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K2 Flowlines and Risers: From Design to Pre-commissioning

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Abstract

K2, a deepwater oil field operated by Eni Petroleum in the Gulf of Mexico approximately 180 miles south of New Orleans, was developed using a three-well, 6.7-mile subsea tieback to the Marco Polo Tension Leg Platform (TLP). This paper presents an overview of the flowline and riser system, and describes the key challenges of the design, fabrication, installation and pre-commissioning phases.

Dual 7-inch/12-inch pipe-in-pipe flowlines were adopted to transport oil from two wells in the North Fault Block and one well in the South Fault Block, through 7-inch heavy-wall Steel Catenary Risers (SCRs), to the Marco Polo TLP. The design constraints included high-pressure high-temperature fluid properties, stringent insulation requirements, uneven seabed bathymetry, possible presence of chemosynthetic organisms, limited platform hang-off load capacity and congested riser area.

The pipe-in-pipe flowlines, insulated with a new nanoporous product, were fabricated onshore and installed by the reel-lay method. Two four-hub Pipeline End Terminations (PLETs) and two dual-hub In-Line Tees (ILTs) were provided to tie-in the wells with 6-inch well jumpers. The installation challenges included potential rotation of the in-line tees, rectification of the flowline spanning caused by seabed irregularities, and strong eddy Vortex currents. A piggable loop was also provided by fabricating and installing a non-standard 7-inch jumper arrangement between the PLETs.

The riser quad joints, insulated with two new product formulations, were fabricated onshore and installed by the J-lay method. The installation challenges included the stringent SCR welding requirements, reducing the cycle time of the ultrasonic welding inspection and molded field joints, and the presence of strong eddy Vortex currents.

After installing riser spools at the top of the SCRs, the K2 flowline and riser system was successfully pre-commissioned with the use of chilled water to minimize the stabilization time required for the hydrotest.

Introduction

From the design phase through to the pre-commissioning phase, the K2 flowlines and risers presented numerous challenges. This paper will describe the key challenges encountered and the subsequent solutions adopted.

Development Overview

The K2 field is located in Green Canyon Block 562, approximately 180 miles south of New Orleans in 3,950 feet (1,200 metres) of water (see Figure 1). The development plan consisted of a subsea tie-back through Green Canyon Block 607 to the Marco Polo Tension Leg Platform (TLP), located approximately 6.7 miles away in Green Canyon Block 608 in 4,300 feet (1,310 metres) of water (see Figure 2).

The well locations selected for the initial development involved drilling one well (#1) in the South Fault Block and two wells (#2 & #3) in the North Fault Block. The subsea tie-back concept chosen (see Figure 3) involved laying dual pipe-in-pipe flowlines from the North Fault Block past the South Fault Block, transitioning into Steel Catenary Risers (SCRs) and terminating at the riser porch on the hull of the Marco Polo TLP. Four-hub Pipeline End Terminations (PLETs) were used at the North Fault Block to tie-in two wells, while two-hub In-Line Tees (ILTs) were used at the South Fault Block to tie-in one well. The unused PLET and ILT hubs will provide for two future wells (one at each Fault Block). Titanium stress joints were used at the top of the SCRs, which were hung-off in the separately-installed riser porch. The final connection between the stress joints and the hull piping (which was installed while the TLP was at dockside) was made by installing short riser spools in 90 feet (27 metres) water depth.

Well jumpers were installed on the PLETs and ILTs to connect the wells to both flowlines. A piggable loop was also installed between the PLETs to permit round-trip pigging from the platform. Due to the distance between the flowlines, and the location of the wells between the flowlines, two piggable loop jumper sections were required. To save a connection and reduce the size of the midspan support structure, a non-standard jumper configuration was used whereby one pigging