High Performance Gate Valves, Block Valves, and Actuators
Dril-Quip: A Leader in Technology and Quality

Dril-Quip gate valves and actuators are manufactured from selected high grade materials. Computer-controlled machine tools ensure dimensional accuracy, precision machining and consistent high quality. Before it is shipped to a customer, each product is inspected, assembled and tested to guarantee that it meets customer specifications and Dril-Quip’s standards of quality.

Dril-Quip gate valves are designed to one or more of the following API specifications: 6A, 6AUSV, 6ASSV, 17D, API Q1, 6FC and 6FA.

Dril-Quip has verified the performance of its valves through a variety of tests, which are witnessed and certified by third parties. Dril-Quip is licensed to apply the API monogram on all of its gate valve products. Each Dril-Quip gate valve is inspected and tested in accordance with API specifications, customer requirements, and through the Dril-Quip ISO 9001-certified Quality Management System.

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Headquartered in Houston, Texas, Dril-Quip has manufacturing facilities in the United States, Scotland, Singapore and Brazil. The Company also has sales and services offices in numerous locations throughout the world.

All Dril-Quip facilities have a commitment to manufacture and deliver high quality products and services. The Company manufactures essentially all of its products in-house from high grade steel forgings produced at the Company’s forging facility. Computer numerically controlled (CNC) machine tools are used for consistent high quality, precision machining and dimensional accuracy. Computer tracking systems schedule and monitor each customer’s order throughout the manufacturing process, ensuring product quality and timely delivery.
Dril-Quip’s gate valves, block valves and actuators are ideal for the following applications:

**SURFACE**
- BOP stacks
- Choke and kill manifolds
- Wellheads
- Production trees
- Test trees

**SUBSEA**
- BOP stacks
- Cutting injection wellheads
- Production manifolds
- Production trees
- Lower riser packages
# Applications and Compatibility of Gate Valves and Actuators

## Subsea Applications

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<td>Subsea BOP stacks</td>
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<td>Cuttings and chemical injection systems</td>
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</table>

## Compatibility:

### Manual Gate Valves

- High performance **DHD** Manual Slab Gate Valve

### Hydraulic Actuators

- DA-1 Standard Subsea Fail-Safe Hydraulic Actuator with Rotary Override for Intermediate Water Depth
- DA-3 Subsea Fail-Safe Hydraulic Actuator with Linear Override
- DA-6 Subsea Fail-Safe Hydraulic Actuator with Rotary or Linear Override for Deep Water
- DA-10 Subsea Double-Acting Fail-Safe Hydraulic Actuator for Deep Water

## Surface Applications

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<td>Surface wellheads and trees</td>
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## Compatibility:

### Manual Gate Valves

- High performance **DH** Manual Slab Gate Valve
- High performance **DHS** Manual Split Gate Valve
- High performance **DM** Low Cost Manual Slab Gate Valve
- High performance **DL** Low Cost Manual Slab Gate Valve

### Hydraulic Actuators

- DA-2 Standard Surface Hydraulic Actuator or
- DA-5 Low Profile Surface Hydraulic Actuator
- DA-9 Standard Surface Hydraulic Actuator with Indicator Stem
- DA-9R Standard Surface Hydraulic Actuator with Indicator Stem (compact)
- DLH Low Cost Surface Hydraulic Actuator with Indicator Stem
**DH Series Slab Gate Valve**

**Features common to both**

- Bidirectional flow
- Metal-to-metal sealing
  - Gate-to-seat
  - Seat-to-body
  - Body-to-bonnet
- Metal-to-metal backseat seal
- Two independent backup seat seals
- Non-rising stem design
- No pressure lock
- Surface or subsea application
- Actuators available from Dril-Quip
- Fire-resistant designs available in API 6FA and 6FC

**Slab Gate Valve Operations**

Under pressure, the gate is shifted against the downstream seat, energizing the seals. Fluid is allowed to pass around the upstream seat.

If the body pressure exceeds the upstream pressure, fluid from the body vents upstream, eliminating a pressure-lock situation when the valve is opened.

