Thirty Years Plus of Leadership and Innovation in Subsea Valves

PetrolValves has been a leader in the manufacture of Subsea valves since the early 1970s, with our earliest installations in the North Sea. Today, the Company’s valves and actuators are installed in over 90% of all North Sea Subsea pipelines and production modules. This is a testament to the level of confidence that major end users and engineering contractors have in PetrolValves. These pioneers of Subsea technology have come to depend on PetrolValves’ diverse expertise and capabilities.

As line pressures continue to rise in the North Sea, Caspian Sea, Gulf of Mexico, offshore South America, Asia and Australia, in many cases to over API Class 10,000, and the water depths extend beyond 10,000 ft/3000 meters, PetrolValves continues to meet increasingly demanding design and operational requirements with Ball, Slab Gate, Double Expanding Gate and Check Valves that provide system reliability and a customized solution for each unique operational objective.

PetrolValves focuses on designing and manufacturing tailor-made project specific valves, with design options that include: tungsten carbide overlay, metal-metal seating, duplex trim, CRA overlays, special sealing technology, project specific bores, and valve bodies designed for Ultra-Deep water depths.

In order to provide complete package solutions, PetrolValves designs and manufactures an extensive line of Subsea Actuators, ROV and manual gearboxes that offer a single supply source for the entire scope of the project. Single and double acting linear Actuators are available for Gate Valves and single and double acting patented helical spline (space saving), scotch yoke and rack and pinion Actuators are available for Ball Valves.

Additional options such as Diver and ROV retrievable gearboxes, actuators and pressure caps further extend the flexibility and sophistication of our design options allowing us to meet the most demanding and complex requirements.

Specialized testing capabilities ensure specific project performance integrity, including in-house hyperbaric chamber, bending, API 6A PR2, PSL 3 & 4 and API 17D. Additionally, PetrolValves can confirm through FEA the Valve design for Subsea service at any depth, or the complete FEA of the Valve combined with the pipe string assembly during Subsea deployment, to ensure successful installation.
TYPICAL SUBSEA VALVES CONFIGURATION OPTIONS

BALL VALVES
Top Entry, Side Entry, Welded Body, Double Isolation
• Construction: Carbon Steel / 22/25%Cr Duplex
  Inconel 625 / 718 / 725
• Internal CRA Overlays
• Metal Seating - TCC (Tungsten Carbide Coating)
• Stem TCC for extended Operating Life
• Infinity (patented) metal stem seal
• Thermoplastic seat seals (OD seat ring)
• Environmental seal
• Custom internal bore
• Flexibility in providing double or single piston effect seat designs, or combination
• API and ANSI Classes

SLAB GATE VALVES
Normal Acting, Reverse Acting
• Construction: Carbon Steel / 22/25%Cr Duplex
  Inconel 625 / 718 / 725
• Internal CRA Overlays
• Metal Seating primary option
• Metal Seating - TCC (Tungsten Carbide Coating)
• Infinity (patented) metal stem seal
• Stem TCC for extended operating life
• Custom internal bore
• API and ANSI Classes

DOUBLE EXPANDING GATE VALVES
Normal Acting, Reverse Acting
• Construction: Carbon Steel / 22/25%Cr Duplex
  Inconel 625 / 718 / 725
• Internal CRA Overlays
• Metal Seating
• Infinity (patented) metal stem seal
• Stem TCC for extended operating life
• Custom internal bore
• API and ANSI Classes

CHECK VALVES
Swing, Dual Plate, Nozzle/ Axial Flow
• Construction: Carbon Steel / 22/25%Cr Duplex
  Inconel 625 / 718 / 725
• Internal CRA Overlays
• Lock open via diver or ROV gearbox
• Custom internal bore
• API and ANSI Classes

INSERT VALVES

For any required option not listed, please consult PetrolValves – as we tailor the designs in full accordance with our client’s specifications.

