Flow Control Systems
“Each day, every one of us will challenge ourselves, as one flow control team, to set the standard for the worldwide flow control market. Continuous improvement of customer satisfaction and employee development, through teamwork and product focus, is the key to our success”.

- Baker Hughes flow control product line vision 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 insure 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 over 140 sales and service locations insures personalized service throughout the world. State-of-the-art research and engineering centers in Houston and Aberdeen and manufacturing centers in the USA, UK, Singapore and Venezuela 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.)
- Sliding sleeves
- Nipple-less flow control products
- Flow regulators and flow control accessories
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Applications

“The equipment used to complete oil and gas wells is as varied and complex as the wells themselves.”

An efficiently designed and implemented well completion program can help insure optimum production, minimize equipment repairs, reduce rig downtime, and extend the life of the well. Baker Hughes’ extensive line of flow control products and systems help do all these and more. The strategic location of flow control products in the production string adds a high degree of versatility to the completion. To illustrate this, we have selected a group of application examples that go from a simple single zone completion to the most complex intelligent completions. These examples also include brief explanations of the functionality of each flow control tool according to their respective position in the completion string.

The following is a list of the application examples included in this section:

- Stepped nipple completion
- Single string selective-zone completion
- Gas lift completion
- ESP completion
- Multi-zone water flood injection completion
- Liner top completion
- High pressure/high temperature (HP/HT) stepped nipple completion
- Single string selective gravel pack completion
- Velocity string system
- InForce™ intelligent well system
- InCharge™ intelligent well system
Stepped Nipple Completion

The stepped nipple completion is a common and simple means of completing a well using a series of strategically located nipple profiles (stepping down in size). This type of completion allows positive indication that the through tubing flow control device is correctly located in the desired nipple profile.

The capability of using flow control devices in a completion string, adds great amount of flexibility and versatility to the completion.

The flow coupling with its heavy wall design provides a protection against the abrasive action caused by turbulent flow through the restricted area of the safety valve.

The seating nipples provide a means of landing blanking plugs or check valves capable of holding pressure from above for setting hydraulic packers and testing tubing. They can also be used to isolate the perforations and protect the formation from any damage due to kill fluid loss, or used for landing a choke which will regulate the production flow rate.

The Model CM™ sliding sleeve while in its closed position acts as a straight-through flow path for fluids being injected from above or produced from below. In its open position it provides a full (unrestricted) tubing-to-annulus communication for circulating or displacing fluids during completion operations. A seating nipple profile is also located in the top sub of the sliding sleeve and can be used for locating any flow control device.

The bottom no-go seating nipple, by nature of its design, contains the smallest restriction in the tubing string, serving as a catcher for tools inadvertently dropped downhole. It also may be used for landing recording instruments without restricting the flow and protecting the instruments from flow turbulence and vibration.

The wireline entry guide is always positioned at the bottom end of the production string and its internal bevel allows wireline tools that have exited the end of the tubing string to be pulled back up without hanging up.
Single String Selective-Zone Completion

The single string selective-zone completion permits selective production, injection, testing, stimulation, and isolation of various zones. Selectivity after completion is accomplished by opening and closing sliding sleeves between the packers.

Blast joints located adjacent to producing zones resist the erosive forces of produced fluids.

Model CM™ sliding sleeves are installed as close as possible to the packers below the sleeves to service the entire zone. While in their closed position they act as straight-through flow path for fluids being injected from above or produced from below. In their open position they provide a full unrestricted tubing-to-annulus communication for selective injection or production.

The seating nipples provide a means of landing blanking plugs or check valves capable of holding pressure from above for setting hydraulic packers and testing tubing. They may also be used to isolate the perforations and protect the formation from any damage due to kill fluid loss, or used for landing a choke for regulating the production flow rate.

The wireline entry guide is always positioned at the bottom end of the production string and its internal bevel allows wireline tools that have exited the end of the tubing string to be pulled back up without hanging up.
Gas Lift Completion

In wells where the natural reservoir energy will not create sufficient differential pressure to drive production fluids to surface, artificial lift systems such as gas lift are used to supplement the natural energy enabling the well to produce. Gas lift valves are installed in side-pocket mandrels and spaced out along the production string. The Baker Hughes BOTipod™ software is used to design the completion (number, size, calibration pressure and depth of gas lift valves).

The flow coupling, with its heavy wall design, provides a protection against the abrasive action caused by turbulent flow through the restricted area of the safety valve.

Model CM™ sliding sleeves are installed as close as possible to the packers below the sleeves to service the entire zone. While in their closed position, they act as straight-through flow path for fluids being injected from above or produced from below. In their open position they provide a full unrestricted tubing-to-annulus communication.

The seating nipple provides a means of landing blanking plugs or check valves capable of holding pressure from above for setting hydraulic packers and testing tubing. It may also be used to isolate the perforations and protecting the formation from any damage due to kill fluid loss, or used for landing a choke for regulating the production flow rate. In this particular application, the seating nipple may be used for setting a valve catcher prior to removal and/or installation of the gas lift valves, for catching any inadvertently dropped valve.

The wireline entry guide is always positioned at the bottom end of the production string and its internal bevel allows wireline tools that have exited the end of the tubing string to be pulled back up without hanging up.
Electronic Submersible Pump (ESP) Completion

This electronic submersible pump (ESP) completion is designed for use when the well requires artificial lift. This completion arrangement will allow pulling the pump assembly without intervention to maintain well control, greatly simplifying and accelerating the workover process.

During normal operation, fluid from below the packer will flow up through the packer into the upper annulus to the pump inlet, and is then pumped to the surface. If the pump assembly needs to be removed from the well, the Model Q-22™ sliding sleeve mounted below the sealbore packer automatically closes when the seal assembly is pulled from the packer, providing a secure isolation of the formation below. Thus, well control is maintained without the use of kill-weight fluid or wireline intervention.

When the pump assembly is run back in the hole, the Model Q-22 sliding sleeve opens automatically when the seal assembly is landed in the packer.
Multi-Zone Waterflood Injection Completion

Applications for waterflood completions requiring multi-zone injection can be economically addressed with single string packers. Downhole flow regulators installed in side-pocket mandrels provide control of volumes directed to the upper zones. The lower seating nipple profile below the lower packer can accommodate an in-line flow regulator to control injection into the lower zone.
**Liner Top Completion**

When running a liner top completion there is an option to run with or without seating nipples. In applications where a thru-tubing retrievable bridge plug is not suitable, the use of stepped nipples is the preferred option, such as an HP/HT liner top completion where the use of the stepped nipple design is the preferred method.

