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Design of Field Development Ship for Ultra-Deepwater

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초심해 용 유전개발선의 설계

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Abstract

This technical note is intended to introduce a state-of-the-art offshore construction vessel. This unique vessel is for multi-purpose Field Development Ship (FDS) for deepwater to ultra-deepwater. The FDS is a construction vessel with dynamic positioning (DP) system intended to develop offshore oil and gas field in water depth up to 3000 m. The design criteria and main capacities of the vessel are discussed.

1. Introduction

An analysis of offshore projects under development or study in West Africa and South America shows evolution from traditional water depths to ultra-deepwater (3,000 meter). On this basis, Bouygues Offshore Company in France and Saipem in Italy are building a vessel adapted to meet these ultra-deepwater needs.

SaiBos Construcoes Maritimas, the two company's common subsidiary (50/50) dedicates to offshore installation and contracts in the South Atlantic, will be the owner and operator, and is

managing construction of the vessel.

Preliminary conceptual studies and basic engineering were undertaken in 1997. The engineering subcontract was placed with Shiffko Gmbh of Hamburg, Germany in March 1998, as soon as the final agreement between Bouygues Offshore and Saipem and an accurate evaluation of the investment have been frozen. The total investment is US$150 million. All main equipment orders were issued at the end of 1998, along with the shipyard order at Samsung Shipyard. The construction of the vessel was completed in January 2001.

2. Vessel Design Criteria

The Field Development Ship (FDS) is a multi-purpose crane and pipelaying dynamically positioned (DP) construction vessel. The three main criteria for the vessel design are:

- Develop offshore oil and gas fields in water depths up to 3,000 meters
- Lift and transport heavy subsea and surface modules and equipment
- Transit between construction sites at a cruising speed of 14 knots.

The FDS is being built according to codes Solas/ILO/Marpol with a DNV classification +1A1 and is compliant with Norwegian, UK, and USCG regulations for foreign flag vessels.

The vessel has been designed for sea conditions in the South Atlantic. Tests carried out confirm the optimum behavior of the vessel. The natural period of the ship is 15 seconds in pipelaying mode, which is above the swell periods encountered in the areas where the vessel will be working.

The J-lay operation roll has single maximum amplitude of 5° and the main crane operation angle is 2°. Assurance of stability in operation is made possible with the following systems:

- Anti-rolling with two span bilge keels of 1.24 meters
- Ballast system installed with two 300 cubic meters/hr electric pumps
- Crane compensation by utilizing eight 1,500 cubic meter/hr electric pumps
- Total seawater ballast capacity is 11,539 cubic meters including the two 1,276 cubic meter tanks (one on each side) for the crane ballast itself.

3. Dimensions and Capacities

The vessel is 157.5 meters long and 30 meters wide and has an operating displacement of 25,300 tons with a payload capacity of 4,300 tons. The operating draft is 7.4 meters with a free board of 5 meters. The general

arrangement of the FDS is shown in Figure 1. Total power of 25 MW is produced by diesel-driven generators, with 6.6 KV distributed to all user motors, including six thrusters configured as follows:

- Two stern thrusters for DP and sailing
- Two fore thrusters (azimuth and retractable) for DP
- Two bow thrusters in tunnels for DP.

The vessel is designed to accommodate an optional thruster in order to increase the operational bollard pull from 50 metric tons to 80 metric tons, if it appears to become necessary in the future. For this type of vessel, the station keeping capability must be efficient in order to limit the number of weather stoppages during operations. A particular care and best of art equipment has been chosen based on proven technology.

The DP capacities are:

- In pipelaying mode, DYNPOS AUTR, DNV DP II, with 50 tons bollard pull at sea state 5 and a current of 1.5 knots, all acting abeam
- In subsea mode, DYNPOS AUTRO, DNV DP III, without bollard pull and with the same other conditions.