Note: PetrolValves designs and manufactures Subsea Actuators – Diver or ROV, Gearbox or Hydraulic Actuation – single or double acting to provide a Complete Package, with Single Source Responsibility. Project Documentation/NDE/FAT: tailored to meet Client Specifications.
BODY MATERIAL SELECTION

Subsea valves are exposed to simultaneous aggression from the external environment and the process fluid. In addition, during deployment of the equipment, the internal parts become normally contaminated by seawater with evident implications in terms of corrosion. While external corrosion can be prevented with adequate painting processes and cathodic protection, internal corrosion can be prevented through optional constructions:

A) **Body manufactured in solid Corrosion Resistant Alloy (CRA)**

This solution is highly reliable corrosion wise but:

- the cost of large valve bodies is high
- large size high pressure valve bodies require high wall thickness that may not be commercially available, nor viable in some materials (i.e. 25 % Cr SDuplex with wall thickness in excess of 150 mm.)

B) **Body manufactured in Carbon or Low Alloy Steel**, either forged (A694 F60/65, AISI 4130, AISI 8630, A508 Grade 3, ...) or cast (A352 LCC), where all internal wetted surfaces are protected with Inconel 625 welding overlay (1/8” min. thickness).

This solution provides:

- corrosion resistance equivalent to the solid CRA
- no manufacturing problems with high wall thickness components in CS material
- full compatibility with CS pipes

**Body manufactured as per above case (B) with the extension of Inconel welding overlay limited to critical areas**, i.e.: body seat pockets, area in contact with stem seal, bonnet gasket area. This solution is applicable with mild process fluids (treated gas, sweet gas)
TRIM MATERIAL SELECTION

Closure Element (Ball/Gate Component)
The closure element is normally manufactured in solid CRA (22% Cr Duplex, 25% Cr Super Duplex, Inconel 625, Inconel 718 or Inconel 725). The surface is Tungsten Carbide (TC) Coated, ground and lapped to 0.2 microns Ra maximum. Manufacturing of large balls/gates in solid CRA may become critical due to excessive wall thickness of raw component. To fully guarantee the soundness of the component, the ball / gate is then manufactured in high-strength Carbon or Low Alloy Steel (typically: A694 F60) fully clad on all wetted areas with Inconel 625 (1/8” min. welding overlay). TC coating is provided on top of 625 welding overlay.

Seat Rings
The seat rings are manufactured in high strength CRA which provides flexibility and avoids permanent distortions. Typically seat rings are manufactured in: 22% Cr Duplex, 25% Cr SDuplex or Inconel 625/718/725. 25% Cr SDuplex or Inconel 718/725 are mandatory for pressure exceeding 450 barg (6525 psi). TCC is provided on Metal-Seal area. TC surfaces are ground and lapped to Ra < 0.2 microns

Stem
The Stem is manufactured with materials combining high mechanical strength and corrosion resistance. Typically 25% Cr SDuplex or Inconel 718/725 are provided. For severe/abrasive duties the stem portion interfacing the stem seal is TC coated. All small components, i.e.: bushings, spring holders, trust/radial bearings, are manufactured in CRA materials in accordance with requirements.
TOP ENTRY BALL VALVES

MAIN FEATURES

• PetrolValves top entry valve is trunnion mounted, full or reduced bore, metal seated
• The Valve and all components, including gaskets and double stem support, are designed and manufactured by PetrolValves for deepwater Subsea installation & operation.
• The valve internal profile is shaped to minimize turbulence and to avoid any potential obstacle for the passage of pigs.
• The valve body is designed to safely accommodate all predicable loads, including line pipe reactions.
• Seat & ball flexibility/rigidity designed to accommodate mutual displacements
• Metal-to-metal, bi-directional body seal as standard
• Large variety of stem seals available, including Infinity© metal stem seal (PetrolValves patent)
• Redundancy of sealing functions is available to improve seal reliability
• Both Self-Relieving (SPE) and Double Piston Effect (DPE) seat designs and combinations of SPE & DPE are available
SIDE ENTRY BALL VALVES

MAIN FEATURES

• The valve is a Split Body, trunnion mounted, metal seated, suitable for Subsea installation

• The Valve and all components, including gaskets and double stem support, are designed and manufactured by PetrolValves for deepwater Subsea installation & operation

• Valve body, including the flange bolting, are designed to withstand full operating pressure and pipe reactions (moments and forces)

