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# Dynamic Responses of a Dry Tree Semi-submersible Platform with Ram Style Tensioners in the Post-Katrina Irregular Seas

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## ABSTRACT

This paper presents dynamic responses of a dry tree semi-submersible platform with RAM style tensioners in the post-Katrina irregular seas with the emphasis on maximum heave motions, heeling angles, extreme RAM style riser tensioner strokes and minimum air gap. These key design parameters are essential for determining the feasibility of concept application. In ultra deep water, say 1524 m (5000 ft) plus, there is only one proven dry tree hull form available for the offshore industry. Since there are more and more large reservoirs being discovered in ultra deep water, there are strong market demands to mature more concepts to enhance the competition and improve the field economics. A dry tree semi-submersible platform with RAM style riser tensioners is an alternative hull form which might be market ready soon. By adopting the RAM style tensioners and the nonlinear nature of tensioner vertical stiffness, the platform heave natural period shifts closely to the wave energy. Roll and pitch motions are also affected significantly because of the coupling. The post-Katrina API metocean criteria and new acceptance requirements of 1000-year events, add to the complexity of designing a dry tree Semi-submersible with RAM style tensioners. Therefore, there are strong interests for the offshore industry to explore the characteristics and impacts of dynamic responses of a dry tree semi-submersible platform with RAM style tensioners in the post-Katrina irregular seas.

KEY WORDS: Dynamic Responses; Dry Tree Semi-submersible; Ram Style Tensioner; Post-Katrina Irregular Seas; Coupled Analysis.

## INTRODUCTION

With the significantly increasing demand on the oil and gas supply, exploration in the Gulf of Mexico (GOM) is moving to explore the challenged and complicated ultra-deepwater reservoirs. These reservoirs usually require large drilling rig and drilling variable payload which result in very large topsides in both size and weight. Spars and TLPs are the only two proven dry tree hull forms in water depths below 1524 m (5,000 ft) in the GOM. However the TLP becomes cost prohibitive if the water depth is beyond 1524 m (5000 ft). Thus Spar is only proven hull form for ultra deep water depth. For large payload systems, especially those requiring a large drilling rig and large topsides payload, a suitable Spar size creates a challenge for transportation and installation. The semi-submersible hull form is known to offer advantages over Spars such as larger deck space. A large deck space is important for drilling and quayside integration both of which are essential to reducing offshore commissioning time and risk as well as cost and schedule. Therefore, it is believed that the dry tree semi-submersible is cost competitive with the Spar in moderate topsides payload and is more economical than the Spar with larger topsides payloads. In the current ultra-deep-water market, the Spar is the only dry-tree option for moderate payload systems. If the dry tree semi-submersible solution is mature and market ready, it will increase contracting options, potentially reducing development costs.

The description and application of RAM style top tensioned riser system on Spar have been presented by Perryman et al (2005) and Smith et al (2005). One of the objectives of this paper is to explore use of conventional technologies, including Ram style riser tensioners (same as those used on Spar), and simulate dynamic responses of a dry tree semi-submersible in post-Katrina central west GOM irregular seas. The hull form employed for this study is newly invented and developed by Houston Offshore Engineering, LLC, and is in patent pending status. The proposed hull form makes it possible to utilize the proven technologies and does not need any step-out applications and qualifications including equipment limitations, fabrication, transportation, installation, well-bay layout and health, safety and environmental (HSE) considerations.

In the past two years, two severe hurricanes, Katrina and Rita, created catastrophic loss of platforms and lives. The latest API post-Katrina metocean criteria and acceptance requirements of 1000-year events have compounding effects on floating platform design in the GOM, especially in the central Gulf region. The irregular seas have increased not only in terms of significant wave height (Hs) but also in terms of wave peak period (Tp). Both current speed and wind speed increase considerably as well. The new acceptance requirements of 1000-year events, such as minimum airgap and maximum mooring line tension safety factor, also impact the platform sizing and mooring sizing. Therefore, there are strong interests to explore the characteristics and