JIP proposal:

Retrofit subsea sensor nodes for continuous monitoring using battery less and wireless technology.

This JIP has the objective to reduce risk of failure for critical infrastructure such as risers and mooring chains by collecting continuous sensor information from retrofitted nodes.

A lot of complex, costly, and sensitive equipment is in use for FPSO, wind power, and soon also for the fish rising industry.

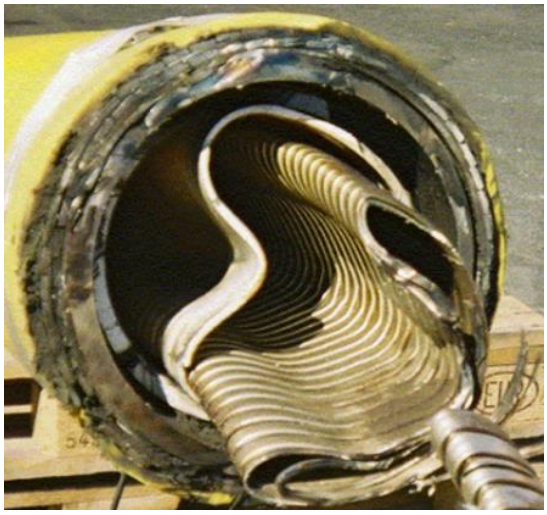
Below the surface there are risers, mooring chains, umbilicals, and power cables that slowly but surely are deteriorated by corrosion, fatigue, and strain. Without self contained sensor nodes at the site, that can be present 24/7 for years, rapid incidents can pas by without anyone noticing.

Relatively new studies calls for intensified inspection as one method to further reduce risk of failure. According to work done like "Handbook on Design and operation of flexible pipes, 2018" more information and improved surveillance will reduce risk of the operation. The key enabler here is fresh real time data that can be feed into asset management systems like digital twins to make better predictions about the integrity of the system.

DNV-GL from 2020 calls for "retrofitted motion sensors on a flexible riser" to assess fatigue. Such equipment is not only useful for risers, but also for other costly and sensitive equipment exposed to the strong forces at sea.

Low power wireless technology has also matured during the last decade making small self contained sensor nodes a possibility also in a subsea environment.

Without continuous monitoring the uncertainty may escalate, putting the operation at risk. Without information, it is harder to take the necessary corrective actions.



Picture of a collapsed carcass from [SEAFLEX, The Petroleum Safety Authority Norway]

SINTEF has been working with advanced sensor nodes for better integrity surveillance like the Smartpipe [1]. This instrumented pipe (next fig) was produced by Bredero Shaw Norway AS at Orkanger. The smartpipe wirelessly reported

CONTACT:

Karsten Husby
+47 93003127
karsten.husby@sintef.no

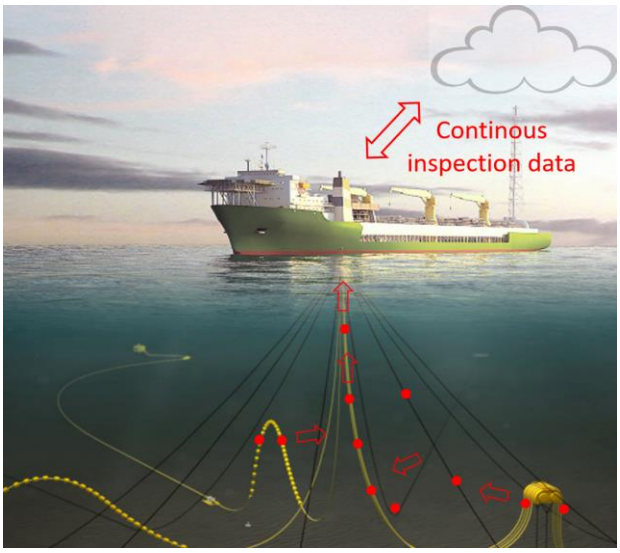
its condition on temperature, wall thickness, vibration, strain, and fatigue cycles.

SINTEF Background: Launching the SmartPipe in 2013

Similar technology well known to SINTEF based on acoustics [2], eddy current [3], vibration, and motion sensors are ready to give valuable information about the long term integrity for risers and chains. However, there is a lack of subsea nodes, online 24/7 for integrity management.

As a consequence, some fields are facing unnecessary risks.

This JIP will therefore give the operator extra and continuous inspection data about subsea assets. The sensor nodes can be retrofitted at critical subsea inspection points (see next fig) that needs extra attention.



Picture of subsea retrofit sensor nodes providing information into the integrity management system

The information is brought wirelessly during all weather conditions into the integrity management system of the operator. The details of the retrofit sensor package needs to be discussed among the partners. But preliminary, it may include:

- Vibration and motion sensors
- Active ultrasound riser inspection
- Passive acoustic emission
- Eddy current inspection

The impact for the operator will be:

- Improved integrity management
- Reduced risk of failure
- Reduced service cost
- Early warning alarms
- Cloud storage
- Digital twins / ML
- Lifetime extension

During the 30 month JIP period starting in 2025 a limited number of prototype nodes will be made and tested in lab, at Dora Testsenter and at SINTEF flow loop. All project results and prototypes will be made available for the partners. The JIP will focus on the following topics:

- Low power wireless underwater communication
- Sensor design for agreed failure modes
- Edge prosessing and ML
- Integrity management system integration

The total budget is estimated to 2100 kEUR.

References

[1] K. Grythe, I. A. Jensen and O. Ø. Knudsen, "Electromagnetic pipeline coating communication for IoT condition monitoring of subsea O&G pipelines," 2020 14th European Conference on Antennas and Propagation (EuCAP), doi: 10.23919/EuCAP48036.2020.9135999.

[2] 3M. Wangensteen, T. F. Johansen, A. Fatemi, E. M. Viggen and L. E. Haugan, "Pitting Detection and Characterization From Ultrasound Timelapse Images Using Convolutional Neural Networks," in IEEE Open Journal of Instrumentation and Measurement, doi: 10.1109/OJIM.2024.3396829.

[3] K. Husby, C. E. Johnsen and V. Ringset, "Presenting a novel NDT Eddy Current probe for crack detection on rough welds and steel with variable permeability," 2022 IEEE Sensors Applications Symposium, doi: 10.1109/SAS54819.2022.9881384.

SINTEF

CONTACT:

Karsten Husby
+47 93003127
karsten.husby@sintef.no