

Gate Valves

Selection issues for gate valves operating in excess of 5000 psi

- Overview
- Applications
- Supplies



Overview



Request for Input to this Decision Guide

- Subsea and shale applications are where one finds most of the gate valves with requirements for greater than 5000 psi service. What are the specific applications, gate valve designs, and materials which are best for each specific application? This analysis is in the early stages. We have identified some suppliers and their products and are asking them for comments. We welcome input from all sources.
- You can gain a better perspective of what is planned for this Decision Guide by perusing the 750°F Ball Valve Decision Guide which is in an advanced state.

Gate Valve Decision Guides Integrated with IIoT and Remote O&M

- This Decision Guide is provided to support the Mcilvaine effort to empower IIoT with IIoW (Wisdom).
- The cost of hydraulic fracturing has been steadily shrinking.
- The selling price of Saudi Crude is variable and provides tough competition for fracturing.
- Valves are an important cost component in the fracturing process.
- The high pressure 5000 psi valves are subjected to a number of challenges.
- Valve designs can evolve to improve fracturing performance and reduce costs.
- This technology is equally important for sub-sea applications which are not presently cost competitive.
- Where do you see activity for your high pressure gate valves in oil and gas in the near term?
- How much of the business is replacement and repair of existing valves?
- What is the typical valve life?
- How can this be extended in the future?

