

Our experience runs deep



## Subsurface Safety and Injection Valves

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**Subsurface safety systems provide the ultimate protection against uncontrolled flow in case of catastrophic damage to wellhead equipment.**

As part of a production safety control system, subsurface safety and injection valves serve an extremely critical role, forming the final defense against uncontrolled flow from a well. At any time, the safety valve must operate flawlessly on demand.

Through the heritage of Camco\* subsurface safety valves, Schlumberger has long represented innovation and quality to the oil and gas industry. We have a proud legacy of pioneering advanced technology for safety control systems in demanding operating environments.

Our wide range of safety and injection valves—based on industry-leading technologies—are built from many years of experience and expertise and play a major role in minimizing safety risks to people and petroleum reserves. Today Schlumberger continues to demonstrate innovation in safety valve technology and valve performance in ultradeepwater, high-pressure, and high-temperature environments.

## Consistently high levels of quality



### SCHLUMBERGER FIRSTS

Since the 1940s, Schlumberger subsurface safety valves have set engineering and performance benchmarks. Many patents have been industry firsts and are now current standards:

- tubing-retrievable valves
- rod-piston hydraulic actuation
- all-metal body joints and non-elastomeric seal technology
- nitrogen-charged power spring valves for ultradeep installations
- redundant hydraulic control systems
- high-pressure, high-temperature valves for extreme operating conditions.

They include the following:

- rod piston-actuation that allows faster and more repeatable hydraulic control and response times
- rugged flapper closure system that withstands extreme slam closures
- curved flapper design that reduces the outer diameter of a valve, enabling valves with larger inner diameters to be installed in a given casing size
- secondary valve capability that allows permanently locked-out valves to accept a secondary slickline-retrievable safety valve
- all-metal, elastomeric, and nonelastomeric seals for wells with working pressures to 137.9 MPa [20,000 psi], temperatures to 204.4 degC [400 degF], and high concentrations of H<sub>2</sub>S and CO<sub>2</sub>
- gas-spring designs for extreme depths and pressures and for applications with very low surface-operating-pressure requirements with redundant control systems.

### Setting the bar

Consistent standards across multiple state-of-the-art manufacturing facilities support our tradition of excellence. For example, all facilities are licensed by the API to apply the API monogram to 14A products—subsurface safety valves.

Our detailed program of quality assurance and quality control exceeds the rigorous demands of the petroleum industry. The Schlumberger leakage-acceptance criteria is substantially higher than those of the API and ISO. For example, API industry standards allow newly manufactured subsurface safety valves a leakage rate of 5 scf/min; however, Schlumberger standard valves are tested to a more stringent requirement and have a leakage rate of only 0.033 scf/min, which is less than 1% and 150 times better than the API acceptance rate.

Our in-house manufacturing controls, advanced manufacturing techniques, latest precision machinery, and highly skilled, experienced personnel enable us to maintain the highest levels of product quality.

### ACCENT ON QUALITY AND RELIABILITY

With more than 80 years of experience providing highly reliable products and services to the petroleum industry, Schlumberger knows what it takes to sustain consistently high levels of quality. Safety systems are perhaps the most regulated component in the oil and gas industry and must satisfy strict design and quality requirements set forth by the American Petroleum Institute (API) and the International Standards Organization (ISO).

Subsurface safety and injection valves must provide reliable control when emergency conditions arise and when conditions such as deep water, high pressures, high temperatures, and corrosive environments increase risk. Reliable control is achieved through stringent engineering design and extensive verification test standards developed over

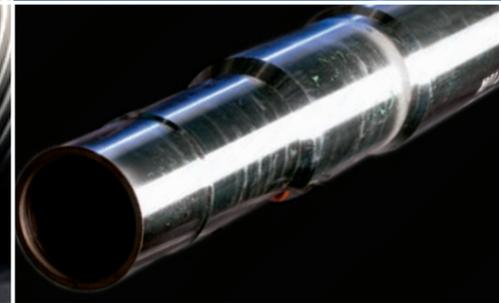
many years. The reliability of Schlumberger valves provides consistent performance in managing well production in both daily operation and catastrophic events.

### Enhancing design

Depth of knowledge and cumulative years of experience have allowed Schlumberger experts to develop safety valve designs that are highly reliable yet functional and uncomplicated. Advances in materials science, coupled with superior quality assurance, have also improved the reliability of our safety valve systems. Design of the most reliable elements has been based on a thorough understanding of critical operating elements, the actuating system (hydraulic piston) and the closure mechanism (flapper).



Designed to weather any challenge



Work on subsea wells is a costly and hazardous process.

Crucial to efficiency and safety are the successful

installation, dependable operation, and long-term reliability

of subsurface safety and injection valves.

