



Drilling Chokes

Ultimate pressure control for the most challenging applications



Drilling Chokes: Advanced technology to meet the challenges of well pressure control, MPD, and UBD in challenging environmental conditions

Controlling downhole pressure continues to be the most complicated issue operators confront daily. Extreme pressures left uncontrolled can lead to catastrophic results, but the inability to manage high equivalent circulating densities (ECD) in low-pore pressure applications can also severely restrict production and raise costs considerably. The stakes are even higher in today's drilling world in which deeper and more complicated well paths have become the norm. Heading off high-pressure influx and keeping your well under control requires careful matching of the right choke for your application and downhole conditions.

Specialists at M-I SWACO, a Schlumberger company, have put decades of experience, expertise, and field-proven technical performance into developing a line of drilling chokes that have become the industry standard for the most demanding and specialized offshore and onshore applications. Our chokes are uniquely designed for a range of highly pressure-sensitive applications, including MPD, underbalanced drilling (UBD), CT, frac plug drillout, frac flowback, ECD control, H₂S applications, well control, and cleanup operations.

Safely getting the most from the well

M-I SWACO has a growing portfolio of industry-recognized drilling chokes and control consoles that provide precise and reliable pressure management for your most critical applications. We offer a wide range of high-performance drilling chokes from 3,000 to 15,000 psi [207 to 1,034 bar] pressure ratings, ensuring a responsive control option for all your offshore and onshore pressure management requirements.

Our line of chokes enables you to shut in the well, determine circulating pressure, break circulation, and maintain near-constant downhole pressure. The AUTOCHOKE* pressure-balanced drilling choke automatically maintains near-constant casing, drillpipe, and bottomhole pressure. Our eCHOKE* electric actuator system uses electronic servo control to provide more accurate control and improved performance in cold temperatures. The VERSA-CHOKE* modular drilling choke technology handles advanced pressure and well control applications.

In addition to helping manage wellbore pressures, our drilling chokes also provide control over fluid loss and water consumption to help minimize a project's environmental footprint and reduce costs.

Features

- Line of chokes from 3,000 to 15,000 psi pressure ratings
- Designed for offshore and onshore applications
- Tungsten carbide wear sleeves
- SUPERCHOKE* high-pressure drilling choke control system designed with rotating disc for flow control
- AUTOCHOKE choke engineered with no-leak shut-in with dual seal design
- VERSA-CHOKE technology designed for position-based control
- eCHOKE system designed with electric motor and electronic console that replaces the air-over-hydraulic console, which can be beneficial for cold weather services

Benefits

- Delivers precise, reliable pressure control
- Includes highly responsive control consoles
- Helps manage ECD
- Increases operational life
- Reduces effects of abrasive solids
- Provides effective control in wide temperature, pressure range
- Controls easily during transition periods
- Simplifies predictable casing and drillpipe pressure control
- Eliminates leakage
- Provides reliable control in cold temperatures
- Enables hot swapping of actuators
- Provides excellent flow characteristics
- Reduces costs of well control, fluid loss
- Minimizes environmental impact
- Promotes safe operations



AUTOCHOKE pressure-balanced drilling choke

The 3,000- and 10,000-psi AUTOCHOKE chokes provide automatic, precise pressure control for pressure-intensive UBD and MPD applications. This pacesetting choke automatically regulates casing pressure under all conditions, including

- regulating mud pump startup or shutdown
- making and breaking drillpipe connections
- automatically adjusting the orifice size to compensate as mud and gas flow alternately through the unit.

The AUTOCHOKE choke is highly effective in H₂S and abrasive fluid applications. With its capacity to automatically maintain casing pressure, the AUTOCHOKE choke makes stripping pipe simpler and safer. As drillpipe is lowered into the hole, an equal volume of fluid under pressure is automatically displaced through the high-performance choke.

