Baker Hughes

Flow Control Systems

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INTRO TO HANDBOOK

Baker Hughes is a leader in well completion and intervention solutions that help exploration and production companies maximize the value of their oil and gas assets by optimizing recovery while reducing capital and operating expense. Baker Hughes was founded over 100 years ago on a simple, fundamental commitment to help our customers solve their oilfield problems by bringing them the highest quality and best performing products and services. Honoring that commitment and providing flawless execution at the well site continues to distinguish us from our competitors a century later. We believe that integrity is at the heart of our organization and that teamwork leverages individual strengths and contributes to our performance culture. We also believe that learning is never finished and that we can continue to grow and improve—as individuals and as a company—through learning. These are the principles that help guide us in our actions and decisions every day. Delivering unmatched value to our customers by meeting—and sometimes exceeding—their needs and expectations is our ultimate goal. Baker Hughes is a Fortune 500 energy technology company and one of the most respected names in the oil and gas service industry. Baker Hughes companies provide best-in-class technology and services in over 120 different countries to help take energy forward.

Flow Control Systems

"We will be the clear flow control market leader by developing downhole tools that enable completion flexibility for our customers, are the simplest to operate, and have the industry's highest ratings and validations."

- Baker Hughes flow control product line strategy statement

Baker Hughes is dedicated to designing, manufacturing, distributing and marketing best in class flow control products and services to support the global oil and gas industry. Flow control products and systems control fluid flow between casing and tubing and within the tubing to help ensure optimum production, minimize equipment repairs, reduce rig downtime and extend well life. Baker Hughes has strategically assembled an extensive product line portfolio that includes industry standards such as the Sur-Set locking system, CM sliding sleeves and the Velox velocity and straddle system. Ongoing new product research and development continually expands both the breadth and depth of solutions available to the industry. Baker Hughes has the depth of experience in sales, operations, engineering and manufacturing to be trusted to meet today's flow control demands. A network of global sales and service locations ensures personalized service throughout the world. State-of-the-art research and engineering centers in Houston, and manufacturing centers in the USA, UK, Dubai and Singapore deliver performance-based, quality products.

The Baker Hughes flow control product line portfolio includes:

- Locking systems with flow control devices (blanking plugs, check valves, chokes, etc.)
- Production sliding sleeves
- Nipple-less flow control products
- Flow regulators and flow control accessories

Sur-Set Flow Control System

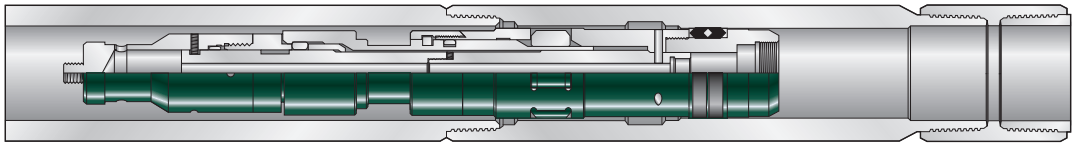
Application

The **Sur-Set™ flow control system** is a unique flow control lock and nipple system that derives its name from the product's unique capability of the running tool not releasing from the lock unless it is completely set. This is a critical feature for long reach and highly deviated wells. By using Sur-Set, the wireline operator is assured that the lock is properly set in the nipple, or the running tool will bring it back to the surface.

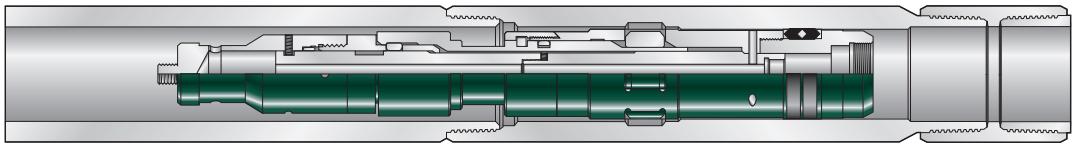
Sur-Set lock mandrels are generally based on a no-go design which gives a positive indication of the location of the nipple. A selective version may also be offered. The no-go shoulder is used for positioning only. Once the locking dogs are fully set the no-go shoulder is free from all pressure. When running in, the lock slides into the nipple profile, contacts the nipple's no-go shoulder and stops in the precise position. Jarring down begins the expansion of the dogs into the nipple groove. When the flow control device is fully set the locking dogs take the weight off the no-go shoulder. All pressure from above and below is now resting on the locking dogs. This was designed to eliminate operators' concerns about pressure ratings, reliability of setting and retention of flow control devices inside high-volume wells. Sur-Set draws on our past experience with many different types of lock mandrel designs, as well as comparisons of competitive products to address these problems.

Sur-Set can be used to secure flow control devices such as blanking plugs, check valves, chokes, gauges and other flow control devices in strategic locations within the completion string by use of seating nipples. The system is composed of three major components; a nipple profile located in the production string, a locking mandrel containing the flow control device, which is used to locate and lock into the production seating nipple, and the running tool which allows the lock to remain attached if not properly set in the correct seating nipple.

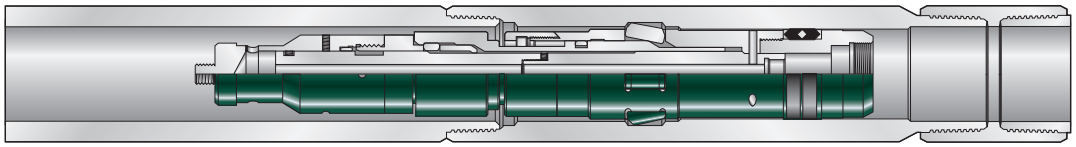
Sur-Set Flow Control System



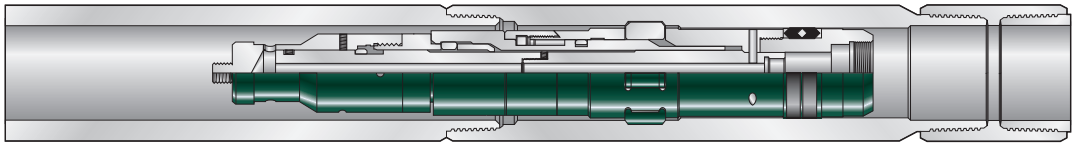
1) Seals meet sealbore



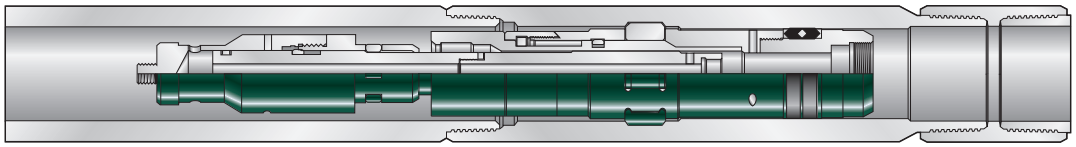
2) Tap down slightly until no-go is reached



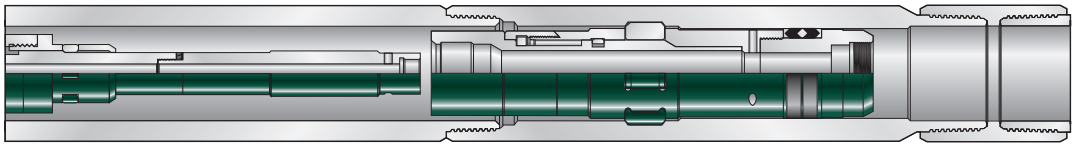
3) Jar down shear screws on running tool, rotate dogs



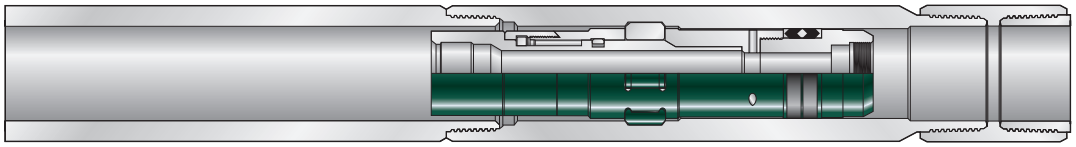
4) Continue to jar down rotated dogs lift lock of no-go,
all loads now taken by dogs, take overpull to ensure lock is set



5) Jar up to Shear D probe pin



6) Pull out of hole



7) Lock fully set

Sur-Set Top/Bottom No-Go and Selective Seating Nipples

Product Family No. H83507

Application

The Baker Hughes **top and bottom no-go seating nipples** provide for the location of various wireline flow control devices in the production string. The nipple's no-go shoulder is used to help locate and set the **Sur-Set™ lock**, but is unloaded once the setting operation is completed.

The top no-go seating nipple is designed to accept only those top no-go type locks which carry the same letter designations as the seating nipple, either either **Model AF™, Model HF™**, or extreme depending upon the required pressure rating.

The bottom no-go seating nipple is designed to accept only those bottom no-go locks and accessories which carry the same letter designations as the seating nipple, either **Model AR™, Model HR™**, or **Extreme R™**, depending on the required pressure rating.

The selective nipples allow for selective setting of Sur-Set lock mandrels, resulting in the ability of running a single size sealbore diameter to be installed along the tubing string.

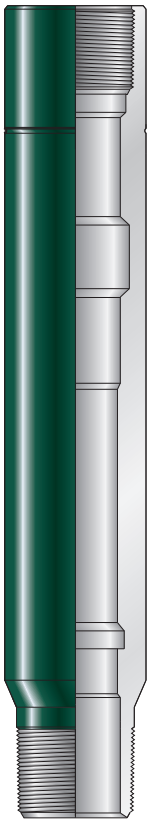
The location and number of seating nipples should be carefully considered in the completion planning stages to allow maximum versatility in the positioning of various flow control accessories.

These nipples are manufactured per NACE specification MR0-175 (latest revision).

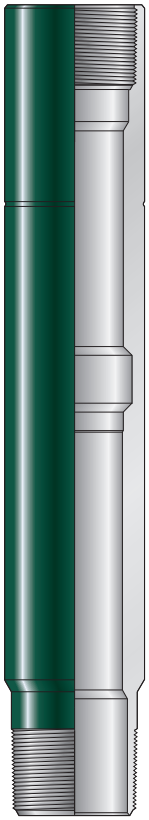
- Land blanking plugs to shut in the well or to test the production tubing
- Land velocity type safety valves (SSCSV)
- Land equalizing check valves
- Land circulating blanking plugs
- Land chokes to reduce surface flowing pressures or to have pressure drops downhole to prevent surface freezing in gas production
- Land instrument hangers with geophysical devices such as pressure and temperature recorders

Advantages

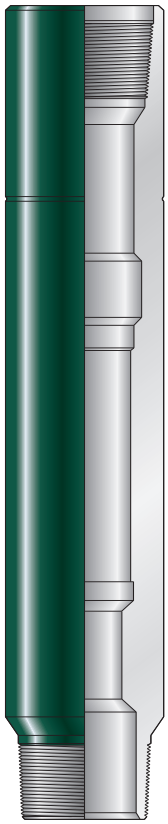
- Manufactured in materials to match the production tubing string with standards 4140 22 RC and 13% Chrome
- Honed sealing bores for maximum sealing performance
- Sealbore - contoured and polished to pass chevron packing without damage
- Integral locking groove
- Extended upper nipple bore eliminates pre-setting
- Simple design
- Available in API and premium threads
- Pressure rating independent of no-go wear



Model A-1 Selective Seating Nipple



Model AF Top No-Go Seating Nipple



Model AR Top No-Go Seating Nipple

Sur-Set Locking Mandrels

Product Family No. H83506

Application

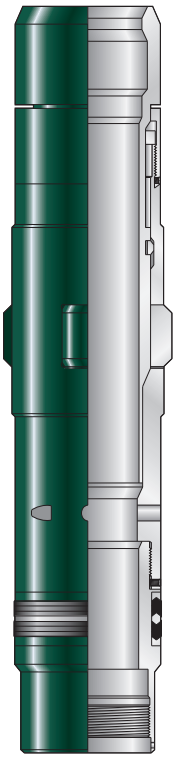
The Baker Hughes **Models AF™, HF™,** and **Extreme type lock assemblies** are top no-go style locks. With a no-go shoulder located just below the locking dogs, these locks will land and lock flow control devices in the models AF, HF, and extreme type top no-go seating nipples. Lock selection should be compatible with the size and model designation (based on designed pressure rating) of the selected seating nipple.

The Baker Hughes **Models AR™, HR™**, and **Extreme R™ lock assemblies** are bottom no-go style locks. These locks have a no-go shoulder either on the packing mandrel or, in cases where packing is not required, it is located on the flow control accessory. These locks will land and lock flow control devices only in the Models AR, HR, and extreme R bottom no-go seating nipples. Lock selection should be compatible with the size and model designation (based on designed pressure rating) of the selected seating nipple.

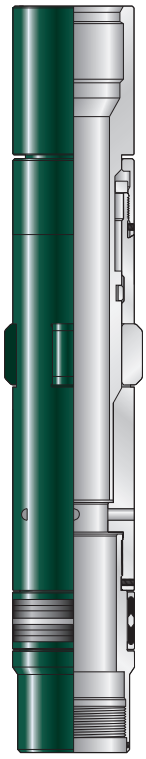
The selective **Sur-Set™ line** uses all the features from the standard top and bottom no-go Sur-Set locking mandrels with the added benefit of maintaining one sealbore diameter for the entire production string. This is accomplished by adding a **Model A-4™** or **Model H-4™ locator** to a Model AR lock. The Sur-Set locking mandrels are run with a **Model A™ running tool**, , and **Model D™ probe**.

Advantages

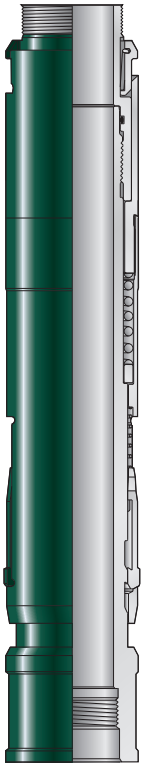
- Simple and rugged construction
- Large pressure bearing locking dogs eliminating no-go shoulder swaging
- Locking mechanism is located above the seating elements, therefore no o-rings are required
- Smooth bore through the lock does not subject the operating mechanism to corrosion or sticking by foreign materials
- Running tool gives a positive indication that the lock is set in the nipple and that the locking operation is complete
- All locks are good for H_2S/CO_2 service at 300°F (148.8°C) with standard seals
- The lock and running tool are compatible with normal wireline equipment and procedures
- Vibration proof



Model AF Top No-Go Lock Mandrel
Product Family No. H83506



Model AR Bottom No-Go Lock Mandrel
Product Family No. H83506



Model A-4 Selective Locator
Product Family No. H83562

Model H Bottom Blanking Plug

Product Family No. H83509

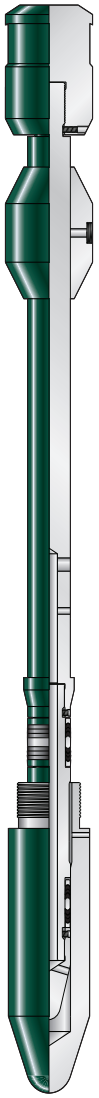
Application

The **Model H™ bottom blanking plugs** with removable mandrel are positive blankoff devices designed to seal off pressure from above and below. These plugs are for use in wells where sand or sediment might be encountered. The plugs have a removable mandrel which protrudes from the fishing neck of the lock so that a sand bailer can expose it for retrieval. It can also be supplied with an internal fishing neck junk catcher for enhanced debris management. The Model H bottom blanking plug may be used with either the top no-go or bottom no-go type locks and is available in a wide range of pressure settings. The plug, with the selected lock attached, is run in and set without the removable mandrel in place, thus, providing a large fluid bypass area and allowing fast run-in times.

The mandrel is then run in and landed inside the plug, blanking-off the bypass ports. Equalization is accomplished by pulling the removable mandrel from the plug and opening the bypass ports to pressure. The plug itself is then pulled using conventional pulling tools.

Advantages

- Integral seal carried on removable mandrel
- Standard running and pulling
- Debris tolerant
- Positive shut off
- Available for HP/HT applications
- Provides positive indication that lock is set in nipple profile



Model H Bottom Blanking Plug
Product Family No. H83509

Model M Bottom Blanking Plug

Product Family No. H83541

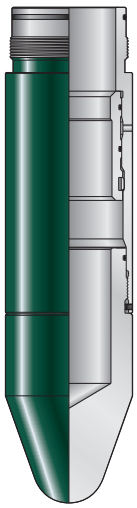
Application

The **Model M™ Sur-Set™ single-trip bypass blanking plugs** are positive blankoff devices designed to seal off pressure from above and below. These plugs consist of a Model M bottom assembled to a Sur-Set lock. The Model M plugs are designed to be run in one wireline trip and equalized and retrieved in two trips. Equalization is obtained by running in the well with a **Model A™ guide**, and equalizing prong. Another trip is required to retrieve the plug with a **Model GS™ type pulling tool**. The Model M plugs are run in with a Model A running tool, a **Model D™ probe** and a **Model MH™ positioning tool**.

While running in, the inner mandrel of the Model M is held in the down position allowing fluid bypass until the plug is locked into the seating nipple. The ports in the plug are closed only after the lock is landed and completely set in the proper setting nipple.

Advantages

- Single-trip installation
- Ideal for gas wells
- Provides positive indication that lock is set in nipple profile



Model M Bottom Blanking Plug
Product Family No. H83541

Model L Bottom Circulating Blanking Plug

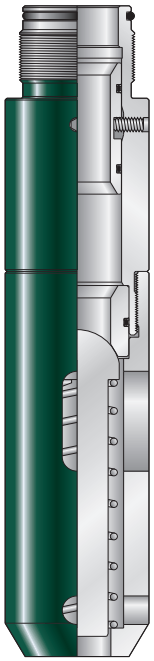
Product Family No. H83540

Application

The **Model L™ bottom circulating blanking plug** is a positive blankoff device run on the bottom of **Sur-Set™ lock** designed to seal off pressure from below while allowing circulation through the plug from above. The circulating plugs are run in a well with the use of a hold open prong. The prong is designed to hold the plunger off-seat allowing fluid bypass. The circulating plug includes a mechanical equalizing sub used to equalize any pressure below the plug before the device is removed.

Advantages

- Provides positive indication that lock is set in nipple profile
- Equalizing sleeve
- One-trip to run
- Provides ability to circulate
- Holds pressure from below



Model L Bottom Circulating Blanking Plug
Product Family No. H83540

Pump-Open Blanking Plug

Product Family No. H99508

Application

The **pump-open blanking plug** is a device that allows for well pressure to be held from above and below. The plug can be equalized by applying pressure from above to a preset value that shears the shear screws installed in the bottoms outer sleeve. Once the outer sleeve shifts down, this allows for a large flow area to be open for circulation. As a contingency, an internal bypass sleeve may be used for equalization.

Advantages

- Applied surface pressure to equalize
- Provides ability to circulate fluids
- Ideal for horizontal applications
- Variable shear pin capability
- Ideal for high turbulent and gas wells
- Provides a positive indication that lock is set in nipple profile

Pump-Open Blanking Plug
Product Family No. H99508

Model V Bottom Check Valve

Product Family No. H83526

Application

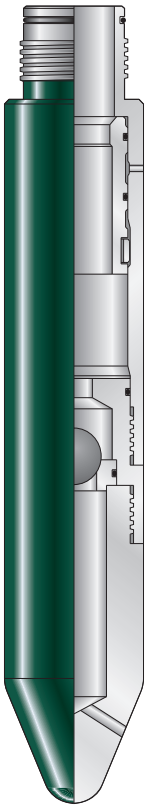
The **Model V™ Sur-Set™ bottom check valves** are designed to prevent downward flow and allow for upward flow. Once the check valve has been landed and locked in a seated nipple, all of the differential applied to the valve is carried by the locking dogs, not the no-go shoulder.

