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REVIEW
NORWEGIAN MARINE TECHNOLOGY RESEARCH INSTITUTE

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Contents:

SINTEF

Hybrid Riser Tower for Harsh Environmental Conditions

The offshore tow is identified as the most challenging obstacle to the use of hybrid riser towers in harsh environments. Complex model tests of the tow are needed to verify this critical operation.

A hybrid riser tower for use in deepwater fields in harsh environments was developed in the first phase of the Joint Industry Project "Demo 2000 Riser Tower JIP", carried out in 2006 and 2007. The JIP was initiated by Aker Solutions and sponsored by DEMO2000 and the oil companies StatoilHydro and Shell, together with Det Norske Veritas and Aker Solutions.

The aim of the project was to develop and qualify hybrid riser towers for use in deepwater fields on the Norwegian shelf. Riser towers are attractive solutions for deep waters and several have been installed on fields west of Africa, but improvements were needed in order to qualify a system for harsher environment conditions. Figure 1 shows a FPSO with two of the riser towers. Each tower consists of a long riser bundle from the seabed to a buoyancy tank 100-200 m below the surface. From this buoyancy tank up to the FPSO there are flexible risers. A typical cross-section of the riser bundle is shown in Figure 2. Riser towers may be used for water depths from 500 m and down to several thousand metres.

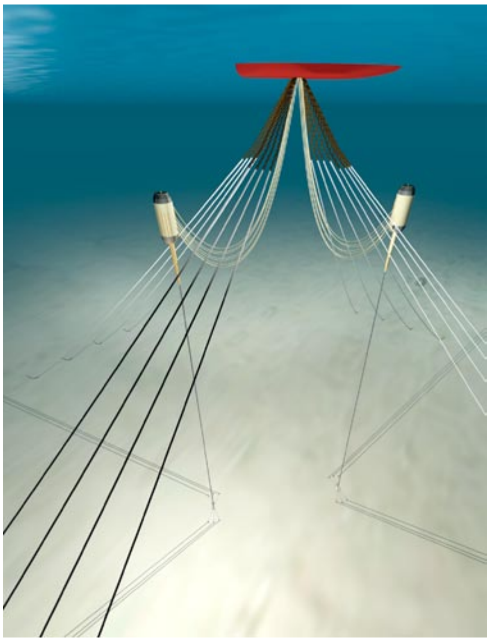

Figure 1. Field development with FPSO and two hybrid riser towers.

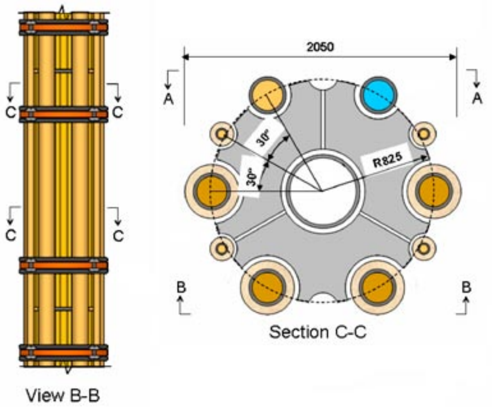

Figure 2. Typical cross-section of hybrid riser tower.

The riser tower will be assembled onshore, towed to the offshore field, upended and connected to a previously installed anchor. The offshore tow is identified as the most challenging obstacle for using hybrid riser towers in harsh environments.

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Safety of Free-fall Lifeboat Passengers during Water Impact

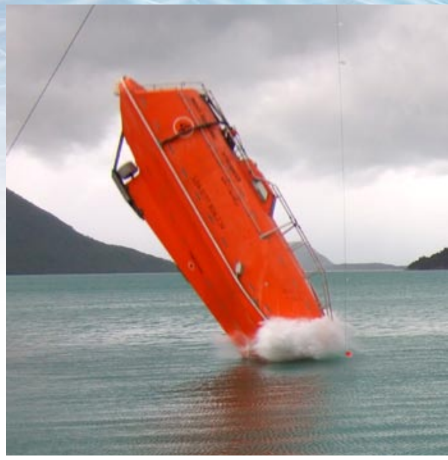

Figure 1. Full-scale testing of a free-fall lifeboat entering calm water.

Once it has been released from its mother vessel, the escape of a free-fall lifeboat relies solely on gravity. This very feature contributes to make free-fall lifeboats a fast and reliable evacuation system. However, in rough sea conditions, acceleration loads on the passengers during water impact can cause severe injuries. MARINTEK has been studying this safety issue for the three past years, using a combination of experimental and theoretical methods.

