

# WORLD'S FIRST VERTICAL REMOTE REPAIR OF A DEEPWATER RISER

## CASE STUDY

2 OFF 4" GAS LIFT RISERS NEAR THE BASE OF A HYBRID RISER TOWER WERE DAMAGED DURING INSTALLATION. TO ENSURE PRODUCTION, IT WAS ESSENTIAL THAT THE DAMAGED SECTIONS WERE BYPASSED. CONNECTOR SUBSEA SOLUTIONS (CSS) DEVELOPED A COMPLETE SYSTEM USING ITS INDUSTRY LEADING MORGRIP® SUBSEA PIPELINE CONNECTORS TO CARRY OUT THE WORLD'S FIRST VERTICAL REMOTE DEEPWATER RISER REPAIR. THE SUCCESS OF THE PROJECT REPRESENTS A NUMBER OF TECHNICAL BREAKTHROUGHS FOR THE INDUSTRY.

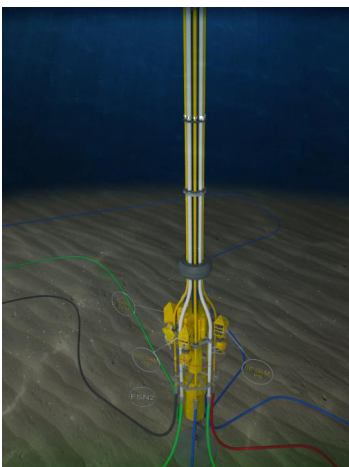
### THE CHALLENGE

The field offshore Angola is in water depths varying between 1 200 m and 1 500 m, making this the deepest pipeline repair ever attempted. Furthermore, with the risers secured in the bundle near the base of the tower, a completely new repair strategy was required.

CSS, owner of the MORGRIP® pipeline repair system, has a long track record and unparalleled experience having supplied 95 % of all remote mechanical connectors used successfully for remote pipeline repairs. Given this track record, the challenge lay not with the design of the permanent repair unit, but the means of installation.

To access the damaged sections, the risers would have to be released from the riser bundle, the coating would then have to be completely removed and the correct cuts made, all within very tight tolerances. Without overstressing the riser, the connector would then have to be aligned, installed, activated and tested, allowing the new flexible jumper bypass to be attached.

To support the repair, a high-load structural clamp would have to be permanently fixed to the riser bundle, providing a means to limit the motion of the new repair spools. All work would need to be conducted by ROV in 1 300 mwd, a mere 50 m above the seabed, which further increased the level of difficulty.



01 // Repair location



02 // Mounting of CSS connector installation frame



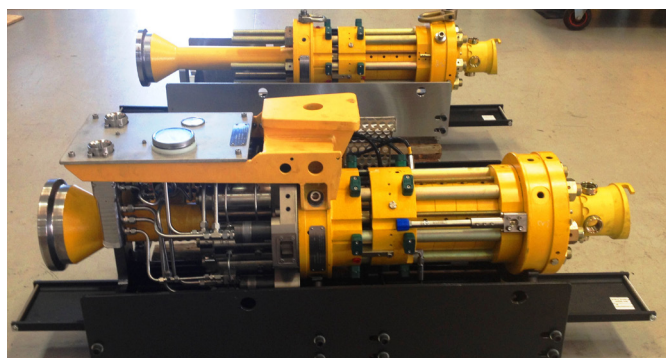
03 // CSS coating removal operation

*“CSS proposed innovative solutions to a complex riser repair project. They prepared a robust testing programme which provided confidence to successfully perform the repair on a live system. The delivery was underpinned by very good project planning and execution”*

*Subsea Engineer for operating company*

## OUR SOLUTION

CSS developed a bespoke solution to meet these challenges. Through supplying both the connector and the installation system, CSS were able to develop the solutions in parallel and ensure the key interface points were carefully managed to reduce operation risk and increase the level of assurance provided to the project.

