OTC 18312

Free Span Remediation Studies for the K2 Pipe-In-Pipe Flowlines

U. Eigbe, M. Fletcher, M. Hensley, D. Ling, and C. Routh, INTEC Engineering

This paper was prepared for presentation at the 2006 Offshore Technology Conference held in Houston, Texas, U.S.A., 1–4 May 2006.

Abstract

The ENI Petroleum K2 field production flowline system consists of two HT/HP (high temperature and pressure) pipe-in-pipe (PIP) flowlines that tie back three oil wells located at Gulf of Mexico Green Canyon 562 to the Marco Polo TLP in a maximum water depth of approximately 4,300 ft (1,310 meters). The flowlines traverse very rough seabed terrain, including an escarpment along the selected route. It was determined from preliminary analysis of the surveyed flowline route and confirmed with as-laid flowline survey data that seabed intervention by use of engineered supports was required at some of the flowline spans, including the escarpment. In particular, at the escarpment it was determined that operating loads during start-up would create excessive bending at the sagbend (due to feed-in) and overbend (due to uplift), exceeding the DNV OS-F101 code-specified limit-state design requirements. The focus of the K2 free span remediation studies was to assess the impact of span supports and overburden with regard to the structural integrity of the flowlines. This was accomplished with a global expansion, bottom roughness and lateral buckling analysis. The bulk of the analysis consisted of "real time" ANSYS finite element modeling of as-laid flowlines, and as-built span supports and overburden design on board the vessel *MSV POLAR KING* on location at the K2 field. During the course of construction, contingencies for span support were investigated as adjustments had to be made to the construction schedule in order to meet the hydrotest timeframe and First Oil milestone dates. The results of the analyses were verified with as-built start-up survey data, including confirmation of lateral buckling within the monitoring stations identified from the ANSYS analysis. An end product of the remediation studies was a fully vetted and field-proven HT/HP PIP analysis tool available for similar applications in future projects.

Introduction

This paper describes the challenges posed by the rough seabed terrain, the methodology for evaluation, and the solutions proposed for the free span remediation work for the K2 dual pipe-in-pipe (PIP) flowlines.

General Overview

The ENI Petroleum-operated K2 field is located in Green Canyon Block 562, approximately 180 miles south of New Orleans in 3,950 ft (1,200 meters) of water. The development plan includes a subsea tie-back through Green Canyon Block 607 to the Marco Polo Tension Leg Platform (TLP), located approximately 6 miles away in Green Canyon Block 608 in 4,300 ft (1,310 meters) of water. The subsea tie-back consists of dual PIP flowlines (designated as "East" and "West" Flowlines) that transition into steel catenary risers (SCRs) at the TLP; as well as a pair of four-hub pipeline end terminations (PLETs) at the North Fault Block and a pair of two-hub in-line tees (ILTs) at the South Fault Block [Ref. 1].

Challenges

The potential for flowline free-spanning was initially identified during the front-end engineering design stage. The construction contractor for the K2 field confirmed areas of excessive span during the visual survey of the partially-laid East Flowline (to 18,180 ft length) and West Flowline (to 18,607 ft length) following Construction Phase 1 in January 2005. ENI Petroleum selected INTEC Engineering to perform offshore assessment of the spans, propose rectification methods to spans and overbends, and provide quality surveillance of resulting span and overburden intervention works during Construction Phase 2.

It was determined from preliminary analysis of the seabed flowline route and confirmed with subsequent as-laid flowline profile data that intervention was required for the flowline spans and overbends in the region of the escarpment, defined approximately as East Flowline stations 62+50 through 66+00 and West Flowline stations 64+00 through 67+00. The analysis and installation of the escarpment span supports and overburden was the main focus of the Construction Phase 2 remediation work.