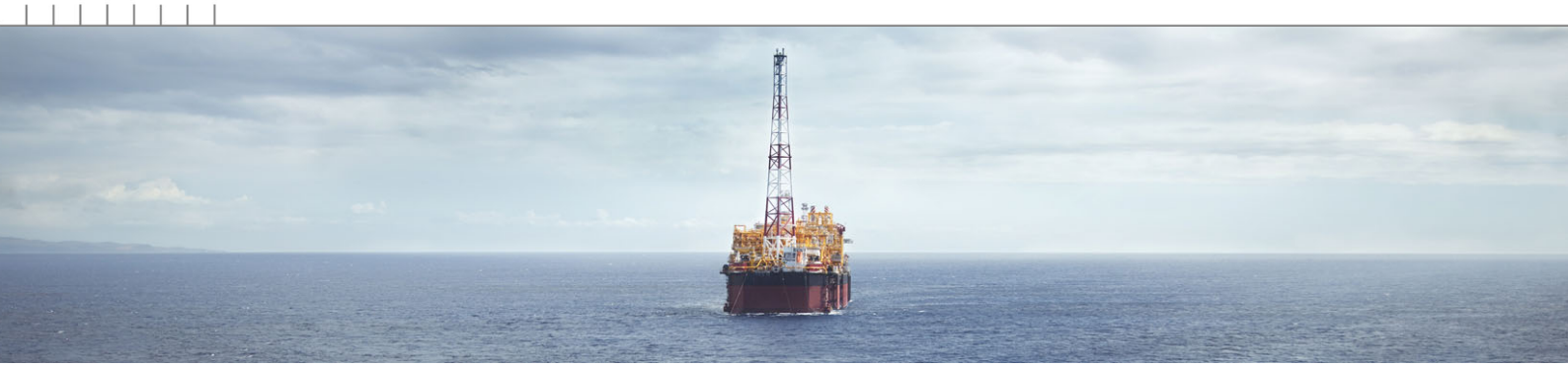
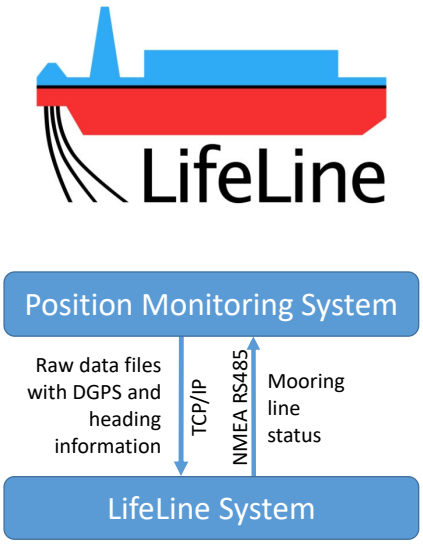
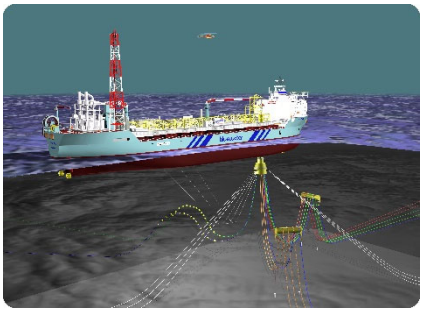


LifeLine

Mooring line failure alarm system with advanced data processing of GPS measurements

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 that must be able to withstand harsh weather loadings. 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, cause higher loads than were predicted resulting in a reduced mooring line reliability. To manage the integrity of the mooring systems during its service life, the unit is often equipped with expensive structural monitoring systems with sensors mounted on the mooring lines. The LifeLine mooring monitoring system is an alternative system which provides the operator constant and reliable feedback of the mooring integrity by real-time processing of the GPS measurements. The LifeLine system can be installed on both existing and new built floaters.