The various capacities are such that the vessel has an autonomy above 30 days. This characteristic is important considering the sites of operation and the opportunities to work on both sides of the Atlantic Ocean. The cruising speed of 14 knots allows the vessel to move rapidly from one site to another.

The main operational capacities of FDS are:

- Installation of pipeline and associated risers up to 20-inch in J-lay mode
- Installation of subsea structures, manifolds, templates, riser bases of up to 600 metric tour
- Offshore lift and installation of surface modules for FPSO, SPAR, TLP
- Installation of deepwater mooring systems for floating units
- Offshore hook-up, subsea maintenance, and commissioning.

4. Pipelay Capacities

The J-lay tower and firing line have been designed to achieve high productivity. Quad-joint strings (52 meters length maximum) are prepared on deck using the permanent firing line. The quad-joint strings are installed through the J-lay tower in friction or collar mode, with a hang-off clamp at the bottom and a traveling clamp to allow the transit of the string in the tower.

The tower is designed for 400 metric

tons tension with a tilting angle of 45° to 96°. Calculations show that such tension allows the laying of pipes in the range of diameters usually used for the flowlines or water injection lines up to water depths of 2,000-3,000 meters. The tower itself is designed for pipe string up to 20 inch outside diameter.

The firing line is organized on the deck to assemble the quad-joints strings in five working stations for welding, NDT, coating. The space on deck (3,000 square meters) is available for storage of standard pipe joints (12 meters) or onshore-prepared quad-joints for pipe-in-pipe flowlines or special steel pipe. Large capacity and heavy racks are loaded without any external help thanks to the vessel main crane capacity.

Installation of flexible pipes (up to 15-inch internal diameter) is executed through the J-lay tower or an overboarding chute with the use of four 90 metric ton tension (maximum of three) pads. The large deck area allows the utilization of several vertical reels for flexible pipes (10 or 15, depending upon deck configuration). Space is available for the installation of a 1,600 metric ton of flexible pipe storage below the main deck.

5. Parallel Installation

The combined installation in parallel of pipelines, flexible pipes, and umbilicals is one of the characteristics of the vessel. The design of the vessel enables the installation of every type of pipe, flexible, and umbilical commonly used in deepwater. The number of vessels on site is therefore limited to the FDS itself. Keeping this in mind, and in order to work in autonomous mode of up to 30 days, the lifting capability of the FDS's cranes was designed accordingly:

- One main crane of 600 metric tons at 30 meters radius, and 300 metric tons at 55 meters radius
- Two 30 metric ton auxiliary cranes
- Two 20 metric ton auxiliary cranes

This allows lifting of pipes and pipe racks onboard, module installation on floating production, storage, and offloading units (FPSO) of other floating units (Spar, TLP), temporary decks or module support frames, as well as installation of mooring systems.

The lifting and handling capabilities are increased by the utilization of the abandonment and recovery (A&R) winches 400 metric tons for 3,000 meters water depth or 600 metric tons for 1,500 meters water depth. An auxiliary winch (100 metric tons) can be used for portside transfer of modules from deck to sea.

Working in deepwater also requires subsea equipment. Two ROVs, rated for

3,000 meters water depth, will be on board permanently. These 150 hp ROVs have extended capacities and an 800-meter horizontal excursion range. These capabilities will allow the monitoring of the touchdown point directly from the vessel, avoiding the use of a specific vessel for such operations. A large range of subsea tools for utilization by the ROVs will be available.

6. Concluding Remarks

The FDS vessel will execute a large range of activities. For example:

- Diversified pipelaying, using rigid pipes (insulated or not), flexible pipes, umbilicals, and others
- Extended lifting and handling capabilities
- Storage capability on deck for pipes, flexibles, moorings, and modules
- Subsea installation and operations.

The FDS is a versatile, multi-purpose vessel adapted to areas in the South Atlantic and other seas such as Gulf of Mexico. The FDS will be a major construction vessel for oil and gas field developments up to water depth of 3000 m.

