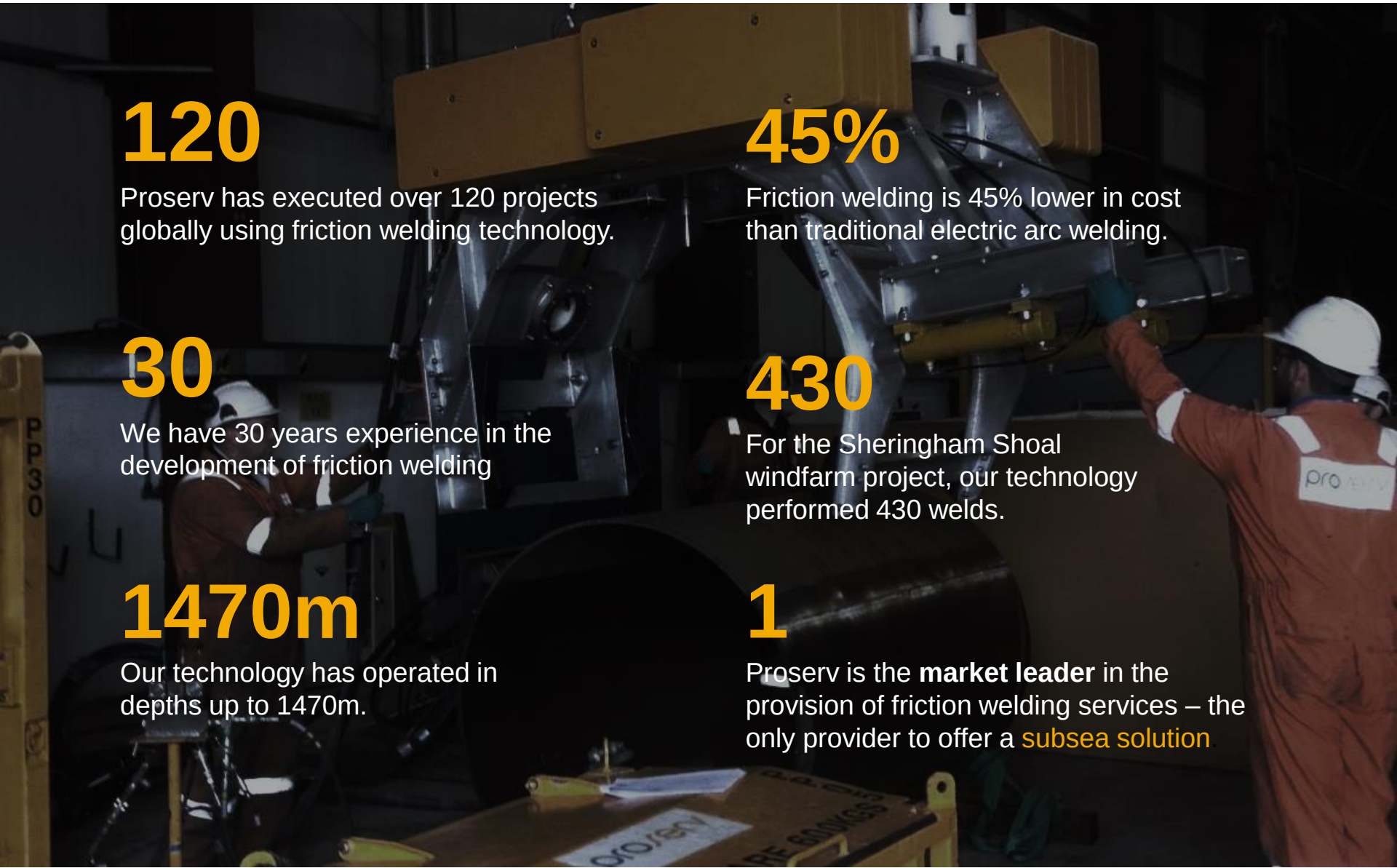
proserv

INGENIOUS SIMPLICITY

Friction Welding

Stephen Booth
Product Manager

Overview



120

Proserv has executed over 120 projects globally using friction welding technology.

45%

Friction welding is 45% lower in cost than traditional electric arc welding.

