**Traditionally the MARIN program LIFSIM has been used extensively by the Offshore Department to assist clients in the design and evaluation of their floating systems. Report outlines some of the latest projects where LIFSIM has been deployed.**

# Offloading of LNG Increasing

Recently several projects have been carried out with multiple floating systems, related to the offloading of LNG offshore. These systems require a careful evaluation of interaction and shielding effects in wind, waves and current. In the forthcoming year, the LIFSIM program will be further extended with the modelling of dynamic positioning made possible.

### Model tests and simulations for Main Pass

The Main Pass Energy Hubb (MPEH) is an offshore LNG offloading terminal, designed and destined for the Gulf of Mexico. Bennett and Associates carried out the design and asked MARIN to carry out model tests and simulations. Expected to be operational in 2007, the MPEH consists of two dolphins moored to the seabed at a water depth of 64 m. The dolphins are triangular-shaped, semi-submersibles, consisting of three vertical columns connected by means of bracings and a heave plate below the columns. Two vertical fender plates are connected by means of a support system to two of the columns. LNG carriers can be moored to the dolphins by means of fenders, breast lines and spring lines. Further stability is obtained by two moored surface buoys that can be connected with wire rope to the stern and bow of the LNG carrier. In between the two dolphins, a production platform is located with an offloading

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Floating Storage and Regassification Unit (FSRU) for LNG.


Main Pass Energy Hubb during tests in the Offshore Basin.

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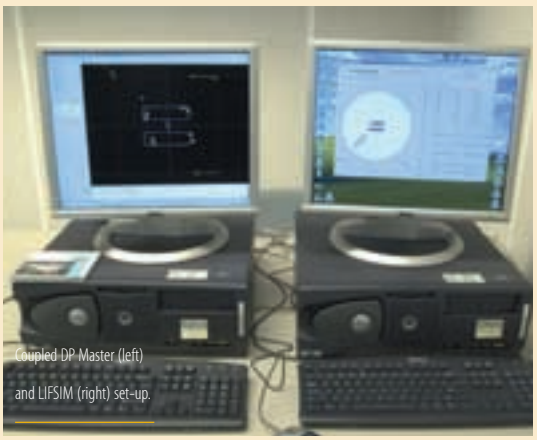
arm for the offloading of LNG. Close to the platform, storage of the gas is provided by means of gas storage caverns. Finally, pipelines transport the gas onshore.

Tests in the Offshore Basin were carried out in operational conditions (wind, current and waves).

# demand for LIFSIM program


Coupled DP Master (left) and LIFSIM (right) set-up.

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The dolphins were also tested in hurricane conditions and in regular waves to obtain the motion response. A diffraction model was made of the three-body system in order to study the complex wave interaction effects between the LNG carrier and the dolphins. The results are currently being used to build a numerical model of the system in the MARIN program LIFSIM.

## Simulations for Cabrillo Port

BHP Billiton's proposed Cabrillo Port offshore deepwater facility is a floating storage and regassification unit (FSRU) for LNG, located 12.1 nautical miles offshore Ventura County, California, in approximately 870 m of water. The FSRU will receive regular shipments of LNG, transfer it to the onboard storage tanks, re-gasify it and transport the gas to the shore through a new subsea pipeline.

MARIN assisted in the design of the FSRU by carrying out time-domain simulations of the system in various wind, wave and current conditions. A time-domain model was developed in LIFSIM of the LNG FSRU with an LNG carrier moored alongside. A two-body diffraction analysis was carried out for the calculation of the wave loads and wave interaction effects.

A total of 260, three-hour simulations were carried out to determine the weather thresholds. The maximum line, fender loads and relative motions were derived for each run.

## Extension LIFSIM with DP

As part of research activities MARIN has developed a coupling between the multi-body time domain simulation program LIFSIM and the DP control software DPMASTER. The DPMaster program contains all the elements of a conventional feedback DP system and is also used for DP model tests carried out at MARIN. For this research project the physical model in the basin was replaced by a numerical LIFSIM model.

All relevant data such as the position of the vessel and the actual thruster forces is shared by the two programs. The coupled model can be used to simulate offloading operations with a DP vessel involved.

During the simulation, LIFSIM models the floater and the DP vessel in time domain. If the DP vessel drifts away from the target position DPMaster reacts by generating an appropriate required thruster action. The thruster forces will then be put on the vessel in the LIFSIM model to keep it onto the target position. The results from this model are used to study the dynamic behaviour of the DP vessel and the second floater as well as the hawser loads between the two.

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