#### SCHLUMBERGER SAFETY VALVES

Safety valves, an integral part of well completions, protect offshore and land production installations. Schlumberger surface-controlled subsurface safety valves use the innovative rod piston hydraulic-actuation system developed by Schlumberger. All series contain a rugged, metal-to-metal InconeI® flapper closure mechanism plus secondary soft seal. Schlumberger offers six main safety valve styles, ranging from basic to the most high-tech design available in the industry.

#### TRC-II Series

TRC-II\* series tubing-retrievable safety valves incorporate the best laboratory and field-proven technologies. They contain a minimum of critical, dynamic, and static seals. Patented gas-powered actuators with disconnect rod pistons allow reduced operating pressures for depths exceeding 3,658 m [12,000 ft], so the valves can be positioned below hydrate- or paraffin-deposit regions to increase operating efficiency. Two redundant hydraulic control systems are insensitive to production tubing pressure and operate at pressures much lower than those required by conventional valves.

#### Pinnacle series

Pinnacle\* tubing-retrievable safety valves are designed for ultrahigh pressures and severely corrosive environments up to 204.4 degC [400 degF]. They use an enhanced premium piston sealing system incorporating reliable metal-to-metal dynamic seals with spring-energized, filled Teflon® sealing elements, static up and down stops, and a precision piston tube. They have a compact flow tube nose seal to minimize the intrusion of debris into the flapper and power spring systems.



### Subsurface and Injection Valve Applications

Series	Standard Service	Deep Water	Ultradeep Water	Big Bore	HPHT <sup>†</sup>	Cement Through	Injection
TRC II			●		●		
Pinnacle					●		
SlimTech	●	●		●			●
TRMAXX	●	●				●	●
Reliance	●						
Recovery	●						
INtegrity							●
A							●

<sup>†</sup> High-pressure, high-temperature

#### SlimTech series

SlimTech\* reduced-OD tubing-retrievable safety valves are designed with a premium curved-flapper closure mechanism, allowing a fully optimized geometry—a large inner diameter with reduced outer diameter. These valves have a minimum of critical, static, and dynamic seals to ensure maximum reliability. They use a premium hydraulic piston sealing system with static open/close sealing. This series is available with or without the flapper-mounted equalizing system.

#### TRMAXX series

TRMAXX\* tubing-retrievable safety valves are designed with a rugged flapper closure mechanism and a minimum of critical, static, and dynamic seals to ensure maximum reliability. They use a premium hydraulic piston sealing system with static open/close sealing. This series is available with or without the flapper-mounted equalizing system.

#### Reliance series

Reliance\* cost-effective utility safety valves were created to fit simple applications and operating environments. Their design is similar to that of the TRMAXX valve except for the single rod piston and standard hydraulic piston sealing system with Viton® sealing elements.

#### Recovery series

Recovery\* slickline-retrievable safety valves provide industry-leading reliability and high value. These valves maximize long-term performance and reduce potential leak paths. They are available in a range of sizes and are designed to accept any manufacturer's lock assemblies for convenient use as a secondary insert safety valve. The valves can also be used as primary protection in applications requiring a slickline-retrievable installation. This series is available with or without the flapper-mounted equalizing system.

## Consistently high levels of quality



### SCHLUMBERGER INJECTION VALVES

Unlike surface-controlled safety valves, subsurface-controlled injection valves require no hydraulic control line to operate; they open under injection flow. They are designed to prevent flowback or blowouts in the event surface safety systems malfunction or become damaged. Schlumberger injection valves open at predetermined injection flow rates and can be set at unlimited depths. They are available with working pressures of up to 68.96 MPa [10,000 psi]. With proper material choices, they are suitable for severely corrosive environments.

### **INtegrity series**

INtegrity\* injection valves are tubing retrievable, engineered to allow a larger inner diameter and thus increased injection flow rates than conventional injection valves, up to 70,000 bbl/d. These valves have only two body joints, to ensure maximum reliability, and use proprietary Cam-P\* premium threads to achieve a reliable metal-to-metal seal. They have a rugged, metal-to-metal sealing flapper-closure mechanism and secondary soft seal. These versatile valves allow easy slickline replacement of the choke orifice when the injection flow rates are changed.

### **A series**

A series slickline-retrievable injection valves have a minimum number of critical, static, and dynamic seals to ensure maximum reliability. These valves accept any manufacturer's lock assemblies and are available in a range of sizes and chokes for multiple injection flow rates.