The Model V bottom check valve uses a standard Sur-Set locking mandrel for the seating and locking method and uses a sleeve for bypass and equalization.

The check valves are designed to seat in **Models AF™ and AR™ type seating nipple** profiles. The **Models AFV™** and **ARV™ equalizing check valves** are designed to hold a maximum of 10,000 psi (690 bar) from above. The HP/HT Model V bottom check valves are designed to set in **Model EOF™ seating nipples** and have been tested to 12,500 psi (862 bar) and 330°F (166°C).

Advantages

- Provides a means to pressure test tubing while allowing tubing to fill during run-in
- Provides a plug to set hydraulic set packers
- Provides positive indication that lock is set in nipple profile
- Large flow area
- Fluid bypass for retrieval
- Available for HP/HT application
- One trip to run/one trip to pull



Model V Bottom Check Valve
Product Family No H83526

Model T-2 Check Valve for Sur-Set Seating Nipples

Product Family No. H80963

Application

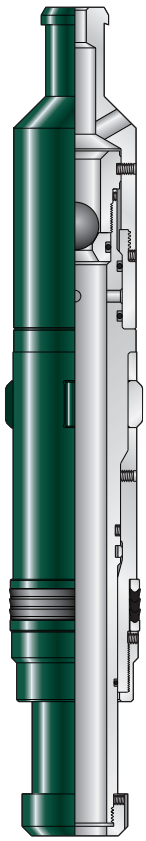
The **Model T-2™ check valves** are designed to prevent downward flow and allow for upward flow. Once the Model T-2 check valve has been landed and locked in a seated nipple all the differential applied to the valve is carried by the locking dogs, not the no-go shoulder.

The T-2 equalizing check valve is run in the hole with a **Model SB™** or **Model JDC™ pulling tool** and not a Baker Hughes **Model A™ running tool**, therefore does not follow the **Sur-Set™ philosophy** of not releasing from the running tool unless the plug is properly set in the nipple profile. If running a check valve and you are required to know that your lock is set correctly in the nipple profile the **Model V™ check valve** bottom may be used.

Equalization of the Model T-2 check valves occur during retrieval. Upward jarring will shear the shear screws in the equalizing sub allowing for equalization; continued jarring will release the locking dogs allowing the check valve to return to surface. This feature is also important for bypass when retrieving the check valve through tight spots or other sealbores within the tubing string.

Advantages

- Provides a means to pressure test tubing while allowing tubing to fill during run-in
- Provides a plug to set hydraulic set packers
- One-trip to run/one-trip to pull



Model T-2 Check Valve for Sur-Set Seating Nipples
Product Family No. H80963

Models C and D Choke Bottoms

Product Family No. H99508

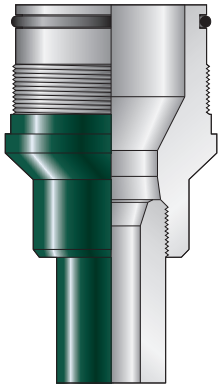
Application

The **Models C™** and **D™ choke bottoms** are designed to be run in conjunction with Baker Hughes **Sur-Set™ locking mandrels**. They are designed to restrict tubing flow from below and are available in various sizes in 1/64-in. (0.40 mm) increments.

The Model C choke bottom has an integral metal component with a specific orifice size. The Model D choke bottom incorporates a ceramic insert orifice bonded into a metal housing, which is ideal for high erosion applications.

Advantages

- Reduces gas-oil ratios under certain conditions
- Prevents freezing of surface controls
- Prolongs the flowing life of a well by controlling bottomhole pressures
- Lessens water encroachment under certain conditions by stabilizing bottomhole conditions



Model C Choke Bottom
Product Family No. H99508

Models SLB and B Instrument Hanger Bottoms

Product Family Nos. H80337 and H80338

Application

The **Model SLB™ instrument hanger** allows for geophysical instruments to be hung in a **Sur-Set™ seating nipple**. The bottom incorporates large flow ports that are equal or greater than the flow area of the smallest inside diameter of the Model SLB instrument hanger.

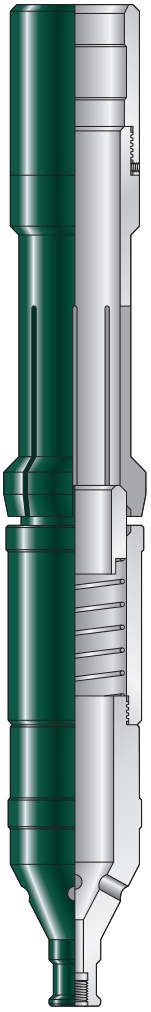
The bottom can be supplied with any thread connection for attachment to commercial memory gauges.

The **Model B™ instrument hanger bottom** allows for geophysical instruments to be hung on the bottom of a Sur-Set locking mandrel. The bottom incorporates large flow ports that are equal or greater than the flow area of the smallest inside diameter of the locking mandrel.

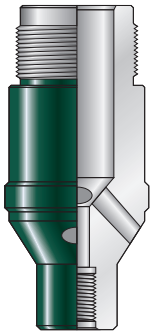
The bottom can be supplied with any thread connection for attachment to commercial memory gauges.

Advantages

- Ability to hang a variety of intruments
- Soft setting prevents jarring through instruments
- Large flow area



Model SLB Instrument Hanger
Product Family No. H80338



Model B Instrument Hanger Bottom
Product Family No. H80337

Model A Running Tool with Model D Probe

Product Family Nos. H81155 and H81156

Application

The **Model A™ running tool** is used to run and set all **Sur-Set™ locking mandrels**. It is designed to prevent accidental setting even if tight spots are encountered while running in the well. The running tool and lock will not separate until the locking dogs on the locking mandrel are fully expanded into the nipple locking profile. If this does occur, the running tool will not release and will bring the lock back out of the well when retrieving the running tool.

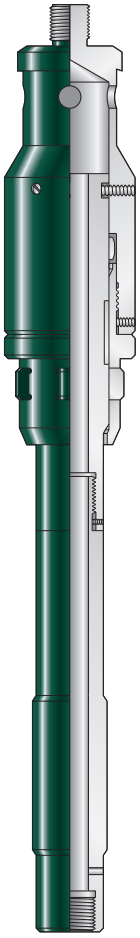
The Model A running tool is designed to be used in conjunction with the **Model D™ probe**.

While running in, the running tool dogs are fastened securely to the lock's internal fishing neck (expander mandrel). If the fishing neck does not travel far enough to completely stroke extending the large locking dogs, the running tool dogs will not retract and the lock will not be released. Both the running tool and lock will be retrieved, indicating a miss-run.

Once the lock sets inside the nipple, the running tool dogs retract and release the fishing neck. The running tool returns to surface after shearing the pin in the Model D probe leaving the lock securely in the seating nipple.

Advantages

- Simple design
- Running tool cannot release from plug unless properly set in its mating profile
- Tell-tale ring provides positive indication of successful lock setting
- Minimal running and retrieving tools requirement



Model A Running Tool
with Model D Probe
Product Family No. H81156

Model MH Positioning Tool

Product Family No. H81254

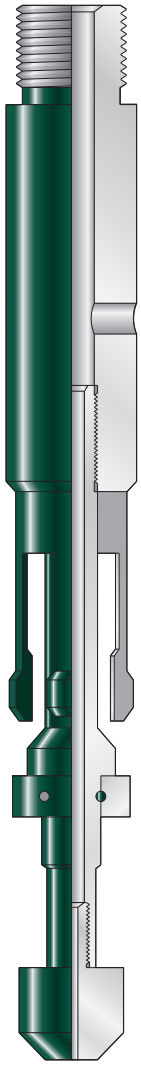
Application

The **Model MH™ positioning tool** is used in conjunction with the Model A running tool and Model D probe when running **Model M™ blanking plug** devices. This assembly attaches to the box thread of the Model D probe. Once the locking mandrel is set and the running tool is retrieved, the collet on the positioning tool shifts the blanking sleeve up closing the bypass ports. This allows the well to be isolated from the point of the plug placement.

The positioning tool is used with other flow control devices that use the Model M bypass sleeve for blanking off the bypass ports of the device.

Advantages

- Provides fluid bypass while running in the hole
- Provides one-trip to run capability
- Compatible with all sur-set equipment



Model MH Positioning Tool
Product Family No. H81254

Hydraulic Model A Running Tool

Product Family No. H81167

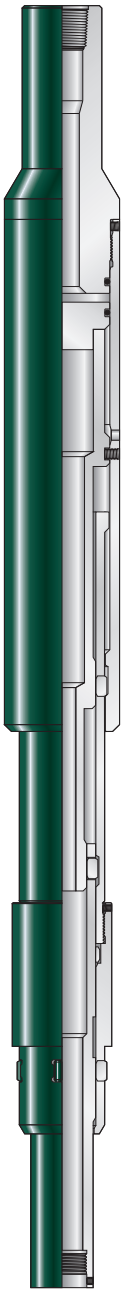
Application

The **hydraulic Model A running tool**, is a hydraulic activated and release running tool designed to run **Sur-Set™ locking mandrels** on coiled tubing or threaded pipe. The running tool is used in conjunction with the **Model D™ probe** and incorporates all features of the standard Model A running tool.

The locking mandrel is run to depth, set-down weight is applied with the coiled tubing, and pressure is then applied to the coiled tubing to shear the shear screws in the running tool and allow the piston to travel down. As the piston strokes down, it sets the locking mandrel while disengaging from the fishing neck. A straight pull or jarring force is then applied after the application of pressure, shearing out the Model D probe and releasing from the set locking mandrel.

Advantages

- Simple design
- Running tool cannot release from plug unless properly set in its mating profile
- Tell-tale ring provides positive indication of successful lock setting
- Minimal running and retrieving tools requirement



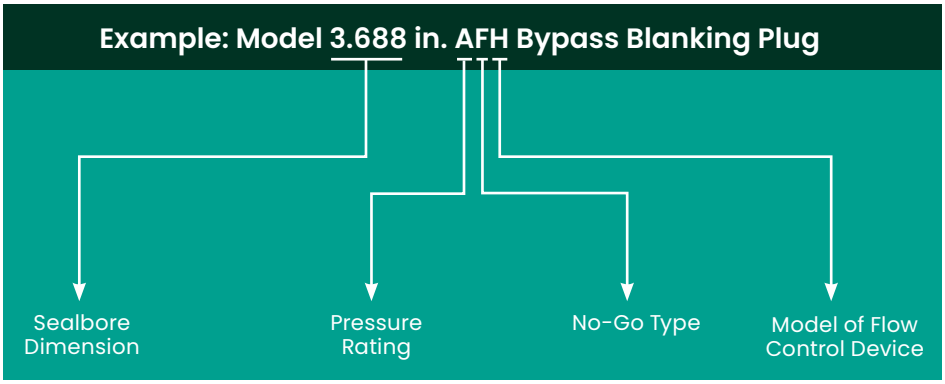
Hydraulic Model A Running Tool
Product Family No. H81167

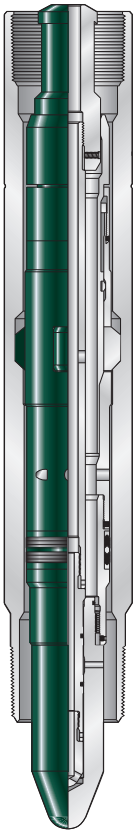
Sur-Set System Identification

Application

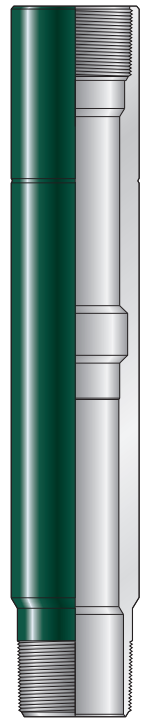
The **Sur-Set™ product line** consists of a wide selection of available flow control accessories. An identification system for any combination of these components has been developed. Identification is made through the use of a series of numbers and model letters, which determine each component.

The first number will determine the sealbore dimension of the nipple and lock. The first letter will identify the pressure rating of the system [A - 10,000 psi (690 bar) from above and below; H - 10,000 psi (690 bar) from above and 15,000 psi (1035 bar) from below, and E "extreme" 15,000 psi (1035 bar) from above and below]. The second letter will generally indicate the no-go type, top no-go "F" (full bore through the nipple) or bottom no-go "R" (restricted bore through nipple). The final letter "H" (blanking plug) indicates the type of flow control accessory.

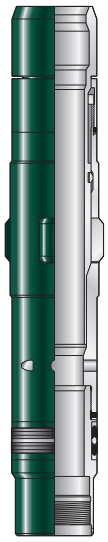




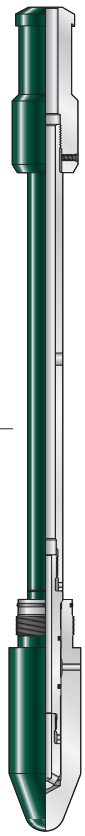
Model AFH Sur-Set Nipple and Plug System



Model AF Nipple



Model AF Lock



Model H Bypass Blanking Plug System

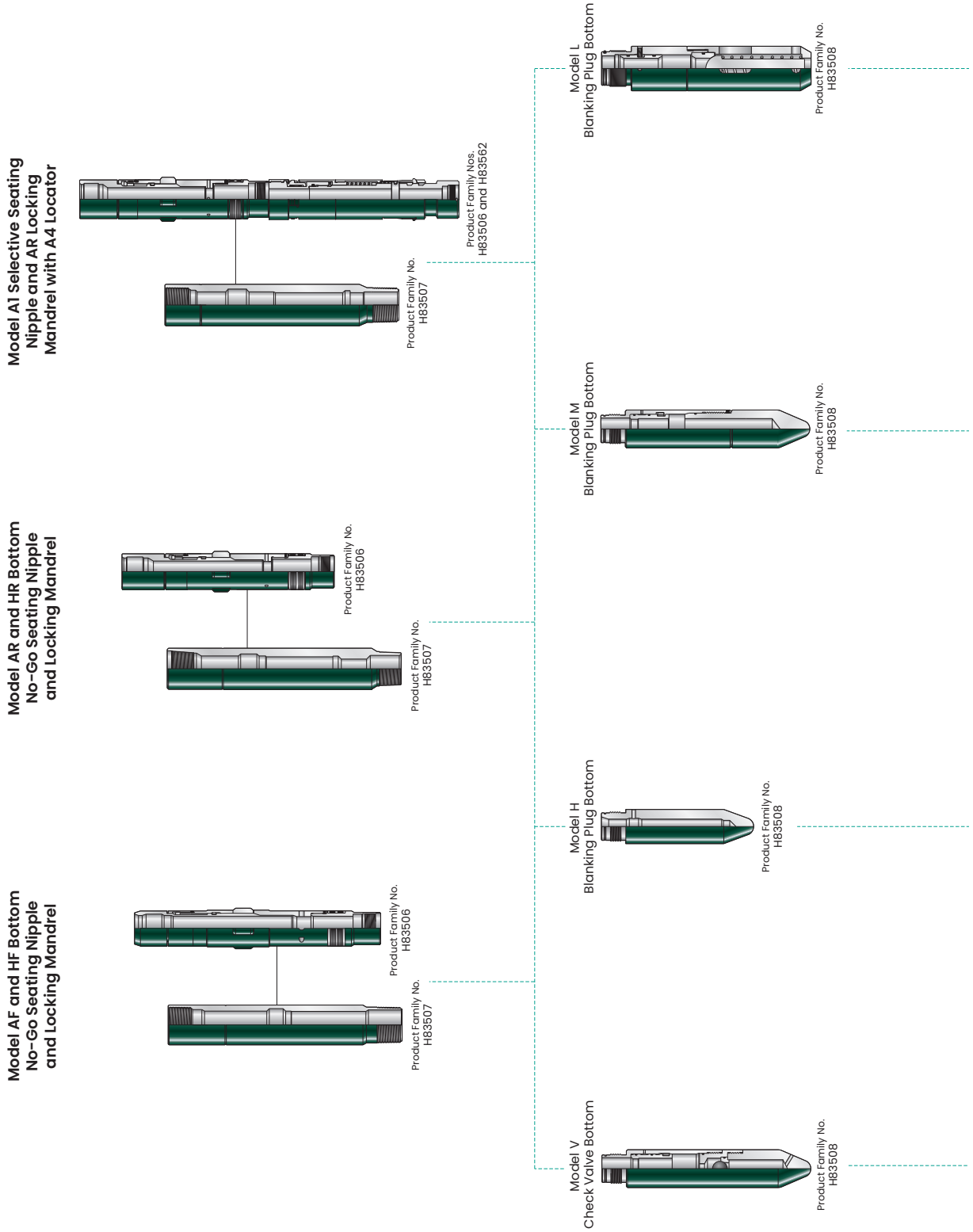
Sur-Set Locking System Nomenclature

Sur-Set Letter Nomenclature		
Lock	**Nipple**	**Definition**
A	A	10k psi from above and below
H	H	10k psi from above and 15k psi from below
E	E	15k psi from above and below
	-1	Selective
	AF/HF	**Nipple -** Full bore, top no-go **Corresponding lock -** Lock OD is larger than packing size designation/seal bore
	AR/HR	**Nipple -** ID restricted bore, bottom no-go **Corresponding lock -** Lock OD is less than the packing designation/seal bore
	EF	**Nipple -** Full bore, top no-go **Corresponding lock -** Lock OD is larger than packing size designation/seal bore
	ER	**Nipple -** ID restricted bore, bottom no-go **Corresponding lock -** Lock OD is less than the packing designation/seal bore

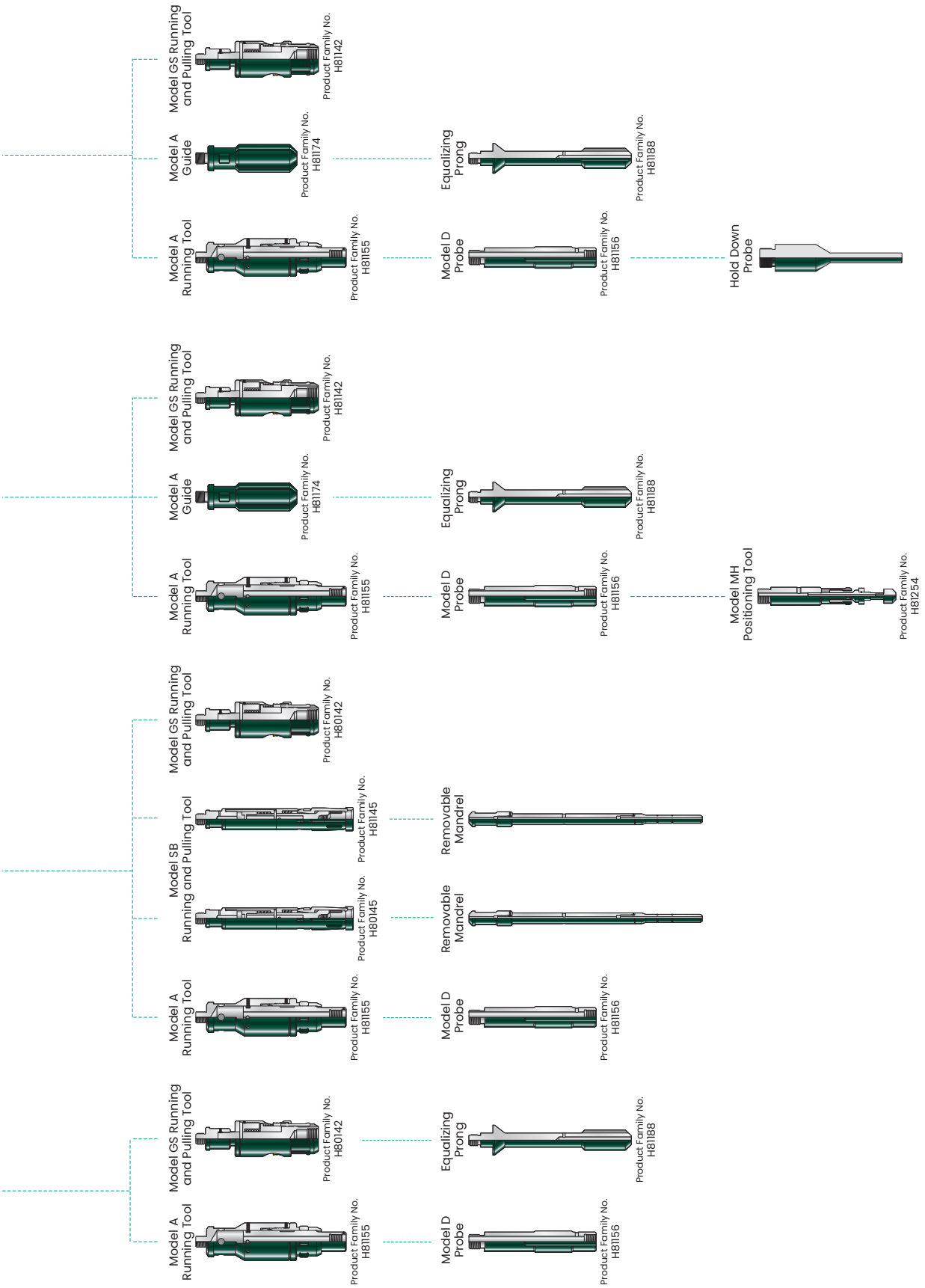
Plugs		
Plugs	**Nipple**	**Definition**
AH	A-1	Plug assembly w/'H' type plug bottom and prong Two trips to run/two trips to pull
AFH	AF	
ARH	AR	
HFH	HF or AF	
HRH	HR or AR	
AFH-ET	AF	Plug Assembly x/'H-ET' type plug bottom and prong 'ET' = extreme temperature Two trips to run/two trips to pull
ARH-ET	AR	
EFH-ET	EF	
ERH-ET	ER	
AM	A-1	Plug assembly w/'M' type plug bottom seal mandrel One trip to run/two trips to pull (option for one trip pull)
AFM	AF	
ARM	AR	
HFM	HF or AF	
HRM	HR or AR	