Advantages

- **High pressure rating**
 - 3,000 psi [207 bar]
 - 10,000 psi [689 bar]
- **Maintains casing pressure**
 - Controls fluid with dynamically positioning shuttle
 - Automatically adjusts fluid flow to regulate casing and drillpipe pressures
- **Precise control and reduced cost**
 - The precise control of the AUTOCHOKE choke can dynamically change bottomhole pressure (BHP) when managed pressure drilling is required.
 - Automatic adjustment during well control operations minimizes the occurrence of overpressuring the formation and the resultant fluid loss, reducing fluid-loss costs.
- **Frac plug drillout operation**
 - The dynamic shuttle enables proppant slugs to flow through the AUTOCHOKE choke unit while maintaining a constant fluid return stream. The hardfaced wear sleeve and tungsten carbide downstream sleeves stand up to the highly abrasive sand flow of frac operations.
- **Compliance**
 - M-I SWACO designs, manufactures, and monograms in accordance with API Spec 6A and in compliance with NACE MR0175. Optional third-party ABS and DNV certification are per customer request at an additional cost.
- **High capacity**
 - High-capacity 3-in [76 mm] choke bore improves flow characteristics at the throttle point and through the choke bore.
 - Self-cleaning orifice reduces plugging.
- **Overpressure protection**
 - The operator can dial in the desired maximum casing pressure, and the AUTOCHOKE choke unit automatically opens to protect the well from overpressure.
- **Downstream choke bore protection**
 - Extended-wear tungsten carbide sleeves increase in-service life, reducing the effects of abrasive solids and protecting the API ring gasket.
- **No-leak shut-in seals and long-life materials**
 - Metal-to-metal and elastomer-to-metal seals are constructed of long-life components for severe service operations such as tungsten carbide static trim, reversible dynamic trim, a hardfaced shuttle nut, and an internal removable body sleeve.



AUTOCHOKE choke control console

The AUTOCHOKE choke console is constructed of stainless steel and includes drillpipe and casing pressure gauges, a hydraulic set-point regulator and gauge, and a hand-operated hydraulic backup pump. The AUTOCHOKE choke console is equipped with an electronic position indicator, digital pump-stroke-rate meter, timer, and clock.

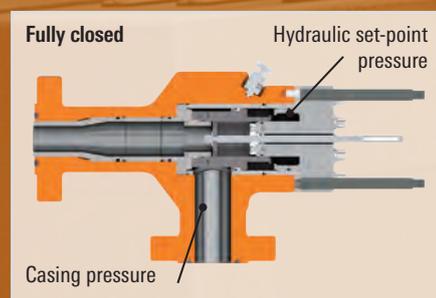
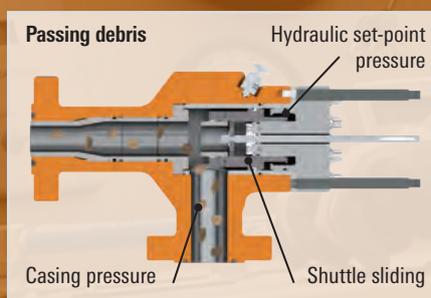
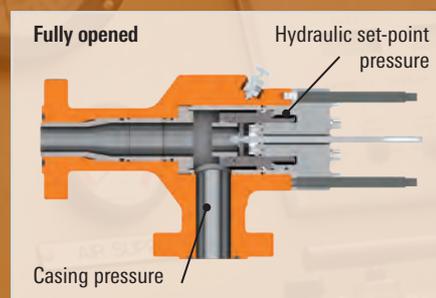
How it works

The unique design of the AUTOCHOKE choke control console features a dynamically positioning shuttle that moves back and forth on an axis housed inside a hardfaced wear sleeve. The dynamic trim seats into the 3-in [76 mm] diameter orifice in the static trim piece. Hydraulic pressure, which is adjusted through a set-point pressure regulator, is applied to the backside of the shuttle. This creates a pressure balance between the casing pressure of the well and the hydraulic pressure of the AUTOCHOKE choke unit.

If the casing pressure is higher than the hydraulic pressure, the shuttle opens, which increases the orifice size. If the casing pressure is lower than the hydraulic pressure, the shuttle closes, decreasing the orifice size. As the shuttle moves, it regulates the flow of fluid or gas from the well through the orifice.

The set-point pressure applied to the backside of the shuttle assembly is adjusted by a pressure regulator and measured by the set-point gauge located on the choke control panel. The annulus pressure is applied to the front side of the shuttle assembly.