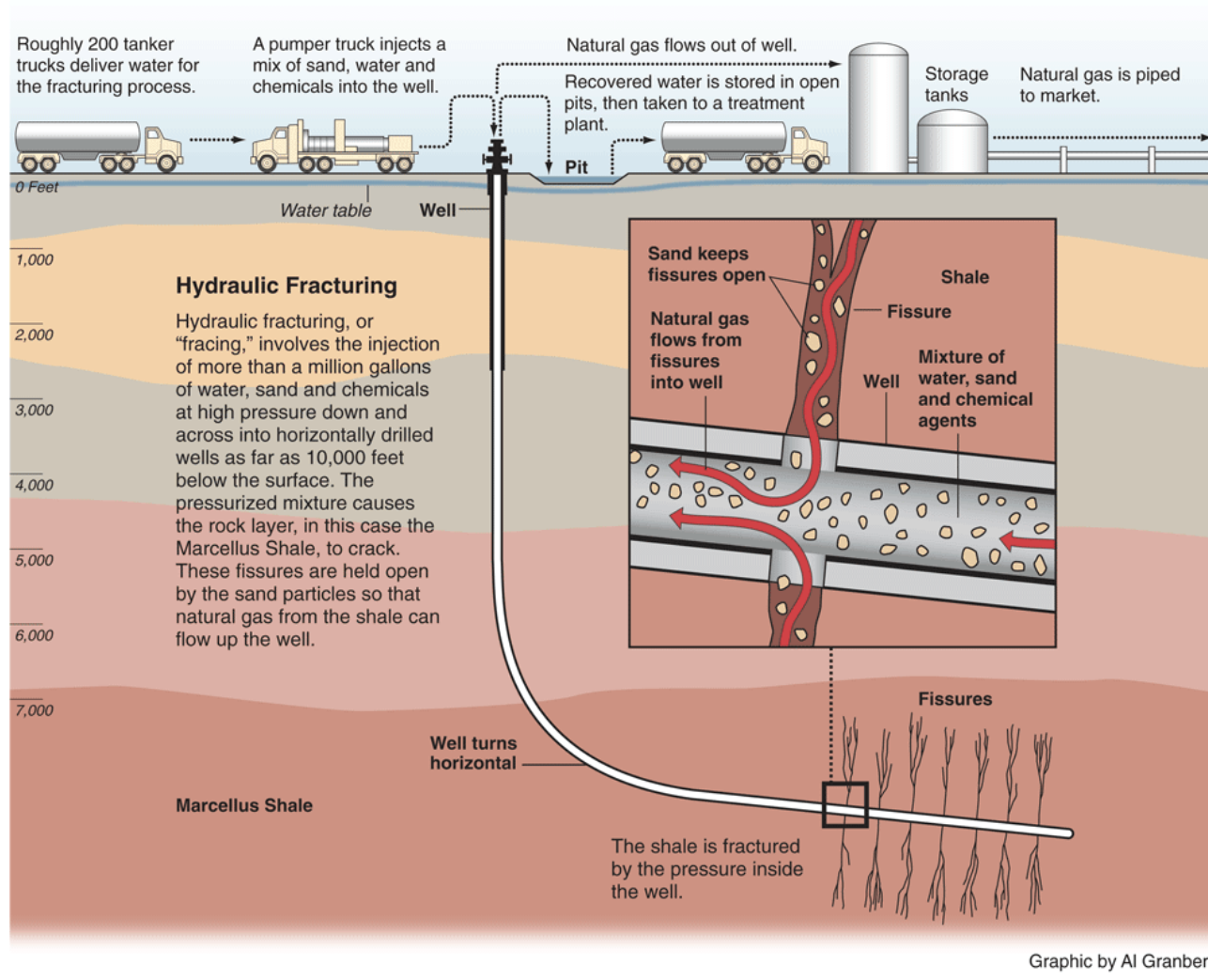
Types of Gate Valves

- There are four primary designs for gate valves – a slab gate, an expanding gate, a wedge valve and a knife gate valve.
- **Slab gate** valves are comprised of a single gate unit which raises and lowers between two seat rings and are primarily used for transporting crude oil and NGLs. The Cameron GROVE G4N fabricated gate valve and WKM Saf-T-Seal gate valve are ideal choices for this application.
- Unlike a slab gate valve that only has one unit, an **expanding gate** valve includes two units – a gate and segment. The gate and segment units collapse against each other for travel, and separate when the valve is fully opened or fully closed, to affect a mechanical seal.
