{1714}$$

$$\text{Brake Horsepower} = \frac{\text{GPM} \times \text{PSI}}{1714 \times \text{ME}}$$

2. Fluid Flow Formulae:

$$\text{GPM} = \frac{(\text{Plunger Diameter})^2 \times 0.7854 \times \text{stroke length} \times \text{number of plungers} \times \text{RPM}}{231}$$

$$\text{GPM} = \frac{\text{BHP} \times 1714 \times \text{ME}}{\text{PSI}}$$

3. Pressure Formula:

$$\text{PSI} = \frac{\text{BHP} \times 1714 \times \text{ME}^*}{\text{GPM}}$$

4. Rod Load Formula:

$$\text{Rod Load (lbs.)} = (\text{Plunger Diameter})^2 \times 0.7854 \times \text{PSI}$$

5. Flow Velocity Formula:

$$\text{Flow Velocity (ft./sec.)} = \frac{\text{GPM} \times 0.3208}{\text{Internal Area}^{**}}$$

6. Torque Formula:

$$\text{Torque (ft. lbs.)} = \frac{\text{BHP} \times 5252}{\text{RPM}}$$

Notes to formulae above:

BHP Brake Horsepower
GPM Gallons Per Minute
*ME is usually 0.9 (90%) for Weir SPM pumps. Check with other manufacturers for their specs.
**Internal Area (inside diameter)² x .7854

CLEARANCE REQUIREMENTS

Bearings and Bushings

Wrist pins or bushings containing clearances greater than or equal to 0.010 inch should be replaced.

General Rule: 0.001 inch clearance per 1.000 inch diameter of the shaft/wrist pin.

Example: 6.000 inch shaft = 0.006 inch clearance.
3.000 inch wrist pin = 0.003 inch clearance over the bushing.

Crossheads and Crosshead Guides

The clearances vary between pump models.

Pump Model (Weir SPM)	Tolerance Requirements (Inches)	Tolerance not to Exceed (Inches)
TWS 250 & TWS 400	0.010 to 0.015	0.020
TWS 500, TWS 600 & TWS 600S	0.008 to 0.012	0.014
TWS 1000, TWS 1250 & TWS 1500	0.008 to 0.002	0.014
TWS 900, TWS 1300 through TWS 2250, QWS 2000 & QWS 2500	0.025 to 0.30	0.035

These rules do not apply to roller type bearings. Check maintenance manual for the clearances on roller bearings.

LIBERTY EXHIBIT 1061, Page 82

TORQUE TABLE

ALLOY STEEL STUDS, SAE GRADE 7		
DIA. IN.	DRY THREADS TORQUE FT. LBS.	LUBRICATED THREADS TORQUE FT. LBS.
1/4	8.3	6.2
5/16	17.2	12.9
3/8	30.5	23.9
7/16	48.8	36.6
1/2	74.5	55.8
5/8	148.0	111.0
3/4	262.0	196.0
7/8	425.0	318.0
1	635.0	477.0
1 1/8	900.0	675.0
1 1/4	1270.0	955.0
1 3/8	1660.0	1245.0
1 5/8		2300.0

CAPSCREWS & BOLTS, SAE GRADE 5		
DIA. IN.	DRY THREADS TORQUE FT. LBS.	LUBRICATED THREADS TORQUE FT. LBS.
1/4	6.7	5.1
5/16	13.9	10.4
3/8	24.7	16.5
7/16	39.4	29.6
1/2	60.3	45.2
5/8	120.0	90.0
3/4	212.0	159.0
7/8	315.0	236.0
1	472.0	354.0
1 1/8	633.0	475.0
1 1/4	900.0	675.0
1 3/8	1170.0	877.0
1 5/8		

To obtain the required torque on the 1 3/8" and 1 5/8" studs, use a hammer lug wrench after tightening with a standard wrench. Turn the nut another 30°(just less than 1/8 turn) with the hammer.

TORQUE TABLE

PONY ROD STUDS		
TYPE	LOCATION	TORQUE
TWS 400	Cross Head	675 (Thread Lock)
RR500	Cross Head	500 600 (Lubed)
TWS 500	Cross Head	675 (Thread Lock)
TWS 600	Cross Head	675 (Thread Lock)
TWS 600S	Cross Head	675 (Thread Lock)

PLUNGERS		
TYPE	LOCATION	TORQUE
TWS 400	Plunger	500 600 (Lubed)
RR500	Plunger	675 (Thread Lock)
TWS 500	Plunger	500 600 (Lubed)
TWS 600	Plunger	500 600 (Lubed)
TWS 600S	Plunger	500 600 (Lubed)

NOTES

[illegible]

- Well Service Pumps
- Plug Valves
- Swivel Joints
- Check Valves
- Relief Valves
- Hammer Unions
- Integrals
- Safety Products
- Sales
- Rental
- Refurbishment
- Testing
- Recertification
- Pump Repair
- Iron Management Program


 ISO
9001

DNV Certified

TORQUE CONVERSIONS/METRIC CONVERSIONS

TORQUE CONVERSIONS EQUIVALENTS POUND INCH - POUND FOOT - NEWTON METER

pound foot x 12 = pound inch
 pound foot x 1.356 = Newton meter
 Newton meter x 8.850 = pound inch
 Newton meter x .0737 = pound foot
 pound inch x .083 = pound foot
 pound inch x 0.113 = Newton Meter

METRIC TO ENGLISH CONVERSIONS ENGLISH TO METRIC CONVERSIONS

inches x 25.4 = millimeters (mm)
 inches x 2.54 = centimeters (cm)
 feet x .3048 = meters (m)
 yard x .9144 = meters (m)
 psi x .0689 = bar
 psi x .006894757 = Megapascals (MPa)
 psi x 6.894757 = kpa
 psi x .0703 = Kilogram force per square centimeter (Kgf/cm²)
 pound force x 4.448 = Newtons
 pound · inch x .113 = Newton · meters (N · m)
 pound · foot x 1.356 = Newton · meters (N · m)
 millimeter x .0394 = inch (in)
 centimeter x .3937 = inch (in)
 meters x 3.281 = feet (ft)
 meters x 1.0936 = yards (yd)
 bar x 14.5 = psi
 Megapascals x 145.0 = psi
 Kilogram force per square centimeter x 14.22 = psi
 Newtons x .2248 = pounds force (lb · f)
 Newton · meter x 8.850 = pound · inches (lb · in)
 Newton · meter x .737 = pound feet (lb · ft)

<https://web.archive.org/web/20100714080639/http://www.weiroilandgas.com/pdf/PUMP%20MONITORING%20DEVICE%20FLYER.pdf>



Pump Monitoring Device (PMD)

Protect your well service pumps with instant real time information during operation.

Weir SPM's PMD was developed to allow users to continually monitor the status of their pumps in real time. Information on the pump's current operation is constantly being fed and displayed to the customer in an easy to view format.

The PMD gives the user the opportunity to make the necessary changes during operation to minimize or prevent costly damage to pumping equipment, and increase the longevity of their pumps.

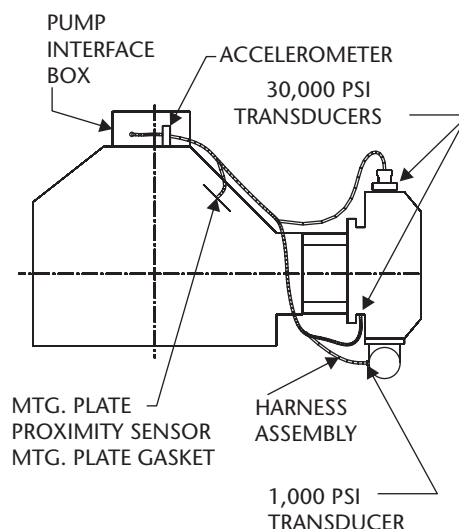


Now Available... REAL TIME DATA for unmatched pump troubleshooting capabilities.

The PMD System is easily installed and can transmit data directly to the data van on site. The system's software is both user-friendly and exceptionally informative. Detailed information is available for each equipped pump in operation, with alarms set up to warn users if an unfavorable condition occurs. Weir SPM's PMD is the ultimate tool to protect your pumps and operate at maximum efficiency.

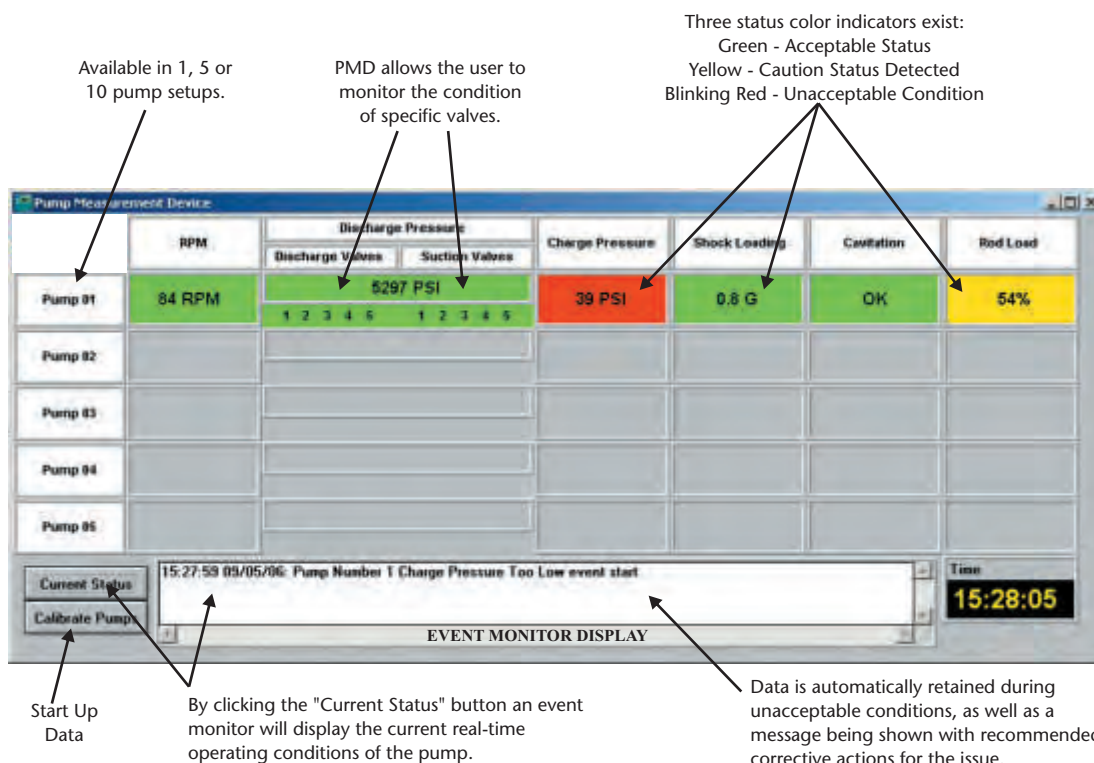
Consisting of a Pump Interface Box and various sensors on the pump, and a Data Interface Box with CPU located in the data van, the PMD will deliver information to monitors installed in the data van in real time. The PMD software will display vital information to the user and offer troubleshooting suggestions to allow the user to quickly respond to any issue with their equipment.

PMD Sensor Layout



Information Available:

- Pump Speed (RPM)
- Discharge Valve Status
- Suction Valve Status
- Discharge Pressure
- Charge Pressure
- Shock Loading
- Cavitation
- Rod Load



The PMD informs users on the current status of their pumps through status indicator "alarms". A wealth of information is available to the user in an accurate and easy to read format that is unmatched by any other system available to the market.

Weir SPM

7601 Wyatt Drive
Fort Worth
TX 76108
USA

Tel: (817) 246 2461
Fax (817) 246 6324

www.weiroilandgas.com



[https://web.archive.org/web/20090815221450/http://www.weiroilandgas.com/pdf/WEIR%20SPM%20GENERAL%20CATALOG%20\(0509\).pdf](https://web.archive.org/web/20090815221450/http://www.weiroilandgas.com/pdf/WEIR%20SPM%20GENERAL%20CATALOG%20(0509).pdf)

Weir SPM



Weir SPM

General Catalog

Well Service Pumps
Flow Control Products
Manifold Trailers
Safety Products
Post Sale Services

The sun never sets on the well service equipment designed and manufactured by Fort Worth based Weir SPM. Product manufactured in Fort Worth, Texas is on the job on nearly every continent of the world, from the jungles of South America, to the deserts of the Middle East, on the Siberian plains of Russia, and in our own backyard in the Barnett Shale. In fact, Weir SPM has more well service pumps operating in the Barnett Shale than any other pump manufacturer.

Through innovative engineering, Weir SPM now offers the well service industry's most comprehensive line of plunger pumps, as well as the industry's most complete array of flow control valves and high-pressure flow control components. Weir SPM has also expanded its product line to include innovative safety equipment for flow line operators, winning the Woelfel "Best Mechanical Engineering Innovation" Award for its Flow Line Safety Restraint System from the American Society of Mechanical Engineering during the 2002 Offshore Technology Conference.

Weir SPM extends its reach around the world in order to fulfill the needs of its customers on a global basis. Though products are designed and manufactured in-house at its Fort Worth location, Weir SPM increases its global coverage through its sales offices and service centers strategically situated around the world. Currently, Weir SPM utilizes twelve sales and service facilities spread across



the United States, as well as three facilities in Canada, one in Mexico, one in Aberdeen, Scotland, one in Dubai, UAE, one in Singapore, one in Australia, and a fleet of Mobile Units operating on demand around the globe. Weir SPM also relies on the numerous Weir Oil and Gas Services facilities located around the globe to provide support services where Weir SPM may not have a local base.

Weir SPM is the worldwide leader in well service pump and flow control equipment for the oil and gas industry. The focal point of Weir SPM's product portfolio is its line of high-pressure plunger pumps - the largest, most comprehensive range offered in the industry. Weir SPM manufactures a variety of pump models to meet any need: intermittent duty service pumps for a full range of well service applications and extended duty plunger pumps for oilfield and industrial applications requiring a smaller footprint. Weir SPM's pumps are technologically advanced and manufactured to the highest quality standards.

In addition to its line of pumps, Weir SPM manufactures the industry's most complete line of valves and flow control products. The valve product line includes various sizes and pressure rated plug valves, emergency relief valves, check valves, dart valves and butterfly valves. Hammer unions, integral union connections, swivel joints, steel hose loops and a variety of well service specialty products complete the flow control product line. Weir SPM also offers innovative safety equipment for well service providers, including the award winning Flow Line Safety Restraint System and the innovative clamp connecting flow line system, Safety Iron®. Weir SPM's Safety Iron® is now available in a next generation manifold trailer package for increased performance during fracturing applications.

Quality is priority number one, therefore Weir SPM operates under an ISO-approved quality system within its manufacturing facility and at its service centers. Additionally, the company is approved by DNV, CE and other entities for the entire Weir SPM product line. Weir SPM's products are designed using state-of-the-art engineering programs to ensure that all products are of the highest quality. To further ensure that each product exported around the world is reliable and safe, all flow control assemblies are pressure tested to 150% of their rated working pressure, and each pump is powered up and tested at full power. Weir SPM does not institute batch testing.

With a half century of experience and a proven track record of steady growth, Weir SPM has well established its presence in the global marketplace. Weir SPM's emphasis on strong customer service and detailed attention to product quality will aid in keeping it a leading supplier of equipment for the worldwide petroleum industry. Weir SPM is focused on growth and maintaining its position as a technical leader in the well service equipment industry. This technical expertise is being developed through highly skilled employees, through state-of-the-art design, superior engineering and manufacturing tools, and a commitment to working tirelessly to acquire the resources needed to expand upon our exponential growth.



Weir SPM Global Locations

Fort Worth, TX	Red Deer, AB, Canada
Houston, TX	Red Cliff, AB, Canada
Odessa, TX	Grande Prairie, AB, Canada
Longview, TX	Villahermosa, Mexico
Alice, TX	Aberdeen, Scotland
Elk City, OK	Dubai, UAE
Brighton, CO	Singapore
Grand Junction, CO	Perth, Australia
Jane Lew, WV	
Lafayette, LA	
Searcy, AR	
Williston, ND	



Contact Info and Contents

Corporate, Engineering and Manufacturing

7601 Wyatt Dr.
Fort Worth, Texas 76108
P: 1.800.342.7458 • 817.246.2461
F: 817.246.6324
www.weiroilandgas.com

Sales Offices

Houston, Texas

363 N. Sam Houston Pkwy. E., Suite 1100,
Houston, Texas 77060
P: 281.820.7807 • F: 281.820.7804

Singapore

545 Orchard Road 15-02,
Far East Shopping Ctr., Singapore 238882
P: 65.6738.3078 • F: 65.6234.2581

Service Centers

United States

Alice, Texas ▲◆■

2450 Business Hwy. 281 North • Alice, Texas 78332
P: 361.661.0900 • F: 361.661.0909

Brighton, Colorado ▲◆■

7450 Johnson Drive, Suites C & D • Frederick, Colorado 80504
P: 720.494.1805 • F: 720.494.7208

Elk City, Oklahoma ▲◆■

1600 Merritt Road • Elk City, Oklahoma 73644
P: 580.225.1186 • F: 580.225.1597

Fort Worth, Texas ▲◆■∞

7601 Wyatt Drive • Fort Worth, Texas 76108
P: 817.246.2461 • F: 817.246.6324

Grand Junction, Colorado ▲◆■∞

842 21-1/2 RD • Grand Junction, Colorado 81505
Ph: 970-243-4600 • F: 970-243-8027

Jane Lew, West Virginia ▲◆■

7645 Highway 19 North • Jane Lew, West Virginia 26378
P: 304.884.7222 • F: 304.884.7622

Lafayette, Louisiana ▲◆■

3535 Hwy. 90 East • Lafayette, Louisiana 70518
P: 337.837.3161 • F: 337.837.8171

Longview, Texas ▲◆■

1116 W. Harrison Road • Longview, Texas 75604
P: 903.291.1279 • F: 903.291-1109

Odessa, Texas ▲◆■∞

2424 E. I-20 • Odessa, Texas 79766
P: 432.580.3887 • F: 432.333.1351

Searcy, Arkansas ▲◆■

2211 Taylor Road • Searcy, Arkansas 72143
P: 501.305.3296 • F: 501.305.3419

Williston, North Dakota ▲◆■

5044 Petroleum Park • Williston, North Dakota 58801
P: 701-572-0776 • F: 701-572-0783

▲ = Product Stocking ◆ = Rental ■ = Refurbishment/Recertification ∞ = Pump Refurb/Repair

Canada

Grande Prairie, Alberta, Canada ▲◆■

104, 11231 - 97 Ave. • Grande Prairie, AB T8V 5N5
P: 780.402.3857 • F: 780.402.7081

Red Cliff, Alberta, Canada ▲◆■

1202 Dirksen Drive N.E. • Red Cliff, AB T0J 2P0
P: 403.504.8353 • F: 403.504.8370

Red Deer, Alberta, Canada ▲◆■∞

Unit A, 8060 Edgar Industrial Crescent
Red Deer, AB T4P 3R3
P: 403.341.3410 • F: 403.341.3072

Mexico

Villahermosa, Mexico ▲◆■

Bodega 3, Lote 8, Manzana 3 • Sobre Calle San Lazaro
Parque Logistico Industrial, Tabasco
Villahermosa, Tabasco 86150
P: 52-993-142-7083

Europe

Aberdeen, Scotland ▲◆■∞

Badentoy Industrial Park, Portlethen
Aberdeen AB12 4YD, Scotland
P: 44.1224.783666 • F: 44.1224.784184

Middle East

Dubai, United Arab Emirates ▲◆■

Oilfields Supply Center L.T.D.
Building 22, P.O. Box 1518 • Jebel Ali, Dubai, U.A.E.
P: 971.4.8836.368 • F: 971.4.8836.485

Australia

Perth, Australia ▲◆■

Henderson Service Center • 20 Stuart Drive
Perth, Western Australia 6166
P: 61.8.9410.7500 • F: 61.8.9410.7510

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The following recommendations for Weir SPM flow control products are intended to be a guide to maximize efficiency, extended product life, and create a safer work environment.

