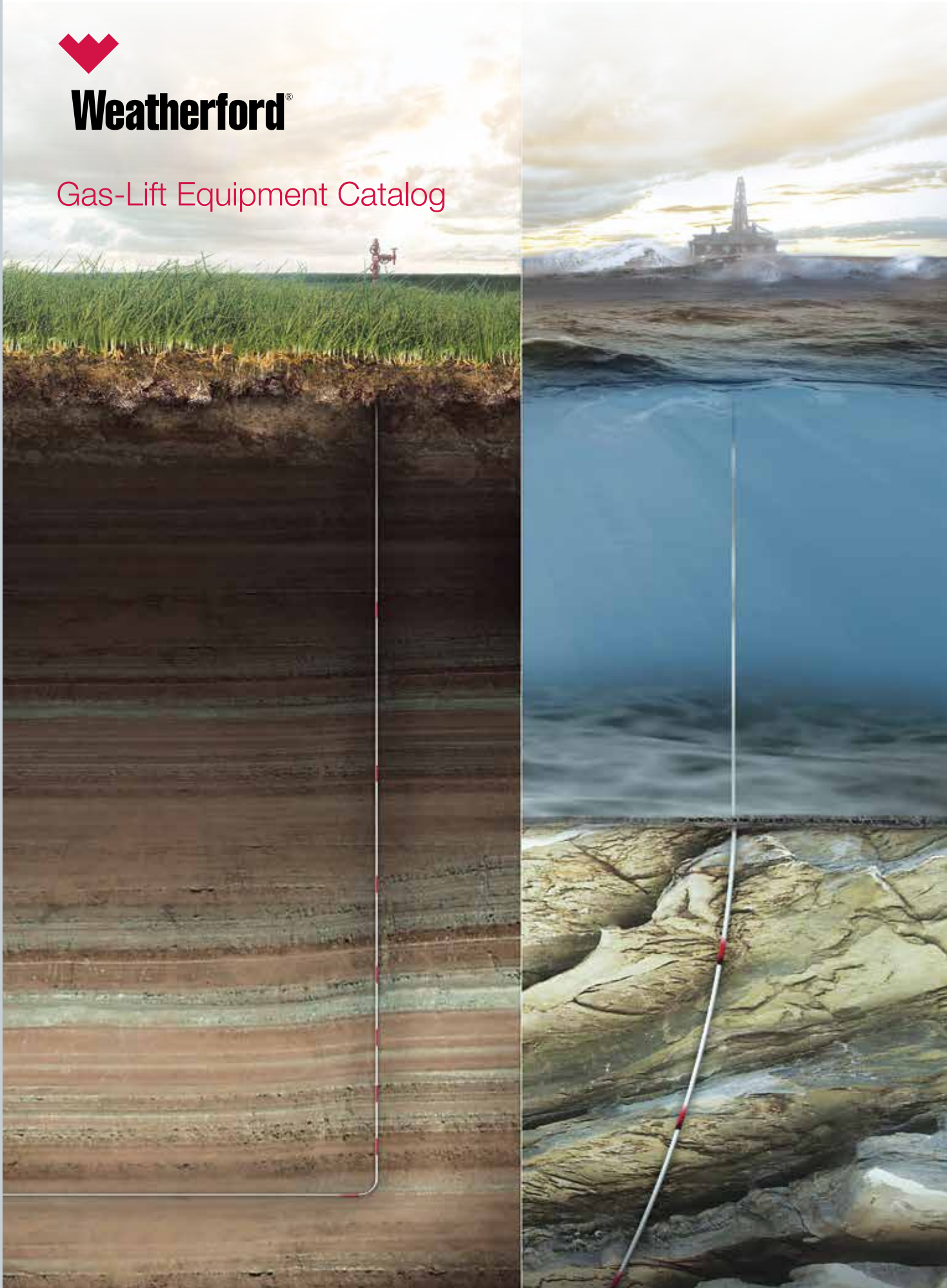
Weatherford®

Gas-Lift Equipment Catalog



Making Lift an

Exact Science

Only Weatherford offers products and expertise for all forms of lift, as well as offering advanced software and equipment to optimize your production performance. These capabilities mean that we give you a system recommendation based on an exacting analysis of reservoir data. Matching the system to the task ensures better control of lifting costs and enhanced reservoir recovery. Put our comprehensive technical support, one-stop product supply, and experienced analysis services to work for you today.

Contents

Introduction

Real Result

TECHNOLOGY AND EXPERIENCE
Renew Productivity in South Louisiana

Objective

To optimize lift-gas usage and maximize production in a developing field.

Results

- A Weatherford gas-lift specialist worked in-house with the operator, reviewing gas-lift designs and production reports for 83 wells.
- The wells were modeled with WellFlo®, DynaLift™ and VALCAL software to determine optimization potential and were prioritized to make use of available lift gas.
- Valve performance spreadsheets, linked to well test reports, were developed to give the operator a quick view of the operating conditions of each well.

Value to Clients

Oil production increased by 728 B/D (115.74 m^3/d), or 13% for the wells targeted.

Location

Plaquemines Parish, Louisiana, USA

Well Depths

3,300 to 9,700 ft (1006 to 2957 m)

Casing

7-in., 26-lb/ft

Tubing

2-7/8 in.

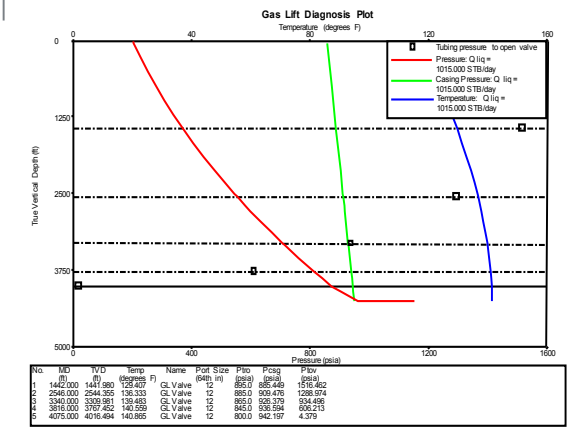
Gas-Lift Injection Pressure

950 psi (6.6 MPa)

Products/Services

-Gas-lift design services
-WellFlo, DynaLift, and VALCAL software

WellFlo® Gradient Plot



2005–2006 Optimization Results

- 2006 Optimization from GLV changes (3 wells) 212 BOPD
- 13 wells had GL rates increased, 7 improved, 6 no improvement
  - Oil increase = 516 BOPD
  - GL increase = 750 Mscfd
- GL decreased in 4 wells, saving 350 Mscfd

	Number of Wells	Rate Change (Mscfd)	BOPD Increase
Valve Change	3	430	212
GL Rate Change	13	750	516
GL Rate Decrease	4	-350	0
Total	**17**	**830**	**726**

Weatherford Gas-Lift Systems

Weatherford gas-lift systems offer exceptional economic value and flexibility in all gas-lift applications. Our McMurry-Macco® gas-lift systems include a complete portfolio of value-added products, services, and solutions for production enhancement and ultimate reserve recovery.

Weatherford is certified per API 19G1 and 19G2 to provide V-1 rated gas-lift mandrels and gas lift valves, currently the highest standards recognized by the industry, and is leading the way by expanding gas-lift equipment technology in deepwater and shale reservoir applications. The complete Weatherford family of McMurry-Macco gas-lift products ensures compatible, flexible solutions for every gas-lift application. Whether for a low-producing, onshore conventional or shale well, an intermittent-producing well, or a deepwater, highly deviated, high-producing continuous-lift well, Weatherford has the equipment and expertise to ensure maximum reservoir productivity and increased operational efficiency.

Our technical-support capabilities and field support are second to none. Weatherford technical experts use state-of-the-art analysis software for installation design and sizing, individual well evaluation, and troubleshooting. If a thorough analysis proves gas lift is not the ideal lift method, then Weatherford can evaluate your well for other artificial-lift methods.

In addition to gas lift, Weatherford offers other compatible lift-enhancement solutions, including waterflooding, steam flooding, downhole gauge carriers, concentric packoffs, and downhole corrosion monitoring.

Weatherford Advantages

- Complete infrastructure in all major areas to support customer operations
- The most comprehensive suite of gas-lift-solution offerings for onshore and offshore applications
- Experienced professionals to analyze, design, and troubleshoot gas-lift installations
- Complete mechanical-engineering staff to design customized equipment for specific applications
- Full range of downhole capabilities, including waterflooding, steam flooding, and chemical injection
- Globally recognized leading developer of gas-lift equipment technology and extensive performance testing
- Field-proven solutions, including deepwater and high-volume applications
- Products and services backed by a solid global supply chain
- Capability to evaluate and offer all forms of artificial lift
- A complete line of computerized engineering optimization with electronic controllers

Introduction

Weatherford Gas-Lift Systems

System Components

Weatherford manufactures in alignment with American Petroleum Institute (API) and International Organization for Standardization (ISO) standards and offers clients the option of their products being certified to these standards.

Gas-Lift Valves

Weatherford offers a complete line of McMurry-Macco® wireline-retrievable and tubing-retrievable gas-lift valves, including injection-pressure-operated, production-pressure-operated, and pilot-operated gas-lift valves. Special application valves are also offered in tubing- and wireline-retrievable configurations in 5/8-, 1- and 1 1/2-in. outside diameter (OD) models.

Gas-Lift Mandrels

Weatherford offers an extensive range of wireline-retrievable side-pocket mandrels and tubing-retrievable mandrels. Each gas-lift mandrel series features 1- and 1 1/2-in. inside diameter (ID) pocket profiles and includes both oval and round body designs. Several configurations and models are available, ranging from forged and machined pocket designs, high-pressure solid-body designs with full-length machined grooves to facilitate control lines, and special-clearance designs. Each model can be configured with various porting options, including tubing flow, annular flow, side-string, bypass, and chemical-treating injection systems.

Kickover Tools

Weatherford KOT kickover tools enable gas-lift valve wireline operations to be performed more effectively by automatically recocking downhole during valve pulling and setting operations. Also, this tool does not require repinning after a valve is retrieved or set, saving time during wireline operations.

Other Gas-Lift Equipment

Latches: A complete line of latches is available for side pockets with 180° K type and 360° A type latch-pocket profiles, specifically designed to lock gas-lift valves and side-pocket accessories into the appropriate side-pocket mandrel.

Communication and isolation devices: Weatherford has an integrated line of communication and isolation devices, including wireline-retrievable dummy valves, equalizing dummy valves, and shear-orifice valves.

Surface controls: Our surface controls include an in-line variable-orifice choke, which is a calibrated, adjustable choke for regulating injection gas. Pneumatically operated motor valves and electronic controllers are also offered for use in wells needing intermittent-type lift control.

Slimhole mandrels: Weatherford slimhole mandrels are used with packoff assemblies or coiled-tubing strings for maximum flexibility.

Pack-off equipment: Our line of packoff equipment includes isolation tools for tubing strings.

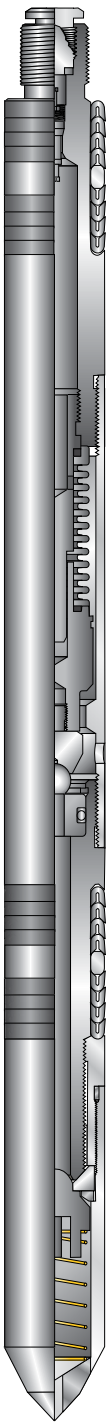
Chemical injection, steam-flood, and waterflood systems: Weatherford offers comprehensive packages of production enhancement solutions with a proven history of exceptional performance in demanding environments throughout the world.

Automation: We also have a complete offering of production-enhancement solutions featuring real-time predictive information at the wellsite or from the desktop.

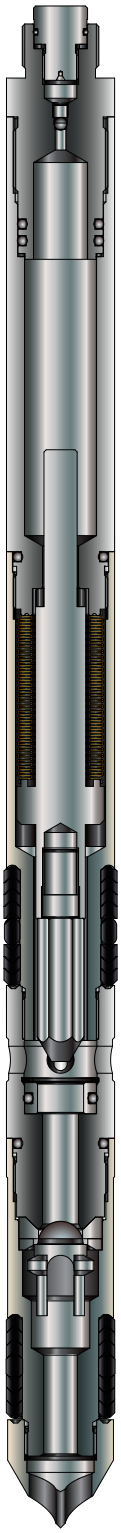
Application Considerations

	Typical Range	Maximum
Operating depth, true vertical depth (ft/m)	5,000 to 10,000 1524 to 3048	15,000 4572
Operating volume (B/D, m^3/d)	100 to 10,000 16 to 1590	30,000 4770
Operating temperature (°F/°C)	100° to 250°/ 38° to 121°	400°/ 204°
Wellbore deviation	0 to 50°	70° (short to medium radius)
Corrosion handling	Good to excellent with upgraded materials	
Gas handling	Excellent	
Solids handling	Good to excellent with upgraded materials	
Fluid gravity	> 15° API	
Servicing	Wireline or workover rig	
Prime mover type	Compressor	
Offshore application	Excellent	
System efficiency	10% to 30%	

Gas-Lift Valves



R-1 Valve



R-2 Valve

R Series Injection-Pressure-Operated, Wireline-Retrievable Valves

Weatherford McMurry-Macco® R series injection-pressure-operated (IPO) gas-lift valves are the most frequently used valves in gas-lift systems today because of their durability, performance, and wireline retrievability. These versatile valves are used for continuous or intermittent gas-lift operations. Depending on the side pocket mandrel design, these valves can be used for tubing or annular flow applications.

Weatherford R series IPO gas-lift valves have a nitrogen-charged dome-and-bellows configuration. The nitrogen charge located inside the dome acts on the three-ply MONEL® bellows to hold the valve in the closed position. The valve opens when the combined forces of the injection pressure (acting on the effective area of the bellows) and the tubing pressure (acting on the area of the port) exceed the dome-pressure charge of the valve. Upon opening, gas is injected into the production conduit, aerating the fluid column.

All R series IPO gas-lift valves contain an integral check valve to prevent the occurrence of reverse flow from the tubing to the casing. The check valve uses dual seals. Initially, an elastomer seal is established. As the differential pressure increases, a metal-to-metal seal is established. Dual-check versions are available in 1 1/2-in. OD valves for increased protection against backflow.

The R series injection valves are available in stainless steel or MONEL materials that meet National Association of Corrosion Engineers (NACE) MR0175 requirements. Special erosion-resistant coatings and a wide variety of standard, chemical-resistant and high-temperature elastomers are also available.

Applications

- Continuous or intermittent gas-lift operations
- Tubing- or casing-flow applications (based on the side-pocket porting configuration)
- Kickoff gas wells that are loaded up with production fluid
- Flowback enhancement of stimulation and waterflood applications

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Features, Advantages, and Benefits

- R series valves feature a wireline-retrievable design, which eliminates the need to pull the tubing to repair or replace the valve, reducing maintenance and repair costs.
- The unique positive bellows protection (PBP) feature of every R series 1 1/2-in. valve traps silicon fluid within the bellows as the valve reaches its full open position. The trapped silicon fluid forms a hydraulic barrier that protects the bellows from high hydrostatic pressures in the well.
- The bellows mechanical stop prevents the bellows from stacking, increasing the bellows' life cycle
- Silicon-dampening fluid in the bellows also minimizes chattering, preventing valve seat damage and vibration that can lead to valve failure.
- An internal bellows-guidance system prevents corkscrewing of the bellows, increasing valve open-and-close life cycle.
- The integral reverse-flow check valve with elastomer primary seal and metal-to-metal secondary seal prevents tubing-to-casing communication, avoiding costly workover operations.
- The R-1BL model includes an integral bottom latch that acts as a backup for the primary latch, reducing the potential for latch failure.
- The R-1D model features a double O-ring seal on the tail plug that provides enhanced sealing integrity for the nitrogen dome-pressure charge, increasing the service life of the valve. In addition, the design of these models allows for an increased dome volume, which reduces the bellows load rate.
- Compatibility with all common top latches allows the valves to be deployed in a wide variety of applications, enhancing operational flexibility.
- Replaceable floating MONEL or tungsten carbide seat allows the valve to be easily serviced, reducing maintenance costs.
- The standard packing-element system enhances performance and extends the service life of the valve, requiring fewer replacements and reducing operating costs.
- Valves are available with special coatings to prevent scale buildup and enhance erosion resistance.

Specifications

Valve Model	Valve Model Number	Latch Type	Valve OD		Effective Bellows Area (Ab)		Port Size		Area of Port (Ap*)		Ap/Ab Ratio	1–(Ap/Ab)	PPEF** (Ap/Ab) / 1–(Ap/Ab)
			(in.)	(mm)	(in.²)	(mm²)	(in.)	(mm)	(in.²)	(mm²)			
R-1	0101-XXX	BK-2	1	25.4	0.31	200.00	1/8	3.18	0.013	8.40	0.042	0.958	0.044
							5/32	3.97	0.021	13.55	0.067	0.933	0.072
R-1D	0102-XXX						3/16	4.76	0.029	18.71	0.095	0.905	0.105
							1/4	6.35	0.052	33.55	0.166	0.834	0.199
R-1BL	0116-XXX	Integral					5/16	7.94	0.080	51.61	0.257	0.743	0.346
R-1HV	0127-XXX	BK-2	1	25.4	0.31	200.00	3/8	9.53	0.114	73.55	0.368	0.632	0.582
R-2	0201-XXX	RK	1-1/2	38.1	0.77	496.80	3/16	4.76	0.029	18.71	0.038	0.962	0.040
							1/4	6.35	0.052	33.55	0.067	0.933	0.072
R-2B	0201-2XX	RK					5/16	7.94	0.080	51.61	0.104	0.896	0.115
							3/8	9.53	0.114	73.55	0.148	0.852	0.174
							7/16	11.11	0.154	99.35	0.201	0.799	0.250
							1/2	12.70	0.200	122.58	0.260	0.740	0.351

* Port diameter based on port size plus 0.006 in. (0.152 mm) for lapped seat
** Production pressure effect factor, formerly referred to as tubing effect factor

C-I Valve

C-2 Valve

C Series Injection-Pressure-Operated, Tubing-Retrievable Valves

Weatherford McMurry-Macco® C series tubing-retrievable, injection-pressure-operated (IPO) valves are installed in gas-lift mandrels for continuous or intermittent gas-lift applications.

C series IPO gas-lift valves have a nitrogen-charged dome-and-bellows configuration. The nitrogen charge, located inside the dome, acts on the three-ply MONEL® bellows to hold the valve in the closed position. The valve opens when the combined forces of the injection pressure (acting on the effective area of the bellows) and the tubing pressure (acting on the area of the port) exceeds the dome-pressure charge of the valve. Upon opening, gas is injected into the production conduit, aerating the fluid column.

C series valves are available in several configurations to meet various application requirements. The C-1R valve is similar to the C-1 model with the added capability of reverse-flow operation. The C-2 valve has a unique positive-bellows-protection (PBP) feature, which traps silicon fluid within the bellows as the valve fully reaches its open position. The trapped silicon fluid forms a hydraulic barrier that protects the bellows from high hydrostatic pressures in the well. An internal bellows-guidance system also prevents the bellows from deforming. C-2 valves contain silicon-dampening fluid in the bellows, which also prevents valve-seat damage.

Applications

- C series valves are used for intermittent- or continuous-flow applications with tubing-retrievable gas-lift mandrels.
- The C-1 and C-3 valves can be used with the PM and CM-3 special-application mandrels, respectively. These applications include packoff, coiled-tubing, and smaller-diameter installations.
- The C-1R valve is capable of reverse flow for annular-flow applications.

Real Result

Gas-lift system enables production in dead well

An operator needed an economically viable method of artificial lift to restore gas production in a new horizontal well in eastern Oklahoma, USA, that would not flow naturally. Weatherford McMurry-Macco gas-lift equipment and a retrievable PR-3 double-grip production packer were installed in the well at a 67° angle, enabling the operator to maximize production by installing a mechanical-set production packer and injecting gas into the well at the deepest depth possible.

The objective was met economically with relatively low risk, and the well's gas production averaged approximately 1.1 MMscfpd. Weatherford gas-lift technology enabled the operator to make more accurate economic evaluations for drilling and producing additional wells in this field. Four other nonproductive wells were subsequently completed with similar results.

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Features, Advantages, and Benefits

- The PBP feature of the C-2 valve uses silicon fluid to protect the bellows from high hydrostatic pressure, providing greater system reliability.
- Silicon-dampening fluid in the bellows minimizes chattering, preventing valve seat damage and vibration that can lead to failure of other valve components.
- The replaceable, floating MONEL or tungsten-carbide seat simplifies valve servicing, reducing maintenance costs.
- An associated reverse-flow check valve (CV series) prevents reverse flow, avoiding costly workover operations.
- Double check valves can be easily assembled for added protection, ensuring gas-lift system integrity.
- A maximum-bellows-travel stop prevents the bellows from stacking, increasing the bellows' life cycle.
- C series valves feature a large dome volume, which improves the operating efficiency of the valves, reducing operating costs.

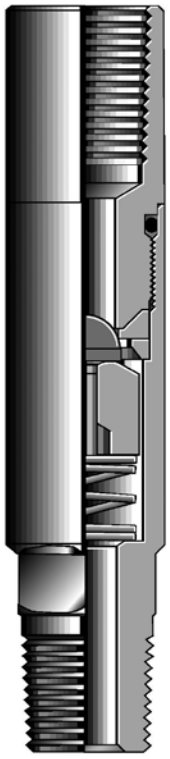
Specifications

Valve Model	Valve Model Number	Valve OD		Effective Bellows Area (Ab)		Port Size		Area of Port (Ap*)		Ap/Ab Ratio	1–(Ap/Ab)	PPEF** Ap/Ab 1–(Ap/Ab)
		(in.)	(mm)	($in.^2$)	(mm^2)	(in.)	(mm)	($in.^2$)	(mm^2)			
C-1	3601-XXX	1	25.4	0.31	200.00	1/8	3.18	0.013	8.40	0.042	0.958	0.044
						5/32	3.97	0.021	13.55	0.067	0.933	0.072
						3/16	4.76	0.029	18.71	0.095	0.905	0.105
						1/4	6.35	0.052	33.55	0.166	0.834	0.199
						5/16	7.94	0.080	51.61	0.257	0.743	0.346
C-2	3701-XXX	1-1/2	38.1	0.77	496.8	3/16	4.75	0.029	18.71	0.038	0.962	0.040
						1/4	6.35	0.052	33.55	0.067	0.933	0.072
						5/16	7.94	0.080	51.61	0.104	0.896	0.115
						3/8	9.53	0.114	73.55	0.148	0.852	0.174
						7/16	11.11	0.154	99.35	0.201	0.799	0.250
						1/2	12.70	0.200	122.58	0.260	0.740	0.351
C-3	3801-XXX	5/8	15.9	0.12	77.4	1/8	3.18	0.013	8.40	0.111	0.889	0.124
						5/32	3.97	0.021	13.55	0.170	0.830	0.205
						3/16	4.76	0.029	18.71	0.243	0.757	0.320

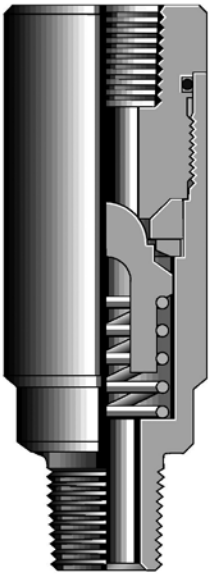
* Port diameter based on port size plus 0.006 in. (0.152 mm) for lapped seat
** Production pressure effect factor, formerly referred to as tubing effect factor

Options

- All C series valves are available in stainless steel or MONEL materials that meet NACE MR0175 requirements.
- Special erosion-resistant coatings and a wide variety of standard, chemical-resistant, and high-temperature elastomers are available.



CV-1
Check Valve



CV-2
Check Valve

CV Series Tubing-Retrievable, Reverse-Flow Check Valves

Weatherford McMurry-Macco® CV series reverse-flow check valves are attached to the bottom of gas-lift valves or other flow-control devices that do not have an integral check valve to prevent fluid backflow through the valves. Backflow of fluids into the annulus can damage casing, reduce the life of gas-lift valves, and possibly create unsafe wellbore conditions.

When the gas-lift valve is open, the upstream (typically casing) pressure on the check valve is greater than the downstream (typically tubing) pressure. The higher upstream pressure depresses the spring-loaded dart, allowing the injection gas to flow through the check valve and into the production tubing. If the downstream pressure is greater than the upstream pressure, flow across the check dart causes the dart to seat, preventing backflow.

CV series check valves have dual seals for added protection against backflow. When the tubing pressure comes in contact with the bottom of the check, the elastomer seal is established. As the differential pressure increases, a metal-to-metal seal is formed for additional protection.

Applications

- Used to prevent backflow of pressure and fluids from the production conduit to the injection conduit during normal production operations or during acidizing or circulation operations
- Prevents the need to repeatedly unload fluids from the injection conduit
- CV-1 and CV-2 valves used with gas-lift valves and orifice valves

Features, Advantages, and Benefits

- Dual-seal design provides added protection against backflow, protecting the casing from damage and avoiding costly workover operations.
- Check valves can be screwed together to create a double- or triple-check barrier, providing protection against backflow.
- An INCONEL® spring withstands corrosive and high-temperature conditions, delivering reliable performance and extending the life of the valve.
- CV series check valves feature a standard and premium elastomer seal system that enhances pressure-sealing performance, reducing valve and equipment failures.

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Gas-Lift Valves

Specifications

Check Valve Model	Valve Model Number	Valve OD		Equivalent Port Diameter		Connection to Mandrel	Connection to Valve	Injection Flow	
		(in.)	(mm)	(in.)	(mm)			Annulus to Tubing	Tubing to Annulus
CV-1	4301-XXX	1	25.40	7/16	11.11	1/2-in. M-NPT	1/2-in. F-NPT	X	
CV-1IH	4302-XXX								X
CV-1IHR*	4305-XXX*			13/32	10.32			X	
CV-2	4303-XXX	1-1/2	38.10	1/2	12.70			X	
CV-3	4304-XXX	5/8	15.88	1/4	6.35	1/4-in. M-NPT	1/4-in. F-NPT	X	

* Connection has 3/8-in. (9.53-mm) female hex for mounting in PM-1 mandrel.

Options

- Standard material is 316 stainless steel. Optional MONEL® and INCONEL materials are available for highly corrosive environments.
- A wide variety of standard, chemical-resistant, and high-temperature elastomers is available for specific requirements.

