



Gas Lift Application Guide

Tubing-Retrievable/ Wireline-Retrievable

Selection Tables



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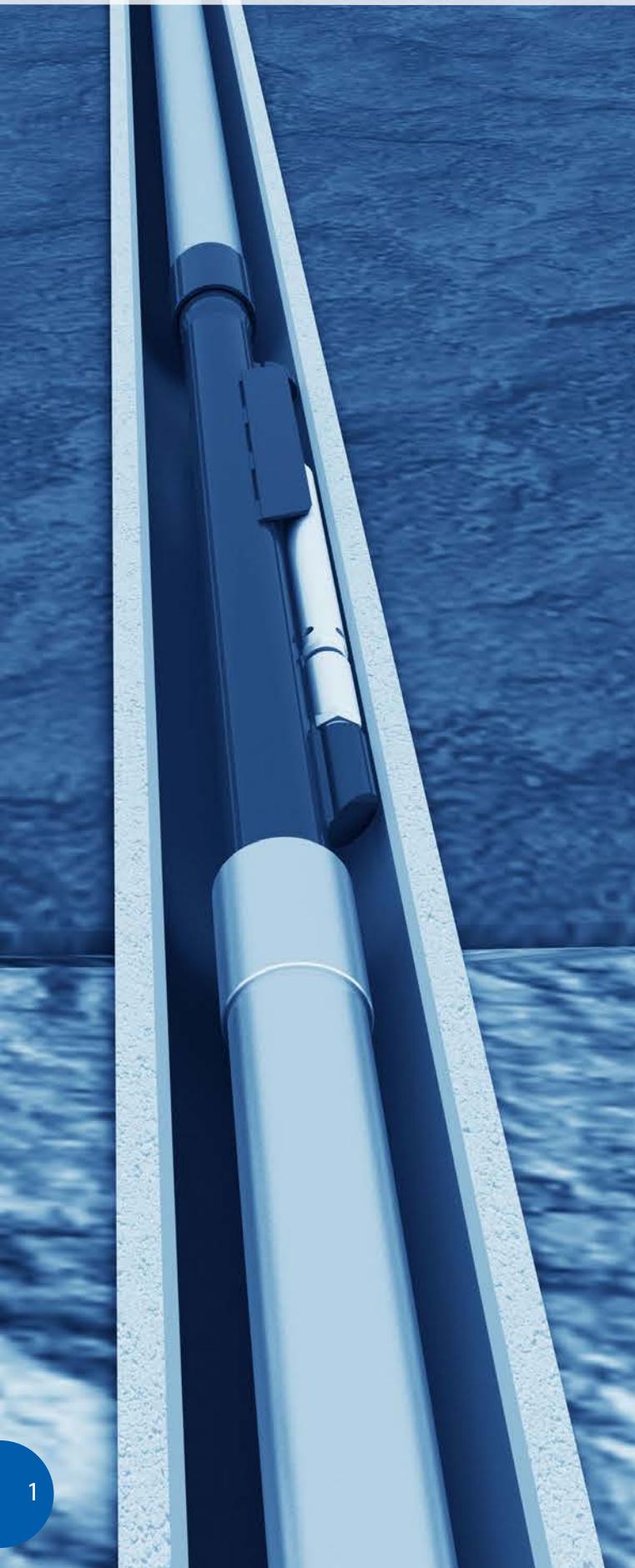
Introduction to Gas Lift

Flowco Gas Lift

Maximizing the use of available natural energy from a reservoir is crucial to any production installation. The natural energy in many wells or fields is often unable to produce sufficient reservoir pressure to cause the well to flow under its own power, or to deliver the required volume of oil to the surface at optimum rates. In these situations, some form of artificial lift or secondary recovery process must be used to supplement the reservoir's natural energy.

Gas Lift is an artificial lift process that most closely resembles the natural flow process and basically operates as an enhancement or extension of that process. This secondary recovery method is suitable for almost every well. The only major requirement is an economical supply of pressurized injection gas. As produced fluids in natural flow wells travel up the production string, the natural gas comes out of solution and expands as it continues to rise to the surface.

As the gas expands, it displaces fluid in the production tubing, lightens the produced fluid column, and lowers the hydrostatic pressure against the formation. As the hydrostatic pressure of the produced fluid column decreases, the well continues to flow on its own. If the reservoir pressure falls below the hydrostatic pressure of the producing column of fluids, then flow from the reservoir would cease, and the well would no longer be capable of flowing under its own energy. By supplementing the formation gas with injected gas, the required pressure differential between the reservoir and wellbore can be reestablished.



Types of Gas Lift Systems

Continuous flow and intermittent flow are the two type of gas lift systems used in the oil and gas industry. Because of its cyclic nature, intermittent lift is best suited to wells that produce at relatively low rates. Continuous lift will usually be more efficient and less expensive for wells that produce at higher rates where it can be maintained without excess use of injection gas.

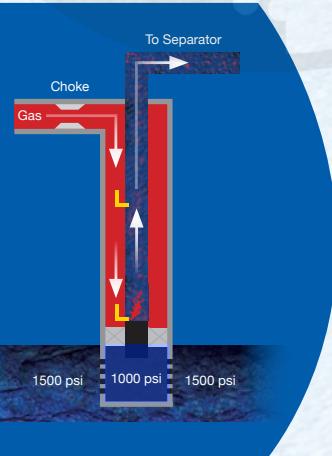
Continuous Flow Gas Lift

The majority of gas lift wells are continuous flow gas lift. This type of gas lift is the most common because it resembles the natural flow of a well. Using a continuous injection of compressed gas into the well reduces flowing bottomhole pressure and increases production.

In the continuous flow gas lift process, relatively high-pressure gas is injected downhole into the produced fluid column. This injected gas joins the formation gas to lift the fluid to the surface by one or more of the following processes:

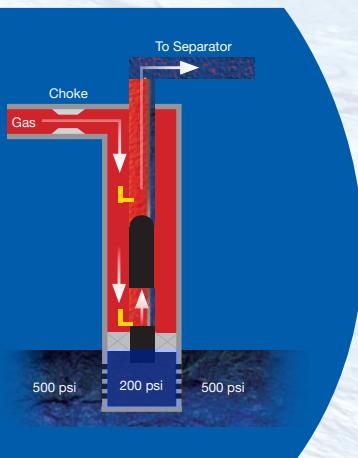
Reduction of the fluid density, and thus the fluid column hydrostatic pressure, making the reservoir pressure greater than the produced fluid column hydrostatic pressure so that the reservoir fluids are capable of flowing to the surface.

Expansion of the injection gas so that it pushes liquid ahead of it which further reduces the produced fluid column weight, thereby increasing the differential between the reservoir and the wellbore



Continuous Flow Gas Lift

With casing (annular) flow, the gas is injected down the tubing string and fluids are produced out of the tubing/casing annulus. Higher gas lift injection rates must be available to prove efficient in this application and surface facilities must be set up to handle higher fluid volumes.