A complex slamming situation

Under a contract with the Norwegian Oil Industry Association, MARINTEK carried out an extensive series of experiments on free-fall lifeboats, on both model and full scale (Figure 1). The experiments aimed to characterize acceleration levels on lifeboat occupants during water entry, pressure loads on the hull, and forward speed after water exit. Acceleration loads during impact in waves were found to be much higher than in calm water, and often beyond the limits imposed by current IMO regulations. Accelerations were also found to depend on a wide range of parameters: hull shape, mass distribution, wave heading relative to the lifeboat, and the point of impact on the wave surface.

Development and validation of a theoretical model

Under these conditions, assessing the operational limits of a free-fall lifeboat in terms of significant wave height would have been costly and time-consuming if it had been carried out by model testing alone. In collaboration with NTNU, therefore, MARINTEK developed a theoretical method of predicting three-dimensional motions of a body impacting a wave surface. The description of "slamming" is based on conservation of momentum, combined with a von Karman approach, meaning that the water rising close to the hull is neglected. Body motions are described in terms of six degrees of freedom and wave kinematics is described in three dimensions. This allows any type of impact in waves to be described (see for example Figure 2). This theoretical model has been implemented in a free-fall lifeboat simulator and validated by comparing predicted accelerations at impact to experimental data. About 300 cases with different types of lifeboats in various wave conditions were used in this validation phase.

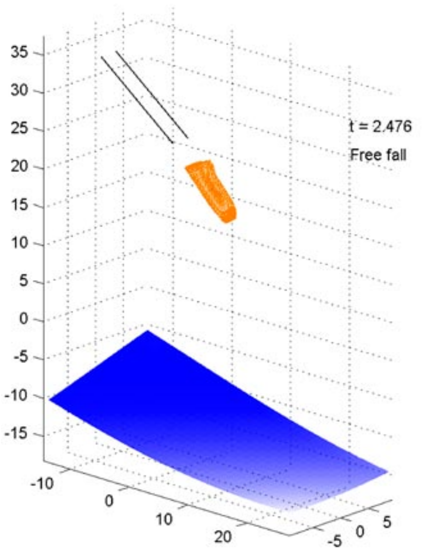

Figure 2. Snapshot from a simulation in stern quartering seas.

Reassessing operational limits of 16 types of lifeboats

The simulator has then been used to re-evaluate the operational limits of 16 different types of free-fall lifeboats installed on the Norwegian continental shelf. The efficiency of the software and the use of a high-performance computer cluster made it possible to carry out the whole project in less than seven months. Statistical estimates of the severity of impacts (Figure 3) were obtained for a wide range of sea states. Selected impact situations were studied in detail by specialists in injury-biomechanics. The risk of injury was assessed here by means of numerical simulations, which were validated by full-scale and laboratory trials using instrumented dummies (Figure 4).

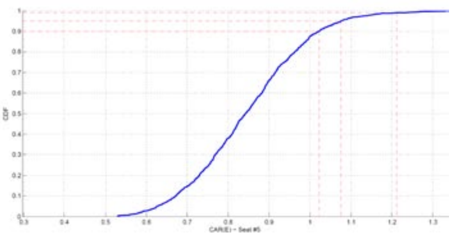

Figure 3. Cumulative distribution function of the CAR index for a given seat, in a given sea state. The CAR index is calculated from acceleration time series. Below 1, the risk of injury to the occupant is supposed to be low.

Towards new regulations and new lifeboats

MARINTEK experts have recently been involved in the development of recommended practice for the design of free-fall lifeboats. New contracts have also been awarded for the verification of novel designs. A similar approach that combines experiments and numerical simulations will be used.

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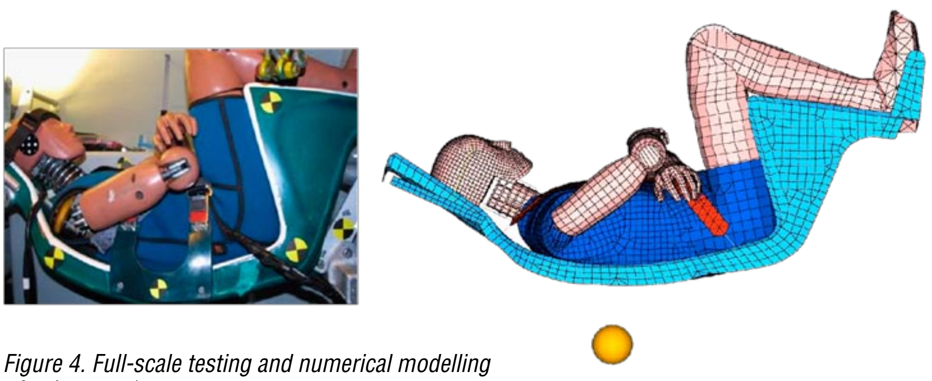


Figure 4. Full-scale testing and numerical modelling of a dummy. (Courtesy TNO Automotive, The Netherlands.)