- **Wedge gate** valves are comprised of a tapered gate that is metal-to-metal sealing. In contrast to a slab gate valve or an expanding gate valve, wedge gate valves are not piggable because of the void that is left in the bottom of the valve body when the valve is open. These valves do not have a bore through the gate itself – instead, the gate retracts into the valve body when open – which saves height space that is necessary for slab and expanding gate valves.
- A **knife gate** valve is used to cut through extremely thick fluids and dry bulk solids. The design of this valve makes it inherently self-cleaning, as the knife is cleared of abrasives with each stroke as it passes the seat rings and skirts. The gate unit of this type of valve is thin compared to other gate valve types and is guided in place by the water-type body that sandwiches the gate.

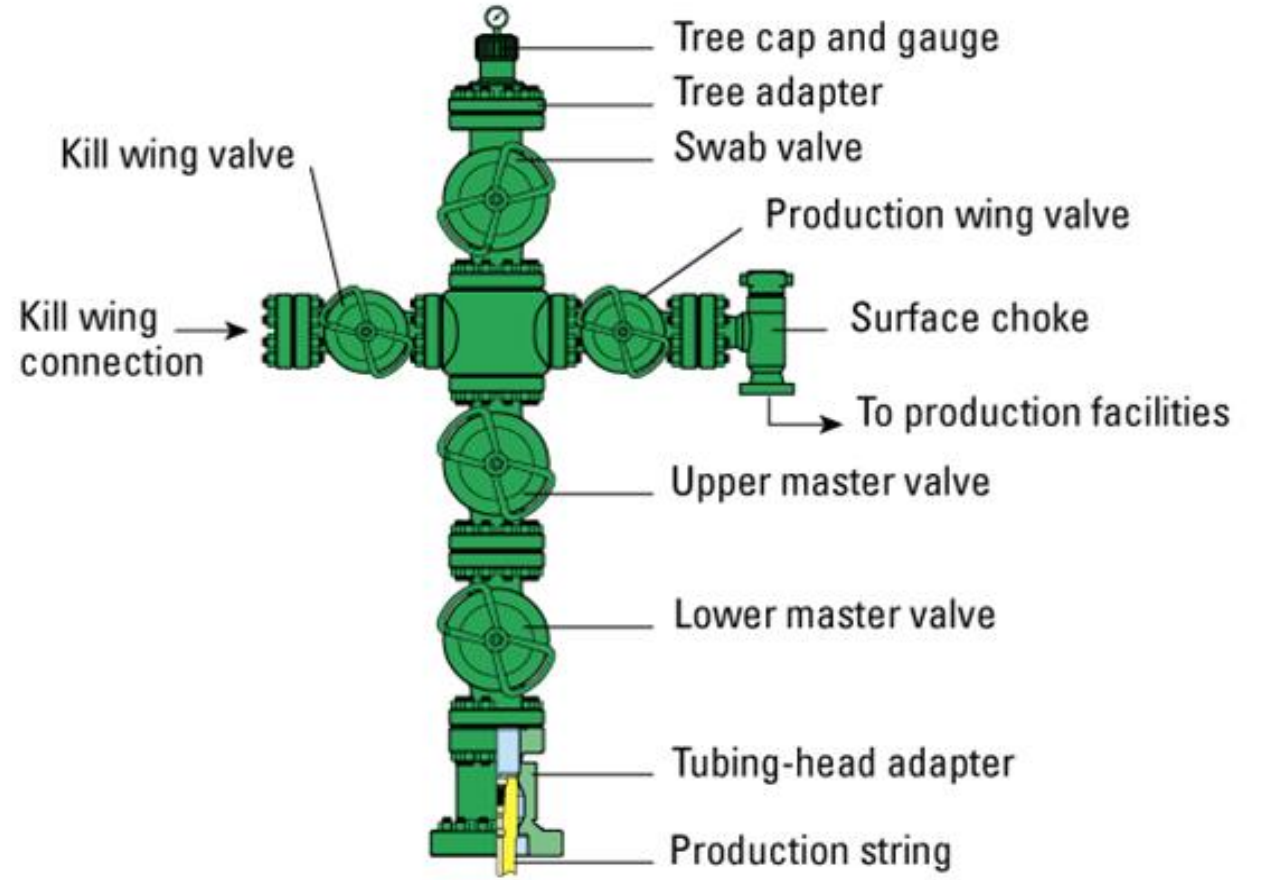
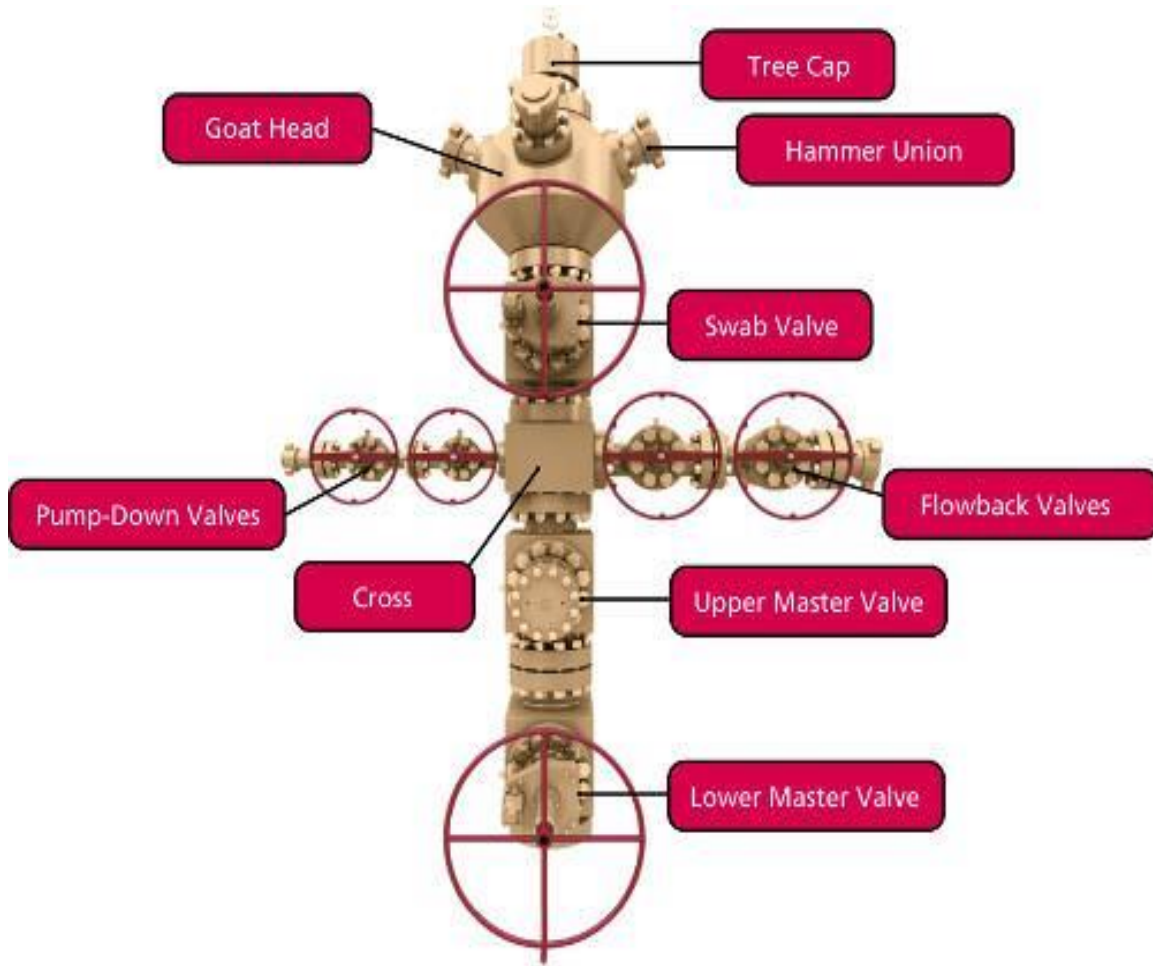
Applications



