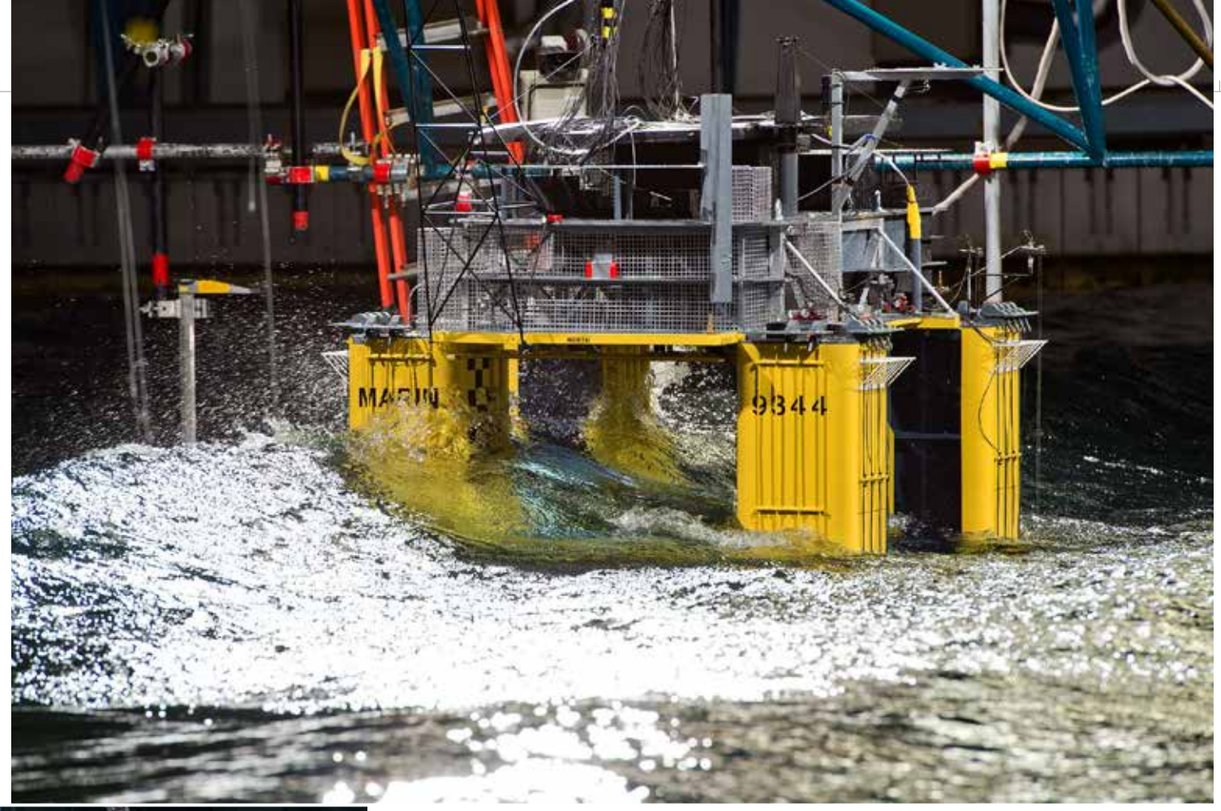
HESS on why it returns to MARIN to find answers

Joel Witz, Global Engineering Advisor at global independent energy company Hess Corporation, has been a regular visitor to MARIN for nearly three decades. Report asks how MARIN's testing facilities have assisted this leading energy firm over the years.