![Closed Valve Under Pressure](image1)

![Body Pressure Exceeds Line Pressure](image2)

![Fully Opened Position](image3)
**DHS Series Split Gate Valve**

**SLAB AND SPLIT GATE DESIGNS**

- Shear pin prevents damage due to valve overtorque
- Forged body and bonnet
- Low maintenance
- Seats are easily field replaceable
- No special tools required for repairs
- Field-proven performance

**Features exclusive to the DHS split gate design**

- Seats are testable from both directions without isolation
- Reduced operational torque

**DHS Split Gate Valve Operations**

Dril-Quip’s patented split gate design is unique because of its sequence of operations. The stem nut lifts the short gate first. The relief port in the short gate connects with the upstream port, allowing pressure in the valve body to equalize across the short gate. Continued rotation moves the short and long gate to the fully opened position.
OPERATIONAL SEQUENCE OF THE DHD AND DHS METAL-TO-METAL BACKSEAT

The non-rising stem has a selective metal-to-metal backseat that can be engaged to isolate the stem packing for replacement while the valve is in service.

1. Close the gate valve by rotating the handwheel to the right.
2. Loosen the bonnet cap one to two turns.
3. Rotate the handwheel to the right until the backseat shoulder contacts the bonnet.

With the gate bottomed out, the stem is mechanically locked in the backseat position. The integrity of the seal is verified through the bonnet bleeder plug.

Metal-to-metal backseat seal allows for easy maintenance.

DHD AND DHS SERIES GATE VALVES
OPERATIONS AND FEATURES

DHD SLAB GATE
1. **Stem Flats** allow the valve to be operated with a wrench when the handwheel is removed.

2. **Handwheel Shear Pin** protects the valve from damage due to overtorque.

3. **Handwheel Retainer Pin** can be used as a backup for the shear pin.

4. **Weather Seals** protect internal parts from moisture and debris. The lower seal acts as an elastomeric check valve to prevent pressure from building up in the cap and keeps water out in subsea applications.

5. **Dual Heavy Duty Bearings** provide easy, low-torque operation.

6. **Non-Rising Stem** is ideal for high pressure service. The stem does not stroke through the stem packing, resulting in less wear and lower torque to operate. The stem is fixed and the gates travel up and down the stem.

7. **Dual Stem Packing** is a multi-spring energized "Teflon® seal that produces bubble-tight sealing along the length of the stem. The Teflon seal material is suitable for most well fluids and temperature ranges. The stem packing allows easy, low operating torque even under high temperature and high pressure conditions.

8. **Grease Port** provides access for lubrication of the wetted valve components. The port also provides a means to verify the backseat seal.

9. **Metal-to-Metal Backseat Seal** permits replacement of the stem packing while the valve is under pressure. The valve operator can engage the backseat seal, isolating the stem packing from any bore pressure.

10. **Gate Lifting Nut** is separate from the gate to allow optimum stem-and-nut material combinations. It also permits the gate to float with the seats, which is important to provide a seal at low bore pressures.

11. **DX Style Ring Gasket** provides an efficient, pressure-energized metal seal between the bonnet and body for high pressure applications.

12. **Stem** with high endurance ACME threads offers large contact area for maximum durability and shearing resistance.

13. **Heavy Duty Gate Guides** minimize amount of debris entering the valve body.

14. **Gate** has a hard-faced design that ensures bubble-tight metal-to-metal sealing.

15. **Seat** includes a gate-to-seat seal that is hard-faced for bubble-tight metal-to-metal sealing. The seat-to-body seal is dual metal-to-metal for superb sealing. When the valve is closed, well pressure forces the gate and downstream seat against the pocket, energizing this dual metal-to-metal seal.

16. **Two Independent Backup Seals** include a pressure-energized Teflon face seal and a spring-energized Teflon lip seal. These two backup seals help keep debris from getting to the metal sealing area as well as ensure low pressure sealing.

17. **High Force Wave Spring** pushes the seat against the gate to maintain constant sealing in low or high pressure. The wave spring also forces the seat to wipe the gate face as the valve strokes, cleaning away sand and debris, preventing damage and leak paths from forming.