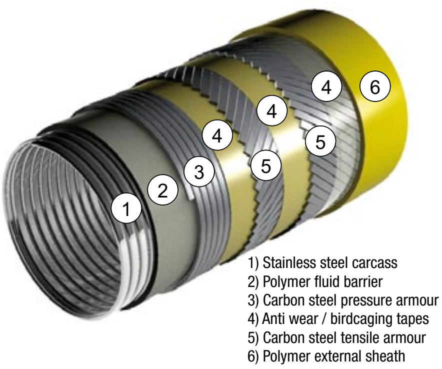
Flexible Risers - Corrosion Fatigue

Floating Production Systems and Flexible Risers

Through the 1990s, the concept of floating production systems (FPS) was developed and implemented as a cost-effective way of exploiting offshore oil and gas fields. For deepwater fields, there are usually no alternatives, except when they are close to the shore. For marginal fields, costs may be significantly reduced by employing FPS instead of traditional fixed platforms.

The riser system is a critical element in floating production: if risers fail, the entire system fails. A floating production system generally requires risers that allow large floater motions induced by wind, current and wave loads to occur without over-stressing the pipe. In most cases the risers of an FPS are nonbonded flexible pipe, which is a compliant structure made of a composite nonbonded pipe wall that allows large variations in curvature. The load-carrying elements are steel profiles - armour wire - of medium- to high-strength steel.

In many cases, armour wire fatigue is a limiting factor in the design life of flexible risers. In the as-fabricated state, void space in the pipe annulus is filled with atmospheric air. Until a few years ago, the fatigue design of flexible risers was based on S-N data obtained by component testing in air, with the implicit assumption that the environment in a pipe annulus is benign with regard to armour wire fatigue. However, for several possible reasons, the chemical composition of the annulus may change during operation, as discussed below.



Cross-section of a flexible riser, showing the most important layers of the wall structure.

Seawater ingress

It is known from service experience that seawater flooding of flexible pipes due to leakage of the external sheath is a possible scenario. In that case the effect of cathodic protection, for example by shielding at some distance from the point of leakage - needs to be considered. The chemistry of sea water, in particular oxygen levels inside the annulus and also the possibility of corrosion induced by bacterial activity are important issues. The diffusion of gases from the bore, in particular CO_2 and H_2S, and their respective partial pressures, are important parameters.

Diffusion from the bore

Similar issues arise with respect to diffusion from the bore; e.g. the rate of diffusion of water vapour, condensation in the annulus, ionic content of condensed water, diffusion of gases from the bore, in particular CO_2 and H_2S, and their partial pressures.

Repaired pipe

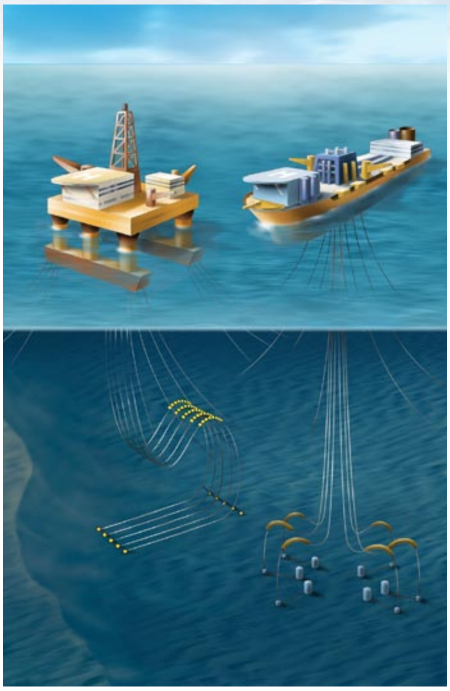
Pipes that have suffered seawater ingress can be flushed and repaired, and then re-installed. The following issues arise: time-frame for inspection and repair before corrosion fatigue damage may take place, effects of inhibitors, possibly with residual seawater, CO_2 and H_2S, on residual life.

Diffusion from bore - prediction models

Models have been developed to predict the diffusion of various species from the bore, based on Fick's Laws. The models may be used to predict the annulus environment, in particular water condensation and gas concentrations. The generic problem is that due to the large number of parameters a test matrix capable of covering all possible design cases becomes very large.

Joint Industry Project

In co-operation with SINTEF Materials and Chemistry, MARINTEK is running a Joint Industry Project (JIP) with the aim of developing a basis for fatigue design of armour wire in which the effects due to the chemical environment in a pipe annulus are taken into account. The project was started in 2001 and is now in Phase VI, which will be completed in 2010. All the current suppliers of nonbonded flexible risers are participating in the project, and are providing materials for testing.



Floating production systems with flexible risers.

Testing is carried out on tensile armour wire in air, as well as in aqueous environments with CO_2 and/or H_2S at various partial pressures. No standardised test methods were available, and new equipment and a test protocol had to be developed for the project. S-N curves have been obtained for more than 50 different combinations of material grade, environmental composition and loading parameters, covering a range of 10^5 - 10^7 cycles to failure.