Intermittent Gas Lift

Intermittent Gas Lift

When low reservoir pressure and low production rates are present in a wellbore, intermittent gas lift can be a better option. In this process, high-pressure gas is injected in intermittent cycles to displace liquid slugs to the surface. This type of gas lift is only used for tubing flow. Due to high injection rates from the compressor in intermittent gas lift, the energy in the formation gas does little to assist in lifting most wells.

Advantages, Applications & Requirements



Almost any well requiring artificial lift to produce hydrocarbons is a candidate for gas lift

Advantages:

- + Low initial installation cost
- + High lifting efficiencies
- + Operator control of production rates at the surface
- + Minimal moving parts
- + Flexibility of lifting from near the surface or deep within the wellbore

Gas Lift Applications:

- + Almost any well requiring artificial lift to produce is a candidate for gas lift
- + Produce wells to depletion regardless of how low the rate of production
- + Kick off wells that will flow naturally once the heavier completion fluids are vacated from the production string
- + Unload water from gas wells that would otherwise prevent gas production

Gas Lift System Requirements:

- + Installation of the appropriate gas lift equipment both on the surface and in the wellbore
- + An available and economic supply of pressurized injection gas





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TP
Gas Lift
Valve

TUBING-RETRIEVABLE TP Valve Series

INJECTION PRESSURE OPERATED GAS LIFT VALVES

TP Valve Series

- + The TP-1 model in this series is a 1" O.D. valve.
- + The TP-1.5 model is a 1-1/2" O.D. valve.

Applications

Used for intermittent or continuous flow applications with tubing-retrievable gas lift mandrels. Smaller size valves are available for use with the IM and CT-IM special application mandrels for packoff, special clearance and smaller diameter installations.

Features

- + Large dome volume improves operating efficiency of valve
- + Optional reverse-flow check valve (TP-1 and TP-1.5 models)
- + Mechanical travel stop increases the cycle life of the bellows
- + Three-ply Monel® bellows
- + Silicon fluid bellows protection
- + Replaceable floating Monel® seat (tungsten seat available)
- + Silver-brazed bellows connections
- + Stainless steel or Monel® materials available
- + Pressure rating up to 1800 psi PTRO maximum
- + Temperature rating of 250° F (standard service)
- + Port sizes from 1/8" to 1/2"

TP Series Specification Guide

Valve Series Model	Ab Effective Bellows Area (sq. in.)	Port Size (in.)	Ap* Area of Port (sq. in.)	Ap/Ab Ratio	1-(Ap/Ab)	PPEF Ap/Ab 1-(Ap/Ab)
TP-1	0.31	1/8	0.014	0.044	0.956	0.046
	0.31	5/32	0.021	0.067	0.933	0.072
	0.31	3/16	0.029	0.095	0.905	0.105
	0.31	1/4	0.052	0.166	0.834	0.199
	0.31	5/16	0.080	0.257	0.743	0.346
	0.31	3/8	0.114	0.368	0.632	0.582
	0.77	3/16	0.029	0.038	0.962	0.040
	0.77	1/4	0.052	0.067	0.933	0.072
	0.77	5/16	0.080	0.104	0.896	0.115
	0.77	3/8	0.114	0.148	0.800	0.174
	0.77	7/16	0.154	0.200	0.739	0.250
	0.77	1/2	0.201	0.261	0.632	0.353

*Port diameter based on port size plus .006" for tapped seat

TP VALVE SERIES

TUBING-RETRIEVABLE TC Valve Series

GAS LIFT CHECK VALVES

TC Valve Series

- + The TC-1 model in this series is a 1" O.D. valve.
- + The TC-1.5 model is a 1-1/2" O.D. valve.

Applications

These valves are used with tubing-retrievable gas lift valves that do not have an integral check valve, such as the TP-1 and TP-1.5 gas lift valves. A primary application for these valves is preventing back flow from the injection valve which damages casing. Other applications include preventing production commingling in dual gas lift installations and improving pressure integrity during acidizing and circulation operations.

Features

- + Stainless steel or Monel® materials available
- + Inconel® spring
- + Eliminates need to re-unload annulus liquid since valve prevents annulus fill up during shut down periods
- + Elastomeric and metal-to-metal seat for bubble tight seal
- + Seal system options available
- + Valves can be stacked for additional protection

TC Series Specification Guide

Valve Series	Valve Series Model	Valve O.D. (in.)	Port Size (in.)	Connection Thread Type	Mandrel
TC SERIES	TC-1	1.00	7/16	1/2" NPT	JR Series
	TC-1.5	1.50	1/2	1/2"-3/4" NPT	SR Series



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TC Check Valve



TC Check Valve

TC VALVE SERIES



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SR Series
Gas Lift Mandrel

TUBING-RETRIEVABLE JR and SR Series GAS LIFT MANDRELS

The JR and SR Series mandrels are tubing-retrievable gas lift mandrels installed as a component of the tubing string. The external ported lug of the mandrels provides attachment of the gas lift devices.

JR Mandrel Series

This mandrel has a lug configured for 1" O.D. tubing-retrievable gas lift equipment.

SR Mandrel Series

This mandrel has a lug configured for 1.5" O.D. tubing-retrievable gas lift equipment.

Applications

Installed as part of the tubing string to accept tubing-retrievable gas lift equipment for producing wells requiring gas lift. Both mandrels can be used in either a single or dual string completions. JR and SR mandrels may be installed in the casing drift I.D. while maintaining post-completion operations through the bore of the mandrel.

Features

- + Full tubing I.D.
- + Guard plates on side of mandrel protect valve from damage while running in hole
- + Tubing-string connection threaded on both upper and lower ends with appropriate terminal threads
- + Various ported-lug configurations for specialized applications
- + Drift I.D. compatible with tubing connection drift in most tubing thread types, sizes and weights
- + Available in various materials for standard, H2S service and hostile well environments
- + Special clearance available on request

Tubing Retrievable Gas Lift Mandrels Series Specification Guide

Tubing Size (in.)	Mandrel Lug I.D. (in.)	Mandrel Model	Mandrel O.D. (in.)	Drift I.D. (in.)**	Mandrel Length (in.)*
2-3/8"	1.00	JR	3.78	1.901	51.00
	1.50	SR	4.28	1.901	51.00
2-7/8"	1.00	JR	4.34	2.347	51.00
	1.50	SR	4.84	2.347	51.00
3-1/2"	1.50	SR	5.56	2.867	51.00

** Mandrel Drift I.D. may vary according to the type of thread connection

* O.D. and Length dimensions include coupling

SPECIAL APPLICATION Conventional Packoff - CP Series

PACKOFF EQUIPMENT

The Flowco Production Solutions CP Series packoffs are wireline-retrievable, isolation tools which utilize an elastomer-type element designed to seal in the I.D. of the production tubing. CP packoffs are normally run as a component of a packoff assembly on slickline or coiled tubing. In more common applications, CP packoffs are used to install gas lift systems and isolate or control communication between the casing and the production string. Standard tubing stops hold the control device in place and assist in maintaining seal compression.