- Treating or discharge iron is produced for the following services:
 - Standard Service
 - H₂S / Sour Gas Service
 - Low Temp Service
- Weir SPM recommends that you designate specific strings of iron for the following applications, and that the designated iron remain in that service application throughout the product's life:
 - Energized Fluids
 - Acids
 - Sour Gas
 - Low Temperature Applications
- **Flow rates above 42 feet per second are not recommended.**
- Every string of iron should be pressurized to its maximum planned working pressure prior to each use.
- Pressure seal line pipe threads are not recommended for pulsating service above 10,000 psi or where side loading or erosion are suspected. (Integral or Non-Pressure seal threads are recommended.)
- Most flow control products are certified for the following temperature rating:
 - Minimum: -30° C
 - Maximum: 110° C
- Personnel must not be around pressure vessel products while pressure is present or being applied.
- Each string, as well as each component, must have regular intervals of maintenance and inspection for safe, proper performance.
- Never tighten or hammer wing unions when pressure is apparent.
- Welding, brazing or heating on high pressure Weir SPM components is prohibited.
- General maintenance will extend the life of flow control products.
 - Grease plug valves and swivel joints after every job.
 - Replace seals to help prevent leaks and washouts of seal faces.
 - Clean all seal areas thoroughly.
 - Flush all products with water after each job.

Hammer Union & Safety Iron® Connections

Broadening the product line to meet the needs of our customers and the industry as a whole, Weir SPM currently offers flow control products in two styles of end connections. Traditional hammer union connections have long been the industry standard for connecting flow line components. Consisting of a wing nut and sub, and threaded end, hammer union connections require the use of a sledgehammer to assemble. Weir SPM's patented Safety Iron® was designed to offer a safer and more effective alternative to the hammer union connection. Consisting of a seal ring, upper clamp utilizing "captive bolts", and lower threaded clamp, Safety Iron® is assembled with the use of an impact wrench instead of a sledgehammer. Both hammer unions and Safety Iron® connections offered by Weir SPM are manufactured under strict quality standards and have proven to perform consistently in the field. For information on Safety Iron®, please see page 15 and 16.

Most flow control products manufactured by Weir SPM can be made with either Safety Iron® or Hammer Union connections.



Swivel Joints

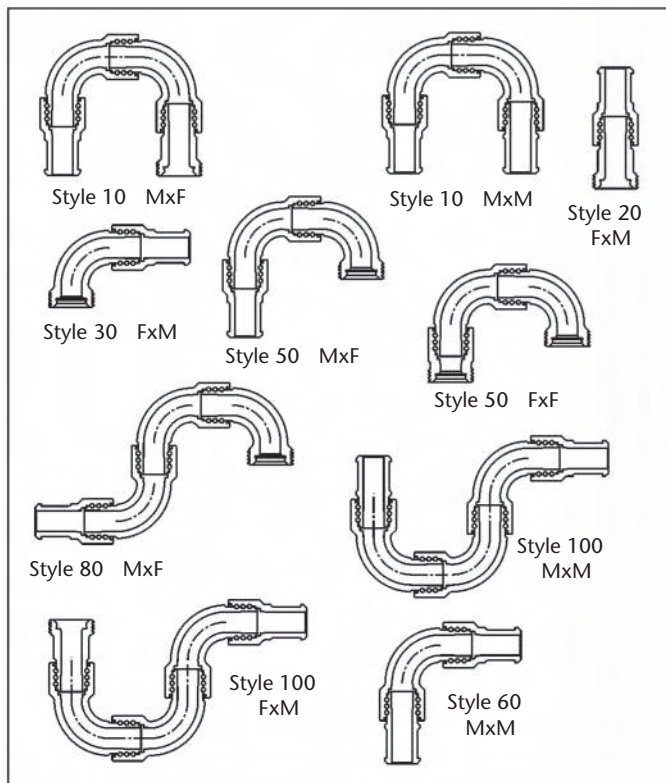
Weir SPM's 3" Fig. 1502 and 4" Fig. 1002 Long Radius Swivel Joints have undergone a design enhancement, creating a superior and longer lasting product. New features have created a swivel with extended life while maintaining uniform flow.

New features include:

- Additional erosion material under critical ball race locations:
 - 3" Fig. 1502 - over 13% more
 - 4" Fig. 1002 - over 22% more
- More stable assembly with better load distribution in 3" Fig. 1502 series, featuring longer ball race life.
- Better distribution of material for more robust female ball race components in 3" Fig. 1502 and 4" Fig. 1002 models.
- No danger for any mismatches.
- Available in traditional hammer union styles or in Weir SPM's patented Safety Iron® connections.



All Weir SPM swivel joints feature uniform wall thickness throughout for longer and more uniform flow of fluids (including slurries and abrasives), elastomeric packing for service to 225°F, instream packing that is designed not to enter stream regardless of velocity, and improved lubrication.



Pressure Rating	Size					
	2"	2" H2S	3"	3" H2S	3" x 2"	4"
Style 10 Fig. 1502 MxF	•	•	•	•		•
Style 10 Fig. 1502 MxM	•	•	•	•		•
Style 20 Fig. 1502 MxF	•		•	•		
Style 30 Fig. 1502 MxF	•		•	•		
Style 50 Fig. 1502 MxF	•	•	•	•	•	•
Style 60 Fig. 1502 MxF	•	•	•	•		
Style 80 Fig. 1502 MxF	•	•	•	•		
Style 10 Fig. 602 MxF						•
Style 10 Fig. 602 MxM						•
Style 50 Fig. 602 MxF						•
Style 100 Fig. 1502 MxF	•	•	•	•	•	
Style 100 Fig. 1502 MxM	•	•	•	•	•	
Style 10 Fig. 1002 MxF						•
Style 10 Fig. 1002 MxM						•
Style 50 Fig. 1002 MxF						•
Style 10 Threaded Swivel	•					
Style 20 Threaded Swivel	•					
Style 50 Threaded Swivel	•					

Weir SPM's product mix is constantly being revised to meet customer needs. Contact Weir SPM Engineering for the latest product offering information.

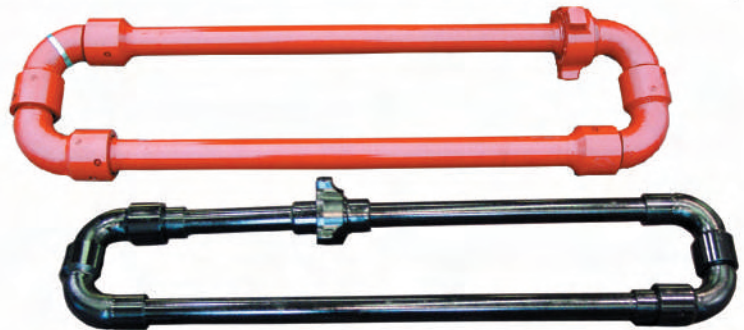
Steel Hose Loops and Pipe

Steel Hose Loops

Weir SPM all-steel hose loops are used for a variety of high pressure well service applications including discharge lines, water lines, cementing and circulating lines, well test lines and temporary flow lines.

Weir SPM all-steel hoses utilize field-proven Weir SPM swivel joints for greater flexibility, shock and vibration resistance, and more uniform flow. Also utilized are Weir SPM wing union end connections for fast, pressure-tight make-up and break-out.

These rugged hoses handle a full range of fluids to cold working pressures up to 15,000 psi and come in sizes and configurations to meet any need. Hoses for sour gas service are available at cold working pressure up to 10,000 psi. Weir SPM hoses are designed to easily and conveniently fold up for storage and transportation.



Weir SPM Model	Color Code	Method of Construction				NSCWP* (PSI)	Size (In.)	
		Threaded	NPS	Integral	Welded		2	3
Long Radius Swivel Joints	Olive Green†		•	•	•	10,000	•	•
	Red		•	•	•	15,000	•	•
Long Radius Swivel Joints	Black	•				10,000	•	

† Sour Gas Service

*Non-Shock Cold Working Pressure

Flow Line Piping

Weir SPM all-steel, one piece flow line piping, with wing union end connections, eliminates the need for welds or threads for an uninterrupted bore and greater flow. This light-weight piping is available in lengths to 10 feet to handle fluids at cold working pressures to 15,000 psi.

They are used on high-pressure discharge lines, auxiliary flow lines, choke-and-kill lines and for abrasive applications.

Weir SPM also manufactures flow line piping in non-pressure seal thread styles as well as butt weld styles in sizes ranging from 1" to 4" and in pressure ranges from 6,000 to 20,000 psi, up to 20 feet in length.

Weir SPM is in the process of adding an identification groove to all NPST subs. This is being implemented per the Shell mandate.



Integral Style

Size (In.)	Type of Service	NSCWP* (PSI)	End Connection
2	Standard	15,000	Fig. 1502 Union
2	Sour Gas	10,000	Fig. 1502 Union
3	Standard	15,000	Fig. 1502 Union
3	Sour Gas	10,000	Fig. 1502 Union
4	Standard	15,000	Fig. 1502 Union

NPS & Butt Weld Piping

Style	NSCWP* (PSI)	1"	1½"	2"	3"	4"	Non Press Seal	Butt Weld
Fig. 602	6,000	•	•		•	•	•	•
Fig. 1002	10,000	•	•	•		•	•	•
Fig. 1502†	10,000	•	•	•	•			•
Fig. 1502	15,000	•	•	•	•	•	•	•
Fig. 2002	20,000			•	•			•
Fig. 2202†	15,000			•	•			•

*Non-Shock Cold Working Pressure

† Sour Gas Service

Weir SPM's product mix is constantly being revised to meet customer needs. Contact Weir SPM Engineering for the latest product offering information.

Weir SPM



Plug Valves

1", 1" X 2", 1½", and 2" Plug Valves

Weir SPM high pressure plug valves are tough, field-proven units that provide dependable service for applications such as cementing, fracturing, acidizing, coiled tubing, and sand control. Available in 1", 1" X 2", 1½" and 2" sizes and in pressure ratings to 15,000 psi NSCWP*, Weir SPM plug valves feature quality components throughout for greater dependability, minimum weight, and maximum strength. Plug valves are available in standard service and sour gas service models. Special models are available to 20,000 psi.

3" and 4" Plug Valves

Weir SPM three-inch and four-inch plug valves are available in pressure ratings to 20,000 psi NSCWP*. Features include a flanged body for easier maintenance, integral inlets and outlets, hand crank, locked-open and shut gear drive standard, and multiple lubricating inlets. Standard service and sour gas service models are available. Weir SPM's latest plug valve offering is the 3" SP150 Manual Actuated Plug Valve.

Remote Operation

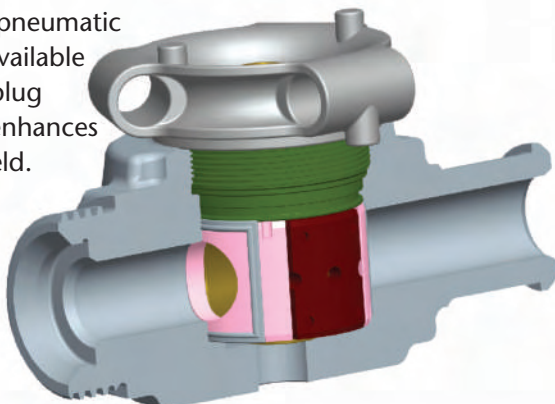
Hydraulic and pneumatic actuators are available for all sizes of plug valves, which enhances safety in the field.



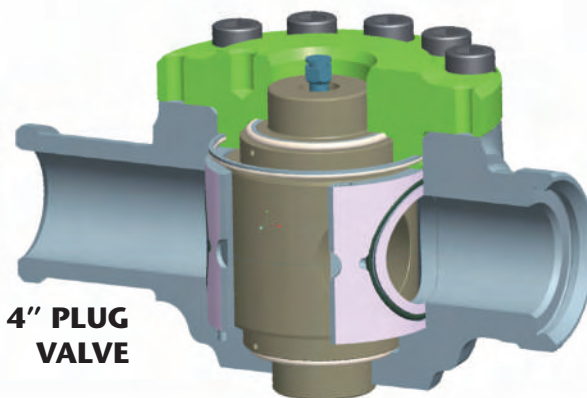
Repair and Seal Kits

Weir SPM repair kits and seal kits contain all the parts necessary to rebuild valves in the field or in the shop. Weir SPM seal kits contain all items in the standard repair kit, except the plug. Individual components and elastomer kits are also available.

2" PLUG VALVE



4" PLUG VALVE



Valve Model	NSCWP* (PSI)	End Connections	Size					
			1"	1" X 2"	1½"	2"	3"	4"
SP50TF	5,000	Threaded	•			•		
SP100TF	10,000	Threaded				•		
SP150TF	15,000	Threaded			•	•		
SP150TM	15,000	Threaded		•				
SP150TMF	15,000	Threaded		•				
SP150WU	15,000	Fig. 1502	•	•	•	•	•	•
SP200WU	20,000	Fig. 2002				•	•	

Special models are available in 20,000 psi. *Non-Shock Cold Working Pressure

Weir SPM's product mix is constantly being revised to meet customer needs. Contact Weir SPM Engineering for the latest product offering information.

LIBERTY EXHIBIT 1061, Page 96

Liberty Energy, Inc. and Liberty Oilfield Services LLC v. U.S. Well Services, LLC, IPR2024-01274

Check Valves

Weir SPM check valves are made of high strength steel and are precision manufactured to exact tolerances for clapper styles in 2" through 4" sizes, dart styles in 1" through 3" sizes, and CO2/nitrogen styles in 2" and 3" sizes. The clapper design features either a standard coating or superior abrasion and acid resistant coating to give longer operating life in corrosive applications.

The rugged valves operate at working pressures from 6,000 to 20,000 psi in well service applications such as acidizing, cementing, fracturing, and energized fluids. Weir SPM's check valves are manufactured from solid forgings to maximize strength and increase abrasion resistance.

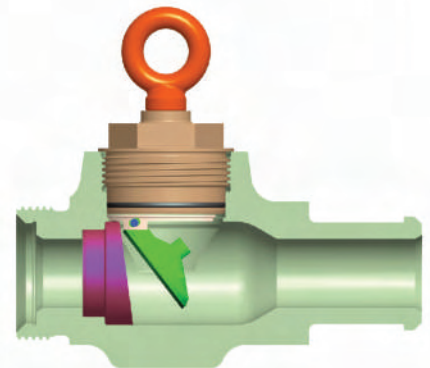
Weir SPM carries the most complete line of check valves available to the well service industry. Various configurations are offered, including wing-ahead (standard flow) or thread-ahead (reverse flow) models.



CLAPPER STYLE

**Available in Standard Flow (Wing Ahead)
and Reverse Flow (Thread Ahead)**

Valve Size	Inlet	Outlet	Upstream / Downstream	NSCWP* (PSI)
2" 1502	Male	Female	Reverse Flow	15,000
2" 1502	Female	Male	Standard Flow	15,000
2" 2002	Female	Male	Standard Flow	20,000
3" 1502	Male	Female	Reverse Flow	15,000
3" 1502	Female	Male	Standard Flow	15,000
3" 1502 Sour Gas	Male	Female	Reverse Flow	10,000
3" 1502 Sour Gas	Female	Male	Standard Flow	10,000
3" 2002	Female	Male	Standard Flow	20,000
4" 602	Female	Male	Standard Flow	6,000
4" 1002	Female	Male	Standard Flow	10,000
4" 1002	Male	Female	Reverse Flow	10,000
4" 1502	Male	Female	Reverse Flow	15,000
4" 1502	Female	Male	Standard Flow	15,000



Weir SPM's Clapper Style Check Valves are placed in the treating line to allow flow to the well but isolate any back flow upstream of the valve. Clapper designs include Buna N rubber coatings for standard service, Viton for solvent and severe acid service, and Urethane coating for high abrasion resistance (HAR).

*Non-Shock Cold Working Pressure

Weir SPM's product mix is constantly being revised to meet customer needs. Contact Weir SPM Engineering for the latest product offering information.

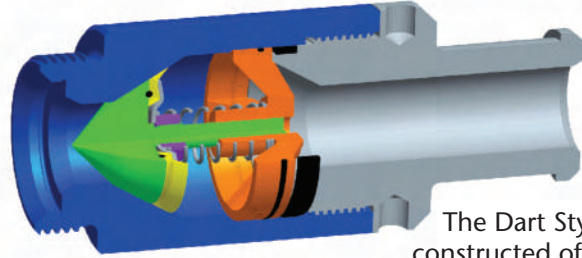
Weir SPM



Check Valves

DART STYLE

**Available in Standard Flow (Wing Ahead)
and Reverse Flow (Thread Ahead)**



The Dart Style Valve is constructed of a two-piece body that houses an inline spring loaded dart. When fluid enters from the inlet side, it will overcome the low spring force on the dart. The dart will travel away from the inlet and allow the fluid to flow around towards the outlet. When fluid flow stops, the light spring force closes the dart against its seat, preventing fluid from flowing back through the flow line. The Weir SPM Dart Style Check Valve is available for standard service and for sour gas (H2S) environments.

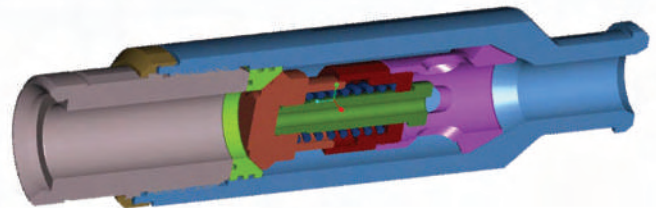
Valve Size	Inlet	Outlet	Upstream / Downstream	NSCWP* (PSI)	Service
1" 1502	Female	Male	Reverse Flow	15,000	Standard
1" 1502	Female	Male	Standard Flow	15,000	Standard
1½" 1502	Male	Female	Reverse Flow	15,000	Standard
1½" 1502	Female	Male	Standard Flow	15,000	Standard
2" 1502	Male	Female	Reverse Flow	15,000	Standard
2" 1502	Female	Male	Standard Flow	15,000	Standard
3" 1502	Male	Female	Reverse Flow	15,000	Standard
3" 1502	Female	Male	Standard Flow	15,000	Standard
2" 1502	Male	Female	Reverse Flow H2S	10,000	H2S
2" 1502	Female	Male	Standard Flow H2S	10,000	H2S
3" 1502	Male	Female	Reverse Flow H2S	10,000	H2S
3" 1502	Female	Male	Standard Flow H2S	10,000	H2S

*Non-Shock Cold Working Pressure

Weir SPM's product mix is constantly being revised to meet customer needs. Contact Weir SPM Engineering for the latest product offering information.

CO2 / NITROGEN STYLE

**Available in Standard Flow (Wing Ahead)
and Reverse Flow (Thread Ahead)**



Weir SPM offers a specially designed CO2/Nitrogen Poppet Check Valve in sizes 2" and 3" to produce increased safety by preventing back flow in volatile CO2 and Nitrogen pumping flow lines. These stainless steel trim valves ensure that fluid cannot flow back into the manifold area or into pumps, and are rated at 15,000 psi.

Valve Size	Inlet	Outlet	Upstream / Downstream	NSCWP* (PSI)	Service
2" 1502	Male	Female	Reverse Flow Low Temp	15,000	Standard
2" 1502	Female	Male	Standard Flow Low Temp	15,000	Standard
3" 1502	Male	Female	Reverse Flow Low Temp	15,000	Standard
3" 1502	Female	Male	Standard Flow Low temp	15,000	Standard

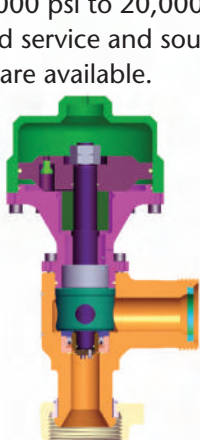
*Non-Shock Cold Working Pressure

Weir SPM's product mix is constantly being revised to meet customer needs. Contact Weir SPM Engineering for the latest product offering information.

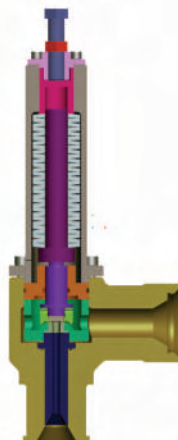
Relief Valves

Weir SPM Emergency Relief Valves provide over-pressure protection for reciprocating pumps, treating lines, pressure vessels and other equipment operating under a variety of pressure and flow conditions. The valves are compact, simple to operate and rely on the system's pressure to open when a preset pressure is exceeded, and automatically snap shut when the pressure drops.

The valves are externally adjustable, and unlike shear relief valves, which use common nails to trigger the valve, Weir SPM's Emergency Relief Valves utilize an internal spring, nitrogen, or rig air to activate opening and closing. Valves are available in 2", 3" and 4" models. Operating pressures range from 1,000 psi to 20,000 psi. Standard service and sour gas models are available.



