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**THE BOUYANT TOWER AND FLOATOVER CONCEPT**

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The oil and gas industry is known for its constant rate of innovation. It pushes the limits of subsea exploration as deepwater fields and wells are drilled even deeper and located further offshore.

So it’s no surprise that a new generation of oil platform has been designed. The first of its kind, the Buoyant Tower which currently sits in the Pacific Ocean, may well revolutionize exploration and production around the world.

**New generation design**

Designed to reduce the overall timelines from offshore exploration to production, this new concept facilitates the fabrication and installation of a drilling and production platform, while enabling reduced project timings and costs, and provides the flexibility to re-use and re-locate the Buoyant Tower anywhere in the world.

Comprising four cylindrical tubes with one central suction pile, each cell measures 8.4 meters / 28 feet in diameter, and 60 meters / 197 feet in length. The central suction pile, integral to the full structure, attaches the structure to the seabed. On top of the 2,500 ton Buoyant Tower hull, sits a 1,500 ton platform where the production drilling is carried out. Suitable for water depths between 50 and 280 meters / 165 to 920 feet, it can be used in any type of field with any variation of reservoir characteristics – oil, gas or a combination, and the drilling can be modularized to adapt to the needs of the operation.

The tower is designed on existing cell spar technology and due to the simplicity of the cellular components of the hull, it falls in the category of a ‘compliant structure’ – one that accommodates the dynamic forces through flexibility instead of resisting the loads rigidly, thereby limiting the internal dynamic loads - and is less expensive than fixed platform alternatives. Similarly, the system is well suited for regions with seismic activity, better than a traditional fixed platform.

The topside and fabricated tower of a production platform – which can vary dramatically in weight, from less than 1,000 tons to more than 40,000 tons - are first loaded onto a heavy vessel for transportation to its offshore installation location. The vessel then submerges to allow the tower to float off, while the topside remains on-board supported by a truss system. Once the tower is in an upright position, it is towed close to its final destination. The critical float-over operation, which involves placing the topside over the tower to connect the two together, can then begin.

An important aspect of the design is to help dampen the loads while performing the float-over; the crucial challenge being to transfer the load from the topside to the tower mating points in a controlled manner without causing damage to either structure.

Traditionally the topside is lifted on to the tower or substructure by an offshore heavy lifting crane, however, the rates for hiring these can be very high - sometimes running into several hundred thousand dollars a day. Using leg mating units (LMUs) and deck support units (DSUs) will provide a much more cost effective solution and offers a proven technology and successful installation method for offshore constructions.

A major cost saving benefit of the Buoyant Tower design, was that only one major construction vessel was needed for the installation procedure. This project was the first cantilevered float-over operation from a heavy transportation vessel. The motions of the transportation vessel and the design of the cantilever structure had to be thoroughly evaluated.

In addition, the float-over process enables nearly all of the work on the topsides to be completed in the fabrication yard, resulting in much lower labor costs.

**Engineering elastomeric to cushion the impact forces**

The LMUs - which consist of steel structures incorporating engineered elastomeric pads - make the transition possible by dampening the forces created, as the topside’s load is transferred to the tower.

The elastomeric pads are designed to take up the static and dynamic forces of the topside structure, as well as the horizontal forces due to open sea motions during the float-over mating operation. The vertical elastomer pads are normally complemented with horizontal elastomeric pads to cater for this movement. Using data provided by the offshore consultants on the expected loads and movements, the elastomeric pads are carefully engineered and calculated with non-linear finite element analysis (FEA), to achieve the expected spring stiffness for this crucial task.

The assembled LMU can be installed either on the topsides or jacket. In this recent Buoyant Tower project, LMUs were installed underneath the topsides with deck leg casing. The LMU receptor heads and stabbing cones, welded to the tower, were the contact points between the topside and the tower.

DSU’s are also important components for safe float-over operations. The topside is loaded onto the vessel with a deck support frame and the DSUs are then placed between them to absorb the weight of the topsides. This enables the LMUs and DSUs to work together in synchronization. When the heavy vessel starts to ballast, decompression will occur on the DSUs and vertical compression will occur on LMUs.

The fendering systems are commonly used to absorb the impact of the heavy vessel and the tower as it moves forward or sideways during the mating operations. After the installation is completed, the topside structure is welded to the tower. This concept can also be applied to SPAR, Semi-Submersible or TLP design.

FEA design calculations are carried out to identity the high stress build-up area and potential of buckling due to the unstable elastomeric column. Full-size tests help to validate the performance characteristic of the LMU design during the mating process.

**Stringent Quality Control and Testing Requirements**

Weather and sea state conditions are often affected by location, which naturally impacts on vessels in numerous ways, making it imperative to thoroughly test the specific combination of weather and vessel for each application.

With the ability to perform full-size LMU compression testing, to maximum design factored load capacity, clients should specify units which are tested using a press with a capability of 18,300 MT, for the most accurate results. All LMU elastomeric pads shall be tested to verify their non-linear stiffness behavior, before the site installation occurs.

**Designed to perform**

With a large amount of load placed on the elastomer pads during the float-over process – both physically and metaphorically – it is key that a high performance product is specified. Without second chances, every effort must be made to achieve perfection. To ensure this, an understanding of the characteristics and benefits of the elastomeric materials used in the float-over process are important. For example, the number of elastomeric layers and its size, will influence the vertical non-linear stiffness.

**Conclusion**

Innovations within the offshore oil and gas industry have developed rapidly in recently years. As the unpredictable environment continues to produce new challenges, concepts such as the new Buoyant Tower will remain. Due to the high stakes involved in offshore oil platform construction, specifically during the complex float-over process, it is imperative that only the most advanced products and solutions are used.

With this in mind, it is vital to work closely with an experienced designer and manufacturer that can offer world class design engineering and comprehensive testing programs, to ensure optimum solutions and compliancy with all international standards.

**Words:** 1,200