

A large, complex offshore oil and gas platform is shown in the middle ground, featuring multiple levels with yellow railings, white storage tanks, and a tall red and white communication tower. The platform is situated in the dark blue ocean under a cloudy sky. In the foreground, a blue metal railing and a large, curved, ribbed metal structure, likely part of a ship's hull, are visible, framing the view of the platform.

Welding Solutions for Oil & Gas Upstream

voestalpine Böhler Welding
www.voestalpine.com/welding

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ONE STEP AHEAD.

voestalpine Böhler Welding

Metallurgical Expertise for Best Welding Results

voestalpine Böhler Welding (formerly Böhler Welding Group) is a leading manufacturer and worldwide supplier of filler metals for industrial welding and brazing applications. With more than 100 years of experience, the enterprise has decisively influenced the development of welding technology, setting the benchmark with its innovative solutions. The solidity is also reflected in the confidence of our employees who, as owners of the enterprise, hold a good portion of the shares.



As a part of the voestalpine Group, Austria's largest steel manufacturer and one of the world's leading suppliers of specialized steel products, we are a part of a global network of metallurgy experts.

Our customers benefit from:

- Comprehensive welding and steel know-how under one roof
- Coordinated complete solutions comprised of steel and welding filler metals
- A partner offering maximum economic stability and technological expertise

Customer first

Absolute customer focus is our guiding principle. We see ourselves as a provider of solutions to challenging welding projects. We ensure that our customers get the right filler metals, use them correctly, and that all welding process parameters are adjusted for the best possible performance. We consider it as our responsibility to guarantee that we deliver to our customers, now and in the future, the best possible solutions. We also strive to develop new products, optimize existing products, and streamline processes so as to achieve very short turnaround times.

Experienced and committed employees

We rely on committed employees who have been trained to the highest standards. It is their knowledge, skills, and personal commitment that ensure the long-term success of our company and its customers. In combination with our premium quality products, the individual technical support provided by our globally acting application technicians and specialist welding engineers empowers our customers to master even the most difficult and challenging welding tasks.



Three competencies – three brands

In our efforts to afford our customers the best possible support and promote development in line with specific targets, we have built our core competences within Joint Welding, Repair & Maintenance Welding and Soldering & Brazing. This way we offer our customers the largest and most comprehensive product portfolio of filler materials within our three brands:

- Böhler Welding
- UTP Maintenance
- Fontargen Brazing

Welding Solutions for demanding industries

We focus on industries with high technological standards and deliver products tailored to

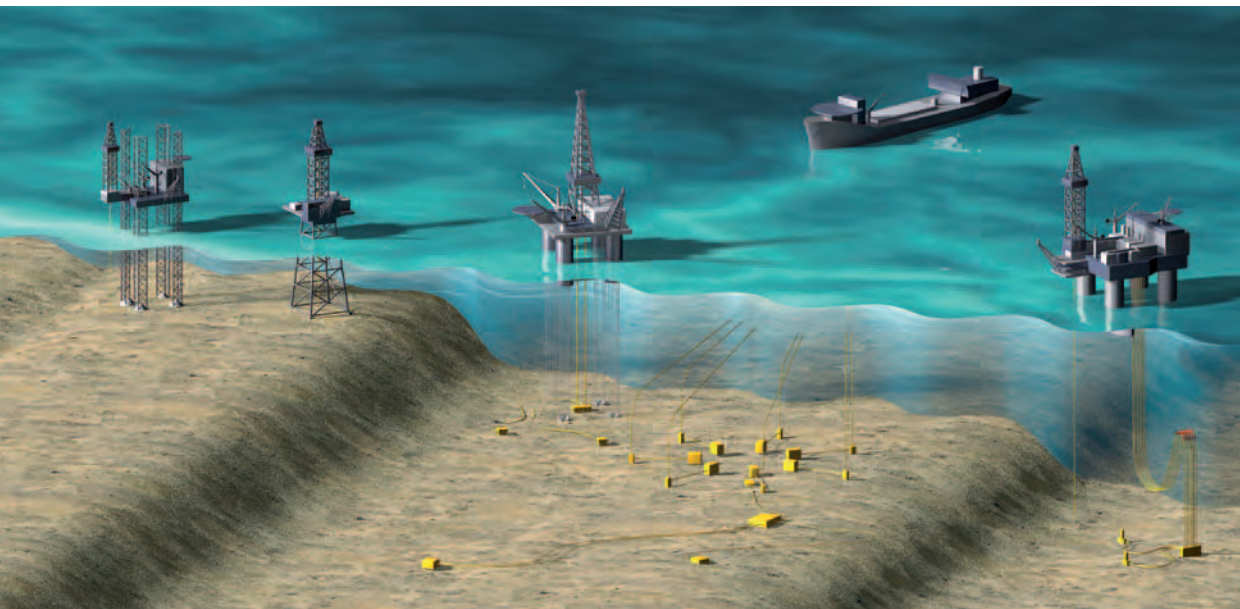
industry-specific requirements. In the development and optimization of filler materials, we collaborate closely with customers, manufacturers, and research institutes.