3" Nitrogen Actuated Relief Valve



3" Spring Actuated Relief Valve

Note:

Approximate flow rate for relief valves:

- 2" Spring - 150 GPM Max.
- 3" Spring - 430 GPM Max.
- 3" and 4" Back Pressure ERV - 750 GPM Max.
- 3" and 4" Unloading Valve - 1000 GPM Max.

As flow requirements increase, then multiple valves may be preferred, and are permissible. You may find that two of the 2" valves are a better economic combination than one 3" valve. Multiples of either valve are allowed as long as the valves are all set within 10% of each other.

Example: If a customer requires a flow of 400 GPM, he may choose to use three 2" spring operated valves or one 3" spring operated valve.

		Design Style	
Size	Description	Spring	Nitrogen Actuated
2"	1502 M Inlet, Line Pipe Thread Outlet	•	
	1502 M Inlet, 1502 F Outlet	•	
	1502 M Inlet, 1502 F Outlet Sour Gas	•	
	2002 M Inlet, 2002 F Outlet	•	
	2202 M Inlet, 2202 F Outlet Sour Gas	•	
3"	602 M Inlet, 602 F Outlet	•	•
	1502 M Inlet, 1502 F Outlet	•	•
4"	602 M Inlet, 602 F Outlet		•
	1002 M Inlet, 1002 F Outlet		•
	1502 M Inlet, 1502 F Outlet		•



The Remote Control Panel is a simple and accurate tool to adjust the settings of the Nitrogen Actuated Relief Valves from a safe distance during operation.

For more information, see page 35.

Weir SPM's product mix is constantly being revised to meet customer needs. Contact Weir SPM Engineering for the latest product offering information.

Hammer Unions

Weir SPM hammer unions are available in a wide range of sizes and in working pressures to 20,000 psi. Pressure seal, non-pressure seal, and welded styles are offered in various sizes and pressures. All Weir SPM hammer unions provide pressure-tight, positive sealing and are available for standard service and sour gas models. Weir SPM hammer unions for sour gas service are specially heat-treated for controlled hardness and utilize fluorocarbon elastomer seal rings.

Figure Number	Pressure Rating (NSCWP*)	Nominal Pipe Size (Inches)								
		1	1½	2	2½	3	4	6	8	10
100	1,000			•	•	•	•	•	•	
200	2,000	•	•	•	•	•	•			
206	2,000	•	•	•	•	•	•	•	•	•
207	2,000					•	•			
400	4,000			•		•	•			
402	4,000			•						
602	6,000	•	•	•		•	•			
1002	10,000	•	•	•		•	•			
1502	15,000	•	•	•		•	•			
2002	20,000			•		•				
2202	15,000			•		•				

*Non-Shock Cold Working Pressure Weir SPM's product mix is constantly being revised to meet customer needs. Contact Weir SPM Engineering for the latest product offering information.

Fig. 100

Black Nut
Yellow Subs



An economical union with precision machined metal-to-metal sealing surfaces for air, water, oil or gas service to 1,000 psi NSCWP*.

Fig. 200

Blue Nut
Gray Subs



A precision metal-to-metal sealing surface between male and female subs for air, water, oil, gas and mud service to 2,000 psi NSCWP*.

Fig. 206

Blue Nut
Gray Subs



A precision metal-to-metal seal plus O-ring seal for air, water, gas, oil, and mud service to 2,000 psi NSCWP*.

Fig. 207

Blue Cap
Gray Subs



Interchangeable Fig. 206 sub with blanking cap and O-ring seal to assure no-leak closure of manifolds and lines to 2,000 psi NSCWP*.

Fig. 400

Black Nut
Red Subs



Features a precision ball and cone sealing surface for sure metal-to-metal seal for air, water, oil, gas and mud service to 4,000 psi NSCWP*.

Fig. 402

Black Nut
Black Subs



A resilient lip-type seal for air, water, oil or mud service to 4,000 psi NSCWP*.

Fig. 602

Black Nut
Orange Subs



A replaceable lip-type seal ring minimizes fluid flow turbulence and gives pressure seal for air, water, oil, gas and mud service to 6,000 psi NSCWP*.

Fig. 1002

Red Nut
Blue Subs



A resilient lip-type seal protects ball and cone seal against abrasion in air, water, oil, gas and mud service to 10,000 psi NSCWP*.

Fig. 1502

Blue Nut
Red Subs



For manifold and truck mountings or installations encountering high pressures including air, water, oil, gas and mud service to 15,000 psi NSCWP*.

Fig. 2002

White Nut
White Subs



For cementing, fracturing, acidizing, testing and choke-and-kill lines where extreme pressures are encountered to 20,000 psi NSCWP*.

Fig. 2202

Green Nut
Green Subs



Especially for sour gas service; with heat-treated components, fluorocarbon elastomer seal rings. For service to 15,000 psi NSCWP*.

*Non-Shock Cold Working Pressure

Integral Union Connections

Weir SPM manufactures a quality line of high-pressure integral union connections in a broad range of configurations and sizes from 1" through 4" and in pressure ratings to 20,000 psi NSCWP*. Manufactured from high strength alloy steel forgings, Weir SPM integrals feature a lightweight design not found in competitors' products. All Weir SPM integral union connections are subjected to controlled heat-treat processes.



Size	Fig. 602 6,000 psi*	Fig. 1002 10,000 psi*	Fig. 1502 15,000 psi*	Fig. 1502 10,000 psi* H2S	Fig. 2002 20,000 psi*	Fig. 2202 15,000 psi* H2S	All Female (Thread)	All Male (Wing)	Combination Styles and Sizes
1"			•				•	•	•
1½"			•		•	•	•	•	•
2"			•	•	•	•	•	•	•
3"	•		•	•	•	•	•	•	•
4"	•	•	•	•			•	•	•

*Non-Shock Cold Working Pressure Weir SPM's product mix is constantly being revised to meet customer needs. Contact Weir SPM Engineering for the latest product offering information.

UNION CHANGEOVER AND CROSSOVER ADAPTORS

Available in a variety of sizes and thread types in female-to-male, female-to-female, and male-to-male configurations from 1" thru 4", in pressure ratings from 6,000 to 20,000 psi NSCWP* in standard service, and up to 15,000 psi in sour gas service.



UNION BULL, GAUGE AND LIFTING BULL PLUGS

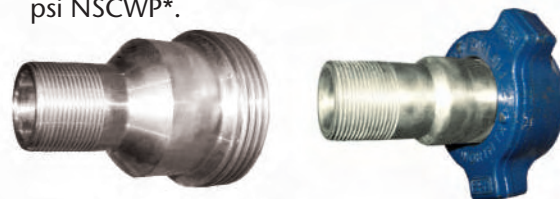
Available in 1", 1 1/2", 2", 3" and 4" sizes in male and female models. Available in pressure ratings to 20,000 psi NSCWP* in standard service, and up to 15,000 psi in sour gas service. Also available with special ports for high pressure testing.



*Non-Shock Cold Working Pressure

UNION MALE AND FEMALE TO PIPE, AND TUBING THREAD SWAGES

Available in numerous sizes and threaded configurations from 1" thru 4" in pressure ratings from 6,000 to 10,000 psi NSCWP*.

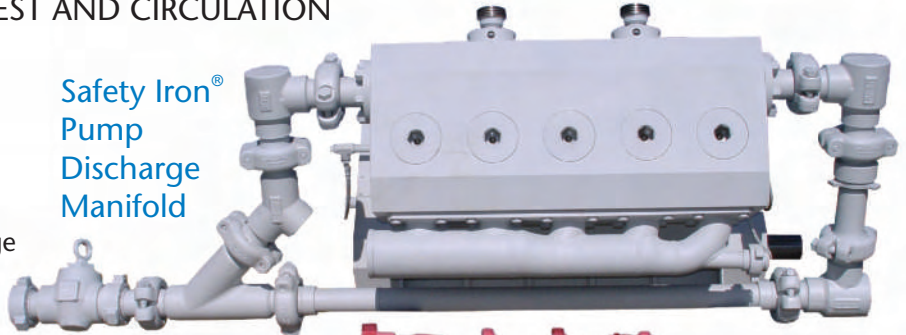


Manifolds, Frac Heads and Cement Heads

PUMP DISCHARGE, FLOW-THRU, TEST AND CIRCULATION MANIFOLDS

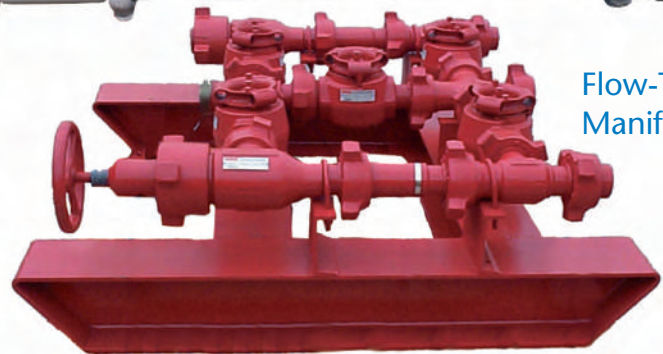
Pump discharge manifolds are available in single or multiple discharge outlets in a variety of integral union connections up to 20,000 psi NSCWP*. Features include full bore, thick-wall tubing and pump discharge flanges to fit most major brands of pumps.

Safety Iron®
Pump
Discharge
Manifold



Flow-thru, test, and circulation manifolds are available in both 5,000 and 10,000 psi NSCWP* for threaded, and to 20,000 psi NSCWP* for all-integral connection sizes. All styles utilize proven Weir SPM plug valves of all sizes, 1" through 4". Available variations include fixed choke and adjustable choke models.

Flow-Thru
Manifold



Weir SPM's Safety Iron® has proven to be an ideal choice for semi-permanent applications. Flow-thru manifolds and pump bridles are just two of the applications when Safety Iron® has performed exceptionally in the field.

*Non-Shock Cold Working Pressure

CEMENT HEADS

Utilizing superior field-tested welding techniques, Weir SPM cement heads provide high-pressure performance in a variety of designs to meet the needs of the industry. Featuring single or double plug head designs, easy-to-attach landing joints, and reliable plug pin performance, Weir SPM cement heads perform with consistency and reliability in the field.

Single and Double Head designs are available in the following sizes:

2.875"
3.50"
4.50"
5.0" - 5.5"
7.0" - 7.63"
8.63" - 9.63"
10.75" - 11.75"
13.375"
16.0"
18.63" - 20.0"

Cement Head Manifolds
also available.



FRAC HEADS

Weir SPM's customizable frac heads allow customers to design their ideal frac head for reliable and consistent performance on their frac sites.

Weir SPM frac heads are manufactured from hardened steel and feature field-proven durable welds at the branches. Available in two styles, the "Goat Head" Style and "Inlet" Style, Weir SPM customizes frac head orders to customer specifications through the use of a *Frac Head Request Form*.

Through the utilization of the *Frac Head Request Form*, customers may customize their purchase through the following design options:

- Pressure Rating
- Top Connection Type
- Minimum Through-Bore Width
- Number of Side Connections
- Side Connection Branch Angle
- Side Connection Branch, Type, and Pressure Rating
- Bottom Connection Type



Choke Tees

Adjustable and positive choke tees are primarily used in choke manifolds, flow thru manifolds and test manifolds. Various forged-body configurations are available in 2-inch and 3-inch sizes, each rated at 15,000 psi NSCWP*. Choke tees are also available in sour gas configuration.

*Non-Shock Cold Working Pressure

Butterfly Valves

Weir SPM butterfly valve's specially designed disc allows for a noticeably smoother media flow, reducing or eliminating turbulence commonly found in other valves. Another superior design feature is the split stem, which allows the disc to automatically center in the media flow path, thus assuring an even seal around the disc. A one-piece phenolic back-up ring allows internal pressure to anchor the seat within the valve body and prevents seat walking. Various seat and disk materials are available.

Available in Sizes
Ranging from 3 Inches
to 12 Inches.



Sur-Drop® Ball Injectors

Weir SPM's Sur-Drop® High-Pressure Ball Injector features the "Positive Feed System", resulting in a reliable feed and injection rate. New design revisions have enhanced operating performance, made maintenance more convenient, and greatly reduced lead time for faster response to customer needs.

New Design Upgrades:

- Improved manufacturing processes allow for more precise machined parts.
- Increased flexibility in operation by consolidating ball cartridge sizes.
 - « 5/8" & 3/4"
 - « 7/8" & 1"
 - « 1-1/8" & 1-1/4"
- Increased convenience in maintenance.
 - « Two-piece screw assembly allows for more convenient replacement of drive stem, without replacing entire assembly.
- Easy manual loading eliminates use of awkward tools.



No-Go Gauge Kits

During extended service of flow control products in the field, components will naturally begin to show symptoms of wear.

In order to allow convenient inspection of these components, Weir SPM now offers No-Go Gauge Kits. These gauges allow for easy qualification of worn hammer union assemblies, swivel ball races, and sub connections.



Available in 1 1/2", 2",
3" and 4"

By inserting the gauge into the worn feature of the component, the part can be easily deemed acceptable or unacceptable. Each Weir SPM gauge is machined from hardened tool steel and is chrome plated for exceptional long life.

Safety Iron® is a clamp connecting flow line system developed to replace traditional wing nut union connections. The product consists of a seal ring utilizing a soft seal and a metal-to-metal seal, an upper clamp with "captive" bolts, and a lower threaded clamp. The metal seal ring and rubber seal freely slip into the tapered flange end. Sealing is accomplished by the end crush on the rubber seal and tapered metal contact from the clamp force. The result is a superior performing connection compared to traditional hammer union connections, and a safer work environment by allowing the user to "throw away the hammer."

**Available in 1½" through 4"
in pressure ratings up to 20,000 psi.**

U.S. Patent No. 7,204,525

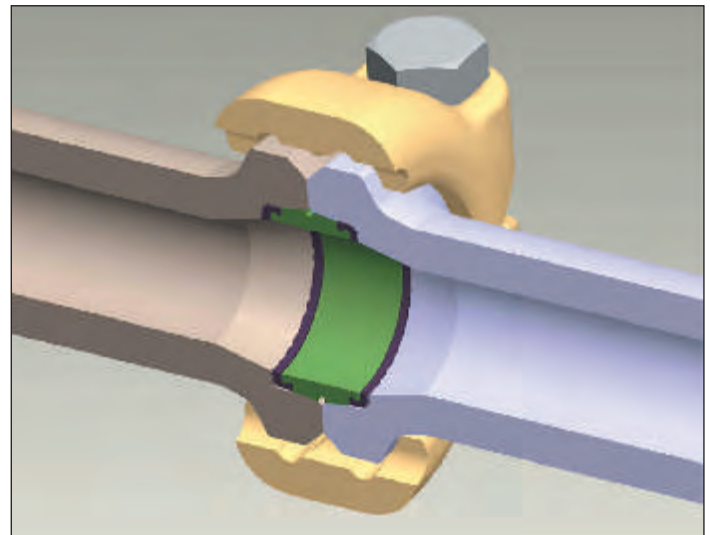


Benefits of Safety Iron® vs. Traditional Hammer Union Connections

- Greater Safety
- Less Physically Demanding Assembly/Disassembly
- Less Injury Prone
- Less Labor Intensive & Less Expensive Reinspection
- Faster Break-down
- More Reliable Seal

Safety Iron® Product Line:

- Swivel Joints
- Check Valves
- Plug Valves
- Relief Valves
- Integrals (Tees, Wyes, Elles, Crosses, and Crossovers)
- Pipe
- Pump Discharge Manifolds



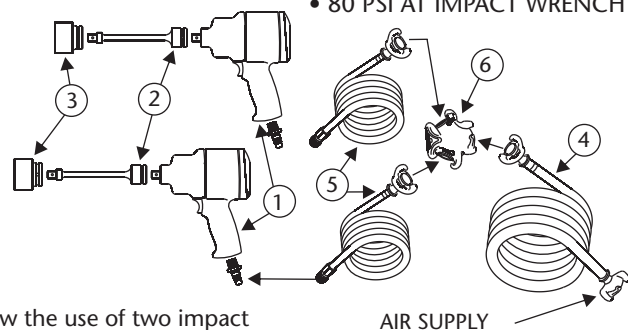
Weir SPM offers Safety Iron® Kits in 1 1/2" 15K, 2" 15K, 2" 20K, 3" 15K, 3" 20K, 4" 10K, and 4" 15K.

Kits Include:

1. (2) Impact Wrenches - 3/4" Drive w/ 3/8" Plug
2. (2) Torque Stick - 3/4" Drive
3. (2) Hex Socket - 3/4" Drive
4. (1) Hose Assembly - 50' x 3/4" Hose w/ Crowsfoot Connection
5. (2) Hose Assembly - 50' x 1/2" Hose w/ Crowsfoot and 3/8" Coupler Connection
6. (1) Wye - 3/4" Crowsfoot
7. (7) Crowsfoot Washer Seal
8. (8) Crowsfoot Pin

MINIMUM AIR REQUIREMENTS

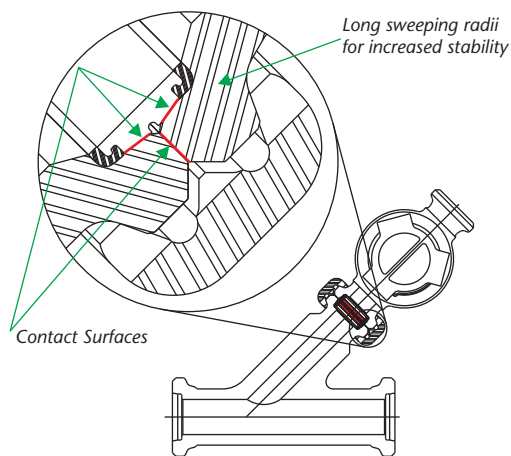
- 45 SCFM PER IMPACT WRENCH
- 80 PSI AT IMPACT WRENCH



*The kits allow the use of two impact wrenches from one air supply source.

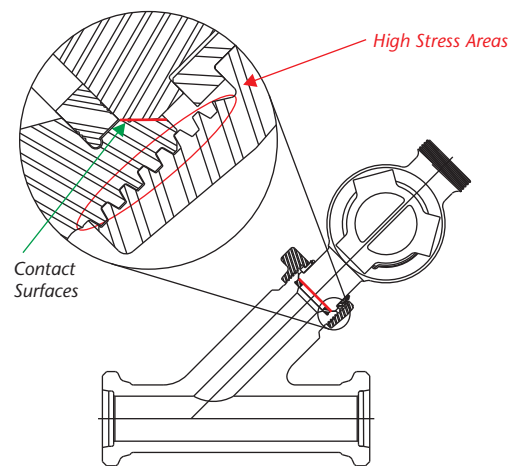
Safety Iron® Connection

Safety Iron® connections have a greater surface contact area for a much more stable connection compared to hammer union seals. Safety Iron® flanges are also more robust with larger sweeping radii for additional strength and vibration resistance.



Traditional Hammer Union Connection

Hammer union connections are limited to only one contact seal surface, greatly reducing the integrity of the connection. Hammer unions, with their thinner wall section at vital points and higher stress areas due to the jagged grooves of the threads, are more susceptible to damage as a result of vibration or side loading.



Fire Safe Safety Iron®

Weir SPM's newest addition to its groundbreaking Safety Iron® product line is Fire Safe Safety Iron®. Fire Safe Safety Iron® is designed to reduce many dangers associated with assembly of traditional flow lines on offshore rigs, while meeting API 6FB compliance for a safer working environment.

Fire Safe Safety Iron® utilizes a metal-to-metal seal, consisting of a metal seal ring, an upper clamp featuring "captive bolts", and a lower threaded clamp. The system provides an effective seal while minimizing the necessary number of components needed to complete a flow line. There is no other offshore clamp-connecting flow line product on the market that utilizes less component parts than Fire Safe Safety Iron®.

Benefits:

- Removes the sledgehammer from the assembly of iron, increasing safety during offshore operations.
- Designed to replace other existing clamp style connections with a reliable, easier to assemble connection.
- Produces a reliable seal that will maintain integrity in the instance of fire.
- For use in permanent or semi-permanent installation.
- Metal-to-metal seal meets API 6FB compliance.
- Available in 2" - 4", rated up to 10,000 psi.

Safety Iron® Manifold Trailers

Weir SPM's Safety Iron® Manifold Trailer provides the market with a uniquely designed manifold system that is ideally suited for stimulation operations, where vibration and side load have proven to be detrimental to the existing hammer union trailer models currently on the market.