The data have been compiled in a database for the assessment of fatigue design criteria for flexible risers. The design criteria are in a format suitable for implementation in software that has been developed for the stress and life-time analysis of flexible risers.

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MARINTEK Wave Impact Loads JIP

The prediction of wave impact on ships and offshore structures in high waves is a high-priority field of research in the offshore industry. MARINTEK has carried out research and development within this area during many years. A Joint Industry Project that started in 2007 is focusing on practical engineering tools and procedures for the industry. The problem involves very complex physical mechanisms which require special attention, and experimental validation is essential. In this project, state-of-the-art technology is combined with MARINTEK's unique and comprehensive range of experience.

Figure 1. Photo from wave-in-deck experiment.

Participants in the JIP include: ABS, Aker Solutions, Chevron, ConocoPhillips, DNV, MARINTEK, Offshore Innovative Solutions, Petrobras, SEVAN and StatoilHydro. Six different areas are being addressed:

- Critical wave parameters
- Air-gap and wave impact on platform decks
- Green water and bow flare slamming on FPSOs
- Wave slamming on platform columns
- Basic physics of slamming
- Practical procedures and recommendations.

The project has resulted in new and improved engineering load prediction tools, as well as extensive and systematic model test data for benchmarking. Recent publications from the work include OMAE2009-79375, OMAE2009-79489 and OMAE2009-79560. Phase 1 of the JIP was completed in March 2009, while a new Phase 2 is being initiated. In the following, some highlights from the recent experimental work are given.

Global wave impact loads on a deck

In order to validate the new tools, an extensive model test campaign was performed in a small towing tank at MARINTEK. Water impact on an idealized deck without substructure was studied. This is relevant for deck impact of slender platforms, where the substructure does not significantly diffract the incident waves, but the findings are also useful for large-volume floating platforms and gravity base structures. The main objectives of the tests were to assess three-dimensional effects and to better understand the effects that transverse and longitudinal structural members have on the fluid flow. The model test results show that three-dimensional effects significantly reduce the wave-on-deck loads. In particular, for the water exit phase, the vertical force is almost halved due to three-dimensional effects. This is also reproduced by simple and robust theoretical methods. It was found that the inclusion of longitudinal girders underneath the deck will reduce the three-dimensional effects. Inclusion of transverse girders has a minor effect on the vertical loading, but the horizontal loads are highly dependent on structural elements that protrude below the deck plating.

Basic experiments on physics of local slamming

The underlying mechanisms in local slamming events were studied through specially designed experiments. A simplified platform structure was employed for this purpose, using a single column with a deck on top. Various types of steep irregular wave groups were run. Measurements were made on the column wall, under the deck, and on the deck side.

The space-time physics and effects of scaling were investigated in detail. For this purpose, a pressure array with 7 x 7 cells was used, as shown in Figure 2. The measurements were compared to traditional force panels covering the same area, and a reasonable agreement was found in the average pressure, although significant local variations were also observed. Tests were run on two different scales: 1:125 and 1:40, and compared (the pressure array was also scaled). High-speed video recordings were also made; see examples in Figure 3. The experiences and findings of the tests are very useful for the planning and interpretation of model tests that involve slamming measurements.

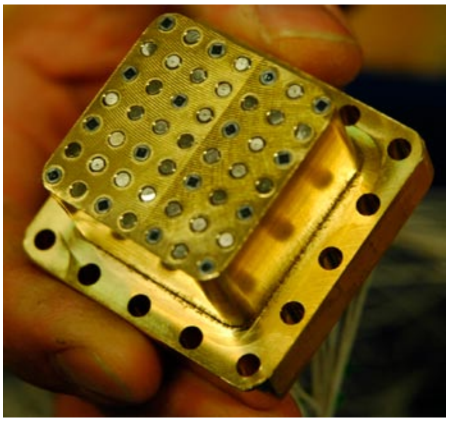

Figure 2. Pressure array.

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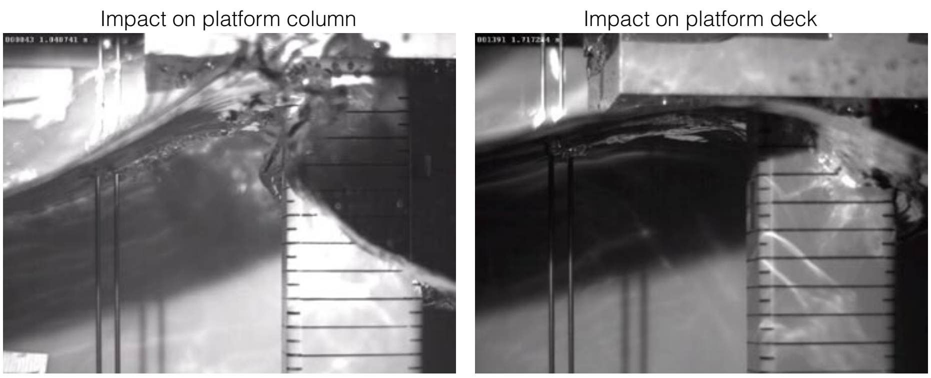

Figure 3. Examples from high-speed video of wave impact on column with deck.