30

We have 30 years experience in the development of friction welding

430

For the Sheringham Shoal windfarm project, our technology performed 430 welds.

1470m

Our technology has operated in depths up to 1470m.

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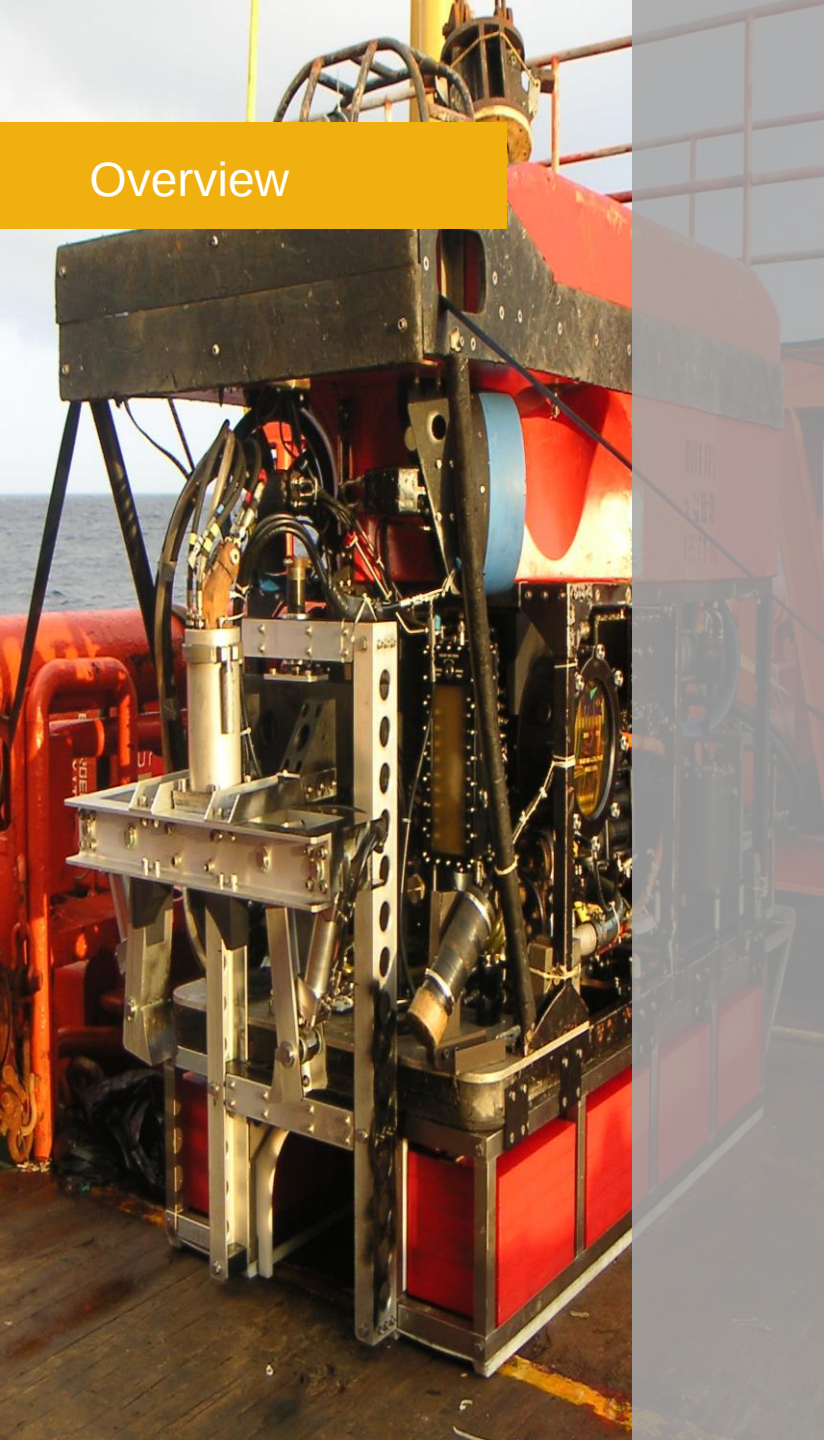
Proserv is the **market leader** in the provision of friction welding services – the only provider to offer a subsea solution.



