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As FPSO vessels have increased in size and complexity, downtime has become more costly. The replacement of large diameter seals, vital to ensure the efficient operation of equipment, such as a swivel stack, usually requires the FPSO to return to port, stopping production. This results in costly downtime and increased CO₂ emissions from the journeys to port and back to the operation site. The ideal solution is for completion of any seal repairs or replacements offshore, in-situ, to speed up the process and minimize equipment downtime.

Trelleborg has taken a new approach to large diameter seal replacement. SealWelding is a complete in-situ service for seal replacement in high-risk environments that allows other equipment to operate throughout the replacement process to reduce the impact on production.



The ideal solution is for completion of any seal repairs or replacements on FPSO vessels to be completed offshore, in-situ, to speed up the process and minimize equipment downtime. (Source: Trelleborg Sealing Solutions)

Manufactured at a Trelleborg facility, replacement seals are taken onboard the FPSO ready for the welding process to begin. Seal welding is the basis for this process, modified and optimized to provide a specialized solution for working in the small spaces of a swivel stack in the high-risk environment on an FPSO.

High-performance process

Production of the seal is to the original specification, in its original material and diameter. A specially designed tool then precisely cuts the seal in one place, and the seal is packaged ready for transportation to the FPSO.

Before the seal is taken offshore, a small piece from the raw material billet is checked and tested, going through a defined sample welding process and then bent at the welding joint; the sample joint is inspected for cracks or surface marks that could affect use. If the sample joint passes all quality checks, the seal is approved for shipment.

Offshore, onboard the FPSO, the seal is installed around the equipment by highly trained personnel from Trelleborg's expert SealWelding team. Using a specialized ATEX zone 1 certified fully enclosed welding machine, the two ends of the seal are joined together seamlessly. The ends of the seal are installed in the weld head enclosure within the welding machine ready for sealing, and the machine is then pressurized. Fully enclosed welding allows other swivel stacks to continue production on the FPSO without safety hazards.



Trelleborg's SealWelding process is a complete in-situ service for seal replacement in high-risk environments that allows other equipment to operate throughout the replacement process to reduce the impact on production. (Source: Trelleborg Sealing Solutions)

Safety is paramount

A control cabinet ensures the smooth running of the process as well as monitoring and logging of all data. Run by a computer, a specially designed program controls the seal welding process to ensure the joint setup is precise.

After the welding process is complete, the seal, removed from the weld head enclosure, is checked thoroughly for anomalies or scratches that can cause leakage or seal failure. The seal is then polished to remove any differences in texture and compared with the original specification requirements, and computer logs and recorded data are checked to ensure the set parameters have been met. Once approved, the welded seal is installed back into the equipment and the hardware assembled, ready for use.

Qualification

Each welded seal must be strong with a weld strength of more than 80% of the original value of the unwelded material. Seals are tested to ensure they exceed the stated yield value to ASTM D4894 standards. A seal should never go beyond the yield value, as it will result in failure.

Welded seals are tested in several ways to check for fatigue or other potential issues; a static test up to 350 bar of pressure, a dynamic test with fluctuations in pressure from 0 to 20 to 70 bar of pressure, and a dynamic test with water and gas at 350 bar pressure. The seal must pass each of these tests before approval.

Equipment and procedures

The specialist welding machine used is ATEX Zone 1 Gas IIC Temperature T4 certified and fully enclosed to ensure welding can safely take place in any high-risk environment, including locations such as onboard an FPSO where methane gas can pose a potential risk. Internal cooling within the machine ensures the surface temperature of the equipment does not exceed +135 OC.

Operational procedures and protocols are in place to make sure that every seal welded using Trelleborg's SealWelding process completes in the same way and has the same high quality every time.