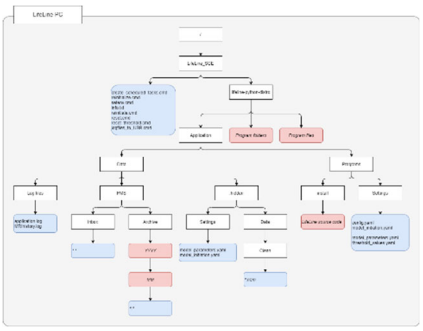


LifeLine system

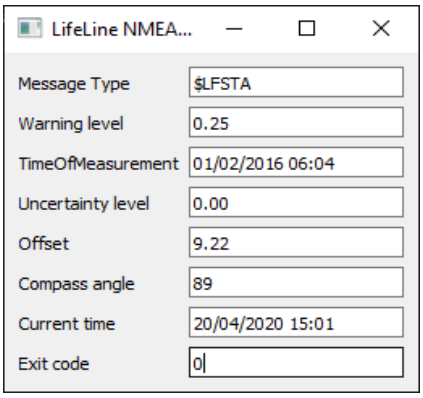
The LifeLine system is a mooring line failure detection system for floating production systems. The associated software is suitable for turret moored and spread moored FPSOs. GPS position and FPSO heading is the only input required by the LifeLine system to be able to assess the mooring lines integrity. The LifeLine software runs on a dedicated PC with a Windows operating system. A TCP/IP connection between the LifeLine PC and the on-board position monitoring system is required to obtain information of the GPS position and FPSO heading. This information is to be provided in data files, e.g. half hour data files. A RS485 interface is required between both systems, which enables the LifeLine System to return information of the status of the mooring lines to the position monitoring system. By means of advanced data processing, the LifeLine system provides two serial output messages containing all the necessary information regarding the mooring line integrity. FPSO specific information required by the software to assess the mooring like integrity is provided in a configuration file.

LifeLine user manual

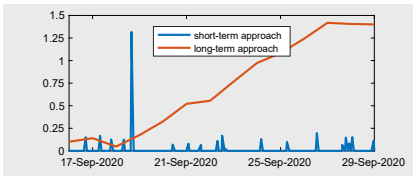
As part of the LifeLine system, a user manual is provided. The user manual is floater specific and contains information regarding the configuration file set up and guidelines on how to interpret the output messages.



LifeLine software architecture



STA output message



Graphical user interface example

LifeLine JIP participants

For more information contact MARIN:
Pieter Aalberts
T + 31 317 49 34 78
M +31 652 03 65 30
E p.j.aalberts@marin.nl

LifeLine methodology

The LifeLine methodology consists of two different but complementary approaches, the short-term-approach (STA) and the long-term-approach (LTA). The STA employs an event-based algorithm to assess the integrity of the mooring system. The algorithm aims to identify a mooring line failure by looking at semi-instantaneous shift in the mean position of the floater. The LTA employs a status-based algorithm. This algorithm aims to identify a mooring line breakage by comparing the zero-environment equilibrium position of the floater pre and post potential failure. The LTA monitors and updates the equilibrium position of the floater periodically. When a failure occurs, the equilibrium position will change and after a sufficient amount of time it will be detected by the LTA. This approach is characterized by a longer detection time but it is not sensitive to data quality and extreme environmental conditions.

Validation and verification

The LifeLine system was validated using different tools and sources of data including numerical simulations, blind tests and in-service measurements. The validations were done for multiple floaters, both spread moored and turret moored, installed in different regions including West Africa, Australia, North Sea, Brazil and Gulf of Mexico.

Software input and output

A configuration file is used to define the floater specific input parameters which includes among others, the type of mooring system (turret or spread moored), floater natural period, maximum allowable identification time (LTA), quality threshold (STA and LTA) and minimum and maximum offset caused by a line failure.

The output of the LifeLine system is returned to the customer position monitoring system by two serial NMEA messages. STA serial messages ($LFSTA) are sent every three hours whereas the LTA serial messages ($LFLTA) are returned once a day. Among others the following information is included in the messages:

- Date and time of the offset event detected (STA)
- Warning level for the mooring line integrity assessment (STA-LTA)
- Offset related to the offset event detected (STA)
- Offset related to the equilibrium position of the floater (LTA)
- Direction associated to the offset position detected (STA-LTA)
- Error code

LifeLine JIP and LifeLine User Group

The LifeLine software was developed within the LifeLine Joint Industry Project from 2018 up to 2020. A user group was initiated in 2021 which is aiming to support the practical application of the LifeLine technology on the field and to support further development needs.

MARIN
P.O. Box 28
6700 AA Wageningen
The Netherlands
T +31 317 49 39 11
E info@marin.nl
I www.marin.nl