• The valve internal profile is properly shaped to minimize turbulence (that may cause local wear and erosion) and to avoid any potential obstacle for the passage of pigs

• All critical gaskets are PetrolValves design

• Seat & ball flexibility/rigidity designed to accommodate mutual displacements

• Metal-to-metal, bi-directional body seal as standard

• Large variety of stem seals available, including Infinity© metal stem seal (PetrolValves patent)

• Redundancy of sealing functions is available to improve seal reliability

• Both Self-Relieving (SPE) and Double Piston Effect (DPE) seat designs and combinations of SPE and DPE are available
SubSea Ball Valves – in API & ANSI Classes

DOUBLE ISOLATION BALL VALVES

MAIN FEATURES

- PetrolValves top entry double isolation valve is trunnion mounted, full or reduced bore, metal seated
- Both Top-Entry and End-Entry design are available
- The valve is designed for deepwater subsea installation & operation
- All valve components, including gaskets and double stem support, are designed and manufactured by PetrolValves for the specific deepwater service
- The valve internal profile is shaped to minimize turbulence and to avoid any potential obstacle for the passage of pigs
- The valve body is designed to safely accommodate all predicable loads, including line pipe reactions
- Redundancy of sealing functions is available to improve seal reliability
HP METAL FLOATING BALL VALVES

MAIN FEATURES
- No internal valve part can become stuck: valve provides tight seal and full operability even with fluids that can solidify or crystallize
- Seat and ball sealing surfaces match perfectly, providing both low contact stresses and self-cleaning behaviour. This guarantees long operational life.
- Both Seat-to-Ball and Seat-to-Body seals are Metal-to-Metal: no soft part is included
- Superior resistance to abrasion and wear

HP metal seated ball are mandatory:
- When Process Fluid carries heavy solids
- When Process Fluid can solidify or even crystallize
- When combination of operating temperature and pressure is not compatible with use of any plastic compound
- When service includes severe temperature transients
SLAB GATE VALVES

MAIN FEATURES

• Metal-to-metal seat-to-gate seal
• Primary seat-to-body seal is metal-to-metal
• Large variety of stem seals available, including Infinity© metal stem seal (PetrolValves patent)
• Proven design for extreme deepwater installation.
• Slab & seat rings match on fully hard-faced surfaces
• Valve end connections may be provided with any type of flange (ANSI B16.5; API 6A; Norsok Compact), any type of Hub, or BW. Studded flanged connections are also available
SLAB GATE VALVES

- PetroValves Subsea Slab Gates are Top Entry Design.
- All Valves are fully bi-directional (unless required differently by client)

TWO VALVE DESIGNS ARE AVAILABLE:

Double Block & Bleed—Double Barrier

In case of failure of upstream seat, the pressure is still retained by the downstream seat

Downstream Seal

The pressure is retained by the downstream seat only. The body pressure assists the actuator stroke (stem ejection force)
DOUBLE EXPANDING GATE VALVES

Double Expanding Gate Valves seal via mechanical stem force, and achieve bubble-tight seal simultaneously and independently at both upstream and downstream seat. Thus the valve creates a true double barrier. This makes the performance of the Double Expanding Gate Valves absolutely unique: in fact a Double Expanding Gate valve can be employed in lieu of two traditional floating seat valves with evident advantages in terms of reliability, cost, weight and space.

The driving mechanism of the gate (cam) is designed to guarantee absolute bi-directional performance of the valve. Petrolvalves DEG permit cycling of the valve (both to close and to open) with fluid flowing in either direction and with pressure up to the maximum rating pressure of the valve.
DOUBLE EXPANDING GATE VALVES

MAIN FEATURES

• Fully metal-metal seal (both seat-body and seat-gate)
• Double block & bleed, double barrier
• Extremely highly reliable in severe service, including deepwater installations
• Large variety of stem seals available, including Infinity© metal stem seal (Petrolvalves patent)
• Flexible seat design guarantees low contact stresses for an extended cyclic life
• Valve may be operated either via ROV and/or via Subsea actuator (multi-turn or linear)
• Valve end connections may be provided with any type of flange (ANSI B16.5; API 6A; Norsok Compact), any type of Hub, or BW. Studded flanged connections are also available