Shale Fracturing with High Pressure Slurry



Frac Gate Valves on Tree and Manifold



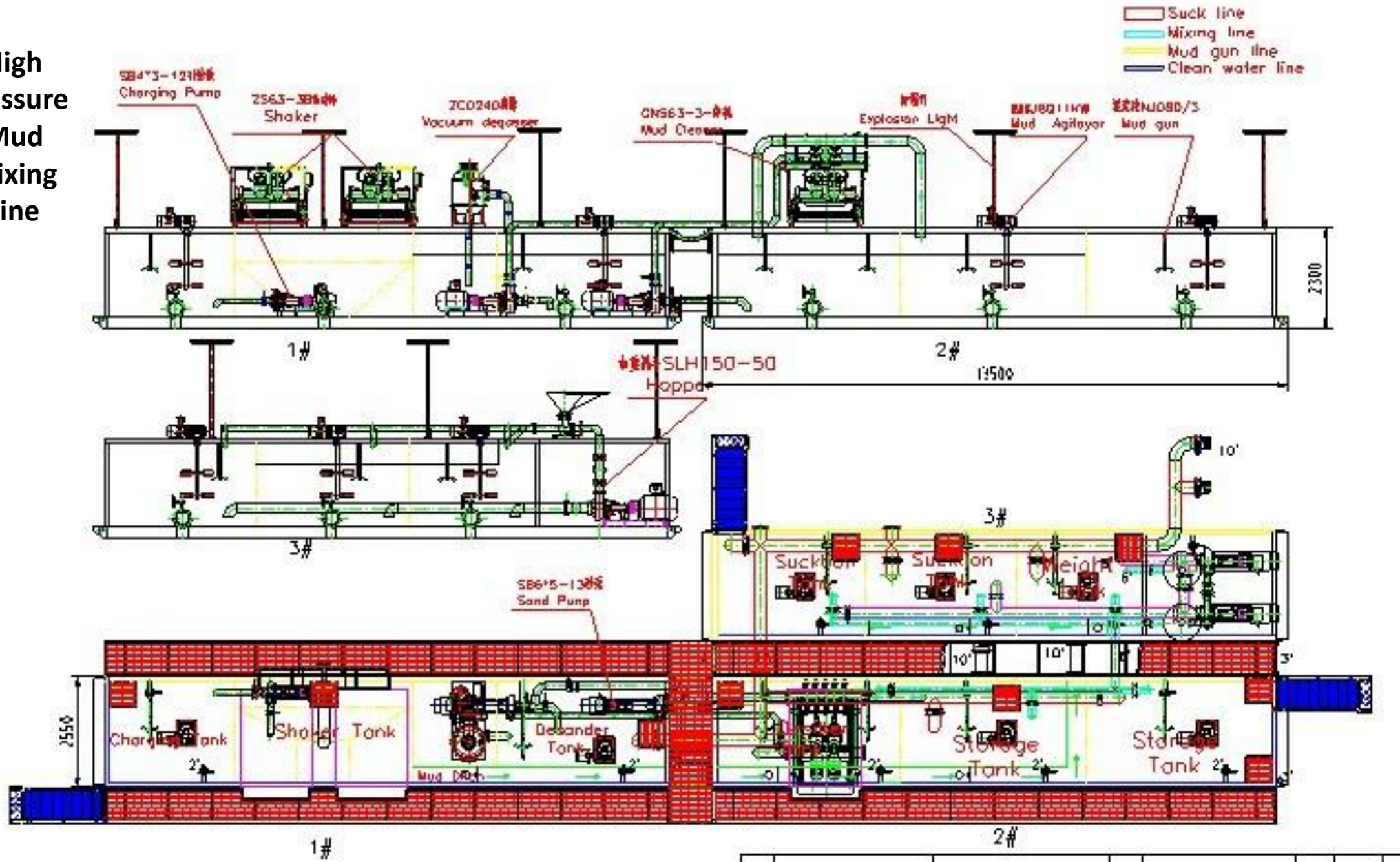
Combination Manifolds



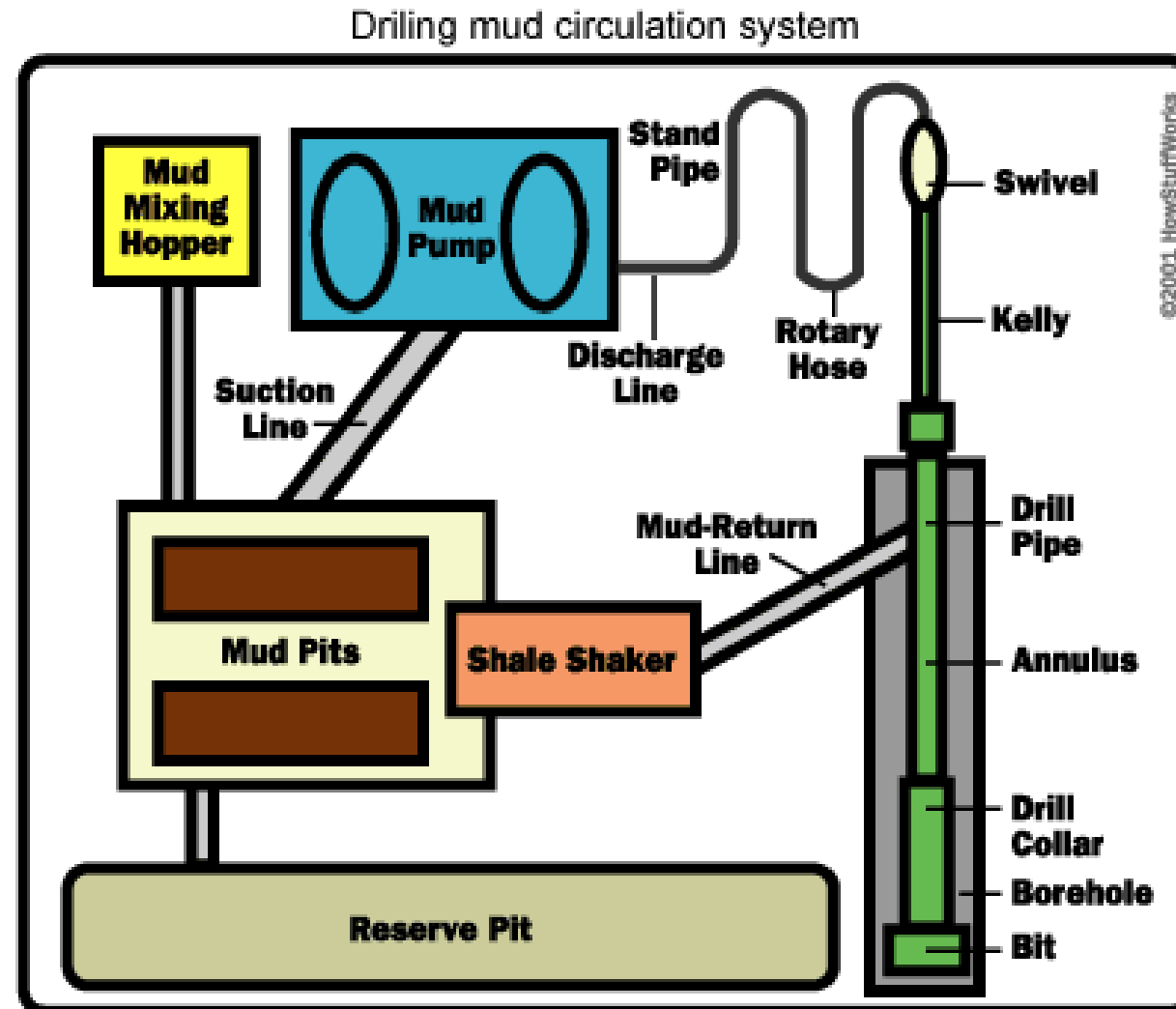
Manifold Trailer



High Pressure Mud Mixing Line



Drilling Mud Recirculation System



API 6A

- API Specification 6A (ISO 10423) is the recognized industry standard for wellhead and Christmas tree equipment. It was formulated to provide for the availability of safe, dimensionally and functionally interchangeable wellhead and Christmas tree equipment. The specification includes detailed requirements for the manufacture of tubular suspension equipment, valves, and fittings used at the location of oil and gas wells to contain and control pressure and fluid flows.
- Specification 6A also serves as the reference source for the design of flanged end and outlet connections for use at 2,000 to 20,000 psi maximum rated working pressures and a family of gate valves for use over these same pressure ranges.

Suppliers



BFE Slab Gate Valve

SLAB GATE VALVE



1. BFE slab-style gate is a simple one-piece & solid gate design, featuring metal to-metal seal between gate and seats, so as to apply to the most severe and demanding service condition, including corrosive and abrasive fluid environments.
2. Non-rising stem design to permit smart valve installation.
3. Full open through conduit construction to eliminate turbulence and pressure drop.
4. Upper grease injection fitting to reduce the abrasion between gate and seats.
5. Back seat with conical seal surface against stem allows stem seal replacement under pressure.
6. Expanding gate design available on request.

BFE Mud Service Gate Valve

BFE manufactures a complete line of quality API 6A valves, and can provide the exact valves and actuators to meet the most demanding application requirements. Their API 6A valves are available in an extensive range of designs, materials, sizes and pressure classes and are in full conformance with API and NACE specifications. All API 6A valves are designed in accordance with API 6A and where applicable with ASME VIII Div.1 and Div.

**MUD SERVICE
GATE VALVE**



1. Special Design made for high-pressure modern drilling mud systems.
2. In the case of dynamic pressure lifetime of the trim designed according to the most severe frequency & amplitude conditions at 7500psi series with modern triplex mud pumps.
3. Soft Seat maximal rating up to 7500psi. For API 10000 and above the applicable design is the slab type.
4. Typical internal fluid types are mud, cement, fracturing and water service.
5. High structural strength: All valves have the pressure retaining parts (Body and Bonnet) only in FORGED STEEL.
6. Self energized packing. The Packing doesn't require initial compression or periodical adjustments.
7. Quality level according to API 6A - PSL 1, 2 or 3.

Bentley Subsea Rotary Gate Valve

Pressure ratings (standard valves) 5,000 psi
10,000 psi 15,000 psi 16,500 psi
Operating depth 3,000 meters, water depth
insensitive, due to no-volume displacement
design

Performance specification Tested to API 6A
appendix F PR2

Rotary gate valves can suit many applications
and various media, from hydraulic fluids to
well fluids to injection chemicals. Porting
and mounting arrangements can be tailored