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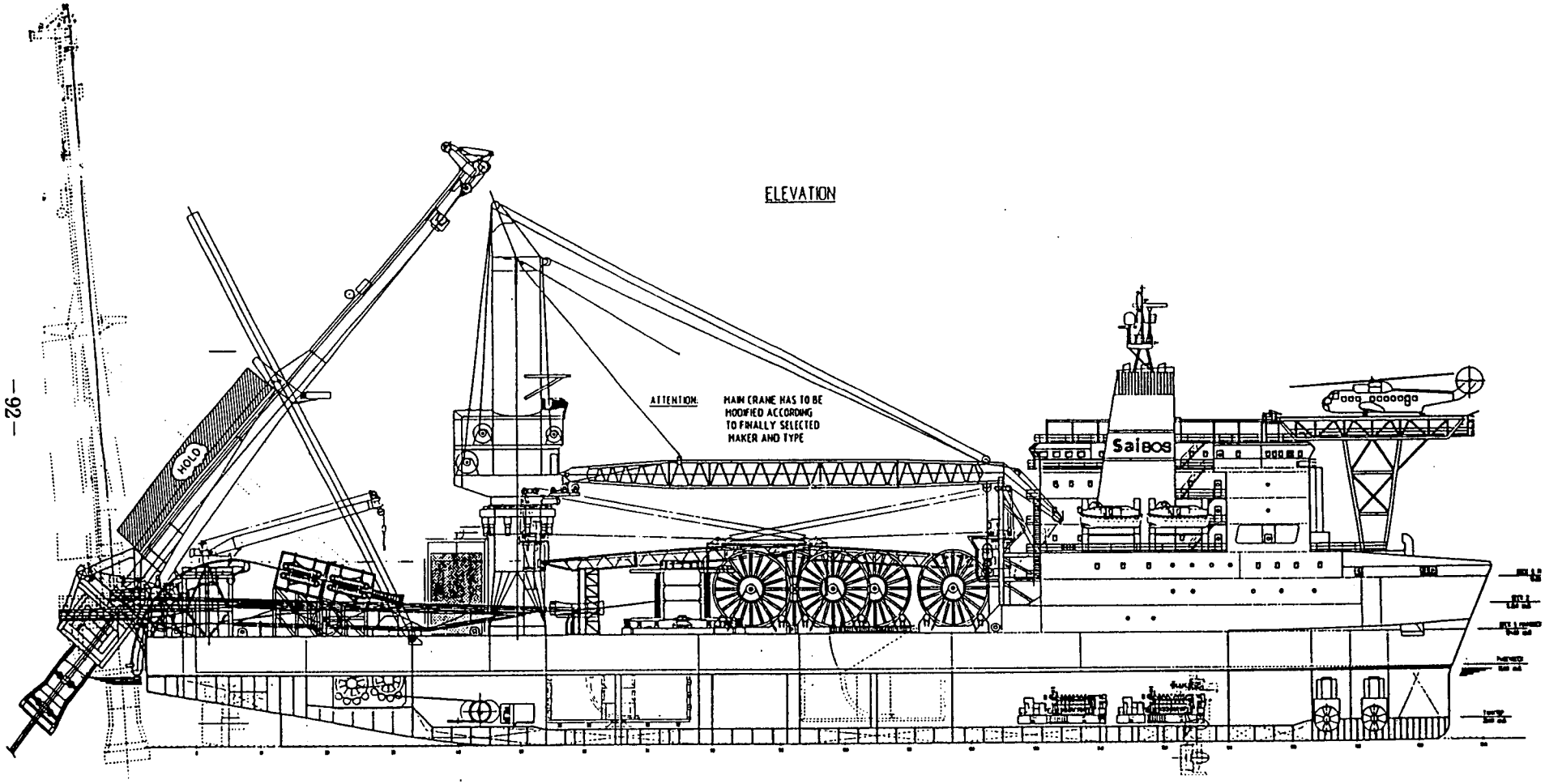

Figure 1. General arrangement of the Field Development Ship