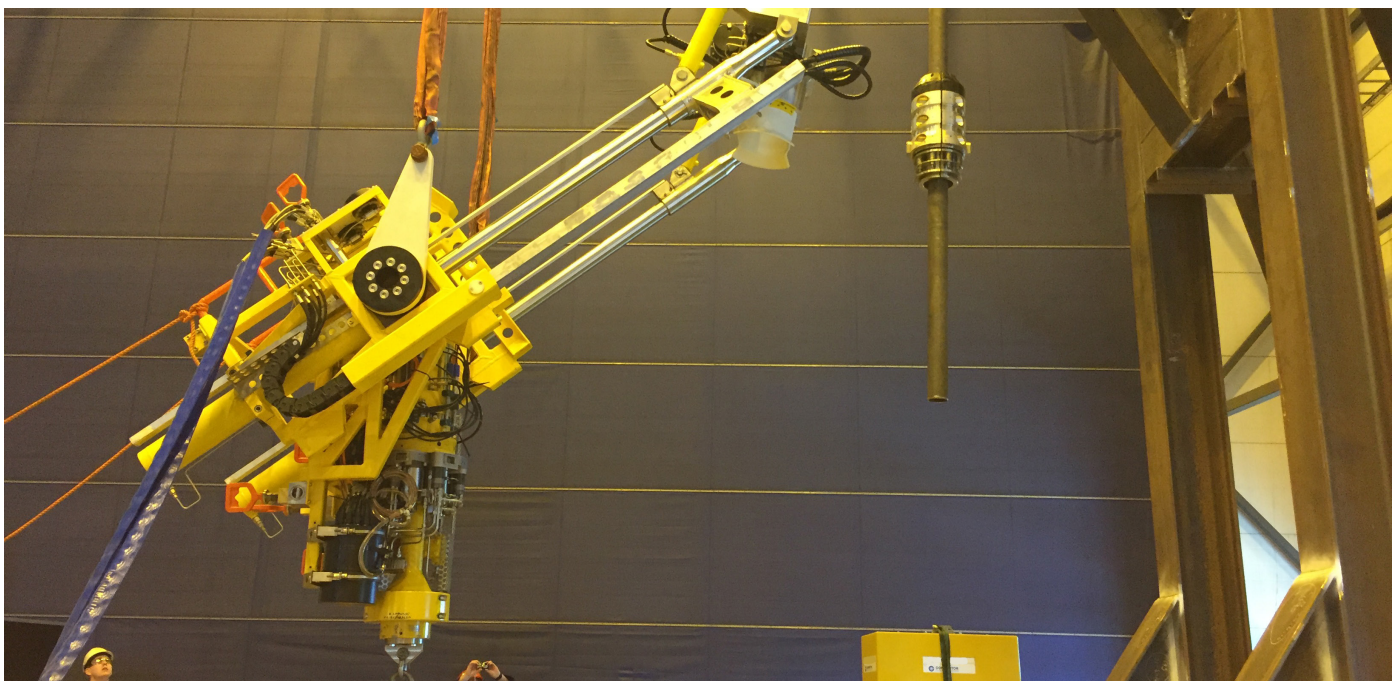


04 // CSS MORGRIP® 4 " Remote Connectors

A complete solution was designed, tested and supplied, comprising of high load clamps, remote clamp installation tools, coating removal tools, connectors and alignment and installation frames. To enable the repair to take place, other new systems needed to be developed, including a 3D buoyancy milling tool that could machine enough space in the buoyancy to enable the risers to be accessed. All equipment had to be ROV compatible and supported with an ROV skid and control systems.

The decision was taken to supply two connectors with two remote installation frames. One spare production connector would also be supplied as a contingency measure along with a dedicated test connector.

The operator and partners had to be convinced of the permanency of the repair solution, which took detailed analysis, extended testing, documented and video evidence and various levels of technology review. The use of a metal graphite composite seal was a key differentiator as it has been proven superior to an elastomeric seal.



