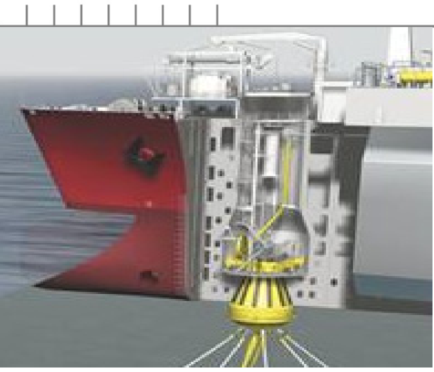
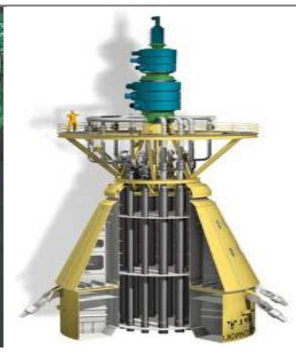
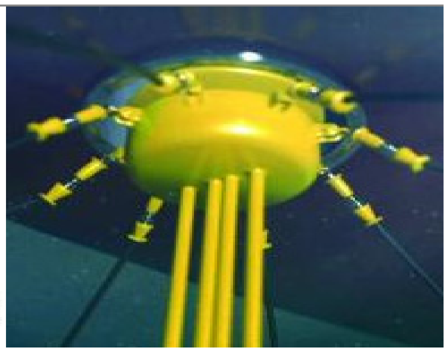


DISCO JIP

Hydrodynamics of Disconnectable Turret Systems

Analysis and Prediction of Hydrodynamic Behaviour of Disconnectable Turret Buoys for FPSOs

In recent years there have been a growing number of projects in the offshore industry that use disconnectable turret systems. The advantage of such a system is that in case a large hurricane or typhoon is moving towards the FPSO it can be disconnected from its risers and mooring quickly to avoid any damage to the facility. In this disconnection phase the turret buoy is detached from the vessel and drops to a safe depth of 100-200 m below the surface. The FPSO is then moved to a safe area until the storm has passed by. Afterwards the buoy can be picked up again and reconnected to the FPSO in a short period of time. In recent years we have learnt that it is challenging to predict the buoy behaviour during disconnect and reconnect without performing extensive model tests at multiple scales. The present JIP proposal focuses on the hydrodynamic design aspects of the buoy in disconnection phase and aims to deliver tools to predict the behaviour in the design phase of the project.

DISCO

Organisation

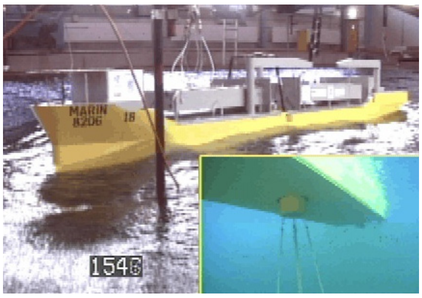
The DISCO JIP will be conducted as a 3-year Joint Industry Project in close co-operation with oil companies, operators, yards and marine system suppliers. MARIN will act as JIP manager and sign participation agreements with all members. All participating companies will be represented in the JIP Steering Group with meetings during the FPSO week every 6 months. Presentations, reports and other relevant info will be posted on the confidential project website.

Objective

The aim of this JIP is to better understand the hydrodynamics of a disconnected turret buoy in close proximity of the FPSO in high sea states. The final objective is to predict dropping behaviour and the motions and mooring forces on the buoy during the disconnection phase in a given wave and current. Model tests and CFD will be used to predict the buoy behaviour and interaction with the moving FPSO in waves and current. The initial acceleration and final velocity of the dropping buoy will be tested and predicted using CFD and a time domain simulation tool for various buoy shapes.

Previous work

MARIN has been involved in testing a number of disconnectable turret systems in recent years. These projects are generally focussed on the behaviour of the buoy in the disconnection phase. One important aspect is how the buoy can detach from the FPSO and drop quickly enough to avoid collision with the FPSO hull. The disconnection itself will generally take place in severe sea states (high waves and current), which makes it challenging to predict the buoy interaction with the FPSO. Another aspect is that the full mooring system is generally tested at a typical model scale of 1:50 to 1:70.



Disconnectable buoy system for DP FPSO JIP

Previous tests at various scales have shown that the buoy acceleration in the early stage of the disconnection may depend on the tested scale and is therefore difficult to predict. CFD is a rapidly developing technique and a good candidate to explain these scaling effects and use them for better predictions of the actual system. Because the disconnection for the real system in severe weather condition is a rare event no data is available for the design of these systems. We believe that a JIP to research the hydrodynamic behaviour of the buoy just after disconnection will provide the required insight and input for the design of safe disconnectable systems.

Scope of work

The objective of the new initiative is to increase the insight into the hydrodynamic behaviour of the disconnectable buoy in realistic environments during the disconnection and reconnection phase. Typically this environment will be dominated by:

- Large waves
- Current
- Motions of the FPSO

To understand the behaviour the first phase of the project will be to determine the hydrodynamic coefficients of the buoy alone and in proximity of the FPSO hull.

- Captive tow tests to investigate current loads
- Oscillation tests to investigate added mass and damping
- Dynamic drop tests in calm water
- Dynamic drop tests in waves with fixed and moving FPSO
- Dynamic motion test in waves with the buoy just below the hull (just after disconnection and during reconnection)

It is proposed to carry out the above tests for a systematic variation of buoy shapes, for instance a torus with varying top angle. These shapes and top angles will be decided by the JIP participants to ensure a realistic case. CFD tools will be used to calculate the behaviour of the buoy for the tested conditions. This includes a multi domain approach where the water velocities from a linear diffraction computation may be used as input for a local CFD domain close to the buoy. In the second phase of the project we will use the hydrodynamic coefficients of the first phase to build a numerical model of the disconnectable system. This model will be tuned for:

- Initial acceleration in calm water
- Final velocity in calm water
- Equilibrium depth of the buoy after disconnection
- Hydrodynamic behaviour in waves close to the hull during reconnection

The tuning of the numerical model will be based on hydrodynamic coefficients which describe the added mass and damping of the buoy in various directions. The working of the model will be validated against the dynamic model test results obtained from phase 1.

Project deliverables

The deliverables of this JIP can be used to improve the hydrodynamic aspects of the buoy design and to mitigate the risk of the buoy impacts against the FPSO/FLNG hull. The most important deliverables of this project will be:

- A special project version of the time domain simulation tool aNySIM_pro will be delivered. This version will be tuned to the model test results which will be performed in this JIP
- Reports of model tests measurements with interaction coefficients and derived RAOs and load coefficients for the buoy on various distances from the FPSO hull
- Reports of comparison with numerical simulations and guidance on future simulations
- Results and input files of CFD computations for a buoy in close proximity of the FPSO hull
- Detailed step-by-step insight into the hydrodynamic processes during the disconnection and reconnection phases and the corresponding scaling effects

For more information contact MARIN:
Olaf Waals
T +31 317 49 32 77
E o.waals@marin.nl