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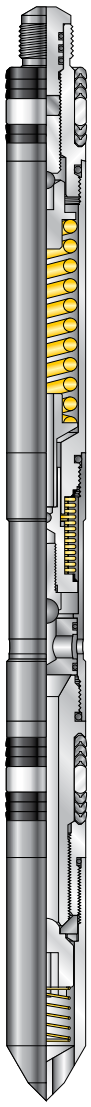
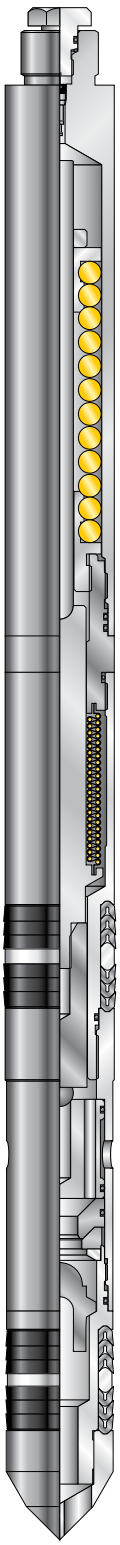
Gas-Lift Valves



RF-1 Valve



RF-2 Valve

RF Series
Production-Pressure-Operated Valves

Weatherford McMurry-Macco® RF series gas-lift valves are spring loaded and production-pressure-operated (PPO). They open and close primarily by tubing pressure. A preset INCONEL® spring provides the force necessary to maintain the valve in a closed position. Because the force of the preset spring tension holds the valve stem on-seat, downhole temperature has virtually no effect on the operation of the valve. The unique Weatherford patent-pending seat design for the RF-1BL valve significantly reduces the effects of injection-pressure buildup that is created as the injection gas flows from the valve. This seat design more than triples the effective crossover seat-exhaust area, allowing the valve to maintain its production-pressure sensitivity. The valve will close at the preset tubing pressure, even under high differential pressures.

Applications

- Continuous-flow gas lift
- Dual gas-lift systems
- Applications where injection pressure is unstable

Features, Advantages, and Benefits

- A spring-loaded pressure-regulating mechanism enables the valve to operate regardless of temperature, enabling dual wells to produce simultaneously.
- A crossover seating mechanism enables the valve to open and close based on tubing pressure, using maximum injection pressure.
- The RF-1 valve has been flow-performance tested to provide accurate gas-lift designs, enabling wells to gas-lift at maximum production rates.
- The RF-1BL valve features an improved high-flow-seat design enabling maximum valve performance, providing increased gas-lifting efficiencies in bottom-latch applications.
- Integral reverse-flow check valves provide a barrier for tubing-to-casing communication, ensuring well containment.
- The standard dimensional design is compatible with all manufacturers' gas-lift mandrels that meet American Petroleum Institute (API) 19G1 standards, providing operational flexibility for all applications.
- The RF valves can be manufactured from various materials to fit well conditions, reducing nonproductive time.

INCONEL is a registered trademark of the Huntington Alloys Corporation.

Options

- Optional Teflon® rings in bellows convolutions
- Optional tungsten-carbide seat available
- Available in top- and integral-bottom-latch models

Specification

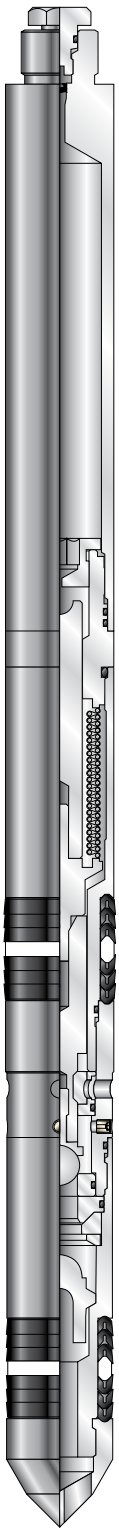
Valve Model	Valve Model Number	Latch Type	Valve OD		Effective Bellows Area (Ab)		Port Size		Area of Port (Ap*)		Ap/Ab Ratio	1–(Ap/Ab)	IPEF** (Ap/Ab) / 1–(Ap/Ab)
			(in.)	(mm)	($in.^2$)	(mm^2)	(in.)	(mm)	($in.^2$)	(mm^2)			
RF-1	0104-XXX	BK-2	1	25.4	0.31	200.0	1/8	3.18	0.013	8.39	0.042	0.958	0.043
							5/32	3.97	0.020	12.90	0.066	0.934	0.071
RF-1BL	0129-XXX	Integral					3/16	4.76	0.029	18.71	0.094	0.906	0.104
							1/4	6.35	0.051	32.90	0.165	0.835	0.197
RF-2	0203-XXX	RK	1-1/2	38.1	0.77	496.8	3/16	4.76	0.029	18.71	0.038	0.962	0.040
							1/4	6.35	0.051	32.90	0.066	0.934	0.071
							5/16	7.94	0.079	50.97	0.103	0.897	0.115
							3/8	9.53	0.113	72.90	0.147	0.853	0.172

* Port diameter based on port size plus 0.006 in. (0.152 mm) for lapped seat
** Injection pressure effect factor

Flow Seat Design

Improved high-flow design
for RF-1BL

Teflon is a registered trademark of E. I. Du Pont de Nemours and Company.



R-2CF Valve

RCF Series
Wireline-Retrievable, Continuous-Flow Valves

Weatherford McMurry-Macco® wireline-retrievable, continuous-flow gas-lift valves use a unique upstream-choke design to deliver improved efficiency in many applications. The opening and closing forces are similar to the traditional injection-pressure-operated gas-lift valve. The difference in the RCF series is that when the valve is in the open position, the injection gas is choked upstream of the main port, allowing the main pressure drop to occur upstream of the main port. This feature prevents full casing pressure from acting on the bottom of the stem while the valve is in the open position and allows the valve to close on a reduction in tubing pressure. The RCF series continuous-flow gas-lift valves are designed for continuous-flow gas lift and may use maximum available injection pressure down to the optimal point of injection.

Applications

- Continuous-flow applications
- Applications where multiple unloading valves are needed to reach the point of injection
- Good performance in common annulus duals
- Applications where low injection pressures prevent deepest lift-point

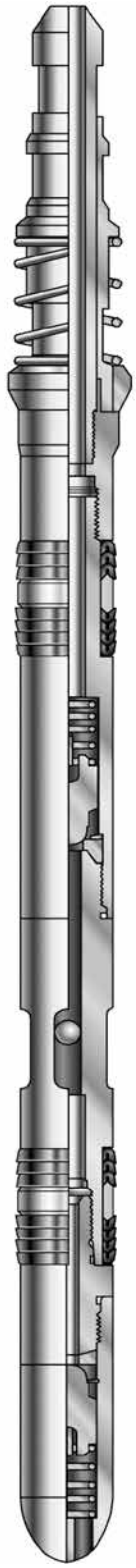
Features, Advantages, and Benefits

- The choke upstream of the main port enables the valve to close on a reduction in tubing pressure, using maximum injection pressure and potentially increasing production rates.
- Choking configuration enables the main pressure drop to occur across the choke, reducing erosion of the main port and prolonging the life of the gas-lift valves.
- Three-ply MONEL® bellows and a bellows-protection system enable the valve to withstand high differential pressures, reducing failures and nonproductive time.
- Integral reverse-flow check valves provide a barrier for tubing-to-casing communication, ensuring well containment.
- The standard dimensional design is compatible with all manufacturers' gas-lift mandrels that meet American Petroleum Institute (API) 19G1 standards, providing operational flexibility for all applications.
- RCF series valves can be manufactured from various materials to fit well conditions, reducing nonproductive time.

MONEL is a registered trademark of the Huntington Alloys Corporation.

Specifications

Valve Model	Valve Model Number	Latch Type	Valve OD		R Ap/Ab	1-R	Maximum Port Size (in.)
			(in.)	(mm)			
R-1CF	0115-XXX	BK-2	1	25.4	0.257	0.743	5/16
R-2CF	0215-XXX	RK	1-1/2	38.1	0.260	0.740	1/2



RC-1DC Valve

RC Series
Wireline-Retrievable Circulation Valves

Weatherford McMurry-Macco® RC series wireline-retrievable circulation valves protect the sealbores of side-pocket mandrels from erosion and abrasion when circulating fluids or gases through the mandrel pockets. The valve is ported to flow both from the top section through a ported latch, and downward through the nose to maximize the flow capability. Double check valves in the RC-DC series permit flow only from the annulus to the tubing; the RC series allows flow from either direction.

Applications

- Special application valves used for high-rate fluid circulation
- Can be used in continuous-flow gas-lift applications that require high rates of injection-gas not attainable with standard-orifice valves

Features, Advantages, and Benefits

- Increased flow area through the valve body and a flow-through top latch for high-flow-rate circulation operations speed circulation operations, reducing rig time.
- RC series valves fit in the mandrel pocket and protect the mandrel seal bores from erosive flow, reducing lost production related to damaged equipment.
- Valves can be equipped with dual reverse-flow checks, preventing fluids from entering casing annulus and possibly preventing casing corrosion.
- Integral reverse-flow check valves provide a barrier for tubing-to-casing communication, ensuring well containment.
- The standard dimensional design is compatible with all manufacturers' gas-lift mandrels that meet American Petroleum Institute (API) 19G1 standards, providing operational flexibility for all applications.
- The valves can be manufactured from various materials to fit well conditions, reducing nonproductive time.

Specifications

Valve Model	Valve Model Number	Latch Type	Valve OD		Flow Area	
			(in.)	(mm)	($in.^2$)	(mm^2)
RC-1	0118-XXX	BEK-2	1	25.40	0.230	146.5
RC-1DC	0108-1XX				0.200	126.5
RC-2	0219-XXX	RKP	1-1/2	38.10	0.780	500.6
RC-2DC	0207-XXX				0.380	245.2

RO Series Wireline-Retrievable, Single-Point-Injection Orifice Valves

Weatherford McMurry-Macco® RO series valves are wireline retrievable, single-point-injection orifice valves. A replaceable orifice or port controls the volume of gas through the open valve into the production conduit. The spring-loaded, dual-seating, reverse-flow check valve is an integral part of the valve. This design has an elastomeric seal (acting as the primary seal) for low differential pressures. For higher differential pressures, a metal-to-metal seal is established to ensure reliability and act as the secondary seal.

For high injection rates, the RO-HV series orifice valves feature inlet ports and reverse-flow checks that are engineered for maximum flow efficiency.

Applications

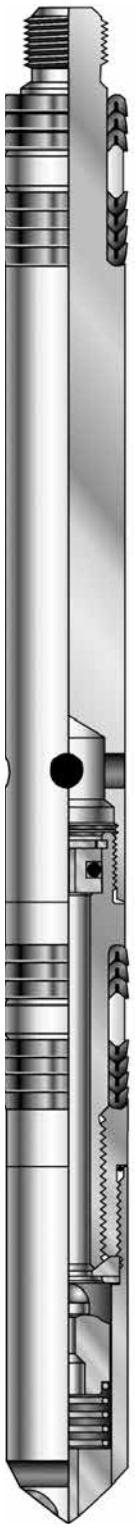
- Establish communication between the tubing and annulus during circulating operations
- Single-point, continuous-flow completions
- Control stable injection at operating valve depth

Features, Advantages, and Benefits

- RO series valves allow unobstructed flow of injection gas into the production tubing, enabling maximum gas passage, which maximizes production rates.
- Valves do not need a pressure-regulating mechanism, reducing the chance of failure and preventing nonproductive time.
- Integral reverse-flow check valves provide a barrier for tubing-to-casing communication, ensuring well containment.
- The standard dimensional design is compatible with all manufacturers' gas-lift mandrels that meet American Petroleum Institute (API) 19G1 standards, providing operational flexibility for all applications.
- Valves can be manufactured from various materials to fit well conditions, reducing nonproductive time.

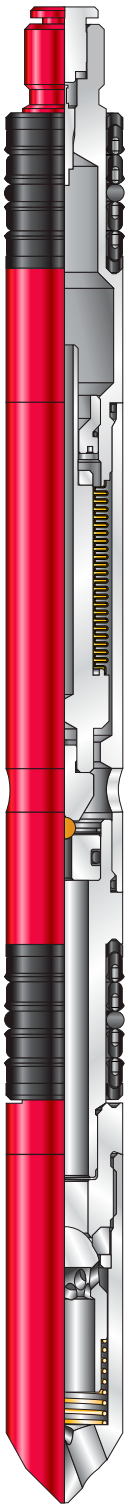
Specifications

Valve Model	Valve Model Number	Latch Type	Valve OD		Port Size	
			(in.)	(mm)	(in.)	(mm)
RO-1	0107-1XX	BK-2	1	25.40	1/8	3.18
					5/32	3.97
					3/16	4.76
					1/4	6.35
					5/16	7.94
RO-2	0206-6XX	RK	1-1/2	38.10	3/16	4.76
					1/4	6.35
RO-2B	0206-XXX				5/16	7.94
					3/8	9.53
RO-2DC	0231-XXX				7/16	11.11
					1/2	12.70



RO-1 Valve

Gas-Lift Valves



RH-1 high-reliability, gas-lift valve.

RH-1 Gas-Lift Valve

High-reliability gas-lift valve specifically designed for deepwater or other high-profile well applications.

The Weatherford RH-1 gas-lift valve is a premium 1-in. nominal outside diameter (OD), wireline-retrievable, injection-pressure-operated (IPO) gas-lift valve specifically designed for deepwater or other high-profile well applications. The high dome-charge capacity of 2,500 psi (241 bar) and differential-pressure rating of 6,000 psi (413 bar) enables the valve to perform in high-pressure injection systems and achieve deeper points of injection.

The valve features a bellows protection system that prevents bellows deformation when exposed to high differential pressures. The check valve can be equipped with a combination modified polytetrafluoroethylene (PTFE) non-elastomeric seal, which has been designed by applying computation of flow-dynamics analysis and physical testing to maximize gas-passage capability and erosion resistance. RH-1 gas-lift valves can meet American Petroleum Institute (API) 19G2 V-1 certification, which is the highest industry standard.

Applications

- Wells that require wireline-retrievable equipment
- Wells with high-injection pressures that require gas-lift valves to have dome charge of up to 2,500 psi (172 bar) and differential submergence pressures up to 6,000 psi (413 bar)
- Wells that require high injection rates to maximize production rates
- High-profile wells with high intervention costs

Features, Advantages, and Benefits

- Empirical test data can be used to predict gas-passage characteristics, which provide gas-lift design accuracy and ensure maximum well productivity.
- Positive bellows protection which reduces operational failures, nonproductive time (NPT), and operating costs is activated by two means: when a mechanical stop prevents bellows over-travel, and when a non-compressible silicon fluid supports the bellows as high differential submergence pressures are applied to the valve.
- A viscous dampening fluid prevents bellows fatigue by decreasing stem pounding and chatter.
- Lapped and matched tungsten-carbide seats provide a robust and resilient seal, which reduces chances of damaging the seal during the unloading phase and ensures efficient well operation.

RH-1 Gas-Lift Valve

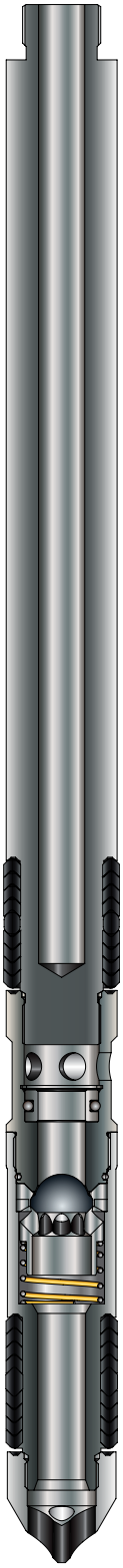
Features, Advantages, and Benefits (continued)

- High-volume integral reverse-flow check valves, which have been tested to API 19G2 V-1 standards, provide a barrier for tubing-to-casing communication and ensure well containment.
- An aerodynamic check valve ensures maximum gas passage and erosion resistance, which increases the overall production rate.
- The check valve can include a combination modified PTFE non-elastomeric seal to maintain sealing integrity in low- and high-pressure situations.
- Optimized stem travel and tightly controlled manufacturing tolerances maximize gas passage and provide a longer lifecycle, which prevents failures and nonproductive time.
- Manufacturing specifications include submergence pressure testing and a specific bellows type, which maximizes the tool lifecycle, prevents failures, and reduces nonproductive time.
- When specified, packing seals can meet API 19G2 requirements, which ensures a proper seal that isolates tubing and casing and prevents well-containment issues.
- The valve is compatible with gas-lift mandrels from all manufacturers that meet API 19G1 standards, which provides operational flexibility.
- The valve can be manufactured from a wide range of materials and can be customized for use in corrosive well conditions.
- The larger dome reduces the load rate and improves flow characteristics, which enables optimal production.

Specifications
IPO Valves

Valve Series Model	Valve Model Number	Latch Type	Valve OD		Ab Effective Bellows Area		Port Size		Ap* Area of Port		Ap/Ab Ratio	1–(Ap/Ab)	PPEF** Ap/Ab 1–(Ap/Ab)
			in.	mm	in.²	mm²	in.	mm	in.²	mm²			
RH-1	0136-XXX	BK-2	1.0	25.4	0.31	200.0	1/8	3.18	0.014	8.4	0.045	0.955	0.047
							5/32	3.97	0.021	13.55	0.068	0.932	0.073
							3/16	4.76	0.03	18.71	0.097	0.90 3	0.107
							1/4	6.35	0.052	33.55	0.168	0.832	0.202
							5/16	7.94	0.081	51.61	0.261	0.739	0.354

**The above Ap/Ab ratios assume tungsten-carbide seats and the values take into consideration the manufacturing and lapping processes.*



RO-2HV Valve

RO-2HV Series Orifice Gas-Lift Valves

Weatherford RO-2HV gas-lift valve is a 1 1/2-in. nominal outside diameter (OD) wireline-retrievable shearable orifice valve specifically designed for deepwater or other high-profile well applications. The valve has been flow-performance and erosion tested to ensure maximum performance. The RO-2HV gas-lift valve can be equipped with Weatherford combination modified PTFE nonelastomeric seal and metal-to-metal seal (QS) or strictly metal-to-metal (Q) check valves, which have been designed by applying computational flow-dynamics analysis and physical testing to maximize gas-passage capability and erosion resistance.

Weatherford RO-2HV gas-lift valves can be provided to meet API 19G2 V-1 certification, currently the highest standard in the industry.

Applications

- Wells requiring equipment to be wireline-retrievable
- Wells that require high injection rates to maximize production rates
- High-profile wells with high intervention cost

Features, Advantages, and Benefits

- The complete assembly has been flow-performance tested for known and predictable gas-passage characteristics, providing accuracy in gas-lift designs to ensure maximum well productivity.
- The valve can be manufactured from various materials and customized to fit well conditions, reducing nonproductive time.
- Integral reverse-flow check valves provide a barrier for tubing-to-casing communication, ensuring well containment.
- The check valve can be provided with Weatherford combination modified PTFE nonelastomeric seal and metal-to-metal seal or a strictly metal-to-metal seal to maintain sealing integrity in low- and high-pressure situations, providing a barrier for tubing-to-casing communication to ensure well containment.
- Aerodynamic check dart—designed for proven flow performance from computational flow dynamics and physical testing—provides maximum gas passage and erosion resistance, increasing overall production rate.
- The standard dimensional design is compatible with all manufacturers' gas-lift mandrels that meet American Petroleum Institute (API) 19G1 standards, providing operational flexibility to all applications.

RD Series Wireline-Retrievable Dummy Valves

Weatherford McMurry-Macco® RD series wireline-retrievable isolation valves are installed in a side-pocket mandrel to block the mandrel injection ports. The dummy valve, with an appropriate latch, can be installed or retrieved in the well completion for various well-servicing operations.

Weatherford RD gas-lift valves can be provided to meet API 19G2 V-1 certification, currently the highest standard in the industry.

Applications

- Sealing off the pocket of the side-pocket mandrel, preventing communication between casing and tubing
- Blanking off the tubing for production until gas-lift valves are required
- Pressurizing the tubing
- Isolating tubing and casing flow during single-alternative production and for test purposes during multipoint water- or gas-injection floods

Features, Advantages, and Benefits

- The valves can be manufactured from stainless steel, MONEL®, or other special alloy materials to fit well conditions, reducing nonproductive time.
- Two sets of packing straddle and pack off casing ports to equalize the casing and tubing pressure, enabling the equalizing prong to be retrieved.
- RD series dummy valves accept most common top latches and install in most mandrel pockets, providing greater operational flexibility and improving efficiency.

Options

- Integral bottom collet latch available (model RD-1BL)
- Special packing seals available for most requirements

RD-1 Valve

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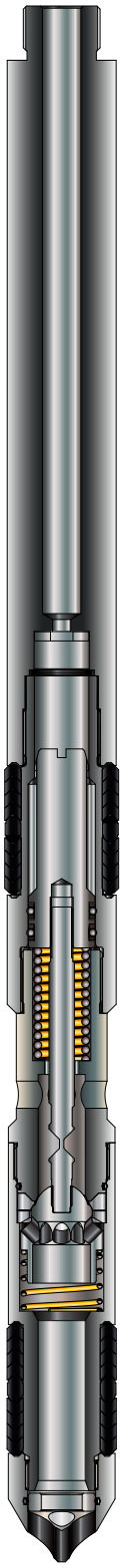


RDDK-2A Valve

RDDK-2A Shearable Orifice Gas-Lift Valve

Weatherford RDDK-2A gas-lift valve is a 1 1/2-in. nominal outside diameter (OD) wireline-retrievable shearable orifice valve specifically designed for deepwater or other high-profile well applications. Upon initial installation, the valve functions as a dummy valve and facilitates the completion test by applying pressure in the annulus. After a predetermined amount of pressure is applied to the annulus, the fracture rod breaks and the valve operates as an orifice valve. The check valve has been flow-performance and erosion tested to ensure maximum performance. The valve can be equipped with Weatherford combination modified PTFE nonelastomeric seal and metal-to-metal seal (QS) or strictly metal-to-metal (Q) check valves, which have been designed by applying computational flow-dynamics analysis and physical testing to maximize gas-passage capability and erosion resistance.

Weatherford RDDK-2A gas-lift valves can be provided to meet API 19G2 V-1 certification, currently the highest standard in the industry.

Applications

- Wells in which casing-to-tubing communication is desired to begin gas-lift operations without wireline intervention
- Wells requiring equipment to be wireline-retrievable
- Wells that require high injection rates to maximize production rates
- High-profile wells with high intervention cost

Features, Advantages, and Benefits

- Valve body is hollow and uses a flow-through latch that ensures the valve senses tubing pressure before valve opens, preventing premature opening.
- The valve can be manufactured from various materials and customized to fit well conditions, reducing nonproductive time.
- Integral reverse-flow check valves provide a barrier for tubing-to-casing communication, ensuring well containment.
- Check valve can be provided with Weatherford combination modified PTFE nonelastomeric seal and metal-to-metal seal or strictly a metal-to-metal seal to maintain sealing integrity in low- and high-pressure situations, providing a barrier for tubing-to-casing-communication to ensure well containment.
- Aerodynamic check dart—designed for proven flow performance from computational flow dynamics and physical testing—provides maximum gas passage and erosion resistance, increasing overall production rate.
- Standard dimensional design is compatible with all manufacturers' gas-lift mandrels that meet American Petroleum Institute (API) 19G1 standards, providing operational flexibility to all applications.

RH-2 Gas-Lift Valve

Weatherford RH-2 is a 1 1/2-in. nominal outside diameter ((OD), wireline-retrievable, injection-pressure-operated (IPO), gas-lift valve specifically designed for deepwater or other high-profile well applications. The high dome-charge capability of 3,500 psi (241 bar) and differential-pressure rating of 6,000 psi (413 bar) make this valve applicable in high-pressure injection systems to achieve deeper points of injection and enable wells to maximize production. This valve features an inverted-bellows mechanical stop that enhances bellows protection to prevent bellows deformation. The valve can be equipped with Weatherford combination modified PTFE nonelastomeric seal or strictly metal-to-metal seal (QS) or with metal-to-metal (Q) check valves, which have been designed by applying computation of flow-dynamics analysis and physical testing to maximize gas-passage capability and erosion resistance.

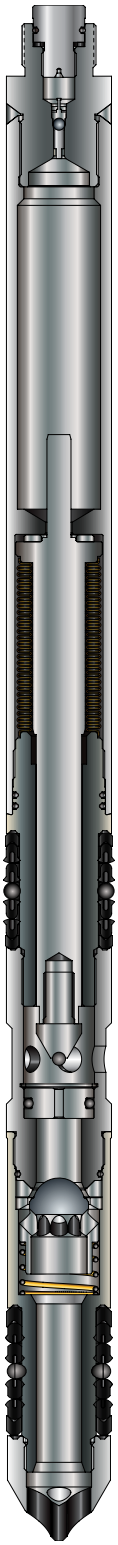
Weatherford RH-2 gas-lift valves can be provided to meet API 19G2 V-1 certification, currently the highest standard in the industry.

Applications

- Wells requiring equipment to be wireline retrievable
- Wells that require high injection pressures up to 3,500 psi (241 bar) and differential pressure up to 6,000 psi (413 bar)
- Wells that require high injection rates to maximize production rates
- High-profile wells with high intervention cost

Features, Advantages, and Benefits

- The complete assembly has been flow-performance tested for known and predictable gas-passage characteristics, providing accuracy in gas-lift designs to ensure maximum well productivity.
- Inverted bellows is used for high-injection-pressure and high-injection-volume systems, enabling deeper points of injection and higher production rates.
- Positive bellows protection is provided when a mechanical stop prevents bellows over-travel and a noncompressible silicon fluid provides support for bellows when high differential pressures are applied to valve, reducing operational failures, nonproductive time (NPT), and operating costs.
- Viscous dampening fluid prevents bellows fatigue by decreasing stem pounding/chatter, reducing well NPT.
- Lapped and matched tungsten-carbide seats provide robust and resilient seal, which reduces chances of damaging the seal during unloading phase while a tight seal provides upper unloading valves a positive seal, ensuring the well operates more efficiently.



RH-2 Valve

RH-2 Gas-Lift Valve

Features, Advantages, and Benefits (continued)

- Integral reverse-flow check valves provide a barrier for tubing-to-casing communication to ensure well containment.
- Aerodynamic check dart—designed for proven flow performance from computational flow dynamics and physical testing—provides maximum gas passage and erosion resistance, increasing overall production rate.
- The check valve can be provided with Weatherford combination modified PTFE nonelastomeric seal and metal-to-metal seal or strictly a metal-to-metal seal to maintain sealing integrity in low- and high-pressure situations, providing a barrier for tubing-to-casing communication to ensure well containment.
- Standard dimensional design is compatible with all manufacturers' gas-lift mandrels that meet American Petroleum Institute (API) 19G1 Standards, providing operational flexibility for all applications.
- The valve can be manufactured from various materials and customized to fit well conditions, reducing NPT.

