A Reusable Seabed Tree Protection Frame on Very Soft Soil

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ABSTRACT
The basic functions of a subsea oil & gas production tree located on the seabed are well pressure containment, flow rate control and chemical injection. Accident loads such as impact force from a dropped object or lateral snag load from a fishing net represent a hazard to the tree resulting in potential loss of asset integrity, environment pollution and operator’s reputation.

In regions with a high level of fishing activities, a protection frame is often deployed to protect the critical components of the seabed tree to ensure its safe and continued operation.

In the present study, a protection frame will be placed over to protect the tree after it is installed and in operation. The frame is to be installed over the tree to sit on a seabed of very soft clay and reused after serving its initial purpose for other areas with similar tree and water depth conditions.

The soft soil condition presents significant design and installation challenges. Foundation options considered are mudmat and suction piles. The evaluation made to select mudmat as the base case is given.

Finite-element modelling and analysis software are used to determine the dynamic characteristics and responses of the frame structure and foundation interacting with the soil.

In-place and lifting analyses are carried out to design and assess the protection frame to ensure that the structural members have the robustness and capability to withstand the anticipated loads under operating, storm, and accidental loading conditions, allowing it fit for reuse on another well.

Installation considerations given to the design of the protection frame to ensure that it can be installed safely and efficiently are described.

KEY WORDS: Subsea Tree; Protection Frame; Dropped Object; Fishing Snag Load; Asset Integrity; Soft Soil.

INTRODUCTION
Subsea production systems are infrastructure installed on the seabed to produce oil and/or gas. They are currently used extensively in shallow to deep water depths all around the world.

With the evolution of reliable subsea control systems, subsea well completions are attractive as a cost-effective way of achieving production from early exploration wells and tapping reservoir extensions beyond the recovery area of the main field facility.

The tree is a sophisticated assembly of valves and instruments connected to the top of a wellhead (Fig. 1). It is a critical component of the subsea production system that should remain operational with minimum downtime. In normal production mode, the subsea tree located on the seabed controls the flow rate and monitors the flow pressure and temperature. When problems occur in the wellbore, the tree is able to close the well. Even though there is a downhole safety valve that will also shut the well to prevent a catastrophic oil spill, damaging the tree can mean losing control and use of the well. The cost of a failure in the tree is significant due to the difficulties in repairing or replacing it.

Fig. 1 Tree Installed on a Subsea Wellhead

Dropped objects are responsible for the vast majority of near-misses and actual fatalities offshore (Seward, 2011). The most common objects falling to the seabed from the surface platforms are tubular, overhead