LifeLine JIP

Dry mooring line monitoring for floating production systems

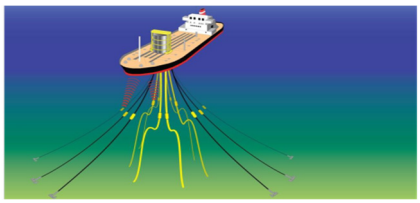
Floating production systems stay at fixed positions year after year without regular dry docking. To ensure station keeping, these units are equipped with mooring systems which must be able to withstand harsh weather loadings. Mooring systems are exposed to a wide variety of environmental conditions. Deterioration of the mooring lines over time will result in a lower resistance against breakage. Moreover, failure mechanisms that were not anticipated during design, such as Out-of-Plane Bending, result in higher loads than were predicted resulting in a reduced mooring line reliability. As a result, mooring incidents have been occurring at high rate during the past decade. More than twenty incidents have happened to production vessels that are moored on-site for prolonged duration. Some of these incidents were of high consequence, such as causing the vessel to drift a short distance, riser ruptures and production shutdown [1]. These incidents are raising concerns for owners and operators.

Organisation
MARIN will take the lead in this project as JIP manager. Oil companies, FPSO operators, suppliers and classification societies are all invited to join this JIP. Project meetings will take place once every six months during the FPSO JIP week. The project will run for three years. The kick-off meeting will be held on Tuesday April 10, 2018 during the FPSO JIP Week in UK.

Considering the large consequences of a mooring system failure, it is appropriate to use alarm systems for mooring line failures. There are many floating production systems that have no means of knowing whether there mooring system is intact though. As an example, 78% of the production units in the North Sea do not have line failure alarms [2]. Floating production systems which do have alarm systems often face technical challenges as the equipment is installed subsea, e.g. on the mooring lines. As a result the equipment often leads to failure and false alarms in the long term. With around 400 floating production systems currently in service and an expected growth of 50% in the coming five years, the industry is facing a challenge in the future. Especially considering the fact that several of them are approaching their design life or in some cases exceeding the original design duration [1].

Objective

The LifeLine initiative seeks to develop a dry mooring line failure alarm system which is based on position measurements only (without subsea equipment). Monitoring of position onboard of turret moored FPSO's have already been performed successfully [3]. Within LifeLine, a methodology of a mooring line failure alarm system based on offset position monitoring and advanced signal processing will be developed. The methodology will be implemented in an onboard software tool which processes the measurements onboard and provides an alarm in case a mooring line failure is suspected.



Deliverables

The project will deliver specifications of the dry mooring line failure alarm system, documentation describing the data processing methodology and the software tool. The deliverables also include the system validation results, screening study results and guidelines for onboard implementation of the monitoring system.

Costs

The participation fee for oil companies and contractors equals 15 kEuro per year. The yearly participation fee for classification societies, authorities and small sized companies equal 7.5 kEuro per year.

References

[1] 'A Historical Review on Integrity Issues of Permanent Mooring Systems', Ma, Duggal, Smedley, L'Hostis and Shu, OTC-24025, 2013.

[2] Report A4163-01 JIP FPS Mooring Integrity.

[3] 'Deepwater Mooring System Monitoring with DGPS', Minnebo, Aalberts and Duggal, OMAE2014-24401, 2014 [to be published].

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Monitoring equipment will be used based on reliable and proven technology without subsea sensors. The latter enables application of the system on both new-built and existing units.

Scope of work

The project comprises the following three tasks: methodology development and sensitivity studies (1), software development for onboard use (2) and software verification and validation by in-service monitoring and numerical simulations (3).

Methodology development and sensitivity studies

In this task a number of identification algorithms will be developed which can be used to provide a reliable alarm for floating production systems in all environmental and loading conditions. These algorithms will be developed and tested for six floating production systems. Fifteen different algorithms based on offset, velocity, accelerations and combinations with standard deviations will be defined and tested for the one year and 10 year condition and for both windward and leeward lines. These algorithms combine multiple statistics to derive information regarding mooring integrity.

Software development

The methodology will be implemented in a tool for onboard applications. This means that the tool shall be reliable, robust and user friendly. Measurement error handling (filter and data checks) will be implemented to ensure that the data is free of spurious measurements and spikes and that no false alarms are provided due to measurement errors. False alarms are reducing the alertness of the crew in case an alarm is occurring originating from an incident. Installation and operation manuals will be provided with the software. The software tool to be developed can be installed on multiple floating production systems and is not bound by licenses.

Software verification and validation

As part of the methodology development and sensitivity studies, the mooring line failure identification algorithms have been tested using simulations. In this task the onboard software including algorithms will be tested using in-service measurements (1) and extensive numerical simulations (2). The objective of the in-service measurements is to test and verify the onboard software including error handling, filtering, data checks and identification algorithms. One year in-servcie measurements will be performed on various floaters in a different environment including Brasil, West Africa and the North-Sea. The extensive numerical simulations will typically encompass one-year simulations of various systems in which a variety of environmental and loading conditions are encountered. During this simulation mooring failures will be included. The simulations will be conducted as blind tests, that is the simulations will be defined and executed by one analyst and the mooring failure identification algorithm will be executed by a second analyst. The second analyst will, however, receive information on the floater and mooring system such that the identification algorithm can be configured correctly.