Check Valve		
Check	**Nipple**	**Definition**
AFV	AF	Run below lock mandrel to hold pressure from above One trip to run/one trip to pull.
ARV	AR	
EFV	EF	
ERV	ER	

Modular Sur-Set Locking System

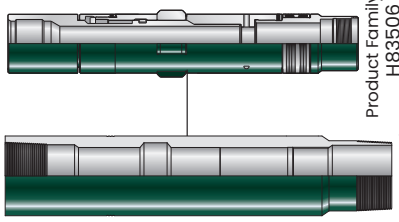


FLOW CONTROL SYSTEMS



Extreme Sur-Set Locking System

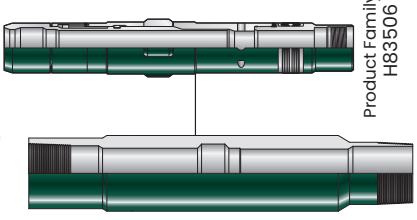
Model ER Bottom No-Go Seating Nipple and Locking Mandrel



Product Family No. H83506

Product Family No. H83507

Model EF Bottom No-Go Seating Nipple and Locking Mandrel



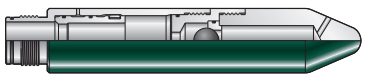
Product Family No. H83506

Product Family No. H83507

Model H-ET Blanking Plug Bottom

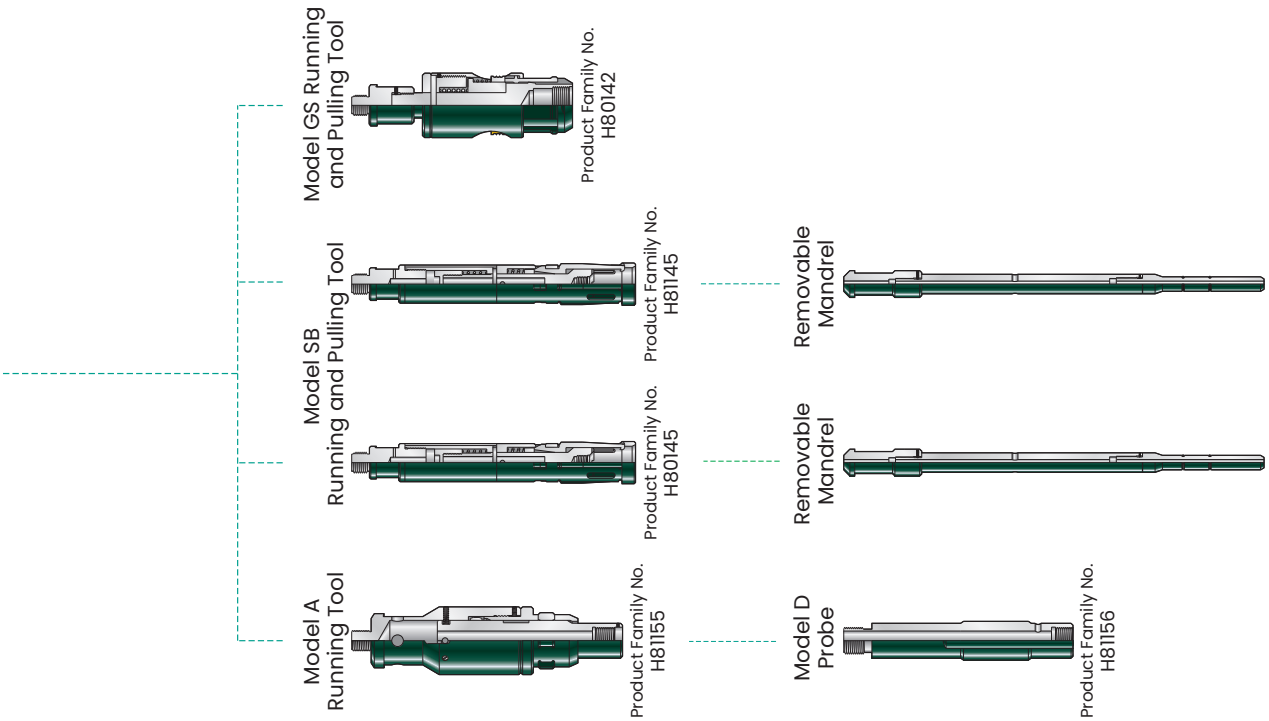
Product Family No. H83508

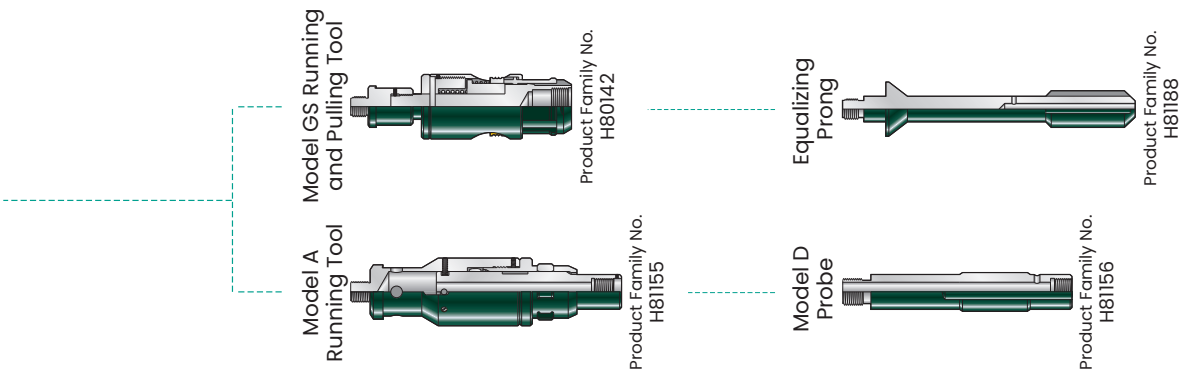
Model V Check Valve Bottom



Product Family No. H83508

FLOW CONTROL SYSTEMS





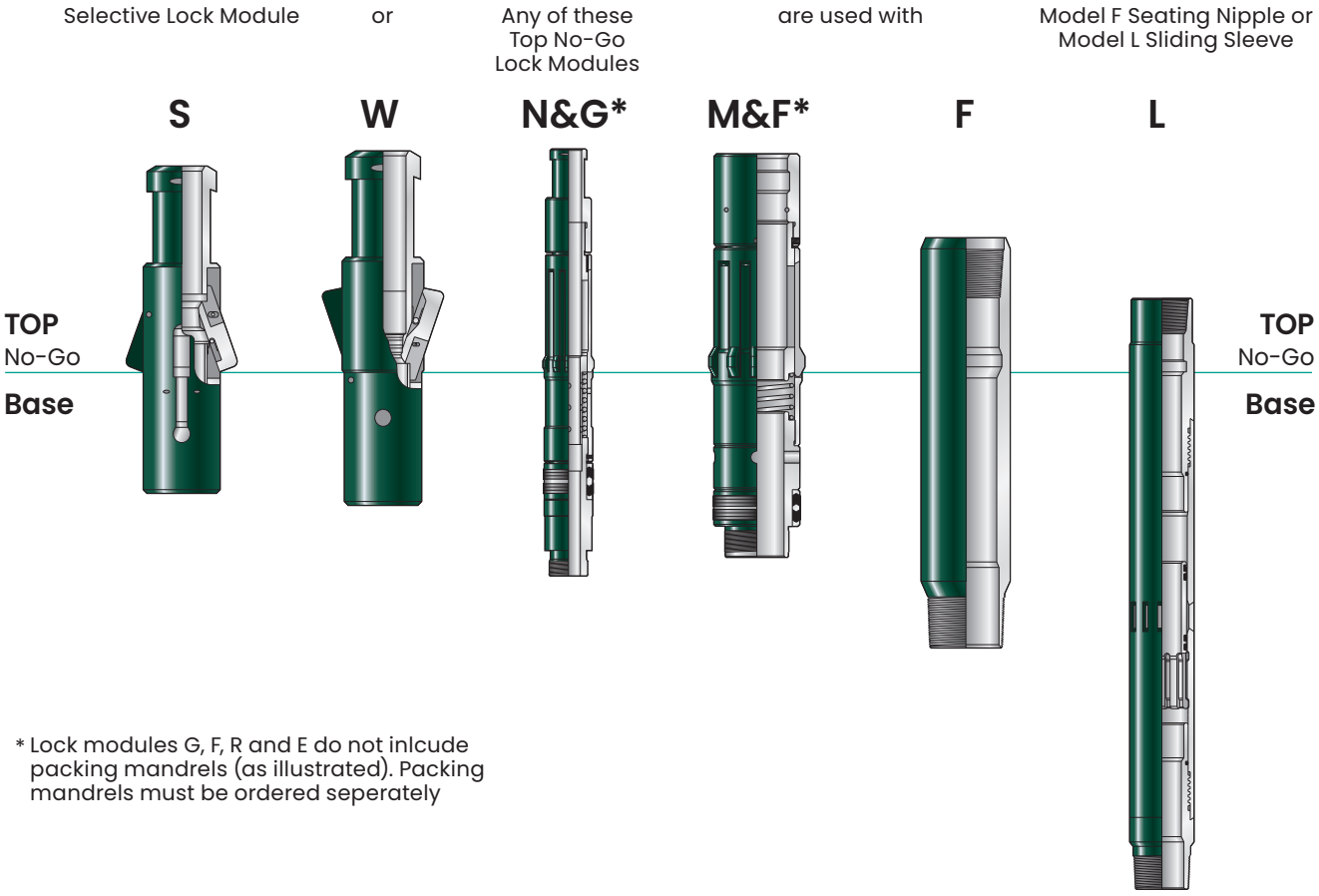
Sur-Set Running/Pulling Tool Guide

Specification Guide

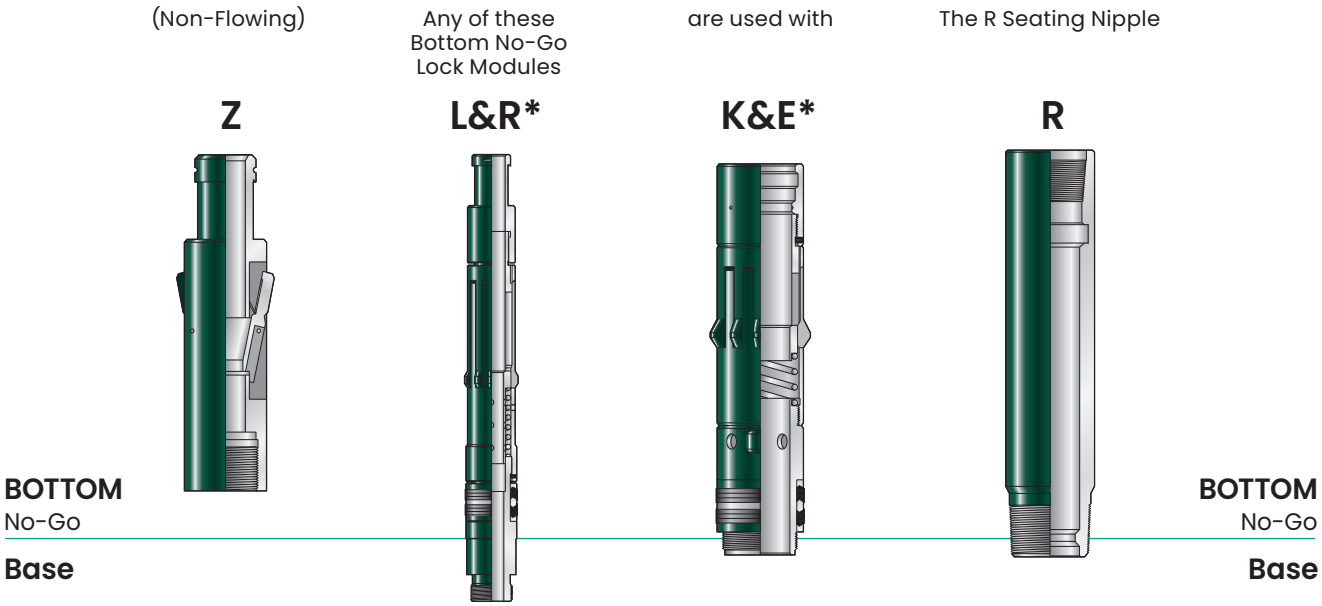
Sealbore		Fishing Neck ID		Model A™ running tool	Model D™ probe for Type A lock	Model D™ probe for Type H lock	Model GS™ pulling tool
in.	mm	in.	mm				
1.710	43.43	1.06	26.92	H811-55-0302	N/A	Built-in with Running Tool	H811-42-1555
1.781	45.24						
1.812	46.02						
1.875 HF	47.63						
1.875 HF	47.63	1.38	35.05	H811-55-0304	H811-56-2300	N/A	H811-42-1875
2.062	52.37			H811-55-3000	N/A	H811-56-3000	
2.125	53.98						
2.188	55.58					H811-56-3200	
2.250	57.15	1.81	45.97	H811-55-3500	H811-56-3500	N/A	H811-42-2315
2.312	58.72				H811-56-3701	H811-56-3704	
2.562	65.07				N/A	H811-56-4101	
2.750	69.85	2.31	58.67	H811-55-0701	H811-56-4300		H811-42-2755
2.812	71.42						
3.125	79.38	2.62	66.55	H811-55-4601	H811-56-4800		H811-42-3125
3.250	82.55						
3.312	84.12				H811-56-5000		
3.347	87.30			H811-55-5200	H811-56-5200		
3.562	90.47						
3.625	92.08				H811-56-5300		
3.688	93.68	3.12	79.25	H811-55-6002	H811-56-5401		H811-42-3685
3.750	95.25						
3.812	96.82				H811-56-5800		
3.875	98.43						
4.000	101.60			H811-55-6003	H811-56-6000		
4.125	104.78						
4.250	107.95						
4.312	109.52						
4.437	112.70				H811-56-6100		H811-42-3865
4.562	115.87	4	101.60	H811-55-1701	H811-56-6700		H811-42-4565
4.750	120.65				H811-56-6900		
5.312	134.92	4.25	107.95	H811-55-7400	H811-56-7300		H811-50-5250 Model M™ pulling tool
5.625	142.88				H811-56-7400		
5.750	146.05			H811-55-1700	H811-56-7500		
5.812	147.62						
5.875	149.23				H811-56-8602		
5.950	151.13			H811-55-6900	H811-56-9000		
6.000	152.40						
8.405	213.49	7.12	180.85	H811-55-8400	H811-56-8400		H811-42-8600

N/A = Non-Applicable.

Flow Control Equipment System



* Lock modules G, F, R and E do not inlcude packing mandrels (as illustrated). Packing mandrels must be ordered seperately



Models F and R Seating Nipples

Product Family Nos. H80150 and H80155

Application

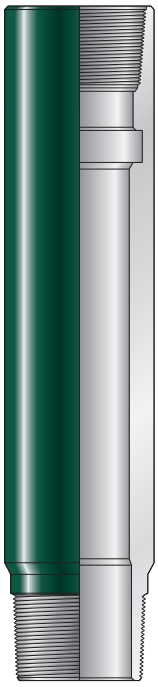
The **Model F™ seating nipple** is a top no-go or selective seating nipple that provides for the location of various wireline flow control devices in the production string. The **Model R™ seating nipple** is a bottom no-go seating nipple that provides for the location of various wireline flow control devices in the production string. The location and number of seating nipples should be carefully considered in the completion planning stages to allow maximum versatility in the positioning of various flow control accessories. Models F and R seating nipples are manufactured per NACE MR0-175. (latest revision)

Models F and Model R seating nipples may be used for the following operations:

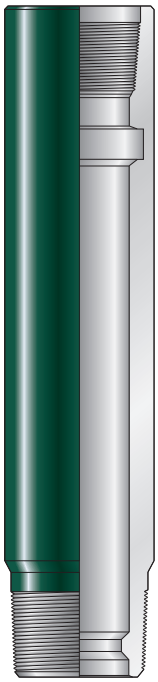
- Land blanking plugs to shut in well or to test the production tubing
- Land velocity type safety valves (SSCSV)
- Land equalizing check valves
- Land circulating blanking plugs
- Land chokes to reduce surface flowing pressures or to have pressure drops downhole to prevent surface freezing in gas production
- Land instrument hangers with geophysical devices such as pressure and temperature recorders
- Prevent loss of wireline workstring in some cases

Advantages

- Material selection - alloy steel, stainless steel and 13% Chrome are heattreated to NACE specifications
- Sealbore - contoured and polished to pass chevron packing without damage
- Integral locking groove
- OD same as coupling OD with properties corresponding to N-80 or better
- Available in API and premium threads
- Nipples ordered with turned-down ODs correspond to turned-down N-80 couplings in diameter and properties