RPV Series Wireline-Retrievable, Pilot-Operated Valves

Weatherford McMurry-Macco® RPV series wireline-retrievable, injection-pressure pilot-operated gas-lift valves are primarily controlled by injection-gas pressure. The valve controls gas pressure and its flow from the casing annulus into the tubing during intermittent gas-lift operations. Intermittent gas-lift requires that a large volume of gas be injected rapidly into the tubing for short periods of time to displace a slug of fluid from the point of injection to the surface. The control of gas during this cyclic operation is enhanced by the valve's ability to control spread (difference in valve opening and closing pressure) and maintain a large primary-injection port for instantaneous gas injection.

RPV-N series valves use a nitrogen-charge bellows to provide closing force.

Because the nitrogen is affected by temperature, accurate operating-depth-temperature information must be used when 1calculating the set pressure.

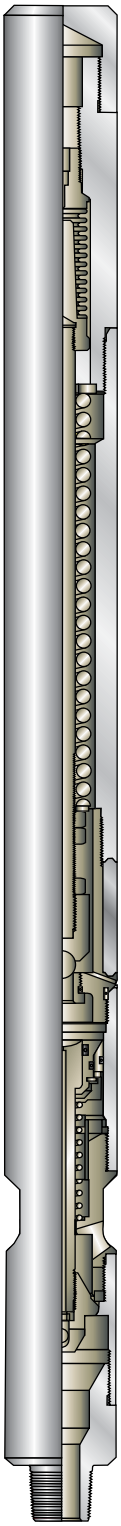
Applications

- Conventional, intermittent gas-lift applications and chamber lift

Features, Advantages, and Benefits

- A control port controls the valve spread to provide optimum injection cycles, that enable maximum production rates in intermittent applications.
- A spring-loaded pressure-regulating mechanism adds simplicity to the valve design, reducing the possibility of nonproductive time.
- The standard dimensional design is compatible with all manufacturers' gas-lift mandrels that meet American Petroleum Institute (API) 19G1 standards, providing operational flexibility for all applications.
- The valve can be manufactured from various materials to fit well conditions, reducing nonproductive time.

*Contact Weatherford for R values and other specific valve information.



CPV-1S Valve

CPV Series Tubing-Retrievable, Injection-Pressure, Pilot-Operated Valves

Weatherford CPV series pilot-operated, gas-lift valves are used to control lift gas during intermittent-gas-lift operations. Intermittent gas-lift requires the rapid injection of a large volume of gas into the tubing for short periods to displace a slug of fluid from the point of injection to the surface. The control of lift gas during this cyclic operation is enhanced by the valve's ability to control spread (the difference in valve opening and closing pressures) and maintain a large primary-injection port for instantaneous injection.

The CPV series valves are installed on tubing-retrievable gas-lift mandrels and are available in either spring-loaded or nitrogen-charged configurations for gas-lift system design flexibility.

The CPV-2S valve has a pilot section that controls the opening and closing of the main power section. The pilot section contains a bellows assembly, spring, stem, and seat. The spring provides the closing force that acts on the pilot valve stem. When the combined injection-gas pressure and production pressure exceeds the spring force, the pilot opens and applies pressure to the main power section. The piston in the power section shifts open to expose an extremely large port, allowing rapid injection of a large volume of gas into the tubing. A variety of pilot valve stems and seats are available so that the spread can be adjusted to compensate for the production parameters of the well.

Applications

- Intermittent gas-lift operations in standard and corrosive downhole environments
- Ideal for chamber-lift installations

Features, Advantages, and Benefits

- CPV series valves incorporate a mechanical stop that prevents the bellows from stacking, providing greater reliability.
- The standard tungsten-carbide ball-and-seat assembly in the pilot section offers the highest abrasion and impact resistance available, providing a robust and stable injection system.
- Valves are available in either spring-loaded or nitrogen-charged configurations, providing gas-lift system design flexibility.
- The spring and bellows design of the CPV-2S valve eliminates the effect of temperature on valve operation, reducing failures.
- The associated external reverse-flow check valve (CV-2), with elastomer primary seal and metal-to-metal secondary seal, prevents tubing-to-casing communication, eliminating a potential cause for costly workover operations.
- Controlled spread provides maximum control of lift gas during the injection cycle, enhancing efficiency.
- Maximum port size in the power section allows sufficient gas to lift a column of fluid up the tubing string at a high velocity, minimizes liquid fallback.
- The power-stem shock absorber increases the service life of the valve, reducing the need for valve replacement.

Specifications

Valve Model	Valve Model Number	Latch Type	Valve OD	
			(in.)	(mm)
RPV-1		Bottom Latch	1	25.4
RPV-1S	0105-2XX	*BK-2M		
RPV-2		RK-2, RA	1-1/2	38.1
RPV-2S	0204-XXX	RK-2, RA		
CPV-2N	3706-1XXX	N/A		
CPV-2S	3705-XXX	N/A		

*Latch is included in the valve assembly

Contact Weatherford for R values and other specific design information.

Options

- CPV series valves are made of 316 stainless steel material; optional MONEL® material is available.
- Elastomeric materials are available for standard and special service.
- A variety of pilot valve stems and seats is available so that the spread can be adjusted to compensate for the production parameters of the well.

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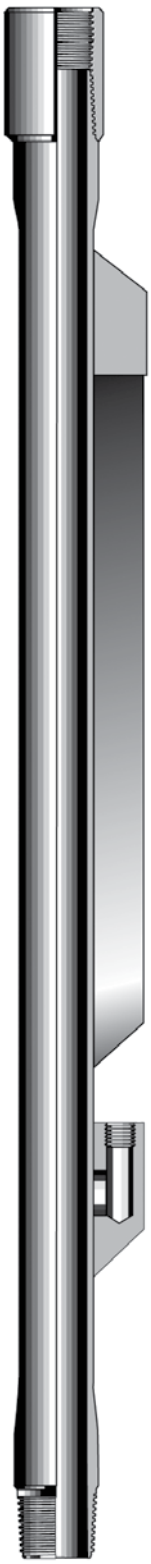


CM Series Tubing-Retrievable Conventional Mandrels

Weatherford McMurry-Macco® CM series gas-lift mandrels are equipped with external lugs to receive tubing-retrievable gas-lift and orifice valves. CM series mandrels are available in standard and heavyweight tubing sizes. A full-bore drift inside diameter (ID) enables wellbore intervention through the production tubing. External guards are attached to the outside diameter (OD) of the mandrels, surrounding the valves and providing protection during tubing running and pulling operations.

Applications

- CM series mandrels are installed as part of the tubing string to carry tubing-retrievable gas-lift equipment, in single- or dual-string completions.
- The CM-1 and CM-2 mandrels are used for 1- and 1 1/2-in. OD gas-lift valves, respectively.
- The CM-1F mandrels are configured for production-operated gas-lift valves for tubing flow or annular with the appropriate check-valve configurations.
- The CM-3 mandrel is available for slimhole and concentric packoff installations for 5/8-in. OD gas-lift valves.

Features, Advantages, and Benefits

- Full-bore drift ID enables wellbore intervention through the production tubing, reducing maintenance costs.
- Guard plates on the sides of the mandrels protect gas-lift valves from damage as they are run in the hole, reducing the need for costly replacements.
- Various ported-lug configurations allow use of the mandrels in tubing or annular-flow applications, providing system design flexibility for individual applications.
- Concentric ID makes these mandrels suitable for use in combination gas-lift/plunger-lift applications, enhancing operational flexibility.

Gas-Lift Mandrels

Specifications

Mandrel Model	Model Number	Tubing Size (in.)	Mandrel Lug ID		Dimension OD	Mandrel OD		Drift ID		Mandrel Length		Test Pressure Rating
			(in.)	(mm)		(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(psi, bar)
CM-1	471X-XXX	2-3/8	1.0	25.4	A	3.783	96.09	1.901	48.29	51.00	1295.40	5,000 344.7
					B	3.706	94.13					
CM-1F	472X-XXX				A	4.096	104.04					
					B	4.019	102.08					
CM-2	481X-XXX		1.5	38.1	A	4.283	108.79					
					B	4.206	106.83					
CM-1	471X-XXX	2-7/8	1.0	25.4	A	4.335	110.11	2.347	59.61	51.00	1295.40	
					B	4.231	107.47					
CM-1F	472X-XXX				A	4.648	118.06					
					B	4.544	115.42					
CM-2	481X-XXX		1.5	38.1	A	4.835	122.81					
					B	4.731	120.17					
CM-1	471X-XXX	3-1/2	1.0	25.4	A	5.063	128.60	2.867	72.82	51.00	1295.40	
					B	4.903	124.54					
CM-2	481X-XXX		1.5	38.1	A	5.562	141.27					
					B	5.427	137.85					

A = Mandrel maximum running OD, standard collar
B = Mandrel maximum running OD, special-clearance collar

Options

- CM series mandrels are available in various materials for standard, corrosive hydrogen sulfide (H_2S), high-temperature, and high-pressure well environments.
- The mandrels are available in standard and heavyweight tubing sizes and connections to suit specific completion designs.
- The mandrels are available in pup-joint grades J-55, N/L-80, and P-110.

PM-1 Mandrel

PM and CM-3 Series Pack-off and Slimhole Gas-Lift Mandrels

Weatherford McMurry-Macco® PM and CM-3 series gas-lift mandrels are used primarily in post-completion gas-lift applications and are installed using a packoff assembly, coiled tubing, or slimhole jointed pipe. Because the operator does not have to pull the primary production string to install the gas-lift equipment, the PM and CM-3 series mandrels provide a low-cost method of retrofitting gas-lift equipment in wells in which a gas-lift system was not initially installed. Weatherford PM mandrels, sometimes referred to as IM (internal-mounted) mandrels, can also be installed below the packer in the Weatherford Xtra-Lift™ system.

The mandrels are threaded on the upper and lower ends, with appropriate threads for connection to a packoff assembly, small jointed pipe, or coiled-tubing connectors. PM-1 series mandrels have an internal lug to accept tubing-retrievable, 1-in. outside diameter (OD) gas-lift and orifice valves. PM-3 and CM-3 series mandrels have an external lug that accepts a 5/8-in. OD gas-lift valve and orifice.

PM/IM and CM-3 series mandrels are compatible with Weatherford solutions for slimhole gas-lift applications, including TP packoffs and related gas-lift valves, stops, coiled-tubing connectors, and Xtra-Lift system. These mandrels are effective in either annular-flow or tubing-flow gas-lift applications and are integrated components of Weatherford slimhole gas-lift retrofit solution.

Applications

- Retrofit completions with gas-lift and orifice valves when not originally installed (PM/IM and CM-3 mandrels)
- Lowering the injection point without pulling the tubing
- Bridging across mandrels spaced too far apart for proper unloading
- Installed below packer in the Weatherford Xtra-Lift system (PM/IM mandrels)
- Slimhole jointed-pipe installations (CM-3 mandrels)
- PM-1 and PM-3 mandrels are used in packoff and coiled-tubing installations (PM-1 and PM-3 mandrels)

Features, Advantages, and Benefits

- These mandrels can be installed by use of a packoff assembly, coiled tubing, or jointed pipe, providing a low-cost method of installing gas-lift equipment.
- The design of these mandrels enable the gas-lift system to operate past failed gas-lift mandrels, avoiding costly workover operations to replace damaged mandrels.
- The PM-3 and CM-3 mandrels have a smooth inside diameter (ID) for easier wireline-tool passage, enhancing operations.
- The PM-1 mandrel uses a standard, conventional 1-in. OD gas-lift and orifice valve for increased durability, enhancing performance, and reducing costs.

Specifications

PM-1 Mandrel for 1-in. OD Valve, Internal Mount

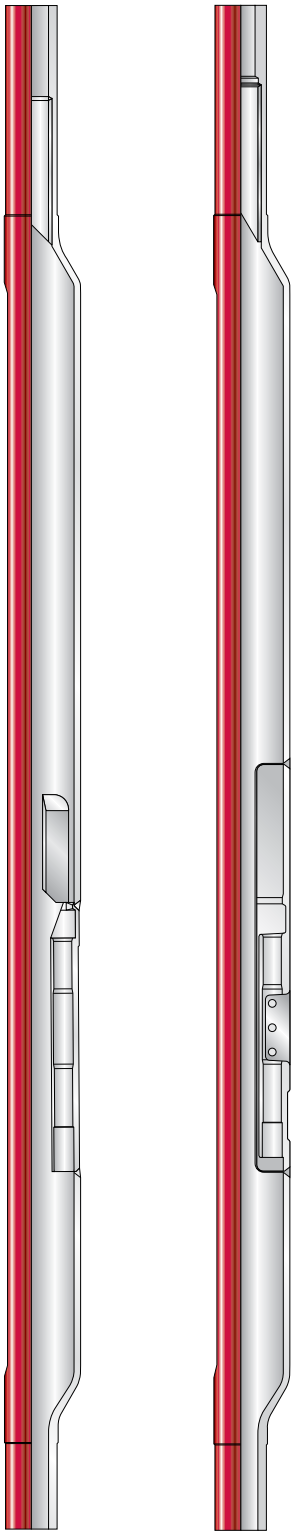
Model Number	Thread		Maximum OD		Equivalent ID		Mandrel Length	
	Size (in.)	Type	(in.)	(mm)	($in.^2$)	(mm^2)	(in.)	(mm)
4511-XXX	1-1/4	10RD NUE	1.853*	47.06	0.836	539.35	31.00	787.40
4512-XXX	1-1/2	10RD NUE	2.250	57.15	1.270	819.15	31.00	787.40

Mandrel configurations to house a 5/8-in. are also available upon special request
*1.853-in. OD is not standard for 1 1/4-in. tubing; therefore, tensile strengths will be lower.

Options

PM and CM-3 mandrels available in AISI 4130 and can be heat-treated for hydrogen sulfide (H_2S) service. Other materials are available on request.

Special designs are available for insertion across sliding sleeves.



SMO-1 Mandrel SFO-1 Mandrel

S Series Side-Pocket Mandrels—Oval-Body, Forged and Machined (SF, SFO, SIFO, SM, and SMO Series Mandrels)

Weatherford McMurry-Macco® forged-pocket (SF and SFO series) and machined-pocket (SM and SMO series) side-pocket mandrels feature an oval-body design and threaded connections for installation in the tubing string. The side pocket is offset from the bore of the tubing, which allows full tubing drift, through the mandrel and without restriction, for well-servicing operations. The side pocket contains profiles and sealbores to land gas-lift and other flow-control devices.

Flow-control devices are installed in the side pocket using a kickover tool, which is run into the well using standard wireline techniques. The SFO and SMO series mandrels include an integral orienting sleeve that aligns the kickover tool and flow control devices with the pocket for precise installation in straight and deviated wellbores. The SF and SFO series mandrels have a one-piece forged pocket/deflector, which guides the flow-control device into the pocket and deflects tools larger than the pulling/running tool back into the tubing bore of the mandrel. The SM and SMO series mandrels have a machined pocket and tool guard to perform the same function.

Applications

- The SF-1 mandrel has a one-piece forged pocket/deflector and a 1-in.inside diameter (ID) pocket for installation in straight wellbores.
- The SFO-1 mandrel has a one-piece forged pocket/deflector, a 1-in. ID pocket, and an integral orienting sleeve for installing gas-lift devices in deviated wellbores. The SIFO series mandrel contains integrally forged swaged end connections.
- The SM-1 and SM-2 mandrels have machined pockets and tool guards and 1- and 1 1/2-in. ID pockets for installing gas-lift devices in straight wellbores.
- The SMO-1 and SMO-2 mandrels have machined pockets and tool guards; 1- and 1 1/2-in. ID pockets and integral orienting sleeves for installing gas-lift devices in straight and deviated wellbores.
- The SMO-2RA mandrel has machined pockets and tool guards and a 1 1/2-in. ID pocket with a 360(degree) latch profile for use with the RA-type latch.

Gas-Lift Mandrels

Features, Advantages, and Benefits

- Side-pocket design eliminates the need to pull or rerun the tubing string to install or replace gas-lift valves.
- Side pocket is offset from the tubing bore, which maximizes the flow area and allows full tubing drift for well servicing operations through the mandrel, without restriction.
- Oval-body mandrel design is ideal for dual-completion applications and reduces overall running clearances.
- Slotted orienting sleeve in select models enables precise installation and retrieval of gas-lift equipment in straight and deviated wellbores.
- Tool guard protects gas-lift equipment from damage by deflecting tools larger than the pulling/running tool from the flow-control device.
- The forged pocket has recessed opposing ports that prevent flow erosion and port blockage if the mandrel pocket is positioned against the casing wall.
- The mandrel material is fully heat-treated to provide the best combination of strength and corrosion resistance for its intended use.
- The one-piece forged pocket/deflector (SF and SFO series) provides a smooth internal profile to enhance the passage of wireline tools and reduce flow turbulence around the pocket section.

S Series Side-Pocket Mandrels—Oval-Body, Forged and Machined (SF, SFO, SIFO, SM, and SMO Series Mandrels)

Specifications

Dimensions

Mandrel Model	Model Number	Tubing Size (in.)	Pocket Size (in., mm)	Pocket Type	Pocket Latch Configuration	Orienting Sleeve	Major OD (in.,mm)	Minor OD (in.,mm)	Drift* (in.,mm)
SF-1	1612-XXX	2-3/8	1.0 25.4	Forged	180°	No	4.250 107.95	2.910 73.91	1.901 48.29
SIF-1	1612-XXX								
SFO-1	1712-XXX					Yes			
SIFO-1	1712-5XX								
SM-1	1812-XXX			Machined		No			
SIM-1	1812-XXX								
SMO-1	1912-XXX					Yes			
SIMO-1	1912-5XX								
SM-2	2012-XXX		1.5 38.1	Machined	360° A-type	No	4.750 120.65	4.000 101.60	
SIM-2	2012-5XX								
SMO-2	2412-XXX				180°	Yes			
SF-1	1613-XXX	2-7/8	1.0 25.4	Forged	180°	No	4.75 120.65	4.00 101.60	2.347 59.61
SIF-1	1613-5XX								
SFO-1	1713-XXX					Yes			
SIFO-1	1713-5XX								
SM-1	1813-XXX			Machined	180°	No	4.75 120.65	4.00 101.60	
SIM-1	1813-5XX							3.98 101.09	
SMO-1	1913-XXX					Yes		4.00 101.60	
SIMO-1	1913-5XX							3.98 101.09	
SFO-2	2113-XXX		1.5 38.1	Forged	180°	Yes	5.40 137.16	4.62 117.42	
SM-2	2013-XXX			Machined	360° A-type	No	5.43 137.92		
SMO-2	2413-XXX				180°	Yes	5.40 137.16		

*1.901-in. drift is for 2 3/8-in. 4.7 lb-ft tubing
*2.347-in. drift is for 2 7/8-in. 6.5 lb-ft tubing

Gas-Lift Mandrels

Dimensions

Mandrel Model	Model Number	Tubing Size (in.)	Pocket Size (in.,mm)	Pocket Type	Pocket Latch Configuration	Orienting Sleeve	Major OD (in.,mm)	Minor OD (in.,mm)	Drift* (in.,mm)
SF-1	1614-XXX	3-1/2	1.0 25.4	Forged	180°	No	5.313 134.95	4.125 104.78	2.867 72.82
SIF-1							5.360 136.14	4.180 106.70	
SFO-1	1714-XXX					Yes	5.313 134.95	4.125 104.78	
SIFO-1	1714-XXX						5.36 136.14	4.180 106.70	
SM-1	1814-XXX			Machined	180°	Yes	5.313 134.95	4.03 102.36	
SIM-1	1814-XXX						5.36 136.14	4.18 106.70	
SMO-1	1914-XXX						5.313 134.95	4.125 104.78	
SIMO-1	1914-XXX						5.36 136.14	4.180 106.70	
SFO-2	2114-XXX		1.5 38.1	Forged	180°	Yes	5.968 151.59	5.00 127.00	
SM-2	2014-XXX			Machined	360° A-type	No	5.968 151.59	5.00 127.00	
SMO-2	2414-XXX				180°	Yes			
SMO-1	1916-XXX	4-1/2	1.0 25.4	Machined	180°	Yes	6.410 162.81	5.50 139.70	3.833 97.36
SFO-2	2116-XXX		1.5 38.1	Forged	180°	Yes	7.02 178.31	5.63 143.00	
SMO-2	2416-XXX			Machined	180°	Yes	7.03 178.56	5.63 143.00	
SFO-2	2118-XXX	5-1/2	1.5 38.1	Forged	180°	Yes	8.01 203.56	6.84 173.79	4.653 118.19

*2.867-in. drift is for 3 1/2-in. 9.3 lb-ft tubing
*3.833-in. drift is for 4 1/2-in. 12.60 lb-ft tubing
*4.653-in. drift is for 5 1/2-in. 20 lb-ft tubing

S Series Side-Pocket Mandrels—Oval-Body, Forged and Machined (SF, SFO, SIFO, SM, and SMO Series Mandrels)

Pressure Ratings

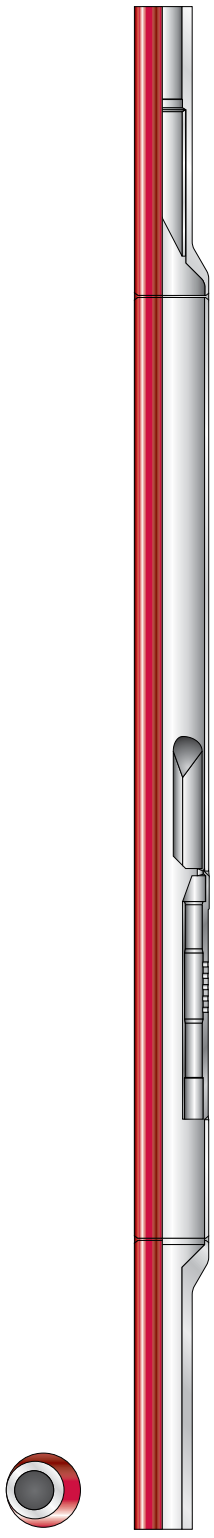
Mandrel Model	Model Number	Tubing Size (in.)	Test Pressure*							
			Standard Service				Sour Service			
			Internal		External		Internal		External	
			(psi)	(bar)	(psi)	(bar)	(psi)	(bar)	(psi)	(bar)
SM-1	1812-XXX	2-3/8	8,000	551.0	6,000	413.4	6,000	413.4	4,000	275.6
	1813-XXX	2-7/8								
	1814-XXX	3-1/2								
SIM-1	1812-5XX	2-3/8	8,000	551.0	6,000	413.4	6,000	413.4	5,000	344.5
	1813-5XX	2-7/8								
	1814-5XX	3-1/2	7,000	482.6	5,500	379.2	special request			
SMO-1	1912-XXX	2-3/8	8,000	551.2	6,000	413.4	6,000	413.4	4,000	275.6
	1913-XXX	2-7/8								
	1914-XXX	3-1/2								
	1916-XXX	4-1/2	7,000	482.3	5,000	379.0				
SIMO-1	1912-XXX	2-3/8	8,000	551.2	6,000	413.4	6,000	413.4	5,000	344.5
	1913-XXX	2-7/8								
	1914-XXX	3-1/2	7,000	482.3	5,500	379.0			4,500	310.1
SF-1	1612-XXX	2-3/8	8,000	551.2	6,000	413.4	6,000	413.4	5,000	344.5
	1613-XXX	2-7/8								
SIF-1	1612-XXX	2-3/8	8,000	551.2	6,000	413.4	6,000	413.4	5,000	344.5
	1613-XXX	2-7/8								
SFO-1	1712-XXX	2-3/8	8,000	551.2	6,000	413.4	6,000	413.4	5,000	344.5
	1713-XXX	2-7/8								
	1714-XXX	3-1/2	7,000	482.3	5,500	379.0			4,500	310.1
SIFO-1	1712-5XX	2-3/8	8,000	551.2	6,000	413.4	6,000	413.4	5,000	344.5
	1713-5XX	2-7/8								
	1714-5XX	3-1/2	7,000	482.3	5,500	379.0			4,500	310.1
SM-2	2012-XXX	2-3/8	8,000	551.2	6,000	413.4	6,000	413.4	4,500	310.1
	2013-XXX	2-7/8								
	2014-XXX	3-1/2								
SIM-2	2012-XXX	2-3/8	8,000	551.2	6,000	413.4	6,000	413.4	4,000	344.5
SMO-2	2412-XXX	2-3/8	8,000	551.2	6,000	413.4	6,000	413.4	5,000	275.6
	2413-XXX	2-7/8								
	2414-XXX	3-1/2								
SFO-2	2113-XXX	2-7/8	7,500	516.8	6,000	413.4	6,000	413.4	5,000	344.5
	2114-XXX	3-1/2	8,000	551.2	6,500	447.9	7,000	482.3	5,500	379.0
	2116-XXX	4-1/2	7,500	516.8	6,000	413.4	6,000	413.4	5,000	344.5
	2118-XXX	5-1/2	8,500	585.6	7,000	482.3	6,500	447.9	5,500	379.0

* Pressures are based on low-alloy steel, heat treated for standard and corrosive environments.
Pressure may vary with the type of end connections and with special-clearance applications.

These pressure ratings are based on test pressures at ambient temperature with no compression or tensional loads. Actual pressure ratings will vary depending on the temperature, compression, and tensional loads. Contact Weatherford for further information.

Options

- All oval-body side-pocket mandrels are available in AISI 4130 alloy material, which can be heat-treated specifically for corrosive hydrogen sulfide (H_2S) service. High-alloy materials such as 13-chrome (13-Cr) and 9-chrome (9-Cr) are also available.
- For specialized applications such as chemical injection, waterflood, bypass injection, and pressure-gauge monitoring, multiple mandrel configurations with a variety of features are available.