Whether destined for use in challenging scenarios or in standard applications – our high quality filler materials are ideally suited for all applications in the following industry sectors:

- Oil and Gas
- Pipeline
- Chemical
- Power Generation
- Transportation & Automotive
- Maintenance & Repair
- Brazing Industries

Our Industry competence comes from experienced people

Oil and gas play an important role in the future global energy supply model. However, the emergence of new and unconventional sources of oil and gas will change the landscape with regard to extraction and processing in many significant ways.



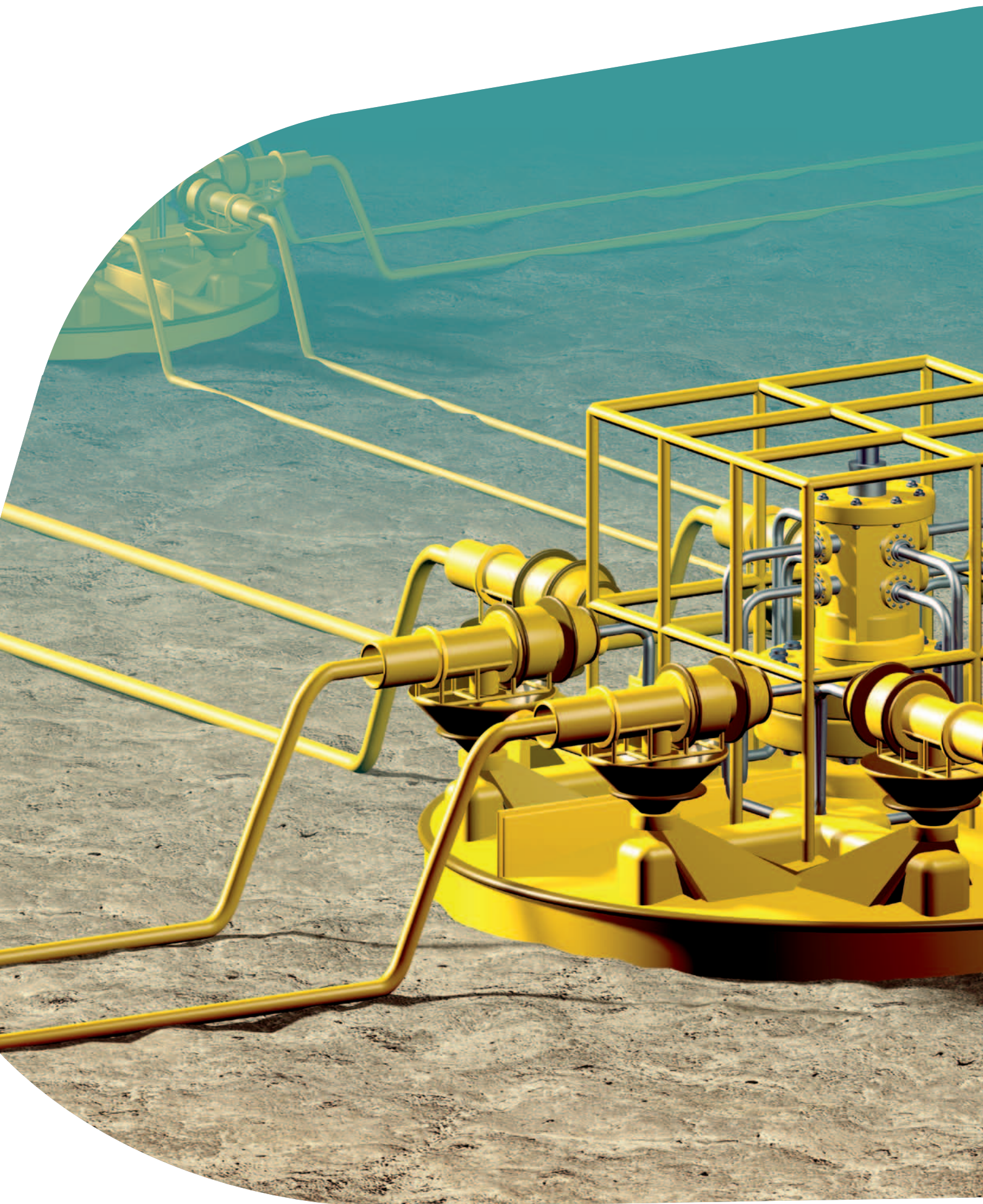
The Upstream Oil & Gas segment refers to the search for crude oil and natural gas, followed by their recovery and production. This segment is also referred to as the exploration and production (E&P) sector; it includes the search for potential underground or sub-sea oil and gas fields, the drilling of exploratory wells, and the subsequent drilling and operation of the wells that recover and bring the crude oil and/or raw natural gas to the surface.