Model F Seating Nipple
Product Family No. H80150



Model R Seating Nipple
Product Family No. H80155

Models F and R Flow Control System

Application

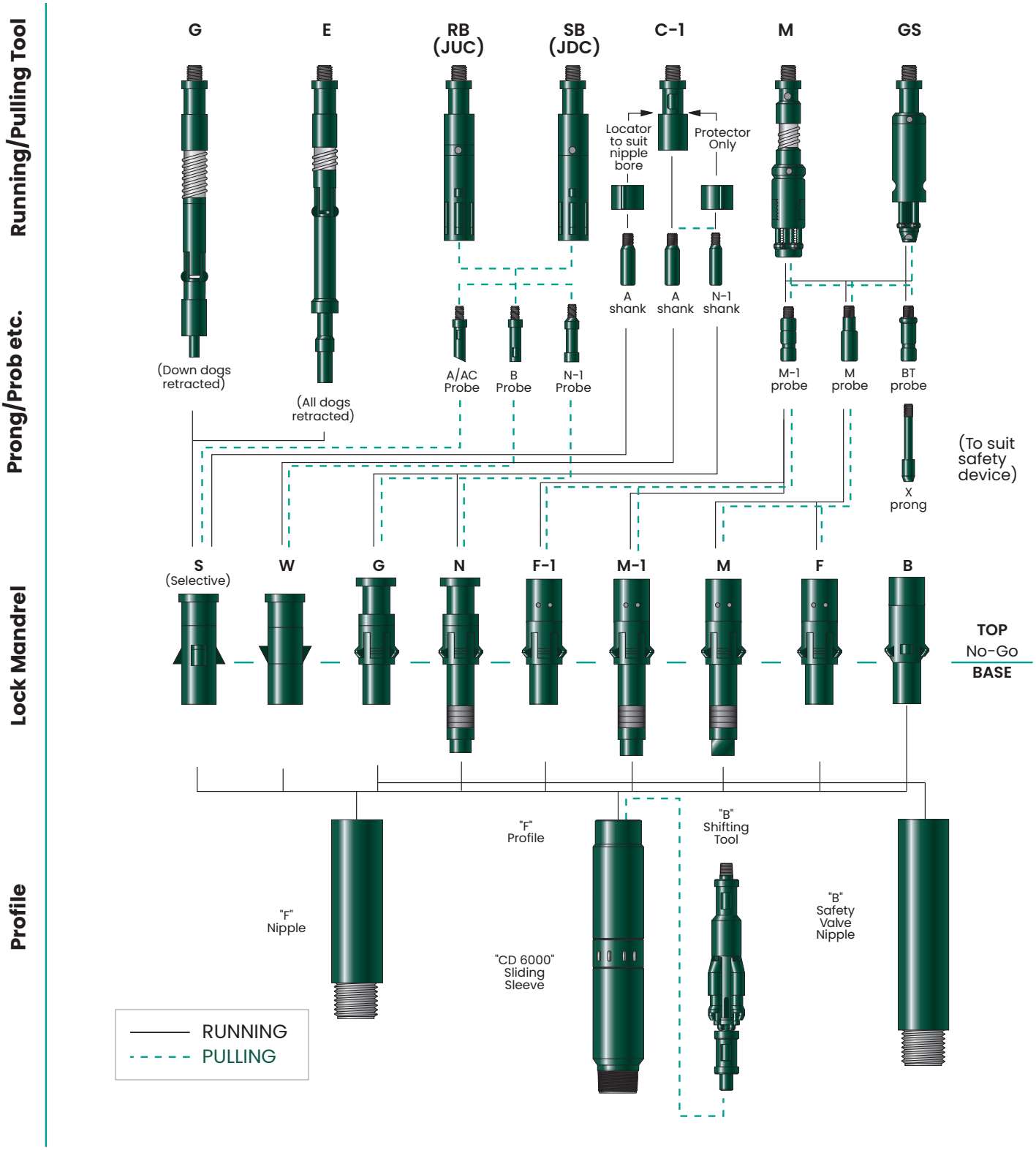
The subsurface control of fluid flow, both tubing to casing and within the tubing is a very important part of efficient completion and production practices. Baker Hughes flow control equipment designed to set in sliding sleeves and seating nipples can be described as consisting of two basic modules. The lock module that holds the product in place and the flow control module. The interchangeability of the two basic components, plus adapters in some cases, means that many specifically tailored products can be assembled together easily and quickly from a minimum number of stocked modules. This interchangeability means that Baker Hughes flow control equipment is both economical as well as versatile.

The basic seating nipple of the Baker Hughes flow control system is the **Model F™ non-ported nipple**. This nipple will accept selective, top no-go, non-flowing, and top no-go flowing locks. Selective indicates that the lock will pass through any number of seating nipple sealbores until the selected nipple is reached for deployment. Top no-go locks indicate that they have a shoulder that seats in the upper portion (top of sealbore) of the Model F nipple.

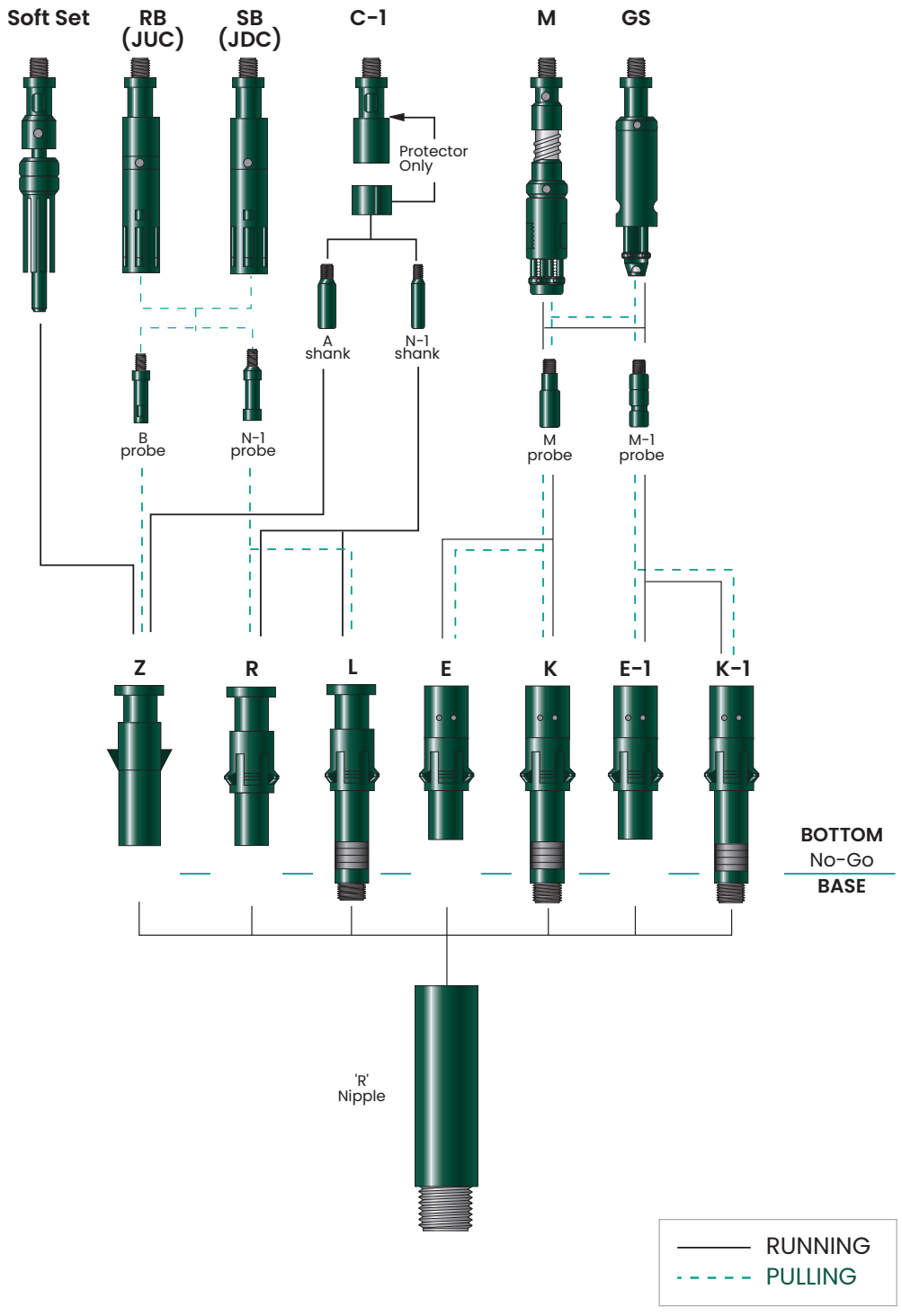
The **Model R™ non-ported seating nipple** is also available and has a shoulder at the bottom below the sealbore area that the bottom no-go locks seat on. Bottom no-go non-flowing and flowing locks offer some selectivity in that they will pass through Model F nipples until they reach the Model R nipple.

Flow control modules that blank off flow, check flow from above or below, and choke flow along with separation sleeves and instrument hangers, can be made up to the bottoms of the locks.

Models F and R Flow Control System



FLOW CONTROL SYSTEMS



Model W-2 Top No-Go, Model Z-2 Bottom No-Go, and Model S-2 Selective Lock Subassemblies

Application

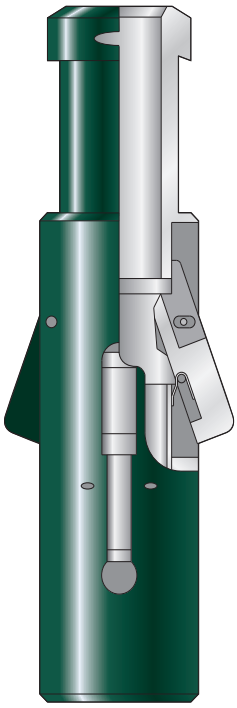
The Baker Hughes **W-type lock subassemblies** are top no-go style locks. With a no-go shoulder located just below the locking dogs, these locks will land and lock flow control devices in the F-type no-go seating nipples. These locks are designed for low volume or non-flowing applications due to the latching dog's protrusion into the flow path.

The Baker Hughes **Z-type lock subassemblies** are bottom no-go style locks. With a no-go shoulder located on the flow control accessory, these locks will land and lock flow control devices in the R-type no-go seating nipples. These locks are designed for low volume or non-flowing applications due to the latching dog's protrusion into the flow path.

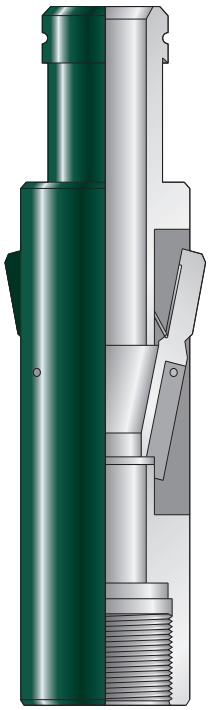
The Baker Hughes **S-type lock subassemblies** are selective style locks. This means that they can be run through any number of seating nipples of the same sealbore diameter until the selected nipple is reached. With dog type locks facing both upward and downward (instead of a no-go shoulder), these locks will land and lock flow control devices in the F-type no-go seating nipples. Installation and retrieval requires no movement relative to the seating nipple. These locks are designed for low volume or non-flowing applications due to the latching dog's protrusion into the flow path.

Advantages

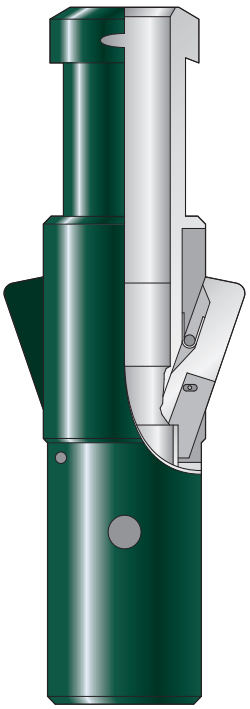
- Can be used in either standard or sour gas environments as all parts are manufactured with current NACE specifications
- Simple and rugged construction
- Run and retrieved using standard wireline procedures
- Available for tubing sizes from 1¼-in. (31.75 mm) through 3½-in. (88.9 mm)
- Modularity reduces completion and maintenance costs



Model S-2
Lock Subassembly



Model Z Bottom No-Go
Lock Subassembly



Model W Top No-Go
Lock Subassembly

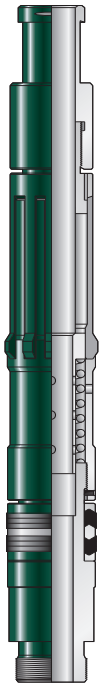
Models N and M Top No-Go Lock Subassemblies

Application

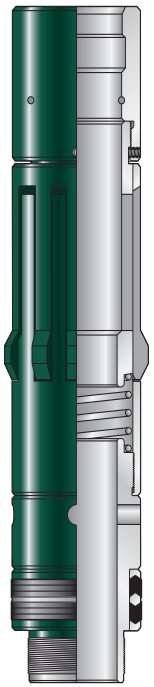
The Baker Hughes **N- and M-type lock subassemblies** are top no-go style locks. They were designed with a collet-type lock to prevent upward movement and a no-go shoulder just below prevents downward movement. These locks will land and lock flow control devices in the F-type no-go seating nipples. The smooth ID and uninterrupted flow path allow these locks to be used in high volume completions. **Model N™ locks** have external fishing necks and are available in sizes 2⅜-in. (60.33 mm) and 2⅞-in. (73.03 mm) **Model M™ locks** have internal fishing necks and are available in sizes 3½-in. (88.9 mm) through 7-in. (177.8 mm).

Advantages

- Very large flow areas for high volumes
- Simple and rugged construction
- High flow rates cannot dislodge plunger which holds latch in locked position
- Can be used in either standard or sour gas environments as all parts are manufactured to current NACE specifications
- Run and retrieved using standard wireline procedures
- Available for tubing sizes from 2⅜-in. (60.33 mm) through 7-in. (177.8 mm)
- Modularity reduces completion and maintenance costs



Models N and G
Lock Subassembly



Models M and F
Lock Subassembly

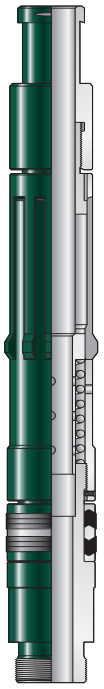
Models L and K Bottom No-Go Lock Subassemblies

Application

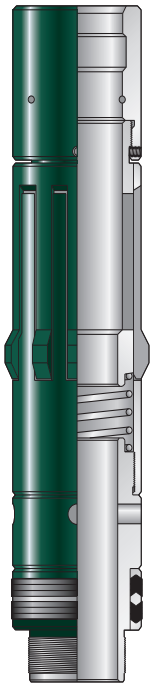
The Baker Hughes **L- and K-type lock subassemblies** are bottom no-go style locks. They were designed with a collet-type lock to prevent upward movement and a no-go shoulder located on the flow control accessory to prevent downward movement. These locks will land and lock flow control devices in the R-type no-go seating nipples. The smooth ID and uninterrupted flow path allow these locks to be used in high volume completions. **Model L™ locks** have external fishing necks and are available in sizes 2⅜-in. (60.33 mm) and 2⅞-in. (73.03 mm) **Model K™ locks** have internal fishing necks and are available in sizes 3½-in. (88.9 mm) through 7-in. (177.8 mm).

Advantages

- Very large flow areas for high volumes
- Simple and rugged construction
- High flow rates cannot dislodge plunger which holds latch in locked position
- Can be used in either standard or sour gas environments as all parts are manufactured to current NACE specifications
- Run and retrieved using standard wireline procedures
- Available for tubing sizes from 2⅜-in. (60.33 mm) through 7-in. (177.8 mm)
- Modularity reduces completion and maintenance costs



Models L and R
Lock Subassembly



Models K and E
Lock Subassembly

Model R Bottom for RZR-20 Bypass Blanking Plugs

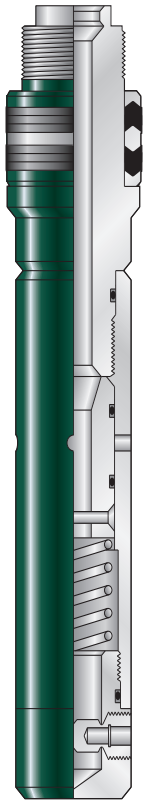
Product Family No. H80614

Application

The **Model R™ bypass blanking plug** bottom holds pressure from above and below. The valve is designed to be held open during run-in by use of the Model B prong. Upon release of the running tool, the valve is closed to hold pressure. The valve also incorporates a built-in method for allowing equalization.

Advantages

- Holds pressure from either direction
- Can be held open to bypass fluid while running and pulling
- Pressures can be equalized across the blanking plug by shifting the bypass valve open or breaking the secondary equalizing plug



Model R Bypass Blanking Plugs
Product Family No. H80614

Models FWG, RZG, and FSG Bypass Blanking Plugs with Removable Mandrel

Product Family Nos. H80688, H80689 and H80687

Application

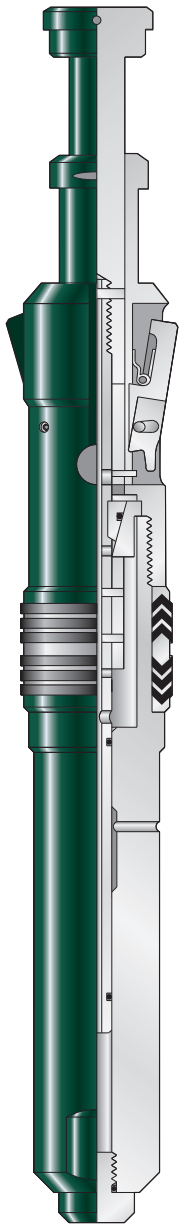
The **Model FWG™ bypass blanking plug** is a top no-go wireline retrievable tubing plug that is designed with a removable mandrel for equalizing pressures.

The **Model RZG™ bypass blanking plug** is a bottom no-go wireline retrievable tubing plug that is designed with a removable mandrel for equalizing pressures.

The **Model FSG™ bypass blanking plug** is a selectively run wireline retrievable tubing plug that is designed with a removable mandrel for equalizing pressures.

The **removable mandrel** is held in the bypass position by the running tool to allow fluid bypass when landing in the seating nipple. When the plug is locked into the desired seating nipple, the removable mandrel is shifted and locked to close the bypass ports.

To equalize, a standard wireline pulling tool latches onto and retrieves the removable mandrel. After the pressures have been equalized through the bypass ports, the plug may be retrieved with a standard pulling tool and proper probe.



Model FWG Blanking Plugs
Product Family No. H80688

Model H Bottom for Models FMH and RKH Bypass Blanking Plugs with Removable Mandrel

Product Family No. H80690

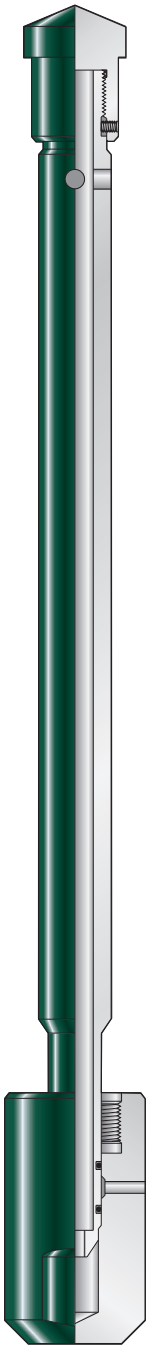
Application

The **Model FMH™ bypass blanking plug** is a top no-go wireline retrievable tubing plug that is designed with a removable mandrel for equalizing pressures.

The **Model RKH™ bypass blanking plug** is a bottom no-go wireline retrievable tubing plug that is designed with a removable mandrel for equalizing pressures.

The bypass blanking plug is run without the removable mandrel to allow fluid bypass when landing in the seating nipple. The plug is securely locked in place and then the mandrel is landed in the plug to close bypass ports.

To equalize, a standard wireline running and pulling tool latches onto and retrieves the removable mandrel. After pressures have been equalized through the bypass ports, the plug may be retrieved with a standard running and pulling tool.



Model M Bottom for
Model FMH Blanking Plug
Product Family No. H80690

Model FB-2 and Model RB-2 Equalizing Check Valves

Product Family Nos. H80935 and H80936

Application

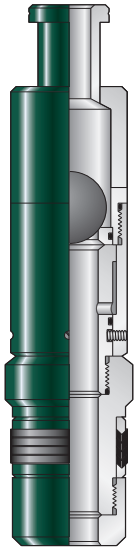
The Baker Hughes equalizing check valves, sometimes called standing valves, prevent downward flow while allowing upward flow through the device. These wireline retrievable check valves are run and landed in Baker Hughes components with **Models F™** or **R™** profiles. They are used to test tubing, set hydraulic packers and prevent fluids from entering the formation during intermitted gas lift installation.

