Subsea 7 is developing and implementing leading-edge pipeline welding technologies, including a diversity of linepipe materials, in order to satisfy evolving and increasing market demand, and also to meet progressively more stringent pipeline fabrication codes and operator specifications.

Since 2006, Subsea 7 has operated an in-house central technical authority for pipeline welding, NDT and field-joint coating in rigid pipelines globally. Underpinning this philosophy, Subsea 7 has recently made four important strategic investments in applied pipeline welding technology development:

- entering into a technical partnership with CRC-Evans Pipeline International, one of the world’s leading designers and manufacturers of automatic welding systems for pipeline construction
- committing to an extensive welding R&D programme to meet future industry demands
- opening in 2013 of a new expanded Global Pipeline Welding Development Centre
- combining all reel-lay, S-lay, J-lay welding, inspection and field joint coating capability within a single entity, namely the Pipeline Production Team (PPT).
First deployment of unique By-Pass Purge welding system

The Skuld project offshore pipe lay operation for Statoil offshore Norway using Seven Oceans presented the first opportunity to implement the Subsea 7 Aquasol By-Pass Purge system for execution of the offshore tie-in welds. Performance of these critical welds is made difficult by the ‘suck and blow’ conditions within the pipeline which cause difficulties in creating an inert purge atmosphere needed to ensure the soundness of the girth weld. The unique design feature of the By-Pass Purge includes a fully sealed enclosure to maintain the integrity of the purge gas together with a central vent which allows the draughts to pass through the pipeline without disturbing the internal purge gas. The entire system is made uniquely of fully water-soluble materials, which enables the system to be flushed out on completion, and its design and materials are sufficiently robust to withstand the rigours of offshore operations. This innovative system significantly increases the reliability of offshore welding operations with better assurance of weld quality and minimal risk of extended vessel time.

AUT system for Pipe-in-Pipe (PIP) swaged weld

In deepwater fields, one of the technical challenges is the pipeline insulation to ensure the flow assurance of the oil at 100°C to 150°C when the outside environment is between 0°C to 4°C. For this purpose Subsea 7 and ITP have developed high-performance PIP. At the end of double joints, the outer pipe is swaged down to its inner pipe and welded. The swage weld is a key point of the PIP integrity, so its quality is subject to special attention. Subsea 7, in collaboration with ApplusRTD, has developed an automatic ultrasonic testing (AUT) system to conduct 100% inspection. The swaged weld is inspected by a multi-UT-technique combining conventional pulse-echo, phased-array linear and sectorial scans and TOFD. The method allows a perfect mapping of the weld in order to determine if the level of imperfection is acceptable, thus ensuring the integrity of the high-performance PIP system.

Welding advances for clad/lined and solid CRA pipe

Subsea 7 continues to further develop and deploy its advanced Pulsed Gas Metal Arc Welding (PGMAW) technology for technically demanding linepipe materials including CRA clad/lined and solid CRA pipe. A key part of the welding solution is the use of the ‘Cold Metal Transfer’ (CMT) process for root welding. This is an advanced Gas Metal Arc Welding (GMAW) technique which allows the weld root to be deposited very precisely, with minimum heat input, giving good control of the root-bead quality and profile. These are essential features to maintain the corrosion performance of the pipeline. Assurance of the weld root quality is achieved by internal inspection using state-of-the-art camera and laser equipment. Following initial deployment for clad fabrication in the Vigra spoolbase in 2012, this welding solution has been utilised in Subsea 7’s Ubu spoolbase for riser fabrication in both clad and lined pipe for the Guará-Lula NE project in Brazil during 2013. To date, in excess of 120km clad/lined pipe has been successfully welded to high-quality standards using the advanced CMT/PGMAW solution.

2013 saw the first-time application of this advanced CMT/PGMAW solution for the fabrication of 13Cr linepipe. This enabled the use of conventional copper back-up shoes to be eliminated, resulting in a significant improvement in weld root corrosion performance. Continued successful deployment of the CMT/PGMAW solution is a testament to its reliability.

Welding qualification for reelable high-strength steels

Subsea 7 developed and qualified a mechanised girth weld procedure based on the CMT/PGMAW welding process. Procedure qualification was successfully performed in compliance with DNV OS-F101, including mechanical, fracture toughness and sour service testing.