CP Series Packoff Equipment

- + CP-20 Packoffs - Upper and lower packoffs used in 2-3/8" tubing.
- + CP-25 Packoffs - Upper and lower packoffs used in 2-7/8" tubing.

Applications

This equipment is commonly used to isolate holes in the tubing or to install tubing-retrievable, slimhole concentric gas lift valves in wells where a gas lift system was not originally installed. Packoff equipment can be set and retrieved with standard slickline tools. Accessory equipment include stingers and receptacles for longer isolation intervals, and running the upper and lower assembly separately.

Features

- + Expandable, elastomer-type seals for positive isolation
- + Ratchet mechanism maintains compression on packing elements
- + Optional stinger and receptacles for longer isolation intervals
- + Can be used with IM mandrels for gas lift installations
- + Simple field re-dressing
- + Large I.D. for minimum pressure drop
- + Pressure differential rated up to 2,500 psi
- + Temperature rating of 250° F (standard service)

CP Series Specification Guide

Valve Series	Packoff Series Model	Tubing Size Nominal (in.)	Tubing Weight (lbs/ft)	Maximum O.D. (in.)	Minimum I.D. (in.)	Thread Connection Type
CP SERIES	CP-20	2-3/8	4.7	1.860	1.000	1-1/4" NUE 10 RD
	CP-25	2-7/8	6.5	2.290	1.250	1-1/2" NUE 10 RD



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CP-20/25
Upper
Packoff



CP-20/25
Lower
Packoff



CP-20/25
Stinger



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WP Gas Lift Valve

WIRELINE RETRIEVABLE

Injection-Pressure-Operated Gas Lift Valves

WP SERIES GAS LIFT VALVES

The Flowco Production Solutions WP Series gas lift valves are retrievable, injection-pressure-operated valves with a nitrogen-charged dome and bellows configuration. Since the charge pressure is affected by temperature, it is important to use accurate operating depth temperature information when calculating the set pressure. The nitrogen dome pressure is preset at a reference temperature and corrected to an operating depth temperature for the desired application. The valve is held on seat by the downward force of the nitrogen charge inside the bellows.

WP Valve Series

- + The WP-1 model is a 1" O.D. valve.
- + The WP-1.5 model is 1-1/2" O.D. valve.

Applications

For intermittent or continuous gas lift, and tubing or casing flow applications depending on pocket porting configurations.

Features

- + Maximum travel stop increases the cycle life of the bellows
- + Integral reverse-flow check valve to prevent tubing-to-casing communication
- + Three-ply Monel® bellows
- + Compatible with all common top latches
- + Silicon dampening fluid minimizes throttling effects
- + Replaceable floating Monel® or tungsten carbide seat
- + Silver-brazed bellows connections
- + Guidance system designed to prevent corkscrew of the bellows
- + Stainless steel or Viton® materials available
- + Pressure rating up to 1,800 psi Pressure Tested Open Rack (PTRO) maximum
- + Temperature rating of 250° F (standard service)
- + Port sizes from 1/8" to 1/2"
- + Standard Viton® packing element system with other packing materials available

WP Series Specification Guide

Valve Series Model	Ab Effective Bellows Area (sq. in.)	Port Size (in.)	Ap* Area of Port (sq. in.)	Ap/Ab Ratio	1-(Ap/Ab)	PPEF Ap/Ab 1-(Ap/Ab)
WP-1	0.31	1/8	0.014	0.044	0.956	0.046
	0.31	5/32	0.021	0.067	0.933	0.072
	0.31	3/16	0.029	0.095	0.905	0.105
	0.31	1/4	0.052	0.166	0.834	0.199
	0.31	5/16	0.080	0.257	0.743	0.346
	0.77	3/16	0.029	0.038	0.962	0.040
WP-1.5	0.77	1/4	0.052	0.067	0.933	0.072
	0.77	5/16	0.080	0.104	0.896	0.115
	0.77	3/8	0.114	0.148	0.800	0.174
	0.77	7/16	0.154	0.200	0.739	0.250
	0.77	1/2	0.201	0.261	0.632	0.353

*Port Diameter based on port size plus .006" for lapped seat

WP SERIES

WIRELINE RETRIEVABLE

Injection-Pressure-Operated Gas Lift Valves

WP-C SERIES GAS LIFT VALVES

The Flowco Production Solutions WP-C Series gas lift valve is a retrievable, injection-pressure- operated valves with a nitrogen-charged dome and bellows configuration. These valves include an attached running head and integral bottom collet latch for installation in all mandrels with a bottom latch recess.

Since the charge pressure is affected by temperature, it is important to use accurate operating temperature information when establishing the set pressure criteria. The nitrogen dome pressure is preset at a reference temperature and corrected to an operating depth temperature for the desired application. The valve is held on seat by the downward force of the nitrogen charge inside the bellows.

WP-C Valve Series

- + The WP-1C model is a 1" O.D. valve.

Applications

For intermittent or continuous gas lift, and tubing or casing flow applications depending on pocket porting configurations.

Features

- + Large dome area improves operating efficiency of the valve
- + Integral collet bottom latch
- + Maximum travel stop increases the cycle life of the bellows
- + Integral reverse-flow check valve to prevent tubing-to-casing communication
- + Silicon dampening fluid minimizes throttling effects
- + Replaceable floating Monel® or tungsten carbide seat
- + Silver-brazed bellows connections
- + Guidance system designed to prevent corkscrew of the bellows
- + Stainless steel or Monel® materials available
- + Pressure rating up to 1,800 PTR maximum
- + Temperature rating of 250° F (standard service)
- + Port sizes from 1/8" to 1/4"
- + Standard Viton® packing element system with other packing materials available

WP-C Series Specification Guide

Valve Series Model	Ab Effective Bellows Area (sq. in.)	Port Size (in.)	Ap* Area of Port (sq. in.)	Ap/Ab Ratio	1-(Ap/Ab)	PPEF Ap/Ab 1-(Ap/Ab)
WP-1C	0.31	1/8	0.014	0.044	0.956	0.046
	0.31	5/32	0.021	0.067	0.933	0.072
	0.31	3/16	0.029	0.095	0.905	0.105
	0.31	1/4	0.052	0.166	0.834	0.199

*Port diameter based on port size plus .006" for lapped seat

WP-1C Latch Specification Guide

Valve Series Model	Valve O.D. (in.)	Latch* Type	Pulling Neck O.D. (in.)	Running Neck O.D. (in.)	Maximum O.D. (in.)
WP-1C	1.00	Bottom Collet	0.875	0.875	1.125

*Compatible running and pulling tool information available upon request

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WP-C Gas Lift Valve

WP-C SERIES



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WO Orifice Valve

WIRELINE RETRIEVABLE Gas Lift Orifice Valves

WO SERIES ORIFICE VALVE

The Flowco Production Solutions WO Series valves are retrievable, single-point-injection orifices. A replaceable orifice controls the volume of gas through the open valve into the production conduit. A spring-loaded, reverse-flow check valve is incorporated as an integral part of these valves.