Overview

Proserv is a global market-leader in the provision of friction welding technology solutions, a unique process for maintaining the integrity of assets in explosive atmospheres and subsea environments.

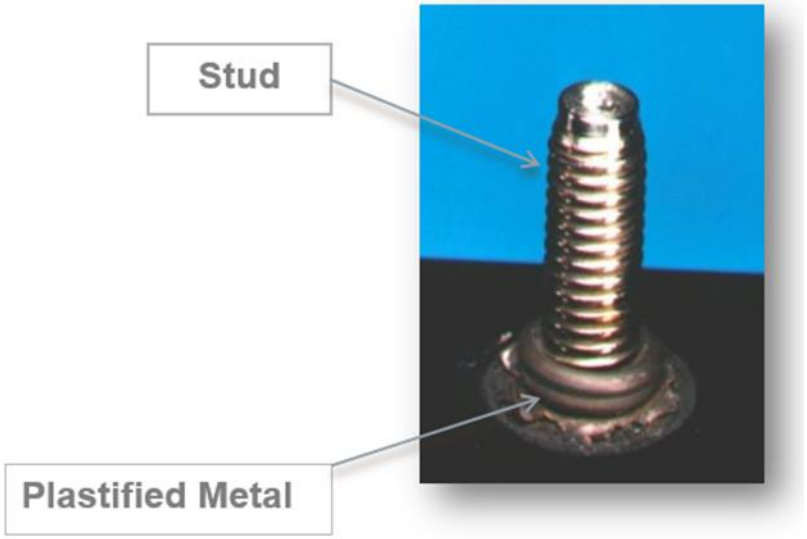
With a proven track record, and due to the significant cost and operational efficiencies it offers over more traditional methods, friction welding has become an essential part of many asset owners corrosion and integrity management programmes.

Friction Welding Process

What is Friction Welding?

Friction welding is a form of solid phase welding e.g. when a blacksmith puts two pieces of metal into a furnace, heats them up until they are glowing hot then places them together onto an anvil before striking them with a hammer

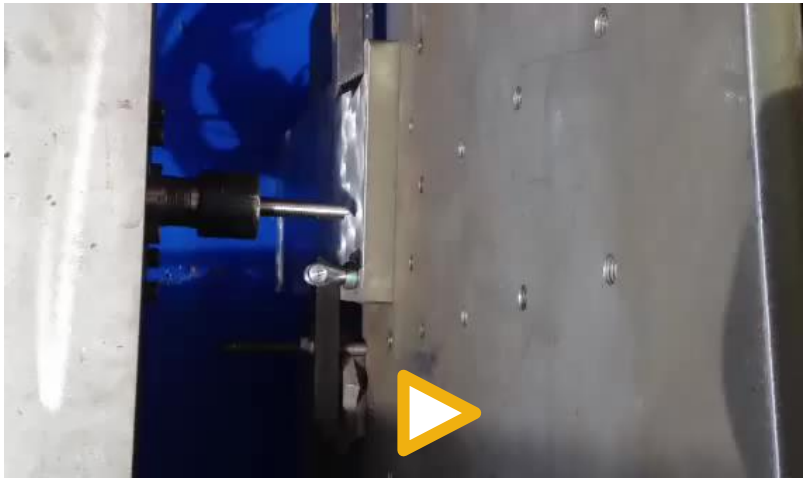
1. Rotate the stud at high speed
2. Apply pressure forcing the stud onto the substrate
3. Friction between the stud tip and the substrate causes the metal surfaces to heat and a thin layer of metal to flow plastically under pressure (without melting) to the periphery of the weld, removing impurities from the interface
4. The rotation is stopped and the pressure maintained for a few seconds to produce a solid phase forged weld with a fine grain structure