*"Teflon® is a registered trademark of DuPont*

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**DHS Split Gate**

- A. Upstream Split Gate
- B. Downstream Split Gate
- C. Relief Port
- D. Alignment Slot

Only the patented Dril-Quip DHS Split Gate design eliminates the double gate drag that is present in other split gate designs. In addition to allowing the upstream and downstream seat seals to be tested by pressurizing into the body cavity, the split gate design cuts torque requirements in half. This also reduces stem diameter and actuator piston size. Space and cost savings are a result of this unique design.
DHS and DH Series Gate Valves Specifications

Valve Components

1. Hand Wheel
2. Hand Wheel Shear Pin
3. Hand Wheel Retainer Pin
4. O-Ring
5. Cap
6. 1/8” NPT Plug
7. Jam Plug
8. O-Ring
9. Bearing
10. O-Ring
11. Bearing Thrust Ring
12. Packing Nut Assembly
13. Packing Sub Assembly
14. Bonnet
15. Hollow Hex Plug
16. DX Ring Gasket
17. Stem
18. Lift Nut
19. Seat Assembly
   A. Lip Seal
   B. Seat Ring
   C. Wave Spring
   D. Face Seal
   E. Seat
20. Gate Guide
21. Downstream Gate
22. Upstream Gate
23. Alignment Pin
24. Seat Assembly
   A. Lip Seal
   B. Seat Ring
   C. Wave Spring
   D. Face Seal
   E. Seat
25. Gate Guide
26. Gate
27. Nut
28. Stud
29. Body
### Trim Options

<table>
<thead>
<tr>
<th>Valve Part Description</th>
<th>API Class AA (Trim AA) Regular Trim</th>
<th>API Class BB (Trim BB) Alloy Body w/ Stainless Internal Trim</th>
<th>API Class CC (Trim CC) Full Stainless Trim</th>
<th>API Class DD (Trim DD) Alloy Body w/ Alloy Internal Controlled Hardness</th>
<th>API Class EE (Trim EE) H, SIC, Service Alloy Body w/ Stainless Internal Trim Controlled Hardness</th>
<th>API Class FF (Trim FF) H, SIC, Service Full Stainless Controlled Hardness</th>
<th>API Class HH (Trim HH) H, SIC, Service CRA Cladded Controlled Hardness</th>
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<td>Low Alloy Forging</td>
<td>410 Stainless Steel or F6NM SS Forging</td>
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<td>410 Stainless Steel</td>
<td>Low Alloy Forging w/625 Cladding</td>
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<td>410 Stainless Steel</td>
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**Nominal Sizes**

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- API material classes available in: AA, BB, CC, DD, EE, FF, HH
- Temperature ranges: -75°F to 350°F
- PSL levels available in: 2, 3 and 4
- Forged bonnet and body with spring-energized seals
- Surface and subsea applications
- Available in fire-resistant trim per API 6FA and 6FC
- Available in a variety of sizes and pressure ratings
• **Manual Override Stem and Piston Stem** have the same diameters in their respective sealing areas. This allows the spring housing volume to remain constant as the valve strokes, eliminating the possibility of hydraulic fluid lock.

• **Spring Housing** can be removed and installed as a unit, simplifying maintenance and increasing safety.

• **Bonnet Assemblies** are interchangeable. The manual and actuated valves use the same valve body and seals to permit interchangeability. To convert a manual valve to a hydraulic valve, replace the gate with the actuated gate and manual bonnet assembly with the actuated bonnet assembly.

• **Compensation Port** is connected to the hydraulic reservoir for maintaining ambient ocean pressure behind the piston.

• **Packing Vent Check Valve** In the unlikely event the stem packing leaks, the packing vent check valve allows the leaked fluid to vent, eliminating the possibility of the valve being closed by pressure build-up under the piston.
1. **Rod for Manual Override and Visual Position Indicator** provides visual indication of the gate valve’s open and closed positions. Dril-Quip also offers electric indicators. For manual control, the hex head at the top provides a square for rotating to open. Manual override is standard on all actuated valves.

2. **Sealing System for Indicator Rod** includes PolyPak™ seals that are equipped with sharp corners to provide superior rod wiping when the valve is actuated. Backup wear rings help ensure a long seal life. Additional bidirectional sealing rings provide a barrier, keeping actuator fluid contained and seawater out.

3. **Safety Snap Ring** retains the spring when the end cap is removed.

4. **Return Spring** is powerful enough to close the gate valve, even with zero bore pressure.

5. **Fill Port** maintains anti-corrosion fluid in spring cartridge housing and serves as the spring housing pressure-relief port.

