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Advanced engineering allows mooring facilities close to offshore structures

Reliable engineering and design methods facilitate mooring floating systems next to offshore structures in more conditions than ever before.

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SEPLA anchors are installed with the use of a suction follower that is similar to a standard suction pile. (Images provided by InterMoor)

Mooring accommodation barges, work barges, and tender-assisted drilling (TAD) units in close proximity to other offshore structures is common practice in the offshore oil and gas industry. As the necessity for these structures expands into new environments, mooring system providers are working to provide comprehensive design, analysis, procurement, fabrication, and installation services to meet changing needs.

Meeting needs head on

Over the past 10 years, InterMoor Inc. has become increasingly involved in mooring floating bodies close to other offshore structures. Since 2002, InterMoor has moored barges and semi-submersibles next to dynamically positioned drilling rigs, jackups and fixed jackets around the world.

Most recently, InterMoor completed a challenging mooring installation offshore Angola. This 2008-2009 development consisted of a drilling and production platform (DPP).

During this project, the TAD was used to install drilling equipment within the DPP's topsides and would be connected with a personnel transfer bridge (PTB) during normal drilling operations. Initially, the TAD remains moored on location for four to five years and thereafter returns intermittently as needed over the course of the remaining 15 years. This TAD would be moored on location for eight to 10 years. The mooring was designed and installed to achieve a tight watch circle and to meet permanent mooring system requirements.

The system is an eight-leg taut polyester design with InterMoor's patented suction-embedded plate anchors (SEPLAs). A subsea connector was incorporated to allow pre-installation of the anchors and facilitate mooring line recovery since the TAD will be disconnected and reconnected several times during its 20-year design life. The SEPLAs are permanently installed for the duration of the project.

Because of the proximity to the DPP and gangway stroke limitations, the TAD mooring system had to be designed to meet stringent design criteria. The nominal clearance between the two bodies

This TAD is installed in 1,200 ft (366 m) water depth offshore Angola.

during normal operating condition is approximately 71 ft (22 m), and the PTB has a maximum bridge stroke of +/- 23 ft (7 m). Minimizing TAD offset was the main design driver. Minimizing the vessel offset and PTB stroke allows the bridge to remain engaged to maximize drilling up time. From a strength perspective, the system was designed to meet API-RP-2SK recommended safety factor requirements. Additional mooring system design requirements include ensuring:

- A 33-ft (10-m) minimum clearance between the TAD and DPP in all design conditions (including one-line failure);
- Enough winch over capacity to position the TAD to within 15 ft (4.5 m) of the DPP to perform heavy-lift operations; and
- Polyester would not come in contact with the seabed and that the top portion of polyester would be at least 150 ft (46 m) below the waterline.

Extensive strength and fatigue analyses were required to achieve an optimal mooring design for the TAD. Detailed site-specific metocean data were provided for the 10-year return period operating conditions and 100-year survival conditions. These included extreme wind, current, sea, and swell events. The use of environmental directionality was necessary to meet the design requirements. It also was necessary to obtain wind speed time histories to properly simulate and evaluate the mooring system's response to sudden, short-duration West Africa squalls. The water depth at the mooring location is approximately 1,200 ft.

The company awarded the mooring component procurement contract to InterMoor, and suppliers shipped all components directly to Angola. InterMoor was responsible for tracking the equipment, providing status updates, and arrival information.

TAD installation

The mooring system installation was conducted in three phases using a dynamically positioned support vessel. SEPLA installation was performed in October and November 2008, and the polyester preset and TAD hookup operations took place in July and August 2009.

SEPLA anchors are installed with the use of a suction follower that is very similar to a standard suction pile. The follower embeds the anchor, and the retaining slings are cut with a remotely operated vehicle (ROV) to allow the follower to be recovered to surface.

The installation vessel did not have an A-frame, which is the most common method of installing SEPLAs. So InterMoor had to design, fabricate, and deliver installation aids to facilitate the use of the vessel crane in conjunction with a hold-back winch to launch the follower over the starboard side in a controlled manner. The follower was lowered to the seafloor using only the crane.

SEPLA installation involved a challenging vessel mobilization in Angola. The vessel crane had to be configured for its heavy-lift mode, and a section of bulwarks and several sections of the wood and steel deck were removed to accommodate the installation aids. Aids included the follower overboarding chute, a chain chute, a mud mat lowering sheave platform, and other smaller components. The aids, which were welded along the deck, required minor modifications due to space requirements. Minor vessel modifications were suggested to ensure adequate deck strength to handle the installation loads. Once on site, each SEPLA's installation was achieved in approximately 16 hours. Minimal downtime resulted from crane block sensitivity to swell height.

Mobilization for the polyester preset and TAD hookup occurred offshore. Mooring components were loaded in certified offshore lifting containers at quayside on supply vessels. The preset polyester rope sections were spooled to the installation vessel's main winch directly from the containers and then paid out overboard and re-spooled with back tension. All equipment had to be tracked on the various supply vessels and transferred to the installation vessel.

A 957-ft (292-m) section of polyester was installed with a 370-ft (113-m) section of chain and a subsea mooring connector to connect with the preinstalled anchor and subsea mud mat. All eight mooring lines were bollard-pulled to 215 metric tons line tension to rotate the SEPLA and remove construction stretch from the polyester. The preset moorings were buoyed off in preparation for the hookup operations.

A tug and an anchor handling vessel towed the TAD to location. Once the TAD arrived on location, the preset buoy was recovered, and a 450-ft (137-m) polyester insert section was installed. The installation vessel backed down to the TAD to receive the fairlead wire. When the preset moorings were hooked up to the TAD, the lines were cross-tensioned. The installation vessel then performed an ROV survey of the eight mooring lines.

In the fall of 2009, the TAD was winched in close proximity to the DPP to lift the drilling package onto the platform. EXP