Simulation of Floating Wind Turbines

Rigid-body dynamics

MARINTEK is extending its wide range of capabilities and competence from the modelling and analysis of offshore structures to also cover offshore wind turbines. Our objective is to provide design tools that can be used also for floating wind turbines. Both the time-domain simulation programs SIMO and RIFLEX and the frequency-domain analysis program MIMOSA provide a useful basis for this development.

SIMO is a program for time domain simulation of motions and loads of vessels and other structures involved in marine operations at sea. Force models include hydrodynamic forces on submerged parts of the structure(s), wind forces on above-water parts, mooring forces and other coupling forces. The comprehensive hydrodynamic force models include linear and quadratic potential forces, slender-body force models as generalised Morison-type forces, coupling line forces, and specified control forces. Viscous forces are included, but these are still regarded as a matter for further research, in particular for extreme wave conditions.

SIMO has a ‘slot’ for user-defined force models that allows essential wind turbine modules to be implemented and tested as dll’s (dynamic link libraries). Two modules have been developed:

- A wind-load module based on blade element momentum (BEM) theory
- A control module for blade pitch angle and power take-off (generator torque).

These facilities enable forces and motions of a floating wind turbine to be modelled using the standard version of SIMO. By modelling the floating body and the tower as different bodies, stiffly connected at the tower base, the forces on the tower base due to motions and wind can be calculated. At present, the model runs with uniform wind over the propeller disk, and rigid-body motions are calculated. A non-uniform wind model with more realistic (i.e. less) coherence over the propeller is currently being implemented.

This model provides a proper coupling of wind speed, wind forces, rotor motions, and support structure motions. Typical uses include:

- Establishment of motions and mooring-system loads
- Calculation of power and analysis of short-term fluctuations in generator power, depending on wind and wave conditions
- Calculation of tower base forces, nacelle and rotor bearing forces
- Study of interaction of wave-induced motions and turbine forces, depending on turbine control specification
- Quantification of influence of power take-off and blade pitch control on tower pitch motions. Individual blade pitch control will require proper spatial sampling of the wind field.

Elastodynamics

The wind force module and control modules will be incorporated as extensions to the nonlinear FEM program RIFLEX. This will enable a fully coupled analysis to be performed by means of a combined SIMO-RIFLEX simulation. This is widely used to simulate floating offshore structures, both as a steady-state simulation in order to obtain response statistics, and for operator-controlled transient states, such as installation, mating, launching, etc. It has been commercialised as DEEP-C by DNV Sesam Software.

For the floating wind turbine application, the extensions comprise the BEM load module, spatial wind-field modelling, and control systems for blade pitch and torque for power take-off, as implemented and tested in the rigid-body simulation model.

The elastic modelling includes blade deflection, elastic deflection of floating tower, dynamic cable and mooring line responses. Intended use:

- Design verification of final system; extreme loads and fatigue loads
- Dynamic interaction of selected blade/-turbine design and floating tower design. In particular, relative motions (clearance) between tower and rotor blades
- Adapting control/power take-off to floating support structure behaviour.

This development is part of a joint competence development project (KMB) performed by SINTEF Energy Research, IFE, and MARINTEK and funded by the Research Council of Norway and several industrial partners. Project manager: John Olav Tande.

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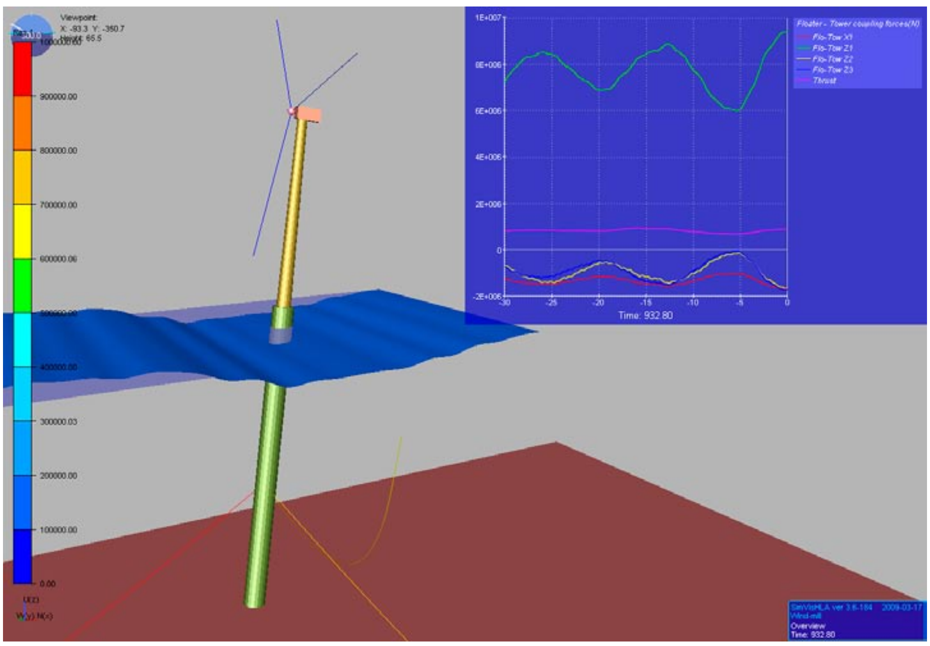