SMOR-1A Side-Pocket Mandrel

SMOR Series Side-Pocket Mandrels—Round-Body, Machined (SMOR and SMR Series Mandrels)

Weatherford McMurry-Macco® SMOR and SMR series side-pocket mandrels feature a round cross-sectional profile with machined swages, pocket, and tool guards. The mandrels have threaded connections for installation in the tubing string. The robust design enables installation of these mandrels in applications where premium alloy, special dimensional requirements, and/or increased pressure and tensile-strength capabilities are required. The side pocket is offset from the bore of the tubing, allowing full tubing drift for well-servicing operations through the mandrel, without restriction. The side pocket contains profiles and sealed bores to land appropriate flow-control devices. Gas-lift valves and other appropriate flow-control devices are installed in the side pocket using a kickover tool, which is run into the well using standard wireline techniques.

SMOR series mandrels include an integral orienting sleeve that aligns the kickover tool and flow-control device above with the pocket for precise installation in straight and deviated wellbores. SMR series mandrels do not have orienting sleeves and should only be installed in straight wellbores. These mandrels feature a tool guard at the top of the pocket, which deflects tools larger than the pulling/running tool back into the tubing bore to prevent damage to the valve latch.

SMR-1 and SMR-2 series mandrels have 1- and 1 1/2-in. inside diameter (ID) pockets and are designed for installation in straight wellbores. SMOR-1 and SMOR-2 series mandrels have 1- and 1 1/2-in. ID pockets and integral orienting sleeves and tool guards for installation in straight and deviated wellbores.

Applications

- SMOR and SMR series mandrels are used as internal receivers for gas-lift valves and other flow-control devices in standard, high-pressure, and corrosive service, primarily in single completions.
- SMOR and SMR series mandrels are available with a variety of features for specialized applications such as chemical injection, waterflood, bypass injection, and pressure-gauge monitoring.

Gas-Lift Mandrels

Features, Advantages, and Benefits

- The high-pressure design enables use of these mandrels in deep applications requiring high-pressure and/or tensile ratings, providing options for use in demanding environments.
- The side pocket is offset from the tubing bore, maximizing the flow area and allowing full tubing drift for well-servicing operations through the mandrel without restriction.
- The side pocket eliminates the need to pull or rerun the tubing string to install or replace gas-lift equipment, reducing operating costs.
- The machined pocket and tool guard prevent tools larger than the pulling/running tool from damaging the valve latch, protecting gas-lift equipment.
- The slotted orienting sleeve provides positive alignment of the kickover tool, ensuring reliable running and pulling of gas-lift equipment in deviated wellbores.
- The mandrel material is fully heat-treated, providing the best combination of strength and corrosion resistance for its intended use.
- SMOR-A and SMR-A series mandrel configurations are available with a special-clearance outside diameter (OD) for installation in smaller-diameter casing, where standard-diameter mandrels may not be practical, providing operational flexibility.

SMOR Series Side-Pocket Mandrels—Round-Body, Machined (SMOR and SMR Series Mandrels)

Specifications

Dimensions

Mandrel Model	Model Number	Tubing Size (in.)	Pocket Size (in., mm)	Pocket Latch Configuration	Orienting Sleeve	Major OD (in., mm)	Minor OD	Drift* (in., mm)
SMOR-1	2212-XXX	2-3/8	1.0 25.4	180°	Yes	4.50 114.30	N/A	1.901 48.29
SMOR-1A	2312-XXX					3.85 97.79		
SMR-1B	2512-XXX				No	3.75 95.25		
SMOR-1	2213-XXX	2-7/8	1.0 25.4	180°	Yes	5.00 127.00	N/A	2.347 59.61
SMOR-2	2913-XXX		1.5 38.1		Yes	5.44 138.18		
SMR-2	3013-XXX				No			
SMOR-1	2214-XXX	3-1/2	1.0 25.4	180°	Yes	5.75 146.05	N/A	2.867 72.82
SMOR-2	2914-XXX		1.5 38.1		Yes	6.00 152.40		
SMR-2	3014-XXX				No			
SMOR-2	2916-XXX	4-1/2	1.5 38.1		Yes	7.07 146.05		3.833 97.36

*1.901-in. drift is for 2 3/8-in. 4.7 lb-ft tubing
*2.347-in. drift is for 2 7/8-in. 6.5 lb-ft tubing
*2.867-in. drift is for 3 1/5-in. 9.3 lb-ft tubing
*3.833-in. drift is for 4 1/2-in. 12.60 lb-ft tubing

All dimensions and ratings for round-body side-pocket mandrels represent the standard (average) for the tubing and pocket-size configuration. Slight differences in OD, ID, metallurgy, thread weight, thread, etc., will result in variations to the specifications listed above. Contact Weatherford for further information.

Gas-Lift Mandrels

Dimensions

Mandrel Model	Model Number	Tubing Size (in.)	Pocket Size (in., mm)	Pocket Latch Configuration	Orienting Sleeve	Major OD (in., mm)	Minor OD	Drift (in., mm)
SMOR-2	2918-XXX	5-1/2	1.5 38.1	180°	Yes	8.000 203.20	N/A	4.65 118.19
SMOR-2	2919-XXX	7	1.5 38.1	180°	Yes	8.312 211.12	N/A	5.25 133.27

All dimensions and ratings for round-body side-pocket mandrels represent the standard (average) for the tubing and pocket-size configuration. Slight differences in OD, ID, metallurgy, thread weight, thread, etc., will result in variations to the specifications listed above. Contact Weatherford for further information

Pressure Ratings

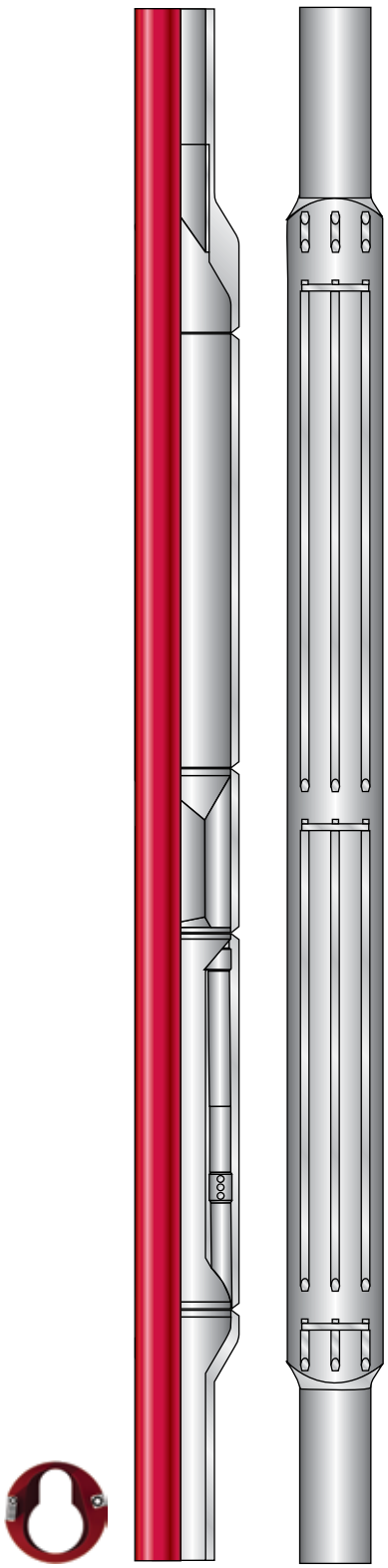
Mandrel Model	Model Number	Tubing Size (in.)	Test Pressure*							
			Standard Service				Sour Service			
			Internal		External		Internal		External	
			(psi)	(bar)	(psi)	(bar)	(psi)	(bar)	(psi)	(bar)
SMR-1	2512-XXX	2-3/8	7,880	543.31	7,540	519.86	6,010	414.37	5,750	396.45
SMOR-1	2212-XXX	2-3/8	17,310	1193.48	15,880	1094.89	13,190	909.42	12,100	834.27
	2213-XXX	2-7/8	Special Request				11,940	823.23	11,020	759.80
	2214-XXX	3-1/2	13,930	960.43	12,960	893.56	10,620	732.22	9,870	680.51
SMOR-1A	2312-XXX	2-3/8	Contact Weatherford for pressure-rating information							
	2313-XXX	2-7/8	Contact Weatherford for pressure-rating information							
SMOR-2	2913-XXX	2-7/8	13,630	939.75	12,690	894.94	10,380	715.68	9,670	666.72
	2914-XXX	3-1/2	Special Request				10,000	689.48	9,380	646.73
	2916-XXX	4-1/2	Special Request				8,060	555.72	7,610	524.69

* Pressures are based on low-alloy steel, heat treated for standard and corrosive environments.
Pressure may vary with the type of end connections and with special-clearance applications.

These pressure ratings are based on test pressures at ambient temperature with no compression or tensional loads. Actual pressure ratings will vary depending on the temperature, compression, and tensional loads. Contact Weatherford for further information.

Options

- SMOR and SMR series mandrels are available in AISI 4130 alloy material, which can be heat-treated specifically for corrosive hydrogen sulfide (H_2S) service. Other materials are available on request.
- SMOR and SMR series mandrels are available with a variety of features for specialized applications such as chemical injection, waterflood, bypass injection, and pressure-gauge monitoring.
- SMR-2RA and SMOR-2RA mandrels have a 1 1/2-in. ID pocket and a 360° latch-lug profile. The SMR-2RA mandrel is designed for installation in straight wellbores. The SMOR-2RA mandrel includes an orienting sleeve for installation in straight and deviated wellbores.



SBRO Series Round, Solid-Body, Side-Pocket Mandrels

Weatherford premium SBRO series side-pocket mandrels feature a round cross-sectional profile, an integral orienting sleeve, and a unique bat-wing tool guard for 1- and 1 1/2-in. outside diameter (OD) flow-control devices. These mandrels have a pocket-and-deflector section, which is machined from solid-bar stock. This design eliminates all longitudinal welds, providing an extremely strong mandrel for the most demanding environments. Internal profiles, including the bat-wing profile located at the tool guard and the upper and lower swages, are designed and tested to provide smooth passage of wireline tools in highly deviated wellbores, ensuring trouble-free operation during the life of the well. These mandrels can be custom-built for specific applications to facilitate control lines with either full-length machined grooves or rails. The SBRO series mandrels are ideal for applications in which superior strength and increased pressure capabilities are required.

Flow-control devices are installed in the side pocket using a kickover tool, which is run into the well using standard wireline techniques. The upper swage section contains an orienting sleeve that aligns the kickover tool with the side pocket for precise installation of flow-control devices in straight and deviated wellbores. The special bat-wing tool guard at the top of the pocket captures and guides the flow-control device into the pocket and deflects tools larger than the pulling/running tool back into the tubing bore of the mandrel.

The side pocket consists of a latch lug, two polished bores, and recessed inlet ports that provide communication between the casing annulus and the tubing. In gas-lift operations, flow from the casing enters the opposing mandrel ports, travels through the flow-control device, and enters the tubing string. The packing on the flow-control device seals the bore above and below the ports and isolates the tubing-injection pressure from the formation pressure.

Weatherford SBRO gas-lift mandrels can be provided to meet API 19G1 V-1 certification, currently the highest standard in the industry.

Applications

- Used as internal receivers for the installation and retrieval of flow-control devices for gas-lift, chemical-injection, and waterflood applications, primarily in single completions
- Can be custom-built for specific applications to facilitate control lines with either full-length machined grooves or rails
- Can be installed in deviated and straight wellbores

Gas-Lift Mandrels

Features, Advantages, and Benefits

- Solid-body design eliminates longitudinal welds, providing superior strength and increased pressure capabilities.
- Swages bat-wing profile tool guard have smooth and tapered surfaces specifically designed to avoid wireline snags and corrosion traps, preventing shielded areas that can inhibit application of the proper protective coating.
- The bat-wing tool-guard profile ensures that flow-control devices are guided into the pocket while larger tools are deflected back into the tubing bore of the mandrel, preventing damage to the valve latch.
- The solid pocket has recessed opposing ports, preventing flow erosion or blockage of ports if the mandrel pocket is positioned against the casing wall.
- Mandrel material is fully heat-treated, providing the best combination of strength and corrosion resistance for its intended use.
- The slotted orienting sleeve enables positive alignment of the kickover tool, ensuring reliable running and pulling of gas-lift equipment in deviated wellbores.
- High-pressure design enables use of these mandrels in deep applications that require high pressure and tensile ratings.
- SBRO series mandrel configurations are available with a special-clearance OD for installation in smaller-diameter casing, where standard-diameter mandrels may not be practical.

SBRO Series Round, Solid-Body, Side-Pocket Mandrels

Specifications

Dimensions

Mandrel Model	Model Number	Tubing Size (in.)	Pocket Size (in., mm)	Body Configuration	Pocket Type	Orienting Sleeve	Major OD (in., mm)	Drift (in., mm)
SBRO-1	2712-XXX	2-3/8	1.0 25.4	Round	Solid machined	Yes	4.60 116.84	1.90 48.26
SBRO-1A	2712-XXX						3.85 97.79	1.90 48.26
SBRO-1	2713-XXX	2-7/8					5.00 127.00	2.35 59.61
SBRO-1A	2713-XXX						4.50 114.30	2.35 59.61
SBRO-1	2714-XXX	3-1/2					5.50 139.70	2.87 72.82
SBRO-1	2716-XXX	4-1/2					6.38 161.93	3.83 97.36
SBRO-1A	2716-XXX						5.98 151.97	3.83 97.36
SBRO-2	2813-XXX	2-7/8	1.5 38.1	Round	Solid machined	Yes	5.25 133.35	2.35 59.61
	2814-XXX	3-1/2					5.97 151.59	2.87 72.82
	2816-XXX	4-1/2					7.06 179.37	3.83 97.36
	2818-XXX	5-1/2					8.00 203.20	4.65 118.19
	2819-XXX	7					9.25 234.95	5.80 147.19

All dimensions and ratings for round, solid-body, side-pocket mandrels represent the standard (average) for the tubing and pocket size configuration. Slight differences in OD, ID, metallurgy, thread weight, thread, etc., will result in variations to the specifications listed above. Contact Weatherford for further information.

Options

- The SBRO series mandrels are available in AISI 4130 alloy material, which can be heat-treated specifically for corrosive H_2S service.
- Because of their totally machined design, the SBRO series mandrels are available in a number of configurations and materials, including 9Cr-1Mo, 13Cr, Super 13-chrome (S13Cr), F6NM, and INCOLOY® 718 and 925.
- A variety of configurations are available for specialized applications such as chemical injection, waterflood, bypass injection, and pressure-gauge monitoring.
- Configurations with a special-clearance OD are available for installation in smaller-diameter casing.
- Dimensions and pressure ratings will change for custom-designed mandrels with special thread connections, special rails or grooves, and special metallurgy. Pressure ratings can be provided based on specific conditions.

INCOLOY is a registered trademark of the Huntington Alloys Corporation.

SBRO-DVX™ Side Pocket Gas-Lift Mandrel

Weatherford patented SBRO-DVX side-pocket gas-lift mandrel features unique dual external valves, which prevent corrosive well fluids from entering the casing annulus through the gas-lift valves or through empty side-pocket mandrel pockets. These check valves provide a second and third barrier of protection for the casing string against high pressures, hydrogen sulfide (H_2S), carbon dioxide (CO_2), and other hazards. External placement of the valves enhances safety, protects the casing string and the environment, and makes the SBRO-DVX mandrel ideal for use in severe well conditions.

Weatherford SBRO-DVX gas-lift mandrels can be provided to meet API 19G1 V-1 certification, currently the highest standard in the industry.

Applications

- Deepwater, subsea, or other high-profile wells where it is beneficial to prevent wellbore fluids from entering the annulus
- Wells where well control is a concern during the gas-lift valve pulling and installation process

Features, Advantages, and Benefits

- Dual external valves prevent wellbore fluids from entering the casing annulus and protect the casing string from high pressures and corrosive fluids, enhancing safety and environmental integrity.
- The design avoids the problem of tubing-to-casing communication that occurs with standard side-pocket mandrels during gas-lift valve change out, preventing tubing flow into the casing when the gas-lift valve is removed from the pocket.
- The complete unloading of the casing annulus and tubing after gas-lift change-out is not required, reducing downtime in well production.
- The DVX mandrels can be tested to the highest American Petroleum Institute (API) validation levels, ensuring the design integrity of the mandrel can withstand extreme wellbore conditions.
- Industry-standard pocket configuration accepts 1.0-in. and 1.5-in. (25.4-mm and 38.1-mm) outside diameter (OD) gas-lift valves and latches from other manufacturers, increasing operational versatility.
- Pocket and check valve configurations provides ample gas passage capability, enabling maximum production rates.
- Packing stack arrangement allows optimum force distribution to prevent valve from being ejected from mandrel pocket, reducing the chances of nonproductive time.
- Gas-lift valve is pulled and installed with standard industry wireline tools, improving logistical concerns of equipment availability.

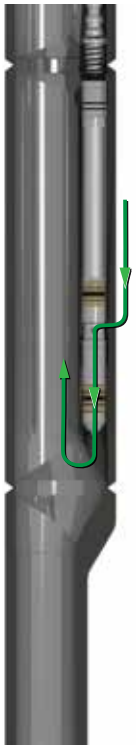
SBRO-DVX™ Side Pocket Gas-Lift Mandrel

Options

- Custom mandrel designs are available for premium threads and weights, special running-OD clearance, premium metallurgy (such as 13Cr, S13Cr, and 718 INCONEL®).
- Special protective rails or grooves can be included in the design to facilitate different combinations of multiple data and chemical-injection lines.

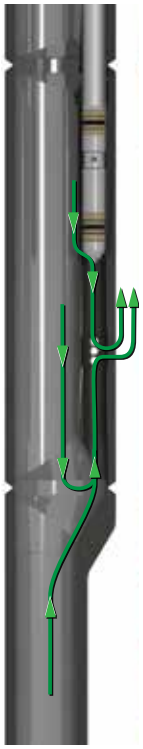
Standard Side-Pocket Mandrel

Valve in pocket



Injection gas through the gas-lift valve.

Valve out of pocket



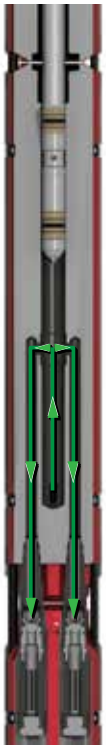
When the valve is pulled from the standard side pocket mandrel, well fluids flow into the casing through the mandrel pocket.

DVX Type Side-Pocket Mandrel

Valve in pocket

Injection-gas path through external check valves, then through mandrel pocket, valve, slot, and into the tubing.

Valve out of pocket



When the valve is pulled from the DVX-type gas-lift mandrel, well fluids are contained in the tubing.

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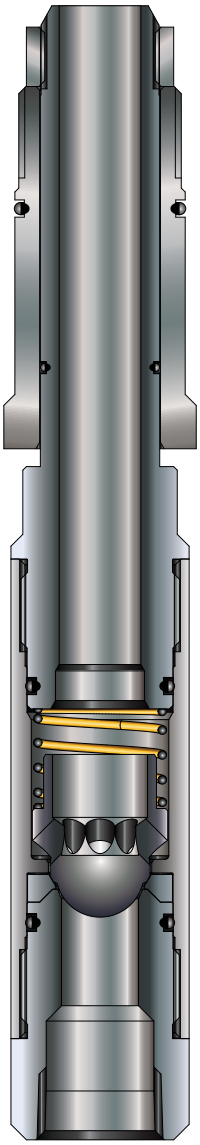
CV-2 DVX™ Check Valves

Weatherford CV-2 DVX check valves are specifically designed to be connected externally to Weatherford DVX gas-lift mandrels. These check valves function independently of gas-lift valve checks and serve as a secondary independent barrier to prevent produced fluids from entering the casing. If a gas-lift valve needs to be pulled from an existing mandrel, these valves go on-seat during the pulling operation and prevent corrosive fluids from contacting casing. These check valves have been designed and tested for maximum gas-passage capability and are equipped with Weatherford combination modified PTFE nonelastomeric seal and metal-to-metal seal. CV-2 DVX check valves have passed many erosion tests performed by numerous operators for deepwater projects. These valves have been designed by applying computational flow-dynamics analysis and physical testing to ensure maximum gas-passage capability and erosion resistance.

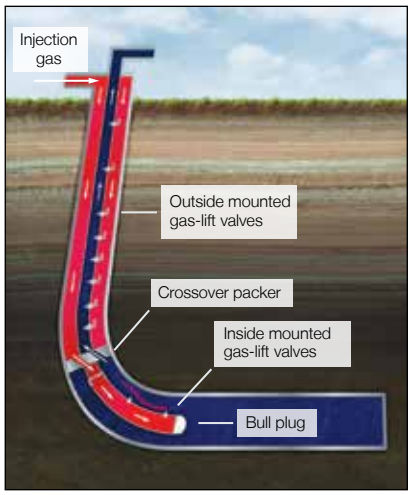


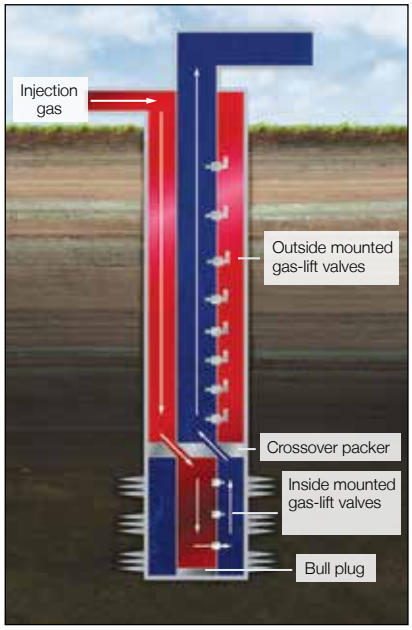
Applications

- Wells in which it is critical to prevent corrosive fluids from entering the annulus during gas-lift valve changes
- Wells that require high injection rates to maximize production rates
- High-profile wells with high intervention cost

Features, Advantages, and Benefits

- Customized design works in conjunction with Weatherford DVX gas-lift mandrel to create an independent secondary backup-check system to contain pressure and fluids in tubing when gas-lift valve is pulled from the mandrel pocket, preventing corrosive fluids from entering casing while eliminating redundant unloading of casing after valve replacements.
- The complete assembly, which has been analyzed by computational flow-dynamics analysis affords known and predictable gas-passage characteristics, providing accuracy in gas-lift designs to ensure maximum well productivity.
- Aerodynamic check dart—designed for proven flow performance from computational flow dynamics and physical testing—provides maximum gas passage and erosion resistance, increasing overall production rate.
- The valve can be manufactured from various materials and customized to fit well conditions, reducing nonproductive time.





Injection gas

Produced fluids and injection gas

Xtra-Lift™ Extended-Perforation-Interval Gas-Lift System

Weatherford Xtra-Lift extended-perforation-interval gas-lift system lowers the injection point below the packer in a gas-lift well to increase production rate. With the Xtra-Lift system in place, gas is injected down the annulus through a series of pressure-injection-operated gas-lift valves. As differential pressures permit, gas is transferred into the bypass packer and injected into the dead string. With PM-1/IM gas-lift mandrels and internally mounted gas-lift valves and checks in the dead string, the injection gas can be injected out into the area between the dead string and the casing wall. The Xtra-Lift gas-lift system enables all flow to occur around the tail string, with supplemental gas being supplied from the surface to increase volume to sufficient rates needed to lift the produced fluids. All produced fluids and injection gas enter the bottom of the bypass packer and return to the surface via the production tubing.

Applications

- Continuous-flow gas-lift wells
- Conventional wells with long perforated intervals
- Horizontal wells where lowering the injection point below packer is advantageous

Features, Advantages, and Benefits

- Specialized packer design, along with tail string below packer with gas-lift valves, lowers the point of injection below the packer, increasing production.
- Customized gas-lift valve port sizes and pressure settings in tail string provides efficient use of injection gas, improving operational efficiency.
- By not repeatedly unloading fluid through gas-lift valves, the equipment life is prolonged, saving operating costs.
- The Xtra-Lift gas-lift system depletes the well to lower bottomhole pressure, improving economic pay-off.
- Specialized packer design, along with tail string below packer, with gas-lift valves with customized port sizes and pressure settings achieves a stable flow versus running the installation without a packer, enabling operational efficiency.

CT Series Coiled-Tubing Gas-Lift Valves

Weatherford McMurry-Macco® line of gas-lift valves and mandrels for coiled tubing has been used successfully in many applications. The most common application is to run the coiled tubing, complete with conventional gas-lift valves and mandrels, inside the production tubing of an existing completion. The top of the coiled tubing is then hung-off at the top of the wellhead with a tubing hanger. Injection gas is injected down the annulus, between the coiled tubing and the production tubing, and the well is produced up the coiled tubing.

Sometimes existing gas-lift wells must be lifted from a deeper point because bottomhole pressure has declined. Coiled tubing is made up with additional mandrels and gas-lift valves and run down the inside of the production tubing. The top of the coiled tubing is hung-off just above the bottom side-pocket mandrel. A wireline-retrievable orifice valve is placed in the bottom side-pocket mandrel to supply injection gas from the casing annulus to the production-tubing/coiled-tubing annulus. The well is then gas-lifted using the coiled-tubing gas-lift valves, permitting a deeper point of injection. This procedure offers several advantages:

- The procedure eliminates the need to perforate the tubing for packoff-type gas-lift valves.
- The coiled tubing is hung-off below the subsurface safety valve, eliminating the need to run specially designed subsurface safety devices within the coiled-tubing string.
- The coiled tubing in the lower section of the well serves as a velocity string, helping the fluid flow without loading. The flow then opens up to the larger production tubing in the upper section of the well, where tubing pressures are lower, and the gas is expanded, creating higher fluid velocities. Maintaining the larger tubing in the shallow part of the well prevents the fluid velocity from becoming high enough to restrict the production rate from frictional pressure losses.

Real Result

Fluid-loading well issues resolved

A coiled-tubing (CT) gas lift, using Weatherford McMurry-Macco lift system, solved fluid-loading well issues to recover the last of a field's reserves in east Texas, USA. Well A's problems included circumvent tubing, rod wear, and solid-sticking problems with gas lift. Well B needed to convert from intermittent to full-time production.

Two different sizes of the McMurry-Macco lift equipment were installed in the two wells. The result was the elimination of pulling jobs and the avoidance of fishing jobs where a portion of the tubing could not be pulled, saving the operator a significant cost. Total CT gas-lift installation was made in 1 day for each well. The payout for Well A was realized in 1 month. For Well B, production tripled by producing the well every day rather than intermittently; payout was realized in 3 months.

CT Valve

Gas-Lift Automation

CFO™ Gas-Lift Automation System

Weatherford CFO automated gas-lift system provides many benefits over manual gas-lift operations. These benefits are realized in gas flow, gas usage, footprint requirements, and quality of oil production.