WO Series Orifice Valves

- + The WO-1 model is a 1" O.D. valve.
- + The WO-1.5 model is a 1-1/2" O.D. valve.

Applications

These valves have no closing function and are commonly used to control stable injection at the operating valve depth.

Features

- + Stainless steel or Monel® materials available
- + Orifices sizes from 1/8" to 1/2" diameter ports (WO Series)
- + Flow capacity governed by orifice size
- + Replaceable floating orifice
- + Spring-loaded, reverse-flow check valve (WO Series)

WO Series Specification Guide

Valve Series	Valve Series Model	Valve O.D. (in.)	Latch* Type	Max Port Size (in.)
WO SERIES	WO-1	1.00	BK-2	5/16
	WO-1.5	1.50	RK, RA, T-2	1/2

*Compatible running and pulling tool information available upon request.



WO SERIES

WIRELINE-RETRIEVABLE Gas Lift Dummy Valves

WD and WD-C SERIES DUMMY VALVE

WD-1C Dummy Valves

The Flowco Production Solutions WD and WD-C Series dummy valves are retrievable, isolation tools installed in a side pocket mandrel to block the mandrel's injection ports. The valve with appropriate latch may be installed or retrieved prior to or after completion for various procedures.

WD Series Dummy Valve

- + The WD-1 model is a 1" O.D. valve.
- + The WD-1.5 model is a 1-1/2" O.D. valve.

WD-1C Series Dummy Valves

This series includes an integral bottom collet latch and is typically used when a retrievable latch will not engage in the latch-pocket profile of a side pocket mandrel.

The WD-1C model is a 1" O.D. valve with integral bottom collet latch.

Applications

Used to seal off the pocket of a side pocket mandrel, preventing communication between the casing and tubing. These valves are also used to blank off the tubing for production until gas lift valves are required. Other applications include pressurizing the tubing in various procedures, isolating tubing and casing flow during single-alternative production, and isolating tubing and casing flow for test purposes during multi-point water or gas injection floods.

Features

- + Stainless steel or Monel® materials available
- + Two sets of packing to straddle and pack off casing ports
- + Accepts most common top latches
- + Installs in most mandrel pockets depending on valve model
- + Integral bottom collet latch (WD-C Series)

WD and WD-C Series Specification Guide

Valve Series	Valve Series Model	Valve O.D. (in.)	Latch* Type	Pulling Neck O.D. (in.)	Running Neck O.D. (in.)
WD SERIES	WD-1	1.00	BK-2	--	--
	WD-1.5	1.50	RK, RA, T-2	--	--
WD-C SERIES	WD-1C	1.00	Bottom Collet	0.875	0.875

*Compatible running and pulling tool information available upon request.

Note: A core extension is required for the WD-1C model to keep the skirt from shouldering on the pocket, allowing for a shear release feature



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WD
Dummy
Valve

WED-1
Equalizing
Dummy
Valve

WIRELINE RETRIEVABLE Dummy Valves

WED SERIES EQUALIZING DUMMY VALVES

The Flowco Production Solutions WED Series equalizing valves with integral latches are virtual dummy valves designed to provide controlled equalization or circulation between the casing and tubing.

The downward shifting of the latch opens the communication port, allowing circulation or equalization. Once shifted, the valve can be pulled in the same trip as the integral top latch and redressed, if needed.

WED Valve Series

- + The WED-1 model is a 1" O.D. valve.
- + The WED-1.5 model is a 1-1/2" O.D. valve.

Applications

Primarily used to equalize casing and tubing pressure, the most common application is multiple water flood zones isolated by packers. After equalization, the valve must be pulled and redressed, if needed, to prevent communication between the casing and tubing. The valve may also be used to blank off the tubing for production until gas lift valves are required. Other applications include pressurizing the tubing in various procedures, isolating tubing and casing flow during single-alternative production, and isolating tubing and casing flow for test purposes during multi-point water or gas injection floods.

Features

- + Stainless steel or Monel® materials available
- + Two sets of packing to straddle and packoff casing ports
- + Integral top latch to equalize tubing and casing pressure
- + Fluid circulation after equalization
- + Equalizing feature for controlled flow during equalization prior to removing
- + One trip equalizing and pulling operation can be performed in one trip
- + Standard Viton® packing element system with other packing materials available

WCS-1 Series Specification Guide

Valve Series	Valve Series Model	Valve O.D. (in.)	Latch* Type
WED SERIES	WED-1	1.00	Integral
	WED-1.5	1.50	Integral

*Compatible running and pulling tool information available upon request.

WIRELINE RETRIEVABLE Dump Kill Valves

WDKR and WDKS SERIES DUMP KILL VALVES

The Flowco Production Solutions WDKR and WDKS Series dump kill valves function as virtual dummy valves to isolate the injection ports when installed in side pocket mandrels. These valves also permit circulation between the casing and tubing when the casing-over-tubing pressure differential exceeds a preset opening pressure. Applying pressure to the casing annulus creates the differential required to open the valve circulation ports. The opening pressure of the valve is preset before installation in the mandrel. The WDKR and WDKS valves should always be run with a ported latch for pressure balance and to prevent the opening mechanism from becoming fluid locked.

WDKR Series Kill Valves

These valves use an adjustable draw bar to hold the isolation mechanism in the closed position. An integral, double check valve prevents tubing-to-casing annulus flow once the valve is shifted to the locked-open position.

- + The WDKR-1 model is a 1" O.D. valve.
- + The WDKR-1.5 model is a 1-1/2" O.D. valve.

WDKS Series Kill Valves

In this series, shear screws hold the internal piston in the closed position to isolate the circulation ports. As the casing-over-tubing differential pressure is applied, the piston shifts upward and opens the circulation path between the casing and tubing. This series includes an integral, reverse-flow check valve to prevent tubing-to-casing annulus flow.

- + The WDKS-1 model is a 1" O.D. valve.
- + The WDKS-1.5 model is a 1-1/2" O.D. valve.

Applications

Valves are installed in side pocket mandrels when a virtual dummy valve is needed to pack off the communication ports in the mandrel, yet retain the option of being able to circulate between the casing and tubing without well intervention. After applying pressure to convert the valve to the circulating valve operation mode, the valve must be retrieved, redressed, and rerun back into the side pocket mandrel for it to function as a virtual dummy valve again.