An increase in annulus pressure or a decrease in the hydraulic set-point pressure will cause the shuttle assembly to move away from the static trim, increasing the orifice size. This enables fluid to flow from the well and decreases the casing pressure until it equals the set-point pressure.



SUPERCHOKE high-pressure drilling choke control system

SUPERCHOKE high-pressure drilling choke control system has three configurations and uses a main SUPERCHOKE system body. It has different actuators to operate the choke and comes with different consoles to operate the right actuator:

- manual actuator—wheel hydraulic
- actuator—hydraulic console electric
- actuator—eCHOKE system

The highly advanced 5,000-, 10,000-, and 15,000-psi SUPERCHOKE system has become one of the industry's most widely used chokes, particularly for well kill and high-pressure applications. The SUPERCHOKE system delivers easy, precise, and reliable well pressure control during transition operations such as mud pump startup or shutdown. The SUPERCHOKE system is equally effective when mud and gas are flowing alternately through the choke. It is designed and manufactured for H₂S service and abrasive fluid applications.

SUPERCHOKE system modes of operation:

- **If operations are normal**
 - power to the control console is supplied by rig air to provide hydraulic power to the SUPERCHOKE system.
- **If rig air is lost**
 - activation is manual with hydraulic pump located on control console.
- **If hydraulic lines are severed**
 - activation is manual with bar provided on the choke indicator head.

Advantages

- **Multiple pressure-sensitive applications**
 - Well kicks
 - Well testing
 - Well cleanup operations
- **High pressure rating**
 - 5,000 psi [345 bar]
 - 10,000 psi [689 bar]
 - 15,000 psi [1,034 bar]
- **Dependable choke-disc design**
 - Heavy-duty, diamond-lapped tungsten carbide discs honed to near-perfect flatness. Rotation of actuator fork enables finite regulation of the opening size from full-open to full-close.

- **Positive closure**

- A 17° dead band overlap beyond the full-close position ensures closure even if the plates become worn from extended exposure to abrasives-laden fluid flow. Quality of the seal is not affected by pressure drops and surges. In fact, the seal improves under pressure.

- **Tungsten carbide sleeves**

- Increase in-service life. Extended wear sleeves reduce the effects of abrasive solids and protects the API ring gasket.

- **Versatility**

- Ideal for offshore and onshore applications.
- Can be converted with an eCHOKE system for cold weather applications or when an electric-actuated SUPERCHOKE system is preferred.

- **Choke certifications**

350-degF option

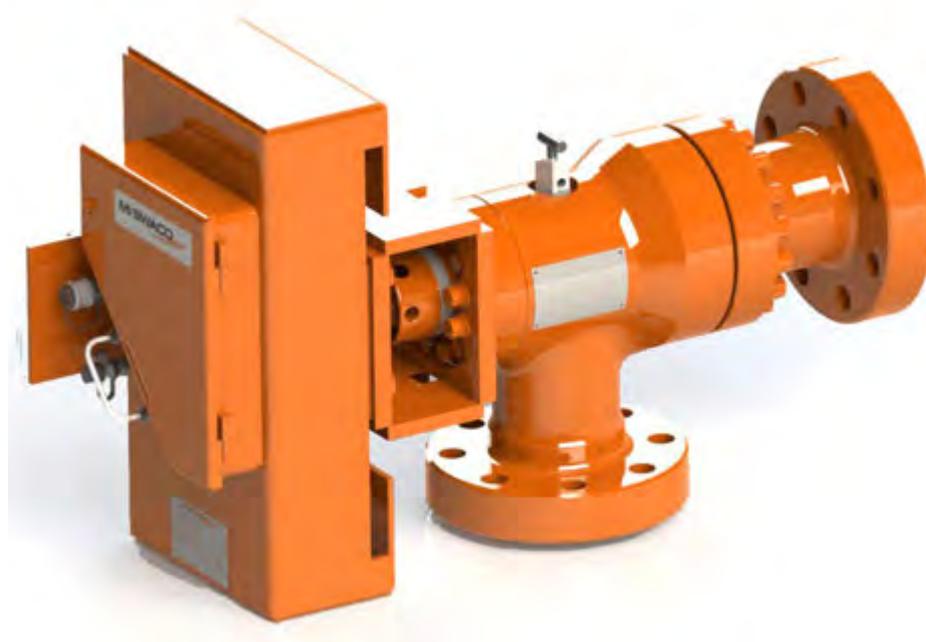
- Designed, manufactured, and monogrammed in accordance with API Spec 6A, API Spec 16C, and NACE MR0175.
- The temperature ranges from –20 to 350 degF for PR2, PSL3, or PLS3G, and Material Class EE for H₂S service.
- All nonmetallic elastomers comply with NACE TM0187.
- Optional certifications are available for ABS CDS, DNV-OS-E101, CE marked, NORSOK Z-016 and D-002.
- Customized certification is available.