- The CFO system ensures extremely stable gas-flow rates and virtually eliminates surge.
- A 5- to 10-percent reduction in gas usage is typical. The system optimizes injection-gas:liquid ratio and provides field optimization during upset conditions.
- The CFO unit is lighter than other automated systems and is designed so that the complete flow loop can be installed in the space typically required for the manual valve.
- The result is a system that can increase production 5 to 10 percent with little or no slugging.

Economic Benefits

- The system offers an immediate production increase with low capital investment.
- Remote-operation capability can reduce labor requirement and transportation costs.
- Diagnostics reduce platform visits and improve maintenance planning.
- The system continues to operate during communication interruptions, increasing up time.

System Benefits

- Constant gas-flow rate can increase production.
- No piping modification means reduced installation cost.
- System measures and controls flow over a 30:1 turndown.
- Well-test times are reduced.
- Well optimization is improved.

Operational Advantages

The system can be controlled locally or remotely for convenience and ease of operation. On-site, the CFO system has an easy-to-read display for processing variables. The keypad facilitates on-the-spot changes to set points, and the manual controls simplify maintenance functions. System functionality can be easily verified on-site if needed.

Remote operation offers multiple advantages and benefits, including simplified system integration into the operator's network; savings in personnel costs; complete monitoring and control during hurricane mode; user-definable alarms; diagnostics for accurate problem identification before going on-site; constant, real-time data access; elimination of manual data logging; quick access to historical data; and provision of production accounting information.

Specifications

Performance Specifications

The flow assurance of the standard CFO system is ±2 percent of full-scale flow over the turndown of the control valve, normally 30:1 for a glove valve. This rate can be improved with the use of characterized trim or with reduction of the turndown of the high-accuracy range.

Measurement Repeatability

Flow	0.25% full scale
Maximum pressure	0.1% full scale
Temperature	34°F (1°C) body temperature measured by K type thermocouple
Drift	1% full scale per 6 months
Calibration	Independent zero and span adjustments for all sensors

Operating Temperature Range

Ambient	0.25% full scale
Process media	0.1% full scale
Temperature effect	34°F (1°C) body temperature measured by K type thermocouple

Other Features

Totalizer	Totalizes mass flow until reset; available through digital link; variable-width pulse from discrete output
Data logger	300 most-recent samples at user-defined intervals from 1 sec (5 min total) to 3 hr (34 days total)

Software Specifications

Computer	Windows® 3.x or higher, 80486 processor, 33 MHz, 8 MB RAM
Drive required	Hard disk 10 MB
CFO per link	Up to 31

Physical Specifications

Pressure	316L stainless steel, Viton® O-ring seal (standard); HASTELLOY® C optional; other alloys on request
Housing	Cast, powder-coated aluminum
Tubing	316 stainless steel with Swagelok® fittings
Environmental vibration	NEMA 3, up to 2 G, 30 to 500 Hz measured at electronics
Pressure sensor over-range	Two times maximum operating pressure, with negligible change in output

Windows, Viton, HASTELLOY, and Swagelok are trademarks of their respective owners.

CFO™ Gas-Lift Automation System

Electrical Specifications

Power supply	Nominal 24 VDC (18 to 64 VDC allowable) providing 300 mA
Analog inputs	Isolation protection to 1,000 V
Command auxiliary input	13-bit resolution, 16-Hz sampling rate
Analog outputs	Two 4-20 mA; each driving up to 750 W
Discrete inputs (2 channels)	Jumper-selectable input voltages of 120 and 24 V accept either AC or DC signals; pulse width > 1/16 sec
Discrete output No. 1: Alarm relay	Jumper-selectable NO or contacts; maximum relay contact rating: 24 VDC resistive; Groups A and B: 230 mA; Group C: 590 mA; Group D: 800 mA
Discrete output No. 2: Pulse relay	24 VAC or VDC operation; maximum output switching frequency of 256 Hz
Nonincendive	Class I, Division II, Groups B, C, D
Overload protection	Minimum 500 V isolation; 24 V power fuse protected
Serial interface	Dual RS-485 ports; Modbus protocol

Chemical-Injection Equipment

Introduction

Chemical injection is the process of injecting fluid chemicals into the production stream of a well to control corrosion and harmful deposits in the tubing and tubing accessories during production.

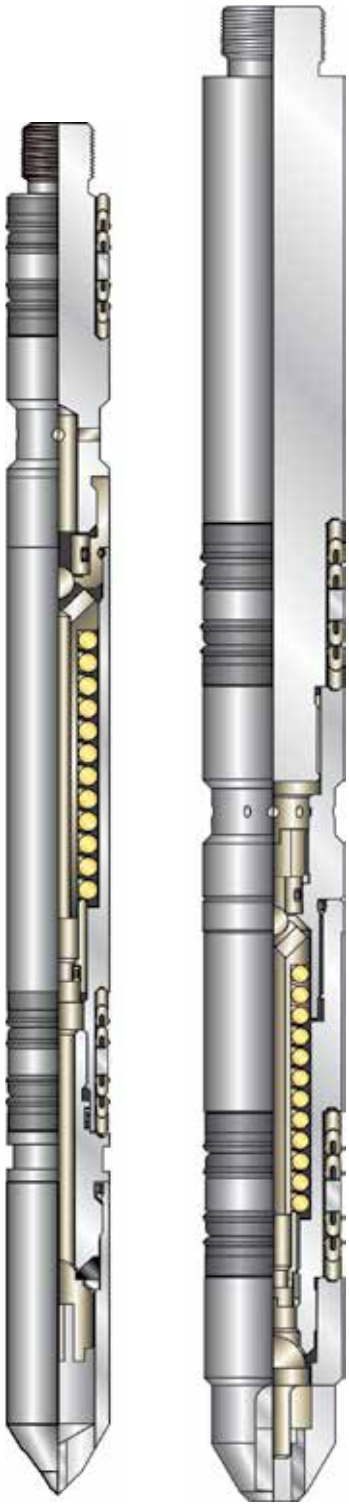
In a typical chemical-injection installation, a chemical-injection mandrel with a chemical-injection valve is installed as part of the production-tubing string. A chemical-injection line can be run from the chemical-injection mandrel to the surface to act as a conduit for the injection fluid. In other installations, the injection chemical is pumped down the tubing/casing annulus and into a port in the chemical-injection mandrel. Reverse-flow check valves are installed at the point of injection to prevent flow from the production tubing from entering the injection-flow path. A high-pressure pump, capable of overcoming tubing pressure, is installed on the surface to pump the chemical-injection fluid into the downhole point of injection in the production stream.

Applications

- Extending the life span of the production tubing by minimizing internal corrosion in hostile well environments with hydrogen sulfide (H_2S) and/or carbon dioxide (CO_2)
- Reducing completion costs by allowing the installation of less-expensive grades of production tubing in some applications
- Minimizing or eliminating the buildup of deposits such as salts, paraffin, and scale that reduce the tubing inside diameter (ID) and lead to lower production rates

Benefits

- Minimizes maintenance and operating costs
- Reduces initial installation cost in many installations
- Can be installed in almost any wellbore configuration
- Maximizes the time between costly workovers on completions in hostile well environments



RCI-1A Valve (1-in. OD)

RCI-2A Valve (1.5-in. OD)

RCI Series Wireline-Retrievable, Chemical-Injection Valves

Weatherford McMurry-Macco® RCI series wireline-retrievable, chemical-injection valves are used to control the injection of chemicals for treatment of harmful deposits and corrosion in tubing and around downhole tools. These valves are installed in chemical-injection side-pocket mandrels using a kickover tool and standard wireline techniques.

The valves' injection rate is controlled by the size of the port, the tension adjustment of the internal INCONEL® power spring before installation, and pump-in rate. The valves are in a normally closed position as a result of the combined force of the preset spring tension and the tubing pressure on the valve stem. A chemical pump at the surface injects chemicals down the casing annulus or through a separate injection line attached to the mandrel. From the casing annulus or injection line, the chemical enters the injection valve port. The valve opens when the chemical-injection pressure (the surface chemical-pump pressure plus the hydrostatic pressure of the chemical) exceeds the spring force and tubing pressure, allowing chemicals to flow into the tubing string. An integral reverse-flow check valve prevents backflow into the casing annulus or injection line.

Applications

- RCI series valves are used in wells that require the continuous or intermittent injection, via the casing annulus or the injection-control line, of corrosion inhibitors or other chemicals to treat corrosion or harmful deposits in the tubing and around downhole tools.

Features, Advantages, and Benefits

- INCONEL power spring withstands corrosive and high-temperature conditions, delivering reliable performance and extending the life of the valve.
- The power spring is available in a wide range of sizes to fit low-set and high-set pressure requirements so that set pressure is maintained, ensuring consistent operation.
- Tungsten-carbide ball and insert seat (standard) offer the highest abrasion and impact resistance available, providing a robust and stable injection system.
- Design excludes crossover seats to decrease the likelihood of valve plugging, increasing the flow efficiency of the valve.
- Integral reverse-flow check valve prevents tubing-to-casing annulus communication during operation, prolonging the valve's life cycle.
- Check-valve spring is made from durable MP35N alloy material, ensuring that production fluids do not enter the injection conduit.
- Wireline-retrievable design allows valve to be pulled, serviced, and reinstalled without pulling the tubing, reducing maintenance and repair costs.
- Setting tool facilitates adjustment of valve injection pressure, ensuring consistent operation.

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Specifications

Set Pressure Guide						
					Spring Part Number and Wire Diameter	
					99641183 (0.145 in., 3.68 mm)	
					Set Pressure	
Valve Model	Valve Model Number	Latch Type	Valve OD (in., mm)	Port Size (in., mm)	Minimum (psi, bar)	Maximum (psi, bar)
RCI-1A	0109-XXX	BK-2	1.0 25.4	1/8 3.175	1,000 68.9	9,800 675.0
				3/16 4.763	1,000 68.9	6,500 448.0
				1/4 6.350	1,000 68.9	4,300 296.0
RCI-2A	0208-XXX	RK	1.5 38.1	1/8 3.175	1,000 68.9	14,400 447.9
				3/16 4.763	1,000 68.9	8,100 199.8
				1/4 6.350	1,000 68.9	4,850 133.7

Different spring designs for special set pressures are available upon request
Set pressures based on standard Monel 400 valve material. Higher pressures can be obtained with stronger valve material.

Options

- RCI series injection valves are available in stainless steel, MONEL®, or INCONEL materials.
- Tungsten-carbide ports are standard and are available in 1/8-, 3/16-, and 1/4-in. sizes.
- Standard moly-filled Teflon® packing-element system enhances performance and extends the service life.

CCI-1A Valve

CCI Series Tubing-Retrievable, Chemical-Injection Valve

Weatherford CCI-1 valve is a spring-loaded chemical-injection valve designed to control the injection of chemicals, fluids, and water for treating corrosion and harmful paraffin, salt, and hydrate deposits inside tubing and around downhole tools.

The valve is installed on a tubing-retrievable, chemical-injection mandrel. Before installation, the injection rate of the valve is adjusted by the port size and tension of the internal INCONEL® power spring. The preset spring tension maintains the valve in a normally closed position.

A chemical pump at the surface injects chemicals down the casing annulus or through a separate injection line attached to the CCI-1 valve. From the casing annulus or injection line, the chemical enters the injection valve port. The valve is primarily controlled by the differential between the injection pressure and the tubing pressure. The valve opens when the pressure differential across the stem and seat exceeds the preset spring tension, allowing chemicals to flow into the tubing string. An integral, reverse-flow check valve prevents backflow into the casing annulus or injection line.

Applications

- The CCI-1 valve is used for downhole injection of corrosion inhibitors and various chemicals to treat, intermittently or continuously, harmful deposits and corrosion in the tubing or around downhole tools.
- This valve is useful in both annular and injection control-line applications.

Features, Advantages, and Benefits

- INCONEL power spring and check-valve spring withstand corrosive and high-temperature conditions, delivering reliable performance and extending the life of the valve.
- Spring-loaded operation allows accurate functioning of the CCI-1 valve, regardless of well temperature, providing consistent operation.
- Integral reverse-flow check valve prevents tubing-to-casing annulus communication during operation.
- Valve design excludes crossover seats, decreasing the likelihood of valve plugging and increasing the flow efficiency of the valve.
- Setting tool enables easy adjustment of valve injection pressure.
- Tungsten-carbide ball and insert seat (standard) offer the highest abrasion and impact resistance available, providing a robust and stable injection system.

INCONEL is a registered trademark of the Huntington Alloys Corporation.

Specifications

Valve Model	Valve Model Number	Valve OD (in., mm)	Port Size (in., mm)	Maximum Set Pressure (psi, bar)
CCI-1A	3604-XXX	1.00 25.40	1/8 3.18	8,400 578.8
			3/16 4.76	
			1/4 6.35	
CCI-1B		1.19 30.20	1/8 3.18	8,400 578.8
			3/16 4.76	
			1/4 6.35	

Options

- The CCI-1 valve is constructed of 316 stainless steel and is also available in premium materials, such as MONEL® and INCONEL, for corrosion resistance in wells with high concentrations of hydrogen sulfide (H_2S) or carbon dioxide (CO_2).
- A wide variety of standard, chemical-resistant, and high-temperature elastomers is available as well.
- Special erosion-resistant coatings for flow-wetted parts are available.

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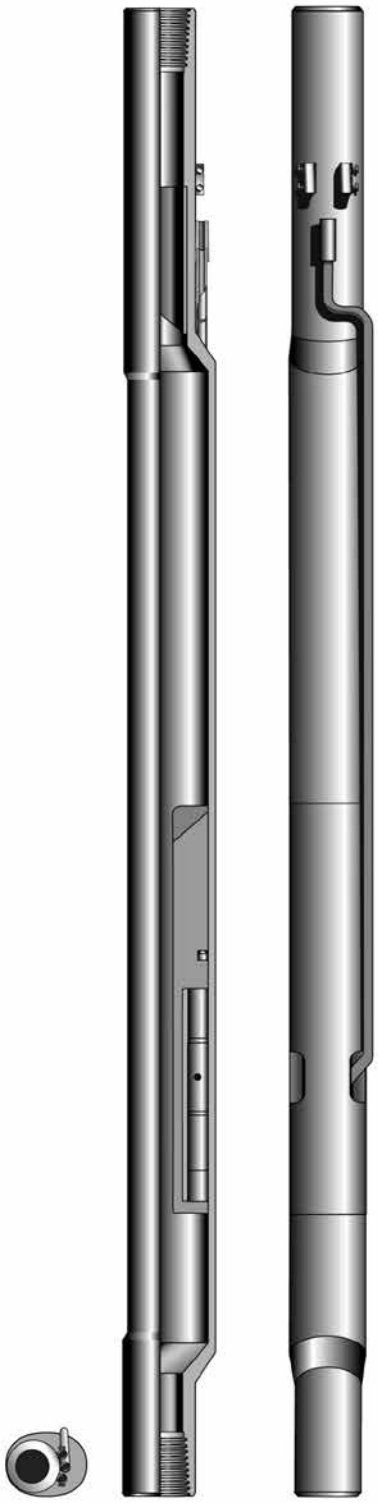


SFO-CI Series
Side-Pocket Mandrel

SFO-CI and SMO-CI Series Side-Pocket Mandrels, Oval-Body, Forged and Machined

Weatherford McMurry-Macco® SFO-CI and SMO-CI series chemical-injection, side-pocket mandrels feature an oval cross-sectional profile and threaded connections for installation in the tubing string. Attached to the mandrel pocket for the chemical-injection valve is an integral injection tube, which is connected to the capillary-injection line that is used to pump chemicals from the surface to the mandrel downhole. The side pocket is offset from the bore of the tubing, allowing full tubing drift through the mandrel for well-servicing operations without restriction.

The side pocket encompasses profiles and sealbores to land chemical-injection devices. The SIF and SIM series mandrels have integrally forged swages.

Chemical-injection devices are installed in the side pocket using a kickover tool, which is run into the well, using standard wireline techniques. SFO-CI and SMO-CI mandrels include an integral orienting sleeve, which aligns the kickover tool and injection device with the side pocket for precise installation in straight and deviated wellbores. SFO-CI and SIFO-CI series mandrels have a one-piece, forged pocket/deflector that guides the chemical-injection device into the pocket and deflects tools larger than the pulling/running tool back into the tubing bore of the mandrel. SMO-CI and SIMO-CI series mandrels have a machined pocket and tool guard that perform the same function.

The chemical-injection system for both series of mandrels includes a chemical pump that injects chemicals through the wellhead and down an injection line to the chemical-injection valve in the mandrel side pocket. When the chemical-injection valve opens, the chemicals flow into the production string. A reverse-flow check valve prevents wellbore fluids from flowing back into the injection line.

Applications

- Oval-body mandrel design overall running clearances and is ideal for dual-completion applications.
- SFO-CI and SMO-CI series mandrels are used in single or dual completions as receivers for wireline-retrievable chemical-injection valves to enhance production and remediate corrosion, paraffin, salt, and scale formation, ultimately prolonging production life.
- The SFO-CI series mandrels feature an oval body with a one-piece, forged pocket/deflector, a side pocket with an injection-line connection, and an integral orienting sleeve for injection-device installation in straight and deviated wellbores.
- The SMO-CI series mandrels feature an oval body with a machined tool guard, a side pocket with an injection-line connection, and an integral orienting sleeve for injection-device installation in straight and deviated wellbores.

Chemical-Injection Equipment

Features, Advantages, and Benefits

- Side-pocket design eliminates the need to pull or rerun the tubing string to install or replace chemical-injection equipment, reducing maintenance costs.
- The side pocket is offset from the tubing bore, maximizing the flow area and allowing full tubing drift for well-servicing operations through the mandrel without restriction.
- Slotted orienting sleeve enables precise installation and retrieval of chemical-injection equipment in straight and deviated wellbores, enhancing production flexibility.
- One piece, forged pocket/deflector (SFO-CI series) and machined pocket and deflector (SMO-CI series) protect chemical-injection equipment by preventing tools larger than the pulling/running tool from damaging the valve latch.
- Injection-line lug is located under the upper swage, providing added protection as tubing is run and pulled.
- Mandrel material is fully heat treated to provide the best combination of strength and corrosion resistance for its intended use.

SFO-CI and SMO-CI Series Side-Pocket Mandrels, Oval-Body, Forged and Machined

Specifications

Dimensions

Mandrel Model	Model Number	Tubing Size (in.)	Pocket Size (in., mm)	Pocket Type	Orienting Sleeve	Major OD (in., mm)	Minor OD (in., mm)	Drift* (in., mm)
SIFO-1CI	1762-XXX	2-3/8	1.0 25.4	Forged	Yes	4.31 109.42	2.91 73.91	1.901* 48.29
SFO-1CI	1763-XXX	2-7/8	1.0 25.4	Forged	Yes	4.75 120.65	4.03 102.36	2.347* 59.61
SIFO-1CI	1763-XXX					4.75 120.65	3.98 101.09	
SFO-1CI	1764-XXX	3-1/2	1.0 25.4	Forged	Yes	5.31 134.95	4.03 102.36	2.867* 72.82
SIFO-1CI	1764-XXX					5.36 136.14	4.03 102.36	

*1.901-in. drift is for 2 3/8-in. 4.7 lb-ft tubing
*2.347-in. drift is for 2 7/8-in. 6.5 lb-ft tubing
*2.867-in. drift is for 3 1/5-in. 9.3 lb-ft tubing

Specifications

Pressure Rating

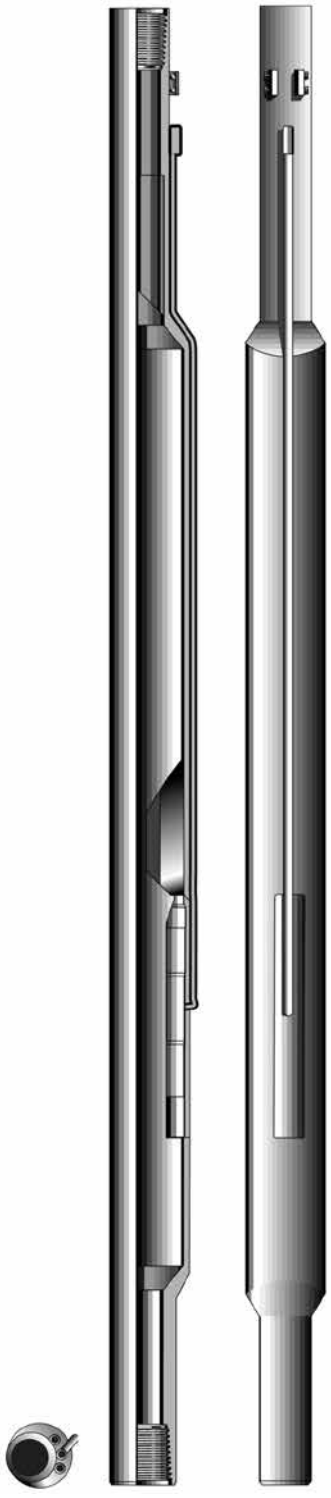
Mandrel Model	Model Number	Tubing Size (in.)	Test Pressure*							
			Standard Service				Sour Service			
			Internal		External		Internal		External	
			(psi)	(bar)	(psi)	(bar)	(psi)	(bar)	(psi)	(bar)
SIFO-1CI	1762-5XX	2-3/8	8,000	551.20	6,000	413.40	6,000	413.40	5,000	344.50
SFO-1CI	1763-XXX	2-7/8	8,000	551.20	6,000	413.40	6,000	413.40	5,000	344.50
	1764-XXX	3-1/2	7,000	482.30	5,500	378.90			4,500	310.10

* Pressures are based on low-alloy steel, heat treated for standard and corrosive environments.
Pressure may vary with the type of end connections and with special-clearance applications.

These pressure ratings are based on test pressures at ambient temperature with no compression or tensional loads. Actual pressure ratings will vary depending on the temperature, compression, and tensional loads. Contact Weatherford for further information.

Options

- SFO-CI and SMO-CI series mandrels are available in AISI 4130 alloy material, which can be specially heat-treated for corrosive hydrogen sulfide (H_2S) service. High-alloy materials, such as S13Cr and 9Cr, are also available.
- Multiple configurations are available for specialized cable and injection-line bypass capability.
- Injection-line termination lug is available in several thread configurations for reliable termination in high-pressure applications.
- Protection lugs are available for protection of the mandrel injection tube.



SMOR-CI Series
Side-Pocket Mandrel

SMOR-CI Series Side-Pocket Mandrels, Round-Body, Machined

Weatherford McMurry-Macco® SMOR-CI series side-pocket mandrels feature a round cross-sectional profile with machined swages, pocket, and tool guard. The mandrels have threaded connections for installation in the tubing string. The robust design enables installation of the mandrels in applications in which premium alloy, special dimensional requirements, and/or increased pressure capabilities are required.

The SMOR-1CI mandrel has a 1-in. inside diameter (ID) side pocket, and the SMOR-2CI mandrel has a 1 1/2-in. ID side pocket. The side pocket is offset from the bore of the tubing, allowing full tubing drift for well-servicing operations through the mandrel without restriction. The side pocket encompasses profiles and sealbores to land chemical-injection devices.

Chemical-injection devices are installed in the side pocket using a kickover tool, which is run into the well using standard wireline techniques. The SMOR-CI series mandrels include an integral orienting sleeve that aligns the kickover tool and injection device above the pocket for precise installation in straight and deviated wellbores. The mandrels feature a tool guard at the top of the pocket to deflect tools larger than the pulling/running tool back into the tubing bore of the mandrel to prevent damage to the valve latch.

Applications

- SMOR-CI series mandrels are used as internal receivers for chemical-injection valves and related equipment in standard, high-pressure, and corrosive service, primarily in single completions.
- These mandrels can be installed in straight and deviated wellbores.

Features, Advantages, and Benefits

- High-pressure design allows mandrels to be used in deep applications requiring high burst- and collapse-pressure ratings and high tensile ratings.
- Side pocket is offset from the tubing bore, maximizing the flow area and allowing full tubing drift for well servicing operations through the mandrel without restriction.
- Side pocket avoids having to pull and rerun the tubing string to install or replace a chemical-injection device, reducing costly workover operations.
- Slotted orienting sleeve enables precise installation and retrieval of chemical-injection equipment in straight and deviated wellbores.
- Machined pocket and tool guard protect chemical-injection equipment by preventing tools larger than the pulling/running tool from damaging the valve latch.
- Mandrel material is fully heat-treated to provide the best combination of strength and corrosion resistance for its intended use.
- The injection lug is tucked under the upper swage for additional protection of injection-line termination.

Chemical-Injection Equipment

Specifications

Dimensions

Mandrel Model*	Model Number	Tubing Size (in.)	Pocket Size (in., mm)	Body Configuration	Pocket Type	Orienting Sleeve	Major Running OD (in., mm)	Drift* (in., mm)
SMOR-1CI	2252-XXX	2-3/8	1.00 25.40	Round	Machined	Yes	4.50 114.3	1.901 48.29
	2253-XXX	2-7/8					5.00 127.0	2.347 59.61
	2254-XXX	3-1/2					special request	
SMOR-1CI	2256-XXX	4-1/2	1.00 25.40	Round	Machined	Yes	special request	
SMOR-2CI	2956-XXX		1.50 38.10				special request	

*1.901-in. drift is for 2 3/8-in. 4.7 lb-ft tubing
*2.347-in. drift is for 2 7/8-in. 6.5 lb-ft tubing
*2.867-in. drift is for 3 1/5-in. 9.3 lb-ft tubing
*3.833-in. drift is for 4 1/2-in. 12.60 lb-ft tubing

Round-body mandrels are custom-made, so their dimensions and pressure ratings represent the standard (average) for the tubing size. Slight differences in outside diameter (OD), ID, metallurgy, thread weight, thread, etc., will result in variations to the specifications listed above. Contact Weatherford for further information.

Pressure Rating

Mandrel Model*	Model #	Tubing Size		Test Pressure*							
				Standard Service				Sour Service			
				Internal		External		Internal		External	
		(in.)	(mm)	(psi)	(bar)	(psi)	(bar)	(psi)	(bar)	(psi)	(bar)
SMOR-1CI	2252-XXX	2-3/8	60.33	Special Request				12,850	885.98	11,800	813.58
	2253-XXX	2-7/8	73.03					12,000	826.80	11,000	757.90
	2254-XXX	3-1/2	88.90					10,400	717.05	9,720	670.17
	2256-XXX	4-1/2	114.30					9,000	620.53	8,000	551.58

* Pressures are based on low-alloy steel, heat-treated for standard and corrosive environments.
Pressure may vary with the type of end connections and with special-clearance applications.