The liner top stepped nipple completion uses a series of nipple profiles (stepping down in size) strategically placed in the completion, in order to allow positive indication that the through tubing flow control device is correctly located in the desired nipple profile. This, together with the usage of other flow control tools, gives versatility and flexibility to the completion.

In lower pressure liner top wells, the elimination of nipples in favour of the Model NPR™ bridge plug can also be used. This will maximize dimension and allow the flexibility to set the Model NPR bridge plug anywhere in the completion string.

This particular completion plan was designed to accommodate a staged perforation schedule, zonal isolation, multiple contingencies, and ease of workover.
High Pressure/High Temperature (HP/HT) Stepped Nipple Completion

Generally, the industry accepted definition of a high pressure/high temperature (HP/HT) well is when the downhole conditions include temperatures exceeding 300°F (148°C) and pressures in excess of 10,000 psi (690 bar) combined. When running any flow control device in these hostile conditions it is extremely important to use proven reliable equipment.

The stepped nipple completion concept is to date, the preferred option in HP/HT applications, which uses a series of nipple profiles (stepping down in size) strategically placed in the completion in order to allow positive indication that the through tubing flow control device is correctly located in the desired nipple profile. The Extreme Sur-Set™ system does exactly this, it is a proven, reliable non-elastomeric system with an outstanding run history. Together with the usage of other flow control tools, it provides versatility and flexibility to the completion.
Single String Selective Gravel Pack Completion

The single string selective gravel pack completion allows the commingling of zones or separate production isolation, testing, or stimulation of individual zones. This level of flexibility is achieved by the placement of Model SLCM™ slimline sliding sleeves in the isolation strings of the successive gravel pack assemblies. In a single string selective completion, the isolation string is run on the bottom of the production seals that sting into the upper packer or on the bottom of the snap-latch seal assembly for another gravel pack setting above.
Velocity String System

The Baker Hughes Velox™ system is a modular system that has a number of different applications which can be broken down into two types, straddle packoff and velocity string. This particular illustration talks about the Velox system being used in a velocity application.

Late in a field’s life, flowing gas wells lose pressure and production velocity. Over time, these wells can load up with produced water, whose accumulated weight eventually stops gas flow. The use of the Velox velocity system offers a cost-effective solution by deploying a smaller ID tubing string hung off a Velox packoff below the existing tubing safety valve. By inserting production tubing with a reduced diameter and cross-sectional area, the velocity string increases the annular velocity of the flowing gas, so that the water is carried from the well and gas production continues.

The Velox velocity and straddle system is either a combined mechanical and hydraulic set, or purely hydraulic set system. Velox uses existing technology to provide the customer with a low cost and reliable tool that can be run and set in one trip.
InForce Intelligent Well System

This well schematic represents a typical multizone intelligent completion system with repeated subassemblies consisting of a packer with feed-through ports and a hydraulic Model HCM™ sliding sleeve. The system can be completed with pressure/temperature gauges and flowmeters in each zone for real-time monitoring.

Model HCM sliding sleeves allow selectivity without the need for any well intervention. Applying hydraulic pressure from surface through control lines actuates the sliding sleeves opening or closing them.
InCharge Intelligent Well System

This completion illustrates the Baker Hughes state-of-the-art, all-electric InCharge™ intelligent well system. The InCharge system is designed to provide the customer with features and benefits for completing critical wells where inflow/outflow controlling and pressure/temperature/flow monitoring are required and the use of conventional methods is not suitable. The intelligent production regulator (IPR) in its standard (tubing-to-annulus control) and shrouded (tubing-to-tubing control) versions are the active InCharge system components.

The IPR is an infinite variable choke regulator that integrates a new generation of downhole electronics, selected to meet aeronautic/space/military industry standards and downhole quartz gauges to the field proven CM™ sliding sleeve technology. The main advantage and feature of this equipment is to allow adjustments of the inflow and outflow characteristics based on real-time data without the use of conventional methods. The shrouded IPR (S-IPR), different from its standard version (not shrouded) is a tubing-to-tubing flow control device which diverges the injection fluids through the IPR ports to the outer-annulus space (defined by the shroud housing ID and the IPROD) and back to the tubing through a perforated pup joint (refer to the completion design shown and notice that the wireline retrievable plug installed into this shrouded IPR between its ports’ and the perforated pup joint sections).

This particular completion design provides the customer full control of the injection fluids being diverged to both zones by choking either one of the valves installed while monitoring downhole pressure and temperature. The 5-1/2 in. flow measurement unit measures the total inflow rate being injected from surface. Then, part of the injection fluids is diverted to the upper zone through the 5-1/2 in. IPR ports (tubing annulus control). The 3-1/2 in. flow measurement unit measures the remaining flow rate being injected on the lower zone thru the 3-1/2 in. S-IPR (tubing-tubing control).
Sur-Set Flow Control System

APPLICATION

Sur-Set™ 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 nipples 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.

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 insure 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

9Chrome-1Moly Steel (18-22 RC Max)

APPLICATIONS
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, it 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 MR-01-75 (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

Features/Benefits
- Manufactured from 9Chrome-1Moly (18-22 RC Max) for H₂S - recommended CO₂ service (other material available)
- 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
Sur-Set Locking Mandrels

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 an Model AR lock. The Sur-Set locking mandrels are run with a Model A™ running tool, (product family no. H81155), and Model D™ probe, (product family no. H81156).

Features/Benefits

- 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 H₂S/CO₂ 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
Short Sur-Set Locking Mandrel for Tubing Hanger Plugs

Product Family No. H99508

APPLICATION
The short Sur-Set™ locking mandrels are a version of the Sur-Set locking mandrels that have a reduced linear length from the locking dogs to the top of the fishing neck. Used in standard Sur-Set hanger profiles and also in HP/HT operations, this feature is critical when moving wellheads on or off, preventing damage to the flow control device that would otherwise be protruding above the flange face. The short Sur-Set locking mandrel incorporates all the standard features of the standard Sur-Set locking mandrels to insure reliable service. Another feature that can be incorporated in this plug or any tubing hanger/wellhead plugging device is the “ST” seal, which is a single seal face that provides sealing integrity from both above and below.

Features/Benefits
- All features/benefits of standard Sur-Set lock
- Minimal stick up for subsea tubing hanger operations
Model H Bottom Blanking Plug
Product Family No. H83618

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 time. 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.

Features/Benefits
- 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 M Bottom Blanking Plug
Product Family No. H83616

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, (product family no. H83616), 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, (product family no. H81171) and equalizing prong, (product family no. H81188). Another trip is required to retrieve the plug with a Model GS™ type pulling tool, (product family no. H81150). The Model M plugs are run in with a Model A running tool, (product family no. H81155), a Model D™ probe, (product family no. H81156), and a Model MH™ positioning tool, (product family no. H81254). 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.