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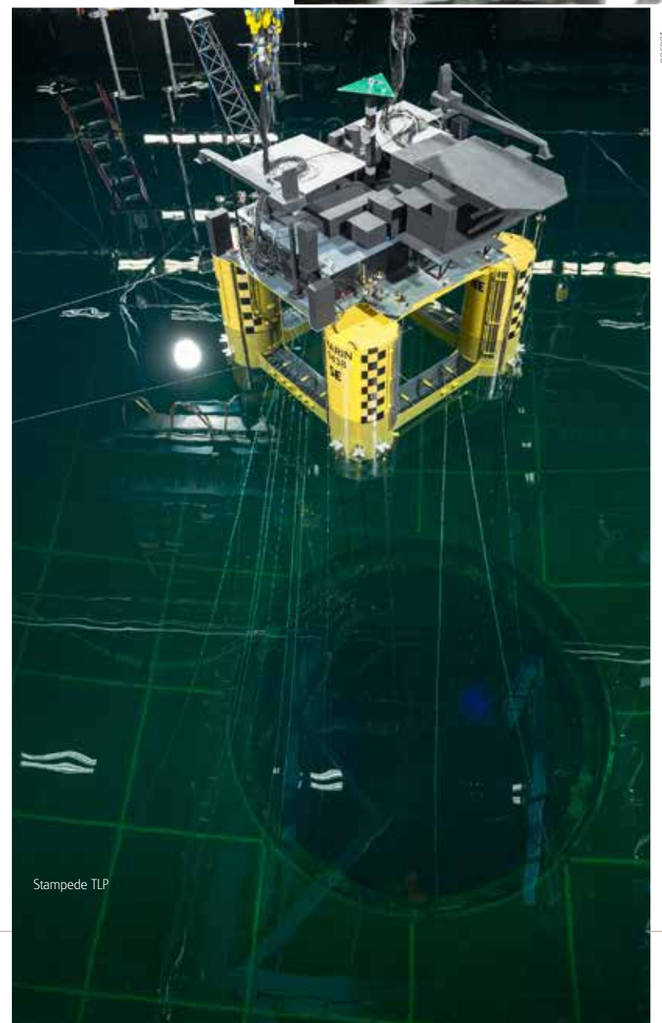
Joel recalls his first visit some 30 years ago to MARIN's headquarters in Wageningen, commenting that there were impressive facilities for the time but above all, he remembers the inspiring enthusiasm for hydrodynamics. Since those early days, he says, there have been step changes such as new facilities like the Offshore Basin and progressive changes in model construction techniques and improvements in instrumentation, data acquisition and analysis but MARIN's employees' enthusiasm for hydrodynamics has remained the same.

Commenting on why HESS has returned time after time, Joel outlines what specific design questions the energy company looks to have answered by model tests. Over the years, the company has performed a range of model tests focused on specific design questions. "For example, wind tunnel tests of an offshore platform in a calibrated marine boundary layer give the load coefficients needed for input into the numerical models used to determine the dynamic response. Towing tests provide similar drag load coefficients and can also be used to evaluate Vortex Induced Motion (VIM) responses that are difficult to estimate today by other means. And finally in the context of MARIN with the Offshore Basin it is possible to test the system in combined environments of wind, waves and currents so there is further insight into the overall system response, including the underlying structure-wind-wave-current interactions."



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Stampede TLP

Greater confidence HESS also looks at the tests in the Offshore Basin to ensure that it has not missed or underestimated any important nonlinearities in the design models that are influential in the response. "When one does model tests on a bespoke system it is not unusual to make some discoveries not foreseen in the design process beforehand." Then armed with a set of quality model test results HESS can refine numerical models giving it greater confidence that its design is robust.

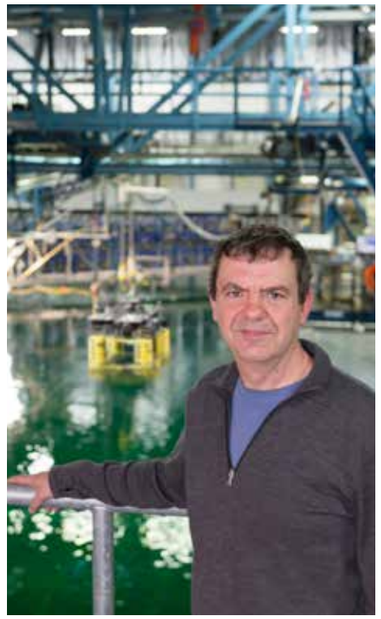
Several HESS projects at MARIN have also included time-domain simulations of moored platforms and FPSOs. Joel comments on how he sees the relation between model tests and computer simulations as 'symbiotic'. Both time domain simulations and model tests are needed in engineering design to evaluate the expected performance of the physical structures that we intend to build, he says. "Neither fully replicate all the complexities of a full-scale structure in the physical world but with both we can be reasonably confident that our design is sufficiently robust in terms of technical integrity." Neither is perfect but it is all about managing inherent risks to ensure a safe design in as low as reasonably practicable (ALARP) terms, Joel stresses.

With modern design HESS looks at an ever-increasing set of load cases to ensure it has a full screening to identify the governing load cases. Even with a significant timetable of model testing it is not practical to fully screen for every factor due to the time involved in setting op each load case, he says. With time domain simulations on the other hand, it is possible to do a full screening simply because of the available computer power these days and from this numerical screening HESS can identify the key load cases that it needs to model test. These model tests provide an extremely valuable but often underestimated role in the form of QA/QC of numerical models, Joel adds.