Petrolvalves exclusive stem gaskets available: both thermoplastic and fully metal (Infinity©)

Petrolvalves exclusive “bi-directional” and “multiple barriers”. Body seals prevents possibility of leaks to environment

Extremely robust and reliable cam-mechanism guarantees sealing capability and full operability in any condition, regardless of pressure distribution (real bi-directional performances)

Petrolvalves exclusive flexible seat design guarantees:
• bubble tight seal
• low operating thrust
• extended cyclic life
PetrolValves Design Department can support Customers to select the ‘fit-for-purpose’ Check Valve type. Investigations involve use of CFD codes; simulations can be carried-out in both static and dynamic regime.

PetrolValves range of production of Subsea check valves includes:

- Dual Plates
- Swing Check
- Nozzle Check
SubSea Check Valves

SWING CHECK VALVES

MAIN FEATURES

• Standard seat seal: metal-to-metal
• Smooth transition of internal conduit for safe pigging operations
• Different designs available of clapper-locking mechanism
• Suitable for deepwater installation and operations
• Large variety of stem seals available, including Infinity© metal stem seal (PetrolValves patent)
INSERT VALVES

Subsea insert valves are designed to permit removal of valve insert by means of an ROV/ROTM.

Valve insert includes all critical parts of sealing members exposed to erosion or wear. In this way deepwater Subsea installations can be maintained to extend operational life.

PetrolValves manufacturing program includes following Subsea Insert Valve Design:

- Ball Valves
- Double Expanding Gates Valves
- Slab Gates Valves
- Swing Check Valves
- Choke Valves

Subsea Insert Ball Valve

NS 40”
204 barg design pressure
SubSea Insert Valves

INSERT VALVES
DOUBLE EXPANDING GATE

NS 40"
204 barg design pressure
**BODY DESIGN**

All predictable loads are accurately taken into account to evaluate the required valve body strength. Design tools and standard design methodologies are based on numerical simulations performed with the most updated FEA calculation codes.

**BALL AND SEAT DESIGN**

A sophisticated design process is used to evaluate the optimal (mutual) flexibility and stiffness of both ball and seat rings: design guarantees that the flexibility of seat ring can match the elastic deformation of ball.
CFD ANALYSIS

By means of CFD calculation, flow, pressure and fluid velocity can be evaluated. Erosion index and cavitation effect can be calculated and valve design optimized.
BODY BONNET SEAL

PetrolValves Subsea Body-Bonnet Seal system includes a metal-to-metal gasket that is exclusively PV design; this gasket is the result of years of experience gained with both factory test and field feedback.

Some additional (redundant) gaskets are included as options to fulfil requirements arising from different operating scenarios.

PRIMARY METAL-TO-METAL GASKET
This gasket is PetrolValves design and it is qualified up to 3000m water depth.

LEAK TEST PORT
Available upon request to check each individual body gasket

SECONDARY GASKET—PTFE LIP SEAL
Available upon request (redundant barrier)

ENVIRONMENTAL SEAL
Available upon request (redundant barrier)

Sophisticated numerical simulation (FEA) are performed to anticipate tightness of sealing system.

Simulation includes non-linear behaviour of the assembly made of body/bonnet flanges and bolts.
Subsea Stem Gasket

**DOUBLE BACK SEAT (SLAB GATES)**
Double Backseat provides primary metal stem seal in both open and closed position

**INFINITY® METAL SEAL (BALL, SLAB & DEGV)**
Infinity® stem seal has been qualified for rising stem valves according to API 6A - PR2 + Endurance (1200 cycles)

The metal stem seal is in series (redundant) to the standard thermoplastic packing

Inconel 718 Gasket (TCC on lips)

**TYPICAL STEM SEAL ARRANGEMENT**
(PetrolValves design & manufacture)

Environmental gasket

Redundant stem gaskets (Available upon request)

Double Thermoplastic gasket

Springs to recover gasket wear

Full Thermoplastic double—bidirectional stem seal

Subsea Stem Gaskets are proprietary PetrolValves design and manufacture.