according to need. Body size, stems, seals



Cameron

- The 2” to 4” non-rising stem version of the WKM Pow-R-Seal Model M is commonly utilized in wellhead manifold systems because of its reliable mechanical seal and high pressure capability.
- Certain gate valves also can be designed easily into drilling manifold systems, like the Cameron DEMCO DM series, with space saving and versatile mounting designs.
- In the power industry, NEWCO and DOUGLAS CHERO gate valves are ideal for standard and critical applications, such as steam distribution in power plants. By replacing the body and bonnet flanges with a welded connection, the design of this valve eliminates a leak path, reduces weight and simplifies the application of exterior insulation. This, in concert with the forged steel body, provides the highest integrity sealing available.
- For the challenging subsea environment where pressures are extremely high, temperatures are low and operation is difficult, subsea manifolds that integrate valves and interface panels are used for critical isolation. The simple design of the Cameron RING-O slab gate valve is ideally suited for integration into these systems and can be manually, ROV or hydraulically actuated for ease of operation.

Cameron Demco Applications

Designed for dependable, heavy-duty performance in abrasive service conditions, the Cameron DEMCO DM 5000-psi gate valves are commonly selected for a number of oilfield applications, including:

- Pump-manifold block valves
- High-pressure mud mixing lines
- Standpipe manifolds
- High-pressure drilling system block valves
- Wellheads
- Well treating and frac service
- Production manifolds
- Production gathering systems
- Production flow lines



Cameron is a Major Supplier of Frac Valves

- Gate valves in frac trees and manifolds control high-pressure, high-volume, abrasive fracturing fluids for days—and even weeks. Given the erosive, corrosive, and sometimes sour nature of typical fracturing and flowback fluids, the valves are trimmed for maximum corrosion and erosion protection and feature
- Corrosion-resistant alloy (CRA) inlay in seat pockets and ring grooves
- Two ports for flushing and greasing the valve body cavity.
- Because of these features and the industry's most stringent maintenance program, which includes cleaning, disassembly, inspection, reassembly, and testing before valves returned from the field are assigned to the next project, Cameron frac valves provide three times more uptime compared with other suppliers, minimizing NPT and related costs.
- Designed as a manual valve for high-pressure applications, the FLS-R-Frac valve is a heavy-duty, reliable gate valve for hydraulic fracturing. It reduces exposure to potential erosion and contamination associated with the midrange position because it quickly cycles from fully closed to fully open. The FLS-DA2-Frac gate valve offers all the same metal sealing features, with the addition of a double-acting hydraulic actuator for fast, positive, remote actuation. It remains in position should hydraulic power failure occur. The bidirectional FLS-Frac valve offers flow direction versatility and increased service life. The full bore, through-conduit FLS valve is the preferred frac valve for 10,000-psi and 15,000-psi working pressures with 1 13/16-in nominal bore size.