The Process

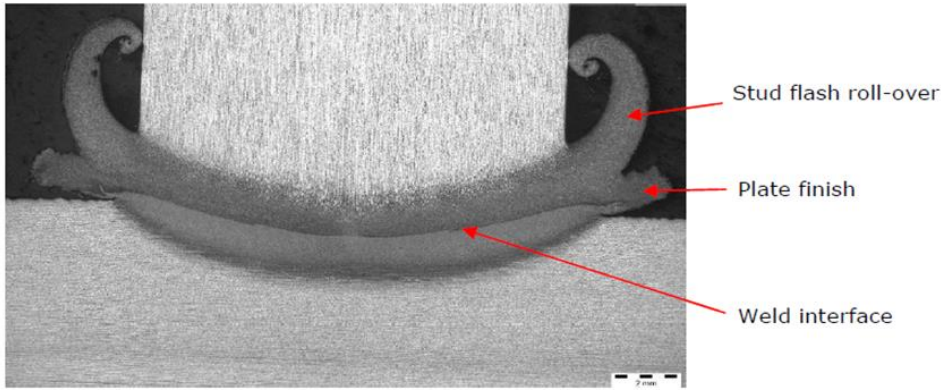
Friction welding is a solid-state welding process that has existed for over **60** years.

- Rotation of stud at optimal speed
- Apply pressure forcing the stud onto the substrate.
- Friction between the stud tip and the substrate causes the metal surfaces to heat and a thin layer of metal to flow plastically under pressure (without melting) to the periphery of the weld, removing impurities from the interface.
- The rotation is stopped and the pressure maintained for a few seconds to produce a solid phase forged weld with a fine grain



The Process

- Controlled welding parameters make it highly repeatable (topside and subsea)
- No mixing of stud and base material so dissimilar metals can be joined readily
- Residual stresses at the weld are compressive giving good fatigue strength
- No need to remove coatings
- Hydrogen is not evolved or absorbed (solid phase process with no liquid weld pool)
- Low resistance connection (>0.01ohm)
- Large surface area welded connection means high currents can be carried



A Macro section through a S355 stud friction welded to S355 plate

The Benefits

Efficiencies

- Significantly reduced installation costs compared to traditional welding
- Subsea stud changing allows multiple welds to be preformed without having to recover the ROV
- Good fatigue life properties due to compressive residual stresses

Integrity

- Minimal detrimental effect to the structural integrity of the parent material
- No stray currents therefore no risk of damage to electrical / electronic equipment

Flexibility & Application

- Hydraulic system provides a fully integratable solution for ROV delivery of anode attachment
- Ability to retrofit discreet sacrificial anodes to in-service FPSO hulls
- Bespoke solutions including low profile connections to reduce snagging risk.

Example Benefits

- Significantly reduced installation costs
- Minimal detrimental effect on the structural integrity of the parent material
- A fully ROV-installed galvanic anode retrofit solution
- Extremely low profile termination reducing snag risk
- No stray currents that could damage electrical equipment and control systems
- Ability to retrofit discrete sacrificial anodes to in service FPSO hulls
- Extremely low resistance and robust connection