6. **Stroke Adjustment Ring** controls drift setting, allowing stroke adjustment without requiring disassembly of the actuator piston housing.

7. **Piston Stem**

8. **Sealing System for Piston Rod**

   bidirectional seal and backup wear rings that isolate control fluid from actuator fluid.

9. **Compensation Port**

10. **Sealing System for Piston** includes bidirectional seal and backup rings that isolate control fluid from the compensation port fluid.
DA SERIES SURFACE HYDRAULIC ACTUATORS FOR DH & DHS GATE VALVES

Dril-Quip’s Surface Gate Valve product line incorporates the use of the DH and DHS Gate Valves with the DA2 and DA5 Hydraulic Actuators. Alternative actuators are available. Contact a Dril-Quip Sales Representative for more information.

VARIOUS ACTUATORS ARE AVAILABLE
• DA2 Fail-Safe Hydraulic Actuator is standard for surface applications
• DA5 Reduced-Height Fail-Safe Actuator, used where tree configuration requires minimum actuator length, such as cassion well bays
• DA9 Fail-Safe Actuator for standard surface applications with piston rod extension and can be used with lock-open devices
• DA9R Fail-Safe Actuator for standard surface applications and compact profile
• DLH Economic Actuator used with the series DL Gate Valve only

ACTUATOR FEATURES
• VISUAL AND ELECTRIC POSITION INDICATORS are available
• OPERATING PRESSURE RANGES from 1,500 to 6,000 psi
• DRIFT ADJUSTMENT POSSIBLE before full assembly
• SLICKLINE AND BRAIDED CABLE shear is available
• ACTUATOR is easily removable from the bonnet
• UPPER SPRING RETAINER retains return spring in the upper section of the housing during assembly and disassembly
• OPTIONAL LOCK-OPEN DEVICES available on some models
• LOWER SPRING RETAINER retains return spring in the lower section of the housing during disassembly and reassembly
• LIP SEAL WITH BACKUP WEAR RING contains hydraulic pressure for the operating piston. The backup ring reduces wear and keeps the piston aligned with the actuator sleeve
• PISTON AND ACTUATOR are coated for corrosion protection
**Model DHF Features**

- Designs meet standard API Specifications and have passed fire-safe tests as specified by API 6FA (DHF) and API 6FC (DHFC)
- Series DHFV incorporates high performance fire-safe feature that allows the gate to partially shift and vent trapped body pressure. These features are also available with the split gate valve design
- Metal-to-metal seat-to-body and seat-to-gate seals
- Fire-resistant bonnet design

**Bonnet Features**

- **The Valve** is made so the stem-to-bonnet metal-to-metal backseat will engage in a fire. This is done to eliminate the possibility of the packing burning out and creating a new fuel source for the fire. All other components are made to withstand the half-hour burn and cooldown without leaking. After the valve cools down, the stem packing is replaced and the valve stroked. The pressurized valve must not show any significant leakage during the test.
- **The Metal-to-Metal DX Bonnet Seal** is pressure-energized and will not leak due to high temperatures.
- **A Nut Shroud** is added to protect the bonnet bolting from direct flame.
- **A Eutectic Ring** is positioned above the upper bearing face and will melt in the event of a fire, or if the temperature exceeds 250°F. If this occurs, valve body pressure forces the stem upward and a metal-to-metal backseat seal is engaged. This seal isolates the valve bore and body pressure from the stem packing.
- **A Spring Cartridge** is used to engage the stem’s backseat when the Eutectic Ring has melted and there is no or low body pressure in the gate valve.

**Significant Design Features of the API 6FA Design**

- **Components** of the pressurized valve can withstand a half-hour burn and cooldown and one-time operation without significant leakage.
- **The Stem Packing** is made up of a high temperature Teflon-and-metal backup ring that can withstand the heat of a half-hour burn.
DM AND DL GATE VALVES AND DLH ACTUATOR

**STANDARD FEATURES**

- Non-rising stem design
- Metal-to-metal selective backseat
- Low torque requirements for valve operation
- Bidirectional sealing seats are field replaceable
- Non-wedging slab gate reduces stress on the stem in open or closed position
- Metal-to-metal bonnet seal
- Valve body cavity retains grease to reduce foreign material accumulation or hydrate formation while increasing the life of the valve