Snapshot of SIMVIS visualisation, with time traces of tower support forces.

Resource-efficient Supply Vessel Planning

Supply vessels are used in logistics operations in the Norwegian Sea to bring cargo from onshore supply bases out to offshore installations. In collaboration with StatoilHydro, MARINTEK has developed an optimisation-based decision-support model that will be used by StatoilHydro at tactical level to determine the optimal fleet of supply vessels and its weekly sailing schedule.

Figure 1. Offshore supply vessel (Havila Shipping).

Offshore supply vessels are one of the most costly resources used in offshore supply operations. A reliable and cost-effective supply service requires good planning of routes and schedules. This planning problem is not straightforward or easy to solve, as there are many aspects that need to be considered and requirements that must be adequately dealt with. MARINTEK's decision-support model can be used to find solutions to planning problems in a matter of minutes.

The planning challenge

In supply operations, vessels sail a weekly schedule from an onshore supply base. Questions that need to be answered in the operations planning process are:

- What is the optimal fleet of supply vessels that will support the optimal sailing schedule?
- Which routes should be sailed by which vessel and on which days on a weekly schedule?
- In what sequence should the installations on a route be visited?

The vessels' sailing schedule needs to be designed in such a way that it meets certain requirements, such as:

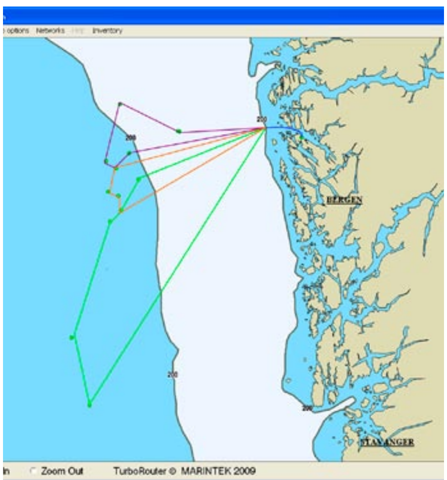

Figure 2. Three possible sailing routes, screenshot from TurboRouter®

- Each installation needs to be visited a given number of times in the course of the week
- An installation must be visited during its opening hours
- No more than one vessel can visit an installation at the same time

It is often necessary to change the weekly sailing schedule, due to factors such as changes in supply demand from the offshore installations. Weather conditions in the Norwegian Sea, which are more unstable in winter than in the summer, will require robust plans with more slack during the winter than in the summer, so that delays will not have great impact on a schedule.

The fleet of supply vessels may be fixed, or there may be a pool of vessels to choose from. In any case, it is always worth checking whether it is possible to reduce the existing fleet. Reducing the fleet by one vessel would typically save around NOK 60 million a year.

An optimisation model

The optimisation-based decision-support model has been developed with the aim of providing rapid and efficient support for the decision-making process described above. The model consists of two main parts: a route generator and a master model, in which appropriate routes and vessels are selected. The result is an optimal weekly schedule for an optimal fleet of offshore supply vessels on the basis of the input and requirements specified.

The route generator generates the fastest or shortest sailing route for all combinations of installations that are to be visited. The routes are generated for each vessel because the vessels' loading capacities, sailing speeds and fuel consumption rates may differ. Problem aspects such as installation opening hours and maximum or minimum duration on a route are dealt with in the route generation process.

A sailing route will typically have a duration of two or three days before a vessel returns to the base to start on a new route. Vessels may thus sail up to three routes a week. The combination of routes needs to fulfil certain requirements, for example, that all installations get their required number of visits during the week. In this context, the routes may be viewed as columns, where a master model selects a number of columns that together satisfy the requirements and do so in the most cost-effective way.

Several aspects of the supply vessel operation planning problem can be formulated as requirements in the master model. These can be general, such as setting a minimum time between two visits to an installation, or more problem-specific, such as fixing departure for a particular installation to be on a given day.