The Downstream Oil & Gas segment refers to the processing and refining of the extracted crude oil and gas from both conventional and unconventional resources.

This segment is also referred to as hydrocarbon processing and includes refineries, natural gas processing plants, petrochemical processes (olefins and aromatics), as well as methanol plants.

voestalpine Böhler Welding Group provides high-quality welding-filler-based solutions for safe, efficient, and cost-effective operation of upstream, midstream, and downstream facilities and equipment to these segments worldwide.

These products are supplied by regional manufacturing, development, sales, and support units under a range of product brand names that are recognized worldwide.



Surface

Oil & Gas Upstream Surface Systems consist of the following. **Offshore:** Fixed or Floating Systems, constructed in dedicated fabrication sites, and shipyards. Utilized for exploration (drilling), production (extraction), processing and transportation of hydrocarbons and associated materials, connected to the sea bed, via S.U.R.F components. **Onshore:** Drilling packages, systems and surface well head components, the later using similar material combinations as noted in greater detail within the Sub Sea section of this document.

Jack-up Rig Overview

Hull: The hull of a jack-up unit is a watertight structure that supports equipment, systems, and human resources so as to enable operation of the unit. While afloat, the hull provides buoyancy and supports the weight of the legs, spud cans (footings), and topside equipment. These rigs operate in fixed locations with water of the order of 150 meters deep and drilling ranges in excess of 10,000 meters.

Legs and footings: Legs and footings are steel structures that support the hull when it is in elevated mode, providing stability and resistance to lateral loading. Spud cans (footings) are required to increase the load-bearing area, the legs being able to extend over 150 meters or to be retracted and remain wholly above the surface of the water while the structure is being towed.

Cantilever: A platform extension with drill floor and derrick that can facilitate connection to fixed platforms as part of a wider production system.

Summary of materials used for construction of main components:

Typical steel grades:

- **Hull:** girders and deck plate:
DIN StE355 (StE36) DIN T StE420 (TT StE43)
- **Cantilever:** DIN StE355 (StE36)
DIN T StE420 (TT StE43)
- **Legs:** ALDUR 700QL1, A514grade Q, A517grF, SUPERELSO 690SR, API x65
- **Spud cans (footings):** DIN StE355 (StE36)
DIN T StE420 (TT StE43)

Fixed and Floating Structures

Fixed platforms: These generally consist of fixed tubular structures made from steel plates, tubes, and pipes in a braced format with nodal interfaces, fixed to the seabed via piles and templates, and normally restricted to water depths of less than 100 meters. These constructions are used as the base for topside structures, facilitating accommodation, utilities, exploration, and production of oil & gas, often linked by subsea systems. The typical components and steel grades offered are as follows:

Jacket structure:

■ Piles, bracing, and tubular components:

Manufactured using a variety of diameters and thickness, depending on steel grade and design criteria

■ Nodes: Intersection of structural tubular components

■ Mud mats: Used to spread the load (weight) of the structure on the seabed, manufactured primarily of plate material