05 // CSS vertical remote system integration trial

*“CSS provided an excellent technical solution to a very challenging problem. Project management and engineering was excellent throughout, with elements of the project delivered against a very tight time frame. The testing regime was well planned and managed, and the tools and hardware worked as per design, achieving the functional requirements without re-work. This transferred through to the field, where the tooling and connectors performed very well and achieving first time leak tight connections on both connectors”*

*Project Lead for the operating company*

## PROJECT EXECUTION

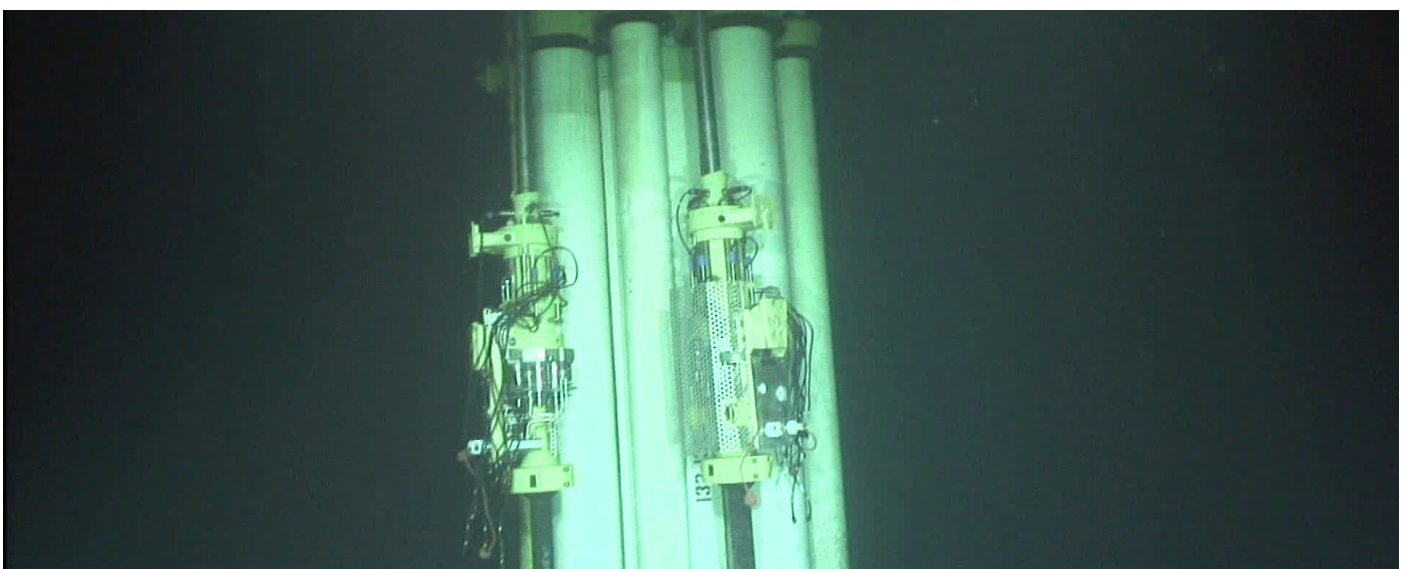
The MORGRIP® connectors were designed and manufactured in Wednesbury, UK with the installation equipment being designed and manufactured in Bergen, Norway. Following an 8-week extended factory acceptance testing programme which included 12 pipe activations, hydrotests, gas tests, temperature/pressure cycling and external load application, the connectors then travelled to Angola for site integration testing. The final stage was shallow-water testing involving the use of an ROV to remotely activate and hydrotest the complete system.

The regulatory process from the operator and industry bodies required a stringent technology readiness and acceptance process to ensure the technology was mature. Video animation was provided to detail each step of the repair process and showcase the planned operations to mitigate any risks at an early stage.

Once in location, the system was deployed over the course of a month during favourable weather windows, leading to the successful repair of both risers. The installation became an innovation milestone for the industry.



06 // CSS MORGRIP® 4 " Remote Connectors installed



07 // CSS MORGRIP® 4 " Remote Connectors tied-back