These pressure ratings are based on test pressures at ambient temperature with no compression or tensional loads. Actual pressure ratings will vary depending on the temperature, compression and tensional loads. Contact Weatherford for further information.

Options

- SMOR-CI series mandrels are available in AISI 4130 alloy material, which can be specially heat-treated for corrosive hydrogen sulfide (H_2S) service. Optional materials are available to meet the challenges of harsh downhole environments.
- American Petroleum Institute (API) and premium standard threads are available in box-by-box or box-by-pin configurations.
- Custom designs with protective rails are available for cable and injection bypass applications.
- SMOR-CI series mandrel configurations are available with a special-clearance OD for installation in smaller-diameter casing, where standard-diameter mandrels may not be practical.
- Injection-line termination lug can be provided with various premium metal-to-metal connections.

CI Series Tubing-Retrievable Mandrels

Weatherford McMurry-Macco® CI series chemical-injection mandrels are equipped with an external lug to receive tubing-retrievable chemical-injection valves and check valves. This series consists of two sub-series: CS-CI and CM-CI.

CS-CI series mandrels are machined from solid bar stock. This design eliminates all welds, providing an extremely strong mandrel for the most demanding environments. In addition, CS-CI mandrel designs are available with external protection for bypass cables and control lines. External guards are machined onto the outside diameter (OD) of the mandrel to protect the chemical-injection line and valve during tubular running and pulling operations.

CM-CI series mandrels are equipped with a welded external lug to receive tubing-retrievable chemical-injection valves and check valves. CM-CI series mandrels are also equipped with welded guards that house the chemical-injection device, protecting it and the injection line from damage during running and pulling operations. CM-CI mandrels offer economical choices for less-demanding downhole-injection applications.

CI series mandrels are available in a variety of sizes and materials and can be custom-designed for service in high-pressure, high-temperature, and highly corrosive environments. Experienced Weatherford engineering and technical support staff can assist in the selection of the proper materials for the application.

Applications

- CI series mandrels are installed as part of the tubing string to allow injection of chemicals into the tubing string by capillary-injection line or casing annulus.
- These mandrels are also used to inject water to inhibit salt formation in the tubing string.
- CI series mandrels can also serve as sensing points for downhole pressure determination.
- CS-CI series mandrels are designed for the most demanding environments.
- CM-CI mandrels offer economical choices for less-demanding applications.

Features, Advantages, and Benefits

- The tubing-retrievable configuration accommodates larger, more robust valve designs, providing maximum functionality and increasing system reliability.

Specifications

CI-SUB Series

Mandrel Model	Model Number	Tubing Size (in.)	Mandrel Lug ID (in., mm)	Mandrel Running OD (in., mm)	Drift ID (in., mm)	Mandrel Length (ft/m)
CI-SUB	5112-XXX	2 3/8	1.00 25.40	4.00 101.60	1.90 48.29	5.00 1.52
CI-SUB	5113-XXX	2 7/8		4.50 114.30	2.35 59.61	4.33 1.32
CI-SUB	5114-XXX	3 1/2		5.29 134.37	2.87 72.82	5.17 1.57
CI-SUB	5116-XXX	4		5.60 142.32	3.22 81.66	
CI-SUB	5118-XXX	5 1/2		7.14 181.36	4.65 118.19	

Dimensions correspond to basic designs. Numerous options are available on request. Contact Weatherford for additional information.

CI Series Tubing-Retrievable Mandrels

Specifications

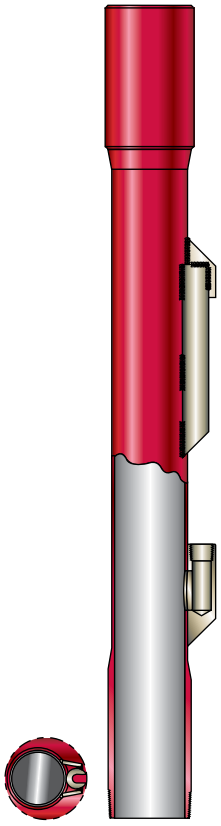
CM-CI series

Mandrel Model	Model Number	Tubing Size (in.)	Mandrel Lug ID (in., mm)	Dimension OD[1,2]	Mandrel OD (in., mm)	Drift ID (in., mm)	Mandrel Length (ft, m)
CM-1CI	471X-XXX	2-3/8	1.00 25.40	A	3.783 96.09	1.901 48.29	4.25 1.30
				B	3.706 94.13		
		2-7/8		A	4.335 110.11	2.347 59.61	
				B	4.231 107.47		
		3-1/2		A	5.063 128.60	2.867 72.82	
				B	4.903 124.54		

A = Mandrel maximum running OD with standard collar
B = Mandrel maximum running OD with special-clearance collar

Options

- Lug thread is available in numerous high-pressure connection designs.
- Dual-injection valve capability is available for increased chemical-injection volume.
- Internal lock profiles can be incorporated for additional functionality.
- Mandrels are available in a variety of alloys to meet stringent operating conditions in corrosive, high-pressure, and high-temperature environments.



CM-1CI
Mandrel

SBRO-CI Series
Side-Pocket Mandrels, Solid-Body

Weatherford premium SBRO-CI series side-pocket mandrels feature a round cross-sectional profile, an integral orienting sleeve, and a unique batwing tool guard for the installation of 1-in. and 1 1/2-in. outside diameter (OD) chemical-injection devices. The mandrels have a pocket and deflector section that is machined from solid-bar stock. This design eliminates all longitudinal welds, providing an extremely strong mandrel for the most demanding environments. Internal profiles, including the batwing tool guard, are designed and tested to provide smooth wireline-tool passage in highly deviated wellbores, ensuring trouble-free operation throughout the life of the well.

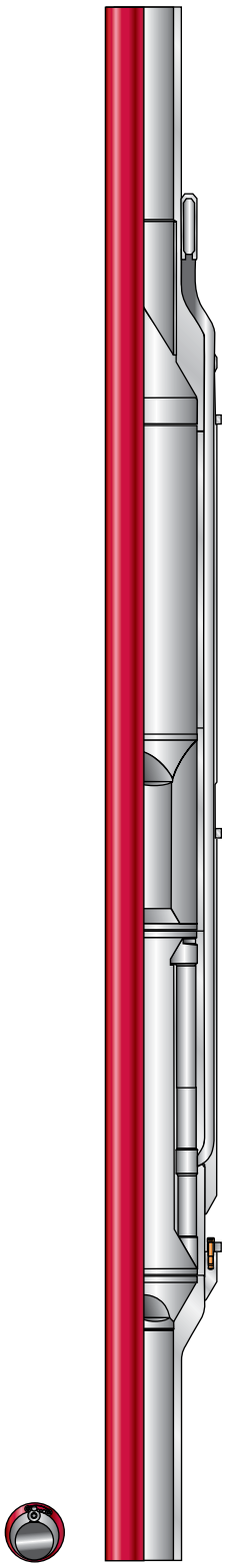
The SBRO-CI series mandrels are ideal for applications in which superior strength and increased pressure capabilities are required. Chemical-injection devices are installed in the side pocket using a kickover tool, which is run into the well using standard wireline techniques. The upper swage section contains an orienting sleeve that aligns the kickover tool with the side pocket for precise installation of chemical-injection devices in straight and deviated wellbores. The special batwing tool guard at the top of the pocket captures and guides the chemical-injection device into the pocket and deflects tools larger than the pulling/running tool back into the tubing bore of the mandrel.

These side-pocket mandrels also feature an integral injection tube attached to the mandrel pocket. The injection tube is connected to the capillary-injection line, which is used to transport chemicals from the surface to the mandrel downhole.

Because of their totally machined design, the SBRO-CI series mandrels are available in a number of configurations and materials.

Applications

- Used as internal receivers for the installation and retrieval of chemical-injection devices, primarily in single-string completions
- Can be installed in deviated and straight wellbores



SBRO-CI Series Side-Pocket Mandrels, Solid-Body

Features, Advantages, and Benefits

- Solid-body design eliminates longitudinal welds, making the SBRO-CI mandrels ideal for applications in which superior strength and increased pressure capabilities are required.
- Side pocket, guard, and swages have smooth and tapered surfaces specifically designed to avoid wireline snags and traps, preventing shielded areas that can inhibit the application of proper protective coating.
- The bat-wing tool-guard profile ensures that chemical-injection devices are guided into the pocket while larger tools are deflected back into the tubing bore of the mandrel, preventing damage to the valve latch.
- Mandrel material is heat-treated to provide the best combination of strength and corrosion resistance for its intended use.
- The slotted orienting sleeve guarantees positive alignment of the kickover tool, ensuring reliable running and pulling of chemical-injection equipment in deviated wellbores.
- The injection lug is tucked under the upper swage, providing added protection of injection-line termination.
- Side-pocket mandrel allows for installation or removal of chemical-injection valve without having to pull tubing, reducing costly workover operations.

Specifications

Dimensions

Mandrel Series Model	Model Number	Tubing Size (in.)	Pocket Size (in., mm)	Body Configuration	Pocket Type	Pocket Latch Configuration	Orienting Sleeve	Running OD (in., mm)	Drift (in., mm)
SBRO-1CI	2752-XXX	2-3/8	1.00 25.40	Round	Solid machined	180°	Yes	4.56 115.82	1.90 48.29
SBRO-1CI	2753-XXX	2-7/8	1.00 25.40	Round				5.28 134.11	2.35 59.61
SBRO-1CI	2754-XXX	3-1/2	1.00 25.40	Round				6.00 152.40	2.87 72.82
SBRO-2CI	2864-XXX		1.50 38.10					6.59 167.39	
SBRO-1CI	2756-XXX	4-1/2	1.00 25.40	Round				7.00 177.80	3.87 98.37
SBRO-2CI	2866-XXX		1.50 38.10					7.69 195.33	3.83 97.36
SBRO-1CI	2758-XXX	5-1/2	1.00 25.40	Round				8.06 204.80	4.65 118.19
SBRO-2CI	2868-XXX		1.50 38.10					8.63 219.20	
SBRO-2CI	2869-XXX	7	1.50 38.10	Round				9.13 231.90	6.06 153.90

Dimensions and pressure ratings will change for custom-designed mandrels with special thread connections, special rails or grooves, and special metallurgy. Pressure ratings can be provided based on specific conditions. Contact Weatherford for further information.

Options

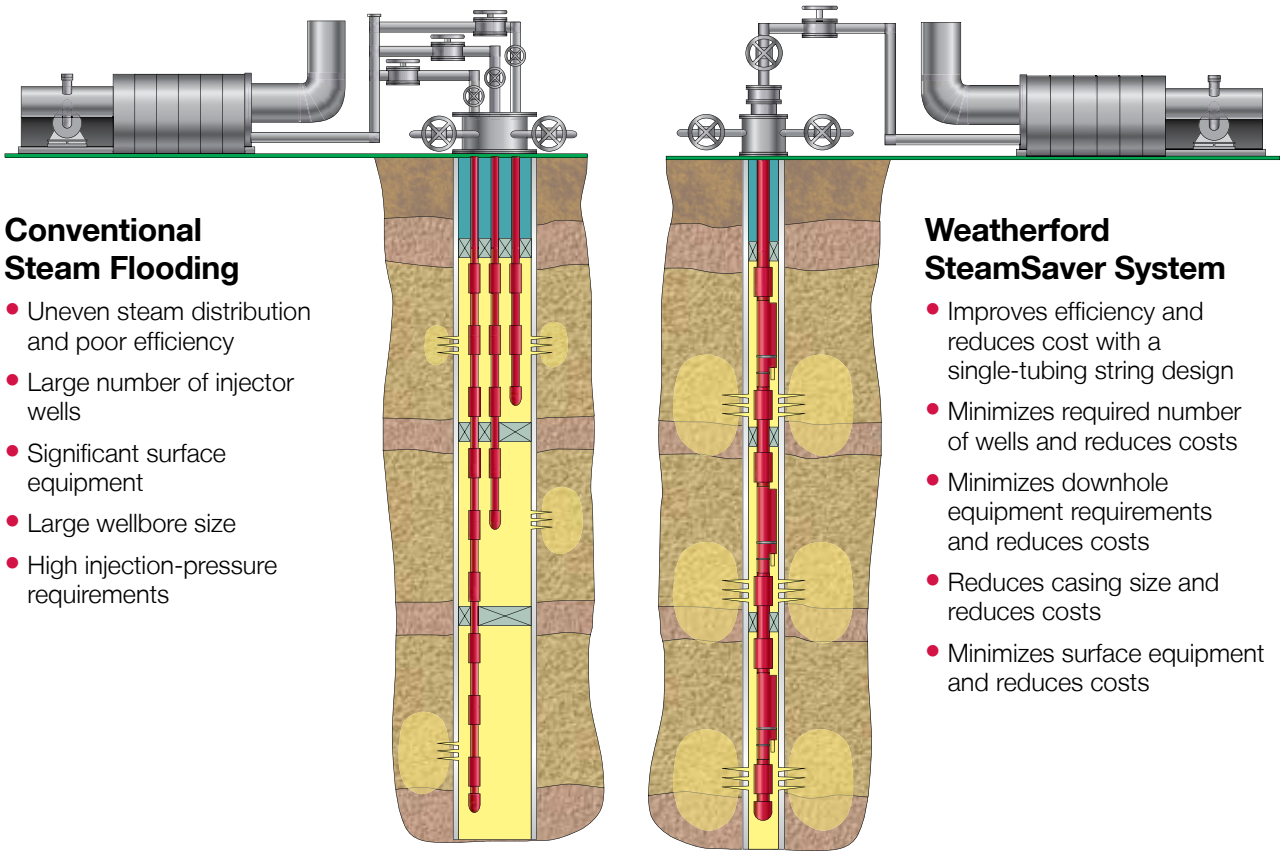
- SBRO-CI series mandrels are available in AISI 4130 alloy material, which can be specially heat-treated for corrosive hydrogen sulfide (H_2S) service. Optional materials are available to meet the challenges of harsh downhole environments.
- American Petroleum Institute (API) and premium standard threads are available in box-by-box or box-by-pin configurations.
- Custom designs with protective rails are available for cable and injection bypass applications.
- SBRO-CI series mandrel configurations are available with a special-clearance OD for installation in smaller-diameter casing where standard-diameter mandrels may not be practical.
- Injection-line termination lug can be provided with various premium metal-to-metal connections.
- Dimensions and pressure ratings will change for custom-designed mandrels with special thread connections, special rails or grooves, and special metallurgy. Pressure ratings can be provided based on specific conditions.

Steam-Injection Equipment

SteamSaver® Injection System

Simplify well completions. Minimize operational costs. Weatherford patented SteamSaver injection system controls steam rate and enhances steam quality by reducing the number of injection wells and the size of the wellbore. This Weatherford innovation can also potentially reduce the equipment requirement and the surface injection-pressure requirement.

The SteamSaver injection system addresses several issues left unresolved with use of traditional steam-flood solutions.



Conventional Steam Flooding

- Uneven steam distribution and poor efficiency
- Large number of injector wells
- Significant surface equipment
- Large wellbore size
- High injection-pressure requirements

Weatherford SteamSaver System

- Improves efficiency and reduces cost with a single-tubing string design
- Minimizes required number of wells and reduces costs
- Minimizes downhole equipment requirements and reduces costs
- Reduces casing size and reduces costs
- Minimizes surface equipment and reduces costs

Features, Advantages, and Benefits

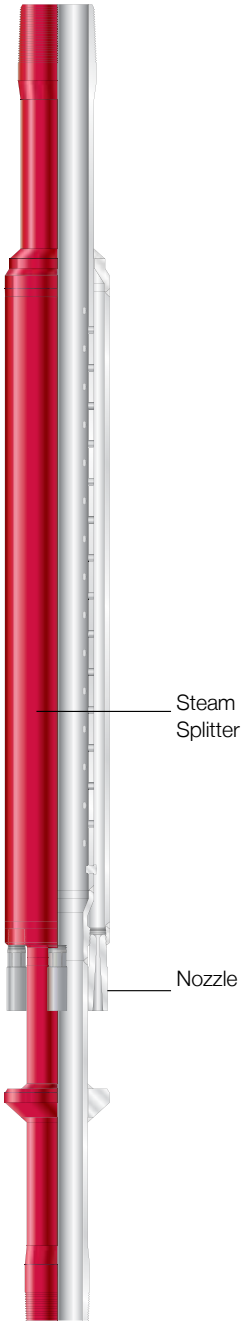
- Constant injection volume into multiple zones improves allocation of steam for greater system efficiency and improved recovery.
- System design reduces the quantity of injector wellbores, minimizing completion equipment costs.
- System design reduces hole-size requirements, which allows smaller casing and minimizes costs.
- In steam-assisted gravity drainage (SAGD) or cyclic steam-injection applications, heat is distributed evenly along horizontal well sections, potentially improving recovery.
- System's potential to minimize required injection pressure at surface can reduce steam-generation costs.

Steam-Injection Equipment

System Components

Steam injection mandrels

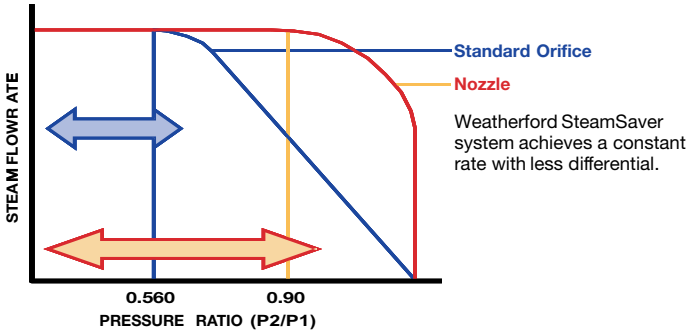
Consist of mandrel, pressure-recovery nozzle, and steam-splitter sleeve.



Surface monitoring equipment

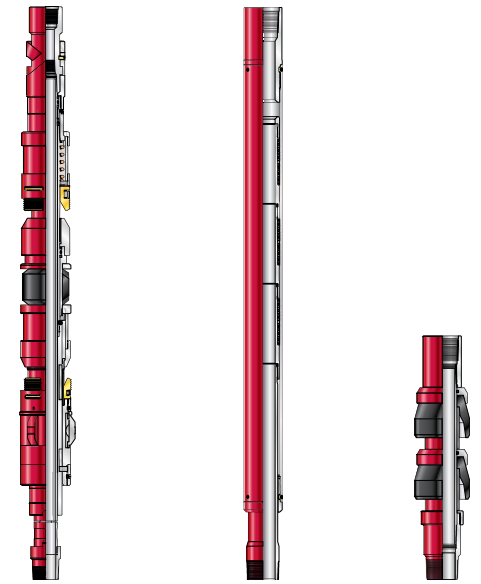
Records injection pressure, injection rate, and steam quality.

SteamSaver Injection System Performance



Isolation packers

Thermal packers with integral expansion joint or thermal-cup packers with separate expansion joints; located between injection zones.



Thermal Packer

Expansion Joint

Cup Packer

Waterflood-Injection Systems

Achieve an even, efficient sweep with Weatherford waterflood-injection systems. Versatile Weatherford systems of regulator valves and side-pocket mandrels provide the injection rates and reliable operation operators need to effectively manage waterflood-injection performance. In high-injection-rate applications, clients can rely on Weatherford unique dual systems for maximum rates with minimal casing wear. In lower-rate applications, standardized system components are interchangeable with other products for operational convenience and increased dependability.

Worldwide, Weatherford waterflood-injection systems serve single-zone and multiple-zone applications in a range of tubing sizes from 2-3/8 to 4-1/2 in. In the various field locations, multiple-zone completions have numbered into the hundreds or thousands, with single-well injection rates up to 25,000 bwpd. Many of these installations have benefited from Weatherford expertise and technology for almost a decade.

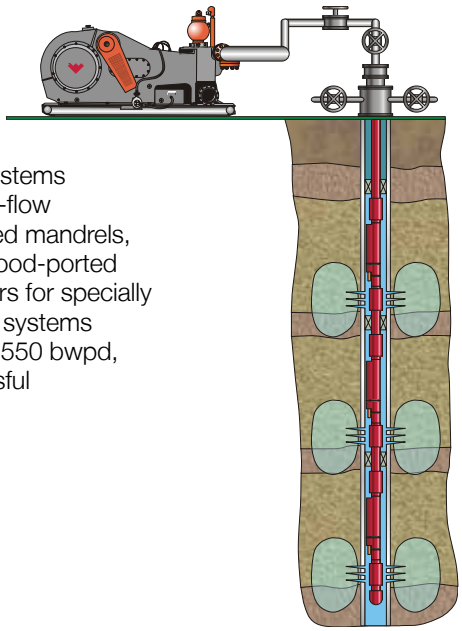
Features, Advantages, and Benefits

Simple, reliable, and cost-effective, Weatherford waterflood systems significantly reduce operational complexity and expense by

- reducing the number of injector wells and tubing strings and the wellbore diameter;
- minimizing surface and completion equipment;
- stabilizing surface injection pressure;
- maintaining flow-rate at the injection zone.

Simple Design, Maximum Dependability

Weatherford waterflood-injection systems are based on a full range of reverse-flow regulators for standard tubing-ported mandrels, standard-flow regulators for waterflood-ported mandrels, and unique dual regulators for specially ported waterflood mandrels. These systems provide injection rates from 60 to 5,550 bwpd, providing all the options for successful waterflood management.



Regulators and Valves

Dual and Standard Regulators

RWF series 1- and 1 1/2-in. outside diameter (OD) regulator valves provide an efficient method of regulating water volumes injected down a single tubing string into multiple packer-isolated zones.

Standard RWF series regulators provide injection rates from 60 to 2,700 bwpd. The regulator, latch, and mandrel components of these systems are interchangeable with most major brands.

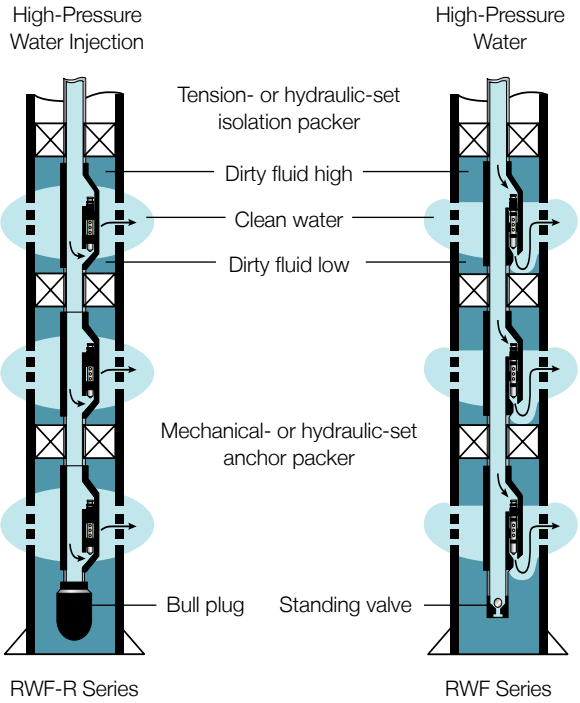
RWF-R series 1- and 1 1/2-in. OD reverse-flow regulator valves are used in standard tubing-ported mandrels. These regulators provide injection rates from 60 to 1,000 bwpd.

Specialized Waterflood Valves

For some applications, RO-WF series orifice valves are used to control water volumes injected into individual zones. This typically occurs on the initial injection startup or when injection rates exceed the maximum rates of regulator valves. The injection rate is dependent on port size and varies with the pressure differential.

ED series equalizing dummy valves are installed with the well completion as a means of testing and setting isolation packers.

ED-WFD series equalizing dummy valves and RO-2WFD series orifice valves are used with SBRO-2WFD special dual-ported waterflood mandrels.



Typical well schematics showing the flow direction or injection direction as water travels through the RWF-R and RWF series regulators.

Waterflood-Injection Systems

Brazilian Waterflood Project

Job site in Brazil prepares for waterflood operations.

Waterflood valve inspected and prepared for assembly.

Night installation of Weatherford waterflood injection system.

Waterflood Services

Weatherford has extensive global experience in waterflood operations. In addition to waterflood-injection systems, we provide isolation packers and surface equipment for monitoring and controlling injection pressure, injection rate, and temperature.

The combination of computer analysis, quality products, global distribution, and experienced personnel brings our clients answers to the most difficult waterflood challenges without the added expense of multiple suppliers, multiple billing, and multiple crews on-site.

Waterflood Services

Region/ Location	Well Completion Type or Application	Number of Injection Wells	Total Service Time (years)	Fluid Rates (BWPD)	Number of Mandrels per Well
Argentina	Multizone water injection	400+	10+	300 to 1,000	5 to 15
Colombia	Multizone water injection	250+	4	200 to 1,200	7 to 12
USA	Multizone water injection	10+	10	500 to 1,000	2, 3
	Single-zone water injection	40+		2,000 to 8,000	1, 2, 3
		25+	5	1,000 to 5,000	1, 2
West Africa/ Angola	Multizone water injection	75+	7	8,000 to 25,000	3, 4

PB Wireline-Retrievable Safety Valves

Wireline-Retrievable, Subsurface-Controlled, Subsurface Safety Valves Models PB and HP-PB

Weatherford Model PB and Model HP-PB safety valves are wireline-retrievable, poppet-type, subsurface-controlled subsurface safety valves, available in 3,000-psi (20.6-MPa) and 10,000-psi (68.9-MPa) set-pressure variants. Each valve model is tubing-pressure sensitive and can be adjusted to close at a preset tubing pressure. Weatherford subsurface-controlled, gas-lift valve technology has been applied to create a nitrogen dome-charged, bellows-operated safety valve that can be adjusted to close at a predetermined tubing pressure between 50 psi (0.344 MPa) and 10,000 psi (68.9 MPa).

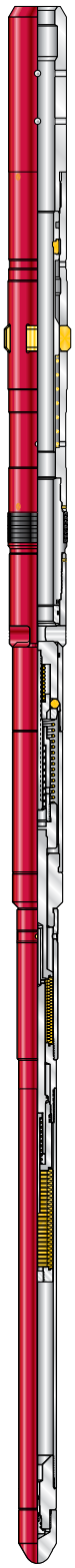
Each valve model is normally open and will remain in this position in the well to allow production to flow to the surface. If well control is compromised, the tubing pressure will fall to a predetermined pressure where the valve is set to close. Following closure, each model is designed to automatically recock and reopen as soon as equalization is achieved, either by pressuring the tubing string or by deploying a wireline-equalizing prong. The safety valve i s then automatically returned to the open position. Each valve model has no setting depth limitation and can be installed in any existing seating nipple or, by using the PB packer, set in tubing strings with damaged or no pre-existing nipple profiles.