Product Features:

- Multiple configurations allow for increased variability in flow rate, and inlet/outlet configuration.
- Greater vibration resistance compared to traditional hammer union alternatives.
- Large sweeping radii in high pressure components for increased strength at connections.
- More robust wall thickness to prevent failure in high risk areas.
- Available built-in coiled-cable suspension for high pressure component mounting increases flexibility and reduces risk of cracked integrals.
- Isolation valves available for flexibility in flow line communication and utilization.
- Available with crossovers at high pressure outlets for greater compatibility with existing inventories.
- DOT certified trailer.



Weir SPM Safety Iron® Manifold Trailers are available with flexible mounts, such as a coiled cable suspension mounting, for high pressure components, greatly reducing the chance of fatigue cracks in integral components due to the vibration caused during transport and operation.

Optional Design Configurations:

- Flexible high and low pressure line arrangements for various flow rates
- Flexible high and low pressure inlet/outlet arrangements for various station configurations
- High pressure iron size and pressure ratings (3" & 4" / 10K & 15K)
- Isolation valves between the high and low pressure lines
- Tee or lateral connections leading to swing arms
- Configuration of swing arms

Safety Hammer™

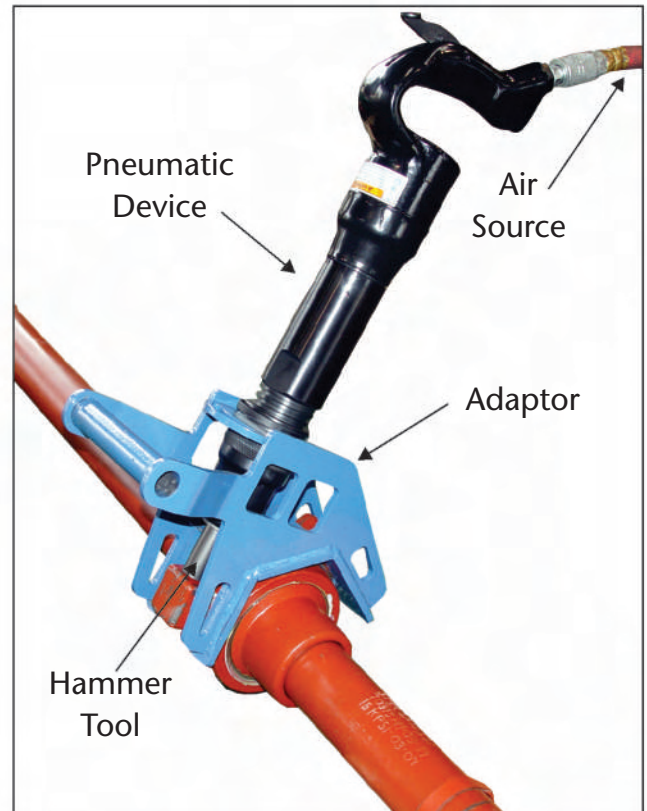
Weir SPM's newest product designed to increase safety on the work site is the Safety Hammer™. The Safety Hammer™ promotes a safer work environment by reducing the dangers associated with assembling hammer union connections using a sledgehammer. Safety Hammer™ is a pneumatic tool designed to properly seal hammer union connections with the ease of pushing a button. The dangers of using a sledgehammer are greatly reduced as most connections on-site can be made with the Safety Hammer™.

The Safety Hammer™ is an assembly composed of two main parts: high strength alloy steel adaptor and pneumatic hammer. The steel adaptor can be changed out as needed to fit different union sizes. In order for the Safety Hammer™ to function as intended, Weir SPM recommends 29 SCFM per hammer, with an air pressure of 90 psi and 1/2" air supply hose size. The Safety Hammer™ will make up and break down the hammer union depending on its orientation.

Available in 2" 1502, 3" 1502, 4" 200/206 and 4" 602/1002.



The Safety Hammer™ now features an upgraded impact tool made of a harder and tougher material for improved life with extended utility, and a redesigned contact end to minimize flaring of the edge.



To use the Safety Hammer™, simply hand-tighten the hammer union connection until the wing nut ceases to rotate. Slide the Safety Hammer™ adapter over the wing nut so that it bears against one of the three lugs. Orient so that the impact tool striking the wing nut lug will tighten the connection. Apply a turning force to the gooseneck handle until the wing nut ceases to rotate. Squeeze the trigger and continue to apply a slight turning force to the gooseneck handle. The hammer union will be quickly tightened. There is no other tool on the market that allows for such convenient and safe assembly of hammer union connections.

Benefits:

- Lightweight design that is easy to install and operate.
- Less labor intensive assembly/disassembly.
- Lower risk of injury by removing hammer from assembly process.
- Adaptor can easily be interchanged for different size wing unions.

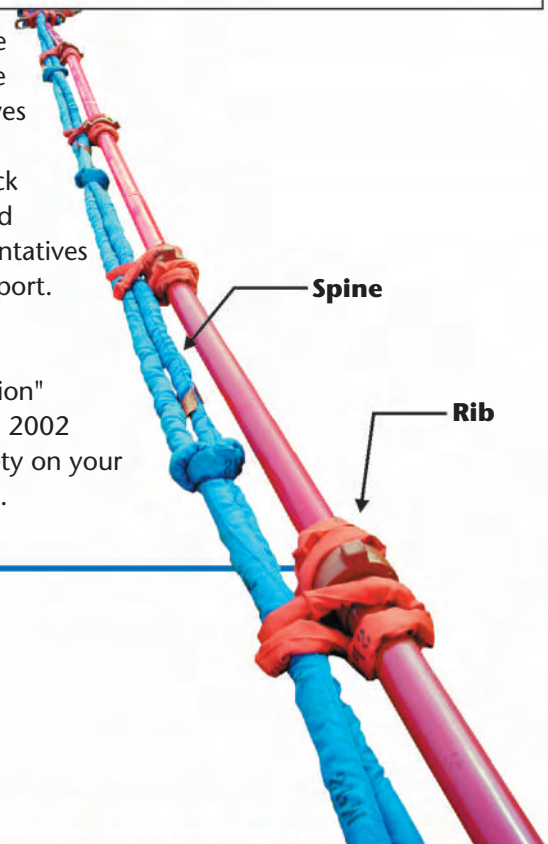
Weir SPM



Flow Line Safety Restraint System

Weir SPM's Flow Line Safety Restraint System is designed to help provide a safer environment in case of rupture or disengagement of the flow line while under pressure. The FSR has been credited with saving multiple lives and preventing catastrophic damage since its inception. FSR is recommended for all pumping service lines as they leave the skid or truck all the way to the wellhead, and should be mandatory for energized fluid pumping services. Systems are available for rent with Weir SPM representatives available to perform on-site training and full-service installation and support.

The FSR system was acknowledged for its innovation and performance capabilities, receiving the Woelfel "Best Mechanical Engineering Innovation" Award from the American Society of Mechanical Engineering during the 2002 Offshore Technology Conference. For peace of mind and increased safety on your site, there is no better option than the Flow Line Safety Restraint System.



RENTAL PACKAGES

Weir SPM has a large fleet of FSR Rental Units located around the globe for quick response to customer requests. Upon order, Weir SPM technicians will deliver the unit to a site as requested and will provide training to customers' employees to ensure proper installation of components or provide full service installation. Weir SPM offers FSR trailers, and customized cargo containers for offshore use, to better organize component parts and make transport of materials safer and more convenient. There is no more convenient way to satisfy the safety requirements of both the operator and service provider on site.



The FSR Rental Fleet undergoes constant inspection, as well as regular recertification and testing to insure that the FSR components perform as expected. Each component features identification and recertification badges so the customer may verify the components comply with regulations.



The Flow Line Safety Restraint System prevented this wellhead from becoming airborne and deterred the flow line from striking a functional gas well. Notice how the pipe is bent, yet still held in place.

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, safe handling, and installation. Misuse, side loading, improper maintenance, or disassembly under pressure can cause serious injury or death!

LIBERTY EXHIBIT 1061, Page 108



Well Service Pumps

Weir SPM manufactures the most comprehensive range of high-pressure plunger pumps in the industry. Weir SPM's plunger pump designs incorporate the ultimate in weight and space savings while having a reputation for dependable service even in today's hybrid extended duty applications, such as under-balanced coiled tubing drilling.

Weir SPM offers intermittent duty pump models for the full range of well service applications, and extended duty plunger pump models for those oilfield and industrial applications requiring greater work periods with a small-footprint, lightweight pump.

Weir SPM's DNV Type Approved intermittent duty plunger pumps range from 250 BHP to 3500 BHP with pressure capabilities up to 20,000 psi. Premium plungers, valves, seats, packing, etc. can be configured to a variety of well service needs from mud based coiled tubing support services to hot oil, cementing, acidizing, fracturing, gravel packing, etc.

Weir SPM's durable extended duty plunger pumps range from 175 BHP to 1575 BHP. These extended duty plunger pumps are specially designed to provide durable service in extended applications one day and provide exceptional high pressure / high rate intermittent service the next. These pumps' unique versatility in duty cycle adaptability greatly increases the range of work that can be performed and the amount of revenue than can be generated with a single pump. These pumps are designed so that the expendable parts (packing, etc.) can easily be reconfigured for mud, water, drill cutting, acid, cement, etc.

Weir SPM pumps are available with life cycle enhancing "auto-fretting" processing of the fluid cylinder. This very economical process adjusts for the harmful effects of cyclic stress and the stress corrosion cracking which can occur in high-pressure fluid cylinders. Weir SPM's state-of-the-art auto-fretting process results in a fluid cylinder with several times the fatigue life expectancy at a fractional increase in cost.

Classroom and shop training is available to better familiarize the customer with the design parameters, technical specifications and operating characteristics of each pump model.

Weir SPM provides a wealth of technical data, assembly drawings and maintenance information on its pumps (and flow control products as well) through an interactive home page on the Internet at www.weiroilandgas.com.



Every Weir SPM pump is tested to full power in house before it is delivered to the customer to ensure quality and proper performance. Weir SPM's 4500 hp test booth can run any pump up to full working power before delivery to the end user.





Pump Reference Guide

WEIR SPM PUMP MODEL EXPLANATION:

QWS		-	2500	-	SD
1st letter indicates number of cylinders:			2nd two letters indicate the intended duty cycle:		Numbers indicate max. rated BHP:
T = triplex			WS = intermittent, such as well service		2500 = 2500 BHP
Q = quintuplex			HB = extended, such as hydroblast		SD = super duty
					LW = special lightweight design
					S = short
					HV = horizontal valve
					DD = direct drive

Common Pump Formulas:

- Hydraulic Horse Power (HHP) = (GPM x PSI) / 1714
- Brake Horse Power (BHP) = (GPM X PSI) / (1714 x ME)
- Pressure (PSI) = (BHP x 1714 x ME) / GPM
- GPM = (BHP x 1714 x ME) / PSI
- Rod Load = PD x PD x .7854 x PSI
- GPR = (PD x PD x .7854 x SL x NC) / 231
- GPM = GPR x RPM

GPM - Gallons Per Minute
 PD - Plunger Diameter
 NC - Number of Cylinders
 ME - Mechanical Efficiency
 SL - Stroke Length
 GPR - Gallons Per Revolution

Extending Pump Life & Preventative Maintenance Program

Extending Pump Life:

Extending pump life requires careful operation by the customer. The customer should observe and utilize the following tools and practices:

- Dual inlet or Zoomie manifold
- Properly sized and maintained suction pulsation dampeners
- Properly maintained valves/seats/inserts
- Improved discharge harmonics (may require high pressure dampener)
- Correct piping placement, proper supercharging
- Proper sand and gel concentrations and blender operations

Maintenance:

At the very least, the following maintenance programs should be set up, operated, and recorded for review:

- Power end lube oil and filter inspection
- Fluid end valves and inserts inspection
- Fluid end seats inspection
- Fluid end valve springs inspection
- Plunger packing inspection

Proper maintenance practices are the best way to increase the life of your pumps and pump components. Weir SPM strongly suggests that each customer develop a maintenance program to be followed at all times.

Pump Duty Cycles

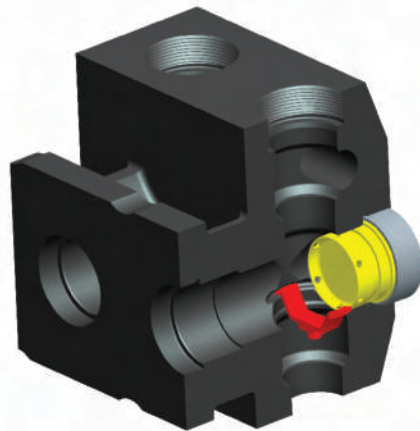
For information on pump duty cycles, Contact Weir SPM Engineering.

Autofrettage

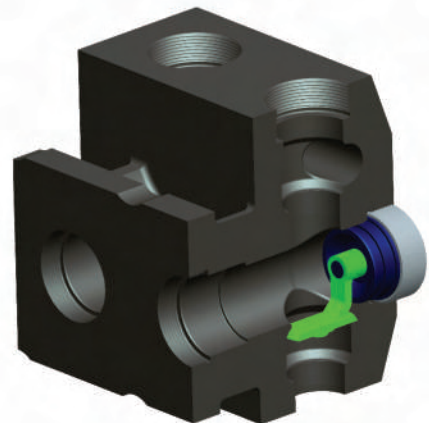
Intersecting bores in a fluid cylinder exhibit very high stresses at the corners of the intersection. To combat this problem created at the bore intersections, Weir SPM recommends that the customer utilize the Autofrettage option when purchasing a fluid end. The Autofrettage procedure is a technique where a "one-time" high hydraulic pressure is imposed on the bore intersection of a new cylinder inducing plastic strain at the intersection while elastic strain remains elsewhere. Relaxation of this one time pressure treatment causes these high-risk areas to develop a residual compressive stress, mitigating the destructive effects of the fatigue. The Autofrettage process may not completely eliminate the likelihood of fatigue failure (since corrosion and erosion still occur). However, it should significantly increase the number of cycles the product can tolerate, ultimately extending the life of the fluid cylinder.

Fluid End Configurations

Weir SPM currently offers fluid ends in three configurations, OPI, "Wing" Style Suction Valve Stop, and Grooveless. The "Wing" style fluid end was an improvement over the industry standard OPI style for a number of reasons including cost, serviceability and fluid cylinder life. Due to the customer's need for increased pumping durations, rates, and pressures, Weir SPM has adopted a Grooveless (GL) version of the suction valve stop. The GL design eliminates a groove in the fluid cylinder and is intended to extend the cylinder's life. All three versions are available and can be used throughout a broad range of the Weir SPM pump product line. Consult Weir SPM Sales to determine which style would be beneficial for you.



The traditional "**wing style**" fluid end uses a grooved suction bore to lock the valve stop in place. This groove reduces material in key locations possibly leading to cracks in the cylinder during the mature phase of its life cycle.

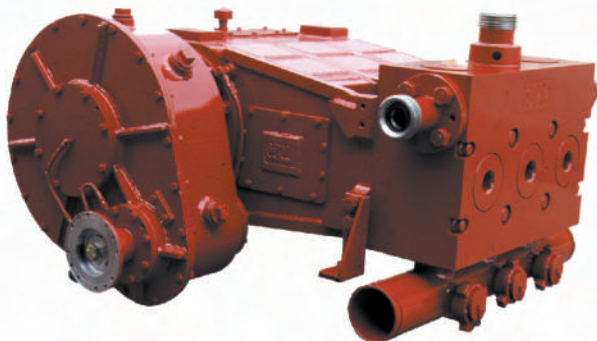


Weir SPM's new **Grooveless Fluid End** eliminates the groove in the fluid cylinder by replacing the old "wing style" valve stop. The new valve stop design locks under a ridge in the fluid cylinder bore and is held in place through a stem on the suction cover.

Weir SPM



TWS 600S



The TWS 600S offers a versatile small footprint pump that can perform a variety of duties for the well service industry. The unique design features an offset crankshaft / crosshead design which substantially reduces the load on both the crosshead and crosshead guides as well as the main roller bearings supporting the crankshaft. The TWS 600S can be utilized in a back-to-back configuration to perform rugged acidizing, cementing, gravel packing and snubbing operations.

TWS 600S Performance Data ^{1, 2}

PLUNGER DIAMETER in (mm)	OUTPUT PER REV gal/rev (liter/rev)	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		50 / 230		120 / 552		200 / 920		300 / 1380		450 / 2070	
		gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
2½ (63.5)	.38 (1.4)	19 (72)	20,372 (1436)	46 (174)	20,165 (1421)	76 (290)	12,099 (853)	115 (434)	8,066 (568)	172 (651)	5,377 (379)
2¾ (69.9)	.46 (1.8)	23 (87)	16,836 (1186)	56 (210)	16,665 (1174)	93 (350)	9,999 (705)	139 (526)	6,666 (470)	208 (788)	4,444 (313)
3 (76.2)	.55 (2.1)	28 (104)	14,147 (997)	66 (250)	14,003 (987)	110 (417)	8,402 (592)	165 (625)	5,601 (395)	248 (938)	3,734 (263)
3½ (88.9)	.75 (2.8)	37 (142)	10,394 (732)	90 (341)	10,288 (725)	150 (568)	6,173 (435)	225 (851)	4,115 (290)	337 (1277)	2,744 (193)
4 (101.6)	.98 (3.7)	49 (185)	7,958 (561)	118 (445)	7,877 (555)	196 (741)	4,726 (333)	294 (1112)	3,151 (222)	441 (1668)	2,100 (148)
4½ (114.3)	1.24 (4.7)	62 (235)	6,288 (443)	149 (563)	6,224 (439)	248 (938)	3,734 (263)	372 (1407)	2,489 (175)	558 (2111)	1,660 (117)
INPUT POWER: BHP (Kw)		253 (188)		600 (448)		600 (448)		600 (448)		600 (448)	

1 Based on 90% ME and 100% VE - Intermittent Service Only.

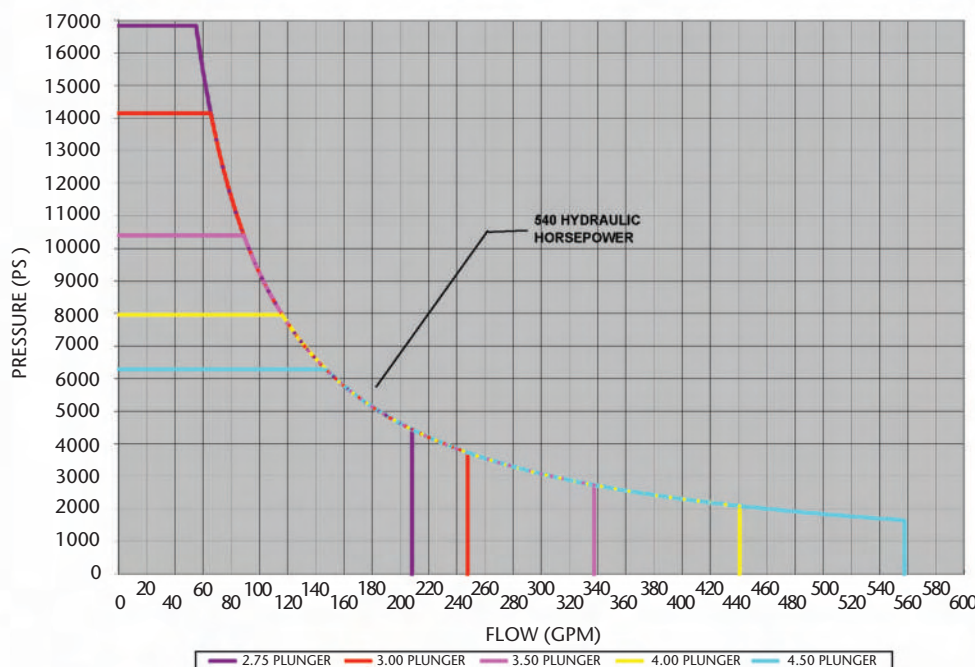
2 For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

APPLICATIONS: Acidizing, cementing, gravel packing, snubbing.

Rated Max. Brake HP.....600 BHP (447 Kw)
Maximum Rod Load.....100,000 Lbs. (43,360 kg)
Stroke Length.....6" (152.4 mm)
Gear Ratio.....4.61:1
Length.....50 1/4" (1,276 mm)
Width.....52 15/16" (1,344 mm)
Height.....23 7/8" (607 mm)
Weight Dry (Approx.).....4,940# (2,040 kg)

Pump dimensions are approximate. For full detailed drawings, please contact Weir SPM Engineering.