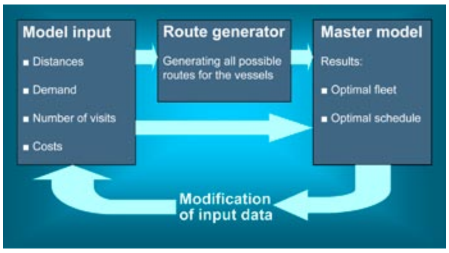

Figure 3. Concept overview.

"What-if" analysis using the decision support model

The decision-support model may be used extensively to perform "what-if" analyses, and can provide answers to possible scenarios in a short time. Examples of analyses can be

1) What if a given installation is open 24h?
- A much more cost-effective schedule may be found if the installation can be visited during its present closing time

2) What if a given vessel only sails one route a week?
- Savings can be made if the vessel is released on the spot market or used by another supply base during the idle part of the week.

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Using Cases to Generalise on Maintenance Practice for FPSOs

In the PETROMAKS project "Integrated Operations – A key enabler to operational excellence in maintenance management of FPSOs", cases have been used to learn about maintenance practice in Teekay Petrojarl.

The cases:

- Condition monitoring of gas compressor, and
- Continuous improvement of pressure safety valve (PSV) maintenance

were selected and analysed in detail. Both onshore and offshore maintenance personnel on four vessels were interviewed. The results of the interviews were used to further develop work processes for all activities related to condition monitoring of gas compressor and maintenance of PSVs for each vessel on a detailed level. The cases were used to discuss similarities and differences between the vessels, and how changes should be implemented.

Teekay Petrojarl FPSO.
(Courtesy of Teekay Petrojarl Production)

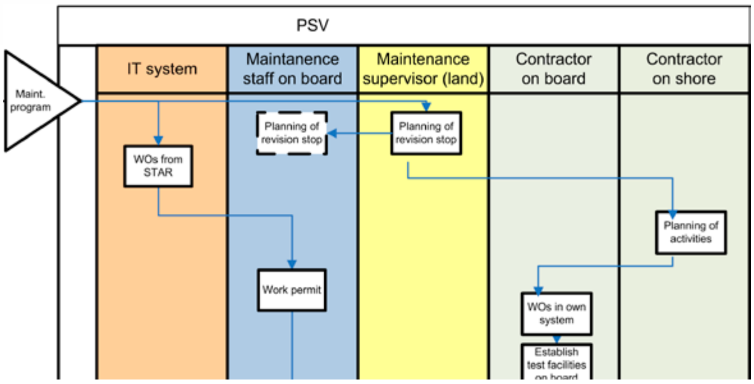

Figure 1. Example of work process with functions and activities.

In addition to specific information and conclusions about the selected cases, the in-depth discussions with maintenance personnel provided knowledge regarding maintenance practices in the company in general. Many of the findings from the cases also represent general trends in the company.

For PSVs, it was found that quality of registered data was crucial for the implementation of changes at specific test intervals based on the industry standard (OLF 070), using Probability of Failure on Demand as the means of interval optimisation. Much has been learned from the challenges which were faced and successfully overcome in analysing the PSV data and applying the results. This will be of benefit when other technical safety barriers are being dealt with, so the experience will be used to ease the process of implementing the methodology on other systems.

In the case "condition monitoring of gas compressor", the information regarding organisational and human aspects was at least as valuable as that on technical equipment, sensors and data. This will all be used when a new strategy for condition monitoring is being implemented. This can be done because the high-level MTO (man, technology, organisation) findings for gas compressors are believed to be representative of several types of equipment, in terms of use and knowledge of condition monitoring in the company.

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Resource-efficient ....

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3) What if we start to service a new installation from this supply base?
- Is there sufficient flexibility in the existing fleet to accommodate an increase in demand?

The results of such analyses can be used to create a cost-effective, reliable and customer-oriented schedule for supply vessel operations. This decision-support model makes for easy and rapid analysis of many aspects of such complex problems. Such a process can take weeks or even months if it is done by hand. StatoilHydro implemented the optimisation-based decision-support model for tactical planning purposes in early 2009.

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Modernizing Laboratory Equipment in Ship and Ocean Laboratory

With the aim of improving quality and efficiency, we have standardized some key systems in the Ocean Laboratory and on the two carriers in the Towing Tank.

Background

In order to raise the quality of test results and the efficiency of model testing, MARINTEK has made a major effort to standardize and upgrade key systems in our laboratories. We will now have identical data acquisition (DAQ) systems, position measurement systems, and video recording systems in the Ocean Laboratory and on the Towing Carrier and the Sea-keeping Carrier in the Towing Tank.

