Vortex Induced Motion Study for Deep Draft Column Stabilized Floaters

Project Fact Sheet

Program
Ultra-Deepwater Program

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11121-5404-03

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RPSEA Share
$2,138,100

Cost Share
$535,592

Prime Contractor
Houston Offshore Engineering

Participants
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Research Objectives

The project objective was to improve the overall mooring system safety and riser system integrity by testing design parameters for deep draft column stabilized floaters (DDCSFs) to determine which have the most impact on vortex induced motion (VIM). Recent studies by industry have reported that the field measured VIM response of platforms is lower than the VIM response predicted by scaled model testing. The project will focus on full scale computational fluid dynamics (CFD) simulations and effect of damping from mooring and risers on VIM response. DDCSFs have excellent applicability for development of challenging reservoirs in deepwater and ultra-deepwater in the Gulf of Mexico. However, increased payload requirements and a general desire to reduce platform motions have resulted in larger platforms with deeper drafts, making them susceptible to VIM. Improved VIM performance has the potential to increase hydrocarbon reserves by making reservoirs more accessible to safe, reliable development.

Approach

The study utilized CFD analysis and model testing to determine the sensitivity of VIM responses to DDCSF geometric parameters. The project studies both four-column DDCSFs and multi-column DDCSFs, specifically, the paired-column DDCSF developed by Houston Offshore Engineering (HOE).

The work was divided into two phases. The Phase 1 scope of work was primarily background research into VIM data and design practices, sizing DDCSFs and performing CFD analysis to understand DDCSF VIM sensitivity. CFD analysis will be conducted in full scale and model scale, and with and without damping to understand the effects from scaling and damping. The Phase 2 scope of work was primarily model testing and preparation of design guidance for the industry.

The study was led by HOE along with participants Los Alamos National Laboratory, MARIN, John Halkyard Associates and Red Wing Engineering. A Working Project Group (WPG) has been established to provide technical guidance. The WPG includes Chevron, Statoil, ABS, DNV GL, and Technip. The total project cost is estimated to be about $2.6mm, 80% of which is contributed by RPSEA. The remaining 20% was contributed by industry and participant cost share. Key deliverables associated with the project are model test data, CFD results and a recommended practice document that contains beneficial guidance for the oil and gas industry.

Accomplishments

As part of the CFD work, three different commercial CFD software (ANSYS FLUENT, Altair Acusolve, CD-adapco STAR-CCM+) were validated with the model test data available from the RPSEA4405 project. The hull form sensitivity of conventional and paired-column DDCSF to VIM performance was tested utilizing CFD. Sensitivity studies related to y+ values, mesh convergence, and turbulence models were also conducted to validate the accuracy of CFD predictions. VIM model testing of conventional and paired-column semisubmersible hull forms were conducted at MARIN. Testing also included a passive and active damping system to simulate the external damping due to mooring and risers, which is typically ignored in VIM tests. Multiple levels of damping were tested. The conventional DDCSF model was equipped with column force measurement system, so the results can be correlated with the CFD predictions. The results showed that the model test and design practice methodology currently followed by the industry is over predicting the VIM of DDCSFs.

Future Plans

Correlation of model test data and CFD analysis is planned. Some additional full scale CFD analysis will be conducted to investigate the scale effects further. The industry guidelines will be prepared and the project is expected to be completed by September 2016.