Features/Benefits
- Single-trip installation
- Ideal for gas wells
- Provides positive indication that lock is set in nipple profile
Model L Bottom Circulating Blanking Plug
Product Family No. H83632

APPLICATION
The Model L™ bottom circulating banking 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.

Features/Benefits
- 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 P Bottom Blanking Plug
Product Family No. H83643

APPLICATION
The Model P™ bottom blanking plug is a solid plug that holds pressure from above and below. The design of this plug does not allow for bypass during run-in, so care should be taken when running this bottom. A built-in method is incorporated allowing for equalization during retrieval.

Features/Benefits
- Has solid bottom that holds pressure from either direction
- Pressure can be equalized by breaking the equalizing plug
- Provides positive indication that lock is set in nipple profile

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.

Features/Benefits
- 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
Model V Bottom Check Valve

Product Family No. H99508

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 seating nipple all the differential applied to the valve is carried by the locking dogs and 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).

Features/Benefits
- 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 T-2 Check Valve for Sur-Set Seating Nipples

Product Family Nos. H80963 and H80964

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 seating nipple all the differential applied to the valve is carried by the locking dogs and 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.

Features/Benefits
- 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
Models C and D Choke Bottoms
Product Family No. H80759

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.

Features/Benefits
- 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 B Instrument Hanger Bottom
Product Family No. H80337

APPLICATION
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.

Features/Benefits
- Ability to hang a variety of intruments
- Large flow area

Model SLB Instrument Hanger for Sur-Set Seating Nipples
Product Family No. 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.

Features/Benefits
- Ability to hang instruments
- Soft setting prevents jarring through instruments
- Large flow area
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 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.

Note: There may be a letter "O" between the first two letters in this case between the "A" and the "F"; this indicates that the material the tool has been manufactured from is other than standard Sur-Set™ material (9Chrome-1Moly 18-22RC 80MYS).

Example: Model 3.688 in. AFH Bypass Blanking Plug
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.

Features/Benefits
- 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 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.

Features/Benefits
- Provides fluid bypass while running in the hole
- Provides one-trip to run capability
- Compatible with all sur-set equipment
Pres-Sur-Set Running Tool
Product Family No. H81166

APPLICATION
The Pres-Sur-Set™ running tool allows the setting of a Sur-Set™ locking mandrel on slickline at deviations up to 70°. After the locking mandrel has been pushed or circulated into place and has located on the no-go shoulder of the seating nipple, surface pressure is applied to shear the release pins in the running tool. Once the shear pins have sheared, hydrostatic pressure sets the locking mandrel.

Like the Model A™ running tool, the Pres-Sur-Set will not release from the locking mandrel unless it is properly set in the nipple. If the locking mandrel is miss-run, the running tool will return the device to surface.

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<th>Features/Benefits</th>
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<td>Running tool cannot release from plug unless properly set in its mating profile</td>
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<td>Minimal running and retrieving tools requirement</td>
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<td>Eliminates mechanical jarring</td>
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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.

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- **Top No-Go not available.**
- **Bottom No-Go not available.**

*A= 10k psi (689.48 bar) from above and below; K= 10k psi (689.48 bar) from above and 15k psi (1034.21 bar) from below.*
## Sur-Set Running/Pulling Tool Guide

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<th>Model A™ Running Tool</th>
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N/A = Non-Applicable.
Modular Sur-Set Locking System

Model AF and HF Bottom No-Go Seating Nipple and Locking Mandrel
Model AR and HR Bottom No-Go Seating Nipple and Locking Mandrel

Model V
Bottom Check Valve
Product Family No. H89508

Model H
Bottom Blanking Plug
Product Family No. H83618

Model M
Bottom Blanking Plug
Product Family No. H83616

Product Family No. H83602

Product Family No. H80185

Product Family No. H80178

Product Family No. H83601

Product Family No. H83616

Product Family No. H83618

Product Family No. H836002

Product Family No. H80178

Product Family No. H80185

Product Family No. H836002

Product Family No. H836018

Product Family No. H83616

Product Family No. H836002

Product Family No. H836018

Product Family No. H836002

Product Family No. H836018

Product Family No. H83616

Product Family No. H836018
Extreme Sur-Set
Product Family No. H83940

APPLICATION
High pressure/high temperature (HP/HT) wells have presented unique challenges to equipment suppliers in dealing with the hostile environment these wells present. The use of HP/HT equipment is expected to grow as more of these hostile fields are developed. The equipment used in these applications requires more stringent qualification and quality control.

Generally, the industry standard accepted definition of an HP/HT well is where the bottomhole temperature is exceeding 300°F (148°C) with a maximum pore pressure in the formation in excess of 0.8 psi/ft (0.180 bar/m) or requirements for pressure control equipment exceeds 10,000 psi (690 bar). In practice, the downhole equipment that is considered for HP/HT wells generally has been designed for pressures between 10,000 psi (690 bar) and 15,000 psi (1,034 bar) combined with a temperature range between 275°F (135°C) and 450°F (232°C). Sealing system and metallurgy choice is critical.

The Extreme Sur-Set™ non-elastomeric flow control locking system meets and exceeds the criteria to operate within the HP/HT locking system market. With an extensive successful history, it has repeatedly proven its capabilities as the number one HP/HT locking system.

The HP/HT industries have leaned toward the use of a stepped locking nipple system. This offers positive indication that the desired profile has been reached and the operator is assured that the flow control device is set in the desired nipple profile. This is a critical feature when carrying out operations on these high cost applications.

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, the lock contacts the nipples nogo 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.
Baker Hughes Models F and R Flow Control System

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, choke flow along with separation sleeves and instrument hangers can be made up to the bottoms of the locks.
Model F Seating Nipples
Product Family Nos. H80150 (Alloy Steel), and H80151 (Stainless Steel)

Model R Seating Nipples
Product Family Nos. H80155 (Alloy Steel), and H80156 (Stainless Steel)

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 MR-01-75 (latest revision).

Features/Benefits
- Material selection - alloy steel, stainless steel and 9Chrome -1Moly are heat treated 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

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
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 dogs 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 dogs 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 dogs protrusion into the flow path.

Features/Benefits
- 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 1-1/4 in. (31.75 mm) through 3-1/2 in. (88.9 mm)
- Modularity reduces completion and maintenance costs
Models N and M Top No-Go Lock Subassemblies

Models L and K Bottom No-Go Lock Subassemblies

**APPLICATION**

The Baker Hughes N- and M-type lock subassemblies are top no-go style locks. 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 2-3/8 in. (60.33 mm) and 2-7/8 in. (73.03 mm) Model M locks have internal fishing necks and are available in sizes 3-1/2 in. (88.9 mm) through 7 in. (177.8 mm).