Data acquisition

After a very thorough evaluation of candidate suppliers, HBM's MGCplus hardware and their Catman Enterprise software were chosen as our new DAQ system. MGCplus is a complete DAQ platform, with high-resolution analogue-to-digital conversion, precision amplifiers, and built-in digital filters. We also use MGCplus in our calibration laboratories, and we will soon have an

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Hybrid Riser Tower .... *Cont. from page 1*

In the relatively mild west Africa environment the tower floats on the surface when it is being towed from the yard to the field. In harsher environments this towing method produced unacceptable fatigue, due to wave loads. A novel submerged towing method was therefore developed in phase 1, and this appears to be very attractive, as analyses have indicated no significant stress or fatigue problems.

Phase 2 of the project was launched in 2008 with financial support from DEMO2000 and the other phase 1 participants, in addition to MARINTEK. The primary objective of Phase 2 is to demonstrate by model testing that the long and slender riser towers can be safely transported from the onshore assembly yard to the offshore field by the submerged tow method. The model test campaign is being carried out at MARINTEK. An overview of the submerged offshore tow is shown in Figure 3. MARINTEK is Aker Solutions' co-operating partner in this part of the project and is responsible for the test campaign. The test campaign includes towing tests in the Towing Tank and vortex-induced vibration (VIV) tests in the Ocean Basin.

The objective of the model test programme is to study the behaviour of the Hybrid Riser System during tow-out in various potential critical situations, i.e. when exposed to wave loads and/or to ocean currents, and preferably also in accident situations, such as lost of tug thrust, simulation of survival conditions, system manoeuvrability.

The model test campaign was regarded as complex and challenging, implying a very long and flexible model of the tower with correctly scaled bending stiffness and an integrated advanced fibre-optical strain sensor system. The model set-up consisted of the submerged riser tower, two towing line/chain systems and two tugs. The forward tug was moored to the forward carriage by a horizontal mooring system consisting of lines and linear springs. The aft tug was connected to the aft carriage by a single line with a constant back-tension. Even at a model scale of 1:38.6 the total length of model set-up was around 70 m, which meant that a purpose-built connection between the two towing carriages had to be designed.

The riser was heavily instrumented with 80

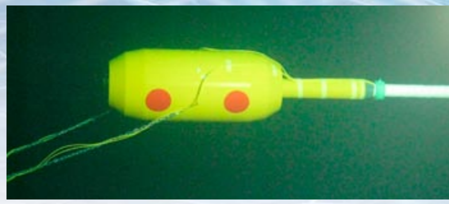

Figure 4. Model of the upper buoy and the top of the tower.

fibre-optic strain gauges located at 20 different sections, in order to acquire records of bending and axial strain. Motions in six degrees of freedom of the two tugs were measured by the OQUS optical tracking system. The motions of the submerged buoys were derived from video tracking of underwater video recordings. Figure 4 shows the model of the upper buoy and the top of the riser bundle. The marks on the buoy model are used for video tracking. Forces on the towing lines were also measured, as was towing speed. This meant that three different data acquisition systems had to be combined in order to collect the necessary data.

The first part of the model tests (the towing tests) confirmed that the proposed towing method is feasible. However, the test results from the towing tests need to be further analysed before final conclusions can be drawn. The final part of the model tests (VIV tests) also still remains to be performed.

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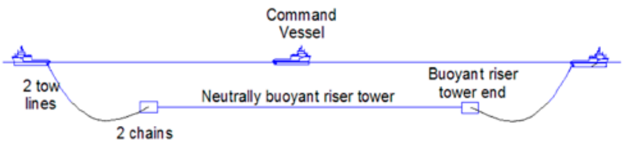

Figure 3. Overview of the submerged offshore tow.

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MGCplus system for model instrumentation verification before actual testing starts.

Position measurements

We have used motion capture cameras from Qualisys AB since 1995. They developed their "extended volume measurement system" in response to our specifications in 1997. We have also been involved in the development of their new underwater position measurement system. It was therefore natural to select them as supplier when they recently released their new Oqus line of position measurement cameras. This spring we are installing an Oqus system in the Ocean Laboratory (fig. 1). The system will improve overall measurement performance, have better motion-tracking capabilities, and extend measurement coverage to the whole basin area. In the Towing Tank we are currently introducing an Oqus camera system on the Towing Carrier, while later this year we will receive a third Oqus system for the new Sea-keeping Carrier, which is currently under construction. In addition to these systems, a new underwater Oqus position measurement system has substantially increased our measurement capabilities.

Video

A third major upgrade has been the switch to digital video production work flow. Digital video recordings are now stored in real time on dedicated video servers. This has eliminated the time-consuming task of digitizing video tapes before editing. For the customer the elimination of analogue transmission and storage translates into higher image quality. Real-time digitization also makes it possible to quickly edit selected cuts and send them to the project eroom.

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Figure 1. New Oqus position measurement cameras in the Ocean Laboratory.