The **Model FB-2™ equalizing check valves** are complete units (not flow control bottoms) used to land on the top no-go shoulder of a Baker Hughes Model F seating nipple. The no-go shoulder prevents downward movement, but the valves are not locked into the nipple to prevent upward movement. The check valve is equalized by shifting open large bypass ports during retrieval operations.

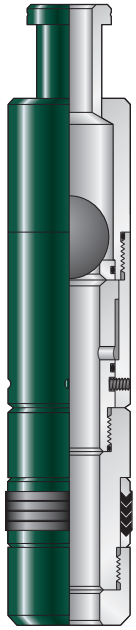
The **Model RB-2™ equalizing check valves** are complete units (not flow control bottoms) that seat on the bottom no-go shoulder of a Baker Hughes Model R seating nipple. The no-go shoulder prevents downward movement, but the valves are not locked into the nipple to prevent upward movement. The check valve is equalized by shifting open large bypass ports during retrieval operations.

Advantages

- Large flow area
- Fluid bypass for retrieval
- Single-trip installation and removal
- Simple design



Model FB-2
Equalizing Check Valve
Product Family No. H80935



Model RB-2
Equalizing Check Valve
Product Family No. H80936

Model M Running and Pulling Tool

Product Family No. H81150

Application

The **Model M™ running and pulling tool** is a jar down to release device used to run and pull wireline flow control devices with internal fishing necks. In the running position, the dogs will retract to enter the fishing neck, then the dog spring will return the dogs to the engaged position. The tool can then be pulled upwards to retrieve the subsurface device.

Should the need arise to disengage from the subsurface equipment, the pin can be sheared by jarring down, allowing the dogs to retract and the tool to be retrieved to the surface.

Advantages

- Emergency shear release
- Simple design
- Large dog contact area

Model M Running and Pulling Tool
Product Family No. H81150

Model E Selective Running Tool

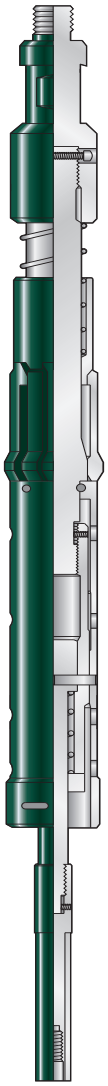
Product Family No. H81117

Application

The **Model E™ selective running tool** is used to run wireline accessories equipped with the Model S selective lock (all locks retracted) into sliding sleeves and the Model F landing nipple. The tool provides a means of locating and landing a Model S lock in any one or all of the same size selective sealbores in the tubing string. The tool can be dressed in two different ways. When the tool is positioned below the selected nipple or sleeve, upward movement trips the tool and opens either the down facing locks or all of them, depending on how the tool was dressed. To land in seating nipples, all dogs should be released. To land in a sliding sleeve, only down facing dogs should be released.

Advantages

- Protected tubing ID and sealbores, collet does not trail in tubing ID
- Controls lock release



Model E Selective Running Tool
Product Family No. H81117

Model C-1 Running Tool

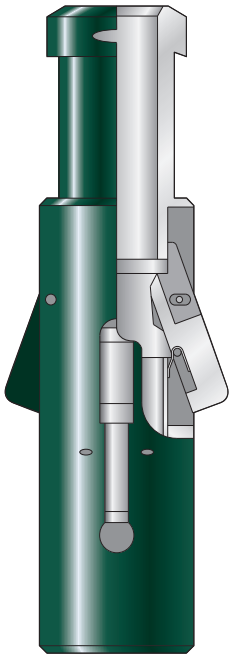
Product Family No. H81106

Application

The **Model C-1™ running tool** runs Baker Hughes flow control devices that have external fishing neck locks. The tool is ran with a thread protector or locating ring depending upon the application. The thread protector, which is the same OD as the tool body, is used for all applications that do not require a no-go on the tool itself. The locating ring converts the tool to a no-go type running tool which is desirable when setting Baker Hughes **Model S™ locks** in sliding sleeves. A box down connection accepts the **Model A™** or **Model N-1™ shank** when required.

Advantages

- Provides locating running tool for S-type lock subassemblies
- Permits running in W- and Z-type locks retracted
- Low cost
- Provides positive indication of lock properly engaged



Model C-1 Running Tool with Thread Protector
Product Family No. H81106

Soft Release Running Tool

Product Family No. H81140

Application

The soft release running tool is an upstrain, slackoff setting device used when it is not desirable to jar to release the tool when installing geophysical gauges in a Baker Hughes **Model F™** or **R™ nipple**. The running tool and instrument hanger are run to a point below the locking groove, then picked up until the upper locks engage the groove, and then a strain is taken. Release is completed by slacking off and then picking up.

Advantages

- Soft release
- No shear pins to shear
- Positive location
- Prevents damage to geophysical instrument
- Large bypass

Soft Release Running Tool
Product Family No. H81140

Prongs

Model A Prong
Product Family No. H81170

Model A™ prong is widely used in running and pulling operations.

Model A Prong
Product Family No. H81170

Model B Prong
Product Family No. H81172

Model B™ prong runs R-type blanking plugs.

Model B Probe
Product Family No. H81172

Model C Prong
Product Family No. H81173

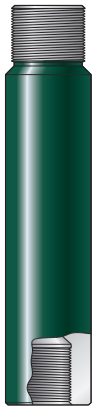
Model C™ prong equalizes **Model R™ blanking plugs**.

Model C Probe
Product Family No. H81173

Shanks

Model A Shank
Product Family No. H81180

The **Model A™ shank** is used with the Model C-1™ running tool to run **Models S™, W™, and Z™ locks** (retracted) during running, and it can be used as a prong carrier when prongs are required during running operations.



Model A Shank
Product Family No. H81180

Model N-1 Shank
Product Family No. H81185

The **Model N-1™ shank** is used in conjunction with the **Model C-1™ running tool** to run and land Baker Hughes flow control equipment having a **Model G™** or **Model R™ lock**.

Model N-1 Shank
Product Family No. H81185

Sliding Sleeves

Application

In oil and gas well completions, sliding sleeves provide a means of communication between the tubing and the annulus for fluid circulation or selective-zone production or injection.

Baker Hughes has pioneered the flow control market for decades, designing and manufacturing best-in-class products, including the most reliable sliding sleeves available in the market. Baker Hughes offers a wide range of sliding sleeves models.

The **Model CM™ family of sliding sleeves** is designed for applications that require high performance tools. Its non-elastomeric design combined with several other unique features provides excellent service in high pressure, temperature and flow conditions. The Model CM sliding sleeve is the most reliable and efficient sliding sleeve available and is the design platform for the rest of the Baker Hughes sliding sleeves.

The **Model CD 6000™** is a lower cost version of the Model CM sliding sleeve. It is designed for applications where downhole conditions are mild and do not require high performance tools. The Model CD 6000 offers the same unique features of the Model CM sliding sleeve aside from the seals, which are a combination of elastomeric and thermoplastic elements.

The **Model SLCM™** is the slimline version of the Model CM sliding sleeve and is designed specially for selective gravel pack applications where sliding sleeves are run inside sand control screens. They also may be used in applications where casing-to-tubing clearance is limited.

The **Model CMP™ (pressure operated CM) family of sliding sleeves** is designed for applications where mechanical shifting with slick line tools is impaired due to the presence of heavy mud or due to the geometry of highly deviated wells.

Baker Hughes also offers interventionless or remote-actuated sliding sleeves that are designed for intelligent well applications. The **Model HCM™** is a control line hydraulic operated Model CM sliding sleeve and the IPR (intelligent production regulator) is an electric actuated infinitively variable sliding sleeve.

CMPA Circulating Sliding Sleeve

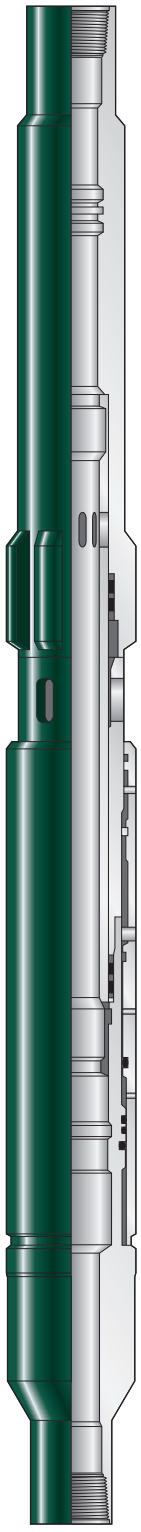
Product Family No. H81081

Application

The **CMPA™ circulating sliding sleeve** is a high performance, nonelastomeric equalizing sliding sleeve which allows communication between the tubing and annulus for circulation. The circulating sliding sleeve allows hydraulic setting of packers and verifies the seal integrity between the packer and the tubing. After the tubing and annular packer pressure test are performed, annular pressure shifts the outer circulating sleeve downward to the full open position. This feature allows for circulation of heavy completion fluids out of the annulus string while the well is flanged up, permitting safer completion of the well and eliminates the need to make a wireline trip in the heavy fluid. When desired, the sleeve can be shifted closed using standard wireline methods with a standard shifting tool. A locking profile is included in the upper sub of the sleeve with a polished seal bore above and below the ports, to accept a variety of wireline locks, packing and accessories. This allows for a multitude of tubing pressure operations prior to opening the sleeve such as setting a packer or testing the tubing.

Advantages

- Allows circulation of heavy fluids with the wellhead in place eliminating wireline trips or releasing from the packer
- Same high-performance features of the industry-leading **CM™ family of mechanical non-elastomeric sliding sleeves**
- A specially designed thermoplastic ring protects the packing unit during shifting by controlling the rush of fluid and/or gas until high differential equalization occurs
- Proprietary high strength compounds are inert and 30% stronger than commercially available materials. Resists hardening alleviating seal bonding
- Milled slots on the housing and insert reduce erosion and allow higher torque and tensile strength through the sleeve
- Offered in standard pressure rating of 10,000 psi and HPHT rating of 15,000 psi for select sizes
- The CMPA flow area is greater than tubing flow area, enabling optimal circulation rates
- Thread connections located within the primary seal stack eliminate o-ring thread seals and reduce potential leak paths
- A locking, angled torque shoulder allows higher torques and reduces thread back off
- Internal honed seal bores are located in the top and bottom housings for placement of flow control devices
- Shifting is achieved utilizing standard wireline or coiled tubing conveyed tools



CMPA Circulating Sliding Sleeve
Product Family No. H81081

Models CMD and CMU Non-Elastomeric Sliding Sleeves

Product Family Nos. H81080 and H81079

Application

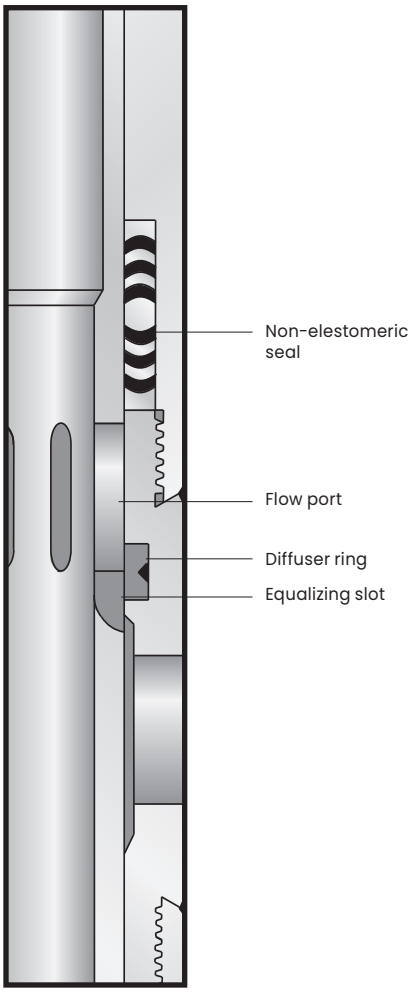
The **Model CM™ series** sliding sleeves are high-performance, equalizing sliding sleeves which allow communication between the tubing and annulus for circulation or selective-zone production. When desired, the sleeve can be shifted open or closed using standard wireline methods and a B-type shifting tool. The tool is designed such that any lock profile and compatible sealbores can be specified to accept a wide range of wireline locks and accessories. The sleeve is available in **Model CMD™**, downshift-to-open or **Model CMU™**, upshift-to-open versions.

The nominal working specifications for the sleeve, in most cases, are burst, collapse and tensile equal to N-80 tubing, 375°F (191°C) service temperature with a 1,500 psi (103 bar) maximum shifting differential. The sleeves have been designed in four standard materials; 4140, 13% Chrome, and Nickel Alloy 718 for a wide range of services.

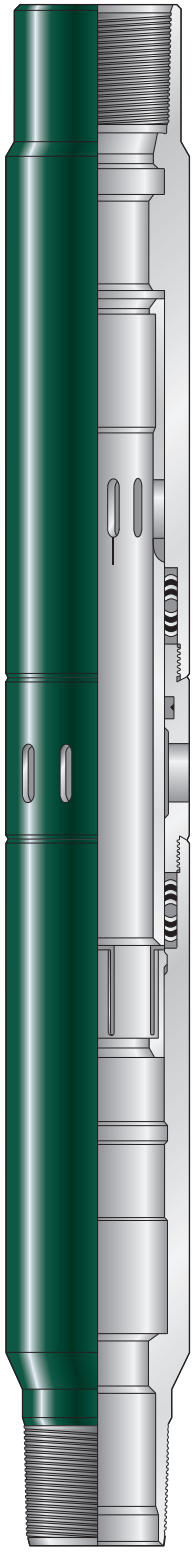
In designing the Model CM series sliding sleeves, several unique features have been combined to upgrade seal performance and increase service life.

Advantages

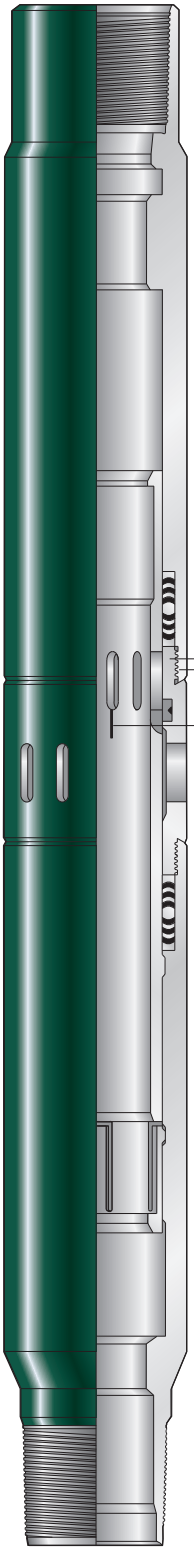
- A specially designed diffuser ring made of high-strength thermoplastic is critically spaced between the flow ports and the upper packing unit. This prevents damage to the upper packing unit during shifting by controlling the rush of fluid or gas, and lessens the likelihood of tool string damage by providing for slow equalization of high differentials
- The seal stack is manufactured from proprietary, high strength, non-elastomeric compounds that are chemically inert and 30% stronger than commercially available materials. Rather than becoming hard and brittle or bonding to the metal, as is the case with elastomeric materials, our seal compound actually behaves as a lubricant, alleviating seal bonding problems
- Mill slots replace drill holes as flow ports on both the housing and the insert to allow more flow area, reduce erosion and allow higher torque and tensile strength through the sleeve
- Locating the threaded connection inside the primary seal stack eliminates the need for O-ring thread seals and cuts the number of potential leak paths in half
- A locking, angled torque shoulder replaces traditional square shoulder to allow higher torques and reduce thread back-off
- The threat of galling is further reduced by coating critical metallic components with proprietary surface treatments. This assures that the sleeve will be redressable in the future even when ordered in CRA materials. These coatings also provide corrosion and erosion resistance. High nickel alloys are coated with the Baker Hughes **BAKERTRON™ ion plating process**
- Modular design permits conversion from a Model CMD to Model CMU or vice versa by only changing the upper and lower subs



FLOW CONTROL SYSTEMS



Closed



Equalized

Designed in four standard materials: 4140, 13% Chrome and Nickel Alloy 718. Compression, burst and tensile properties are compatible with N-80 tubing. Optional designs with higher strengths are available on request.

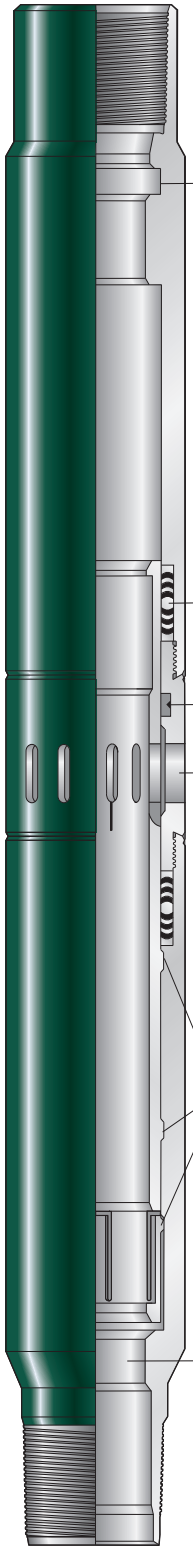
Spacing between seals and diffuser system is critical to the long-term life of the system. This allows the flow ports on the closing sleeve to fully bypass the seals before equalization occurs

Self-locking threaded connection located inside the seal system eliminates the need for elastomeric thread seals and prevents the assembly from backing off downhole

Equalizing slots
Testing proves that slots cause less damage to seals during shifting than equalizing holes

Simplified shifting and equalizing Baker Hughes Model CM™ equalizing tool, run in tandem with a Model B™ or a Baker Hughes Model CM shifting tool, assuring proper positioning for equalization. The Model CM equalizing tool is used to shift the sleeve to the equalizing position. Once equalized the Model B or Model CM shifting tool is used to fully open the sleeve. (The Model CM equalizing tool is optional and is not required for seal protection.)

Smooth shifting after introduction to the well environment (temperature, chemicals, corrosion), the Model CM sleeve shifts as easily as on surface. Tests show that the Model CM shifts at the same force as comparable sleeves.



Open

Built-in landing nipple available with **Models F™, Sur-Set™, AF™,** or most any other profiles. This profile can be used in conjunction with the lower polished bore to land flow control devices.

High performance seal system
The Model CM sleeve is equipped with a specially configured, chemically inert seal system composed of proprietary thermoplastic compounds. These state-of-the-art seals will function in virtually any environment up to a maximum of 375°F (191°C)

Unique thermoplastic diffuser ring
This thermoplastic ring slows the high pressure rush of fluids over the seal stack during shifting. Combined with a high performance seal stack, this ring allows the Model CM sleeve to be shifted through 25 open and closed cycles (50 shifts at maximum temperature and shifting differential) without damage. O-ring and T-seal configurations in the same situation last less than 5 cycles.

Large communication ports
The ports are sized to be larger than the sealbore of the sleeve so as not to restrict the flow of fluids.

Three position collet
Closed, equalized, open

Lower polished bore

Model SLCM Sliding Sleeve

Product Family No. H81137

Application

The **Model SLCM™ sliding sleeve** is an addition to the high-performance series of the existing **Model CM™ sliding sleeves**. The Model SLCM uses the same non-elastomeric sealing and equalizing features, but with a slimline outside diameter. This smaller outside diameter allows for the Model SLCM to be placed into current standard Baker Hughes screens without any modifications. The device allows for versatility during installation of a gravel packed completion while allowing for a reliable inflow device during selective production once the completion is installed.

When desired, the isolation valve can be equalized or shifted open or closed using existing wireline CM-type equalizing/shifting tools or standard wireline B-type shifting tools. The product is designed with standard features including the Baker Hughes **Model BX™ nipple profile**, RTS-8 end connections, 10,000 psi (690 bar) burst and collapse rating and a nominal pressure opening differential of 1,500 psi (103 bar) (equivalent to Model CM sliding sleeve). The product has also been designed in two standard material configurations-4140 for standard services, and 17-4PH stainless steel for corrosive services.