Features

- + Stainless steel or Monel® materials available
- + Standard Viton® packing element system with other packing materials available
- + Ability of valves to convert from virtual dummy valve operation to circulating valve operation eliminates expense associated with re-entering well to install a circulating valve
- + Tubing-over-casing pressure differential will not open the valves
- + Adjustable opening pressure according to application requirements
- + Integral double-check valves prevent tubing-to-casing annulus flow (WDKR Series)
- + Integral check valve prevents tubing-to-casing annulus flow (WDKS Series)

WDKR and WDKS Series Specification Guide

Valve Series	Valve Series Model	Valve O.D. (in.)	Latch* Type	Release Mechanism
WDKR SERIES	WDKR-1	1.00	BK-P	Draw Bar
	WDKR-1.5	1.50	RK-P, T-2-P	Draw Bar
WDKS SERIES	WDKS-1	1.00	BK-P	Shear Screws
	WDKS-1.5	1.50	RK-P, T-2-P	Shear Screws

*Compatible running and pulling tool information available upon request.

WDKR-1
Valve WDKS-1
Valve



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WCS-1
Circulating
Valve

WIRELINE RETRIEVABLE Circulating Valves

WCS-1 SERIES CIRCULATING VALVES

The Flowco Production Solutions WCS-1 Series circulating valves protect the seal bores of side pocket mandrels from erosion and abrasion when circulating fluids or gases through the mandrel's ports. The double check valves in this series permit flow only from the annulus to the tubing. Higher circulating rates are achieved when installing these valves with a ported latch.

WCS-1 Valve Series

- + The WCS-1 model is a 1" O.D. valve.
- + The WCS-1.5 model is a 1-1/2" O.D. valve.

Applications

Installed in 1" and 1-1/2" side pocket mandrels to prevent circulated gases or fluids from damaging the side pocket seal bores. These valves are designed for high gas or fluid rate passage requirements during circulation.

Features

- + Stainless steel or Monel® materials available
- + Standard Viton® packing element system with other packing materials available
- + Abrasion-resistance overlays available
- + Increased flow area since flow permitted from both nose and latch ends
- + Integral double-check valve design to prevent tubing-to-casing annulus flow
- + Installed with a ported latch for increased circulation rates

WCS-1 Series Specification Guide

Valve Series	Series Model (in.)	Valve O.D. (in.)	Latch* Type
WCS SERIES	WCS-1	1.00	BK-2-P
	WCS-1.5	1.50	RK-P, T-2-P

*Compatible running and pulling tool information available upon request.



WCS SERIES

WIRELINE RETRIEVABLE Pilot Operated Gas Lift Valve

PV-S1 Valve

The Flowco Production Systems PV-S1 is a 1 inch O.D. wireline retrievable injection pressure pilot operated gas lift valve that is primarily controlled by injection gas pressure. The PV-S1 controls injected gas flow and pressure to inject large volumes of gas into the production tubing during intermittent gas lift operations. The large instantaneous gas volume helps to more efficiently displace the liquid slug to the surface.

The valve houses a power spring, bellows, stem, and seat. The power spring provides the closing force of the valve. When injection gas pressure exceeds the closing force then the power spring compresses, lifting the pilot valve stem off its seat allowing gas to depress the power piston assembly permitting a large volume of gas to be injected rapidly through the valve into the production string. Multiple pilot stems and seats sizes are available allowing a spread between the opening and closing casing pressure to compensate for production conditions.

The PV-S1 is constructed of premium materials for corrosion resistance in wells with high concentrations of H2S and/or CO2. Different packing and elastomeric materials used in the valve are available for standard and special service.

Features

- + Stainless steel and Monel type materials are standard plus other premium materials available.
- + Monel bellows (Silver brazed bellows connections)
- + Mechanical stop prevents bellows over-stroke
- + Stem assembly utilizes a tungsten carbide ball in pilot section
- + Replaceable Monel seat (tungsten carbide inserted available)
- + Bellows has no internal Nitrogen gas charge—eliminates temperature effect
- + Robust integral reverse flow check valve and high rate exit paths in housing body
- + BKM-2 type top latch
- + Compatible with other manufacturer's side pocket mandrels
- + Controlled spread using multiple-port sizes
- + Power stem has shock absorber for longer cycle life
- + Maximum injection port (for large gas volumes)

Applications

- + Intermittent gas-lift applications, conventional, and chamber lift

PV-S1 Specifications

PV-S1 VALVE	
Maximum Valve O.D. inches	1.015"
Overall Length inches	19.18"
Port Sizes inches	1/8, 3/16, 1/4, 5/16, 3/8
Latch	INTEGRAL BKM-2 (Modified to fit PV-S1)
Mandrels	Most 1" Retrievable SPM manufactured by OEM's
Metallurgy / Seal Material	Stainless Steel, Monel, / Viton, Neoprene, Teflon, Peek *

* PV-S1 can be manufactured from various materials to perform in all service conditions.



PV-S1
Valve



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WIRELINE RETRIEVABLE Latches

Flowco Production Solutions offers a wide range of latches for installing wireline-retrievable gas lift, chemical injection, and waterflood valves in side pocket mandrels. Latches are designed to lock in place when located in either a 180° or a 360° latch pocket profile. To retrieve a latch and attached valve, upward jarring of the tool string shears the release pin, permitting the locking mechanism to disengage from the pocket latch profile.

180° G-Type Latch Pocket Profile

Latches for 180° latch pocket profile have a spring-loaded, ring style locking mechanism. A ported I.D. is included in some designs for applications requiring a communication path between the latch and attached valve.

+ BK-2 Latch Series

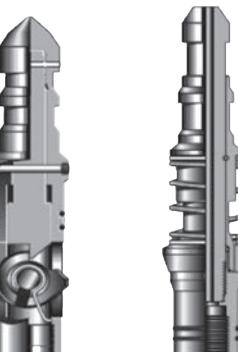
This series includes a BK-2 and a BK-2-P model used to secure a 1" valve or dummy valve in a side pocket mandrel with a 1" I.D. pocket. The BK-2-P model has a ported I.D.

+ RK Latch Series

Used to secure a 1.5" valve or dummy valve in a side pocket mandrel with a 1.5" I.D. pocket, this series includes a RK and a RK-P model. The RK-P model has a ported I.D.