The Baker Hughes L- and K-type lock subassemblies are bottom no-go style locks. Designed with a collet-type lock to prevent upward movement and a no-go shoulder located on the flow control accessory prevents 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 2-3/8 in. (60.33 mm) and 2-7/8 in. (73.03 mm) Model K™ locks have internal fishing necks and are available in sizes 3-1/2 in. (88.9 mm) through 7 in. (177.8 mm).

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<thead>
<tr>
<th>Features/Benefits</th>
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<tr>
<td>- Very large flow areas for high volumes</td>
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<tr>
<td>- Simple and rugged construction</td>
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<tr>
<td>- High flow rates cannot dislodge plunger which holds latch in locked position</td>
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<tr>
<td>- Can be used in either standard or sour gas environments as all parts are manufactured to current NACE specifications</td>
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<tr>
<td>- Run and retrieved using standard wireline procedures</td>
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<tr>
<td>- Available for tubing sizes from 2-3/8 in. (60.33 mm) through 7 in. (177.8 mm)</td>
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<td>- Modularity reduces completion and maintenance costs</td>
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Model B Bottom for Model FSB Bypass Blanking Plug
Product Family No. H80604

APPLICATION
The Model B™ bypass blanking plug bottom holds pressure from below while allowing circulation from above. The bottom is held open during run-in by use of the Model A™ prong. A built-in method is incorporated allowing for equalization during retrieval.

Features/Benefits
- Holds pressure from below while allowing circulation from above
- Can be held open to bypass fluid while running and pulling
- Can be equalized by depressing an internal valve

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.

Features/Benefits
- 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 P Bottom for RZP-20 Blanking Plugs
Product Family No. H80613

APPLICATION
The Model P™ blanking plug is a solid plug that holds pressure from above and below. The design of this plug does not allow for bypass during run-in, so care should be taken when running this bottom. A built-in method is incorporated allowing for equalization during retrieval. This plug does not contain a bypass and therefore, must be used with discretion while running.

Features/Benefits
- Has solid bottom that holds pressure from either direction
- Pressure can be equalized by breaking the equalizing plug
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 H Bottom for Models FMH and RKH Bypass Blanking Plugs With Removable Mandrel
Product Family Nos. H80690 and H80691

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 B Instrument Hanger Bottom
Product Family No. H80337

APPLICATION
The Baker Hughes Model B™ instrument hanger bottom when attached to the proper lock, is used to land geophysical instruments in a Baker Hughes Models F™ or R™ seating nipple or nipple insert under pressure.

Features/Benefits
- Ability of hang a variety of instruments
- Large flow area

Wireline Retrievable Chokes
The Baker Hughes wireline retrievable chokes when landed in Baker Hughes seating nipples restrict flow in a tubing string for various operations.

Chokes can be sized in 1/64 in. (0.40 mm) increments based on optimized flow rate.

The Model D™ choke is identical to the Model C™ choke with the exception the Model D choke has a ceramic flow bean.

Features/Benefits
- Reduces gas-oil ratios under certain condition
- Prevents freezing of surface controls by moving the point of pressure reduction to the lower portion of the wellbore
- Prolongs the flowing life of a well by maintaining bottomhole pressure
- Lessens water encroachment under certain conditions by stabilizing bottomhole conditions
- Reduces production when desirable
Model FB-2 Equalizing Check Valve  
Product Family No. H80935 (Top No-Go)  

Model RB-2 Equalizing Check Valve  
Product Family No. H80936 (Bottom No-Go)  

Model V Equalizing Check Valves  
Product Family Nos. H80902 (FSV), H80902 (FWV), H80904 (RZV), and H80905 (RVK)  

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 intermittent 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.

The Model V™ equalizing check valve bottom when attached to the proper lock is landed into a Baker Hughes Model F or Model R seating nipple or sliding sleeve. It cannot be run with a Model S™ Lock because the ball cannot be held off the seat during running and landing. For retrieval it can be equalized by breaking the equalizing plug.

### Features/Benefits
- Large flow area
- Fluid bypass for retrieval
- Single-trip installation and removal
- Simple design
Baker Hughes Flow Control Equipment System

Selective Lock Module or Any of these Top No-Go Lock Modules are used with Model F Seating Nipple or Model L Sliding Sleeve

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

(Non-Flowing) Any of these Bottom No-Go Lock Modules are used with The R Seating Nipple
Baker Hughes Flow Control Equipment Summary
Model M Running/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 retrieved to the surface.

Features/Benefits
- Emergency shear release
- Simple design
- Large dog contact area

Model G Running Tool
Product Family No. H81108

APPLICATION
The Model G™ running tool is used to run wireline accessories equipped with the Model S™ selective lock (up facing dogs trailing) into 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. It is not recommended for landing selective locks in sliding sleeves.

Features/Benefits
- Allows selection locks to be set with dogs trailing
- Simple construction
- Easy to pin
- Rapid retrieval from well

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.

Features/Benefits
- Protected tubing ID and sealbores, collet does not trail in tubing ID
- Controls lock release
Soft Release Running Tool

Product Family No. H81140

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 Models 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.

Features/Benefits

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

Model C-1 Running Tool

Product Family No. H81106

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.

Features/Benefits

- 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
Models A and AC Probes
Product Family Nos. H81206 and H81208
The Models A™ and AC™ probes are used to retrieve Model S™ locks.

Model B Probe
Product Family No. H81207
The Model B™ probe is used to retrieve Models W™ and Z™ locks.

Model M Probe
Product Family No. H81211
The Model M™ probe is used to run and retrieve Models E™ and F™ locks.

Model M-1 Probe
Product Family No. H81214
The Model M-1™ probe is used to run and retrieve Models E-1™ and F-1™ locks.

Model MA Adjustable Probe
Product Family No. H81218
The Model MA™ adjustable probe, in conjunction with conventional running and pulling tools, is used to both run and pull baker flow control equipment having a Baker Hughes M™ lock.

Model N-1 Probe
Product Family No. H81213
The Model N-1™ probe is used to retrieve Models G™ and R™ locks.
Model A Prong
Product Family No. H81170
Model A™ prong is widely used in running and pulling operations.

Model B Prong
Product Family No. H81172
Model B™ prong runs R-type blanking plugs.

Model C Prong
Product Family No. H81173
Model C™ prong equalizes Model R™ blanking plugs.

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 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 flow control equipment having a Model G™ or Model R™ lock.
Sliding Sleeves

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 which characteristics vary according to the applications they were designed for.

