

Deepwater Umbilical Technology and Installation Services

Oceanering solutions key success factors in Shell Stones record-depth subsea project



Project Overview

Shell's Stones development in Walker Ridge Block 508 in the Gulf of Mexico is the world's deepest-water producing field at 9,600 fsw. To meet the unique challenges of this project, Oceanering designed and manufactured two 23,000 ft / 7,000

m dynamic power umbilicals and provided a wide range of installation services leveraging our extensive deepwater project management experience, responsive technical resources, and advanced ROV technology.

Issues

The Shell Stones umbilicals are the deepest-water dynamic umbilicals on record and weigh more than 180 tons each. Shell's specifications required that both umbilicals include three 20 kv medium voltage triads to power subsea pumping units, 16 steel tubes rated to 15,000 psi for hydraulic and chemical injection, low voltage power cables, and fiber optic signal lines. The umbilicals were also required to be constructed of standard materials, which created the need for special, reinforced riser construction.

The dynamic power umbilicals presented a unique design challenge. The copper power conductors have a low strength-to-weight ratio and required that other components in the umbilical provide enough axial strength to withstand the weight and pressures encountered in this ultra-deepwater application.

In addition, the Stones FPSO was designed to produce through a detachable turret buoy which places additional stress on the umbilicals. To enable the turret to disconnect and reconnect, each of the umbilicals' optical and electrical cables required unusually large, robust connectors. A special pulling head was needed to handle the connectors and umbilicals safely and reliably.

The Oceaneering Solution

The dynamic power umbilicals for the Stones project required custom designs to meet the environmental and mechanical demands of operating at 9,600 fsw. Oceaneering developed dozens of candidate designs for Shell's consideration—with varying component configurations, armoring options, conductor materials, component sizing, and helix angles—before arriving at a technically feasible design that met requirements. Oceaneering completed more than 11,000 hours of engineering and analysis during the design, qualification, manufacture, and testing of the umbilicals and ancillary hardware. Oceaneering designed and manufactured a custom pulling head able to support up to 200 tons of installation load and capable of interfacing with the FPSO's detachable turret buoy.

Execution Plan

In addition to the umbilical and hardware scope, Oceaneering developed procedures for installation of the tubing head spools and wellheads on two initial producing wells in the field. We also created procedures for subsea installation of six jumpers and two flying leads. We fabricated six jumpers—two flowline jumpers, two gas export jumpers, and two well jumpers—at our vendor's facility in Morgan City and all were successfully installed subsea.



Oceaneering was initially contracted to provide ROV services and required tooling and equipment to complete flushing of the field's gas export pipeline and two production flowlines at water depths up to 9,500 fsw / 2,896 msw.

However, before our ROVs could begin this operation, challenges were encountered which prevented the lock-down of a newly-designed production pipeline end terminator (PLET). To prevent delays in flushing and testing the production flowlines, Shell asked Oceaneering to intervene and lock-down the PLET. Oceaneering designed custom ROV tooling to accommodate the PLET operations, expedited manufacturing of the tooling, and completed lock-out of the PLET without significant delays to the project. Flowline flushing and testing proceeded as previously planned.

Installing wellheads for the first two wells at the Stones field was challenging. The 400-ton crane on the available service vessel did not have the capacity to safely lower the wellheads to 9,600 fsw / 2,926 msw using a continuous line of steel cable. Oceaneering replaced 3,000 ft / 900 m of steel cable with neutrally-buoyant synthetic rope, reducing the total weight and enabling efficient wellhead installation. In less than three weeks, Oceaneering modified a flying lead spool to handle the synthetic rope which was attached to the crane and deployed through the service vessel's moon pool.

The detachable turret buoy mooring chains required de-tensioning before the buoy could be joined with the FPSO. Because of the water depth and the size of the chains, this operation required more than 180 tons of line pull. Oceaneering contracted a high-specification vessel to perform the de-tensioning operation and used it on other installation activities, saving approximately 14 vessel-days for the operator.

The extreme water depths and persistent loop and eddy currents complicated ROV operations, especially during wellhead installation. Currents of three knots were experienced on the surface while one-knot currents persisted at 9,600 fsw. These currents required vessel movement and special procedures to compensate for drift while lowering and positioning equipment. The high specification Oceaneering® Millennium® Plus heavy work class ROVs worked at full capacity at these great depths, and met all requirements.

Challenges

Oceaneering faced a number of challenges during flushing of export & flow lines and the installation of wellheads, tubing head spools, jumpers and flying leads on the Stones project. The main issues included operating at such great water depths, compensating for persistent loop and eddy currents, responding to unforeseen problems, and adapting installation procedures to match service vessel capabilities.

Results

The combined expertise of numerous Oceaneering divisions contributed to the success of the Stones project. All Oceaneering personnel were committed to safe and efficient execution of every aspect of the project. Oceaneering designed and manufactured the dynamic power umbilicals for the record-depth project while meeting Shell's requirements and delivering the umbilicals ahead of schedule and without a single lost-time incident.



Oceaneering responded quickly to address issues encountered while providing subsea services, including designing and manufacturing ROV tooling and using synthetic rope to enable wellhead installation with the available service vessel. Throughout the project, Shell called on Oceaneering to identify solutions that were not included in the original scope of work.

Oceaneering's ROV services successfully compensated for persistent currents encountered on this deepwater project. The combination of engineering, operational experience, advanced ROV systems enabled completion of every task on schedule.

During 71 days of offshore operation, Oceaneering crews recorded no LTI or other HSE incidents.



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