These valve models are particularly suited for installation in tubing-retrievable safety valves that have suffered control-line failure, offering the advantage that communication is not required.

The Model PB valve has an operating range of 50 to 3,000 psi (0.344 to 20.6 MPa); the Model HP-PB valve has an operating range of 100 to 10,000 psi (0.689 to 68.9 MPa). The standard safety-valve lock for the Model PB and Model HP-PB safety valves is the Optimax™ OQXSV lock, which is a large-bore version of the Petroline® QX lock. This ambient-pressure safety valve, however, can be configured to accept any manufacturer's lock.

Applications

- Fluid and gas environments
- Production and injection situations where a barrier is needed to flow
- Situations in which the tubing-retrievable safety valve has failed



Wireline-Retrievable, Subsurface-Controlled, Subsurface Safety Valves Models PB and HP-PB

Features, Advantages, and Benefits

- Design, material manufacturing, assembly, and test-documentation retention are in accordance with American Petroleum Institute (API) Q1 and API 14A quality programs and are certified to OCS/API specifications, ensuring integrity to industry standards.
- Several features of the Model PB and Model HP-PB safety valves maximize reliability, safety, and repeatable performance:
  - These valves are wireline-installed and retrieved.
  - Each model offers a large flow area with no flow through the internal working parts of the safety valve.
  - Because closing force is transmitted through the liquid-filled bellows, there are no hydraulic seals.
  - The operating bellows-protection unit is self-contained.
  - The valve's snap-action closure avoids valve disc throttling in the flow stream.
  - With the appropriate test stand, the safety valve can be field-tested and reset.
  - These safety valves can be retrofitted in wells with no existing hydraulic-control line or emergency shutdown (ESD) system. Because each valve model is subsurface-controlled, there is no practical setting-depth limitation.
  - Each valve model can be adapted to any manufacturer's lock or tubing plug.
  - Reopening the valve is accomplished in-situ, either by applying pressure down the tubing string or with an equidapter sub fitted by a wireline-deployed equalizing probe.

Real Result

Subsurface safety valve comes to the rescue

Because a well located in the inland waters of Louisiana, USA, was equipped with a safety valve, a major spill and the associated environmental and economic consequences were prevented when a barge hit the well. This catastrophe was prevented because the operator decided to install Weatherford model PB subsurface-controlled, subsurface safety valves on all flowing wells in the field.

Weatherford modeled each well with nodal analysis to ensure the optimal emergency shut-in setting and installed 15 of the valves in 1 month, with minimal downtime. The quick Weatherford response provided the operator with protection against spills caused by accidents and storms, avoiding costly environmental damage and production losses.

PB Wireline-Retrievable Safety Valves

Specifications

WL Retrievable SSCSV Models
PB Technical Data
Operating range 50 to 3,000 psi

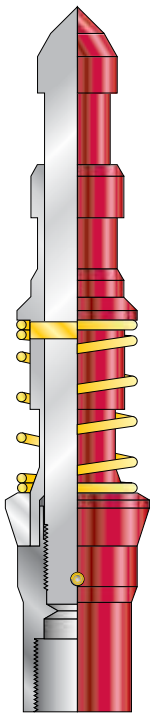
Tubing Nominal OD (in., mm)	Maximum Valve OD (in., mm)	Minimum Nipple Required (in., mm)	Minimum Tubing ID Around Valve (in., mm)	Seat ID (in., mm)	Minimum Flow Area (in., mm)	Part Number
2.375 60.33	1.750 44.45	1.875 47.63	1.845 46.86	0.875 22.23	0.601 15.27	281005
2.875 73.03	2.250 57.15	2.312 58.73	2.358 59.90	1.250 31.75	1.227 31.17	281010
3.500 88.90	2.500 63.50	2.750 69.85	2.878 73.10	1.625 41.28	2.074 52.68	281015
4.500 114.30	3.000 76.20	3.812 96.83	3.606 91.59	2.000 50.80	3.141 79.78	281020
5.000 127.00	3.718 94.44	4.125 104.78	4.480 113.80	2.500 63.50	4.908 124.67	281025

HP-PB Technical Data*
Operating range 100 to 10,000 psi

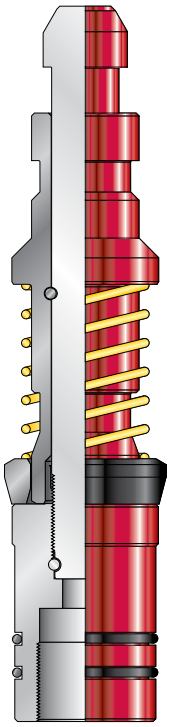
Tubing Nominal OD (in., mm)	Maximum Valve OD (in., mm)	Minimum Nipple Required (in., mm)	Minimum Tubing ID Around Valve (in., mm)	Seat ID (in., mm)	Minimum Flow Area (in., mm)	Part Number
2.063 52.40	1.406 35.71	1.625 41.28	1.454 36.93	0.625 15.88	0.307 7.80	77540
2.375 60.33	1.625 41.28	1.710 43.43	1.845 46.86	0.875 22.23	0.601 15.27	281056
2.875 73.03	2.135 54.23	2.188 55.58	2.358 59.90	1.250 31.75	1.227 31.17	281061
3.500 88.90	2.500 63.50	2.562 65.08	2.878 73.10	1.625 41.28	2.074 52.68	281065

* Contact Weatherford for availability.

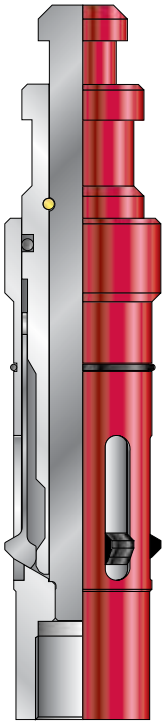
Latches



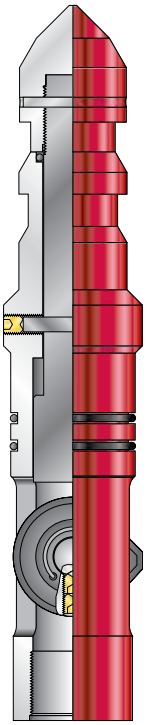
BK-2 Latch



RKP Latch



MT-2 Latch



RA Latch

Wireline-Retrievable Latches for Side-Pocket Mandrels: BK, BEK, RK, RKP, RA, MT, and RM Series

Weatherford offers a variety of wireline-retrievable latches for locking gas-lift, chemical-injection, and other special-application devices into the appropriate side-pocket mandrel. To retrieve the latch and attached valve, the operator jars the tool string upward, shearing the release shear pin and disengaging the locking mechanism from the latch-lug pocket profile. The Weatherford line of wireline-retrievable latches includes the BK-2, BEK-2, RK, RKP, RA, MT-2, and RM models. A ported inside diameter (ID) is included in certain models for applications that require a communication path between the latch and an attached flow-controlled device, such as a circulating valve.

The BK-2 and BEK-2 latches feature a spring-loaded, ring-style locking mechanism. These valves are used to secure a 1-in. outside diameter (OD) valve or dummy valve in a side-pocket mandrel with a 1-in. ID pocket. The two models are similar, but the BEK-2 model has a 0.375-in. ported ID. Both models are compatible with Weatherford McMurry-Macco® series SM-1, SMO-1, SFO-1, SIFO-1, SBRO-1, and SMOR-1 side-pocket mandrels equipped with a 180° latch-lug profile.

The RK and RKP latches also have a spring-loaded, ring-style locking mechanism and are used to secure a 1 1/2-in. OD valve or dummy valve in a side-pocket mandrel with a 1 1/2-in. ID pocket. The two models are similar, but the RKP model has a 0.453-in. ported ID. Both models are compatible with McMurry-Macco series SFO-2, SMOR-2, and SBRO-2 side-pocket mandrels equipped with a 180° latch-lug profile.

The RA latch is used to secure a 1 1/2-in. OD valve or dummy valve in a side-pocket mandrel with a 1 1/2-in. ID pocket. The RA latch has a spring-loaded rotating-cam lock and an O-ring-style debris barrier. This latch is compatible with McMurry-Macco series SM-2, SMR-2, SBRO-2RA, SMOR-2RA, and SMO-2RA side-pocket mandrels equipped with a 360° latch-lug profile.

The MT-2 and RM latches offer additional holding ability with a collet-type and dog-type locking mechanism, respectively. These latches are used to secure a 1 1/2-in. OD valve or dummy valve in a side-pocket mandrel with a 1 1/2-in. ID pocket and a 360° latch-lug profile.

Features, Advantages, and Benefits

- Wireline-retrievable latch design allows valves to be pulled and serviced or replaced without pulling the tubing, reducing maintenance and repair costs.
- A ported ID is included in certain models to allow flow through the latch to an attached flow-controlled device.
- Most 1 1/2-in. OD latch models include two O-rings that provide a barrier against fine sands and debris, protecting the latch from becoming stuck and hindering retrieval.

Specifications

Valve Pocket ID (in., mm)	Latch Pocket Profile	Latch Model	Assembly Number	Latch Mechanism	Ported ID (in., mm)	Pulling Neck OD (in., mm)	Running Neck OD (in., mm)	Running Tool	Pulling Tool
1.0 25.4	180°	BK-2	0901-XXX	Lock-ring	N/A	0.875 22.23	0.750 19.05	JK	1 1/4-in. JDC
		BEK-2	0902-XXX		0.313 7.95				
1.5 38.1	180°	RK	1002-XXX	Lock-ring	N/A	1.185 30.10	0.937 23.80	RK-1	1 5/8-in. JDS
		RKP	1003-XXX		0.453 11.51				
1.5 38.1	360°	MT-2	1005-XXX	Collet	N/A	1.367 34.72	1.000 25.40	TER	2-in. JDC
		RM-2	1007-XXX	Dog			1.340 34.04	JC-3	
		RA	1001-XXX	Cam			1.359 34.52		

N/A = not applicable

Options

- Models are available in standard 316 SS and optional special corrosion-resistant and/or erosion-resistant materials for durability and extended service life.
- Latches are available with special coatings to prevent scale buildup and enhance erosion resistance.

Real Result

Gas-lift system problems eliminated, revenues increase

An operator wanted to return a 100-percent oil cut, high-productivity well in the Gulf of Mexico to production. The well was gas-lifting from several valves, and its severe deviation hindered solving the problem using standard slickline and gas-lift tools.

Weatherford used a wireline-retrievable BK-MSD shear-down latch to lock the gas-lift valve into the mandrel pocket, higher than before. The production increase provided the operator with $8.76 million per year in additional revenue.

KOT Series Wireline Kickover Tools

Weatherford McMurry-Macco® KOT series kickover tools are used to install and retrieve flow-control devices in side-pocket mandrels that have an integral orienting sleeve. KOT series tools are run into the well using standard wireline techniques. The orienting sleeve aligns the kickover tool above the side pocket, enabling precise installation or retrieval of flow-control devices for gas-lift, chemical-injection, and waterflood applications.

KOT series tools are also used to install or retrieve dummy valves, corrosion-monitoring coupon carriers, and other devices.

KOT series tools do not require pinning between runs during running and pulling procedures. When the tool is retrieved through the top of the side-pocket mandrel, the arm assembly is pushed back into position. This quick-recock feature greatly reduces wireline time by eliminating the need to remove the tool from the tool string for disassembly and repinning and also allows the operator several attempts to either set or retrieve a control device without pulling out of the well.

Applications

- **KOT** series kickover tools are used for precise installation of flow devices for gas-lift, chemical-injection, waterflood, corrosion-monitoring, and other applications.
- **KOT-1** tools are used to install 1-in. outside diameter (OD) devices in 2 3/8-, 2 7/8-, 3 1/2-, and 4 1/2-in. tubing.
- **KOT-2** tools are used to install 1 1/2-in. OD devices in 3 1/2-, 4 1/2-, 5 1/2-, and 7-in. tubing. (An 11 1/4-in. spacer bar is required for pulling operations.)

Features, Advantages, and Benefits

- The quick-recock design expedites valve installation and allows several attempts to remove or install the valve without having to pull out of the well.
- Most KOT series tools can be adapted to accommodate a larger tubing size, saving the cost of additional tools and related parts.

Specifications

Model	Valve OD (in., mm)	Assembly Number	Tubing OD (in.)
KOT-1	1.0 25.4	7012-XXX	2-3/8
			2 7/8
		7014-XXX	3 1/2
			4 1/2
KOT-2	1.5 38.1	7024-XXX	3-1/2
			4 1/2
		7028-XXX	5-1/2
		7029-XXX	7

Note: Kickover tools are available for special tubing weights and heavy profile nipples.

Options

- A valve catcher is available with the tools to catch a valve dropped during running and pulling procedures.

SV Series
Wireline-Retrievable Standing Valves

Weatherford McMurry-Macco® SV series standing valves act as check valves to prevent the migration of fluid in tubing back into the formation during intermittent gas-lift or plunger-lift operations. SV series valves serve as a pressure interface between production or load fluids and the formation.

SV-WE valves allow the operator to equalize the production and formation pressure before pulling. The operator latches the valve fishing neck with an SBO-JDC pulling tool and pulls upward. The resulting tension shears a pin and exposes ports, allowing the pressure to equalize. After the pressure has equalized, the standing valve can be easily removed with standard wireline techniques. The valve is installed using a C-1 running tool.

SV-WF valves are non equalizing standing valves designed to hold pressure from above while allowing fluids to flow from beneath the valve. These valves are equipped with three packing cups, a fishing neck, and a full-flow port. SV-WF valves also feature a replaceable hardened and ground-lapped ball and seat.

Applications

- SV series standing valves are used to maintain fluid in the tubing string during testing of the tubing string, setting of packers, or performance of other operations.
- These valves are also used in intermittent gas-lift and plunger-lift applications to prevent formation backflow during the lift cycle.

Features, Advantages, and Benefits

- SV-WE valves are equipped with built-in production-pressure and formation-pressure equalization capability for easy removal using standard wireline techniques.
- The large flow bypass of all SV series standing valves minimizes the restriction of fluid flow.

Specifications

SV-WE Standing Valve

Assembly Number	Size (in., mm)	Flow Area (in.², mm²)	Bypass Area (in.², mm²)	Pressure (psi, bar)	Maximum OD (in., mm)
6624-XXX	2-3/8 60.33	0.885 570.97	0.196 126.45	3.500 241	1.800 45.72
6625-XXX	2-7/8 73.03	1.485 958.06			2.300 58.42

SV-WF Standing Valve

Assembly Number	Size (in., mm)	Fishing Neck Size (in., mm)
6611-XXX	1-1/4 31.75	7/8 22.23
6612-XXX	1-1/2 38.10	1-3/16 30.16
6614-XXX	2-3/8 60.33	1-3/8 34.93
6615-XXX	2-7/8 73.03	1-3/8 34.93

SV-WF Seating Nipple

Assembly Number	Size (in., mm)	ID (in., mm)
99120021	1-1/4 31.75	1.063 27.00
99120031	1-1/2 38.10	1.375 34.93
99120051	2-3/8 60.33	1.781 45.24
99120061	2-7/8 73.03	2.250 57.15

Options

- AISI 4130 alloy material is standard but can be specifically heat-treated for hydrogen sulfide (H_2S) service. Other materials are also available for corrosive environments. Contact Weatherford for more information.

MP-1 Series Standing Valve

Weatherford McMurry-Macco® MP-1 pump-through standing valve combines the downhole check capabilities of a traditional standing valve with the ability to backflow through the valve when necessary. This capability is ideal for performing downhole treatments such as hot oiling without having to pull the standing valve.

To backflow through the MP-1 valve, the tubing pressure is raised to a predetermined set pressure that is higher than the static pressure. The standing-valve set pressure is adjustable up to 3,500 psi (241.3 bar). When the set pressure is reached, fluid passes around the ball and seat and flows out of the bottom of the valve.

With the use of a lock adapter, the MP-1 valve can be run with a variety of locks. Valve materials are compatible with downhole conditions.

Applications

- The MP-1 standing valve is used to prevent fluid backflow during intermittent gas-lift operations.
- The valve can also be used as a traditional check valve or to facilitate downhole treatment operations such as hot oiling.

Features, Advantages, and Benefits

- Pump-through capability enables backflow operations such as hot oiling through the valve, eliminating the need to pull the standing valve before treating the well.
- The range of available lock adaptors allows running the valve on a variety of wireline locks.
- Availability in a variety of material specifications ensures reliable operation in most well conditions.

Specifications

Assembly Number	Size (in., mm)	Flow Area (in.², mm²)	Bypass Area (in.², mm²)	Pressure Range (psi, bar)	Maximum OD (in., mm)
6634-XXX	2-3/8 60.33	0.306 197.42	0.196 126.45	0 to 3,500 0 to 241	1.740 44.20
6635-XXX	2-7/8 73.03	0.785 506.45			2.120 53.85
6636-XXX	3-1/2 88.90	0.767 494.84			2.730 69.34

Options

- The MP-1 standing valve is available in a variety of materials. Contact Weatherford for more information.

BDK® Series Pulling Tool

Weatherford BDK pulling tool is designed for running and retrieving downhole flow-control devices with external fishing necks.

With the pulling tool in the latched position, the dogs are supported within the skirt of the tool. This feature allows sustained jarring without the risk of shearing the dogs. For surface-release operation, the dog assembly has a finger-grip to enable manual release of the tool from the retrieved fishing neck without the need to shear the tool.

The tool can be converted from a shear-up tool to a shear tool simply by changing the top sub. In addition, a range of cores is available to alter the reach of the tool.

Applications

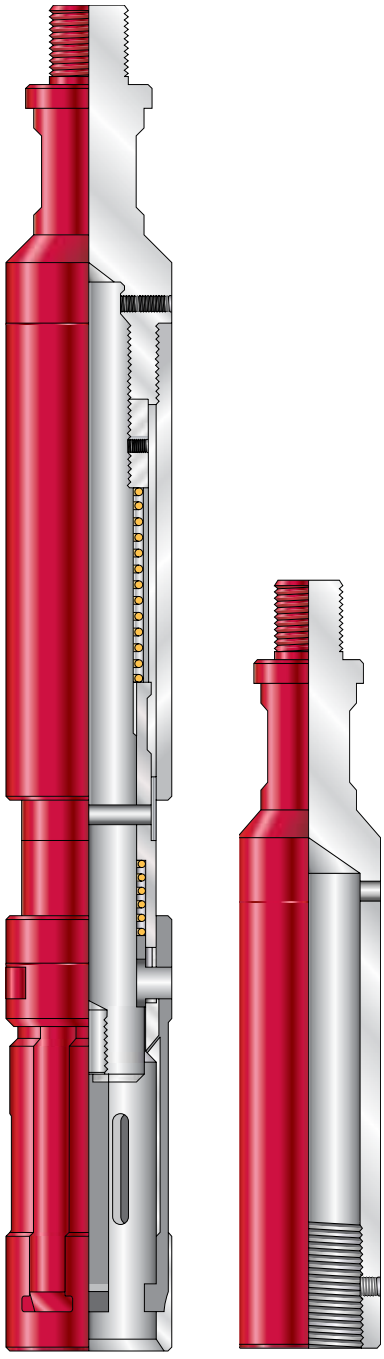
- All wireline operations

Features

- Interchangeable top sub to convert from jar up to jar down
- Range of core lengths
- Supported dog design
- Simple manual release mechanism
- Repinning tool available

Benefits

- Cost-effective design minimizes inventory requirement



Shear-Up Assembly

Shear-Down Sub

BDK® Series Pulling Tool

Specifications

Dimensions

Nominal Size (in.)	Maximum OD (in., mm)	To Engage Fishing Neck OD (in., mm)	Weight (lb, kg)	Makeup Length		Bearing Load	
				Shear Up (in., mm)	Shear Down (in., mm)	Standard (lb, kg)	H_2S (lb, kg)
1.187	1.290 32.77	0.875 22.22	4.2 1.9	11.97 304.04	12.87 326.90	7,606 3450	7,260 3293
1.250	1.450 36.83	1.000 25.40	5.7 2.6	14.46 367.28	14.91 378.71	8,963 4066	8,963 4066
1.500	1.687 42.85	1.187 30.15	7.9 3.6	16.40 416.56	16.87 428.50	21,673 9831	20,688 9384
2.000	1.875 47.63	1.375 34.92	12.1 5.5	16.41 416.81	16.87 428.50	23,230 10 537	22,171 10 057
2.500	2.235 56.77	1.750 44.45	18.1 8.2	16.80 426.72	17.37 441.20	31,632 14 348	30,194 13 696
3.000	2.800 71.12	2.312 58.72	26.5 12.0	17.14 435.36	17.88 454.15	29,930 13 576	28,570 12 959
4.000	3.612 91.74	3.125 79.38	33.1 15.0	18.60 472.44	19.33 490.98	60,830 27 592	58,065 26 338

Sucker Rod Assembly Part Numbers

Nominal Size (in.)	Assembly Number				Top Connection Detail
	Short Reach	Medium Reach	Long Reach	Extra-Long Reach	
1.187	10302-A2				15/16 10
1.250	8784-S-A2	8784-M-A2			
1.500	8784-S-A2	4794-M-A2	4794-L-A2		
2.000	5951-S-A3	5950-M-A3	5950-L-A3	5950-E-A3	1-1/16 10
2.500	5985-S-A4	5985-M-A4	5985-L-A4	5985-E-A4	
3.000	5964-S-A6	5964-M-A6	5964-L-A6	5964-E-A6	1-9/16 10
4.000	4747-S-A6	4747-M-A6	4747-L-A6	4747-E-A6	

Heavy-Duty QRJ Assembly Part Numbers

Nominal Size (in.)	Assembly Number				Top Connection Detail
	Short Reach	Medium Reach	Long Reach	Extra-Long Reach	
2.000	5951-S-C3	5950-M-C3	5950-L-C3	5950-E-C3	1-1/2 HDQRJ
2.500	5985-S-C4	5985-M-C4	5985-L-C4	5985-E-C4	1-7/8 HDQRJ
3.000	5964-S-C6	5964-M-C6	5964-L-C6	5964-E-C6	2-1/2 HDQRJ
4.000	4747-S-C6	4747-M-C6	4747-L-C6	4747-E-C6	

Specifications

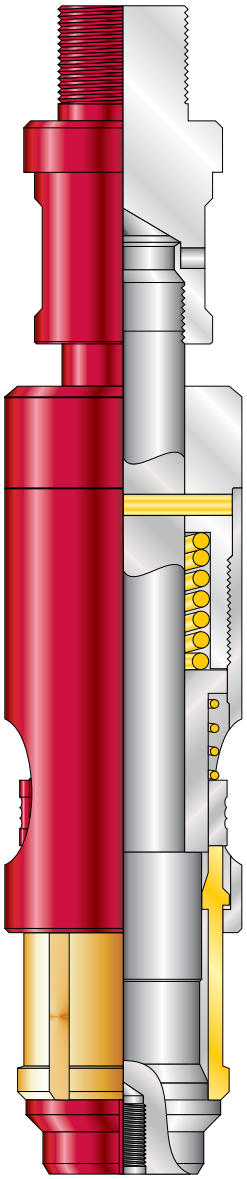
QLS Assembly Part Numbers

Nominal Size (in.)	Assembly Number				Top Connection Detail
	Short Reach	Medium Reach	Long Reach	Extra-Long Reach	
1.187	10302-Q2*				1-1/4 QLS
1.250	8784-S-Q2*	8784-M-Q2*			
1.500	4794-S-Q2*	4794-M-Q2*	4794-L-Q2*		
2.000	5951-S-Q3*	5950-M-Q3*	5950-L-Q3*	5950-E-A3*	1-1/2 QLS
2.500	5985-S-Q4*	5985-M-Q4*	5985-L-Q4*	5985-E-Q4*	1-7/8 QLS
3.000	5964-S-Q6*	5964-M-Q6*	5964-L-Q6*	5964-E-Q6*	2-1/2 QLS
4.000	4747-S-Q6*	4747-M-Q6*	4747-L-Q6*	4747-E-Q6*	

Core Details

Nominal Size (in.)	Assembly Number	Part Number			
		Short Reach** (in., mm)	Medium Reach** (in., mm)	Long Reach** (in., mm)	Extra-Long Reach** (in., mm)
1.187	10302	12256 0.90/22.86	N/A	10304	N/A
1.250	8784	8795-S 0.70/17.78	8795-M 1.50/38.10	N/A	N/A
1.500	4794	4786-S 0.90/22.86	4786-M 1.51/38.35	4786-L 2.51/63.75	N/A
2.000	5951	5943-S 1.34/34.04	5943-M 1.77/44.96	5943-L 2.77/70.36	5943-E 2.84/72.14
2.500	5985	5977-S 1.27/32.26	5977-M 1.52/38.61	5977-L 2.52/64.01	5977-E 2.87/72.90
3.000	5964	5956-S 1.52/38.61	5956-M 1.47/37.34	5956-L 2.78/70.61	5956-E 3.00/76.20
4.000	4747	4735-S 1.65/41.91	4735-M 1.83/46.48	N/A	N/A

* Item not released for manufacture. Contact Weatherford for information.
** Actual reach
Trinity and QRJ connections available on request.
Hydrogen sulfide (H_2S) service tools available on request.



GS-Type Running/Pulling Tool

Weatherford GS type running/pulling tool is designed to locate in standard, internal fishing necks. A set-down weight is required for automatic engagement. To release the tool, downward jarring activates the release mechanism by shearing a pin. If required, the GS type running/pulling tool can be converted to a jar-up release by fitting the Weatherford GR adaptor. For surface operation, the dog assembly has a finger-grip to enable the tool to be manually released from the fishing neck while in the pinned position.