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™ and Model CU 6000™ are lower cost versions of the Model CM sliding sleeves; they are designed for applications where downhole conditions are mild and do not require high performance tools. The Models CD 6000 and CU 6000 offer the same unique features of the Model CM sliding sleeve but with different seals, which are a combination of elastomeric and thermoplastic elements. Also, QPQ coating is not offered.

The Model SLCM™ is the slimline version of the Model CM sliding sleeves and is designed specially for selective gravel pack applications where the sliding sleeves are run inside the 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 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.
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, 9 Chrome-1Moly, 13% Cr, 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.

Features/Benefits

- 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. Alloy and stainless steel grades are treated with QPQ coating which has performed flawlessly since 1985. 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.
Designed in four standard materials: 4140, 1CrMo-1Mo-13, 13Cr 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 9™ or a Baker Hughes Model CM shifting tool, assures 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.

Built-in landing nipple available with Baker 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 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 is a completely new design using 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.

Features/Benefits
- 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
- The metal components are coated with QPQ to eliminate the threat of galling due to metal-to-metal movement (insert in housings) and thread makeup
- 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
Models CD 6000 and CU 6000 Sliding Sleeves
Product Family No. H81000

APPLICATION
The Models CD 6000™ and CU 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 or Model CU 6000 upshift-to-open versions.

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 and CU 6000 series sliding sleeves, several unique features have been combined to upgrade seal performance and increase service life.

Features/Benefits
- 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.
- 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.
- Modular design permits conversion from a Model CD 6000 to Model CU 6000 or vice versa by only changing the upper and lower subs.
- Proprietary non-elastomeric and elastomeric compounds enhance a sealing system designed for diverse environments.
Model CMP Non-Elastomeric Circulating Sliding Sleeve
Product Family No. H81081

APPLICATION
The Model CMP™ non-elastomeric circulating sliding sleeve, is a high performance, equalizing sliding sleeve, which allows communication between the tubing and annulus for circulation or selective-zone production. The external circulating sliding sleeve allows hydraulic setting of packers and verifies the seal integrity between the packer and the tubing. After the annulus pressure test is performed, tubing pressure shifts the external circulating sleeve downward to the full-open position. This feature allows you to circulate heavy completion fluids out of the tubing 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 inner sleeve can be shifted open or closed using standard wireline methods and a Model CM™ or B-type shifting tool. A standard Baker Hughes locking profile is included in the upper sub of the sleeve with a polished sealbore above and below the ports to accept a variety of wireline locks, packing and accessories. The nominal working specs on the sleeve, in most cases are burst, collapse and tensile equal to N-80 tubing, 375°F (191°C) service temperature and 1,500 psi (103 bar) maximum shifting differential. The outer sleeve can be pinned to open at pressure from 1,000 psi (69 bar) to 5,500 psi (345 bar); this varies with each size. The sleeves have been designed in four standard materials: 4140, 9Chrome-1Moly, 13% Cr and Nickel Alloy 718 for a wide range of services.

In designing the Model CMP circulating sliding sleeve, Baker Hughes combined several unique features to alleviate the possibility of seal-related problems.

Features/Benefits
- Allows setting of hydraulic packers with well flanged up
- Allows annulus pressure test to verify packer tubing seal integrity
- Allows circulating lighter fluid in tubing string, while flanged up without the need of a wireline trip
- Eliminates need for wireline work with heavy completion fluid still in tubing string
- Outer sleeve designed not to reclose downhole due to fluid flow
- Allows circulation of kill fluids with wellhead in place prior to releasing packer for safer operation
- The Model CMP has all the other features/benefits of the Model CM series diffuser ring - seal stack, etc.
- Available with Model F™, Model AF™, or other profiles
Model CMP Defender Non-Elastomeric Circulating Sliding Sleeve
Product Family No. H81082

APPLICATION
The Model CMP™ defender non-elastomeric circulating sliding sleeve is a high performance, non-elastomeric equalizing sliding sleeve, which allows communication between the tubing and casing annulus for circulation. When run as part of the Baker Hughes' defender system in a concentric string, the circulating sliding sleeve allows for fluid loss control and well control, but can be activated open without intervention by surface tubing pressure.

When desired, the tubing is pressured up to differentially shear the shear screws in the outer sleeve. As long as the differential is maintained above 500 psi (34.473 bar) the outer sleeve will remain closed. After bleeding the tubing down to 500 psi (34.473 bar) differential, the spring in the outer sleeve will move it up into the open position. This feature allows multiple sleeves to be opened simultaneously. Since the inner sleeve is already in the open position, circulation can be achieved between the tubing and casing annulus.

When desired, the inner sleeve can be shifted down to close or up to open using standard wireline methods with a standard shifting tool. A locking profile is included in the upper sub of the sleeve with a polished sealbore above and below the sleeve ports, to accept a variety of wireline locks and accessories.

Features/Benefits
- Allows circulation of kill fluids with wellhead in place prior to releasing packer for safer operation
- System allows for well control because it holds from both ways until activated
- Can be controlled and opened by raising and lowering surface tubing pressure
- Allows tubing pressure test to verify packer tubing seal integrity
- Eliminates need for wireline work to open the sleeve the first time
Model Q-22 Sliding Sleeve
Product Family No. H81036

APPLICATION
The Model Q-22™ sliding sleeve is a mechanically actuated communication device designed to open or shut off well production. This device is normally attached below a sealbore-type retrievable casing packer and is manipulated open and closed by a stinger sub attached directly to the packer seal assembly. As the seal assembly is lowered into the packer, the stinger sub contacts the closing sleeve of the Model Q-22 and forces it downward, opening the sleeve. When the seal assembly is withdrawn from the packer, the collet on the closing sleeve of the Model Q-22 attaches to the stinger and pulls the closing sleeve to the closed position. When the sleeve is fully closed, the collet will release from the stinger sub on the seal assembly.

Features/Benefits
- Uses time tested Model L™ sliding sleeve bonded seal design
- Available with Model CM™ style sliding sleeve
- Allows well to be shut in while pulling tubing without killing well
- Prevents formation damage
- Can be used with a multitude of sealbore type packers
- Tubing-to-casing seal integrity is maintained until sleeve is fully closed
- Allows retrieval of electric submersible pumps

Model L Sliding Sleeve
Product Family Nos. H81004 (Standard Service), H81012 (H₂S Service), and H81014 (H₂S-CO₂ Service)

APPLICATION
The Model L™ sliding sleeve is a downhole flow control device mounted in the production tubing. It effectively controls flow between the tubing and casing annulus, by means of an internal sleeve that is opened or closed by standard wireline methods.

Features/Benefits
- Simple, positive control
- Unique seal design
- Protected closing sleeve
- Run in tandem
- Additional seating nipple
Model CM Selective Equalizing Tool
Product Family No. H81121

APPLICATION
(Equalizing keys are supplied.)