300-degF option

- Designed, manufactured, and monogrammed in accordance with API Spec 6A and NACE MR0175.
- P-300 temperature rating ranges from –20 to 300 degF, PR1, PSL3, or PLS3G, Material Class EE-0.5 for H₂S service.
- Customized certification is available.

Actuator Certification

- API SPEC 16C, PR2





SUPERCHOKE control system console

M-I SWACO choke-control consoles are available to control either a single or dual SUPERCHOKE system. These consoles are equipped with either standard hydraulic or optional digital casing and drillpipe gauges, pneumatic position indicator, and digital pump-stroke rate meter.

How it works

The advanced design of the SUPERCHOKE system employs an adjustable orifice size that ranges from a maximum area of 1.92 in² [12 cm²] to total shutoff. The control panel provides hydraulic power to the actuator mounted on the SUPERCHOKE system, which in turn rotates the tungsten carbide discs within the SUPERCHOKE system to control orifice size. The control panel comprises a control lever, a master air supply valve, a choke position indicator, drillpipe and casing pressure gauges, pump stroke counter, and rate meter. The hydraulic pump and hydraulic fluid reservoir are located beneath the console. Should air supply be interrupted, an included hand-operated hydraulic pump provides power to control the SUPERCHOKE system.

eCHOKE electric actuator system

The M-I SWACO eCHOKE electric actuator system is a remotely operated, electrically actuated, and variable-speed version of the SUPERCHOKE system and is ideally suited for cold temperatures and similarly harsh environments.

The eCHOKE system incorporates an electric actuator, a local drive box, and the electronic remote console and is applied to the SUPERCHOKE system body. The eCHOKE local drive box replaces the large choke console currently required for hydraulic operation. A single operator can easily carry the small, highly portable remotely controlled actuator control panel to the drill floor.

The predominate benefit of the eCHOKE system in harsh operating conditions is remote delivery of a high degree of control, safety, and speed in well control situations. The eCHOKE system has exhibited excellent high-torque performance. The variable speed drive enables the eCHOKE system to deliver faster open and close speeds.

Three methods of eCHOKE system operation:

- electronic control using the remote console on the drill floor
- electronic control using the local drive box near the choke manifold
- manual control at the choke using the actuator handwheel.

Advantages

- **Multiple pressure-sensitive applications**
 - Well kicks
 - Well testing
 - Well cleanup operations
- **High pressure rating**
 - 5,000 psi [345 bar]
 - 10,000 psi [689 bar]
 - 15,000 psi [1,034 bar]
- **High temperature rating**
 - -20 to 350 degF [-29 to 177 degC]
- **Cold weather service**
 - The electric motor and electronic console replace the air-over-hydraulic console and improve reliability in cold weather environments.
- **Small footprint**
 - The quiet and space-saving design of the remote console enables it to be located in the driller's cabin.
- **Reduced cabling requirements**
 - The eCHOKE system requires only one communication cable between the remote console and local drive box.
- **Variable-speed drive**
 - The operator can easily control the choke opening and closing speed, enabling for precise choke positioning adjustment during critical well control situations.
- **Faster open and close speeds**
 - The 8 seconds from full-open to full-close is faster than a hydraulically actuated choke.
- **Motor and drive power requirements**
 - Holding, 100% speed, .472 A
 - Moving, 100% speed, .832 A
- **Choke body power requirements**
 - Moving, 50% speed, 1.248 A
 - Moving, 100% speed, 2.176 A
 - With 10,000 psi [689 bar]:
 - Moving, 1% speed, 1.44 A
 - Moving, 50% speed, 2.152 A
 - Moving, 100% speed, 3.624 A
- **Certifications**
 - Designed, manufactured, and monogrammed in accordance with API Spec 6A and 16C.
 - Optional certifications available: API Spec 6A PR2, PSL3G, ABS CDS, DNV, CE and PED marked, NORSOK Z-015 and D-002.
 - Designed in accordance with API Spec 6A and NACE MR0175 for H₂S service to Material Class EE-NL.
 - Customized certifications available.
 - Can be ordered with different hazardous area certifications varying from UL Class 1 Division 1 to Class 1 Division 2 or a combination of both for the actuator and remote console