Cameron Demco 7500

- The Cameron DEMCO DM 7500-psi gate valve meets the tough, 7500-psi working pressure demands of deep well drilling. The DEMCO 7500-psi gate valve comes to this market with proven technology. When the market demanded a 7500-psi drilling mud valve, the DEMCO 7500-psi gate valve was introduced to meet the challenge. This is fitting since the DEMCO gate valves (2000 to 5000 psi) continue to be the premium drilling mud valves of choice, as they have been for more than 30 years.

The DEMCO 7500-psi gate valve is available in sizes 2" to 6" (50 mm to 150 mm) with butt-weld end or flanged end connections. Engineered specifically for the high pressure requirements of deep well drilling, the DEMCO 7500-psi gate valve is chosen for the following drilling applications:

- Standpipe manifolds
- Pump manifold block valves
- High-pressure drilling-system block valves
- High-pressure frac service



GE Oil and Gas Gate Valves

Model 1000 Gate Valve	Model 2000 Expanding Gate Valve	Model 2200T Slab Gate Valve	Sandbuster® Slab Gate Valve	Model VG-230SE2 Gate Valve	VG-300 Slab Gate Valve	Model SR-CT2 Expanding Gate Valve	
Description	Cast body slab gate design for lower pressure applications on wellhead annulus outlets & production trees without compromising strength/seal integrity	Uni-directional valve with preferred sealing side. Used on wellhead, production tree and manifold applications with working pressures of 2,000 - 5,000 psi.	High-performance, bidirectional slab gate valve for high pressure, critical service applications of 2,000-20,000 psi on wellheads, production trees & manifolds	High-performance, bidirectional slab gate valve for fracturing service operations with working pressures of 10,000-15,000 psi.	Bidirectional split gate valve for high temp (up to +650°F/+343°C) steam injection wells, thermal secondary recovery & industrial plant applications	High-performance, bidirectional slab gate valve ideal for high pressure, critical service applications on wellheads, production trees and manifolds	For extreme service applications; field-proven & PR2-tested SR valve design; split gates, non-rising stem, full metal sealing & self-energizing CT2 stem packing
Nominal Size	2-1/16" ; 2-9/16" ; 3-1/8" ; 4-1/16"	2-1/16"; 2-9/16"; 3-1/8"; 4-1/16"	1-13/16"; 2-1/16"; 2-9/16"; 3-1/16"; 3-1/8"; 4-1/16"; 5-1/8"; 7-1/16"	4-1/16"; 5-1/8"; 7-1/16"	2-1/16"; 2-9/16"; 3-1/8"; 4-1/16"; 5-1/8" Additional sizes and pressures available upon request	1-13/16"; 2-1/16"; 2-9/16"; 3-1/16"; 3-1/8"; 4-1/16"; 4-1/8"; 5-1/8"; 6-3/8"; 7-1/16"; 8"; 9"	1-13/16" 2-1/16" 2-9/16" 3-1/16"
Working Pressure	2,000; 3,000; 5,000	2,000; 3,000; 5,000	3,000; 5,000; 10,000; 15,000; 20,000	10,000; 15,000	2,000; 3,000; 5,000 Additional sizes & pressures available upon request		



GWC Expanding and Slab Gate Valves for 6A

- **GWC Italia SpA** with its Headquarters in Milan, Italy designs, manufacturers and markets a variety of valves.. GWC Italia SpA which is founded by an Italian Group & USA Entrepreneurial Management team, has become the Parent Company of the long standing GWC Worldwide
- GWC produces a full line of API-6A Gate valves in both expanding and slab gate design. We offer a full range of materials and classes from general to sour service based on customer requirements for wellhead, manifold and fracture applications.
- **SPECIFICATIONS**
- Size Range: 1 13/16" – 7 1/16"
API: 2000 – 15,000 psi
API Standard: 6A
Material Class: AA – FF
- **FEATURES**
- Cast body 2,000- 5,000 psi
- Forged body 2,000- 15,000 psi
- Expanding or Slab Gate
- RTJ or Threaded ends



GWC Users A-M in U.S.

Aera Energy
USA
Berry Petroleum
USA
BCKK Engineering
USA
Beryl Oil & Gas
USA
Black Elk Energy
USA
BP Whiting Cogen
USA
Brigham Exploration
USA
Castex Energy
USA
Century Exploration Chemtex,
West Virginia
USA
Citgo Refinery
USA
Conoco Phillips
USA

CUWCD, Central Utah Water
Conservatory
USA
Denbury Onshore LLC
USA
Denbury Resources
USA
Department of Energy,
Washington
USA
Devon Canada Corporation
USA
Eastern Municipal Water District,
California
USA
EG&G
USA
Elco
USA
Enbridge Energy Encana
USA