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.

Features/Benefits
- Larger contact area,
- Helps to centralize the tool, and
- Helps to prevent premature releasing

Model CM Selective Shifting Tool
Product Family No. H81120

APPLICATION
(Shear-out and release keys are included.)

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.

Features/Benefits
- 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
Sliding Sleeves

Model HB-1 Shifting Tool
Product Family No. H81168

APPLICATION
The Model HB-1™ shifting tool is used to provide a safe and controlled method of opening and closing the Models HL™ and CM™ sliding sleeves. The Model HB-1 is designed with a hollow ID and a common thread connection to be run on coiled tubing in wireline prohibitive completions.

Features/Benefits
- Automatic locating
- Proof of completed shift
- Adjustable shear release values
- Emergency release feature
- Open one sleeve in one-trip
- Open or close all sleeves in one-trip
- Common thread connection - allows any combination of wireline prohibitive tools to be attached to the Model HB-1™
- Hollow ID

Models HB-2 and HB-3 Selective Hydraulic Shifting Tools
Product Family Nos. H81164 and H81198

APPLICATION
The Models HB-2™ and HB-3™ selective hydraulic shifting tools allow for selective shifting of multiple sliding sleeves in a single well. The shifting tools can be hydraulically activated at a desired sleeve depth; shift the sleeve by directly pushing or pulling the coiled tubing or by use of an impact tool. Then, move to a second sleeve without manipulating sleeves located in between. The Model HB-3 shifting tool presents a reduced OD and requires less hydraulic pressure to be activated than the Model HB-2. The Model HB-3 also uses linkage arms instead of keys, which provides higher shifting strength.

Features/Benefits
- Fully selective operation can be run and retrieved through multiple sliding sleeves without actuation
- Application of internal hydraulic pressure down the coiled tubing exposes the shifting keys in Model HB-2 and linkage arms in Model HB-3
- Can be pinned open in locate position for use in the shop or for use as a standard wireline tool
- Wash ports under keys allows debris to be removed
- Emergency release
- Can run two in tandem to shift up and down in one-trip
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.

Features/Benefits
- 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 D-2 Shifting Tool
Product Family No. H81072

APPLICATION
The Model D-2™ shifting tool is a wireline operated tool used to open and close the Model L™ sliding sleeve. Any number of sleeves, of the same size, in a single tubing string can be shifted in any combination or in any sequence.

Features/Benefits
- Automatic locating collet - Positively notifies the operator when the desired sleeve is reached. Running through two consecutive sealbores located feet apart, indicates a sleeve. Running through only one sealbore indicates a landing nipple
- Proof of sleeve shift - After completion of a shift, either open or closed, an attempt to repeat the operation (in the same sleeve) will give a surface indication that the shift was performed
- Safety release - If the sleeve is opened in the presence of a differential pressure in favor of the annulus, the release mechanism is held inoperative by flow until the pressures equalize. During equalization, maximum strain should be held on the wireline string
- Emergency release - The shifting tool has a shear pin release mechanism below the shifting dogs for emergency release
- Deliberate release - Even after the shifting tool is seated in a sleeve, it can be released without shifting the sleeve
- Open/close sequence - Upward jarring opens the sleeve. This allows the use of hydraulic or mechanical jars
- Run in the inverted position, the tool will close the sleeve with downward jarring. At least 6 ft (1.83 m), without restriction, should be provided below the sleeve
Separation Sleeve for Sliding Sleeves for CMAFE Separation Sleeve
Product Family No. H80573

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.

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

Model LD Hanger Tool
Product Family No. H99501

APPLICATION
The Baker Hughes Model LD™ hanger tool is an accessory item used during shifting of sliding sleeve inserts when upward jarring is required. The simple construction incorporates a double-ended collet with an upset matched for a specific sealbore inside the sliding sleeve. The collet is designed to seat on the top of the sealbore or friction hold inside the sealbore allowing the shifting tool to remain engaged inside the insert profile while the link jars collapse. This method allows for an impact during an upward jar instead of relying on the momentum of the tool string running into the sliding sleeve insert.

Features/Benefits
- Enhances upward wireline jarring on sliding sleeves by allowing jars to "recock"
- Compatible with any sliding sleeve
- Simple construction
- Indicates shifting of sliding sleeve

Pump-Down Driver
Product Family No. H99501

APPLICATION
The pump-down driver is used with Baker Hughes shifting tools to provide additional shifting force to the coiled tubing push to shift sliding sleeves in the downward direction.

Features/Benefits
- Enhances upward wireline jarring on sliding sleeves by allowing jars to recock
- Compatible with any sliding sleeve
- Simple construction
- Indicates shifting of sliding sleeve
Mark II Power Driver
Product Family No. H99508

APPLICATION
The Mark II™ power driver is designed to assist in applying force to sliding sleeves in highly deviated wells where standard wireline techniques cannot provide sufficient jarring action. The Mark II can be set to shift either up or down simply by changing the porting sequence. The Mark II can be run in conjunction with a standard shifting tool and lands in the upper sealbore of the sliding sleeve. Application of surface pressure pushes or pulls the shifting tool through the sliding sleeve.

Features/Benefits
- Allows application of force at the shifting tool
- Activation pressure is independent of well conditions
- Non-selective no-go location
- Same tool can be pinned for shifting up or down
- Modular design allows easy changing between sleeve sizes

Coiled Tubing Power Stroker
Product Family No. H81128

APPLICATION
The coiled tubing power stroker is designed to run in conjunction with the Model HB-3™ shifting tool. The power stroker provides a means to locate and anchor in a sliding sleeve. After it is anchored, the power stroker provides an additional downward force with applied hydraulic pressure through the coiled tubing. This applied force is independent of the force applied by the coiled tubing. By locating the sliding sleeve with the Model HB-3 before the power stroker is activated, any sleeve can be shifted selectively.

Features/Benefits
- Application of internal hydraulic pressure down the coiled tubing will activate the coiled tubing power stroker
- Applied force in extended reach well is independent of force applied by the coiled tubing
- Small running OD with entry bevel allows easy entry into tight, deviated, or horizontal sections
- Selectively locates using the Model HB-3 shifting tool
- Wash ports under locking dogs allow debris to be removed
- Emergency release
Model HCM Hydraulic Sliding Sleeve
Product Family Nos. H81134, H81135, and H81136

APPLICATION
A solution to intelligent flow control, the hydraulic surface controlled version of the popular Model CM™ sliding sleeve, the Model HCM™ (hydraulic CM) sliding sleeve is designed for selective production control without the need for intrusive well intervention. The HCM is controlled from the surface by two hydraulic control lines that operate a balanced hydraulic chamber which actuates the insert, similar to current industry standard safety valves.