VERSA-CHOKE modular drilling choke technology

The M-I SWACO 15,000-psi VERSA-CHOKE technology was engineered for advanced well control applications requiring large trim with high pressure and temperature ratings. The highly flexible VERSA-CHOKE technology is ideally suited for high-end pressure management, MPD, UBD, frac plug drillouts, and frac flowback.

Unlike intrinsically pressure-balanced chokes, the position-based VERSA-CHOKE technology is controlled by specially designed hydraulically driven actuators. Unique to the modular VERSA-CHOKE technology is the capacity to easily hot swap actuators without having to disassemble any internal components, thereby reducing maintenance time. A piston-style actuator is designed for use on the 5,000-psi VERSA-CHOKE technology, while a worm-gear actuator is designed for use with any pressure VERSA-CHOKE technology. All actuators are designed to withstand without failure the full rated backpressure of the choke.

Available in reversible 1½-, 2-, and 3-in trim sizes, the VERSA-CHOKE technology is designed for 5,000-, 10,000-, and 15,000-psi ratings and carries an API Standard temperature rating of -20 to 350 degF [-29 to 177 degC]. The capacity to reverse trim, which is common to all pressure ratings, doubles the operational life of the choke.

Moreover, trim can be changed from 1½ to 2 to 3 in by only changing internal components. The modular design also enables customized configurations to meet project-specific installation and operating conditions. Flange sizes of up to 4¼ in are available and custom spool lengths can be provided to meet custom applications upon request.

Advantages

■ Multiple pressure-sensitive applications

- Advanced pressure control
- MPD and UBD
- Frac plug drillout
- Frac flowback

■ High pressure rating

- 5,000 psi [345 bar]
- 10,000 psi [689 bar]
- 15,000 psi [1,034 bar]

■ High temperature rating

- -20 to 350 degF [-29 to 177 degC]

■ Position-based control system

- Worm-gear hydraulic actuator (available for all pressure ratings)
- Piston-style hydraulic actuator (designed for 5,000-psi choke only)

■ Ease of maintenance

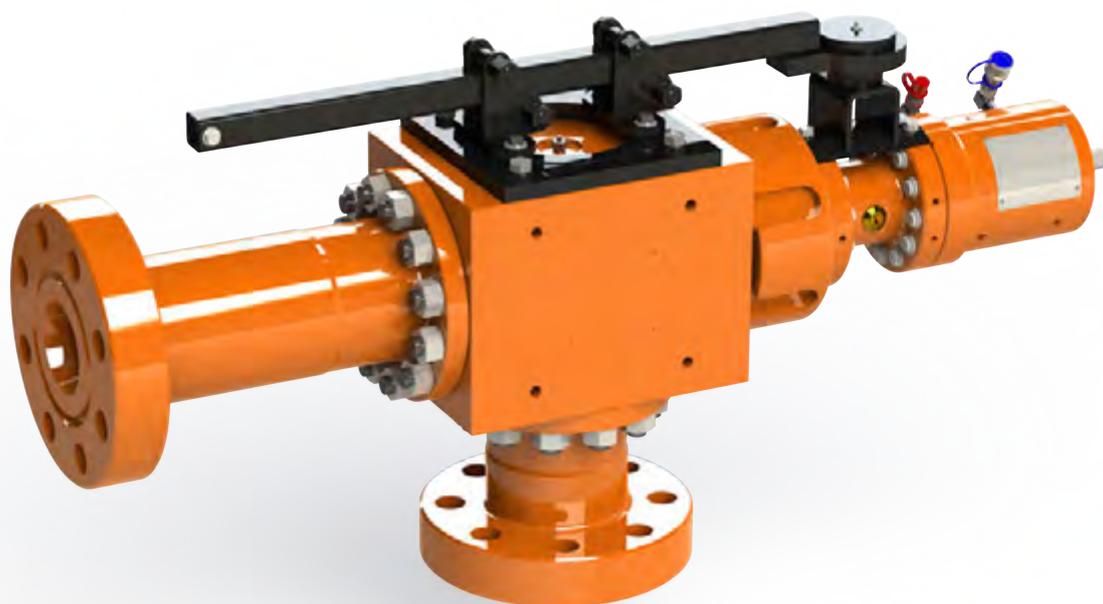
- Actuators can be changed out without having to disassemble any internal components.
- Quick-change internal components