**DM GATE VALVE**
Spring-loaded seats with resilient face seals with metal-to-metal backup

**DL GATE VALVE**
Spring-loaded seats with resilient seals

**DLH ACTUATOR**
- Actuator attached directly to the gate valve body
- Stroke/drift adjustment standard
- Valve grease and test fitting contained in bonnet flange
- PolyPak™ seals for piston and indicator rod
- Simple design for reliable operation and ease of maintenance
- Reliable, economic alternative based on application

2½" 3,000 psi Block Tree with DLH Actuators
Block Trees

6 7/8" 10,000 psi Block/Stack Surface Tree shown with Radial Bolt Connector

5 1/8" 10,000 psi TLP/Spar Stack Surface Tree shown on tubing head with adapter

4 1/16" x 2 1/16" 5,000 psi Guidelineless Dual Bore Subsea Tree Block shown with DX Connector

5 1/8" 10,000 psi Subsea Tree Block shown with DX Connector

4 1/8" 5,000 psi Block Surface Tree shown with Radial Bolt Connector

3 1/2" x 2 1/16" 5,000 psi Dual Bore Surface Tree Block shown with Radial Bolt Connector

5 1/2" x 2 1/16" 5,000 psi Dual Bore Subsea Tree Block shown with DX Connector

2 7/16" 3,000 psi Surface Tree Block shown with Radial Bolt Connector

SingleBore Subsea Tree Block shown with DX Tree Connector
Dril-Quip high performance gate valves are designed to the latest editions and supplements of the API specifications, and the Company is licensed to apply the API monogram to all of its valve products. In addition to API 6A, 17D, API QI, 6FC and 6FA certifications, Dril-Quip manufactures all valve products in accordance with the ISO 9000, 9001 Quality System. In the fifth edition of the API specifications set forth in the mid-1980s, product specifications levels (PSLs) were established to provide quality standards for the various service conditions applicable to different applications. PSL 1 through PSL 4 are defined as follows:

**PSL 1**
- **NACE and Non-NACE, Low Pressure**
  *Includes practices currently being implemented by a broad spectrum of industry for the service conditions recommended in Appendix A of API Specification 6A.*

**PSL 2**
- **Non-NACE, Medium Pressure**
- **NACE, Low H₂S, Low Pressure, Close Proximity**
- **NACE, High H₂S, Low Pressure**
  *Includes all the requirements of PSL 1 plus additional practices currently implemented by a broad spectrum of the industry for the service conditions recommended in Appendix A of this specification.*

**PSL 3**
- **Non-NACE Medium Pressure, Close Proximity**
- **NACE, Low H₂S, Medium Pressure, Close Proximity**
- **NACE, High H₂S, Low Pressure, Close Proximity**
- **NACE, High H₂S, High Pressure, Close Proximity**
- **NACE, High H₂S, Medium Pressure**
- **NACE, Low H₂S, High Pressure**
  *Includes all the requirements of PSL 2 plus additional practices currently implemented by a broad spectrum of users for the service conditions recommended in Appendix A of this specification.*

**PSL 3G**

**Gas Body Test**

In addition to a hydrostatic body test for individual equipment, a gas body test shall be performed. The test is conducted at ambient temperatures using nitrogen as the test medium. The test shall be performed with the equipment completely submerged in a water bath. Valves and chokes shall be in the partially open position during the testing.

The gas body test for assembled equipment shall consist of a single pressure-holding period of not less than 15 minutes; do not start the timing until the test pressure has been reached and the equipment and pressure-monitoring gauge have been isolated from the pressure source.

Test pressure shall equal the rated working pressure of the equipment. No visible bubbles shall appear in the water bath during the holding period. A maximum reduction of the gas test pressure of 2.0 MPa (300 psi) is acceptable as long as there are no visible bubbles in the water bath during the holding period.

**Gas Seat Test**

In addition to, or in place of, a hydrostatic seat test for valves, a gas seat test shall be performed as follows. Apply gas pressure on each side of the gate or plug of bidirectional valves with the other side open to atmosphere. Conduct the test at ambient temperatures using nitrogen as the test medium. Conduct the test with the equipment completely submerged in a water bath. Testing shall consist of two monitored holding periods.