The HCM, used in conjunction with permanent gauges for accurate interpretation of reservoir performance, provides a production monitoring and control system to shorten detect and respond cycle-times in the face of changing downhole conditions, resulting in optimized production and recoverable reserves.

Features/Benefits
- Eliminates intervention - opening and closing of sliding sleeve is controlled from surface via hydraulic control lines
- Reduces cost - eliminates shut down of production and rig downtime associated with manipulation
- Reduces risk associated with intervention
- Reduces wellbore storage effects during transient testing - saves production downtime
- Selective zonal isolation - on-off control of selected zones and commingled zones possible when multiple HCM’s are used
- Slimhole design - shrouded or standard HCM can comfortably run inside common casing sizes
- Based on field-proven Model CM sliding sleeve
- Features Baker Hughes premium thread connections
- Field-proven, high strength non-elastomeric seals
- Design incorporates a scale and solids control feature similar to a Model T-Series™ safety valve
- Integrated control-line plates and covers provide bypass protection for control lines in multiple HCM applications
- Can be actuated repeatedly under severe conditions
- Flow slot configuration resistant to erosion
InCharge Intelligent Production Regulator (IPR)
Product Family No. H81375

APPLICATION
The intelligent production regulator (IPR) is the primary active downhole component in the InCharge™ system. Each IPR integrates an electromechanical adjustable choke and multiple pressure/temperature sensors, all powered from the surface through a single tubing encased conductor (TEC) cable. The IPR enables adjustment of the local inflow/outflow characteristics without the use of conventional intervention methods. Multiple IPRs may be installed providing zonal control and monitoring. Each IPR is independently addressable, giving the operator the ability to adjust any of the zones in the well on command. Power required to drive the IPR actuator and power the sensors is transmitted through the single TEC cable. Data from the on-board sensors and diagnostic systems is sent back to the surface control system over the same TEC line using the proprietary ICS power-on-comms telemetry system.

Features/Benefits
- Infinitely variable choke for precise regulation of flow rates and/or pressure differential for both production and injection applications
- The choke position sensor of the IPR indicates the absolute choke position and requires no choke manipulation to reset after power shutdowns
- Power, communications, and control on one single TEC line increases deployment reliability, reduces running time, and reduces tree-related costs relative to multiline systems
- Electric actuator capable of delivering up to 10,000 lb (4,536 kg) of shifting force to actuate IPR in high friction (scale, sand, paraffin, etc..) environments
- High accuracy quartz pressure and temperature sensors integrated to provide independent tubing and sand-face measurements (upstream and downstream of the choke)
- Mechanical backup system (redundancy) enables coiled tubing-shifting, of the choke to either the fully-open or fully-closed position, in the event of an electronic malfunction
Nipple-Less Completion Technology

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 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
Velox Velocity and Straddle System
Product Family Nos. 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 high 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.

Features/Benefits
- 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
- Increase flow velocity maintaining production profile
- Reduce 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 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 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.

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

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.

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

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

Velox Double Pump Out Sub With Wireline Entry Guide (WEG)
Product Family No. H81982

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 WEG. By using this tool you eliminate the requirement for any slickline intervention when the system is set.

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

*Product Family No. H81980*

**APPLICATION**
The Baker Hughes Model Velox™ running tool is designed to allow the Model 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.

**Features/Benefits**
- 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

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**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.

**Features/Benefits**
- 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
# SPECIFICATION GUIDE

## Velox Velocity and Straddle System

<table>
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<tr>
<th>Pack Off Type</th>
<th>OD in.</th>
<th>Weight lb</th>
<th>ID Range mm</th>
<th>Tool Size</th>
<th>Max Gage OD in.</th>
<th>Min Tool OD in.</th>
<th>Packing Element</th>
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<td>3.400</td>
<td>86.4</td>
<td>70 Velox STV</td>
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</table>

**Note:** ID will be restricted due to thread connection (2.500 in. (63.5 mm) ID restricted to 2.441 in. (62.0 mm) ID), (3.400 in. (86.4 mm) ID restricted to 7.992 in. (203.0 mm) ID). **Proposed Specifications**
Model K-2 Straddle Pack-Off

Product Family Nos. H81952 (Standard Service), H81957 (H₂S-CO₂ 9Chrome-1Moly), and H81959 (H₂S Service)

Model K-3 Straddle Pack-Off

Product Family Nos. H81955 (Standard Service), H81956 (H₂S-CO₂ 9Chrome-1Moly), and H81958 (H₂S Service)

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.

Features/Benefits

- 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)
K-2 and K-3
Straddle Pack-Offs

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.

Models B and B-1 Running Tools
Product Family No. H81109

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

Model A Spear
Product Family No. H81217

APPLICATION
The Model A™ spear is a spring-loaded, internal, sliptype tool used to retrieve Model K removable seating nipples and Model K straddle pack-offs.
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 insure that the wireline lubricator is long enough to accommodate the length of spacer pipe subassembly to be added.

Models B and B-1 Tubing Stops

Product Family No. H80415

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 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 5-1/2 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.

FEATURES/BENEFITS

- 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 H₂S Service

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 CHART

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<th>OD</th>
<th>mm</th>
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### SPECIFICATION GUIDE

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<th>NPR Size</th>
<th>Gage Ring Max OD</th>
<th>Min Tool ID</th>
<th>Min ID Restriction for Retrieval</th>
<th>Temperature Rating</th>
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<td>344.7</td>
<td>125 38</td>
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</tbody>
</table>

- 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

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.
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.

Features/Benefits
- Only one moving part insures dependable and reliable operation
- Regulator can handle flow rates up to 5,000 bbl/day (794.92 m³/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

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.
**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.

**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 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.

**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.
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.

High and Low Flow Rate Throttles

The Model BE™ flow regulator handles flow rates from 250 to 2,500 bbl/day (40 to 397 m³/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 m³/day).

The Model BF™ flow regulator handles flow rates from 50 to 1,000 bbl/day (8 to 159 m³/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.
Model D Ported Bypass Seating Nipple
Product Family No. H80050

APPLICATION
The Model D™ ported bypass seating nipple is a top no-go or selective seating nipple. It is designed with an internal ported bypass seating nipple to accommodate accessory wireline equipment.

When the Model DSJ™ downhole flow regulator is installed in the Model D bypass ported nipple, a regulated amount of injection fluid is diverted through the ports and into the annulus. The remainder of the fluid is bypassed around the regulator and down the tubing. This allows for controlled injection into several zones through a single tubing string.