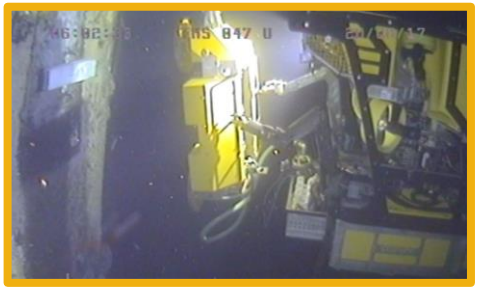
Our Applications

Anode Attachments
On live bundled services pipelines

Sensor Attachments
On live pipelines

Brownfield Upgrades
Topside structural upgrades and repairs

Securing of Risers



Subsea Remediation

Cofferdam Attachment

Greenfield Modifications

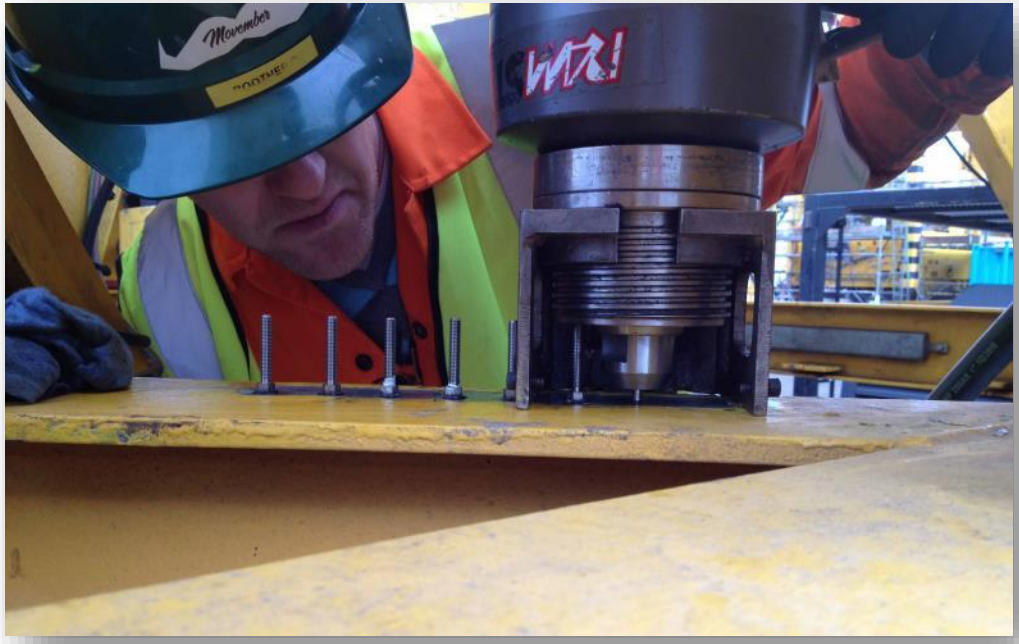
Military Applications
Sub-marine attachments

Fire & Blast Wall Attachments
Accommodation modules

Friction Welding Near Electronic Equipment

Friction welding studs for earthing straps next to an electronic control system on a steel subsea structure.

Proserv's pneumatic friction welding system does not use electrical currents, therefore does not generate any stray electrical currents or potentials which could damage nearby electronic equipment.



Pneumatic Friction Welding System

The R1004 and R1400 Friction Welding systems are pneumatic and primarily used for topside applications, in particular for use in potentially explosive atmospheres, however these can be used subsea to a depth of 40msw.

Common applications are structural attachments in areas where hot work is not permitted and attachment of sensors to live pipelines.

Features & Benefits

- Welds produced in potentially explosive atmospheres (Zone 2)
- Welds produced onto live pipelines
- Welds through coatings without surface preparation
- Welds can be produced in close proximity to electrical equipment
- R1004 – Capable of welding studs up to **12mm**
- R1400 – Capable of welding studs up to **18mm**
- Proven to 40m subsea

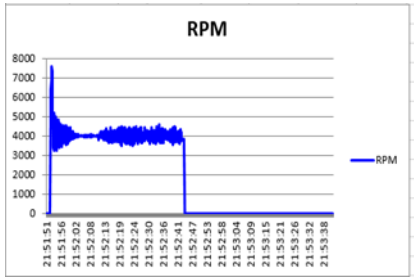
Pneumatic Friction Welding System

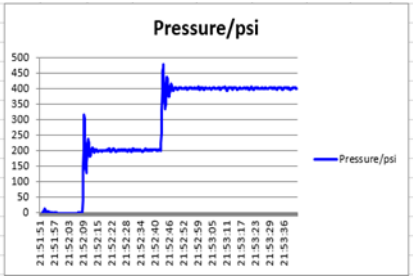
For welding in zoned areas, a water spray is also be applied during the welding and spark arrestors are fitted to the air exhaust

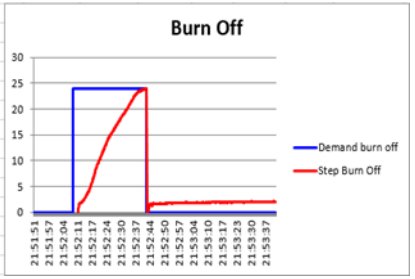
Hydraulic Friction Welding System

A customised control system provides a fully automated weld process, with real time data being used to monitor and control the welding process.