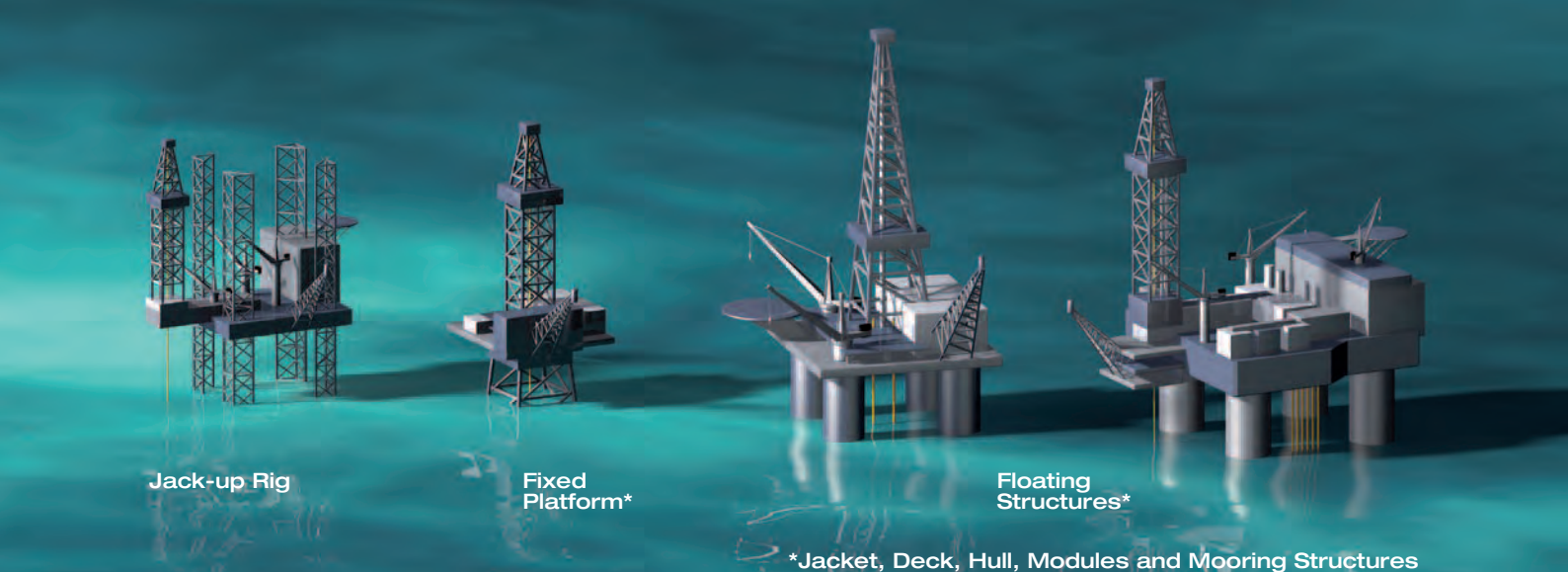
Typical steel grades: DIN StE355 (StE36)

DIN T StE420 (TT StE43) API 2Y Gr 50&60

Deck structure: The deck is the framework within which individual modules are contained, and is constructed from a combination of steel plate girders, structural tubular connections, and nodal interfaces. Typical steel grades employed include DIN StE355 (StE36) DIN T StE420 (TT StE43) API 2Y Gr 50&60, present in a wide range of thicknesses and diameters.

Topside and modules: Depending on the size and design of the platform, the topside (deck) will include a number of functional modules relating to utilities (power and water), accommodation, drilling/production, processing, and transportation (helideck).

Typical Material Grades: Used include Carbon Steel for structural strength, general and process pipework, Austenitic and Duplex Stainless Steels, Nickel and Copper Alloy pipework and components for high temperature, and corrosion resistant applications. DIN StE355 (StE36) DIN T StE420 (TT StE43) API 2Y Gr 50&60.



Floating Production Storage Offloading (FPSO) Floating LNG and Spar Systems

Floating systems are based on hull structures with ballast systems and are constructed using shipbuilding techniques, in some cases starting from a ship hull carcase or pontoon structure, designed individually to cover the needs of specific developments, including exploration (drilling) production (processing), storage, and offloading (to smaller transit tankers or via pipeline). These structures are linked to the seabed via SURF systems.

Hulls and pontoons: As described above for fixed platforms, but with greater emphasis on structural plate; stiffeners and girders being generally made of carbon or high-strength low-alloy steel grades as stated. As such, the range of welding fillers described above would be suitable for the construction of these floating systems.

Table 1: Typical Welding Consumable Combinations for Jack Up Rigs

SMAW	BÖHLER FOX EV 65 (E8018-G) BÖHLER FOX EV 70 (E9018-D1) Thermanit NiMo 100 (E10018-D2)
GTAW	BÖHLER DMO-IG (ER80S-G) Union I Ni 1 MoCr (ER100S-G)
FCAW	Union RV NiMoCr (E111T1-GJ H4)
SAW	Union S 2 Mo + UV 418 TT (F8A6-EA2-A2) Union S 3 NiMoCr + UV 420 TT (F11A6-EG-F6)

Table 2: Typical Welding Consumable Combinations for Jackets, Deck, Hull, Mooring Systems and Modules

SMAW	BÖHLER FOX EV 50 (E7016-1) BÖHLER FOX EV 60 (E8018-C3)
GTAW	BÖHLER EMK 6 (ER70S-6) BÖHLER Ni 1-IG (ER80S-Ni1)
FCAW	BÖHLER Ti 52-FD (E71T-1) BÖHLER Ti 60-FD (E81 T1-Ni1)
SAW	Union S 3 Si + UV 400 (F7A4-EM10K) Union S 2 Si + UV 418 TT (F7A6-EM12K) Union S 2 Ni 370 + UV 421 TT (F7A8-EG-G)

Topsides/modules: As described in the previous section (q.v.).