Advantages

- Slimline outside diameter for use inside standard screen dimensions
- Diffuser ring made of the same high strength thermoplastic used in the Model CM sliding sleeve diffuser ring, spaced between upper packing stack and flow ports. This prevents seal stack damage during shifting by choking or controlling the rush of fluid or gas
- Seal stack manufactured from same proprietary seal material currently used in the Model CM seal stack. Material is chemically inert and eliminates seal bonding problems typically found in elastomeric or o-ring configured seal stacks in sliding sleeves
- Threaded connection located inside the primary seal stack eliminates the need for o-ring thread seals and cuts the potential leak paths to only two
- A locking, angled torque shoulder replaces square shoulders to allow for higher torque ratings and reduce thread backoff
- Mill slots are used for flow ports to reduce erosion and increase flow area while maintaining high torque ratings
- Internal honed sealbores located in top and bottom housings for placement of flow control devices

Model SLCM Sliding Sleeve
Product Family No. H81137

Model CD 6000 Sliding Sleeve

Product Family No. H81000

Application

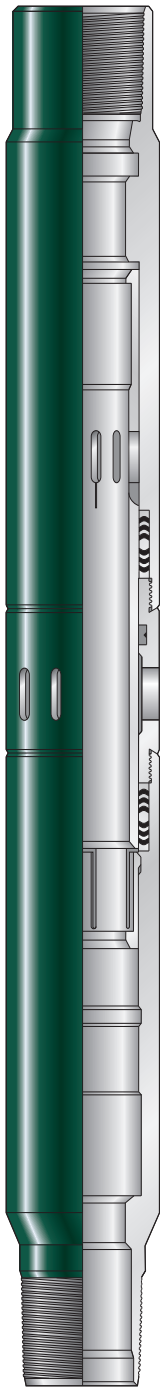
The **Model CD 6000™ series sliding sleeves** are high-performance, equalizing sliding sleeves which allow communication between the tubing and annulus for circulation or selective-zone production. When desired, the sleeve can be shifted open or closed using standard wireline methods and a B-type shifting tool. The tool is designed such that any lock profile and compatible sealbores can be specified to accept a wide range of wireline locks and accessories. The sleeve is available in Model CD 6000 downshift-to-open version.

The nominal working pressure for the sleeve is 6,000 psi (413.69 bar) at 275°F (135°C) service temperature. The sleeve is manufactured of low alloy steel.

In designing the Models CD 6000 sliding sleeves, several unique features have been combined to upgrade seal performance and increase service life.

Advantages

- A specially designed diffuser ring made of highstrength thermoplastic is critically spaced between the flow ports and the upper packing unit. This prevents damage to the upper packing unit during shifting by controlling the rush of fluid or gas, and lessens the likelihood of tool string damage by providing for slow equalization of high differentials
- Mill slots replace drill holes as flow ports on both the housing and the insert to allow more flow area, reduce erosion and allow higher torque and tensile strength through the sleeve
- Locating the threaded connection inside the primary seal stack eliminates the need for o-ring thread seals and reduces the number of potential leak paths
- A locking, angled torque shoulder replaces traditional square shoulder to allow higher torques and reduce thread back off
- Proprietary non-elastomeric and elastomeric compounds enhance a sealing system designed for diverse environments



Model CD 6000 Sliding Sleeve
Product Family No. H81000

Model CM Selective Equalizing Tool

Product Family No. H81121

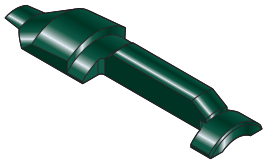
Application

The **equalizing tool** can be used to equalize a sleeve up or down, depending on its orientation. The **Model CM™** uses three keys instead of two as on the **Model BO™ shifting tool** and the **Model BO™ selective shifting tool**.

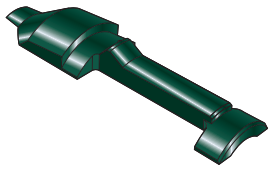
(Equalizing keys are supplied.)

Advantages

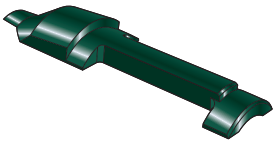
- The three-key design gives it a:
  - Larger contact area
  - Helps to centralize the tool
  - Helps to prevent premature releasing



Equalizing Key



Self-Releasing Key



Shear-Out Key

Model CM Selective Shifting Tool

Product Family No. H81120

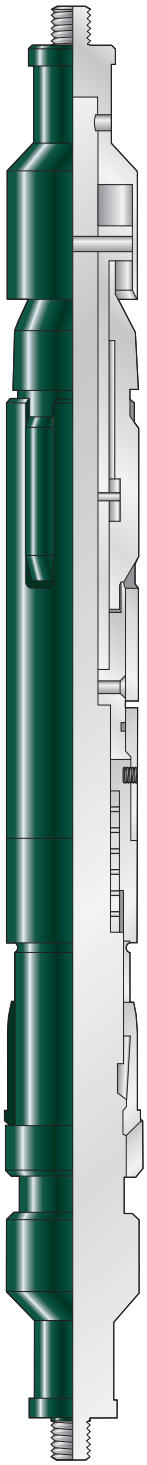
Application

This **shifting tool** is selective; it will not engage any sleeve until the key retainer uncovers the keys. This is done by passing the tool down through a sealbore then lifting it back up through the sealbore again. Once the key retainer is off the keys, it can only be recocked manually at surface. When using the equalizing or releasing keys, the tool will automatically release from the insert at the appropriate location. When fitted with shearout keys the shifting tool is used to selectively shift a single sleeve up. The shear-out keys are not normally used to shift sleeves down as there is no advantage over running releasing keys.

(Shear-out and release keys are included.)

Advantages

- When fitted with releasing keys, the shifting tool can be used to shift one or more sleeves up or down, depending on its orientation
- When fitted with shear-out keys, the shifting tool can only selectively shift a single sleeve up
- The **Model CM** uses three keys instead of two as on the Model BO shifting tool and the Model BO selective shifting tool. The three-key design gives it a larger contact area, helps to centralize the tool, and helps to prevent premature releasing



Model CM Selective Equalizing Tool
Product Family No. H81121

HB-3 Selective Shifting Tool

Product Family No. H81198

Application

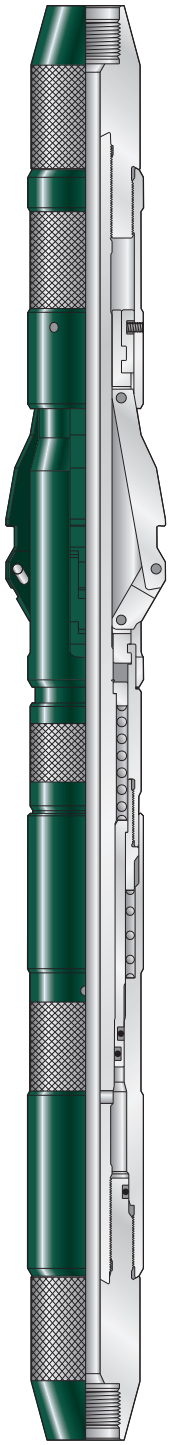
The **HB-3™ hydraulic shifting tool** is designed for shifting the Baker Hughes Type HL™ or CM™ series sliding sleeve on coiled tubing. Flow passage allows washing with tubing while running in the well. After washing past the sleeve, an increase of pump pressure causes a piston to compress a spring, allowing a second spring to extend a set of linkage arms extending out. The sliding sleeve can be shifted either by directly pushing or pulling on the coiled tubing or by use of an impact tool. After the sleeve is shifted, the shifting tool will automatically release. A decrease in pump pressure once again retracts the linkage arms and allows unimpeded movement up and down the hole.

Advantages

- Fully selective operation, can be run or retrieved through multiple sliding sleeves without manipulating the sleeve
- Application of internal hydraulic pressure down the coiled tubing will allow linkage arms to expand
- Low actuation pressure required to expand linkage
- Linkage system exerts maximum radial force when extended and latched into sleeve insert
- Small run in OD
- Wash ports under linkage arms allow debris to be washed away
- Can be run in tandem to shift up and down in one trip

Specification Guides

Tool Size		Tool OD		Shifts Sleeve Sizes	
in.	mm	in.	mm	in.	mm
3.50	88.9	2.50	63.5	2.56	65.0
3.50	88.9	2.50	63.5	2.75	69.8
3.50	88.9	2.50	63.5	2.81	71.3
4.50	114.3	3.00	76.2	3.43	87.1
4.50	114.3	3.00	76.2	3.68	93.4
4.50	114.3	3.00	76.2	3.75	95.2
4.50	114.3	3.00	76.2	3.81	96.7



HB-3 Selective Shifting Tool
Product Family No. H81198

Model SLCM Shifting Tool

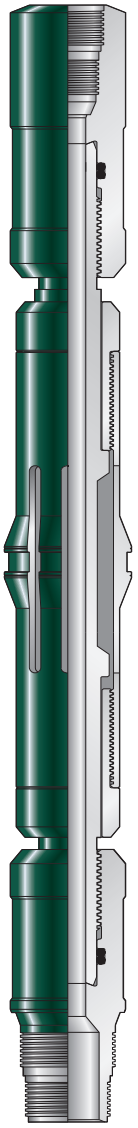
Product Family No. H81100

Application

The **Model SLCM™ shifting tool** is a specially made shifting tool exclusively for the Baker Hughes Model SLCM isolation valve. Shifting tools are available to shift long profile Model SLCMs both up and down (two-way) and either up or down (one-way). For the short profile Model SLCM only a one-way (either up or down) shifting tool is available.

Advantages

- Coiled tubing or washpipe can be used to open and close sliding sleeve
- Automatic locating
- Open or close all sleeves in one-trip
- Open one sleeve in one-trip



Model SLCM Shifting Tool
Product Family No. H81100

Separation Sleeve for Sliding Sleeves

Product Family Nos. H80537, H80573, and H80574

Application

The **separation sleeve** is designed to shut off tubing to annulus flow through the sliding sleeve should the sliding sleeve become inoperative. Straight through flow through the separation sleeve is accomplished by a chevron packing system that will seal off in the upper and lower sealbores, isolating the ports of the sliding sleeve. The separation sleeve is also designed with an internal equalizing plug to equalize pressure before retrieving.

Advantages

- Large flow area
- Equalizing feature
- Straddles above and below sliding sleeve ports thus stopping annulus-to-tubing communication

Separation Sleeve for Sliding Sleeves
Product Family No. H80573

Nipple-Less Completion Technology

Application

The primary feature of a **nipple-less completion** is that the production string has no restrictions, and there are no permanent diameter restrictions such as restrictive nipples to limit access to the producing zones. As a result, mechanical tools can be run through the tubing and landed in the liner to perform workover tasks.

Removing restrictive nipples may create a new set of challenges, such as how to perform functions normally accomplished with the use of nipples and locking mandrels. These functions include a plug or check valve in the well to hydraulically set a packer; pressure testing the tubing; hanging instruments to measure downhole flowing pressures, temperatures, etc., and running chokes to regulate flow.

A production bridge plug is a tool that can be set anywhere in the production string without locating in a seating nipple. Production bridge plugs have been designed with the ability to run and retrieve through the subsurface safety valve, since this is generally the only restriction in the system. This is easily accomplished with a lock and nipple system but the retrievable production bridge plugs, however, must drift with a small enough OD through the safety valve and when the desired depth is reached, the seal element expanded to contact the pipe ID.

The **Velox™ straddle pack-off** is a retrievable tool that is used to patch a leak in the tubing. A typical straddle packoff uses two packoffs, one above and one below the leak. The Velox velocity string system is capable of straddling and isolating producing or injection intervals. Key components of this single trip system are that it can be run on coiled tubing or threaded pipe, set hydraulically, slim walled and retrievable. This system also allows operators to install complicated injection or production control equipment later in the life of the well.

The **Velox™ STV velocity string system** is a retrievable tool that is used to increase the gas velocity, eliminating the problem of produced water by installing a smaller ID tubing string.

Thru-Tubing Hydraulic Release GS Spear

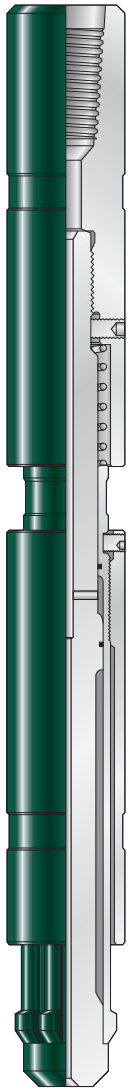
Product Family No. H13311

Application

The **Thru-Tubing Hydraulic Release GS™ spear** is designed to allow engagement with a fish having a standard GS-type (also known as an internal fishing neck) wireline fishing neck looking up. The hydraulic release spear has pump through capabilities specifically designed for coiled tubing applications. The spear is latched up to the fishing neck by applying slight set-down weight at the tool. If fish cannot be freed, simply flowing through the workstring will allow the spear to be released. This feature prevents having to leave any part of a fish downhole.

Advantages

- High strength; engineered for fishing operations
- Improved design allows heavy duty jarring
- Pump through, permits washing sand and debris from top of fish
- Multiple catch; no shear pins to be replaced between operations
- Loads carried by mandrel minimize stress on collets



Thru-Tubing Hydraulic Release GS Spear
Product Family No. H13311

Velox Velocity and Straddle System

Product Family Nos. H81965, H81966, H81967 and H81968

Application

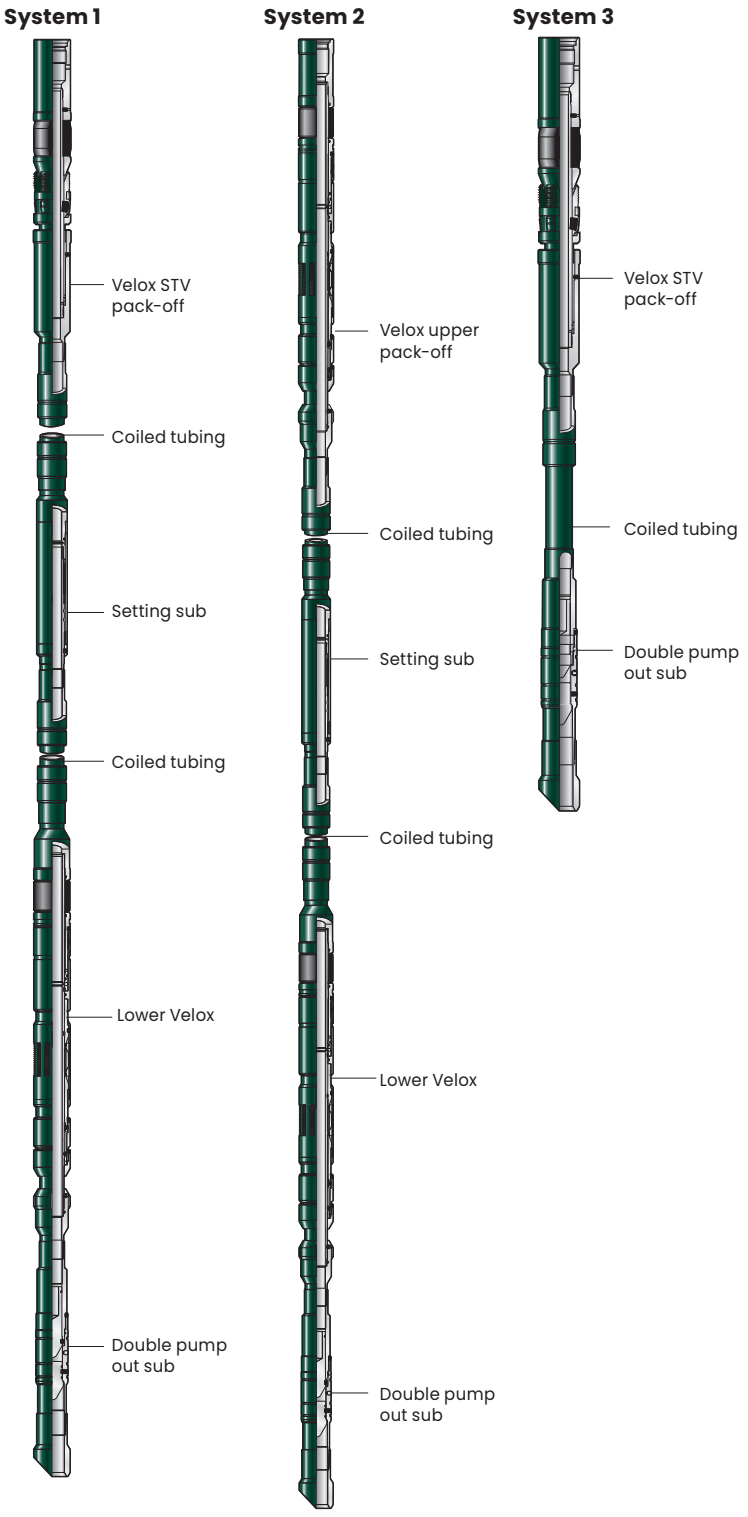
The **Velox™ velocity and straddle system** is either a combined mechanical and hydraulic set or purely hydraulic set system, which uses existing technology to give the customer a low cost, reliable tool that can be run and set in one-trip using a running tool that is compatible with both systems. The system can be run as a velocity string or a straddle system. The velocity system reduces the ID of the production tubing, increasing the gas velocity and eliminating the problem of produced water. When run as a straddle the Velox system can also be used to isolate and pack off a predetermined part of tubing or casing. Retrieval is performed, for both applications, via a straight pull using standard pulling tools.

Operation

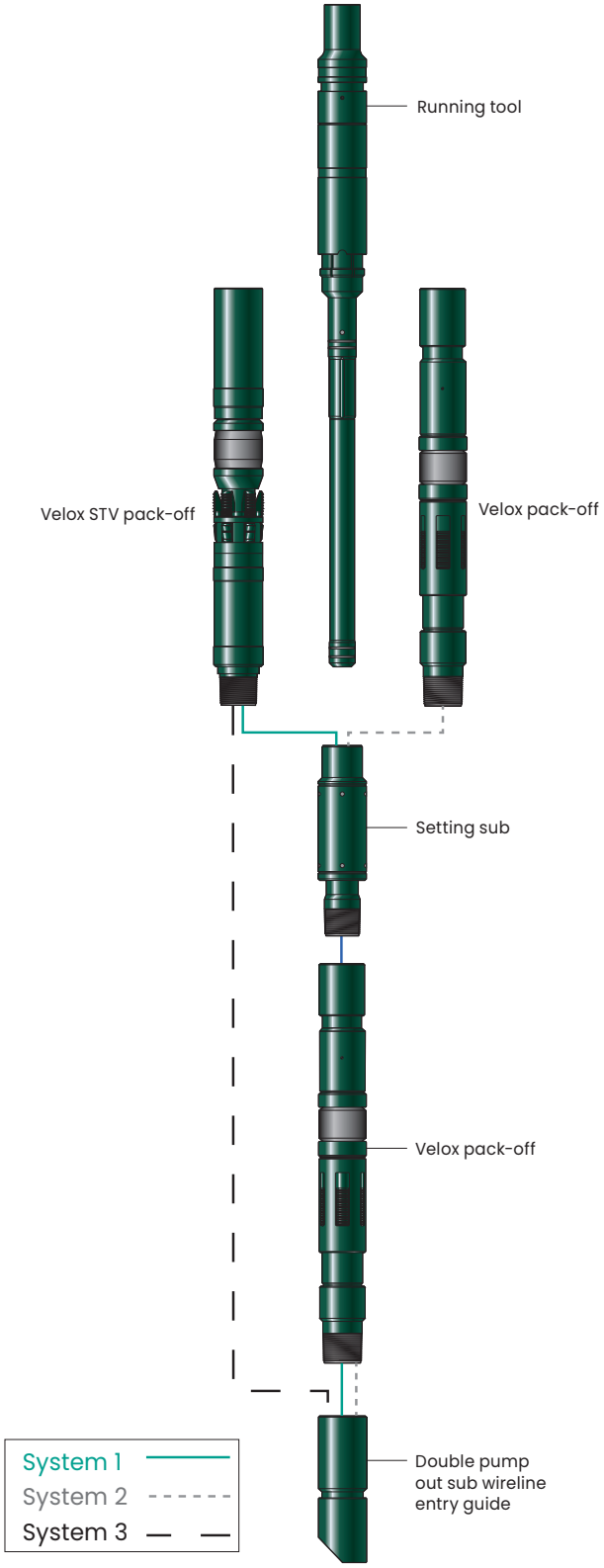
The Velox system can be deployed in one run on either coiled tubing or jointed pipe, which is ideal for highly deviated completions. It can be positioned as desired, under pressure, in a landed tubing string. The Velox system deployment tool string includes the Baker Hughes universal hydraulic disconnect, and the state-of-the-art soft touch makeup tong, which assures a safe, accurate and highly versatile tool joint makeup for ease of connecting upper and lower assemblies.

