As the deepwater CALM buoy becomes a common solution for offloading from spread moored West of Africa FPSOs, MARIN is carrying out an increasing number of model tests in a bid to improve buoy designs. Report outlines two recent model test projects carried out in its Offshore Basin.

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MARIN helps improve CALM buoy design

Bonga SPM buoy tests

For SBM of Monaco model tests were carried out on the Shell Bonga Field SPM system and its associated asymmetric spread mooring system at a scale of 1:60. Since at this model scale it is not possible to model the actual local water depth of 1,000 m due to available maximum model basin depth of 10.5 m, an equivalent mooring system was used in the available scaled water depth of 600 m.
This equivalent mooring system was designed so the load-displacement characteristics and dynamic response characteristics were identical to the characteristics of the full length mooring system. Furthermore, three 19”Bonga Oil Offloading Risers (BOORs) in double wave configuration were modelled in the tests.

Initially, model tests with the buoy alone were carried out in order to confirm the adequacy of the design of the buoy itself, the mooring system and the BOORs. The buoy motions were measured, as well as the tensions in the mooring lines and the risers. Underwater video recordings were made to ensure that the line spacing was sufficient to avoid impact between the mooring legs and the BOORs. In addition, model tests with the shuttle tanker moored to the SPM buoy were carried out to investigate the shuttle tanker motions and bow hawser loads. For these tests various operational and survival conditions were used.

Large scale model tests

For Bluewater Energy Services, MARIN performed a research project to investigate the coupled motions of a CALM buoy and its mooring system (risers and anchor lines). Numerical simulations of the buoy motions were carried out with a newly-developed tool taking into account the coupling between the buoy motions and the dynamics of the mooring system. Until now, the interaction between mooring line dynamics and first-order motions of floaters was often neglected in numerical simulations. For a CALM buoy however, this cannot be done since the mass of the buoy and the mass of the mooring system are of the same order of magnitude.

The aim of the project was to investigate the first order buoy motions. Results of model tests then served as input to the numerical model (damping values and wave force measurements) and to validate the numerical model (buoy motions and top tensions in the risers and mooring lines in waves). A comparison between the model tests and the simulations showed that the surge and heave motions of the buoy can be predicted well with the numerical model.*

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Bonga SPM buoy.

*** References Bluewater Energy Services**

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