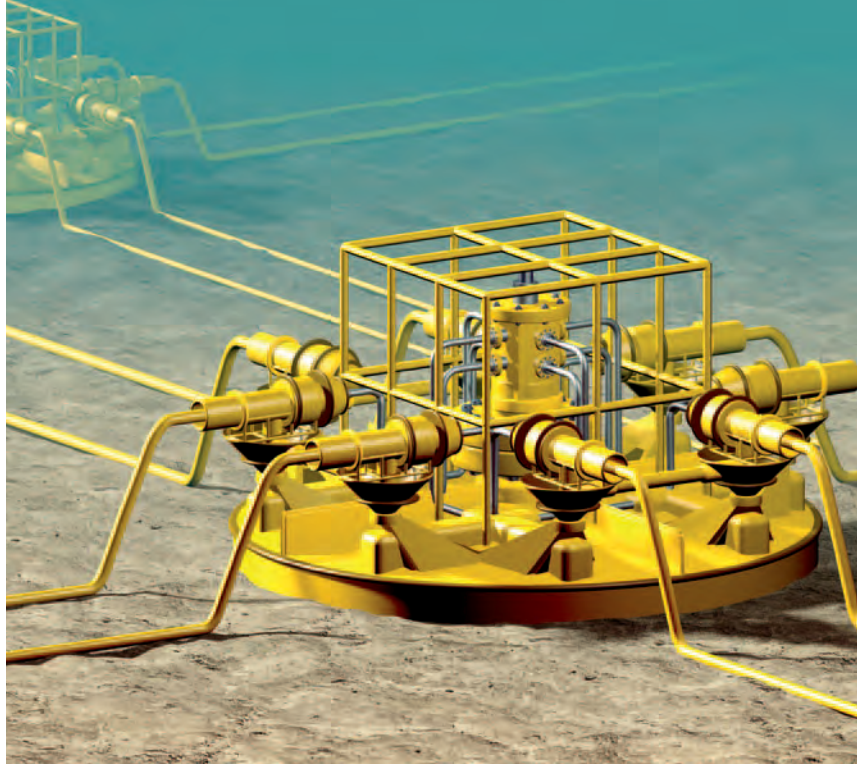
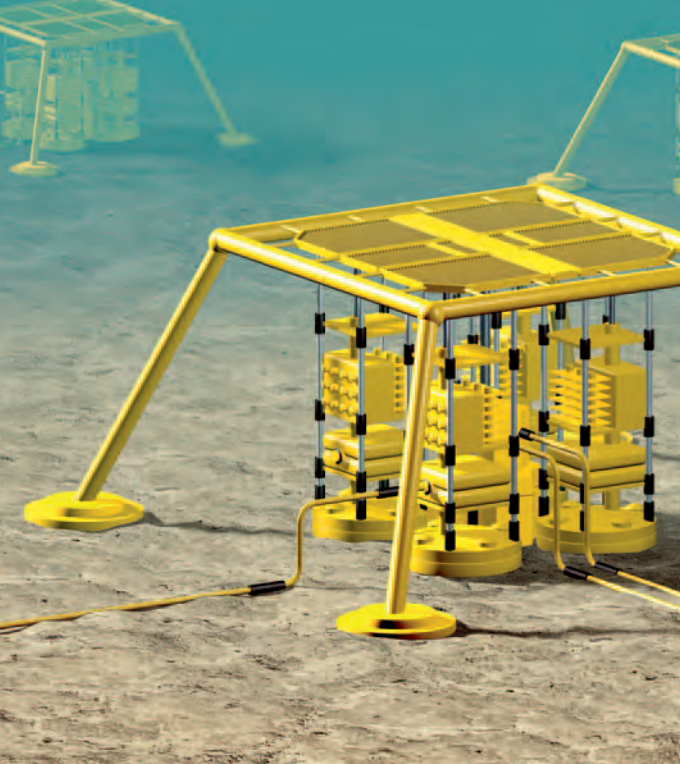
Mooring systems: A mooring system is made up of a mooring line, anchor, and connectors, and is used for maintaining the position of a ship or floating platform in all depths of water, via a mooring line connected to an anchor in the seabed.

Suction piles: These are the predominant mooring and foundation system used for deep-water development projects worldwide. Tubular piles are driven into the seabed and a pump then sucks water out from the top of the pile, so driving it further into the seabed. Material grades used in mooring systems are generally used in fixed jacket and component structures and are covered by the welding processes and fillers offered in the previous section.