There is increasing demand for pipeline installation, including SCRPs, in deeper water, coupled with a requirement for higher operating pressures and temperatures and the need to transport corrosive constituents. For such applications, the use of high-strength steel, Grade X80, offers significant benefits including a reduction in pipeline weight and savings in fabrication and installation costs.

Subsea 7, in collaboration with Vallourec, has performed a qualification programme for reelable X80 linepipe. Vallourec manufactured seamless X80 pipe of 323.9mm OD x 18mm WT pipe in accordance with DNV OS-F101, supplementary P requirements. Subsea 7 developed and qualified a mechanised girth weld procedure based on the CMT/PGMAW welding process. Procedure qualification was successfully performed in compliance with DNV OS-F101, including mechanical, fracture toughness and sour service testing.

In order to address the need to transport more corrosive constituents, BUTTING manufactured Alloy 625 and 316L mechanically lined or BuBi® pipe (323.9 x 17.5 + 3.0mm) using the X80 pipe supplied by Vallourec. Subsea 7 developed a novel girth welding procedure utilising internal welding of the CRA lining and external welding using conventional C-Mn filler wire. The latter facilitated the achievement of overcoming weld metal strength which is necessary for reelable pipe. Girth weld procedure qualification was successfully performed in accordance with DNV OS-F101 including a full-scale reeling trial.

The development of linepipe material and welding solutions for reelable high-strength carbon steel and CRA-lined pipe are considered to be key enablers for the exploitation of deepwater oil and gas reserves in the future.
Global Pipeline Welding Development Centre

2013 saw the completion in Glasgow, UK, of Subsea 7’s new Global Pipeline Welding Development Centre, managed by the company’s Pipeline Production Group (PPG). This new facility considerably enhances our capacity to provide leading-edge welding solutions for the full range of pipeline fabrication requirements.

The new centre incorporates 18 welding bays and supporting cutting and bevelling facilities to perform pipeline welding and testing for spoolbase welding and vessel tie-ins, as well as simulations for our S-lay and J-lay vessels.

The existing development centre has been re-configured to provide advanced NDT capabilities, including full pipe length radiographic testing facilities as well as dedicated R&D facilities. A major advantage of the new centre will be its capability to simulate the production firing line. This will allow PPG to perform realistic pre-production welding trials and operator training, which will facilitate the efficient transfer of technology to our fabrication sites worldwide.

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**MILESTONES**

2005  First J-lay welding using the GMAW process for high-fatigue performance clad steel catenary riser (SCR) in 10 and 12-inch dia pipe for Exxon Erha project, Nigeria.

2006/7  First reel-lay SCR system for Chevron’s Blind Faith, Gulf of Mexico, project. Welding of the 12km of 7-inch line was carried out using an in-house developed hot-wire GTAW mechanised welding system.


2008/9  First lazy-wave SCR system fabricated by Subsea 7 at its Ubu spoolbase, Brazil, and installed by reel-lay for Shell’s BC10 project.

2009/10  First reeled clad pipe fabrication for Subsea 7, for BP’s Skarv project, at Vriga. This included double-jointing, and the use of a camera and laser inspection of the root for the first time.

2010  First use of the Phased Array system for AUT inspection of carbon steel pipelines on Total’s K5CU project at Vigra spoolbase.

2010  First use of Real-Time Digital Radiography on the Apache Bacchus Bundled pipeline project at Wester fabrication site.

2011  First use of mechanised Cold Metal Transfer root-welding process on Dana’s Triton 10-inch pipeline, then lined with plastic pipe using the swagelining method. Weldlink® connectors were NDT’ed using Real-Time Digital Radiography.

2011  First use of Real-Time Digital Radiography on the Centrica Ensign project - the 2-inch pipeline scope at Vriga spoolbase.

2012  Deployment of Subsea 7 advanced CMT/PGMAW welding technology for clad pipe at Vriga.

2013  First-time use of CMT/PGMAW for fabrication of 13 Cr pipe.

2013  Opening of the Global Pipeline Welding Development Centre.

2013  Deployment of CMT/PGMAW welding solution for reelable risers in carbon steel, clad and lined pipe for Guará-Lula NE.

2013  J-lay installation of heavy PIP production lines for Total’s CLOV using the Seven Borealis.