Enbridge Energy Encana
USA
EOG Resources
USA
Genesis Energy Limited Energy
XXI
USA
Fairways Offshore
USA
GOM
USA
Genesis Energy Limited
USA
Greka Energy
USA
Gulf Field Services
USA
Gulf Production
USA
Harvest Oil & Gas
USA
Indiana Harbor
USA

Karnes Enterprises
USA
Kinder Morgan
USA
KR HOLDINGS
USA
LLOG Exploration
USA
March Air Force Base, California
USA
Mariner Energy
USA
Maritech Resources
USA
Medco Energy
USA
Merit Energy
USA
Mogas

Hakima Slab Gate

SLAB GATE VALVES

The Slab Gate Valves features a non-rising stem with a slab gate, Full-Bore Thru-Conduit Design, Floating Slab Gate and Seats, floating seat ring body bushing design to provide safe dependable service. No special tools are needed to change gate and seat assembly. The stem pin protects the stem and internal parts from failure by shearing if the handwheel is over torque. One-piece gate helps to prevent line sediment from entering the body cavity and prevents pressure locks when the up stream pressure drops. A wide range of body and trim materials to meet various operating conditions.



Mud King Gate Valves: 2-6 inches

APPLICATION

- ☞ Drilling and well-treating chemicals
- ☞ Sour gas and crude oil
- ☞ Abrasive drilling mud
- ☞ Pipelines and manifolds
- ☞ Wellheads
- ☞ Water, oil, and gas lines
- ☞ Cements and slurries
- ☞ Corrosive water flood lines
- ☞ Up to 7500 psi and 400° Fahrenheit services

SEAT ELASTOMERS

Buna N (nitrile) is the basic seat elastomer. It is excellent for petroleum oil and gases, fuel oils and alcohols from -10° F to +200°F. **Hypalon** is optionally offered compounded for maximum chemical resistance. Particularly suited for oxidizing acids, it resists hydrocarbon oils and fuels from -10° F to +250° F. Viton is highly resistant to mineral acids and hydrocarbons and resists moderate concentrations of hydrogen sulphide. Serviceable from -10° F to +400° F (Not suitable for steam).

PLASTIC COATINGS

Internally plastic-coated valve bodies and bonnet are available on request.

TESTING

MKP Gate Valves are hydrostatically tested at assembly. Stem seal, body, and seat are inspected for zero leakage under pressure, before acceptance.

PRESSURE RATINGS

MKP Gate Valves are designed for the maximum working pressure and test pressure tabulated below:

5000
5000 WP
7500 PSI Test

7500
7500 WP
11,250 PSI Test

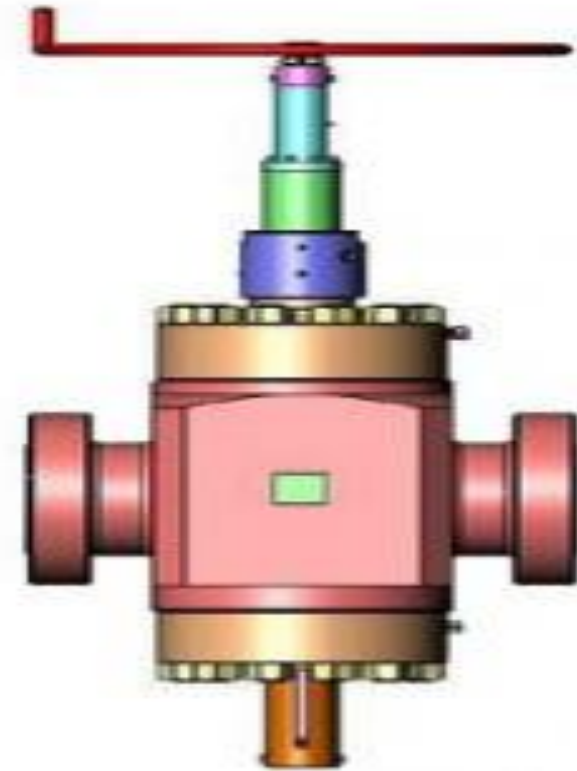
Gate Valve rating must be selected to match the piping system in which the valve will be installed. Tabulated below are working pressures at 100° F for ASTM A-106 Grade B pipe in sizes corresponding to MKP gate valves.

SIZE	SCH. 40	SCH. 80	SCH. 160	X X H
2"	1210	2220	4300	5970
3"	1460	2370	3930	5880
4"	1300	2130	3830	5150
5"	*****	1970	3730	4650
6"	1110	1970	3650	4724



Neeco Industries' API-6A Gate Valve is a Large-bore Valve used in the Fracking Industry.

The NF valves (NF-700 and NF-500) are large-bore high-pressure valves suitable for Fracking Applications. The NF series valves have a proven track record spanning over 5 years and are used by some of the biggest fracking service companies in the USA. The NF Series is made with a dual-bonnet (lower balancing stem) and contains a ball-screw assembly to reduce torque levels during working pressure. The NF series design allows for easy operation, low maintenance and durability in severe conditions. The NF series contains a one-piece seat design and simplified parts in order to provide for easy maintenance and repair. Both NF-700 and NF-500 valves are available with Hydraulic Actuators.