Advantages

- Single-trip system
- Easy makeup
- Ability to pressure test prior to setting
- Coiled tubing and threaded pipe conveyed
- Slim OD can be run/retrieved though restrictions
- Large ID for through tubing intervention
- Increases flow velocity maintaining production profile
- Reduces salting problems
- Water or gas shut off
- Repair and shut off corroded tubing/casing
- Repair parted tubing
- Isolation of perforated sections



Velox Velocity and Straddle System Diagram



Velox Setting Sub

Product Family No. H81981

Application

The Baker Hughes **Model Velox™ setting sub** is designed to be used between two packoffs, allowing tubing movement when setting a straddle. It is supplied with standard premium threads and has variable pinning capabilities.

Advantages

- Allows tubing movement between packoffs
- Shear pinning capabilities
- ID compatible with string

Velox Setting Sub
Product Family No. H81981

Velox Double Pump Out Sub with Wireline Entry Guide (WEG)

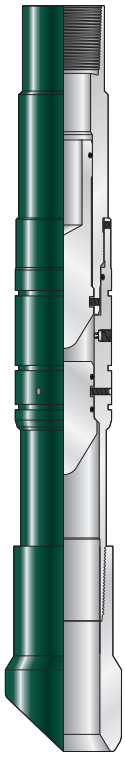
Product Family No. H80573

Application

The Baker Hughes **Model Velox double pump out sub** is a tubing device that allows pressure to be held from below when running the Velox system. The double plug can be equalized by applying pressure from above to a predetermined value of shear screws which allows the plug to blow out leaving a standard wireline entry guide (WEG). By using this tool you eliminate the requirement for any slickline intervention when the system is set.

Advantages

- Single-trip
- Ability to deploy **Velox™ system** under pressure
- Variable pressure rating
- Double mechanical barrier
- WEG once pumped open



Velox Double Pump Out Sub with WEG
Product Family No. H81982

Lockable Standing Valve

Product Family No. H13258

Application

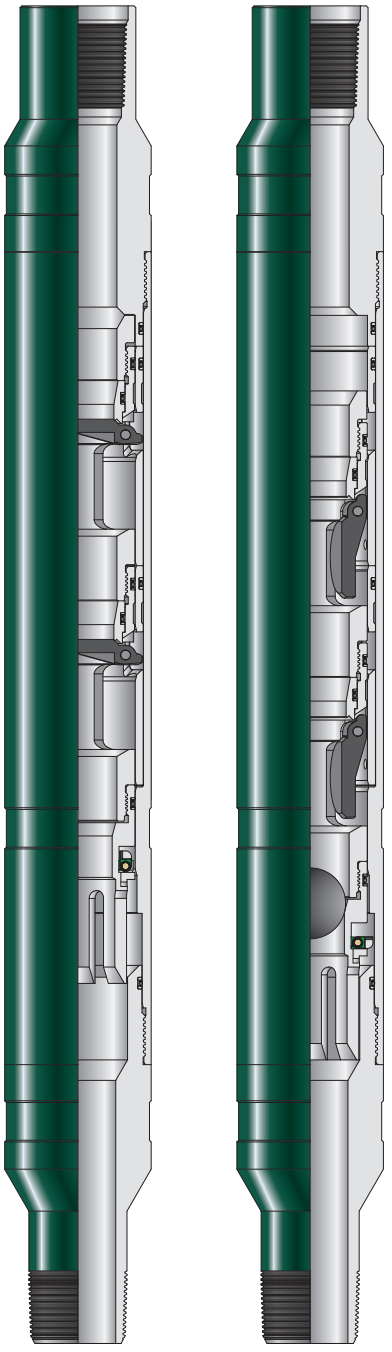
The Baker Hughes **lockable standing valve** can be deployed on a Velocity string to control flow direction. The system includes a dual flapper design which when functioned will lock open allowing flow through the velocity string.

The system is functioned with a disintegrating ball to allow maximum flow rate and eliminate the risks associated with a conventional ball not passing through any internal restriction.

Once shifted the dogs will lock in place therefore, locking the valves in the fully open position.

Advantages

- Maintains access through ID of system
- Disintegrating ball technology to simplify the operation
- Maximum Production rate through ID
- Visible Surface signature that ensures activation
- Permanently locks open
- Interfaces with all other components of the string



RUNNING IN HOLE **FULLY SHIFTED**

Lockable Standing Valve
Product Family No. H13258

Velox STV Upper Pack-Off

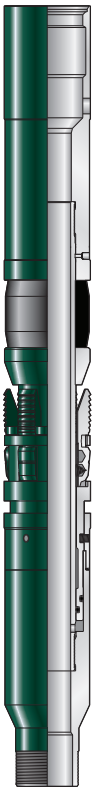
Product Family No. H81966

Application

The Baker Hughes **Model Velox™ STV pack-off** is an economical hydraulic (S) tension set (T) packoff designed primarily for use in a velocity string application. This short, compact, simple constructed packoff has a minimum number of working parts, easing setting and retrieval. Hydraulic slips bite into the casing/tubing wall locking the packoff into position. Thereafter it is packed off via tension from below. The packoff's ability to carry high tailpipe forces keeps the element packed off.

Advantages

- Short and compact
- Simple construction
- Ease of operation
- Low cost
- Rocker-type slips
- High max tailpipe weight rating



Velox STV Upper Pack-Off
Product Family No. H81966

Velox Straddle Pack-Off

Product Family No. H81980

Application

The Baker Hughes **Model Velox upper/ lower pack-off** is a single trip, hydraulic set, coiled tubing or tubing conveyed retrievable tool, primarily used in straddle applications that provide isolation inside the casing or tubing. The Velox upper pack-off is run in conjunction with a setting sub, Velox lower pack-off, and a double pump open sub. The Velox pack-off features field proven slip and one-piece element designs. The lower packoff can easily be converted to an upper packoff by changing the top sub to accept a running tool.

Advantages

- Interchangeable, a simple conversion will enable the straddle packoff to run as either an upper or lower packoff
- Single-trip
- Hydraulic set
- Retrievable

Velox Straddle Pack-Off
Product Family No. H81980

Velox Running Tool

Product Family No. H81980

Application

The Baker Hughes **Velox™ running tool** is designed to allow the Velox STV upper pack-off to be run in live well conditions to a predetermined depth on tubing or coiled tubing, and hydraulically set. After the packoff is set, the running tool is disengaged and tools recovered to surface. The Velox STV running tool has three release methods; two hydraulic and one mechanical.

Advantages

- Three methods of release; two hydraulic and one mechanical
- Load carried by the body minimizes stress on grapple
- Facility to pressure test between running tool and packoff prior to running in hole
- Allows tubing pressure to set packoff

Velox Running Tool
Product Family No. H81980

Specification Guide for Velox Velocity and Straddle System

Pack Off Type	Tubing					Straddle Packoff									Accessory Equipment	
	OD		Weight	ID Range		Tool Size	Max Gage OD		Min Tool OD		Packing Element	Temp		Pressure		Running Tool	Pulling Tool
	in.	mm	lb	in.	mm		in.	mm	in.	mm		°F	°C	psi	bar		
Straddle Upper and Lower	3.50	88.9	9.3	2.992-3.047	76.0-77.4	35 x 2.780	2.780	70.6	1.810	46.0	Nitrile	68-280	20-137.7	1,500-3,500	103.42-241.32	2.70 Hyd GS	2.70 Hyd GS
Velox STV Upper Pack Off			9.2			35 x 2.800	2.800	71.1	1.450	36.8				3,000	206.84	35 Velox STV	
Straddle Upper and Lower	4.50	114.3	11.6-15.1	3.89-4.00	98.9-101.6	45 x 3.700	3.700	93.9	2.560	65.0				1,500-3,500	103.42-241.32	3.50 Hyd GS	3.50 Hyd GS
Straddle Upper and Lower			9.5-11.6	4.000-4.154	101.6-105.5	45 x 3.780	3.780	96.0									
Velox STV Upper Pack Off✷			9.5-13.5	3.920-4.154	99.6-105.5	45 x 3.720	3.720	94.5	1.900	48.3						45 Velox STV	
Straddle Upper and Lower✷	5.00	127.0	18-23	4.044-4.361	102.7-110.8	50 x 4.093	4.093	104.0	2.000	50.8						50 Velox STV	
Velox STV Upper Pack Off✷									1.875	47.6							
Straddle Upper and Lower	5.50	139.7	17-23	4.670-4.976	118.6-126.4	55 x 4.485	4.485	113.9	2.500 ●	63.5						55 Velox STV	
Velox STV Upper Pack Off						55 x 4.530	4.530	115.1	2.000	50.8							
Straddle Upper and Lower✷	7.00	177.8	26-35	6.004-6.380	152.5-162.1	70 x 5.735	5.725	145.7	3.400 ●	86.4						70 Velox STV	4.50 Hyd GS
Velox STV Upper Pack Off						70 x 5.700	5.700	144.8	2.95	74.9							

● ID will be restricted due to thread connection (2.500 in. (63.5 mm) ID restricted to 2.441 in. (62.0mm) ID), (3.400 in. (86.4 in. (86.4 mm) ID restricted to 7.992 in. (203.0 mm) ID).

✷ Proposed Specifications

Models K-2 and K-3 Straddle Pack-Off

K-2 Product Family No. H81952 and K-3 Product Family No. H81955

Application

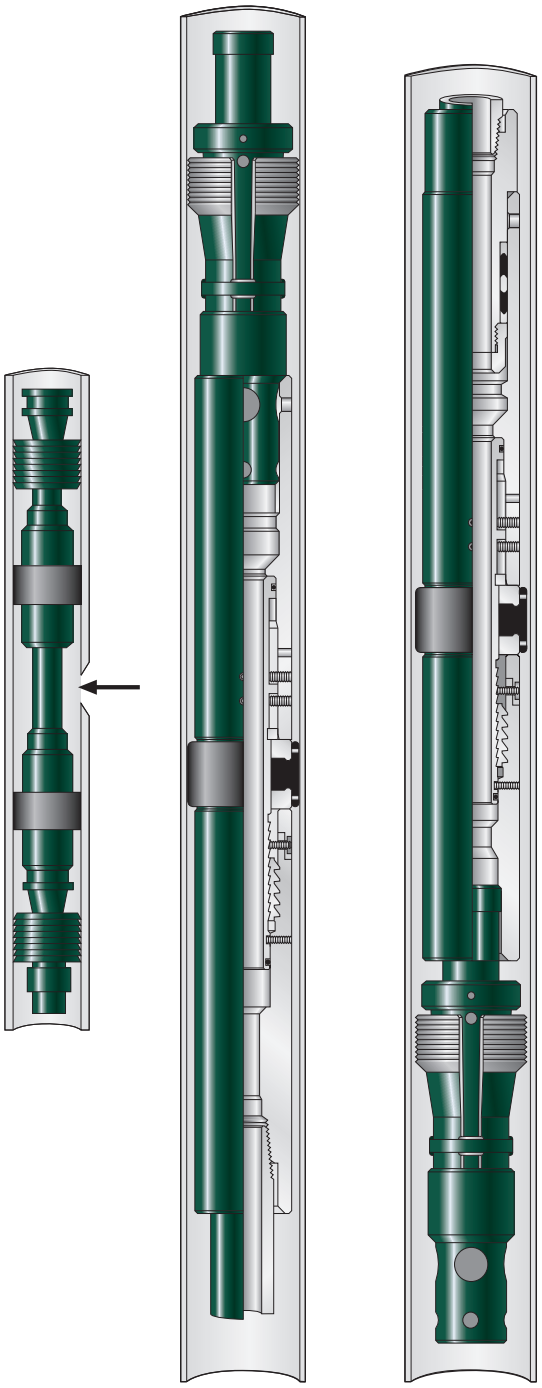
Models K-2™ and K-3™ straddle pack-offs are wireline retrievable tools that provide communication control between the tubing and the annulus. They can be positioned as desired, under pressure, in a landed tubing string and are compatible with normal wireline equipment. Both models perform the same function but have minor design differences.

The straddle packoff system consists of two separate packoff units and two **Model B™ tubing stops**.

Straddle packoffs are used to isolate tubing leaks, install concentric gas lift equipment or blank off a perforated nipple.

Advantages

- Provides two packoffs, one above and one below a tubing communication point
- Hydraulically balanced so pressure from above aids packoff force
- May be positioned where desired, under pressure
- Compatible with normal wireline equipment
- Operating pressure to 5,000 psi (344.8 bar) and temperatures of 275°F (135°C)



Model K Straddle Pack-Off
Product Family No. H81952

Spacer Pipe Subassembly

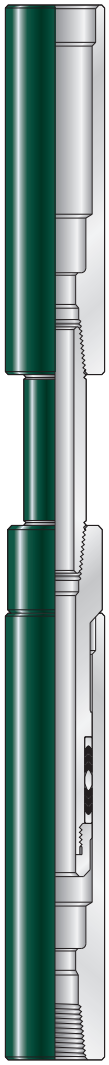
Product Family No. H99508

Application

A useful accessory for the **Models K-2™** and **K-3™ straddle pack-off** is the **spacer pipe subassembly**. The spacer pipe subassembly is used to increase the amount of spacer pipe required between the upper and lower packoff assemblies. Consisting of a special landing receptacle, additional spacer pipe, and a landing shoe subassembly, it can be run under pressure and stabbed into the top of an existing lower packoff assembly downhole.

The running/pulling tools are the same as those used with the upper and lower packoffs.

Care should be taken to ensure that the wireline lubricator is long enough to accommodate the length of spacer pipe subassembly to be added.



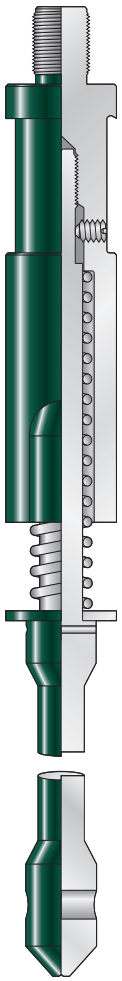
Spacer Pipe Subassembly
Product Family No. H99508

Models B and B-1 Running Tools

Product Family No. H81109

Application

The **Models B™ and B-1™ running tools** are an inertia-triggered device used for running and setting Models B and B-1 tubing stops and are compatible with normal wireline procedures and equipment.



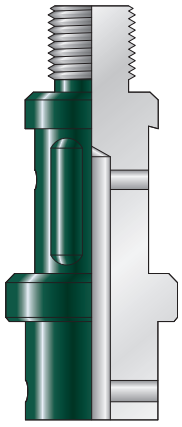
Model B Running Tool
Product Family No. H81109

Model D Running Tool

Product Family No. H81107

Application

The **Model D™ running tool** is used to run **Model K™ removable seating nipples** and straddle pack-offs.



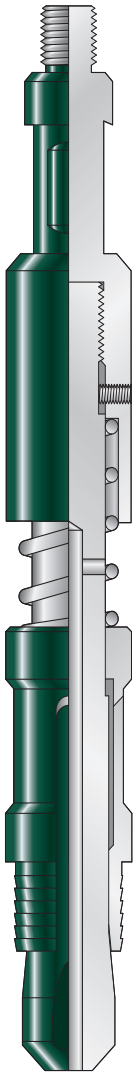
Model D Running Tool
Product Family No. H81107

Model A Spear

Product Family No. H81217

Application

The **Model A™ spear** is a spring-loaded, internal, slip-type tool used to retrieve Model K removable seating nipples and Model K straddle pack-offs.



Model A Spear
Product Family No. H81217

Models B and B-1 Tubing Stops

Product Family Nos. H80412, H80415 and H80416

Application

The **Models B and B-1 tubing stops** use a slipcone combination that locks the stop in the tubing ID and prevents movement in either direction.

Model B-1 Tubing Stop
Product Family No. H80415

Model NPR Production Bridge Plug

Product Family No. H80617

Application

The **Model NPR™ (no profile required) production bridge plug** is a tool that can be set on slickline, electric line, or coiled tubing and retrieved on slickline. The design accepts various devices such as a blanking plug, check valve, choke, instrument hanger, and tubing-conveyed perforating (TCP) gun hanger. The packer-type design results in a tool capable of setting anywhere in the tubing string without requiring nipples for location.

Now the Model NPR product offering has been expanded in the 5½-in. (139.7 mm) size to include 17 lb (7.71 kg) and 20 lb (9.07 kg) tubing while retrieving through a 4.562 in. (115.87 mm) restriction. This is a welcomed addition to the very popular and successful NPR product family.

The Model NPR may be equalized and retrieved in one or two trips.