The primary test pressure shall be the rated working pressure and minimum holding period of 15 minutes. Reduce the pressure to zero between the primary and secondary holding periods. The secondary test pressure shall be at 2.0 MPa (300 psi) ± 10 %, and the secondary test monitored holding period shall be a minimum of 15 minutes. The valves shall be fully opened and fully closed between tests. Test bidirectional valves on the other side of the gate or plug using the same procedure outlined above. Split gate valves may have both seats tested simultaneously.

No visible bubbles shall appear in the water bath during the holding periods. A maximum reduction of the gas test pressure of 2.0 MPa (300 psi) is acceptable as long as there are no visible bubbles in the water bath during the holding period.

**Gas Backseat Test (Optional)**

A gas backseat test may be performed on gate valves, and the gas backseat test shall be used in conjunction with the gas body. The tests are performed at ambient temperatures using nitrogen as the test medium. Tests are conducted with the equipment completely submerged in a water bath. The area between the primary packing and the backseat shall be vented during the test.

The test shall consist of one holding period. The monitored holding period shall be at the rated working pressure, and shall be a minimum of 15 minutes. No visible bubbles shall appear in the water bath during the holding period. A maximum reduction of the gas test pressure of 2.0 MPa (300 psi) is acceptable as long as there are no visible bubbles in the water bath during the holding period.

As outlined on page 10, Dril-Quip valves are available in all of the API-designated trim categories. To help solve highly corrosive and abrasive conditions in harsh environments, Dril-Quip has used a variety of corrosion and abrasion resistant overlay material applied to the wetted surfaces of individual valves and valve blocks. This produces a cost-effective means of supplying equipment for corrosive environments.

Overlay products meet NACE standards MR-01-75, API Spec 6A, PSL-1-3G, and 17D and all weld procedures are certified to ASME Section IX. Dril-Quip’s extensive research and development program strives to produce valve designs that exceed all of the API specifications and meet the ever-more demanding requirements of the Company’s customers.
Various verification tests on Dril-Quip’s actuated and manual gate valves have been performed and passed. They include the following industry standard tests:

- **API Specification 6A PR2**: A 200-cycle endurance test
- **API Specification 6A Appendix F PR2**: A 200-cycle test with 3 minimum-to-maximum temperature cycles
- **API Specification 6A Surface Safety Valve (SSV)/Underwater Safety Valve (USV) PR2 Sandy Service Test (Formally API 14D Sandy Service Test)**: The sandy service rating test consists of placing the gate valve in a flow loop through which a sand slurry is pumped, and operating the gate valve 500 times
- **API Specification 6FA Fire Test for Valves**: A test to demonstrate that the gate valve can survive a fire of 30 minutes duration
- **API Specification 6FC Fire Test for Valves with Automatic Backseats**: A test to demonstrate that the gate valve with an automatic stem-to-bonnet backseat can survive a fire of 30 minutes duration and automatically back-seat
- **API Specification 17D, Subsea Equipment, Tests**:
  - **Pressure Cycling Tests**: A 200-cycle test to simulate startup and shutdown pressure cycling
  - **Temperature Cycling Tests**: A 3-cycle test where the gate valve is alternately heated to its maximum rated operating temperature and then cooled to its minimum-rated temperature. The valve is pressurized at its temperature extremes to verify that it will not leak
  - **Endurance Testing**: A 200-cycle endurance test to simulate the valve operating
  - **Depth Testing**: Testing actuators to various simulated water depth pressures. The gate valve is operated to verify that actuator pressure will not exceed 90% of the rated operating pressure for opening stroke, and will not drop below 100 psi during the closing stroke
- **3,500-Cycle Endurance Test**
- **200-Cycle Endurance Test** of an actuated subsea gate valve placed in a hyperbaric chamber pressurized to the equivalent of 6,000 feet water depth
- **Wireline Shear Tests** using the valve gate to shear a wireline and seal off bubble-tight

Dril-Quip’s test lab is capable of testing valves using pressures up to 25,000 psi (gas or water), and at temperatures of -100°F to 450°F. Using the hyperbaric chamber, valves are tested with external pressure simulating subsea operation at depths up to 12,000 feet. The lab also has multiple automatic, computer controlled test stations. These stations provide sequence control for the various tests, and regulate pressures, temperatures and valve stroke positions while acquiring test data. The automated test stations give Dril-Quip the ability to complete long and complex tests in a matter of days.