Numerical models These days some of the numerical models use large sets of input data, which are often transferred from one numerical tool to another and coupled with embedded assumptions. It is an increasing challenge to check the models. "We have moved a long way from the handwritten calculation sheets where everything was transparent – albeit simple. A carefully executed model test of a governing load identified by a numerical model can be used to verify the predictions. We do not expect the model tests to give exactly the same results as a numerical test but we do expect the same overall picture. If not, we either have perhaps an error somewhere or we have identified a complex physical behaviour whose importance was not fully appreciated from the numerical time domain simulation model."

As CFD calculations are applied to more and more hydrodynamic design problems, what role does HESS expect from CFD? CFD is playing an increasingly important role in hydrodynamic design and this has been facilitated by the ever-increasing availability of cost effective computer power, he says. "There are parallels here with structural design where we have first seen the decade of linear FEA and then the decade of non-linear FEA and this is all due to increased computing power coupled with vast improvements in the human interface with computers in terms of data visualisation and handling."

CFD "But CFD is still at the next level of complexity compared with the aforementioned structural design tools and I think that it will take a while to 'mature'. Today CFD tools are most valuable when they are calibrated against model tests and then used to evaluate parametric variations. In this context with the increased availability of CFD I see an increased need for model



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South Arne platform

tests in a calibration role. After all, computers only do what we instruct them to do using the assumptions we make, and model tests help us with a bit of a reality check."

In recent years, 3D CAD drawings and PVC as a construction material have become the standard at MARIN for building semi-submersible and TLP models. Does HESS consider this an advantage for its own projects? Joel certainly considers that there have been tremendous improvements by using both 3D CAD drawings and (weldable) PVC. "With 3D CAD models we fully represent our design intent and it has allowed us to improve models in the Offshore Basin for wind loads, for example." The one area in particular that has improved compared to a decade ago, is an ability to more accurately replicate wind loads from the wind tunnel tests in the Offshore Basin and the use of a common 3D CAD model is a significant contributing factor, he points out.

"With PVC constructions the quality of the models compared to a decade ago is a magnitude higher and many historical issues, like leakage, just don't happen these days and this is due to the improved construction offered by PVC. And because we can use transparent sections we can place cameras inside the model looking outwards. This gives us a view that we did not have before."

High-speed cameras This also touches on an area that has significantly improved the model tests and that is digital video and high-speed cameras, he adds. "A large part of model testing is the delivery of visual results and we can now capture local events at high resolution. This allows us to study the event in great detail particularly when comparing it to the measured time series of motions, wave elevations and loads."

Stampede TLP project HESS recently visited MARIN for model tests on the Stampede TLP. More details of this successful model test campaign are outlined on the adjacent page. Stampede was in a relatively long line of tests at MARIN for different projects. The Stampede TLP is a conventional TLP and so in itself, the test campaign was relatively straightforward both in scope and execution. But Joel explains, with each new model test campaign HESS sees a trend of increasing complexity in the model construction and associated instrumentation and Stampede followed this trend. "The Stampede model was one of the best built for us and it is a monument to the quality work done in its preparation for the basin campaign," he stresses. "The focus is essentially on executing the required test programme in a tight slot for the basin while achieving the highest quality results that we expect and here the basin crew excel."

But the tests are only the externally visible part of the test campaign, he stresses. The foundations are laid behind MARIN's closed doors by a large number of MARIN personnel including the project engineers, instrumentation and workshop technicians and data analysts who make significant contributions towards our high quality results that we can reliably use. "Here I thank all involved in tests for us who contribute towards our successful sequence of quality tests at MARIN, and long may it continue!"

With each test campaign HESS has always used the lessons learnt from previous campaigns and incorporated new developments. But Joel says he considers the high-speed camera aspects of the Stampede tests as a particular success. "While we used this system in the Offshore Basin in the previous test campaign at MARIN our techniques benefited from this experience to provide excellent visual results for Stampede."

Extreme conditions One of the important aspects for the design of semi-submersibles and TLPs is the deck clearance. What does HESS consider the main issues when addressing the platform response in extreme wave conditions? "The clearance between the deck of a floating facility and the instantaneous local wave elevation is a highly complex one in terms of the underlying physics and really is a subject of a workshop and certainly beyond a simple answer. It is one where there is still some debate and I am not sure that all the contributing physics involved in this structure-wave-current interaction is fully understood." However, he adds: "What I can say is I see model tests as extremely valuable in identifying and capturing these extreme events for subsequent assessment. While today's numerical models help screen these local events we still need high quality representative model tests for this aspect for design." Joel adds that over the next few years he would like to see the further development of CFD tools to improve on air gap prediction methodology for design. "And MARIN is well placed to make a significant contribution in this field!"