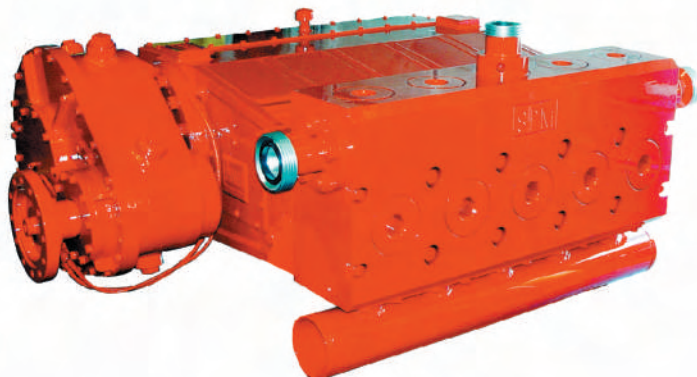
TWS 600S Hydraulic Horsepower Curve



Note: This chart shows this pump's performance at max hydraulic horsepower. Notice as the plunger size for the pump increases, a greater max flow rate is achieved while the max pressure decreases.



QWS 1000S



The QWS 1000S offers a similar design as the TWS 600S with its small footprint, but offers a larger power output. The QWS 1000S can also be set up in the back-to-back configuration to perform acidizing, cementing, gravel packing, and snubbing operations.

QWS 1000S Performance Data^{1, 2}

PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM											
		50 / 231		100 / 461		119 / 548		200 / 922		300 / 1383		450 / 2075	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
2½ (63.5)	0.64 (2.4)	32 (121)	20,372 (1436)	64 (241)	20,372 (1436)	76 (287)	20,368 (1435)	127 (483)	12,009 (853)	191 (724)	8,066 (568)	287 (1086)	5,377 (379)
2¾ (69.9)	0.77 (2.9)	39 (146)	16,836 (1186)	77 (292)	16,836 (1186)	92 (347)	16,833 (1186)	154 (584)	9,999 (705)	231 (876)	6,666 (470)	347 (1314)	4,444 (313)
3 (76.2)	0.92 (3.5)	46 (174)	14,147 (997)	92 (347)	14,147 (997)	109 (413)	14,145 (997)	184 (695)	8,402 (592)	275 (1042)	5,601 (395)	413 (1564)	3,734 (263)
3½ (88.9)	1.25 (4.7)	62 (236)	10,394 (732)	125 (473)	10,394 (732)	148 (562)	10,392 (732)	250 (946)	6,173 (435)	375 (1419)	4,115 (290)	562 (2128)	2,744 (193)
4 (101.6)	1.63 (6.2)	82 (309)	7,958 (561)	163 (618)	7,958 (561)	194 (734)	7,956 (561)	326 (1235)	4,726 (333)	490 (1853)	3,151 (222)	734 (2780)	2,100 (148)
4½ (114.3)	2.07 (7.8)	103 (391)	6,288 (443)	207 (782)	6,288 (443)	245 (929)	6,287 (443)	413 (1564)	3,734 (263)	620 (2345)	2,489 (175)	929 (3518)	1,660 (117)
INPUT POWER: BHP (Kw)		421 (314)		842 (628)		1000 (746)		1000 (746)		1000 (746)		1000 (746)	

¹ Based on 90% ME and 100% VE - Intermittent Service Only.

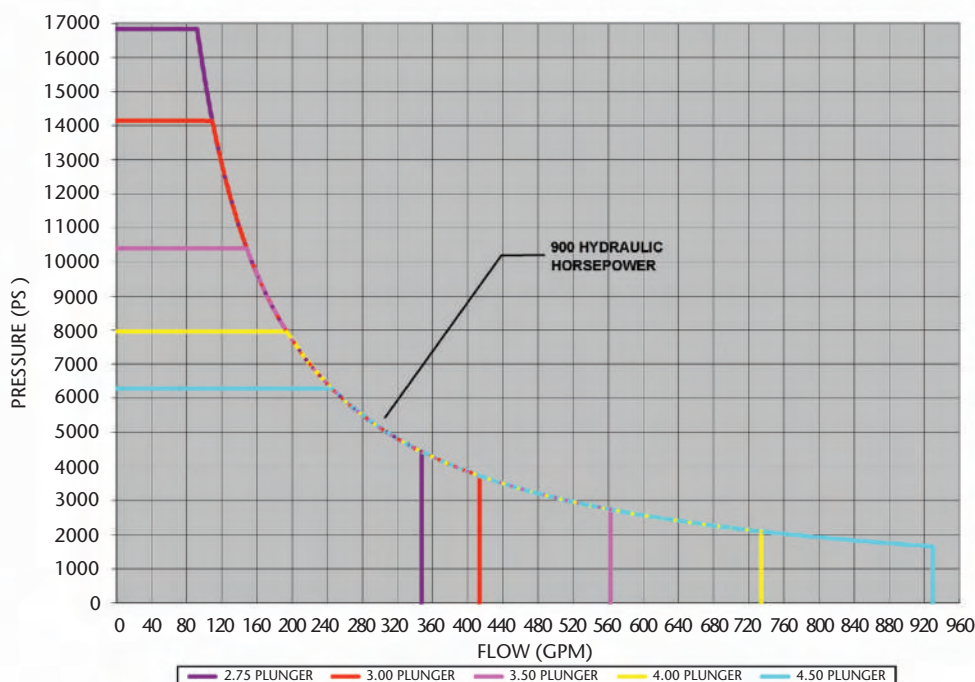
² For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

APPLICATIONS: Acidizing, cementing, gravel packing, snubbing.

Rated Max Brake HP.....1,000 BHP (746 Kw)
 Maximum Rod Load.....100,000 Lbs. (45,359 kg)
 Stroke Length.....6" (152.4 mm)
 Gear Ratio.....4.61:1
 Length.....50" (1,270 mm)
 Width.....73" (1,854 mm)
 Height.....24" (609 mm)
 Weight Dry (Approx.).....7,040# (3,193 kg)

Pump dimensions are approximate. For full detailed drawings, please contact Weir SPM Engineering.

QWS 1000S Hydraulic Horsepower Curve



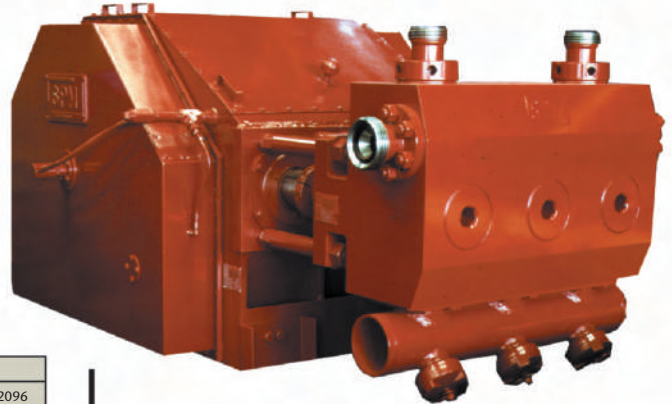
Note: This chart shows this pump's performance at max hydraulic horsepower. Notice as the plunger size for the pump increases, a greater max flow rate is achieved while the max pressure decreases.

Weir SPM



TWS 2250

The TWS 2250 is the most powerful triplex in Weir SPM's line of well service pumps. This staple of the Weir SPM line of well service pumps offers great pressure and flow ratings in a smaller package than the large quintuplex pumps offered by Weir SPM.



TWS 2250 Performance Data^{1,2}

PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		75 / 476		115 / 731		200 / 1271		300 / 1906		330 / 2096	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
3 3/4 (95.3)	1.15 (4.3)	86 (326)	20,372 (1436)	132 (499)	20,372 (1436)	229 (869)	15,124 (1066)	344 (1303)	10,082 (711)	379 (1433)	9,166 (646)
4 (101.6)	1.31 (4.9)	98 (371)	17,905 (1262)	150 (568)	17,905 (1262)	261 (988)	13,292 (937)	392 (1483)	8,861 (624)	431 (1631)	8,056 (568)
4 1/2 (114.3)	1.65 (6.3)	124 (469)	14,147 (997)	190 (719)	14,147 (997)	330 (1251)	10,502 (740)	496 (1876)	7,002 (493)	545 (2064)	6,365 (449)
5 (127.0)	2.04 (7.7)	153 (579)	11,459 (808)	235 (888)	11,459 (808)	408 (1544)	8,507 (600)	612 (2316)	5,671 (400)	673 (2548)	5,156 (363)
5 1/2 (139.7)	2.47 (9.3)	185 (701)	9,470 (667)	284 (1074)	9,470 (667)	494 (1869)	7,031 (495)	741 (2803)	4,687 (330)	815 (3083)	4,261 (300)
5 3/4 (146.1)	2.70 (10.2)	202 (766)	8,665 (611)	310 (1174)	8,665 (611)	540 (2042)	6,433 (453)	809 (3063)	4,288 (302)	890 (3370)	3,898 (275)
6 (152.4)	2.94 (11.1)	220 (834)	7,958 (561)	338 (1279)	7,958 (561)	588 (2224)	5,908 (416)	881 (3336)	3,938 (278)	969 (3669)	3,580 (252)
6 1/2 (165.1)	3.45 (13.0)	259 (979)	6,781 (478)	396 (1501)	6,781 (478)	690 (2610)	5,034 (355)	1,034 (3915)	3,356 (236)	1,138 (4306)	3,051 (215)
6 3/4 (171.5)	3.72 (14.1)	279 (1055)	6,288 (443)	428 (1618)	6,288 (443)	744 (2810)	4,668 (329)	1,115 (4222)	3,112 (219)	1,227 (4644)	2,829 (199)
7 (177.8)	4.00 (15.1)	300 (1135)	5,847 (412)	460 (1740)	5,847 (412)	800 (3027)	4,340 (306)	1,200 (4540)	2,894 (204)	1,319 (4994)	2,630 (185)
7 1/2 (190.5)	4.59 (17.4)	344 (1303)	5,093 (359)	528 (1998)	5,093 (359)	918 (3475)	3,781 (266)	1,377 (5,212)	2,521 (178)	1,515 (5733)	2,291 (161)
INPUT POWER: BHP (Kw)		1137 (848)		1743 (1301)		2250 (1679)		2250 (1679)		2250 (1679)	

¹ Based on 90% ME and 100% VE - Intermittent Service Only.

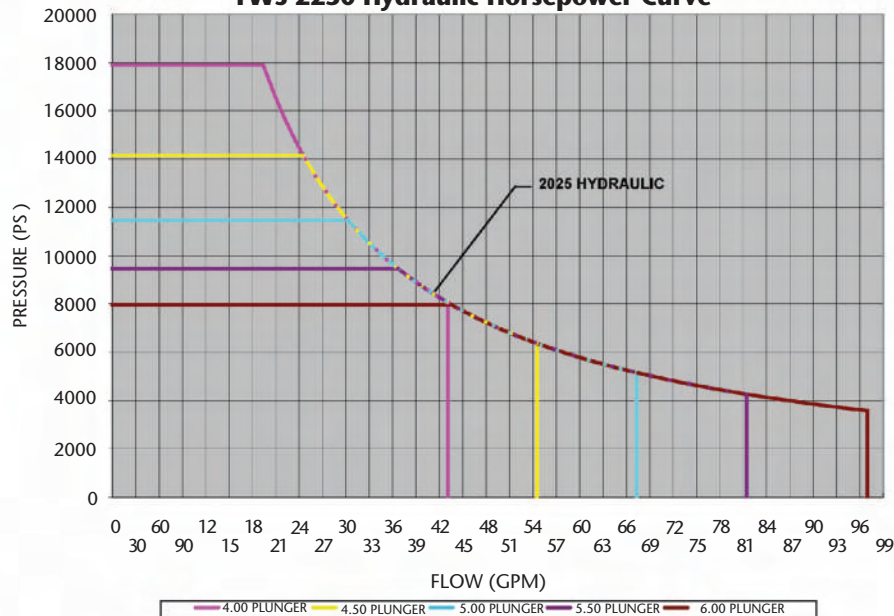
² For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

APPLICATIONS: Fracturing.

Rated Max Brake HP.....2,250 BHP (1,641 Kw)
Maximum Rod Load.....225,000 Lbs. (102,060 kg)
Stroke Length.....8" (203.2 mm)
Gear Ratio.....6.353:1
Length.....89 3/4" (2,280 mm)
Width.....59 3/4" (1,518 mm)
Height.....44 1/4" (1,124 mm)
Weight Dry (Approx.).....12,680# (5,751 kg)

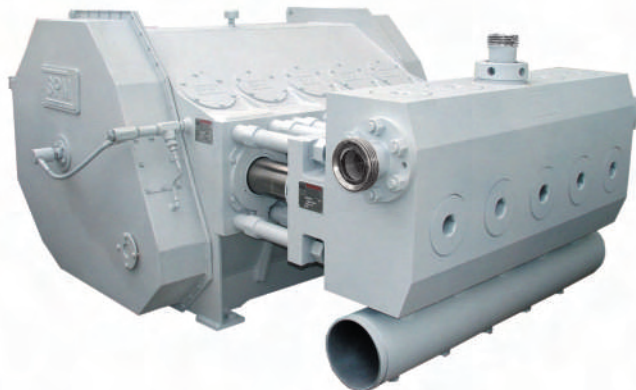
Pump dimensions are approximate. For full detailed drawings, please contact Weir SPM Engineering.

TWS 2250 Hydraulic Horsepower Curve



Note: This chart shows this pump's performance at max hydraulic horsepower. Notice as the plunger size for the pump increases, a greater max flow rate is achieved while the max pressure decreases.

QWS 2500 Classic



The QWS 2500 Classic is a proven high-powered quintuplex pump. This durable pump can produce large pressure and flow ratings and is a cost efficient alternative to the heavy duty QWS 2500SD. The QWS2500 Classic is a reduced duty cycle pump in comparison to the SD model. Weir SPM recommends the QWS 2500SD for use in harsh pumping environments, such as slick water fracturing. See page 27 for more information.

QWS 2500 Classic Performance Data ^{1, 2}

PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		111 / 705		150 / 953		200 / 1271		250 / 1588		330 / 2100	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
3½ (88.9)	1.67 (6.3)	185 (700)	20,000 (1406)	251 (950)	15,365 (1083)	334 (1264)	11,546 (814)	418 (1582)	9,226 (650)	551 (2086)	6,999 (493)
3¾ (95.3)	1.91 (7.2)	212 (802)	17,420 (1255)	287 (1086)	13,437 (947)	382 (1446)	10,096 (711)	478 (1809)	8,068 (569)	630 (2385)	6,121 (431)
4 (101.6)	2.17 (8.2)	241 (912)	15,315 (1077)	326 (1234)	11,830 (834)	434 (1643)	8,886 (626)	543 (2055)	7,102 (500)	716 (2710)	5,386 (380)
4½ (114.3)	2.75 (10.4)	305 (1154)	12,100 (851)	413 (1563)	9,338 (658)	550 (2082)	7,012 (494)	688 (2604)	5,605 (395)	908 (3437)	4,247 (299)
5 (127.0)	3.40 (12.9)	377 (1427)	9,800 (689)	510 (1930)	7,562 (533)	680 (2574)	5,671 (400)	850 (3217)	4,537 (320)	1,122 (4247)	3,437 (242)
5½ (139.7)	4.11 (15.6)	456 (1726)	8,100 (569)	617 (2335)	6,250 (440)	822 (3111)	4,692 (331)	1,028 (3891)	3,751 (264)	1,356 (5132)	2,844 (200)
5¾ (146.1)	4.49 (17.0)	498 (1885)	7,410 (521)	674 (2551)	5,722 (403)	898 (3399)	4,295 (303)	1,123 (4251)	3,434 (242)	1,482 (5609)	2,602 (183)
6 (152.4)	4.89 (18.5)	543 (2055)	6,805 (478)	734 (2778)	5,254 (370)	978 (3702)	3,943 (278)	1,223 (4629)	3,153 (222)	1,619 (6109)	2,382 (168)
6½ (165.1)	5.74 (21.7)	637 (2411)	5,800 (408)	861 (3259)	4,479 (316)	1,148 (4345)	3,359 (237)	1,435 (5431)	2,687 (189)	1,894 (7169)	2,036 (143)
INPUT POWER: BHP (Kw)		2400 (1790)		2500 (1866)		2500 (1866)		2500 (1866)		2500 (1866)	

1 Based on 90% ME and 100% VE - Intermittent Service Only.

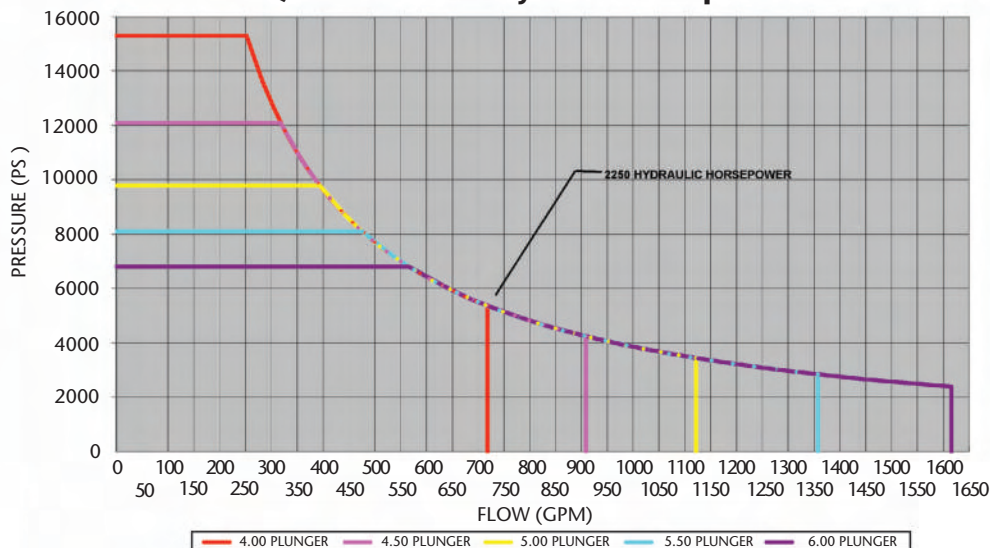
2 Pumps with pressures in excess of 15,000 psi require special gauge and discharge flanges. Contact Weir SPM Engineering for information.

APPLICATIONS: Fracturing.

Rated Max Brake HP.....2,500 BHP (1,866 Kw)
Maximum Rod Load.....192,325 Lbs. (87,239 kg)
Stroke Length.....8" (203.2 mm)
Gear Ratio.....6.353:1
Length.....84 3/4" (2,153 mm)
Width.....73 7/8" (1,877 mm)
Height.....43 3/8" (1,102 mm)
Weight Dry (Approx.).....15,180# (6,885 kg)

Pump dimensions are approximate. For full detailed drawings, please contact Weir SPM Engineering.

QWS 2500 Classic Hydraulic Horsepower Curve



Note: This chart shows this pump's performance at max hydraulic horsepower. Notice as the plunger size for the pump increases, a greater max flow rate is achieved while the max pressure decreases.

Weir SPM



QWS 2500SD

The QWS 2500SD was developed to handle harsh frac conditions, as seen in the premier North American shale plays. The QWS 2500SD is designed to withstand 10 hours of operation up to 6 days a week while maintaining a high performance rod load capacity that is necessary for pumping in harsh conditions.