Table 3: Typical Welding Consumable Combinations for Modules

Carbon Steel		see Table 2
Stainless Steel	SMAW	BÖHLER FOX EAS 4 M-A (E316L-17)
	GTAW	BÖHLER EAS 4 M-IG (ER316L)
	FCAW	BÖHLER EAS 4 PW-FD (ER316LT1-4)
	SAW	Thermanit GE-316L + Marathon 431 (ER316L)
Duplex Steel (22Cr and 25Cr)	SMAW	Avesta 2205 (ER 2209-17) Thermanit 25/09 CuT (E2595-15)
	GTAW	Avesta 2205 (ER 2209) Thermanit 25/09 CuT (ER 2594)
	SAW	Avesta 2205 + Avesta Flux 805 (ER 2209) Thermanit 25/09 CuT + Marathon 431 (ER 2594)
Nickel Alloys	SMAW	UTP 759 Kb (ENiCrMo13) UTP 6222 Mo (ENiCrMo3) UTP 776 Kb (ENiCrMo4)
	GTAW-GMAW	UTP A 759 (ENiCrMo13) UTP A 6222 Mo (ENiCrMo) UTP A 786 (ENiCrMo14)
	FCAW	UTP AF 6222 Mo PW (ENiCrMo3Ti-4)
	SAW	UTP A 6222 Mo-3 + UTP FLUX 504 (ENiCrMo3)
	SMAW	UTP 387 (ECuNi)
	GTAW	UTP A 387 (ERCuNi)
Copper Nickel		
Titanium	GTAW	UTP A 902 (ER Ti-2)
Cladding		UTP A 6222 Mo-3 (ENiCrMo3) GTAW/GMAW
		SOUDOTAPE 625 (EQNiCrMo3) Strip
		RECORD EST 201 RECORD EST 236

For a complete product range please refer to the inlet filler metals for Oil & Gas Upstream.



Subsurface

SURF Systems (Subsea Umbilical Riser and Flowline)

Regardless of which offshore upstream systems are used, they will all have a complete or partial SURF element as part of a wider extraction system from a fixed or floating system. This subsegment is seen as the fastest growing element of offshore upstream construction globally.

Subsea trees (Christmas trees): Used on offshore oil and gas fields, a subsea tree monitors and controls production from a subsea well. Fixed to the wellhead of a completed well, subsea trees can also manage fluids or gases injected into the well and control the flow. Subsea trees are used in offshore field developments worldwide, from shallow to ultradeep waters. The deepest subsea trees are installed in the waters off Brazil and in the US Gulf of Mexico, many of them rated for water depths of up to 3,500 meters. There are a number of types of subsea trees, rated for water depth, temperature, pressure, and flow.

Wellhead is the equipment at the surface of a well that is used to control the pressure at the point at which the hydrocarbons and water exit the ground.

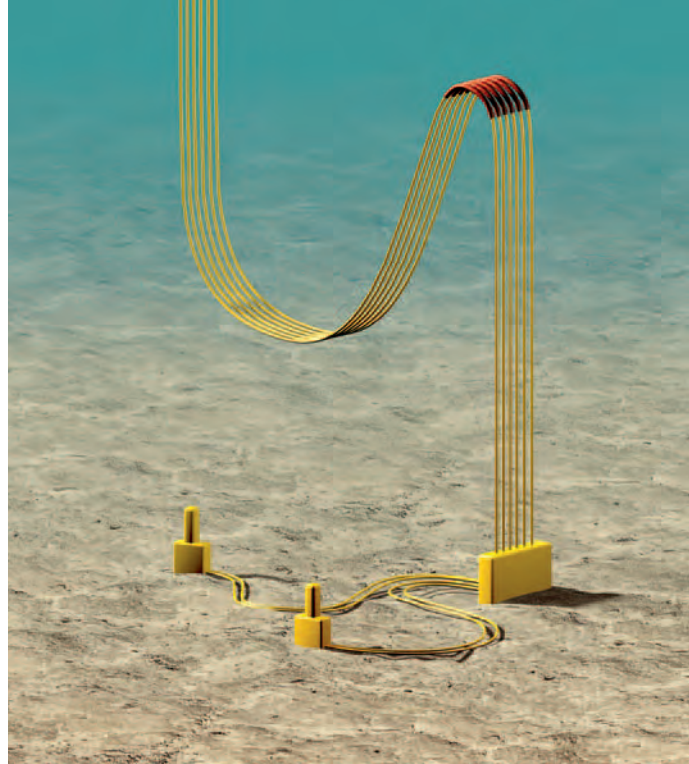
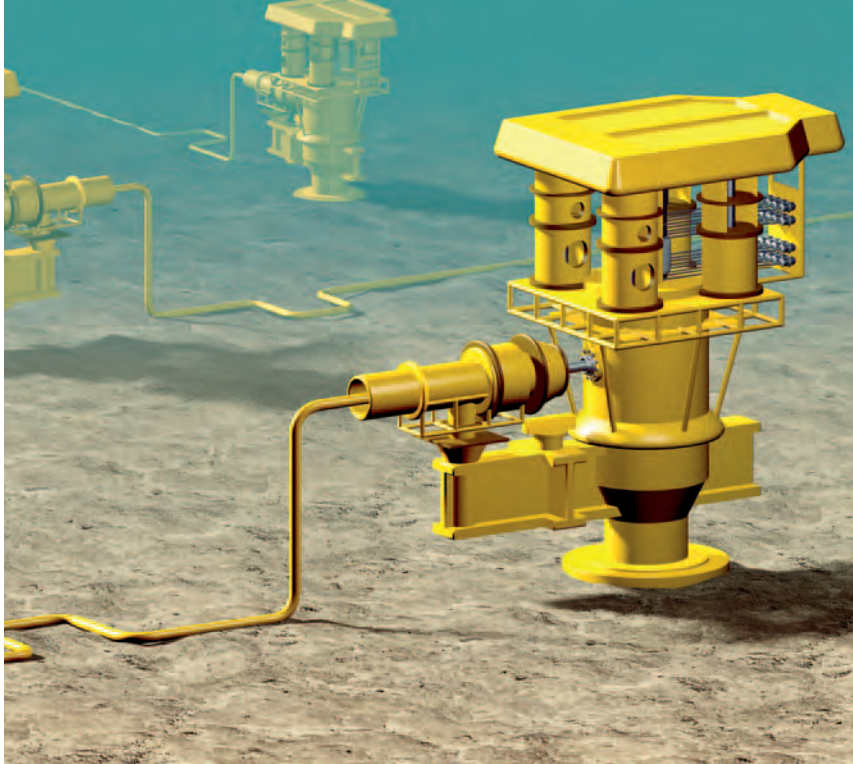
Blowout preventer (BOP) is the equipment installed at the wellhead to control pressure in the annular space between the casing and the drill pipe or tubing during drilling, completion, and workover operations. These are often an integral component of subsea trees.