BK-2 Latch BK-P Latch



RA Latch RK-P Latch



T-2 Latch

Latch Specification Guide

Valve Pocket I.D. Inches	Latch Pocket Profile Inches	Latch Model	Latch Mechanism	Ported I.D.	Pulling Neck O.D. Inches	Running Neck O.D. Inches	Max. O.D. Inches
1.00	180°	BK-2	Lock-Ring	No	0.875	0.750	1.359
	180°	BK-2-P	Lock-Ring	Yes	0.875	0.750	1.359
	180°	RK	Lock-Ring	No	1.187	0.937	1.786
	180°	RK-P	Lock-Ring	Yes	1.187	0.937	1.786
1.50	360°	T-2	Collett	No	1.375	1.000	1.750
	360°	T-2-P	Collett	Yes	1.375	1.000	1.750
	360°	RA	Cam	No	1.375	1.359	1.750

WIRELINE RETRIEVABLE Side Pocket Mandrels

INTRODUCTION TO SIDE POCKET MANDRELS

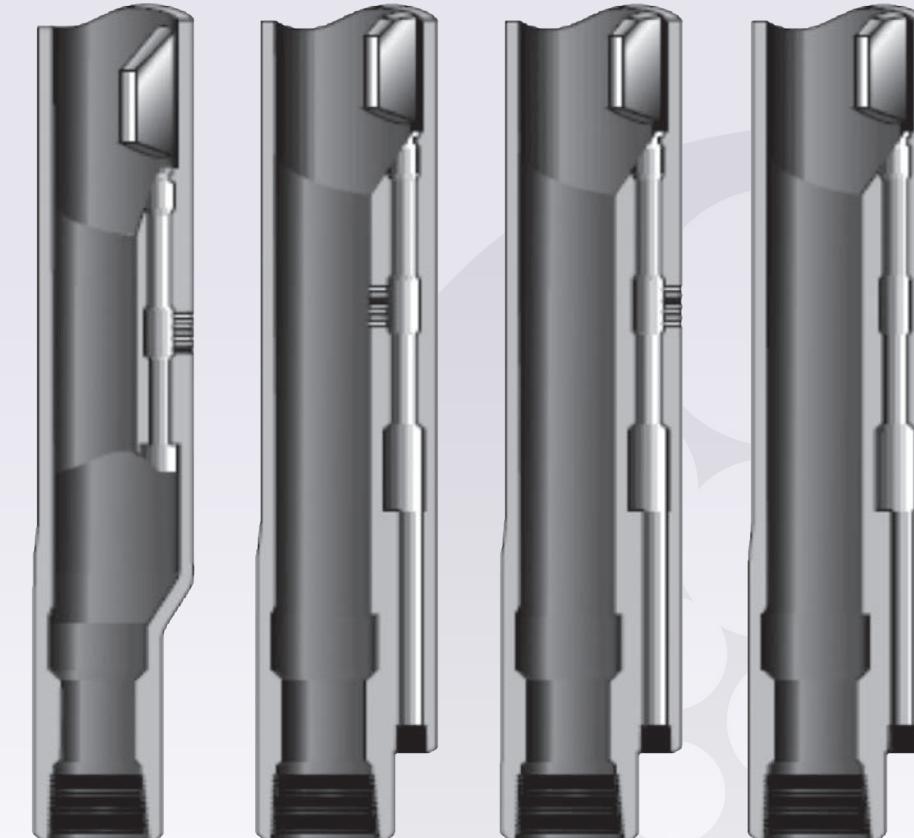
Flowco Production Solutions offers a comprehensive line of side pocket mandrels for a variety of well completions applications. We offer top-quality side pocket mandrels with enhanced features and specifications to meet the most demanding requirements.

The family of side pocket mandrels available from Flowco Production Solutions includes both oval and round body designs. The oval-body mandrels, with both machined and forged pocket designs, are typically used in single and dual string completions. The round-body mandrels are full-opening mandrels commonly used in high-pressure environments and special-clearance applications.

Each mandrel features a standard side pocket profile to receive gas lift valves, chemical injection valves, circulating valves, dummy valves, dump kill valves, and related equipment. Several different pocket porting configurations are available for applications such as water flood injection, chamber lift, chemical injection and annular flow.

Standard Porting Configuration

Tubing Flow Casing Flow Chamber Lift Waterflood Injection



Side Pocket Mandrel





M and F Series Side Pocket Mandrels

SIDE POCKET MANDRELS

Flowco Production Solutions M and F series Side Pocket Mandrels feature an oval-body design and are installed as a component of the tubing string whereby the pocket acts as a landing nipple for retrievable gas lift equipment. The mandrel's pocket is offset from the bore of the tubing, allowing post-completion tools to pass through the mandrel without restriction.

Several mandrel configurations include an integral orienting sleeve to position the kick over tool to the mandrel's side pocket for precise alignment and installation of devices. Mandrels with an orienting sleeve can be installed in both straight and deviated wellbores whereas mandrels without an orienting sleeve can only be installed in straight wellbores.

M Series Side Pocket Mandrels

The mandrels in this series feature machined pockets and guards. Several mandrel configurations with 1" and 1-1/2" I.D. pockets are available.

- + 1D and 1.5D models with 1" and 1-1/2" I.D. pockets and no orienting sleeves. The 1.5D model has a 360° A-type latch pocket profile.
- + 1D-SO and 1.5D-SO models with 1" and 1-1/2" I.D. pockets and integral orienting sleeves. The 1.5D-SO model has a 360° A-type latch pocket profile.
- + 1.5 DG and 1.5 DG-SO models with 1-1/2" I.D. pockets and 180° G-type pocket profiles. The 1.5 DG-SO model includes an integral orienting sleeve.

F Series Side Pocket Mandrels

This series features a one-piece forged pocket/deflector, 1" pocket I.D., and a 180° latch pocket profile.

- + 1F model with a 1" I.D. pocket and no orienting sleeve
- + 1F-SO model with a 1" I.D. pocket and an integral orienting sleeve

Applications

Used as an internal receiver for the installation and retrieval of gas lift valves and related equipment without having to pull or rerun the tubing string. Can be installed in deviated or straight well bores depending upon the mandrel model type. The external shape of these oval-body mandrels make them ideal for dual completion applications.

Features

- + Oval-body design
- + Machined pocket and guards (M Series)
- + One-piece forged pocket/deflector (F series)
- + Models with and without a slotted orienting sleeve to accommodate setting and retrieving in straight and deviated wellbores
- + Tubing-string connection threaded on both swaged sections with appropriate terminal threads
- + Accepts standard gas lift equipment for pocket configuration
- + Variety of pocket configurations for specialized applications
- + Drift I.D. compatible with tubing connection drift in most tubing thread types, sizes and weights
- + Available in standard or H2S service
- + 4130 material is standard and with other materials are available upon request

M-Series F-Series

R, H, and U Side Pocket Mandrels

SIDE POCKET MANDRELS, ROUND BODY

The Flowco Production Solutions R, H, and U Series Side Pocket Mandrels feature a round-body design with machined pocket and guards. These mandrels are installed as a component of the tubing string whereby the pocket acts as a landing nipple for retrievable gas lift equipment. The mandrel pocket is offset from the bore of the tubing, allowing post-completion tools to pass through the mandrel without restriction.