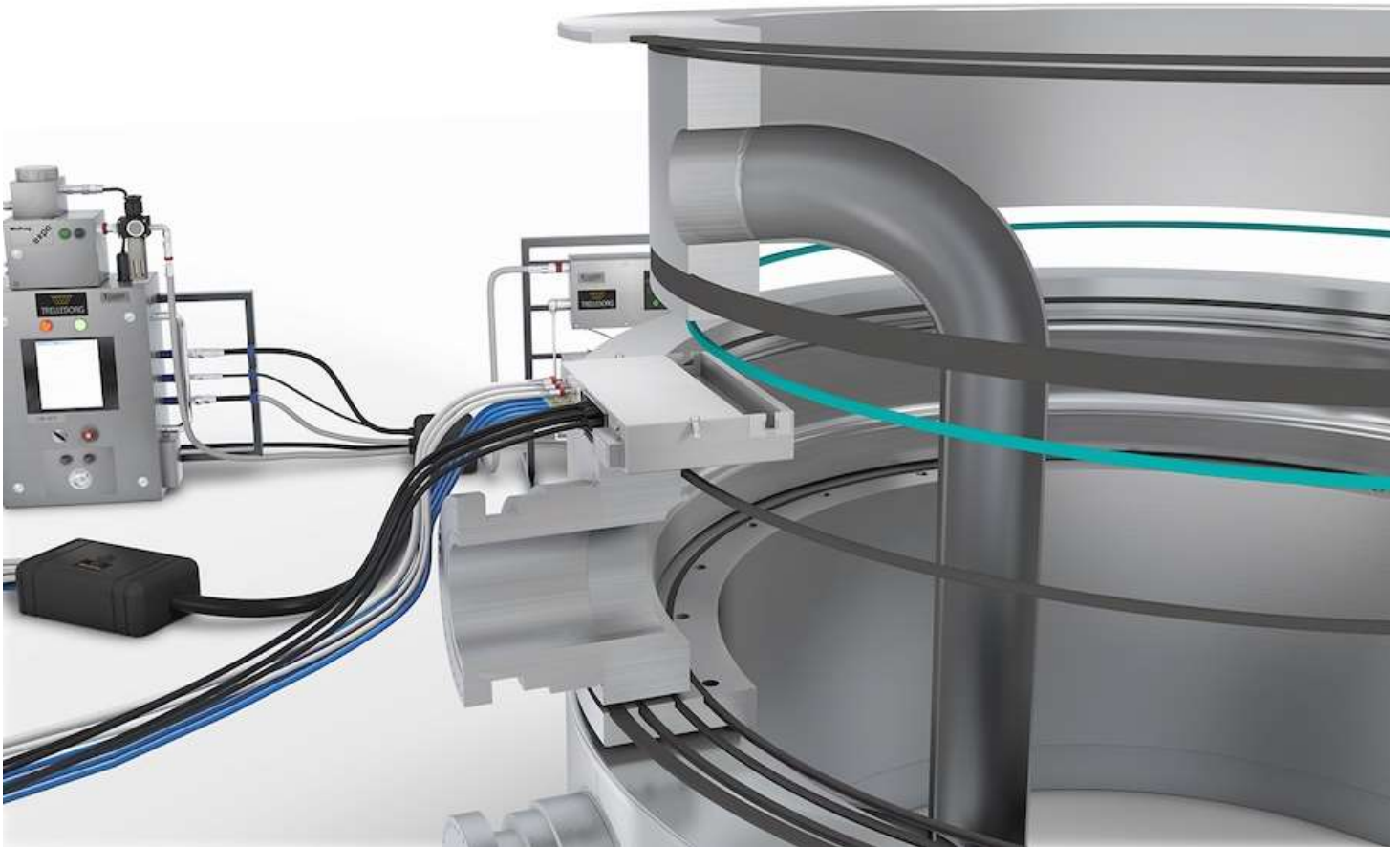
For training purposes, a test environment with a test swivel allows engineers to replicate the offshore environments they will experience, with the enclosed welding system and equipment evaluated to ensure engineers can work safely and efficiently. The test environment also allows identification of potential challenges, allowing changes to be made ahead of the installation.



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Three-phase approach

The seal welding process consists of three phases: a project plan, drawings and, most importantly, a site survey. The survey completed onboard the FPSO enables the engineers to validate the drawings and information and confirm details are as expected, reducing the risk of unexpected challenges during the installation.

Phase 2 of the process is building and validation of a customer-specific welding head tool. Each project has its own custom-designed and built tooling, with a specific seal profile and diameter. Tools are checked and tested in house to confirm consistency in welding of the seal against the key parameters and ensure the weld strength is above 80%.

Once testing and validation is complete, Trelleborg's SealWelding process onboard the FPSO can begin. It is common practice for spare seals to be welded and stored within a protective cable tray in-situ on the swivel stack, ready for instant installation should another seal fail. This reduces downtime for the operator and provides redundancy in the system. Spare seals can store for up to five years, providing a full inspection takes place before use to ensure no degradation has occurred.

Trelleborg's SealWelding technology has seen global success for more than eight years. There is no requirement for the FPSO to return to port, repairs can be carried out offshore to allow continued production and minimize costly equipment downtime.

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