Risers

Risers are conduits for the vertical transfer of materials from the seafloor to the production and drilling facility on the surface and from the facility to the seafloor. There are a number of types of risers, including attached risers, pull-tube risers, steel-catenary risers, top-tensioned risers, riser towers, plus flexible riser configurations and drilling risers.

In the same way as pipelines or flowlines, risers (rigid or flexible) transport both the produced hydrocarbons and production materials such as injection fluids, control fluids, and gas lift. They are usually insulated to withstand seafloor temperatures and to maintain the viscosity of the hydrocarbon fluids they carry.

Whereas production and import/export risers transfer hydrocarbons and production materials during the production phase of the development, drilling risers transfer mud to the surface during drilling activities. Connected to the subsea BOP stack at the bottom and the rig at the top, drilling risers temporarily connect the wellbore to the surface to ensure that drilling fluids do not leak into the water.



Umbilicals

Umbilicals transfer power, chemicals, communications, and other input to and from subsea developments, and are the lifeline to subsea trees, manifolds, jumpers, sleds, and controls. As the connective medium between surface installations and subsea developments, umbilicals can also carry electrical, hydraulic, chemical-injection, and fiberoptic connections.

Subsea processing

With production equipment located on the seafloor rather than a fixed or floating platform, subsea processing provides a cost-effective solution for offshore environments.

Conceived to overcome the challenges of extreme deep-water situations, subsea processing has become a viable solution for fields located in harsh conditions where processing equipment on the water's surface might be at risk. Subsea processing is also an emergent application that can increase production from mature or marginal fields.

Typical Welding Consumable Combinations for S.U.R.F. Systems

Carbon Steel	SMAW	BÖHLER FOX EV PIPE (E7016-1) BÖHLER FOX EV 65 (E8018-G)
	GTAW	BÖHLER EMK 6 (ER70S-6) BÖHLER Ni 1-IG (ER80S-Ni1)
	FCAW	BÖHLER Ti 60-FD (E81 T1-Ni1)
	SAW	Union S 2 Ni 370 + UV 421 TT (F7A8-EG-G)
HSLA Steel	SMAW	BÖHLER Fox EV 70 (E9018-D1) Thermanit NiMo 100 (E10018-D2)
	GTAW	Union 1 Ni 1 MoCr (ER100SG)
	SAW	Union S 3 NiMo 1 + UV 420 TTR-C (F10AG-EG-F3)