The round-body design offers higher "burst and collapse" pressure ratings than most oval-body designs. Special clearance and high-pressure features are incorporated into specific series and models. Several configurations include an integral orienting sleeve to orient the kickover tool to the mandrel side pocket for precise alignment and installation of devices.

Mandrels with an orienting sleeve can be installed in both straight and deviated wellbores.

Mandrels without an orienting sleeve can only be installed in straight wellbores.

R Series Side Pocket Mandrels

These round-body mandrels with 1" and 1-1/2" I.D. pockets are available in several configurations.

- + 1R and 1.5R models which have 1" and 1-1/2" I.D. pockets and no orienting sleeves. The 1.5R model has a 360° A-type latch pocket profile.
- + 1R-SO and 1.5R-SO models which have 1" and 1-1/2" I.D. pockets and integral orienting sleeves. The 1.5R-SO model has a 360° A-type latch pocket profile.
- + 1.5RG and 1.5RG-SO models which have 1-1/2" I.D. pockets and 180°

G-type Pocket Profiles

The 1.5RG-SO mandrel includes an orienting sleeve while the 1.5RG mandrel does not.

H Series Side Pocket Mandrels

These high-pressure mandrels have a 1" pocket I.D. and feature an enhanced "burst-and-collapse" pressure rating design for compatibility with most heavy-weight tubulars. This series is primarily used for deep and/or high pressure applications.

- + 1H high-pressure model with a 1" I.D. pocket and no orienting sleeve
- + 1H-SO high-pressure model with a 1" I.D. pocket and an integral orienting sleeve

U Series Side Pocket Mandrels

These mandrels have a 1" pocket I.D. and feature a special clearance O.D. for installation in small casing sizes where standard O.D. mandrels may not be practical.

- + 1U special-clearance model with a 1" pocket I.D. and no orienting sleeve
- + 1U-SO special-clearance model with a 1" pocket I.D. and an integral orienting sleeve

Applications

- + Receptacle for the installation and retrieval of gas lift valves and related equipment without having to pull or rerun the tubing string
- + Deviated or straight well bores based on inclusion of an orienting sleeve
- + Side pocket mandrels are primarily used in single completions
- + Special applications
- + High burst-and-collapse pressure ratings
- + Deep or high pressure applications
- + Special clearance requirements.



R, H, & U-Series



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WIRELINE RETRIEVABLE

R, H, and U Side Pocket Mandrels

SIDE POCKET MANDRELS ROUND BODY



Features and Special Applications

- + Round-body design ideal for special applications
- + Machined pocket and guards
- + Models available with and without a slotted orienting sleeve to accommodate setting and retrieving in straight and deviated well bores
- + Deep and/or high pressure applications (H Series)
- + Special clearance O.D. for installation in small casing sizes where standard O.D. mandrels may not be practical (U Series)
- + Tubing-string connection threaded on both swaged sections with appropriate terminal threads. Special clearance applications may require special thread connections
- + Variety of pocket configurations for specialized applications
- + Drift I.D. compatible with tubing-connection drift in most tubing thread types, sizes and weights
- + 4130 material for standard and H2S service, with other materials available upon request



WIRELINE RETRIEVABLE

Side Pocket Mandrel

SPECIFICATION GUIDE

Side Pocket Mandrel Specification Guide

The chart below will assist in selecting the appropriate mandrel for a given size and application:

PRODUCT IDENTIFICATION			
X X/X	-XX	-XX	-XX
Tubing Size	Valve Size	Body Pipe Shape	Config. Options
Tubing Size			Per customer requirements
Valve Size	1	1" Valve Outside Diameter	
	1.5	1.5" Valve Outside Diameter	
Body Pipe Shape			
F	Oval Forged Pocket		
M	Oval, Machined, Pocket		
R	Round		
H	High Pressure		
U	Special Clearance – Round		
Type Configuration			
G	"G" 180° Latch Profile		
SO	Selective – Orienting With Guards		
W	Waterflood		
CI	Chemical Injection		
CIS	Chemical Injection with Snorkel		
E	Chamberlift Installation		
EC	Casing Flow		



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Side Pocket Mandrel

SPECIFICATION GUIDE

Tubing Size		Mandrel Pocket I.D.	Mandrel Body Design	Mandrel Series		Major O.D.		Minor O.D.		Drift				
				Mandrel Type	Assembly Number	in.	mm	in.	mm	in.	mm			
in.	mm	in.	mm											
2.375	60.3	1.000	25.4	Oval	SPMO-1.0M	1-110121-X0-XXX	4.250	108	2.910	73.9	1.901	48.3		
					SPM-1.0M	1-111121-X0-XXX								
					SPMO-1.0F	1-110111-X0-XXX								
					SPMO-1.0M-CI	1-110125-X0-XXX								
					SPMO-1.0F-CI	1-110115-X0-XXX								
		1.500	38.1	Round	SPMO-1.0R	1-110251-X0-XXX	4.125	104.8	N/A	N/A				
					SPMO-1.0R	1-110271-X0-XXX	4.500	114.3						
					SPMO-1.0R	1-110221-X0-XXX	3.850	97.8						
					SPM-1.0R	1-111211-X0-XXX	3.750	95.3						
		1.500	38.1	Oval	SPM-1.5M	1-211121-X0-XXX	4.750	120.7	4.000	101.6	2.347	59.6		
					SPMO-1.5M	1-210121-X0-XXX								
2.875	73.0	1.000	25.4	Oval	SPMO-1.0M	1-120121-X0-XXX	4.750	120.7	4.000	101.6	2.347	59.6		
					SPM-1.0M	1-121121-X0-XXX								
					SPMO-1.0F	1-120111-X0-XXX								
					SPMO-1.0M-CI	1-120125-X0-XXX								
					SPMO-1.0F-CI	1-120115-X0-XXX								
		1.500	38.1	Round	SPMO-1.0R	1-120261-X0-XXX	5.000	127.0	N/A	N/A				
					SPMO-1.0R	1-120251-X0-XXX	4.750	120.7						
					SPMO-1.0R-CI	1-120255-X0-XXX	5.250	133.4						
					SPMO-1.0R	1-120231-X0-XXX	4.500	114.3						
		1.500	38.1	Oval	SPMO-1.5M	1-220121-X0-XXX	5.500	139.7	4.593	116.7	2.867	72.7		
					SPM-1.5M	1-221121-X0-XXX								
					SPMO-1.5M-WF	1-220124-X0-XXX								
					SPMO-1.5F	1-220111-X0-XXX								
					SPMO-1.5F-WF	1-220114-X0-XXX								
		1.500	38.1	Round	SPMO-1.5R	1-220251-X0-XXX	5.500	139.7	N/A	N/A				
3.500	88.9	1.000	25.4	Oval	SPMO-1.0M	1-130121-X0-XXX	5.313	135.0	4.125	104.8	2.867	72.7		
					SPM-1.0M	1-131121-X0-XXX								
					SPMO-1.0F	1-130111-X0-XXX								
					SPMO-1.0M-CI	1-130125-X0-XXX								
					SPMO-1.0F-CI	1-130115-X0-XXX								
		1.500	38.1	Round	SPMO-1.0R	1-130261-X0-XXX	5.750	146.1	N/A	N/A				
					SPMO-1.0R	1-130251-X0-XXX	5.500	139.7						
					SPMO-1.0R-CI	1-130255-X0-XXX	6.000	152.4						
		1.500	38.1	Oval	SPMO-1.5M	1-230121-X0-XXX	5.968	151.6	5.000	127	2.867	72.7		
					SPM-1.5M	1-231121-X0-XXX								
					SPMO-1.5M-WF	1-230124-X0-XXX								
					SPMO-1.5F	1-230111-X0-XXX								
		1.500	38.1	Round	SPMO-1.5R	1-230251-X0-XXX	5.968	150.8	N/A	N/A				
					SPMO-1.5R-CI	1-230255-X0-XXX	6.438	163.5	N/A	N/A				
					SPMO-1.5R	1-230231-X0-XXX	5.800	147.3	N/A	N/A				