- Every weld is automatically logged providing a comprehensive record
- Can be used topside or subsea
- For subsea use it can be handled by either a diver or an ROV
- Depth proven to **1500m**. Additional hyperbaric testing is required to prove theoretical maximum working depth of 4000m
- Limited to **24mm** studs. Larger is possible with engineering input
- Fully integrated solution for ROV delivery of anode attachment







Balmoral FPV - Crack Repair

Cofferdam Attachment

Overview

Premier Oil had a requirement to perform a through thickness repair of a crack defect in one of the columns of their FPV. This required a cofferdam to be deployed and secured to the column to allow a hatch to be cut in the leg in order for the welding contactor to make the repair. Proserv was chosen to supply a solution for bringing the cofferdam into location before being educted.

Solution

Proserv's friction welding technology was selected as the ideal solution for providing an efficient method of securing the cofferdam. Two bespoke clamping arrangements were designed, built and tested by Proserv for deploying the friction welding technology onto the column and the pontoon of the vessel.

Proserv provided a training course for the diving contractor, qualifying them to use the pneumatic equipment subsea. The course included both theory and practical elements to ensure all personnel were competent before project delivery offshore.

Conclusion

The Proserv installation solution, including the bespoke clamping arrangements, provided a significantly quicker installation time compared to traditional welding. The solution proved to be very efficient and Premier Oil decided to perform further repairs on the FPV utilising friction stud welding to attach cofferdams in two additional locations.

Client: Premier Oil

Location: North Sea

Equipment: Friction Welding

Benefits

- Installation time of friction welded studs
- Good fatigue properties
- Multiple studs installed at locations using bespoke tooling

Thistle Field - Cathodic Protection

Bespoke Cathodic Protection Engineering Solution

Project Background

A North Sea Operator embarked on a major program of work to extend the life of the one of their installations in the North Sea. Along with a third party, Proserv was engaged to supply a solution for the reinstatement of the Cathodic Protection (CP) system on the platform.

Solution

Proserv's friction welding technology was selected as the ideal solution to connect anode sled cables to the jacket structure. This method was chosen over an impressed current cathodic protection (ICCP) system because of its reliability, ease of deployment and significant cost savings due to the ability to operate the technology using an ROV. As the friction welding anode retrofit was the preferred solution over ICCP, a bespoke interface solution was developed by Proserv to retrofit the anode sleds, the discrete anodes, monitors and measures the performance of the system over its life.

Conclusion

This retrofit solution provided by Proserv is the first of its kind, offering substantial cost savings over the ICCP system. The client, like many others, had concerns over retrofitting ICCP systems to platforms that originally had galvanic systems due to reliability and risk of stray currents which can accelerate corrosion, rather than prevent it. Offering a cost-effective galvanic retrofit solution which can be installed using ROVs provides substantial benefits to the client and is a unique offering in the market at present.

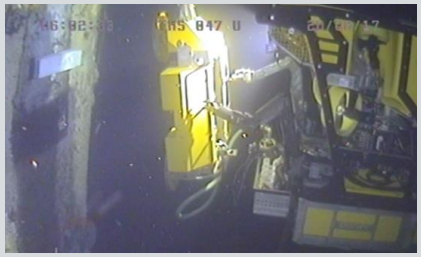
Client: North Sea Operator

Location: UKCS

Equipment: Friction Welding

Benefits

- ICCP was the only option for a major anode retrofit solution - now there is an alternative
- Significant cost-savings (around 50%)
- ROV-installed
- Improved reliability
- Low-risk as no concern over stray currents like there is with ICCP



Norway - Asset Integrity

Water Injection Valve Repair

Client: Statoil

Location: Norway

Equipment: Friction Welding

Project Background

DeepOcean was carrying out inspection work in the Vigdis field when a leak in one of the 12” water injection valves was detected.

Solution

Based on our existing track record with Statoil, Proserv was approached by DeepOcean to qualify a test using friction welding for a Vigdis Ball Valve Repair.

Scope

The following work was completed:

- Analysis of solutions performed to determine optimum repair solution
- Test pieces made from S32760 Duplex Stainless Steel to replicate valve body
- Trials of milling heads performed to determine preferred type
- Development of weld parameters to allow a permanent welded solution and repair

Conclusion

Proserv successfully completed development work for friction welding a plug weld to repair a Super Duplex water injection valve. Hydro static testing was performed at 430 Bar and held for a period of one hour to prove the integrity of the completed plug weld.

Benefits

- Permanent welded solution
- No annual maintenance required
- Low-cost solution
- No impact to production

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