Perar (Italy) has Subsea Gate Valves Rated up to 20,000 psi

- Subsea through conduit gate valves are designed according to API6DSS, API6A, API17D with the addition of customer requirements when present.
The valves do not rely on lubricant or grease to assist sealing between the gate and seat. Metal-to-metal sealing is used between the gate and seat and between the seat and body. Metal-to-metal sealing is also provided between body-to-bonnet and stem-to-body at fail position via backseat.
The Subsea gate valves are actuated by hydraulic actuator or gearbox as requested.
- **BASIC CHARACTERISTICS**
- API6DSS, API6A, API17D design as requested
- Bi-directional sealing
- Floating spring energized metal-to-metal seats (tungsten carbide coating thickness 0,25 mm on seats and 0,4 mm on gate)
- Non-elastomeric seals to avoid the risk of gradual degradation of the seals over their life
- Full metal-to-metal sealing at any primary pressure boundary including valve stem at fail position with the option of double backseat to provide metal sealing at both open and close positions.
- Downstream sealing with pressurized body cavity to assist fail safe stroke
- Forged material to comply with API6A PSL3
- Valve actuation with dedicated hydraulic actuator and ROV operable Gearbox



ViNtrol

ViNtrol, Inc.

Quality Gate Valves for the Most Demanding Applications

ViNtrol, Inc. Gate Valve Product Line Offers:

- Design suitable for actuation and compatible with a wide range of actuators
- Valves for applications from 2000 to 15,000 psi WP
- Positive Metal to Metal sealing (gate-to-seat and seat-to-body)
- Bi-directional sealing design
- Valves fitting a wide range of land and offshore applications.
- -50° F to 650° F Service
- Full bore through conduit construction.
- Components constructed of various alloys and coatings for severe service applications.
- Expanding and Slab design available
- API 6A Safety Shutdown Valves
- API Specification 6A
- API Specification 6D

ViNtrol, Inc. has become a leader in the valve industry as a result of ViNtrol's ability to anticipate and supply the market's requirements. Every valve must meet or exceed standards mandated by our customers and the stringent industry requirements.

ViNtrol gate valves have earned a reputation in all types of service applications. Our attention to total quality and excellence enables ViNtrol, Inc. to consistently deliver the world's finest gate valves to fill customer's needs throughout the world. ViNtrol offers a wide variety of gate valves, actuators, and other 6A products to provide our customers with all of their drilling and production needs.



ViNtrol Expanding Gate 2-7 inches

Available Gate Styles



Expanding Gate

ViNtrol's expanding-style gates are used in 2 1/16 thru 7 1/16, 2000 to 5000 Gate Valves. This popular gate design is used in manual valves to produce a high seating force against both the upstream and downstream seats simultaneously as the handwheel is tightened. This force effects a tight mechanical seal which is unaffected by line pressure fluctuations or vibration. The expanding gate allows a positive mechanical seal across both seats, both upstream and downstream, with or without line pressure.

Expanding-Style Gate Valve Availability

Size (in.)	Working Pressure (psi)		
	2000	3000	5000
2-1/16	NW	NW	NW
2-9/16	NW	NW	NW
3-1/8	NW	NW	NW
4-1/16	NW	NW	NW
7-1/16	NW	NW	NW

ViNtrol Slab Gate 1-7 inches



Slab Gate

ViNtrol slab-style gates are one-piece, solid gates which consistently deliver outstanding sealing performance throughout a wide range of conditions, bore sizes, and working pressures, including corrosive and abrasive fluid environments. These valves meet or exceed the requirements of API Specifications 6A, 6A SSV. Sizes include 1 13/16 thru 7 1/16, 2000 to 15,000PSI

The slab-style gate design effects a metal-to-metal seal on the flow stream and its simple, straightforward design makes it easy to maintain both low and high-pressure sealing situations where contaminants could pose a sediment problem.

Slab-Style Gate Valve Availability

Size (in.)	Working Pressure (psi)				
	2000	3000	5000	10,000	15,000
1-13/16	—	—	—	NS	NS
2-1/16	NS	NS	NS	NS	NS
2-9/16	NS	NS	NS	NS	NS
3-1/8	NS	NS	NS	—	—
3-1/16	—	—	—	NS	BRS
4-1/16	NS	NS	NS	NS	BRS
5-1/8	—	—	—	NS	BRS
7-1/16	NS	NS	NS	NS	BRS

Weir Seaboard Gate Valve used Extensively in Fracking

- The Seaboard™ model range 640/1640 gate valve offers a forged body, bi-directional slab gate, pressure balancing stem, metal-to-metal seals and stem back-seating capability. The chemically inert stem packing uses spring energizing rings that require no adjustment or plastic injection. The non-rising stem reduces tearing of the stem packing while acme thread enhances durability and lowers torque requirements.
- The one-piece slab gate's floating seats use line pressure to supply the sealing force. A stem shear pin protects the valve stem from being damaged due to excessive torque.
- A routine maintenance program keeps repairs to a minimum. If repairs become necessary, vital valve components may be replaced in-line. Gates, seats, stems and other critical parts are easily replaced without the use of special tools. Stem packing can be replaced while the valve is under pressure.
- The 640 valve suits most types of oil and gas service and is recommended for pressures up to 5,000 psi. The 1640 valve is rate for 10,000 psi to 15,000 psi applications. The larger sizes and pressure of this valve are used extensively in fracking applications. Flanged-end configurations are available in standard bore sizes.
- Metal-to-metal seals are used for tight connections in the gate-seat, body-bonnet and stem-bonnet backseat. A selective backseat can be employed without shifting the gate position and provides proven safety during venting, lubrication and stem packing replacement. The seals are stable and thermally insensitive.