QWS 2500SD Performance Data ^{1, 2}

PLUNGER DIAMETER	DISPLACE. PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM											
		100	635	116	736	150	953	200	1271	250	1588	330	2096
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
3½ (88.9)	1.67 (6.3)	167 (631)	19,990 (1409)	193 (730)	19,990 (1409)	250 (946)	15,432 (1088)	333 (1261)	11,574 (816)	416 (1576)	9,259 (653)	550 (2081)	7,015 (494)
3¾ (95.3)	1.91 (7.2)	191 (724)	17,413 (1227)	221 (838)	17,413 (1227)	287 (1086)	13,443 (947)	382 (1448)	10,082 (711)	478 (1810)	8,066 (568)	631 (2389)	6,111 (431)
4 (101.6)	2.18 (8.2)	218 (824)	15,305 (1079)	252 (954)	15,305 (1079)	326 (1235)	11,815 (833)	435 (1647)	8,861 (624)	544 (2059)	7,089 (500)	718 (2718)	5,371 (378)
4½ (114.3)	2.75 (10.4)	275 (1042)	12,093 (852)	319 (1207)	12,093 (852)	413 (1564)	9,336 (658)	551 (2085)	7,002 (493)	688 (2606)	5,601 (395)	909 (3440)	4,243 (299)
5 (127.0)	3.40 (12.9)	340 (1287)	9,795 (690)	394 (1490)	9,795 (690)	510 (1930)	7,562 (533)	680 (2574)	5,671 (400)	850 (3217)	4,537 (320)	1,122 (4247)	3,437 (242)
5½ (139.7)	4.11 (15.6)	411 (1557)	8,095 (570)	476 (1803)	8,095 (570)	617 (2336)	6,249 (440)	823 (3114)	4,687 (330)	1,028 (3893)	3,750 (264)	1,358 (5139)	2,841 (200)
5¾ (146.1)	4.50 (17.0)	450 (1702)	7,406 (522)	521 (1971)	7,406 (522)	674 (2553)	5,718 (403)	899 (3404)	4,288 (302)	1,124 (4255)	3,431 (242)	1,484 (5616)	2,599 (183)
6 (152.4)	4.90 (18.5)	490 (1853)	6,802 (479)	567 (2146)	6,802 (479)	734 (2780)	5,251 (370)	979 (3706)	3,938 (278)	1,224 (4633)	3,151 (222)	1,616 (6115)	2,387 (168)
6½ (165.1)	5.75 (21.7)	575 (2175)	5,796 (408)	665 (2518)	5,796 (408)	862 (3262)	4,474 (315)	1,149 (4350)	3,356 (236)	1,436 (5437)	2,685 (189)	1,896 (7177)	2,034 (143)
6¾ (171.5)	6.20 (23.5)	620 (2345)	5,375 (379)	718 (2716)	5,375 (379)	929 (3518)	4,149 (292)	1,239 (4691)	3,112 (219)	1,549 (5863)	2,489 (175)	2,045 (7740)	1,886 (133)
INPUT POWER: BHP (Kw)		2159 (1611)		2500 (1866)		2500 (1866)		2500 (1866)		2500 (1866)		2500 (1866)	

1 Based on 90% ME and 100% VE - Intermittent Service Only.

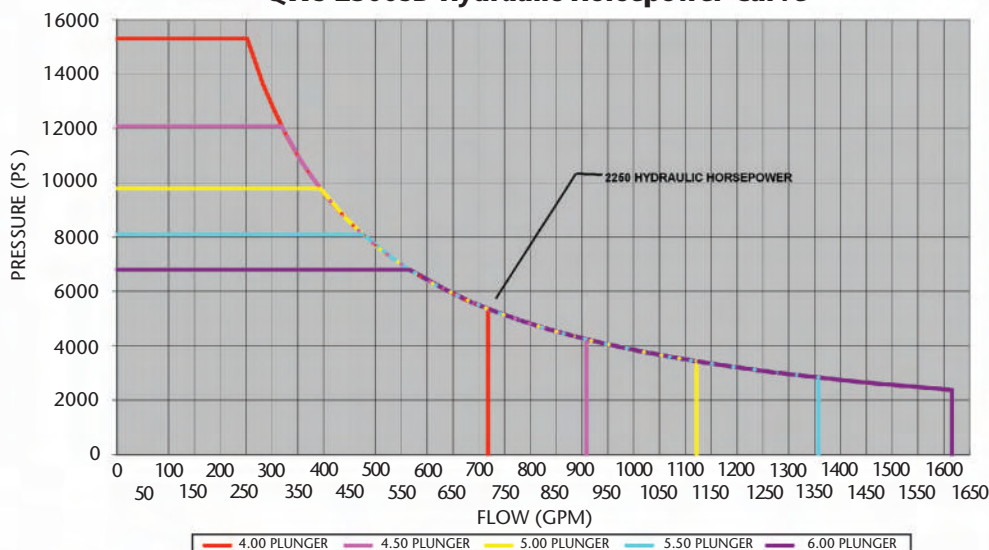
2 For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

APPLICATIONS: Fracturing.

Rated Max. Brake HP.....2,500 BHP (1,866 Kw)
 Maximum Rod Load.....192,325 Lbs. (87,239 kg)
 Stroke Length.....8" (203.2 mm)
 Gear Ratio.....6.353:1
 Length.....84 3/4" (2,153 mm)
 Width.....73 7/8" (1,877 mm)
 Height.....43 3/8" (1,102 mm)
 Weight Dry (Approx.).....16,000# (7,257 kg)

Pump dimensions are approximate. For full detailed drawings, please contact Weir SPM Engineering.

QWS 2500SD Hydraulic Horsepower Curve



Note: This chart shows this pump's performance at max hydraulic horsepower. Notice as the plunger size for the pump increases, a greater max flow rate is achieved while the max pressure decreases.

Weir SPM



QWS 3500



The QWS 3500 is the most powerful well service pump on the market. With 3500 BHP, the pump is designed to eliminate the number of units required on a site to reach its high pressure pumping capabilities, reducing the user's operational costs.

QWS 3500 Performance Data^{1, 2}

PLUNGER DIAMETER	DISPLACE. PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		50 / 355		75 / 532		96 / 680		150 / 1064		200 / 1418	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
4 (101.5)	2.72 (10.3)	136 (515)	20,690 (1458)	204 (772)	20,690 (1458)	261 (988)	20,690 (1458)	408 (1544)	13,233 (933)	544 (2059)	9,925 (699)
4 1/2 (114.3)	3.44 (13.0)	172 (651)	16,348 (1152)	258 (977)	16,346 (1152)	330 (1250)	16,346 (1152)	516 (1954)	10,456 (737)	688 (2606)	7,842 (553)
5 (127.0)	4.25 (16.1)	212 (804)	13,242 (933)	319 (1206)	13,242 (933)	408 (1543)	13,242 (933)	637 (2413)	8,469 (597)	850 (3217)	6,352 (448)
5 1/2 (139.7)	5.14 (19.5)	257 (973)	10,944 (771)	386 (1460)	10,944 (771)	493 (1867)	10,944 (771)	771 (2920)	6,999 (493)	1,028 (3893)	5,250 (370)
6 (152.4)	6.12 (23.2)	306 (1158)	9,196 (648)	459 (1737)	9,196 (648)	587 (2222)	9,196 (648)	918 (3475)	5,881 (414)	1,224 (4633)	4,411 (311)
6 1/2 (165.1)	7.18 (27.2)	359 (1359)	7,835 (552)	539 (2039)	7,835 (552)	689 (2608)	7,835 (552)	1,077 (4078)	5,011 (353)	1,436 (5437)	3,759 (265)
7 (177.8)	8.33 (31.5)	416 (1576)	6,756 (476)	625 (2365)	6,756 (476)	799 (3025)	6,756 (476)	1,249 (4729)	4,321 (305)	1,666 (6306)	3,241 (228)
INPUT POWER: BHP (Kw)		1824 (1361)		2736 (2042)		3500 (2612)		3500 (2612)		3500 (2612)	

¹ Based on 90% ME and 100% VE - Intermittent Service Only.

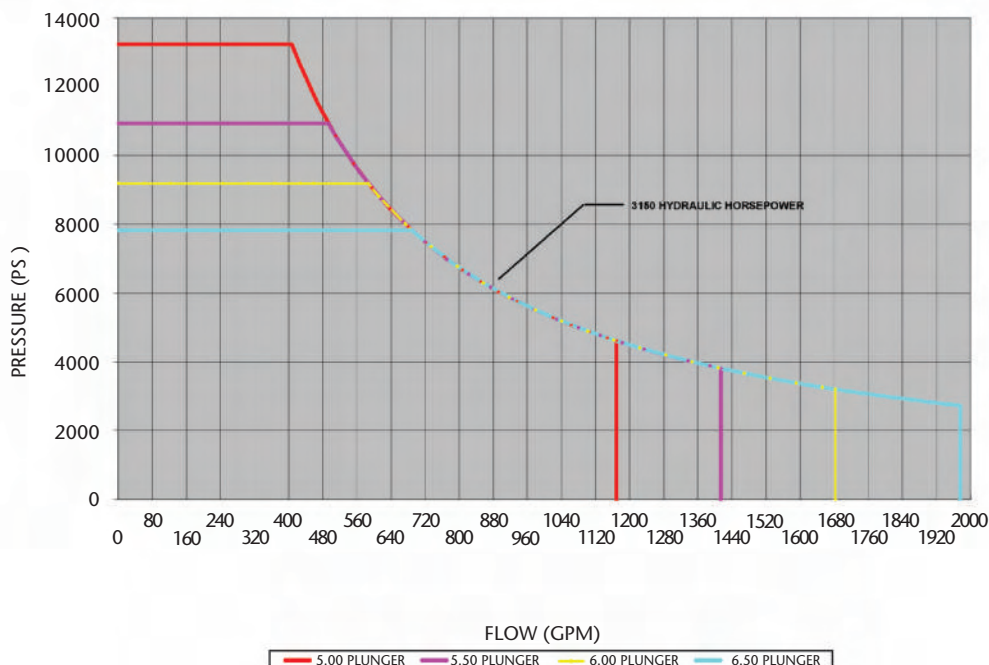
² For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

APPLICATIONS: Fracturing.

Rated Max. Brake HP.....3,500 BHP (2,609 Kw)
 Maximum Rod Load.....260,000 Lbs. (117,934 kg)
 Stroke Length.....10" (254 mm)
 Gear Ratio.....7.091:1
 Length.....94" (2,388 mm)
 Width.....108" (2,743 mm)
 Height.....36" (914 mm)
 Weight Dry (Approx.).....24,000# (10,866 kg)

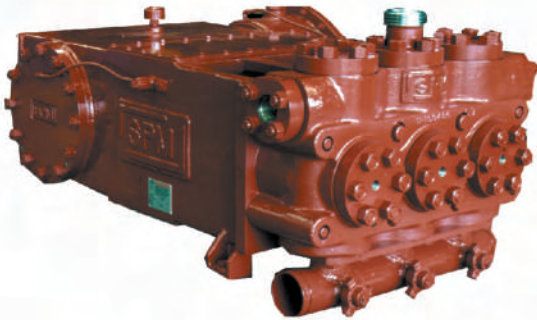
Pump dimensions are approximate. For full detailed drawings, please contact Weir SPM Engineering.

QWS 3500 Hydraulic Horsepower Curve



Note: This chart shows this pump's performance at max hydraulic horsepower. Notice as the plunger size for the pump increases, a greater max flow rate is achieved while the max pressure decreases.

TWS 250



APPLICATIONS: Coiled tubing, snubbing, hot oil, reverse circulation.

Rated Max. Brake HP.....250 BHP (186 Kw)
Maximum Rod Load.....50,000 Lbs. (22,680 kg)
Stroke Length.....5" (127 mm)
Gear Ratio.....4.44:1

TWS 250 Performance Data^{1, 2}

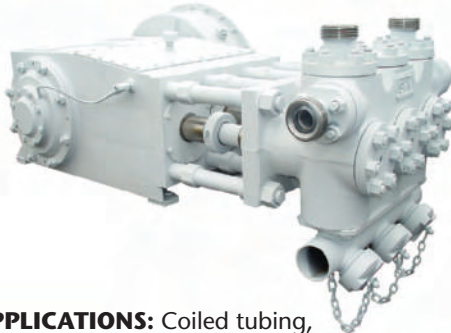
PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		65 / 289		115 / 511		200 / 888		300 / 1332		473 / 2100	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
2 (50.8)	.204 (0.8)	13 (49)	15,915 (1119)	23 (87)	15,915 (1119)	41 (155)	9,409 (661)	61 (231)	6,324 (445)	96 (363)	4,018 (282)
2 1/4 (57.2)	.258 (1.0)	17 (64)	12,575 (884)	30 (114)	12,575 (884)	52 (197)	7,418 (521)	77 (291)	5,010 (352)	122 (462)	3,162 (222)
2 1/2 (63.5)	.319 (1.2)	21 (79)	10,186 (716)	37 (140)	10,186 (716)	64 (242)	6,027 (424)	96 (363)	4,018 (282)	151 (572)	2,555 (180)
2 3/4 (69.9)	.386 (1.5)	25 (95)	8,418 (592)	44 (167)	8,418 (592)	77 (291)	5,010 (352)	116 (439)	3,325 (234)	183 (693)	2,108 (148)
3 (76.2)	.459 (1.7)	30 (114)	7,074 (497)	53 (201)	7,074 (497)	92 (348)	4,193 (295)	138 (522)	2,795 (196)	217 (821)	1,778 (125)
3 1/2 (88.9)	.625 (2.4)	41 (155)	5,197 (365)	72 (273)	5,197 (365)	125 (473)	3,086 (217)	188 (712)	2,052 (144)	296 (1120)	1,303 (92)
3 3/4 (95.3)	.717 (2.7)	47 (178)	4,527 (318)	82 (310)	4,527 (318)	143 (541)	2,698 (190)	215 (814)	1,794 (126)	339 (1283)	1,138 (80)
4 (101.6)	.816 (3.1)	53 (201)	3,979 (280)	94 (356)	3,979 (280)	163 (617)	2,367 (166)	245 (927)	1,574 (111)	384 (1453)	1,005 (71)
INPUT POWER: BHP (Kw)		135 (101)		235 (175)		250 (186)		250 (186)		250 (186)	

1 Based on 90% ME and 100% VE - Intermittent Service Only.

2 For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

Length.....59" (1,499 mm)
Width.....45" (1,143 mm)
Height.....26" (660 mm)
Weight Dry (Approx.).....4,070# (1,850 kg)

TWS 400



APPLICATIONS: Coiled tubing, hot oil, snubbing, reverse circulation, cementing.

Rated Max. Brake HP.....400 BHP (298 Kw)
Maximum Rod Load.....80,000 Lbs. (36,288 kg)
Stroke Length.....6" (152.4 mm)
Gear Ratio.....4.6:1

TWS 400 Performance Data^{1, 2}

PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		50 / 230		100 / 460		200 / 920		300 / 1380		450 / 2070	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
2 1/2 (63.5)	.38 (1.4)	19 (72)	16,305 (1146)	38 (144)	16,305 (1146)	76 (288)	8,120 (571)	114 (431)	5,415 (381)	171 (647)	3,610 (254)
2 3/4 (69.9)	.46 (1.7)	23 (87)	13,475 (947)	46 (174)	13,475 (947)	92 (348)	6,705 (471)	138 (522)	4,470 (314)	207 (783)	2,980 (209)
3 (76.2)	.55 (2.1)	28 (106)	11,320 (796)	55 (208)	11,320 (796)	110 (416)	5,610 (394)	165 (625)	3,740 (263)	248 (939)	2,490 (175)
3 1/2 (88.9)	.75 (2.8)	37 (140)	8,320 (585)	75 (284)	8,320 (585)	150 (568)	4,115 (289)	225 (852)	2,740 (193)	338 (1279)	1,825 (128)
4 (101.6)	.98 (3.7)	49 (185)	6,370 (448)	98 (371)	6,370 (448)	196 (742)	3,150 (221)	294 (1113)	2,100 (148)	441 (1669)	1,400 (98)
4 1/2 (114.3)	1.24 (4.7)	62 (235)	5,030 (354)	124 (469)	5,030 (354)	248 (939)	2,485 (175)	372 (1408)	1,660 (117)	558 (2112)	1,105 (78)
INPUT POWER: BHP (Kw)		203 (151)		400 (298)		400 (298)		400 (298)		400 (298)	

1 Based on 90% ME and 100% VE - Intermittent Service Only.

2 For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

Length.....71-1/4" (1,810 mm)
Width.....75-3/8" (1,913 mm)
Height.....26-1/2" (674 mm)
Weight Dry (Approx.).....4,500# (2,041 kg)

TWS 500 LW



APPLICATIONS: Coiled tubing, reverse circulation, snubbing, acidizing, cementing, gravel packing.

Rated Max. Brake HP.....500 BHP (373 Kw)
Maximum Rod Load.....100,000 Lbs. (43,360 kg)
Stroke Length.....6" (152.4 mm)
Gear Ratio.....4.6:1

TWS 500 LW Performance Data^{1, 2}

PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		50 / 230		100 / 460		200 / 920		300 / 1380		450 / 2070	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
2 1/2 (63.5)	.46 (1.7)	23 (87)	16,845 (1184)	46 (174)	16,845 (1184)	92 (348)	8,385 (589)	138 (522)	5,590 (393)	207 (783)	3,725 (262)
3 (76.2)	.55 (2.1)	28 (106)	14,155 (995)	55 (208)	14,155 (995)	110 (416)	7,015 (493)	165 (625)	4,675 (329)	248 (939)	3,110 (219)
3 1/2 (88.9)	.75 (2.8)	37 (140)	10,400 (731)	75 (284)	10,400 (731)	150 (568)	5,145 (362)	225 (852)	3,430 (241)	338 (1279)	2,280 (160)
4 (101.6)	.98 (3.7)	49 (185)	7,960 (560)	98 (371)	7,960 (560)	196 (742)	3,935 (277)	294 (1113)	2,625 (185)	441 (1669)	1,750 (123)
4 1/2 (114.3)	1.24 (4.7)	62 (235)	6,290 (442)	124 (469)	6,290 (442)	248 (939)	3,110 (219)	372 (1408)	2,075 (146)	558 (2112)	1,380 (97)
INPUT POWER: BHP (Kw)		253 (189)		500 (373)		500 (373)		500 (373)		500 (373)	

1 Based on 90% ME and 100% VE - Intermittent Service Only.

2 For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

Length.....69-11/16" (1,770 mm)
Width.....50-7/8" (1,242 mm)
Height.....29-3/8" (746 mm)
Weight Dry (Approx.).....3,950# (1,792 kg)

Pump dimensions are approximate. For full detailed drawings, please contact Weir SPM Engineering.

Weir SPM



Additional Intermittent Duty Pumps

TWS 600



APPLICATIONS: Acidizing, cementing, gravel packing, snubbing.

Rated Max. Brake HP.....600 BHP (447 Kw)
Maximum Rod Load.....100,000 Lbs. (43,360 kg)
Stroke Length.....6" (152.4 mm)
Gear Ratio.....4.61:1
Length.....73-1/2" (1,867 mm)
Width.....50-7/8" (1,292 mm)

TWS 600 Performance Data^{1, 2}

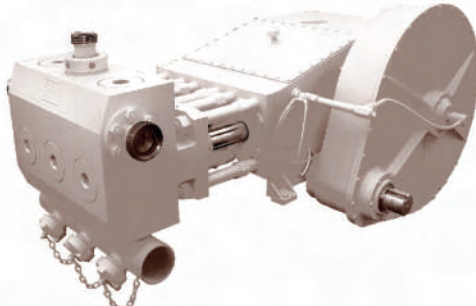
PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		50 / 230		120 / 552		200 / 920		300 / 1380		450 / 2070	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
2 1/2 (63.5)	.38 (1.4)	19 (72)	20,372 (1436)	46 (174)	20,165 (1421)	76 (290)	12,099 (853)	115 (434)	8,066 (568)	172 (651)	5,377 (379)
2 3/4 (69.9)	.46 (1.7)	23 (88)	16,845 (1186)	56 (210)	16,665 (1174)	93 (350)	9,999 (705)	139 (526)	6,666 (470)	208 (788)	4,440 (313)
3 (76.2)	.55 (2.1)	28 (104)	14,147 (997)	66 (250)	14,003 (987)	110 (417)	8,402 (592)	165 (625)	5,610 (395)	248 (938)	3,734 (263)
3 1/2 (88.9)	.75 (2.8)	37 (142)	10,394 (732)	90 (341)	10,288 (725)	150 (568)	6,173 (435)	225 (851)	4,115 (290)	337 (1277)	2,744 (193)
4 (101.6)	.98 (3.7)	49 (185)	7,958 (561)	118 (445)	7,877 (555)	196 (741)	4,726 (333)	294 (1112)	3,151 (222)	441 (1668)	2,100 (148)
4 1/2 (114.3)	1.24 (4.7)	62 (235)	6,288 (443)	149 (563)	6,224 (439)	248 (938)	3,734 (263)	372 (1407)	2,489 (175)	558 (2111)	1,660 (117)
INPUT POWER: BHP (Kw)		253 (188)		600 (448)		600 (448)		600 (448)		600 (448)	

1 Based on 90% ME and 100% VE - Intermittent Service Only.

2 For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

Height.....29-3/8" (746 mm)
Weight Dry (Approx.).....5,400# (2,449 kg)

TWS 900



APPLICATIONS: Acidizing, fracturing, frac-pack.