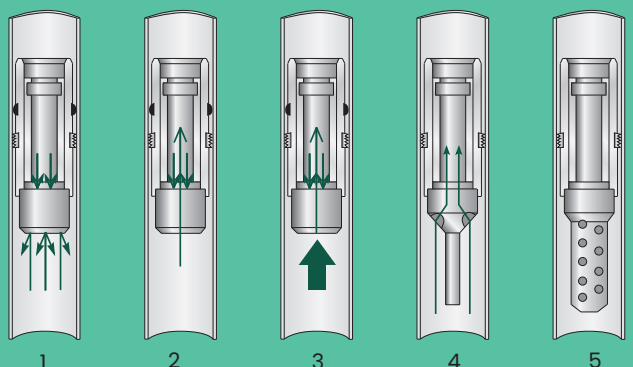
Advantages

- Does not require nipple profile to locate Model NPR - can be set anywhere in the tubing
- Sets on slickline, electric line, coiled or threaded tubing
- Can be retrieved in one-trip
- Special setting feature allows for centralized setting
- Retrieves on 0.108-in. (2.74 mm) slickline with a standard **Model GS™ running tool**
- Uses well pressure to help pack off elements
- Elements return within approximately 3% of original OD on retrieval
- Allows for sand/debris fill
- Quick running and retrieval
- Short overall length facilitates easy running/retrieving through tight spots
- Rotationally locked above the slips to enhance emergency milling of the Model NPR should it be impossible to retrieve by conventional methods
- Slips and releasing mechanism located in a protected area below the packing element provide maximum protection from debris
- Available for H_2S Service

Model NPR Production Bridge Plug
Product Family No. H80617

Flow Control Accessories for Model NPR

The Model NPR is designed to be run with various flow control accessories. With these accessories, the Model NPR can be used as a:



1. Blanking Plug
2. Check Valve
3. Choke
4. Instrument Hanger
5. TCP Gun Hanger

Model NPR Production Bridge Plug

Selection Guide

Tubing/Casing			NPR Size		Tubing/Casing Range			
OD		Normal Weight	Body Size x Gauge Ring OD		Min		Max	
in.	mm	lb	in.	in.	in.	mm	in.	mm
4½	114.3	15.10	-	4½ x 3.65	3.75	95.4	3.90	99.1
		13.50	4½ x 3.79		3.85	97.8	3.99	101.4
		12.60			3.89	98.9	4.02	102.3
		11.60		-	3.94	100.0	4.06	103.3
		10.50			3.99	101.4	4.11	104.5
5	127.0	24.10	4½ x 3.79	-	3.89	98.9	4.10	104.1
		23.30			3.94	100.1	4.14	105.2
		21.40	-	4½ x 3.98	4.03	102.4	4.22	107.1
		20.30			4.09	104.0	4.27	108.5
		18.00			4.19	106.5	4.36	110.7
		15.00	4½ x 4.28	-	4.32	109.7	4.50	114.3
5½	139.7	23.00	5½ x 4.73	-	4.67	118.6	4.76	121.0
		20.00		5½ x 4.62	4.77	121.3	4.86	123.6
		17.00		-	4.82	122.6	4.97	126.3
		15.50	5½ x 4.73		4.88	123.9	5.03	127.7
7	177.8	38.00		7 x 5.72	5.80	147.3	6.04	153.4
		35.00			5.89	149.6	6.12	155.5
		32.00			5.99	152.1	6.20	157.6
		29.00	7 x 5.93	-	6.08	154.6	6.29	159.8
		26.00		7 x 6.03	6.18	157.1	6.38	162.0
		23.00	-		6.28	159.6	6.46	164.2

Model NPR Production Bridge Plug

Specification Guide

NPR Size	Gage Ring Max OD		Min Tool ID		Min ID Restriction for Retrieval		Temperature Rating		Differential Pressure Rating		Max Run-in Speed		Material No.
in.	in.	mm	in.	mm	in.	mm	°F	°C	psi	bar	ft/min	m/min	
4½ x 3.95	3.65	92.7	1.00	25.4	3.68	93.6	250	121	5000	344.7	125	38	H806-17-4500
5½ x 3.79	3.79	96.2	1.00	25.4	3.81	96.8							H806-17-4503
5½ x 3.98	3.98	101.0	1.00	25.4	4.00	101.6							H806-17-4506
5½ x 4.52✸	4.52	114.8	1.25	31.7	4.56	115.8			5000●	344.7●			H806-17-5523✸
5½ x 4.52							270	132	5000	344.7			H806-17-5509
5½ x 4.62	4.62	115.8	1.25	31.7	4.68	119.0							H806-17-5510
5½ x 4.72	4.73	120.2	1.25	31.7	4.75	120.6							H806-17-5511
7 x 5.72	5.72	145.2	2.11	53.5	5.75	146.0							H806-17-7003
7 x 5.93	5.93	150.6	2.11	53.5	5.95	151.1							H806-17-7004
7 x 6.03	6.03	153.1	2.11	53.5	6.12	155.5							H806-17-7005

✸ Special to set in larger ID's and retrieve through small restriction. Centralization may be required.
● Contact your Baker Hughes Representative for performance envelope.

Waterflood Flow Regulators

Application

Waterflood flow regulators provide the ultimate in simplicity, flexibility and cost effectiveness for controlled water injection operations. This system is designed to regulate water volumes accurately with minimal pressure drop. This process allows fluid to be injected into multiple isolated zones through a single tubing string. Each zone is isolated with either a hydraulic set or mechanically set isolation packer. Fluid is injected down the tubing and through each water injection regulator before proceeding into the casing annulus where it can enter the perforations. The regulators operate independently at each isolated zone to control the volume of fluid allowed to enter each zone regardless of injection and zone pressures. The regulator therefore compensates for differential pressure changes and maintains a constant volume into each zone.

The **DSJ downhole flow regulator** is a pressure compensated flow rate control valve which, when landed in a **D Bypass ported seating nipple** provides a simple, economical and efficient method for individually regulating volumes injected into multiple zones down one tubing string. The regulators are designed to maintain a predetermined fluid injection rate regardless of changes in pump and formation pressures.

A Meter and Throttle Valve Combined in one Simple Automatic Unit

Flow Regulators

Baker Hughes flow regulators provide the ultimate in simplicity, flexibility and cost effectiveness for controlled fluid injection operations. These regulators automatically maintain injection rates regardless of variations in pump or formation pressure.

Application Flexibility

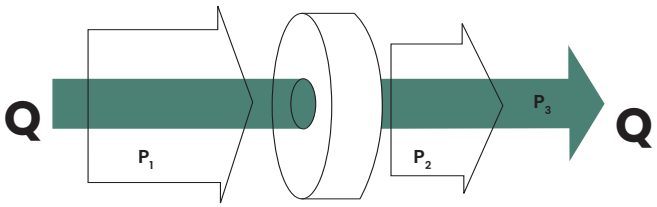
The simplicity of the flow regulator leads to its flexibility. Five different versions are used in the following ways:

- **Model BF™ downhole flow regulator** is run and retrieved on wireline and is seated in a side-pocket mandrel. It is full opening throughout regardless of the number of regulators in the string
- **Model DSJ™ downhole flow regulator** is run and retrieved on wireline and is seated in a **Model D™ ported bypass seating nipple**
- Bypass flow regulator is an integral part of the tubing string and is used in areas where the cost of pulling the string is competitive with wireline costs
- Full opening downhole flow regulator is an integral part of the tubing string and allows full opening throughout regardless of the number of regulators
- Surface flow regulator is installed at any point in the line between the wellhead and the pump source and can be used in surface manifolds

Advantages

- Only one moving part ensures dependable and reliable operation
- Regulator can handle flow rates up to 5,000 bbl/day (794.92 m^3/day) depending on the model used
- Maintains flow rate even with pressure differentials of 100 to 2,500 psi (7 to 172 bar)
- Five different versions of the regulator for both surface and downhole applications are available
- Needs no adjustment before restarting injection after a shutdown
- Special materials are available for highly corrosive environments
- When used in a surface injection manifold, it eliminates the need for flow meter and needle valve
- Consistently out performs commonly used oilfield regulating and metering devices
- Subsurface regulators can be used for controlled injection of any number of zones
- Available in wireline retrievable or tubing mounted versions

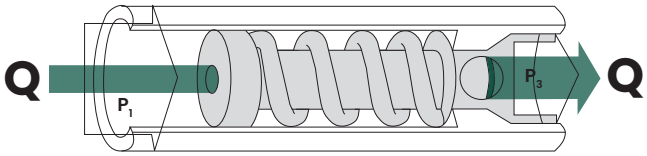
Waterflood Flow Regulators



Q = flow rate
P_1 = line pressure
P_2 = P_1 - 100 psi (7 bar) pressure differential
P_3 = outlet pressure

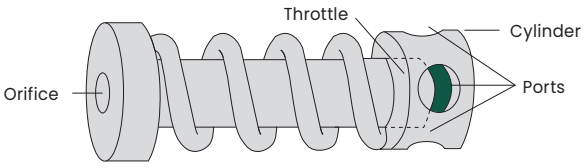
Constant Metering Orifice

A 100 psi (7.03 kg/cm²) pressure differential across an orifice is maintained by determining the correct size of the orifice. The fixed orifice will pass a given fluid at a constant flow rate. It's accurate and positive.



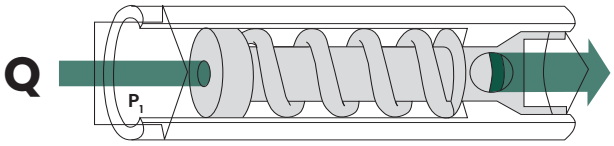
Pressure Increase Across Regulator (P_1 - P_3) Closes Port

If the pressure differential across the entire regulator (P_1 - P_3) increases due to an increase in tubing pressure or a decrease in formation pressure, the piston compresses the spring and narrows the port opening. This creates a greater pressure drop across the throttling ports (P_2 - P_3), while the flow rate (Q) and 100 psi (7 bar) pressure differential across the orifice remain the same.



Built-In Throttle Valve

Pressure variations within the wellbore affect the pressure drop (P_1 - P_2) across the orifice. To maintain a constant 100 psi (7 bar) pressure drop, the flow has to be throttled. A moveable spring loaded piston is fitted in a ported cylinder. The piston movement varies the port opening, and thereby controls the flow through the regulator.



Pressure Decrease Across Regulator (P_1 - P_3) Opens Port

With an increase in formation pressure or a decrease in tubing pressure, the spring forces the piston out of the cylinder, thus widening the port. This reduces the pressure drop across the throttling ports while keeping the orifice pressure differential and flow rate the same.

Waterflood Flow Regulators

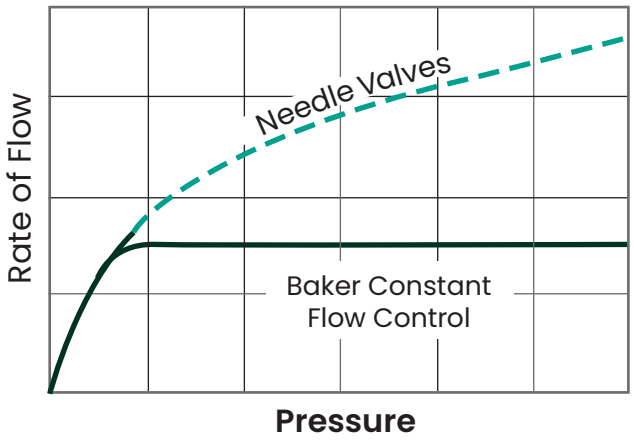
Enlarging an Orifice

An existing orifice plate can be drilled out to a larger size. First, drill a pilot hole about 1/64-in. (0.396 mm) smaller than the orifice size needed. Then, drill the new orifice size. All drilling must be done at a slow drill speed and feed. Remove burrs on the face by adding a slight bevel no greater than 1/64-in. (0.396 mm) around the hole by turning the point of a larger size drill bit in the orifice.

Pressure Requirements at High Flow Rates

A minimum pressure differential of 100 psi (7 bar) is required to operate the flow regulator. However, the pressure differential can vary from 100 to 2,500 psi (7 to 172 bar) without affecting the operation of the regulator. Charts plotting the pressure drop through the regulator versus flow rate are included in detailed descriptions on the following pages.

CAUTION: Acidizing through the regulator may cause permanent damage to the plastic sleeve if the exposure time exceeds 30 minutes. If acidizing is anticipated, a steel sleeve should be used. Special alloy parts for corrosive fluids are available on request. Consult your Baker Hughes representative.

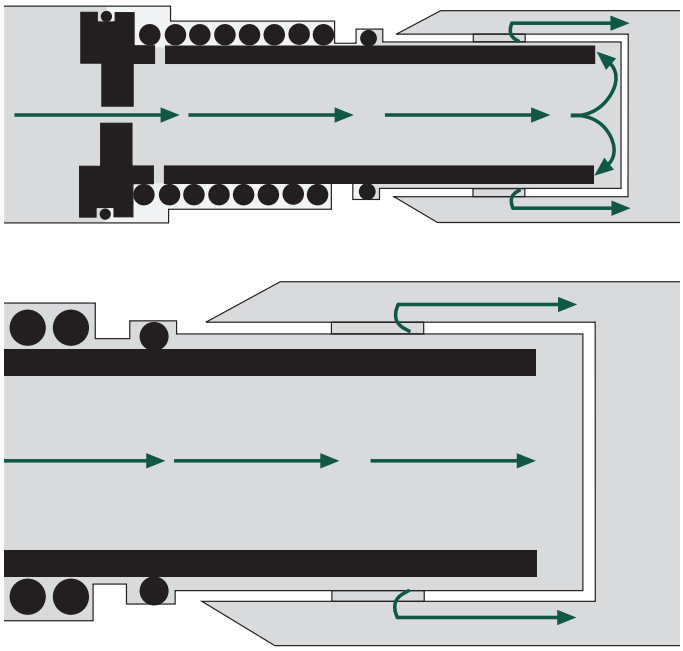


All flow regulators provide constant flow rates which help maintain uniform flood fronts. Constant flow of Baker Hughes regulators is contrasted with conventional needle valve control in this graph.

High and Low Flow Rate Throttles

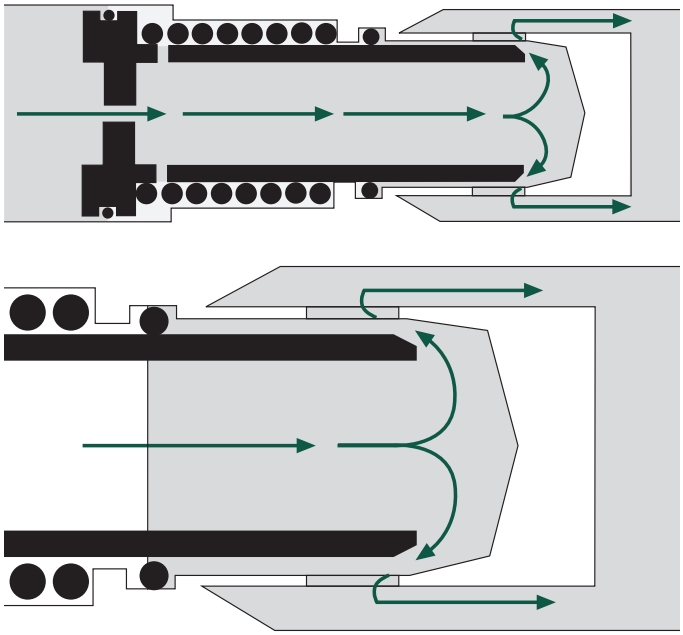
High Fluid Flow Path Through Regulator

The **Model BE™ flow regulator** handles flow rates from 250 to 2,500 bbl/day (40 to 397 m^3/day). This regulator is built with a slide throttle. The fluid flows through the annulus between the piston and the ported cylinder. By changing the length of the annulus, the flow is regulated. **The Model DSJ™** can handle up to 5,000 bbl/day (795 m^3/day).



Low Fluid Flow Path Through Regulator

The **Model BF™ flow regulator** handles flow rates from 50 to 1,000 bbl/day (8 to 159 m^3/day). This regulator is built with a face throttle. By controlling the gap between the tapered end of the cylinder and the tapered end of the piston, the flow is regulated. This unique design allows the regulator to be used at low flow rates without plugging.



Wireline Entry Guide with Pump Out Plug, with Shear-Out Ball Seat, and with Half Muleshoe Bottom

Product Family Nos. H46921 and H79927

Application

The Baker Hughes **wireline entry guide** is designed to be run on the bottom of the tubing string. It will aid wireline tools reentry into the tubing.

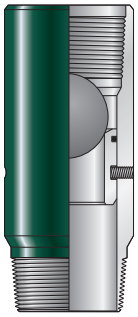
The **wireline entry guide with pump out plug, wireline entry guide with shear-out ball seat**, and the **shear-out ball seat** sub are installed on the bottom end of the tubing to allow the tubing string to be pressured. When the differential pressure at the tool reaches a pre-determined value, the plug, or ball and seat, are pumped out of the tool. After the plug or ball seat have been pumped out, these subs allow unrestricted access from the tubing into the casing below the tubing string.

These products are available in a variety of configurations. Options include a muleshoe guide to facilitate easy entry when running the tubing through the top of a liner or into a sealbore packer, and expendable check valves. The shear-out ball seat sub (product family No. H79927) is furnished in a box x pin configuration for those applications where it is necessary to run additional tubing or completion equipment below the shear-out ball seat sub.

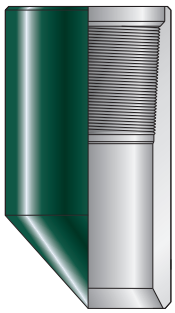
Since each of these tools expend a plug or ball and ball seat during their operation, it is necessary to ensure those parts will safely pass through all equipment that is located below them.

Wireline Entry Guide
Product Family No. H46921

Wireline Entry Guide with Pump Out Plug
Product Family No. H46921



Wireline Entry Guide with Shear-Out Ball Seat Sub
Product Family No. H79927



Wireline Entry Guide with Half Muleshoe Bottom
Product Family No. H46921

Blast Joint

Product Family No. H45750

Application

The Baker Hughes **blast joint**, positioned opposite the perforations in the casing, is used in the tubing string of a flowing well to protect it from the abrasive action of the flowing well. It exposes the maximum of metal in the abrasive area, maintaining at the same time API tubing ID and coupling OD. It is available in 10 ft (3.05 m) or 20 ft (6.10 m) lengths and for use with 2⅜-in. (60.3 mm) through 4½-in. (114.3 mm) production strings.

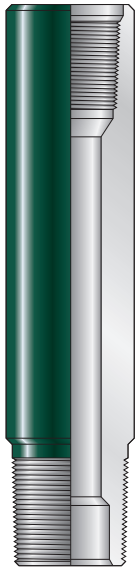
Blast Joint
Product Family No. H45750

Flow Coupling

Product Family No. H81920

Application

The Baker Hughes **flow coupling** is used to protect the integrity of tubing from erosive turbulence. Flow couplings are often used above and below a geometric restriction in the flow path, depending on the well conditions. API Recommended Practices 14B advises use of flow couplings above and below safety valves. Baker Hughes offers flow couplings in 4 ft (1.22 m), 6 ft (1.83 m), 8 ft (2.45 m), and 10 ft (3.05 m) lengths to suit the application.



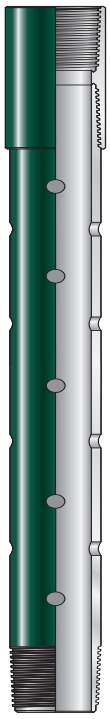
Flow Coupling
Product Family No. H81920

Perforated Spacer Tube

Product Family No. H45743

Application

The Baker Hughes **perforated spacer tube** is used at the end of a tubing string to provide an alternate flow path in cases where wireline measuring devices are used.



Perforated Spacer Tube
Product Family No. H45743

Design Basis Well Environment Data for Material Recommendations

Baker Hughes

Customer:		Date:	
Well Name or Location:		Requester Name/Company:	
		Phone:	
Well Type:	☐Gas ☐Oil ☐Injection/Disposal*:	☐Other:	

*For injection/disposal wells, **provide a report listing all** liquids and gases injected. If well will initially be used as a producer, fill out two forms. **Oxygen ppb is critical for injection wells**.*

Casing/Tubing Selections					
Tubing OD:		Tubing Grade (e.g. L80/13Cr):	/	Tubing ID Coated:	☐Y ☐N
Casing OD:		Casing Grade (e.g. L80/13Cr):	/	Tubing Coating Type:	

List units of measure for ALL data below*

Applicable Equipment Type		Depth (ft, m)	Exposure time to Produced Fluids/Total Well Life
Packer:			/ (yrs, days)
SSSV:			/ (yrs, days)
BFC:			/ (yrs, days)
Liner Hanger:			/ (yrs, days)
Other (specify):			/ (yrs, days)

Downhole Conditions					
Location	Max. Temperature		Min. Temperature		Bubble point (for oil wells) or Max. Pressure
@ Reservoir		**(°F, °C)**		**(°F,°C)**	**(psi, KPa)**
@ Wellhead		**(°F, °C)**		**(°F,°C)**	**(psi, KPa)**

Reservoir **Depth**:	**(ft, m)**
Gas Phase CO_2 @ **(reservoir** or **WH)**:	**(psia, mole %, ppm)**
Gas Phase H_2S @ **(reservoir** or **WH)**:	**(psia, mole %, ppm)**
Elemental Sulfur:	**(None or g/l)**
Design max. **Water Production (Gas)**:	**(bbl/MMSCF, m^3/m^3)**
Design max. **Water Cut (Oil)**:	**(%)**
Design (max.) **Chlorides**:	**(ppm, mg/l)**
Bicarbonate Ion Concentration:	**(ppm, mg/l)**
Organic Acid Concentration:	**(ppm, mg/l)**

Production Inhibitors:	(continuous, batch, none)	Inhibitor type:	(e.g. amine)
Annulus/completion fluid:	(e.g. $CaCl_2$)	Inhib/type:	/
Other fluid exposure/ concentration/time:	(e.g. mud acid, 15% HCl, xylene, toluene, methanol, caustic, >9 pH mud, scale inhibitor)		

Note: Request water and gas analysis reports and include with this form.