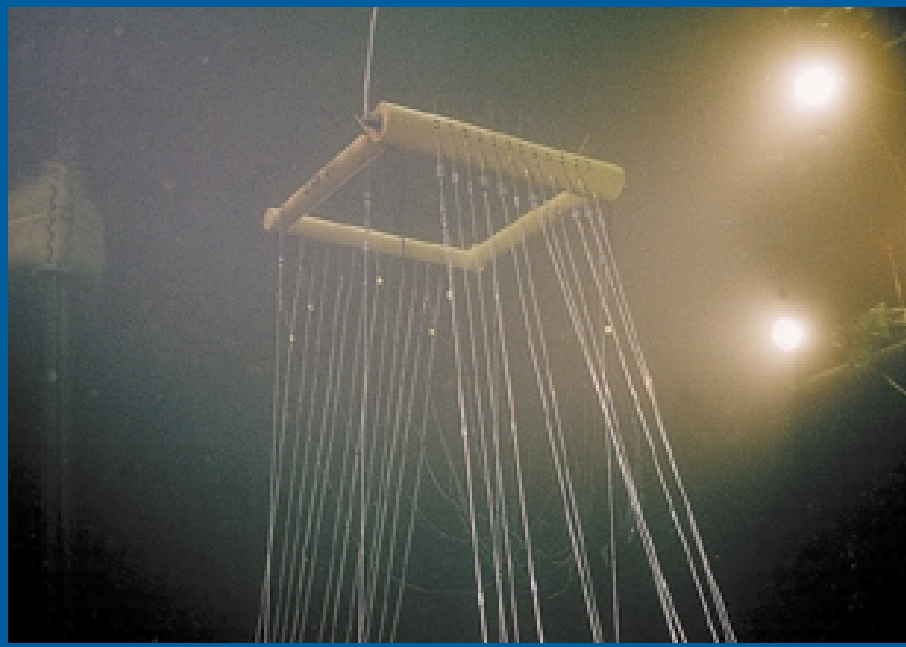
**Brazilian oil company Petrobras has been working together with the university COPEE/UFRJ in Rio de Janeiro on the development of the Sub Surface Buoy (SSB) concept. This to tackle the problem whereby large vertical motions at the bow complicate the use of steel catenary risers (SCRs) from turret moored FPSOs. Report explains.**



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# Deepwater innovations offshore Brazil

The SSB deepwater concept consists of a large submerged buoy connected to the sea bed by means of tethers. This buoy supports the production risers running from the seabed, while flexible jumpers are placed between the submerged buoy and the FPSO turret. The buoy is placed quite far below the water surface which means its motions are sufficiently small to enable the use of SCRs.

In August 2001, an extensive series of model tests was carried out on the SSB concept on behalf of COPPE/UFRJ (Federal University of Rio de Janeiro) under contract of Petrobras. The purpose of the tests was to investigate the overall behaviour of the hybrid buoy in combination with the FPSO. Several different environments were introduced, varying the magnitude and direction of the waves, as well as the vertical current velocity profile.

Two different buoy models were considered. Two series of tests, one with SCRs and one with flexible risers, were carried out with special attention being paid to the displacements of the submerged buoy. From the underwater video recordings of the buoy, which also showed a reference grid in the background, its motions were determined. In addition the accelerations on the hybrid buoy were measured.

The motions of the SCRs, the flexible risers and the jumpers were carefully monitored. Axial loads in two of the tethers, the SCRs (or flexible risers) and the jumpers were also measured.
Due to the large length of the risers and the presence of current, vortex induced vibrations (VIVs) may occur. The selected data acquisition rate was therefore 250Hz. The measured axial tensions in the risers, in combination with the underwater video recordings, were used to determine whether or not VIVs could be observed in the various environmental conditions. The underwater video recordings were also used to verify that no clashing between the risers would occur.

Undoubtedly, the results of the model tests showed the feasibility of the SSB concept. After completion of the model tests, COPPE/UFRJ and Petrobas worked together on the scientific interpretation of the results, using the model test results to validate numerical models and the concept itself. MARIN

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