Rated Max. Brake HP.....900 BHP (671 Kw)
Maximum Rod Load.....160,000 Lbs. (72,576 kg)
Stroke Length.....8" (203.2 mm)
Gear Ratio.....6.353:1
Length.....88-3/8" (2,245 mm)
Width.....54-1/8" (1,375 mm)

TWS 900 Performance Data^{1, 2}

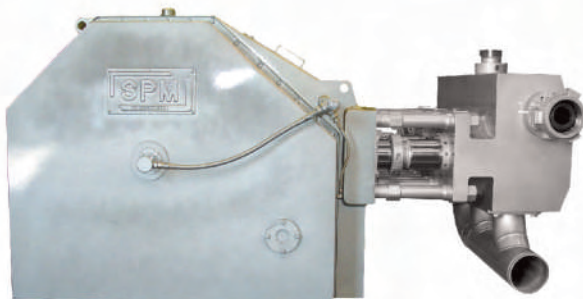
PLUNGER DIAMETER	DISPLACEMENT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		50 / 318		100 / 635		200 / 1271		300 / 1906		330 / 2100	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
3 3/4 (95.3)	1.15 (4.4)	58 (220)	14,490 (1019)	115 (435)	12,075 (849)	230 (871)	6,035 (424)	345 (1306)	4,025 (283)	380 (1438)	3,665 (258)
4 (101.6)	1.30 (4.9)	65 (246)	12,740 (896)	130 (492)	10,680 (751)	260 (984)	5,340 (375)	390 (1476)	3,560 (250)	429 (1624)	3,235 (227)
4 1/2 (114.3)	1.65 (6.3)	83 (314)	10,065 (708)	165 (625)	8,415 (592)	330 (1249)	4,210 (296)	495 (1874)	2,805 (197)	545 (2063)	2,550 (179)
5 (127.0)	2.04 (7.7)	102 (386)	8,150 (573)	204 (772)	6,805 (478)	408 (1544)	3,405 (239)	612 (2316)	2,270 (160)	673 (2547)	2,065 (145)
5 1/2 (139.7)	2.47 (9.4)	124 (469)	6,740 (474)	247 (935)	5,620 (395)	494 (1870)	2,810 (198)	741 (2805)	1,875 (132)	815 (3085)	1,705 (120)
5 3/4 (146.1)	2.70 (10.2)	135 (511)	6,165 (433)	270 (1022)	5,145 (362)	540 (2044)	2,570 (181)	810 (3066)	1,715 (121)	891 (3372)	1,560 (110)
6 (152.4)	2.94 (11.1)	147 (556)	5,660 (398)	294 (1113)	4,725 (332)	588 (2226)	2,360 (166)	882 (3338)	1,575 (111)	970 (3671)	1,430 (101)
INPUT POWER: BHP (Kw)		540 (403)		900 (671)		900 (671)		900 (671)		900 (671)	

1 Based on 90% ME and 100% VE - Intermittent Service Only.

2 For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

Height.....43-1/2" (1,105 mm)
Weight Dry (Approx.).....8,000# (3,629 kg)

TWS 1300



APPLICATIONS: Acid-frac, fracturing, frac-pack.

Rated Max. Brake HP.....1,300 BHP (969 Kw)
Maximum Rod Load.....200,000 Lbs. (90,720 kg)
Stroke Length.....8" (203.2 mm)
Gear Ratio.....7.0:1
Length.....89-3/4" (2,280 mm)
Width.....59-3/4" (1,518 mm)
Height.....44-1/4" (1,124 mm)
Weight Dry (Approx.).....11,550# (5,216 kg)

TWS 1300 Performance Data^{1, 2}

PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		50 / 350		100 / 700		200 / 1400		250 / 1750		330 / 2100	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
3 3/4 (95.3)	1.15 (4.4)	58 (220)	18,115 (1273)	115 (435)	18,108 (1276)	230 (871)	8,720 (613)	288 (1090)	6,965 (490)	345 (1306)	5,815 (409)
4 (101.6)	1.30 (4.9)	65 (246)	15,925 (1120)	130 (492)	15,430 (1085)	260 (984)	7,715 (542)	325 (1230)	6,170 (434)	390 (1476)	5,145 (362)
4 1/2 (114.3)	1.65 (6.3)	83 (314)	12,580 (884)	165 (625)	12,155 (854)	330 (1249)	6,080 (427)	413 (1563)	4,855 (341)	495 (1874)	4,050 (285)
5 (127.0)	2.04 (7.7)	102 (386)	10,190 (716)	204 (772)	9,830 (691)	408 (1544)	4,915 (346)	510 (1930)	3,935 (277)	612 (2316)	3,275 (230)
5 1/2 (139.7)	2.47 (9.4)	124 (469)	8,420 (592)	247 (935)	8,120 (571)	494 (1870)	4,060 (285)	618 (2339)	3,245 (228)	741 (2805)	2,705 (190)
5 3/4 (146.1)	2.70 (10.2)	135 (511)	7,705 (542)	270 (1022)	7,430 (522)	588 (2044)	3,413 (261)	675 (2555)	2,970 (209)	810 (3066)	2,475 (174)
6 (152.4)	2.94 (11.1)	147 (556)	7,075 (502)	294 (1113)	6,820 (497)	588 (2226)	3,410 (240)	735 (2782)	2,730 (192)	882 (3338)	2,275 (160)
6 1/2 (165.1)	3.45 (13.1)	173 (655)	6,030 (424)	345 (1306)	5,815 (409)	690 (2612)	2,905 (204)	863 (3266)	2,325 (163)	1,035 (3917)	1,940 (136)
6 3/4 (171.5)	3.72 (14.1)	186 (704)	5,590 (393)	372 (1408)	5,390 (379)	744 (2816)	2,695 (189)	930 (3520)	2,155 (151)	1,116 (4224)	1,795 (120)
7 (177.8)	4.00 (15.1)	200 (757)	5,200 (366)	400 (1514)	5,015 (353)	800 (3028)	2,505 (176)	1,000 (3785)	2,005 (141)	1,200 (4542)	1,670 (117)
7 1/2 (190.5)	4.59 (17.4)	230 (871)	4,530 (318)	459 (1737)	4,370 (307)	918 (3475)	2,185 (154)	1,148 (4345)	1,745 (123)	1,377 (5212)	1,455 (102)
INPUT POWER: BHP (Kw)		675 (503)		1300 (969)		1300 (969)		1300 (969)		1300 (969)	

1 Based on 90% ME and 100% VE - Intermittent Service Only.

2 For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

Pump dimensions are approximate. For full detailed drawings, please contact Weir SPM Engineering.

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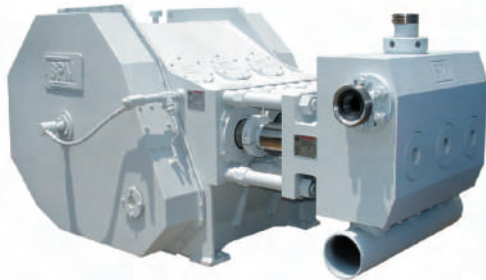
Liberty Energy, Inc. and Liberty Oilfield Services LLC v. U.S. Well Services, LLC, IPR2024-0104

Weir SPM

Additional Intermittent Duty Pumps &
Extended Duty Pumps



TWS 1600 LW



APPLICATIONS: Acid-frac, fracturing, frac-pack.

Rated Max. Brake HP.....1,600 BHP (1,193 Kw)
Maximum Rod Load.....200,000 Lbs. (90,729 kg)
Stroke Length.....8" (203.2 mm)
Gear Ratio.....6.353:1
Length.....84-3/4" (2,153 mm)
Width.....53-7/8" (1,369 mm)
Height.....43-3/8" (1,102 mm)
Weight Dry (Approx.).....8,750# (3,970 kg)

TWS 1600 LW Performance Data^{1, 2}

PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		75 / 476		115 / 731		200 / 1271		300 / 1906		330 / 2100	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
3 3/4 (95.3)	1.15 (4.4)	86 (326)	18,115 (1273)	132 (500)	18,115 (1273)	230 (871)	10,735 (755)	345 (1306)	7,155 (503)	380 (1438)	6,495 (457)
4 (101.6)	1.30 (4.9)	98 (371)	15,925 (1120)	150 (568)	15,925 (1120)	260 (984)	9,495 (667)	390 (1476)	6,330 (445)	429 (1624)	5,755 (405)
4 1/2 (114.3)	1.65 (6.3)	124 (469)	12,580 (884)	190 (719)	12,580 (884)	330 (1249)	7,480 (526)	495 (1874)	4,985 (350)	545 (2063)	4,530 (318)
5 (127.0)	2.04 (7.7)	153 (579)	10,190 (716)	235 (889)	10,190 (716)	408 (1544)	6,050 (425)	612 (2316)	4,035 (284)	673 (2547)	3,670 (258)
5 1/2 (139.7)	2.47 (9.4)	185 (700)	8,420 (592)	284 (1075)	8,420 (592)	494 (1870)	5,000 (352)	741 (2805)	3,330 (234)	815 (3085)	3,030 (213)
5 3/4 (146.1)	2.70 (10.2)	203 (768)	7,705 (542)	311 (1177)	7,705 (542)	540 (2044)	4,570 (321)	810 (3066)	3,050 (214)	891 (3372)	2,770 (195)
6 (152.4)	2.94 (11.1)	221 (836)	7,075 (497)	338 (1279)	7,075 (497)	588 (2226)	4,200 (295)	882 (3338)	2,800 (197)	970 (3671)	2,545 (179)
6 1/2 (165.1)	3.45 (13.1)	259 (980)	6,030 (424)	397 (1503)	6,030 (424)	690 (2612)	3,580 (252)	1,035 (3917)	2,385 (168)	1,139 (4311)	2,170 (153)
INPUT POWER: BHP (Kw)		1012 (755)		1550 (1156)		1600 (1193)		1600 (1193)		1600 (1193)	

¹ Based on 90% ME and 100% VE - Intermittent Service Only.

² For applications demanding pressures over 15,000 psi, contact Weir SPM Engineering.

Extended Duty Pumps

THB 175



APPLICATIONS: Reverse circulation, waterblasting, drill cuttings re-injection.

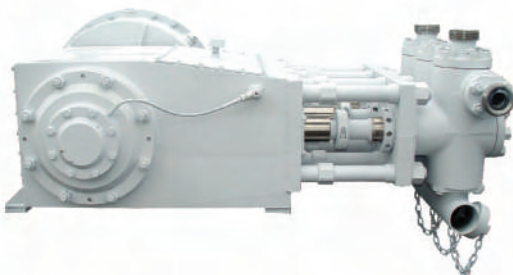
Rated Max. Brake HP.....175 BHP (130 Kw)
Maximum Rod Load.....24,540 Lbs. (11,131 kg)
Stroke Length.....5" (127 mm)
Gear Ratio.....4.44:1
Length.....59" (1,499 mm)
Width.....45" (1,143 mm)
Height.....26" (660 mm)
Weight Dry (Approx.).....4,070# (1,692 kg)

THB 175 Performance Data*

PLUNGER DIAMETER	DISPLACEMENT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		55 / 244		100 / 444		170 / 755		270 / 1200		405 / 1800	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
1 3/4 (44.5)	.156 (0.6)	9 (34)	10,202 (716)	16 (61)	10,202 (717)	27 (102)	10,202 (717)	42 (159)	6,429 (452)	63 (238)	4,286 (301)
2 (50.8)	.204 (0.8)	11 (42)	7,811 (549)	20 (76)	7,811 (549)	35 (132)	7,811 (549)	55 (208)	4,910 (345)	83 (314)	3,253 (229)
2 1/4 (57.2)	.258 (1.0)	14 (53)	6,172 (434)	26 (98)	6,172 (434)	44 (167)	6,172 (434)	70 (265)	3,858 (271)	104 (394)	2,596 (182)
2 1/2 (63.5)	.319 (1.2)	18 (68)	5,000 (352)	32 (121)	5,000 (352)	54 (204)	5,000 (352)	86 (326)	3,140 (221)	129 (488)	2,093 (147)
2 3/4 (69.9)	.386 (1.5)	21 (79)	4,130 (290)	39 (148)	4,130 (290)	66 (250)	4,130 (290)	104 (394)	2,596 (182)	156 (590)	1,731 (122)
3 (76.2)	.459 (1.7)	25 (95)	3,470 (244)	46 (174)	3,470 (244)	78 (295)	3,470 (244)	124 (469)	2,178 (153)	186 (704)	1,452 (102)
3 1/2 (88.9)	.625 (2.4)	34 (129)	2,550 (179)	63 (238)	2,550 (179)	106 (401)	2,550 (179)	169 (640)	1,598 (112)	253 (958)	1,067 (75)
3 3/4 (95.3)	.717 (2.7)	39 (148)	2,222 (156)	72 (273)	2,222 (156)	122 (462)	2,222 (156)	194 (734)	1,392 (98)	290 (1098)	931 (65)
4 (101.6)	.816 (3.1)	45 (170)	1,950 (137)	82 (310)	1,950 (137)	139 (526)	1,950 (137)	220 (833)	1,227 (86)	330 (1249)	818 (58)
INPUT POWER: BHP (Kw)		57 (43)		103 (77)		175 (130)		175 (130)		175 (130)	

*Based on 90% ME and 100% VE - Extended Service Only.

THB 225



Rated Max. Brake HP.....225 BHP (168 Kw)
Maximum Rod Load.....24,540 Lbs. (11,131 kg)
Stroke Length.....6" (152.4 mm)
Gear Ratio.....4.61:1
Length.....74-1/4" (1,810 mm)
Width.....45-3/8" (1,153 mm)
Height.....26-1/2" (674 mm)
Weight Dry (Approx.).....4,500# (2,041 kg)

THB 225 Performance Data*

PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM							
		75 / 346		100 / 461		125 / 576		185 / 853	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
2 1/2 (63.5)	.38 (1.4)	29 (110)	5,000 (352)	38 (144)	5,000 (352)	48 (182)	5,000 (352)	70 (265)	5,000 (352)
2 3/4 (69.9)	.46 (1.7)	35 (132)	4,130 (290)	46 (174)	4,130 (290)	58 (220)	4,130 (290)	85 (322)	4,130 (290)
3 (76.2)	.55 (2.1)	41 (155)	3,470 (244)	55 (208)	3,470 (244)	69 (261)	3,470 (244)	102 (386)	3,470 (244)
3 1/2 (88.9)	.75 (2.8)	56 (212)	2,550 (179)	75 (284)	2,550 (179)	94 (356)	2,550 (179)	139 (526)	2,550 (179)
4 (101.6)	.98 (3.7)	74 (280)	1,950 (137)	98 (371)	1,950 (137)	123 (466)	1,950 (137)	181 (685)	1,950 (137)
4 1/2 (114.3)	1.24 (4.7)	93 (352)	1,540 (108)	124 (469)	1,540 (108)	155 (587)	1,540 (108)	229 (867)	1,540 (108)
INPUT POWER: BHP (Kw)		93 (69)		124 (92)		155 (116)		225 (168)	

* Based on 90% ME and 100% VE - Extended Service Only.

APPLICATIONS: Underbalanced CT drilling, industrial grouting, waterblasting, drill cuttings re-injection.

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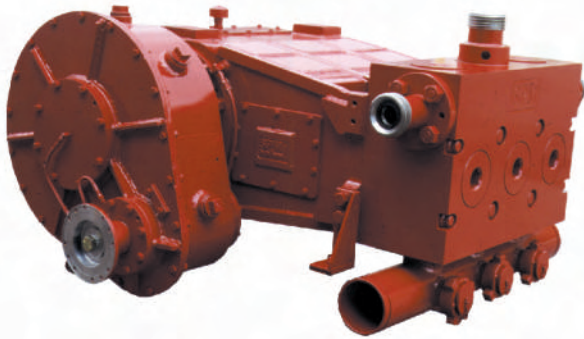
Liberty Energy, Inc. and Liberty Oilfield Services LLC v. U.S. Well Services, LLC, IPR2024-01174

Weir SPM



Extended Duty Pumps

THB 300S



THB 300S Performance Data*

PLUNGER DIAMETER	DISPLACEMENT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		55 / 244		100 / 444		170 / 755		270 / 1200		405 / 1800	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
1 3/4 (44.5)	.156 (0.6)	9 (34)	10,202 (716)	16 (61)	10,202 (717)	27 (102)	10,202 (717)	42 (159)	6,429 (452)	63 (238)	4,286 (301)
2 (50.8)	.204 (0.8)	11 (42)	7,811 (549)	20 (76)	7,811 (549)	35 (132)	7,811 (549)	55 (208)	4,910 (345)	83 (314)	3,253 (229)
2 1/4 (57.2)	.258 (1.0)	14 (53)	6,172 (434)	26 (98)	6,172 (434)	44 (167)	6,172 (434)	70 (265)	3,858 (271)	104 (394)	2,596 (182)
2 1/2 (63.5)	.319 (1.2)	18 (68)	5,000 (352)	32 (121)	5,000 (352)	54 (204)	5,000 (352)	86 (326)	3,140 (221)	129 (488)	2,093 (147)
2 3/4 (69.9)	.386 (1.5)	21 (79)	4,130 (290)	39 (148)	4,130 (290)	66 (250)	4,130 (290)	104 (394)	2,596 (182)	156 (590)	1,731 (122)
3 (76.2)	.459 (1.7)	25 (95)	3,470 (244)	46 (174)	3,470 (244)	78 (295)	3,470 (244)	124 (469)	2,178 (153)	186 (704)	1,452 (102)
3 1/2 (88.9)	.625 (2.4)	34 (129)	2,550 (179)	63 (238)	2,550 (179)	106 (401)	2,550 (179)	169 (640)	1,598 (112)	253 (958)	1,067 (75)
3 3/4 (95.3)	.717 (2.7)	39 (148)	2,222 (156)	72 (273)	2,222 (156)	122 (462)	2,222 (156)	194 (734)	1,392 (98)	290 (1098)	931 (65)
4 (101.6)	.816 (3.1)	45 (170)	1,950 (137)	82 (310)	1,950 (137)	139 (526)	1,950 (137)	220 (833)	1,227 (86)	330 (1249)	818 (58)
INPUT POWER: BHP (Kw)		57 (43)		103 (77)		175 (130)		175 (130)		175 (130)	

*Based on 90% ME and 100% VE - Extended Service Only.

APPLICATIONS: Underbalanced CT drilling, industrial grouting, waterblasting, drill cuttings re-injection.

Rated Max. Brake HP.....300 BHP (223 Kw)
Maximum Rod Load.....54,082 Lbs. (22,531kg)
Stroke Length.....6" (152.4 mm)
Gear Ratio.....4.6:1

Length.....50" (1,270 mm)
Width.....53" (1,346 mm)
Height.....24" (610 mm)
Weight Dry (Approx.).....4,600# (2,086 kg)

THB 350



THB 350 Performance Data*

PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM							
		75 / 346		140 / 645		193 / 890		282 / 1300	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
2 1/2 (63.5)	.38 (1.4)	29 (110)	10,185 (716)	54 (204)	10,185 (716)	74 (208)	7,298 (513)	108 (409)	5,000 (352)
2 3/4 (69.9)	.46 (1.7)	35 (132)	8,418 (592)	65 (246)	8,418 (592)	89 (337)	6,068 (427)	131 (496)	4,123 (290)
3 (76.2)	.55 (2.1)	41 (155)	7,074 (497)	77 (291)	7,074 (497)	106 (401)	5,095 (358)	155 (587)	3,484 (245)
3 1/2 (88.9)	.75 (2.8)	56 (212)	5,197 (365)	105 (397)	5,197 (365)	145 (549)	3,724 (262)	211 (799)	2,559 (180)
4 (101.6)	.98 (3.7)	74 (280)	3,979 (280)	137 (519)	3,979 (280)	190 (719)	2,842 (200)	276 (1045)	1,957 (138)
4 1/2 (114.3)	1.24 (4.7)	93 (352)	3,144 (221)	174 (659)	3,144 (221)	239 (905)	2,260 (159)	349 (1321)	1,547 (109)
INPUT POWER: BHP (Kw)		190 (142)		350 (261)		350 (261)		350 (261)	

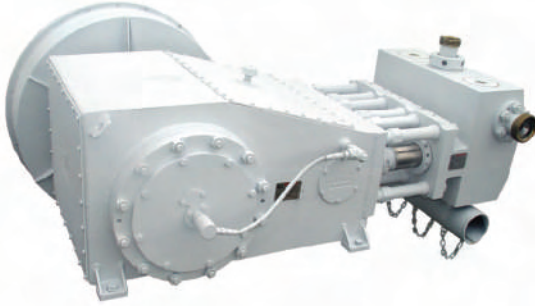
* Based on 90% ME and 100% VE - Extended Service Only.