Specifications

Nominal Size (in.)	Part Number		Tool OD (in., mm)	Fishing Neck Size (in., mm)	Upper Connection	Probe Thread
	JDE	Legacy				
1.250	177981	P46.125.00	1.160 29.46	1.000 25.40	0.94-in. -10 UNS-2A	0.38-in. -16 UNC-2B
1.500	272422	P46.150.00	1.480 37.59	1.187 30.15	0.94-in. -10 UNS-2A	0.50-in. -13 UNC-2B
2.000	272656	P46.200.00	1.850 46.99	1.375 34.92	0.94-in. -10 UNS-2A	0.50-in. -13 UNC-2B
2.160	273045	P46.216.00	2.161 54.89	1.750 44.45	0.94-in. -10 UNS-2A	0.63-in. -11 UNC-2B
2.500	176288	P46.250.00	2.250 57.15	1.750 44.45	0.94-in. -10 UNS-2A	0.63-in. -11 UNC-2B
3.000	126461	P46.300.00	2.720 69.09	2.313 58.75	1.06-in. -10 UNS-2A	0.63-in. -11 UNC-2B
3.310	276612	P46.313.00	3.110 78.99	2.313 58.75	1.06-in. -10 UNS-2A	1.38-in. -12 UNC-2B
4.000	275282	P46.400.00	3.615 91.82	2.313 58.75	1.06-in. -10 UNS-2A	2.13-in. -12 UN-2B
5.000	131099	P46.500.00	4.590 116.59	3.125 79.38	1.06-in. -10 UNS-2A	2.13-in. -12 UN-2B
6.000	TBA	P46.600.00	5.550 140.97	3.125 79.38	1.06-in. -10 UNS-2A	2.13-in. -12 UN-2B

JD Series Pulling Tools

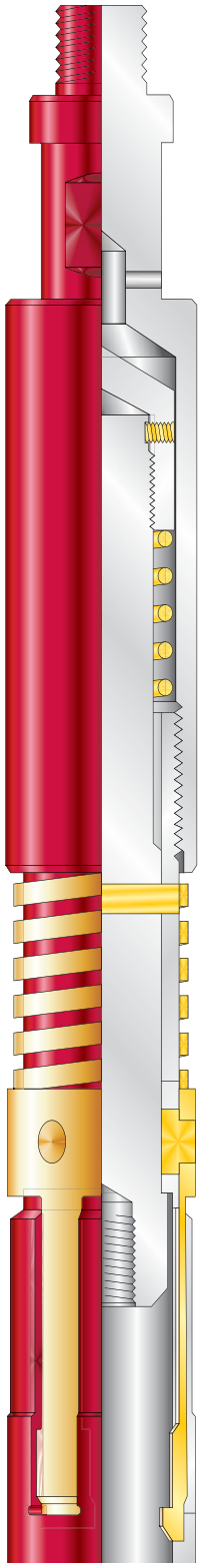
Weatherford JD series pulling tools are wireline-service tools designed to remove from a well retrievable subsurface devices with outside fishing necks. These tools are available with three different core lengths, which enable the tools to retrieve subsurface devices with fishing necks of different lengths of reach.

The JD series pulling tools use the D sub, which is made up to the core of the tool. The dogs, which are mounted on the skirt, are inserted into the vertical openings in the skirt. The dogs are spring-loaded and have pawls located in the windows on the skirt. The pulling tool can be released in the event that the subsurface device cannot be freed by continuous downward jarring.

Three types of JD series tools are used and differ only by their core length, which is selected according to the reach required:

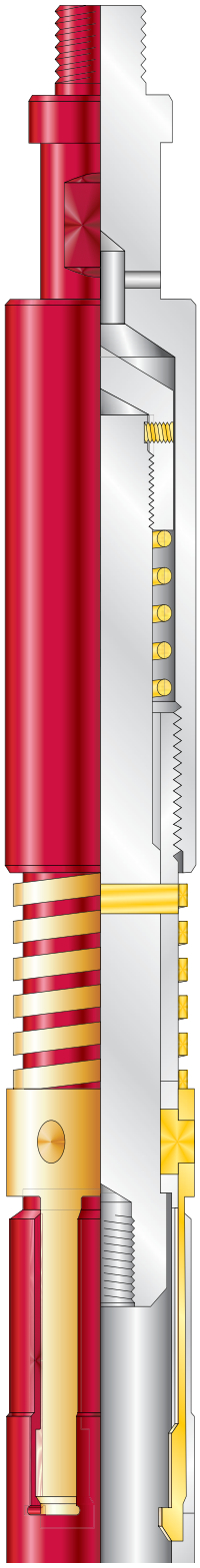
- JDC long core/short reach
- JDS intermediate core/intermediate reach
- JDL short core/long reach

All other parts of each tool are identical and entirely interchangeable.



Specifications

Nominal Size (in.)	Assembly Numbers			Upper Connection (in.)	Maximum OD	To Pull Fishing Neck OD	Prong Connection
	JDC	JDS	JDL				
1-1/4	P54.125.00	P54.125.01	P54.125.02	15/16–10	1.291	0.875	1/4–20
1-3/8	P54.137.00	P54.137.01	P54.137.02	15/16–10	1.375	1.000	N/A
1-1/2	P54.150.00	P54.150.01	P54.150.02	15/16–10	1.422	1.187	1/2–13
1-5/8	P54.162.00	P54.162.01	P54.162.02	15/16–10	1.625	1.187	1/2–13
2	P54.200.00	P54.200.01	P54.200.02	15/16–10	1.859	1.375	1/2–13
2-1/2	P54.250.00	P54.250.01	P54.250.02	15/16–10	2.250	1.750	1/2–13
3	P54.300.00	P54.300.01	P54.300.02	15/16–10	2.812	2.312	5/8–11
4	P54.400.00	P54.400.01	P54.400.02	1-1/16–10	3.750	3.125	1-1/4–12



JU Series Pulling Tools

Weatherford JU series pulling tools are wireline-service tools designed to remove from a well retrievable subsurface devices with outside fishing necks. These tools are available with three different core lengths, which enable the tools to retrieve subsurface devices with fishing necks of different lengths of reach.

The JU series pulling tools use the U sub, which is made up to the core of the tool. The dogs, which are mounted on the skirt, are inserted into the vertical openings in the skirt. The dogs are spring-loaded and have pawls located in the windows on the skirt. The tool can be released in the event that the subsurface device cannot be freed by continuous upward jarring.

Three types of JU series tools are used and differ only by their core length, which is selected according to the reach required:

- JUC long core/short reach
- JUS intermediate core/intermediate reach
- JUL short core/long reach

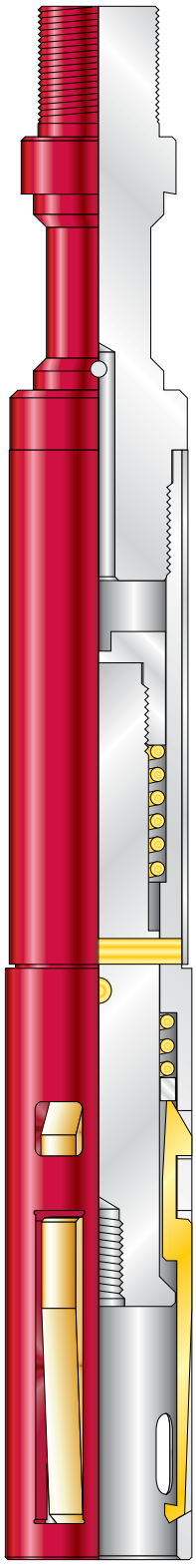
All other parts of each type of tool are identical and entirely interchangeable.

Specifications

Nominal Size (in.)	Assembly Numbers			Upper Connection (in.)	Maximum OD (in., mm)	To Pull Fishing Neck OD (in., mm)	Prong Connection (in.)
	JDC	JDS	JDL				
1-1/4	P55.125.00	P55.125.01	P55.125.02	15/16–10	1.250 31.75	0.875 22.23	1/4–20
1-3/8	P55.137.00	P55.137.01	P55.137.02	15/16–10	1.375 34.93	1.000 25.40	N/A
1-1/2	P55.150.00	P55.150.01	P55.150.02	15/16–10	1.422 36.12	1.187 30.15	1/2–13
1-5/8	P55.162.00	P55.162.01	P55.162.02	15/16–10	1.625 41.28	1.187 30.15	1/2–13
2	P55.200.00	P55.200.01	P55.200.02	15/16–10	1.859 47.22	1.375 34.93	1/2–13
2-1/2	P55.250.00	P55.250.01	P55.250.02	15/16–10	2.250 57.15	1.750 44.45	1/2–13
3	P55.300.00	P55.300.01	P55.300.02	15/16–10	2.812 71.43	2.312 58.73	5/8–11
4	P55.400.00	P55.400.01	P55.400.02	1-1/16–10	3.750 95.25	3.125 79.38	1-1/4–12

BDK® S-Type Pulling Tool

Weatherford BDK S-type pulling tool is designed to locate onto external fishing necks. This tool releases with downward jarring action and can be pinned with aluminum, brass, or steel shear pins. The S-type tool is ideal for running downhole flow-control devices against a no-go shoulder in the landing nipples. The tool is available with a choice of cores to extend its range of capabilities.



BDK® S-Type Pulling Tool

Specifications

Sucker Rod Connection

Nominal Size (in.)	Maximum OD (in., mm)	To Engage Fishing Neck (in., mm)	Connection	Reach			Part Numbers		
				Core - SB (in., mm)	Core - SM (in., mm)	Core - SS (in., mm)	SB Short Reach	SM Medium Reach	SS Long Reach
1.25	1.220 30.99	1.000 25.40	5/8 SR	1.32 33.53	N/A	N/A	0235A-SB-A1	N/A	N/A
1.50	1.430 36.32	1.187 30.15	15/16 SR	0.94 23.88	N/A	1.49 37.85	4399-SB-A2	N/A	4399-SS-A2
2.00	1.766 44.86	1.375 34.93	15/15 SR	1.20 30.48	2.01 51.05	1.59 40.39	4410-SB-A3	4410-SM-A3	4410-SS-A3
2.50	2.187 55.55	1.750 44.45	1-1/16 SR	1.20 30.48	N/A	2.11 53.59	4421-SB-A4	N/A	4421-SS-A4
3.00	2.844 72.24	2.313 58.75	1-9/16 SR	1.26 32.00	N/A	2.20 55.88	4432-SB-A6	N/A	4432-SS-A6
4.00	3.670 93.22	3.125 79.83	1-9/16 SR	1.42 36.07	N/A	N/A	4203-SB-A8	N/A	N/A

QLS Connection

Nominal Size (in.)	Maximum OD (in., mm)	To Engage Fishing Neck (in., mm)	Connection	Reach			Part Numbers		
				Core - SB (in., mm)	Core - SM (in., mm)	Core - SS (in., mm)	SB Short Reach	SM Medium Reach	SS Long Reach
1.50	1.430 36.32	1.187 30.15	1-1/4 QLS	0.94 23.88	N/A	1.49 37.85	4399-SB-Q2	N/A	4399-SS-Q2
2.00	1.766 44.86	1.375 34.93	1-1/2 QLS	1.20 30.48	2.010 51.05	1.59 40.39	4410-SB-Q3	4410-SM-Q3	4410-SS-Q3
2.50	2.187 55.55	1.750 44.45	1-7/8 QLS	1.20 30.48	N/A	2.11 53.59	4421-SB-Q4	N/A	4421-SS-Q4
3.00	2.844 72.24	2.313 58.75	2-1/2 QLS	1.26 32.00	N/A	2.20 55.88	4432-SB-Q6	N/A	4432-SS-Q6
4.00	3.670 93.22	3.125 79.38	2-1/2 QLS	1.42 36.07	N/A	N/A	4203-SB-Q7	N/A	N/A

Heavy-Duty QRJ Connection

Nominal Size (in.)	Maximum OD (in., mm)	To Engage Fishing Neck (in., mm)	Connection	Reach			Part Numbers		
				Core - SB (in., mm)	Core - SM (in., mm)	Core - SS (in., mm)	SB Short Reach	SM Medium Reach	SS Long Reach
2.00	1.766 44.86	1.375 30.15	1-1/2 HDQRJ	1.20 30.48	2.010 51.05	1.59 40.39	4410-SB-C3	4410-SM-C3	4410-SS-C3
2.50	2.187 55.55	1.750 44.45	1-7/8 HDQRJ	1.20 30.48	N/A	2.11 53.59	4421-SB-C4	N/A	4421-SS-C4
3.00	2.844 72.24	2.313 58.75	2-1/2 HDQRJ	1.26 32.00	N/A	2.20 55.88	4432-SB-C6	N/A	4432-SS-C6
4.00	3.670 93.22	3.125 79.38	2-1/2 HDQRJ	1.42 36.07	N/A	N/A	4203-SB-C7	N/A	N/A

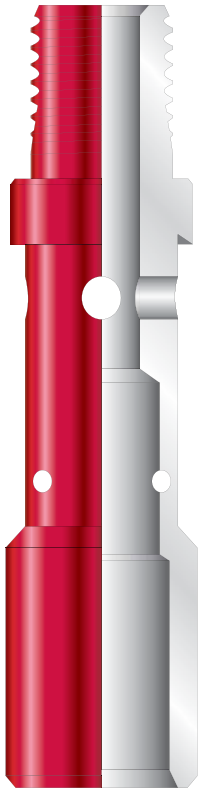
QRJ™ and Trinity™ connections are available on request. Additional sizes available on request.

QRJ and Trinity are trademarks of their respective companies.

Side-Pocket Mandrel Accessory Running Tools

Weatherford Camco side-pocket mandrel accessory running tools are wireline-service tools used to install 1-in. and 1 1/2-in. outside diameter (OD) side-pocket subsurface control devices inside pocket mandrels.

These running tools (except the JEK) consist of a fishing neck, a pin thread connection on the upper end, and a skirt on the lower end, which attaches to the side-pocket device with shear pins. All side-pocket mandrel accessory running tools must be attached to the appropriate kickover tools to install side-pocket subsurface control devices.

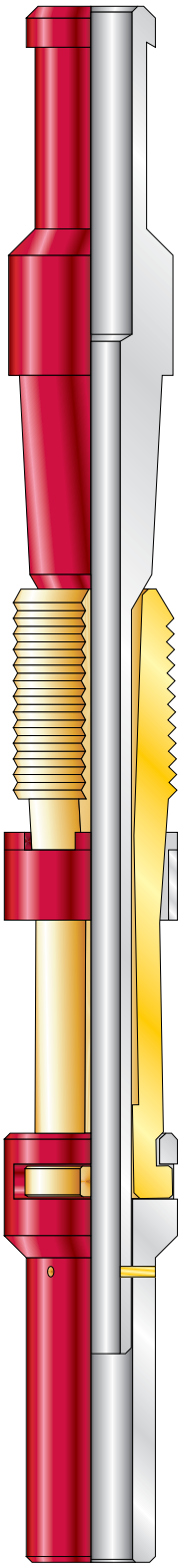


Applications

- GA-2, JK, JEK, and JEK-1 running tools install 1.0-in. OD devices in Camco K series mandrels.
- RK-1, RK-WF, and JC-3 running tools install 1 1/2-in. OD devices in Camco M series mandrels.
- JC-5 running tools install R and RA latches in Otis mandrels.

Specifications

Model	Upper Connection	Fishing Neck Size (in., mm)	Maximum OD (in., mm)	Part Number	
				JDE	Legacy
JK	0.937-in. 10 UNS-2A	1.187 30.15	1.25 31.75	273191	R07.000.02
RK-1	0.937-in - 10 UN 2A	1.187 30.15	1.445 36.70	273151	R07.000.14



Type A Tubing Stop

Weatherford Type A tubing stop offers a simple and reliable means for positioning a tubing anchor in tubing strings equipped with premium threads where no coupling recess is available. The Type A tubing stop is slowly run in-hole to the intended depth and then set by the wireline operator, overrunning the slips. If the position is incorrect, the stop can be picked up and repositioned. When the slips are set, the body of the stop containing the slip cone is driven down tightly behind the slips, holding it in the locked position. Continued downward jarring releases the running tool. The Type A tubing stop is retrieved by upward jarring on the stop body, pulling the slip cone out from behind the slips.

Applications

- Setting tubing anchors in premium tubing

Features

- External fishing neck, run on JDC pulling tool
- Option for internal fishing neck, run on GS pulling tool

Benefits

- Can be installed in premium tubing without coupling recesses
- Position can be moved before jarring to set tight

Specifications

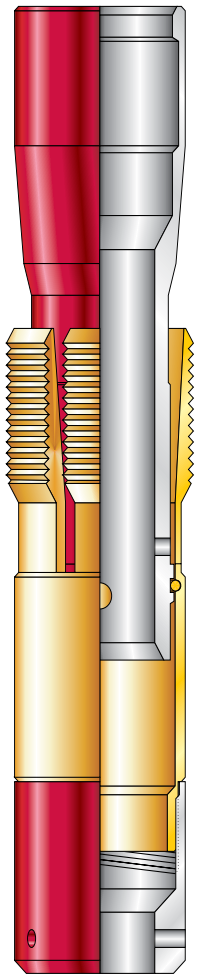
Maximum OD (in., mm)	Part Number		Minimum OD (in., mm)	Maximum Running OD (in., mm)	Pulling Tool
	JDE	Legacy			
1.500 38.10	273954	S28.150.00	0.553 13.54	1.437 36.50	1.50-in. JDC
1.750 44.45	275439	S28.175.00	0.553 13.54	1.437 36.50	1.50-in. JDC
2.000 50.80	271627	S28.200.00	0.615 15.62	1.853 47.07	2.00-in. JDC
2.250 57.15	TBA	S28.225.00	0.750 19.05	2.000 50.80	2.00-in. JDC
2.500 63.50	272185	S28.250.00	1.000 25.40	2.197 55.80	2.50-in. JDC
2.875 73.03	TBA	S28.287.00	0.750 19.05	2.000 50.80	2.00-in. JDC
3.000 76.20	271630	S28.300.00	1.490 37.85	2.710 68.83	3.00-in. JDC
4.000 101.60	720719	S28.400.00	2.302 58.47	3.750 95.25	4.00-in. JDC

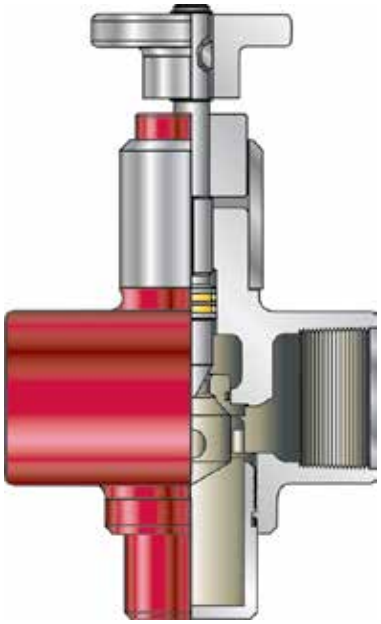
Type G Stop

Weatherford Type-G stop is designed for setting in all tubing (except plastic coated) and holding the force from the top. It is used with the G packoff.

Specifications

Size (in., mm)	Part Number		Maximum Running OD (in., mm)	Minimum ID (in., mm)	Pulling Tool		
	JDE	Legacy			Size	JDE	Legacy
2.000 50.80	271647	S31.200.00	1.975 50.17	1.062 26.97	2.00	272656	P46.200.00
2.500 63.50	271898	S31.250.00	2.410 61.21	1.500 38.10	2.50	176288	P46.250.00
3.000 76.20	271647	S31.300.00	2.995 76.07	1.750 44.45	3.00	126461	P46.300.00





ACV Series Adjustable Choke Valve

Weatherford McMurry-Macco® adjustable choke valve (ACV) is an in-line variable orifice choke, located at the surface, for the control of gas-lift injection flow. The ACV has a calibration dial that enables flow-rate adjustments without time-consuming, fixed-choke changing procedures.

Applications

- The ACV is used to control surface gas-flow rates for gas-lift wells and other applications.

Features, Advantages, and Benefits

- Calibration dial design eliminates time-consuming fixed-choke changing procedures.
- Calibration in 1/64-in. increments facilitates selection of an equivalent orifice to meet any conditions within the valve operating range.
- Tungsten-carbide trim offers the highest abrasion and impact resistance available, providing long trim life and precise process control.

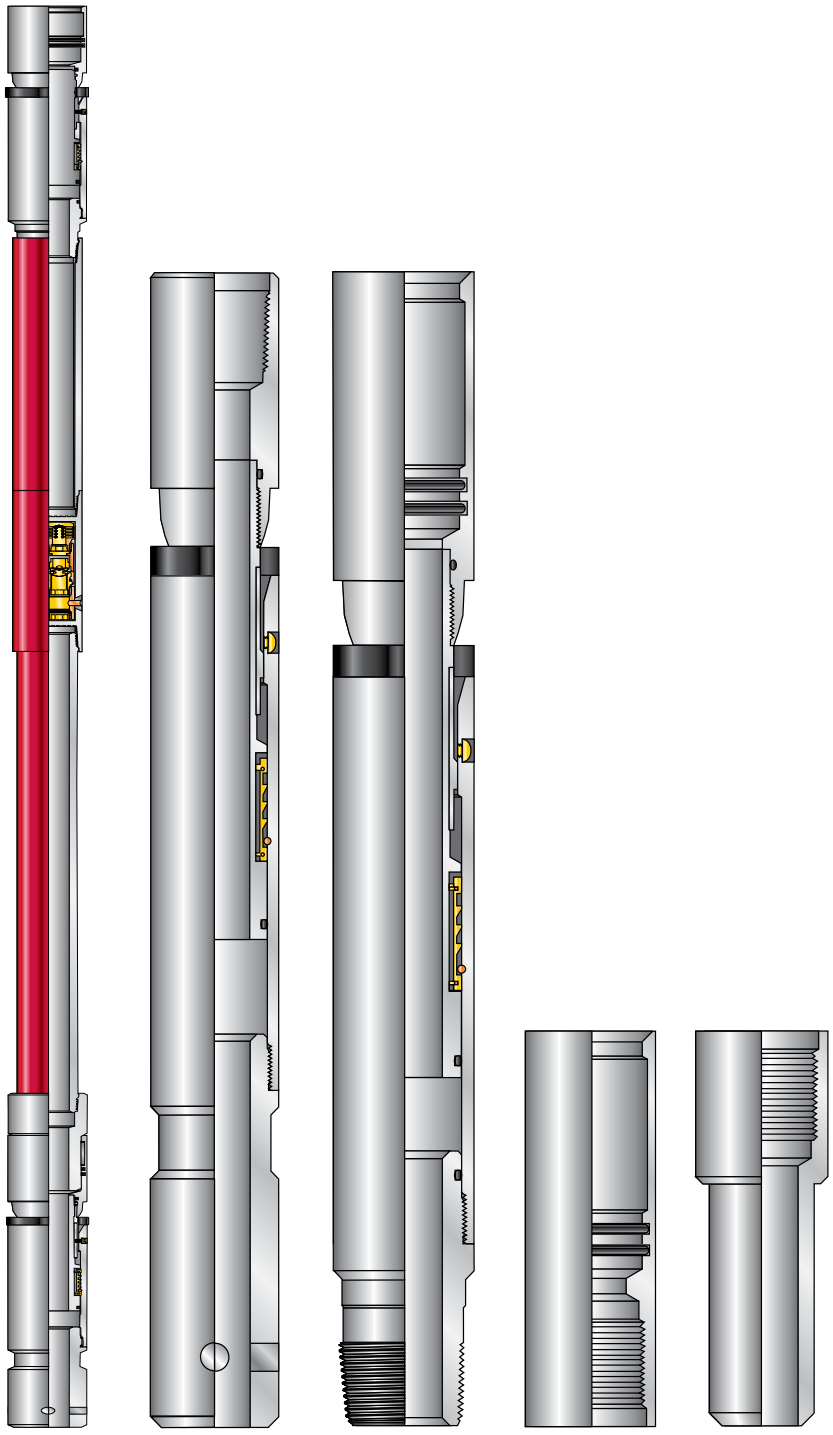
Specifications

	Threaded Valve (NPT)	Flanged Valve
Configurations	1.0 in. 25.4 mm	Up to 3-in. OD Up to 76.2-mm OD
	2.0 in. 50.8 mm	
Body material	Ductile iron*	Steel
Service pressure	3,000 psi 207 bar	5,000 psi 345 bar
Calibration display increments	1/64 in. 0.40 mm	
Maximum choke setting	40/64 in. 15.88 mm	

*Steel is also available to meet specific application requirements.

Options

- The ACV is available with tungsten-carbide trim for severe service.
- The ACV is available in threaded or flanged configurations. The standard body material for threaded valve configurations is ductile iron, but steel is also available to meet specific application requirements. The steel body is standard for all flanged valve configurations.



Pack-off Assembly | Lower Packoff | Upper Packoff | Optional Receptacle | Optional Stinger

TP Series Wireline-Retrievable Tubing Packoff

Weatherford McMurry-Macco® TP packoff is a wireline-retrievable tool used to isolate and control communication between the tubing and the annulus. The TP packoff is used primarily to install gas-lift equipment in wells without a side-pocket mandrel and is also used to isolate and patch holes in the tubing or to isolate leaking gas-lift mandrels or valves.

TP packoffs are usually run and retrieved on wireline. The packoffs use an elastomer-type element to seal in the inside diameter (ID) of the production tubing. Standard tubing stops hold packoff assemblies in place and help to maintain seal compression.

Accessory equipment includes stingers, receptacles, and spacer pipe for longer isolation intervals and for running the upper and lower assemblies separately.

Applications

- Isolate holes in the tubing
- Install tubing-retrievable gas-lift valves in wells in which a gas-lift system was not originally installed
- Replace leaking gas-lift mandrels or valves

TP Series Wireline-Retrievable Tubing Packoff

Features, Advantages, and Benefits

- The positive-lock ratchet mechanism maintains compression on packing elements, ensuring proper downhole installation of the tool.
- The internal GS-type running and pulling neck provides a larger flow area.
- Aluminum shear pins prevent premature setting during running operations.
- The packing element returns to its original shape when relaxed, easing removal by eliminating drag and rolling of the packing element during pulling operations.
- Packoff parts are keyed, allowing proper redressing of the packoff in the field by one person, without special tools.

Specifications

Assembly Number	Tubing Size (in.)	Maximum OD (in., mm)	Minimum ID (in., mm)	Thread Connection				Pressure Rating (psi, bar)
				Upper Element	Lower Element	Receptacle	Stinger	
5512-XXX	2-3/8	1.850 46.99	1.00 25.40	1 1/4-in. NUE Pin	1 1/4-in. NUE Box	1 1/4-in. NUE Pin	1 1/4-in. NUE Box	6,000 413.4
5513-XXX	2-7/8	2.280 57.91	1.25 31.75	1 1/2-in. NUE Pin	1 1/2-in. NUE Box	1 1/2-in. NUE Pin	1 1/2-in. NUE Box	
5514-XXX	3-1/2	2.721 69.11	1.50 38.10	1 1/2-in. EUE Pin	1 1/2-in. EUE Box	1 1/2-in. EUE Pin	1 1/2-in. EUE Box	

Options

- The standard packing element is made of 90-durometer Viton®. Other packing element materials are available.
- Stinger and receptacle are available.

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