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## Flexible Pipe Design Optimization for West Africa Deepwater: Agbami Production Riser Case Study

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### Abstract

Improved design methodologies associated with optimized material selection have been successfully applied in the Agbami development in 1450-1600m water depth to meet the field requirements related to the proposed flexible pipe system. The subsea production and gas/water injection wells will be connected to an FPSO via subsea manifolds, with flexible risers, flowlines and jumpers.

Low-sour service conditions (50ppm H<sub>2</sub>S) specified for the production from Agbami field development were taken into consideration in order to design the most suitable pipe structures. Adequate plastic materials have been selected to optimize annulus environment of corrosive gases to a level compatible with the selected sweet high strength steel wires. Extensive testing has been carried out to ensure the steel wires selected for the Agbami pipe structures have sufficient resistance to SSC/HIC in the anticipated annulus conditions. Design of the 8" production flexible riser structure proved to be challenging to satisfactorily accommodate all loadings associated with the deep-water environment, the low sour environment with the use of high strength sweet steel armor wires and in a single pipe section of 2000m long.

The sealed plastic outer sheath of the flexible risers is protected by a plastic layer re-enforced by means of high strength aramid tapes. This design of the pipe structure significantly increases the mechanical resistance of flexible pipe against any kind of external damage as demonstrated through a series of full-scale qualification tests carried out on real pipe samples and witnessed by Third Party.

The bend stiffener arrangement fitted over the flexible risers and located at the FPSO keel level, has been designed to accommodate abnormal scenario where the FPSO heel angle can reach 17° under damaged conditions for the vessel hull.

An integrity management process has been initiated at the beginning of the project to identify potential causes of failures in order to implement a risk-consistent monitoring and inspection strategy to avoid failure during the service life of the considered flexible pipe system.

This paper describes how innovative pipe design can enable the use of relatively large outside diameter flexible riser, for sour service production application, in deep water whilst utilizing a single pipe section.

### Introduction

Flexible pipe has a long history of successful performance in deep water oil and gas industry. As the oil and gas reserves get deeper, the design challenges associated with the field developments increase. Improvements in the design methodologies, tools and the increased knowledge from field experience on the materials performance used to define the most suitable flexible pipe structures have had an impact on improving pipe design optimization, reducing design cycle times, minimizing the need for project specific qualification and finally reducing pipe cost.