# Trustworthy, long-lasting operation in hostile environments

## INNOVATION AND SUCCESS

Since 1946, Schlumberger subsurface production and control equipment has represented innovation, quality, and reliability. In challenging subsea environments especially, well intervention is increasingly complex, hazardous, and costly. The importance of reliable safety and injection valves is enormous. Through extensive research, development, and field experience, we have consistently responded successfully to the challenges of these environments, including extremes in setting depths, temperature, pressure, and corrosion. These past successes are key to innovations for the future.

### Backflow prevention in deep water offshore Africa and Brazil

Two operators of wells in deep waters off South America and West Africa needed to maximize injection flow rates to maintain reservoir pressures. The South American project consisted of horizontal production wells with vertical water injection wells. The wells were to be individually tied back to a floating production, storage, and offloading vessel (FPSO). Plans for one of the West African fields called for 22 producing wells, 20 water-injection wells, and 2 gas-injection wells, all tied back to an FPSO. A second West African project included 2 rigs, 11 producer wells, and 7 injector wells, tied back to the largest FPSO of its type in the world.

The two companies had both found the limited water injection flow through the inner diameter of traditional through-tubing-installed valves too inefficient and costly. They chose the INtegrity valve for their deepwater injection applications because of its larger inner diameter

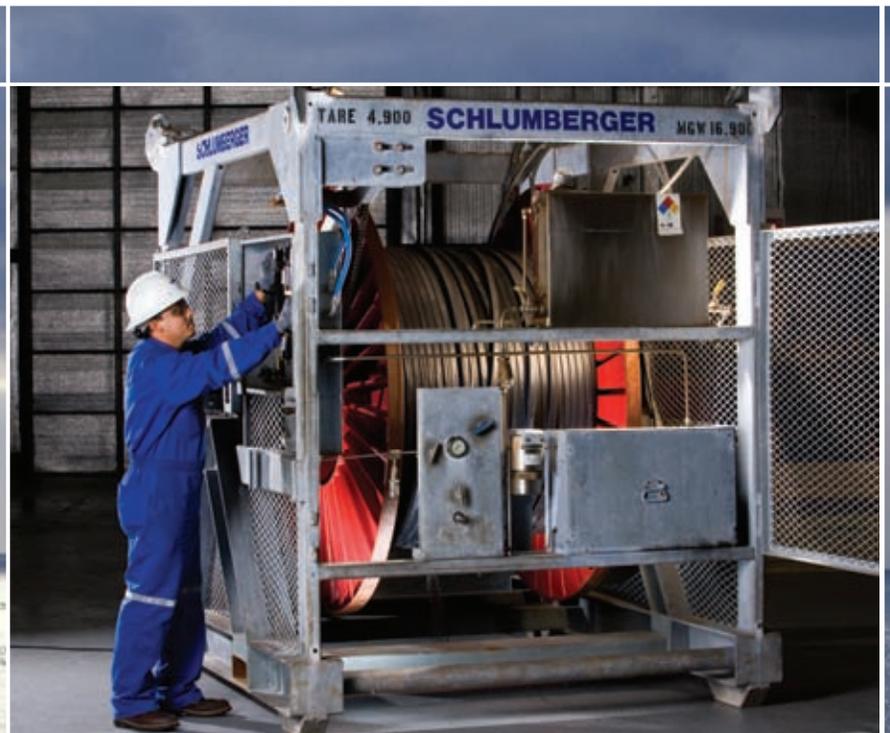
and its reputation for reliability and cost-effectiveness. To date, they have acquired 20 INtegrity injection valves, with each meeting company goals for reservoir and environment protection, and have ordered 13 additional valves.

### Long-lasting protection in record-deep Gulf of Mexico waters

In the ultradeepwater Gulf of Mexico, the development of a field required installing a subsurface safety system at 12,500 ft [3,810 m], deeper than any previously installed. The system had to ensure environmental protection and be effective and cost efficient.

The operator selected TRC-II safety valves because of their highly successful track record in working pressures up to 10,000 psi [68.95 MPa]. The valves were installed at the record depth with no installation or operational problems. The valves' low-operating-pressure design allowed fullbore access and maximum flow rates with the security of a proven emergency well shut-in system.

To date, not one of the nearly 500 TRC series valves installed in multiple completions across the world has mechanically failed after initial installation. Very satisfied with the protection provided, the company plans to use these valves in its other deepwater Gulf of Mexico wells.



# Subsurface Safety and Injection Valves



As the search for hydrocarbons continues into ultradeep waters and other challenging environments, Schlumberger remains strongly committed to helping you protect your investment. Our safety valves provide the security that you need.

## Schlumberger Safety and Injection Valves

- TRC-II series
- Pinnacle series
- SlimTech series
- TRMAXX series
- Reliance series
- Recovery series
- INtegrity series
- A series

[www.slb.com/completions](http://www.slb.com/completions)