APPLICATIONS: Underbalanced CT drilling, industrial grouting, waterblasting, drill cuttings re-injection.

Rated Max. Brake HP.....350 BHP (261 Kw)
Maximum Rod Load.....50,000 Lbs. (22,680 kg)
Stroke Length.....6" (152.4 mm)
Gear Ratio.....4.6:1

Length.....73-1/2" (1,867 mm)
Width.....50-7/8" (1,292 mm)
Height.....29-3/8" (746 mm)
Weight Dry (Approx.).....5,700# (2,586 kg)

THB 550



APPLICATIONS: Underbalanced CT drilling, waterblasting.

Rated Max. Brake HP.....550 BHP (410 Kw)
Maximum Rod Load.....71,400 Lbs. (32,387 kg)
Stroke Length.....8" (203.2 mm)
Gear Ratio.....6.353:1
Length.....88 1/16" (2,236 mm)
Width.....54 1/8" (1,375 mm)
Height.....43 1/2" (1,105 mm)
Weight Dry (Approx.).....8,500# (3,856 kg)

THB 550 Performance Data*

PLUNGER DIAMETER	DISPLACEMENT PER REV	FLOW RATE AT CRANKSHAFT RPM & (INPUT RPM)							
		60 (381)		115 (731)		165 (1048)		215 (1366)	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
3	.73 (2.76)	44 (167)	10,101 (710)	84 (318)	10,101 (710)	120 (454)	7,072 (497)	157 (594)	5,405 (380)
3 1/4 (82.6)	.86 (3.26)	52 (197)	8,607 (605)	99 (375)	8,607 (605)	142 (537)	5,976 (420)	185 (700)	4,587 (322)
3 1/2 (88.9)	1.00 (3.79)	60 (227)	7,421 (522)	115 (435)	7,421 (522)	165 (625)	5,143 (362)	215 (814)	3,947 (277)
3 3/4 (95.3)	1.15 (4.4)	69 (261)	6,464 (454)	132 (500)	6,464 (454)	190 (719)	4,467 (314)	247 (935)	3,436 (242)
4 (101.6)	1.30 (4.9)	78 (295)	5,682 (399)	150 (568)	5,682 (399)	215 (814)	3,947 (277)	280 (1060)	3,031 (213)
4 1/2 (114.3)	1.65 (6.3)	99 (375)	4,489 (316)	190 (719)	4,489 (316)	272 (1030)	3,120 (219)	355 (1344)	2,391 (168)
5 (127.0)	2.04 (7.7)	122 (462)	3,636 (256)	235 (889)	3,636 (256)	337 (1276)	2,518 (177)	439 (1662)	1,933 (136)
5 1/2 (139.7)	2.47 (9.4)	148 (560)	3,005 (211)	284 (1075)	3,005 (211)	408 (1544)	2,080 (146)	531 (2010)	1,598 (112)
5 3/4 (146.1)	2.70 (10.2)	162 (613)	2,750 (193)	311 (1177)	2,750 (193)	446 (1688)	1,903 (134)	581 (2199)	1,461 (103)
6 (152.4)	2.94 (11.1)	176 (666)	2,525 (178)	338 (1279)	2,525 (178)	485 (1836)	1,750 (123)	632 (2392)	1,343 (94)
INPUT POWER: BHP (Kw)		290 (216)		550 (410)		550 (410)		550 (410)	

*Based on 90% ME and 100% VE - Extended Service Only.

THB 1050



APPLICATIONS: Under-balanced CT drilling, waterblasting.

Rated Max. Brake HP.....1,050 BHP (783 Kw)
Maximum Rod Load.....110,500 Lbs. (50,123 kg)
Stroke Length.....8" (203.2 mm)
Gear Ratio.....6.353:1
Length.....89 3/4" (2,280 mm)
Width.....59 3/4" (1,518 mm)
Height.....44 1/4" (1,124 mm)
Weight Dry (Approx.).....12,500# (5,670 kg)

THB 1050 Performance Data*

PLUNGER DIAMETER	DISPLACEMENT PER REV	FLOW RATE AT CRANKSHAFT RPM & (INPUT RPM)							
		215 (1366)		215 (1366)		215 (1366)		215 (1366)	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
3 3/4 (95.3)	1.15 (4.4)	69 (261)	10,005 (703)	109 (413)	10,005 (703)	162 (613)	10,005 (703)	247 (935)	6,559 (461)
4 (101.6)	1.30 (4.9)	78 (295)	8,794 (618)	124 (469)	8,794 (618)	183 (693)	8,794 (618)	280 (1060)	5,786 (407)
4 1/2 (114.3)	1.65 (6.3)	99 (375)	6,948 (488)	157 (594)	6,948 (488)	233 (882)	6,948 (488)	355 (1344)	4,564 (321)
5 (127.0)	2.04 (7.7)	122 (462)	5,628 (396)	194 (734)	5,628 (396)	288 (1090)	5,628 (396)	439 (1662)	3,691 (259)
5 1/2 (139.7)	2.47 (9.4)	148 (560)	4,651 (327)	235 (889)	4,651 (327)	348 (1317)	4,651 (327)	531 (2010)	3,051 (214)
5 3/4 (146.1)	2.70 (10.2)	162 (613)	4,256 (299)	257 (973)	4,256 (299)	381 (1442)	4,256 (299)	581 (2199)	2,789 (196)
6 (152.4)	2.94 (11.1)	176 (666)	3,908 (275)	279 (1056)	3,908 (275)	415 (1571)	3,908 (275)	632 (2392)	2,564 (180)
6 1/2 (165.1)	3.45 (13.1)	207 (783)	3,330 (234)	328 (1241)	3,330 (234)	486 (1840)	3,330 (234)	742 (2808)	2,183 (153)
6 3/4 (171.5)	3.72 (14.1)	223 (844)	3,088 (217)	353 (1336)	3,088 (217)	525 (1987)	3,088 (217)	800 (3028)	2,025 (142)
INPUT POWER: BHP (Kw)		450 (336)		705 (526)		1050 (783)		1050 (783)	

*Based on 90% ME and 100% VE - Extended Service Only.

QHB 1575



APPLICATIONS: Water-blasting, water jetting, ultra high pressure drilling.

Rated Max. Brake HP.....1,575 BHP (1,175 Kw)
Maximum Rod Load.....100,000 Lbs. (45,450 kg)
Stroke Length.....8" (203.2 mm)
Gear Ratio.....6.353:1
Length.....96" (2,438 mm)
Width.....74" (1,877 mm)
Height.....60" (1,524 mm)
Weight Dry (Approx.).....16,500# (7,500 kg)

QHB 1575 Performance Data*

PLUNGER DIAMETER	DISPLACEMENT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM					
		95 / 604		140 / 889		215 / 1366	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)	gpm (lpm)	psi (kg/cm ²)
2 1/2 (63.5)	.85 (3.2)	81 (306)	20,372 (1436)	119 (450)	20,372 (1436)	183 (692)	13,295 (937)
2 3/4 (69.9)	1.03 (3.9)	98 (370)	16,836 (1186)	144 (545)	16,836 (1186)	221 (837)	10,987 (774)
3 (76.2)	1.22 (4.6)	116 (440)	14,147 (997)	171 (649)	14,147 (997)	263 (996)	9,232 (651)
3 1/4 (82.6)	1.44 (5.4)	136 (517)	12,054 (849)	201 (761)	12,054 (849)	309 (1169)	7,867 (554)
3 1/2 (88.9)	1.67 (6.3)	158 (599)	10,394 (732)	233 (883)	10,394 (732)	358 (1356)	6,783 (478)
3 3/4 (95.3)	1.91 (7.2)	182 (688)	9,054 (638)	268 (1013)	9,054 (638)	411 (1556)	5,909 (416)
4 (101.6)	2.18 (8.2)	207 (782)	7,958 (561)	305 (1153)	7,958 (561)	468 (1771)	5,193 (366)
4 1/2 (114.3)	2.75 (10.4)	262 (990)	6,288 (443)	386 (1459)	6,288 (443)	592 (2241)	4,103 (289)
5 (127.0)	3.40 (12.9)	323 (1223)	5,093 (359)	476 (1802)	5,093 (359)	731 (2767)	3,324 (234)
INPUT POWER: BHP (Kw)		1066 (796)		1572 (1173)		1575 (1175)	

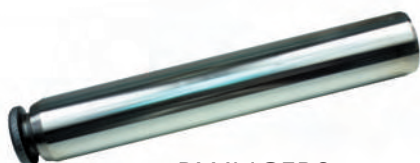
* Based on 90% ME and 100% VE - Extended Service Only.

Weir SPM



Pump Accessories

Fluid End Expendables



PLUNGERS

Weir SPM plungers are engineered and manufactured to precise dimensions with the proper coatings and surface finishes necessary for rugged well service applications.



HIGH PERFORMANCE PLUNGER PACKING

Weir SPM's line of high performance packing is designed and manufactured to give extended and dependable service life in high pressure, corrosive and abrasive pumping applications.



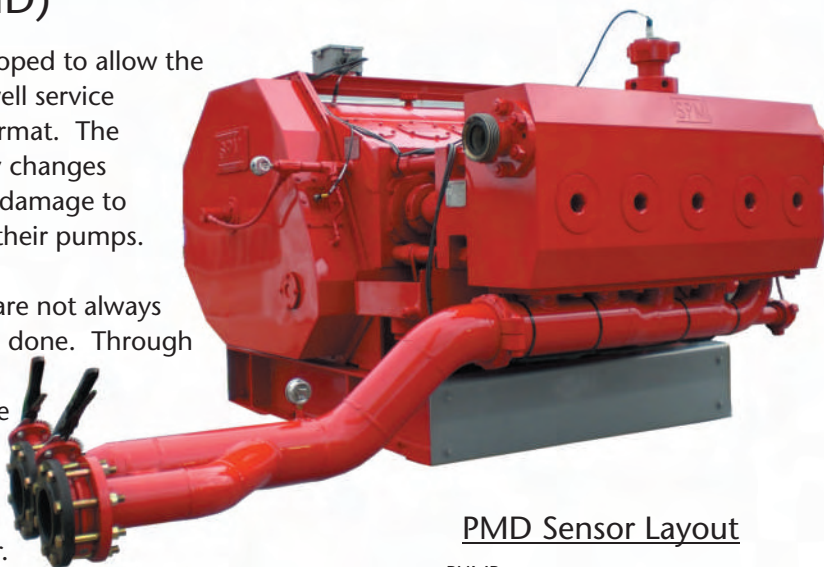
VALVES and SEATS

Weir SPM valves and seats are designed for severe well service applications including high pressure. Weir SPM's new Bonded Valves feature a greater flow area, less abrasion and lower fluid velocity through the seat.

Pump Monitoring Device (PMD)

Weir SPM's Pump Monitoring Device was developed to allow the user to continually monitor the status of their well service pumps with real time data in an easy to read format. The PMD allows the operator to make the necessary changes during operation to minimize or prevent costly damage to pumping equipment and increase longevity of their pumps.

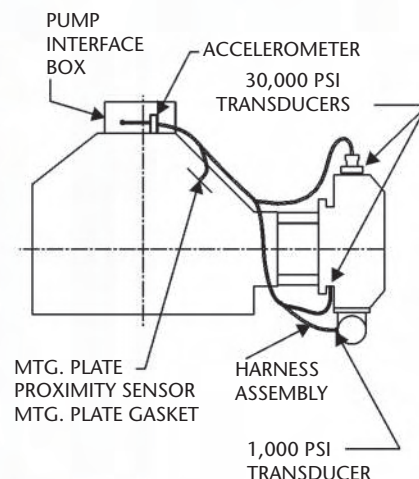
On a loud and hectic frac site, many problems are not always evident until it is too late and damage has been done. Through various sensors installed on the pump, the PMD provides a unique opportunity to diagnose problems such as insufficient charge pressure, discharge and suction valve failure, cavitation, as well as other issues by displaying "alarms" to notify the user of any problems as they occur.



Actual Screenshot

Pump Measurement Device							
	RPM	Discharge Pressure					Rod Load
		Discharge Valves		Suction Valves		Charge Pressure	
Pump 01	84 RPM	5297 PSI				39 PSI	54%
Pump 02		1 2 3 4 5	1 2 3 4 5				
Pump 03							
Pump 04							
Pump 05							
Current Status: 15:27:59 09/05/06: Pump Number 1 Charge Pressure Too Low event start							
Calibrate Pumps							
							Time: 15:28:05

PMD Sensor Layout



Unloading Valve for Drilling Operations



Full Bore Unloading Valve

Weir SPM Full Bore Unloading Valves for drilling applications provide over-pressure protection for mud pumps operating under a variety of pressure and flow conditions. The valves are compact, simple to operate and rely on the system's pressure to open when a preset pressure is exceeded and automatically snap shut when the pressure drops.

The valves are externally adjustable, and unlike shear relief valves which use common nails to trigger the valve, Weir SPM's Full Bore Unloading Valve utilizes nitrogen or rig air (properly filtered) to activate opening and closing. This model is available in 3" and 4" sizes. Operating pressures range from 5,000 psi to 20,000 psi. Standard service and sour gas models are available.

REMOTE RELIEF

Utilized together, the Full Bore Unloading Valve and Remote Control Panel increase safety for operators on drilling sites.

Remote Control Panel for Nitrogen Relief Valve Operation

Weir SPM has designed a Remote Control Panel to work in conjunction with Weir SPM's new Full Bore Unloading Valve (drilling applications) and the Emergency Back Pressure Relief Valve (well service applications).

The Remote Control Panel's primary function is to regulate the flow of air or nitrogen to the relief valve from a designated control station, allowing the operator to change the pressure relief settings with the turn of a knob.



Iron Management Rental Program

Weir SPM's Iron Rental Program provides the customer with a cost-effective alternative to purchasing, maintaining, and recertifying treating iron. Benefits of the program include eliminating the upfront cost of purchasing new iron, commissioning new iron, borrowing money, replacing expendable parts, the labor associated with repair, and inventory during down time. The program allows the user to focus on its primary business, ensures all iron is in compliance, and avoids recertification costs.

Features of the program:

- Monthly reports on rental equipment highlighting all product on rental, length of time on rental, and charges to date by part number for all product rented.
- Daily rates, monthly rates or annual rates.
- 24-hour / 7-day a week service.
- Pickup and delivery service available.
- Containers and baskets can be provided.
- Quick response to customer emergency requirements.
- Fully certified iron packages available to health, safety, and environmental requirements.
- Summary billing.
- Large inventories including full baskets or individual items.



Pump Repair

Weir SPM's professionally trained technicians perform complete pump repair services for many makes and models of well service pumps. Weir SPM reduces downtime through convenient repair services in the field (when possible) or at one of its pump repair facilities located around the globe. The most effective way to keep your fleet of units up and running is to utilize Weir SPM's pump repair services.

Procedures Include:

- Disassembly of all components
- Inspection, including magnetic particle
- Evaluation of repairs
- Cost estimates
- Repair utilizing Weir SPM technicians
- Test
- Documentation to verify product quality
- Repaint

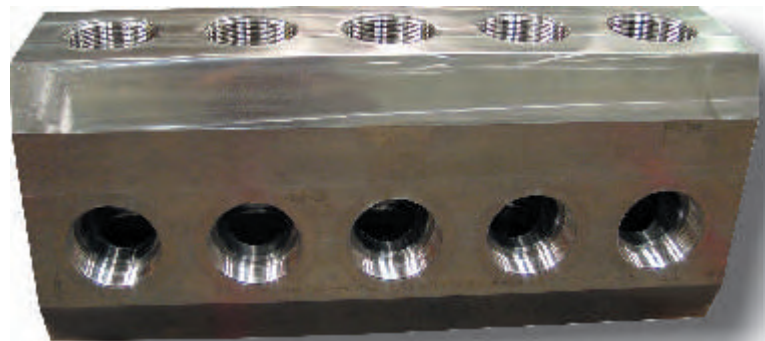
Weir SPM has facilities equipped to perform complete pump repairs at:

- Fort Worth, Texas
- Odessa, Texas
- Deer Park, Texas
- Grand Junction, Colorado
- Red Deer, Alberta, Canada
- Aberdeen, Scotland



Fluid End Repair

In the past, the only option for operators with cracked, washed or eroded fluid ends was to simply discard them. In an effort to offer customers an alternative to disposing of their equipment, Weir SPM has developed a process to return used blocks as reconditioned fluid ends in "like-new" condition. Weir SPM has been implementing this process in select areas with great success. Now, all customers will have the opportunity to evaluate the status of their fluid cylinders and have options of whether to replace or refurbish.



Refurbishment Process Includes:

- Disassembly of all components.
- Visual inspection vital areas.
- Thorough examination using multiple techniques.
- Evaluation of repairs & cost estimates.
- Repair utilizing skilled Weir SPM technicians.
- Test & documentation to verify product quality.
- Repaint.
- Record of all visual findings and dimensional data on formatted reports presented to customer.

Plunger Repair



Weir SPM now offers Plunger Repair services. This service gives customers the opportunity to repair

damaged plungers that would normally be scrapped. The reliable repaired plungers are returned to the customer in "like new" condition, offering a less expensive alternative to the purchase of new plungers.

Iron Recertification and Refurbishment

Weir SPM's Iron Management Program consists of: commissioning new iron, iron refurbishment, iron rental services, high-pressure manifold recertification, high-pressure manifold periodic maintenance, and high-pressure manifold refurbishment. The program is designed to provide recertification of products on demand to maximize safety, quality, and reliability in a cost effective manner.

Benefits Include:

- Maximizing the useful life of the product
- Enhancing product safety and reliability in the field
- Third party certifiable safety on the job site
- Access to Weir SPM's internet-based **Iron Management Database** for up-to-date electronic information



9 Steps to Iron Recertification Program



Step 1:
Visual Inspection



Step 2:
Wall Thickness



Step 3:
Disassembly



Step 4:
Strip Contaminants



Step 5:
Magnetic Particle



Step 6:
Assembly with New Products Kit



Step 7:
Pressure Test



Step 8:
Paint



Step 9:
Certificates

Mobile Recertification Units

Weir SPM has a fleet of Mobile Recertification Units that are currently providing on site service throughout the United States, Mexico, Middle East, Russia, and Far Eastern countries. The MRUs are designed and manufactured to provide a wide variety of services to the customer at a location that is most convenient to them.



Flow Control Product Services

- Certified inspection
- Ultrasonic wall thickness inspection
- Magnetic particle inspection
- Replacement of parts
- Training
- New product sales
- Iron Management documentation
- Rental



Pressure Test Station with full test capability to 30,000 psi; Inside test chamber for valves and integral connections.



Work table and vise for disassembly, re kitting, and re assembly; Ample storage space for parts kits; ¼ ton hoist and jib crane; Wash vat for cleaning parts

Pump Services

- Field repair pump specialists
- Replacement of fluid end expendables
- Fluid end inspection
- Fluid end magnetic particle inspection
- Pump inspection
- Basic power end repair
- Training - maintenance and operation
- Pumps and pump part sales



Gas Powered Generator



Port hole allows pipe to extend beyond the length of the trailer during poor weather conditions.



Magnetic Particle Inspection, yoke style with spray fluid and black light.



Gas Powered Air Compressor disperses 40 cubic feet per minute.



SALES OFFICES

Houston, Texas
Singapore

STANDARD SERVICE CENTER

**(new product sales, iron recertification,
and rental)**

United States

Alice, Texas
Brighton, Colorado
Elk City, Oklahoma
Jane Lew, West Virginia
Lafayette, Louisiana
Longview, Texas
Searcy, Arkansas
Williston, North Dakota

Canada

Grande Prairie, Alberta, Canada
Red Cliff, Alberta, Canada

Mexico

Villahermosa, Mexico

Middle East

Dubai, United Arab Emirates

Australia

Perth, Australia

SERVICE CENTER WITH PUMP REPAIR

United States

Deer Park, Texas
Fort Worth, Texas
Grand Junction, Colorado
Odessa, Texas

Canada

Red Deer, Alberta, Canada

Europe

Aberdeen, Scotland

WEIR OIL & GAS SERVICE CENTER

Edmonton, Alberta, Canada
Aberdeen, Scotland
Abu Dhabi, UAE
Dubai, UAE
Al Khobar, Saudi Arabia
Baku, Azerbaijan

Weir SPM

7601 Wyatt Drive
Fort Worth
TX 76108
USA

Tel: (817) 246 2461
Fax (817) 246 6324

www.weiroilandgas.com