Features/Benefits
- Large flow area around the ported bypass seating nipple and through the ports
- Chevron packing can be run through honed sealing bore without damage
- Ported bypass seating nipple accommodates top no-go or selective locking devices, such as on blanking plugs, separation sleeves or downhole flow regulators
- Internal parts are made of stainless steel for corrosion resistance

Models DSL and DSJ Downhole Flow Regulators
Product Family Nos. H81370 and H81368

APPLICATION
These downhole flow regulators are run on wireline and landed in a Model D ported bypass seating nipple. They provide a simple, economical and efficient method for individually regulating volumes of fluid injected into multiple zones through a single tubing string.

SPECIFICATION GUIDE
Models DSL and DSJ Downhole Flow Regulators

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Family No.</th>
<th>Flow Rate Limitations</th>
<th>Size Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>bbl/day</td>
<td>m³/day</td>
</tr>
<tr>
<td>DSL</td>
<td>H81370</td>
<td>50-1,200</td>
<td>7.95-190.78</td>
</tr>
<tr>
<td>DSJ</td>
<td>H81368</td>
<td>250-2,000</td>
<td>39.75-317.97</td>
</tr>
<tr>
<td>DSJ</td>
<td>H81368</td>
<td>1,500-5,000</td>
<td>39.75-794.85</td>
</tr>
</tbody>
</table>
Model RT Downhole Flow Regulator

Product Family No. H81374

APPLICATION
The Model RF™ downhole flow regulator is a wireline device designed for use in side-pocket mandrels. This device is typically used in waterflood applications where it is desired to control the injection rate individually to multiple zones. The regulator is landed in the side-pocket mandrel and has a unique feature which allows flow to enter from bottom first and exit from the side. This feature helps prevent plugging, a major failure of downhole regulators.

The regulator is designed to maintain a constant pressure drop of 100 psi (7 bar) across its orifice. The flow rate is determined by the orifice size.

Injection fluid flows down the tubing, through the bottom port in the side-pocket mandrel, up through the ports in the nose of the regulator, through the orifice and throttle, and out the side of the regulator.

When flowing, the differential pressure across the orifice causes the spring to compress. As the spring compresses, the flow area through the throttle decreases, causing the flow to momentarily slow down. As the flow slows, the differential pressure across the orifice drops, causing the spring to relax. The regulator will cycle in this manner until the pressures above and below the regulator reach equilibrium. At this point, the desired flow rate is passing through the regulator, and the regulator will constantly adjust itself to any pressure changes in the injection system.

<table>
<thead>
<tr>
<th>Size</th>
<th>Injection Range (BPD)</th>
<th>Differential</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>in.</td>
<td>mm</td>
<td>psi</td>
<td>bar</td>
</tr>
<tr>
<td>1</td>
<td>25.4</td>
<td>40-750</td>
<td>500-2,500</td>
</tr>
<tr>
<td>1-1/2</td>
<td>38.1</td>
<td>80-1,000</td>
<td>500-2,000</td>
</tr>
</tbody>
</table>

Once a flow rate is established, it will be maintained with a +/-3%, independent of back pressure. Flow rates can be regulated within +/-10%

Model BF Downhole Flow Regulator

For Use in Side-Pocket Mandrel

APPLICATION
Baker Hughes Models BF™ and RF flow regulators are designed for deployment in a side-pocket mandrel. Flow rates of 60-1,360 bbl/day (10 - 216 m³/day) are attainable depending upon the flow regulator and orifice size chosen. The Model A™ version of these regulators (Model BFA™ and Model RFA™) contain integral reverse-flow check valves.

The regulators can be run on wireline or in place, and are also wireline retrievable. Use of this type regulator leaves a full-opening through the tubing string.

<table>
<thead>
<tr>
<th>Side-Pocket Mandrel Type</th>
<th>Flow Regulator Without Check Valve</th>
<th>With Check Valve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BF</td>
<td>H81364</td>
</tr>
</tbody>
</table>
Models BF and BE Full-Opening Downhole Regulators
Product Family Nos. H60034 and H60032

APPLICATION
Regardless of the number of downhole flow regulators used in the tubing string, the tubing remains full-open throughout because the regulators are mounted on the outside of the tubing.

The full-opening downhole flow regulator is installed as an integral part of the tubing string. A special corrosive service housing is also available.

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Family No.</th>
<th>Flow Rate Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF</td>
<td>H60034</td>
<td>50-1,200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.95-190.78</td>
</tr>
<tr>
<td>BE</td>
<td>H60032</td>
<td>250-2,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39.75-317.97</td>
</tr>
</tbody>
</table>

Specifications Guide

Models BF and BE Bypass Flow Regulators
Product Family Nos. H60033 and H60030

APPLICATION
In areas where the cost of removing the tubing string is competitive with wireline costs, the bypass flow regulator is frequently used in multiple-zone injection wells.

The bypass flow regulator is made up in either a bypass housing or in a one-piece bypass sub, which is placed in the tubing string at the desired location.

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Family No.</th>
<th>Size</th>
<th>Flow Rate Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF</td>
<td>H60033</td>
<td>All</td>
<td>50-1,200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7.95-190.78</td>
</tr>
<tr>
<td>BE</td>
<td>H60030</td>
<td>2.36 and 2.91</td>
<td>250-2,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3-3/4</td>
<td>250-2,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>39.75-397.50</td>
</tr>
</tbody>
</table>

Due to the limited bypass flow area, the flow rate past any bypass sub should not exceed 4,000 bbl/day (635.94 m³/day).
Models BF and BE Surface Flow Regulators

Product Family Nos. H60008 and H60007

APPLICATION
The Model BE™ surface flow regulator replaces traditional manually controlled needle valves and meters. It is as easy to install as a pipe nipple. These regulators are simple, effective and economical and eliminate diaphragms and complex moving parts. Surface flow regulators provide a means of controlling injection rates without constant manual adjustment. The regulators cut manpower costs for surveillance and adjustment and eliminate frequent replacement of expensive parts and materials.

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Family No.</th>
<th>Flow Rate Limitations bbl/day</th>
<th>m³/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF</td>
<td>H60008</td>
<td>50-1,200</td>
<td>7.95-190.78</td>
</tr>
<tr>
<td>BE</td>
<td>H60007</td>
<td>250-2,500</td>
<td>39.75-397.50</td>
</tr>
</tbody>
</table>

SPECIFICATION GUIDE

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 insure those parts will safely pass through all equipment that is located below them.
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 2-3/8 in. (60.3 mm) through 4-1/2 in. (114.3 mm) production strings.

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.

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.

Model A™ polished nipples are run below blast joints (with seating nipples above) so that eroded joints can be repaired by using spacer pipe to position a packoff device above and below the damaged area.