Pendulous Installation Method and its Installation Analysis for a Deepwater Manifold in South China Sea

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ABSTRACT

This paper describes how to apply the PIM deepwater installation technology to install a 195Te manifold in a water depth of 1,500m. The analysis methodology and numerical findings of the PIM installation are presented here for lifting off deck, overboarding, lowering through slash zone and water column, finally landing into the target box on the seabed. This PIM method is cost effective compared to utilization of scarce specialized deepwater installation vessels or formidably expensive drilling rigs. It should be pointed out that, due to complex geometry of the manifold, hydrodynamic instability may arise during launch operation.

KEY WORDS: PIM; deepwater installation; FRDS; HMPE; coupled motion.

NOMENCLATURE

AHC = Active Heave Compensation
AHTS = Anchor Handling Tow Supply (tug)
CT = Constant Tension
DAF = Dynamic Amplification Factor
DCV = Deepwater Construction Vessel
DP = Dynamic Positioning
DSV = Diving Support Vessel
FRDS = Fiber Rope Deployment System
HLV = Heavy Lift Vessel
HMPE = High Modulus Polyethylene
PIM = Pendulous Installation Method
ROV = Remotely Operated Vehicle
RSV = ROV Support Vessel
SWL = Safe Working Load
WWL = Working Load Limit

INTRODUCTION

The Pendulous Installation Method (PIM) is a non-conventional method originally developed by Petrobras to successfully install 280Te large manifold in water depth of 1,900m, refer to Roveri et al. (2005) and Fernandes et al. (2007), which is due to the low availability and high cost of deepwater construction vessels (DCVs) and heavy lift vessels (HLVs). The PIM method is devised to use small conventional deepwater construction or offshore support vessels, such as small DCVs, DSVs, RSVs, even DP class AHTS tugs, without using special riggings and powerful FRDS systems, capable of deploying 300Te heavy equipment in deep waters up to 3,000m.

The PIM method requires two small installation vessels to launch and deploy a subsea structure onto the seabed. Different from traditional vertical launch, the PIM method uses a conventional steel wire winch system as a launch line to launch the structure in a pendulous motion while using a conventional synthetic fiber rope, such as polyester or HMPE rope, as deployment line to finally deploy the structure onto the seabed. The first installation vessel uses its crane to lift off and overboard the manifold into water and through slash zone, and then transfer the load from the crane to the launch winch wire at a certain water depth. The deployment line is pre-rigged with the lifting slings of the manifold and equipped with a number of buoyancy elements to reduce the winching capacity requirement for both the launch winching system and the deployment winching system. The elongation of the deployment rope under load tension shall be taken into account to avoid any premature touchdown. Through a pendulous movement, the load will gradually transfer from the launch line to the deployment line. The deployment rope is gradually tensioned up to the full load. This can prevent axial resonance by using ropes much longer than the lengths that would fall into the resonance region when lowering through water column and allow ropes to undergo gradual tension after pre-paid. Finally the deployment winch can continue deploying the manifold vertically, position and land it into the target box on the seabed using a conventional vertical way with or without a AHC system. Refer to Fig. 1 for the illustration of the pendulous motion to lower a manifold into deep water.

The PIM deepwater installation technology is proposed here to install a 195Te manifold in a water depth of 1,500m using the HMPE deployment rope rather than the polyester rope. The elongation of the polyester deployment rope at break is approximately 3.7 larger than that of the HMPE rope. In addition the HMPE rope is neutrally buoyant in sea water and less sensitive than polyester ropes and much less