Side Pocket Mandrel

SPECIFICATION GUIDE

Rated Test Pressures							
Standard Service				Sour Service			
Internal Test		External Test		Internal Test		External Test	
psi	bars	psi	bars	psi	bars	psi	bars
8,000	551.5	6,000	413.7	6,000	413.7	4,000	275.8
						5,000	344.7
						4,000	275.8
						5,000	344.7
11,500	792.9	11,500	792.9	9,500	655.0	9,500	655.0
13,500	930.2	13,500	930.2	12,000	827.4	11,000	758.4
6,000	413.7	3,600	248.2	5,000	344.7	3,300	227.5
6,000	413.7	4,750	327.5	5,000	344.7	4,000	275.8
8,000	551.5	6,000	413.7	6,000	413.7	4,000	275.8
						5,000	

Side Pocket Mandrel

SPECIFICATION GUIDE

Tubing Size		Mandrel Pocket I.D.		Mandrel Body Design	Mandrel Series		Major O.D.		Minor O.D.		Drift			
					Mandrel Type	Assembly Number	in.	mm	in.	mm	in.	mm		
4.500	114.3	1.000	25.4	Oval	SPMO-1.0M	1-140121-X0-XXX	6.437	163.5	5.500	139.7	3.833	97.4		
					SPMO-1.0F	1-140111-X0-XXX	6.437	163.5						
				Round	SPMO-1.0R	1-140251-X0-XXX	6.625	168.3	N/A	N/A				
					SPMO-1.0R	1-140231-X0-XXX	6.375	161.9						
					SPMO-1.0R	1-140211-X0-XXX	5.984	152.0						
					SPMO-1.0R	1-140221-X0-XXX	6.125	155.6						
					SPMO-1.0R-CI	1-140225-X0-XXX	6.625	168.3						
				1.500	SPMO-1.5M	1-240121-X0-XXX	7.031	178.6	6.080	154.4				
					SPMO-1.5F	1-240111-X0-XXX								
					SPMO-1.5R	1-240251-X0-XXX	7.031	178.6						
					SPMO-1.5RSB	1-240451-X0-XXX								
					SPMO-1.5R-CI	1-240255-X0-XXX	7.531	191.3						
					SPMO-1.5RSB-CI	1-240455-X0-XXX								
5.500	139.7	1.500	38.1	Oval	SPMO-1.5M	1-250121-X0-XXX	7.938	201.6	6.812	173	4.653	118.2		
					SPMO-1.5F	1-250111-X0-XXX								
				Round	SPMO-1.5R	1-250251-X0-XXX	7.740	196.6	N/A	N/A				
					SPMO-1.5RSB	1-250451-X0-XXX								
					SPMO-1.5R	1-250261-X0-XXX	7.875	200.0						
					SPMO-1.5RSB	1-250461-X0-XXX								
					SPMO-1.5R-CI	1-250255-X0-XXX	8.240	209.3						
					SPMO-1.5RSB-CI	1-250455-X0-XXX								
					SPMO-1.5R-CI	1-250265-X0-XXX	8.375	212.3						

* For mandrel designations not shown above, please contact your local Flowco Representative

Side Pocket Mandrel

SPECIFICATION GUIDE

Rated Test Pressures								Latch Type		Kickover Tool					
Standard Service				Sour Service											
Internal Test		External Test		Internal Test		External Test									
psi	bars	psi	bars	psi	bars	psi	bars								
7,500	517.1	6,000	413.7	6,000	413.7	4,000	275.8	BK-2 BEK-2 INTEGRAL	OK-1 MERLA KOT-1						
7,000	482.6	5,000	344.7												
12,000	827.4	10,000	689.5	9,500	655.0	8,500	586.1								
10,000	689.5	8,500	586.1	9,000	620.5	8,000	551.5								
8,000	551.5	5,500	379.2	6,000	413.7	5,000	344.7								
9,000	620.5	6,000	413.7	7,200	496.4	5,500	379.2								
9,000	517.1	6,000	413.7	7,200	496.4	5,500	379.2								
11,500	792.9	11,500	723.9	9,000	620.5	9,000	620.5								
7,500	517.1	6,000	413.7	6,000	413.7	5,000	344.7	RK RKP	OM-1 KOT-2						
8,500	586.1	7,000	482.6	6,500	448.2	5,500	379.2								
10,000	689.5	9,000	620.5	8,500	586.1	7,500	517.1								
10,750	741.2	9,100	627.4	9,000	620.5	7,800	537.8								
10,000	689.5	9,000	620.5	8,500	586.1	7,500	517.1								
10,750	741.2	9,100	627.4	9,000	620.5	7,800	537.8								





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**Gas Lift Plunger Lift Downhole Gauges
NitroGen® Automation
Capillary Injection**

US Service Centers

Bee Branch, AR	Carlsbad, NM	Bridgeville, PA	Midland, TX
Greeley, CO	Ardmore, OK	Williamsport, PA	New Waverly, TX
Rifle, CO	Eufaula, OK	Cleburne, TX	Overton, TX
Lafayette, LA	Lindsay, OK	Haslet, TX	San Angelo, TX
Watford City, ND	Oklahoma City, OK	Houston, TX	Weatherford, TX
Aztec, NM	Woodward, OK	La Vernia, TX	Douglas, WY
			Rock Springs, WY

Canadian Service Centers

Edmonton, AB Edson, AB Rocky Mountain House, AB