Corrosion Resistant Alloys		
Duplex Steel (22Cr and 25Cr)	SMAW	Avesta 2205 (E2209-17) Thermanit 25/09 CuT (ER 2594)
	GTAW	Avesta 2205 (ER 2209) Thermanit 25/09 CUT (ER 2594)
	SAW	Avesta 2205 + AVESTA FLUX 805 (ER 2209) Thermanit 25/09 CuT + Marathon 431 (ER 2594)
Nickel Alloys	SMAW	UTP 759 Kb (ENiCrMo13) UTP 6222 Mo (ENiCrMo3) UTP 776 Kb (ENiCrMo4)
	GTAW-GMAW	UTP A 759 (ERNiCrMo13) UTP A 6222 Mo (ERNiCrMo3) UTP A 786 (ERNiCrMo14)
	FCAW	UTP A 6222 Mo PW (ENiCrMo3Ti-4)
	SAW	UTP A 6222 Mo-3 + UTP Flux 504 (ERNiCrMo3)
	Cladding	UTP A 6222 Mo-3 (ERNiCrMo3) GTAW/GMAW SOUDOTAPE 625 (EQNiCrMo3) Strip RECORD EST 201 RECORD EST 236

For a complete product range please refer to the inlet filler metals for Oil & Gas Upstream.

Typical Material grades

Used in the general fabrication and construction of SURF systems



Pipe material forging and fittings

- **Carbon and high-strength low-alloy steel grades:** APIx65/70 pipe EN 10208-2 grades L210 – L555MB, 4130/F22 AISI 8620 Mod. Structural components such as support and lifting frames, manifolds, well-heads, BOPs, connectors, and valve components, to secure the structural and mechanical strength of components.
- **Austenitic and martensitic stainless steels, 22Cr duplex and 25Cr super duplex:** UNS S31603, N08904, S41500, S31803/32205 S32760. Used in the manufacturing of heat exchangers, fire fighting systems, ballast water systems, desalination systems, process and service water systems, subsea pipework systems, pressure vessels, flowlines, riser tubes, manifold piping, christmas tree piping, and hydraulic lines.
- **Nickel Alloys:** Nickel chromium molybdenum alloys UNS N0 6625, N08825, N06059, N10276, utilized as alloy fittings, weld-cladding and joining of CRA weld-clad components, flowlines, and risers. Nickel-chromium-molybdenum and nickel-copper alloys are utilized for seawater, general aqueous corrosion, and high-temperature service applications.

Corrosion-resistant cladding materials:

Increasing use of carbon and high-strength low-alloy steel components, weld clad with corrosion-resistant alloys (stainless, nickel alloys), to combat the effects of high-temperature, high-pressure, and corrosive environments as a cost-effective engineering solution in deep-water developments. The underlying product range offers solutions for weld-cladding and joining CRA forgings, plates, pipes, and fittings associated with SURF system components.

Corrosion-resistant alloy weld-cladding solutions:

The underlying range of welding strips, fluxes and flux-cored consumables cover the weld-cladding of large surface areas associated with major components and vessels for upstream processing equipment. This equipment can be land-based, integrated into topside modules processing systems and, increasingly, on the seabed as part of a SURF system. Material grades include austenitic, super austenitic, 22Cr and 25Cr duplex stainless steels, nickel, copper and cobalt based alloys.

Roll-bonded CRA-clad plate joining using SAW/ESW high deposition rate welding processes:

The underlying examples are supplemented by additional products, details of which can be obtained directly from voestalpine Böhler Welding.

Cobalt-based FCAW cladding solution:

Others are available within the wider voestalpine Böhler Welding portfolio and information is available from regional organizations.

If the product list is missing, please contact us.

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voestalpine Böhler Welding

Welding know-how joins steel

Customers in over 120 countries join the expertise of voestalpine Böhler Welding. Focused on filler metals, voestalpine Böhler Welding offers extensive technical consultation and individual solutions for industrial welding and soldering applications. Customer proximity is guaranteed by 40 subsidiaries in 28 countries, with the support of 2,200 employees, and through more than 1,000 distribution partners worldwide. voestalpine Böhler Welding offers three specialized and dedicated brands to cater our customers' and partners' requirements.



Böhler Welding – More than 2,000 products for joint welding in all conventional arc welding processes are united in a product portfolio that is unique throughout the world. Creating lasting connections is the brand's philosophy in welding and between people.



UTP Maintenance – Decades of industry experience and application know-how in the areas of repair as well as wear and surface protection, combined with innovative and custom-tailored products, guarantee customers an increase in the productivity and protection of their components.



Fontargen Brazing – Through deep insight into processing methods and ways of application, Fontargen Brazing provides the best brazing and soldering solutions based on proven products with German technology. The expertise of this brand's application engineers has been formulated over many years of experience from countless application cases.

forwarded by:

Global Industry Segment Management
Oil & Gas Upstream

T. +44 121 5697718
welding.upstream@voestalpine.com