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K2 Subsea Trees and Controls: 15k; 5" Bore; 70 Tons—The Challenges

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Abstract

With two drill centers, well depths of more than 24,000 feet, 4,000' + water depth, high shut in pressures and a 7 mile tieback, K2 presented many challenges. With an aggressive schedule to meet, risk analysis identified that an integrated approach to the supply of the trees and their control system, with incentives to meet even earlier deliveries, would reap the maximum benefit. The project was executed by a small team located in Houston, which managed and coordinated a number of different sites worldwide to ensure that all elements came together on schedule. The stability of this core team, from the design stage through site integration testing to installation provided essential strength to the project, but the real success was provided by the expert technical solution and the application of good project control systems.

Unique tree layouts incorporated the traditional valving into a combined structure which eliminated costly and risk prone manifold structures. The manifold was integrated into the tree which left a simple inline PLET with no actuated valves. Further hurdles were presented at the installation and commissioning phases by this new tree structure which went beyond traditional capabilities of size and weight. The control system was very much simplified by the new tree layouts but third party equipment was a major issue because of the 15K pressure ratings. This paper reviews the many challenges encountered and looks at how technology was pushed to new boundaries.

Introduction

To reap the maximum benefit of early production start up an aggressive schedule was set that presented many challenges. To identify and subsequently quantify these challenges a detailed risk analysis was carried out to determine:

- a. Current technology
- b. Supplier lead times
- c. Project execution philosophy

The selection process and the tree style recommendation for the K2 subsea field development took into consideration industry accepted design philosophies, installation and completion issues, and operating constraints.¹

Various deep water completion tree styles were evaluated and the recommendation from the evaluation led to the selection of a horizontal tree style for the planned well completions.

Technology for 15,000-psi subsea tree system equipment was at the infancy stage. Little field experience existed at the time. Only two fields had been developed in the GOM using 15,000-psi subsea completion equipment, Shell Gyrfalcon² and Amerada Hess Conger³, although most vendors had developed the key components for the tree assemblies (gate valves, isolation valves, connectors and seals etc.), for both monobore and horizontal trees.

During the risk analysis it was identified that the technology of the day had to be enhanced / expanded to meet the technical challenges posed, that traditional lead times associated with the development of new / enhanced technology would not meet the project goals, and that a multiple, non integrated supplier base would only add to the difficulty of meeting the overall objectives.

The outcome of the risk analysis led to the selection of a supplier with a well defined scope and the capability to undertake both the technology improvements needed and the integration and control of a multi product supply chain from locations around the world. Fundamental to the success was the formation of a project team made up of members from the Eni Petroleum integrated project team (IPT) and Vetco Grey located in Houston where all required information and interfaces could be addressed in a timely manner to ensure no unnecessary delays to the overall schedule.

In addition an incentive scheme was developed which would reward the supplier for improving on the contractually committed dates. This incentive scheme, basically the reverse of the more traditional Liquidated Damages clause contained in contracts, led to decisions being made at the supplier level immediately as an opportunity presented itself for