MARIN

Challenging wind and waves

Linking hydrodynamic research to the maritime industry

## Prediction of Water Motions and Pressure Distribution in Moonpools

# MOONPOOL-2 JIP

# Moonpool in Waves during Operation and Transit

## Background

Large water motions can occur in the moonpools of vessels operating or transiting in waves. In the last decade, the size of moonpools has significantly increased. Larger moonpools allow to conduct activities in parallel and thus to cut the operation costs. However, the water motions in the moonpool also tend to become more violent when the moonpool size increases. This can result in unsafe working conditions due to water on deck, and reduce workability if the motion behaviour of the vessel is affected. This can also lead to structural damages due to slamming on the equipment installed in the moonpool. To reduce the water motions, moonpool damping devices are commonly used. However, this is not always the ideal solution as these devices are expensive to produce and maintain. They also actually reduce the moonpool working area.

These observations show that a practical methodology involving reliable tools is required to help the industry to optimise moonpool designs. Guidelines should assist the designer in understanding the effect of the moonpool on the vessel's hydrodynamics. They should also show how to predict the water motions inside the moonpool and to assess the structural design loads. An improved moonpool design will lead to an increased workability, a lower risk of damage and a safer work environment. These all contribute to lower costs.

## Research questions

Within the Moonpool-2 JIP the following research questions will be addressed:

- Which design parameters affect the water motions and loading in the moonpool?
- How accurate are numerical methods in the prediction of water motions and pressure distribution in the moonpool?
- Which methodology is recommended to design a moonpool and assess the effectiveness of damping devices in an early design?
- Which pressure distribution on the moonpool walls is expected, and how does it correlate to the classification society rules?
- What is the safest position in the moonpool to store equipment in a storm?

## Objective

The objective of the Moonpool-2 JIP is to understand the dynamics of wave flows and loading in moonpools in waves during operations and transit, and to provide guidelines for the design and optimisation of moonpools.

## Previous work

MARIN has been involved in testing a large number of offshore vessels with moonpools in recent years. In the period 2013-2015, the Moonpool JIP was conducted together with ten participants. In this project, the hydrodynamics taking place in a moonpool in calm water during transit were investigated. The combination of model tests and CFD computations helped to understand the origin of the moonpool oscillations in calm water during transit.

MARIN
P.O. Box 28

6700 AA Wageningen
The Netherlands

T +31 317 49 39 11
F +31 317 49 32 45

E info@marin.nl
I www.marin.nl

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## Scope of work

The proposed scope of work will be made available in a project plan. Project participants are invited to discuss the final scope of work. At the moment, it is proposed to carry out a scope focusing on moonpool in waves during operation and transit. This involves a practical engineering tool, CFD computations and model tests.

### WP1. Potential Flow Computations (Practical Engineering Method)

A practical engineering method is required for the designer to identify the critical sea states among a multi-year wave climate, i.e. to identify the sea states resulting in the largest water motions which may damage the equipment. Such engineering methods are often based on potential flow theory. In the Moonpool-2 JIP, the applicability, accuracy and limitations of computations of moonpool wave flows based on potential flow theory will be investigated. This will be done by comparing the model test results from WP3 with the results of the numerical model. A benchmark study between participants will be organised. Based on this, guidelines will be defined.

### WP2. CFD Computations

At present, the application of CFD for the calculation of water motions and pressure distributions in the moonpool is still in its early stages. However, the results from the recent Moonpool-JIP show that CFD tools are already capable of predicting moonpool flows for transit conditions in calm water. In the Moonpool-2 JIP, the applicability, accuracy and limitations of CFD computations of moonpool wave flows will be investigated by comparing the model test results from WP3 with model scale CFD calculations. A benchmark study between participants will be organised. Based on this, guidelines for CFD applications on moonpools will be defined.

### WP3. Model Tests

It is proposed to initiate the work by a series of model tests conducted with a scaled model of a generic ship with a moonpool. The tests will be conducted both at zero-speed and with forward-speed in a wave basin. The purpose of the tests is to help to understand the mechanisms causing the water motions and loading inside the moonpool as well as to obtain experimental data that can be used for the validation of numerical methods. The influence of wave properties, moonpool configuration and damping devices will be investigated.

### WP4. Guidelines for moonpool design

The objective of WP4 is to define a practical methodology and guidelines for the design of moonpools. The focus will be on the step-by-step methodology and recommendations to be followed in order to assess the water motions and loading in the moonpool in an early design stage.

## Project deliverables

The JIP will provide:

- Model tests reports containing the measurements results, analysed data, time records in ASCII format and discussion of the results.
- CFD calculation report summarising the results of the benchmark study, and derived guidelines. Individual reports will also be delivered by each participant taking part in the benchmark study.
- Potential flow calculation report summarising the results of the benchmark study, and derived guidelines. Individual reports will also be delivered by each participant taking part in the benchmark study.
- Methodology and recommendations for the design of moonpools.

## Organisation and Schedule

The Moonpool-2 JIP will be conducted as a 2.5-year JIP in close cooperation with oil companies, owners, operators, design offices and yards. MARIN will act as a JIP manager, sign participation agreements with members and issue subcontracts. All participating companies will be represented in the JIP Steering Group with meetings every 6 months. It is noted that participation in the Moonpool-2 JIP does not require participation in Moonpool-1.

## Participation fees

A target participation fee of € 50,000 (excl. VAT) is foreseen for the operators and oil companies, and € 35,000 (excl. VAT) for the other participants. Payment of the participation fees can be divided over 3 years (one third per annual year). A discount is foreseen for participants contributing to the benchmark studies in WP1 and/or WP2.

For more information please contact MARIN;

| | Frédérick Jaouën, MSc | or | Bastien Abeil, MSc |
|---|---|---|---|
| T | +31 317 49 35 09 | | +31 317 49 34 69 |
| E | f.jaouen@marin.nl | | b.abeil@marin.nl |