■ Configuration flexibility

- Modular design and components enable configuration to be customized to specific operating conditions.
- Trim can be changed from 1½ to 2 to 3 in by only changing internal components.
- Available with API Standard 6A material class and EE-NL NACE trim to 350 degF.
- Available with multiple API flange sizes up to 4¼ in.
- Spool length and size can be configured to meet custom applications.

■ Certifications

- Designed, manufactured, and monogrammed in accordance with API Spec 6A and 16C.
- Optional certifications available: API Spec 6A PR2, PSL3G, ABS CDS, DNV, CE and PED marked, NORSOK Z-015 and D-002.
- Designed in accordance with API Spec 6A and NACE MR0175 for H₂S service to Material Class EE-NL.
- Customized certifications available.



M-I SWACO Drilling Chokes Prove Themselves in the Field



Louisiana: SUPERCHOKE System Kills Well in One Circulation, Removes Guesswork

The Situation

The operator planned to reenter a well that had been permitted to 15,000 ft [4,572 m] but encountered a host of formation problems that prohibited drilling past 11,850 ft [3,612 m]. Successfully drilling the reentry required overcoming the lost circulation, high pressure, and differential drillstring sticking experienced in the original well. Using drilling fluid densities of 15.2 lbm/galUS [1.8 sg] or lower would generate a kick while weights higher than 15.6 lbm/galUS [1.8 sg] would lead to lost circulation. The objective was to overcome these potential issues and drill 2,000 ft [610 m] into the formation. The reentry drilling program eventually would require a well control operation to be conducted.

The Solution

For the reentry, M-I SWACO recommended the operator employ its SUPERCHOKE system engineered for precise pressure control in well control, well testing, and well cleanup operations, as well as in high-pressure drilling applications.

The SUPERCHOKE system would overcome the deficiencies of a conventional control panel in which the fixed orifice size in the valve is opened or closed by controlling plates, sleeves, or pin-and-seat elements with a joystick located on a control panel.

In a kill operation, the constant adjustment required with the joysticks made it nearly impossible to hold casing pressure, initial circulating pressure (ICP), and final circulating pressure (FCP) during pump startup, drillpipe schedule, or when gas was being produced. M-I SWACO also looked at the reentry as prime opportunity to again validate the advantages of the SUPERCHOKE system as a single-circulation well kill technology.

The Results

After the well kicked at 2,425 ft with a 14.9 lbm/galUS [1.7 sg] oil-based drilling fluid in the hole, the SUPERCHOKE system was activated and successfully killed the well in one circulation. The operator was able to proceed with drilling 2,000 ft of the targeted formation while skirting the fracture gradient between 15.2 and 15.6 lbm/galUS equivalent mud weights. Throughout the operation, the FCP and drillpipe pressures never deviated higher than 50 psi and enabled the operator to easily maintain constant drillpipe pressure or FCP until the kill weight mud reached the surface at 6,700 strokes. The capacity to kill the well in one circulation saved significant rig time while giving M-I SWACO personnel the ability to record pertinent data to validate the efficiency of the SUPERCHOKE system as a viable well control technology. As demonstrated in this application, a key advantage of the technology is removing the guesswork from critical well-kill operations.

Put our drilling chokes to work for you

To meet the diverse needs of our customers, we offer drilling chokes for purchase and rental and include service maintenance. To find out more about how our high-performance drilling chokes are controlling pressures for our customers worldwide, contact your local M-I SWACO representative.





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