Technology Readiness Report

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Riser Lifecycle Monitoring System for Integrity Management

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Abstract

The Tasks 8 and 9 of this RPSEA project address the commercial plan based upon the Riser Lifecycle Monitoring System (RLMS) field trial test; specifically, the costs and benefits of the RLMS (Task 8) and a summary of the final system design for RLMS encompassing hardware, software, processes, and people (Task 9).

In Phase 1 of the program, an initial Cost/Benefit Analysis (CBA) was performed (Task 8)[1]. The key deliverable from this assessment was an analysis of the overall market for RLMS. It was decided, based on this analysis, to focus Phase 2 on deepwater drilling in the U.S. Gulf of Mexico (GoM). In Phase 1 the major components of the cost of the RLMS were identified. Of these, the most critical were the equipment costs and installation costs. During the course of Phase 2, approximate RLMS equipment costs for the system will be in the range of $500,000 to $1,000,000 U.S. dollars. The wide variability can be ascribed to the relatively low TRL some the components of the system and the relatively small size of the equipment supply chain. This cost can be expected to decrease with a larger number of deployments in the future. The installation and demobilization of the RMLS system was also demonstrated in Phase 2 of the project, and respective costs were estimated based on the operational data collected during the field trial.

Initial proposed benefits for the RLMS were identified in Phase 1 and subsequently refined in Phase 2 as the project team worked with GE Oil and Gas Product Management to validate these proposed benefits. This was achieved through customer interviews and discussion with independent subject matter experts. The conclusion of this effort was that the major benefits of the system are expected reduction of inspection and maintenance costs and reduction of downtime caused by high current events. The quantitative impact of these are discussed below.

The Task 9 for this project was to define an integrated generic RLMS solution for the industry. Based upon the results of the field trial test, a RLMS solution is proposed based on high Technology Readiness Level (TRL) software and equipment including; RFID tags and readers, vibration sensors and power and communications hardware, prototype software that can be generically applied across the installed base and straightforward and low cost installation and maintenance processes. The details of this proposed system are summarized herein.

Task 8 – Business Model Analysis and Cost vs. Benefit Assessment

8.1 Motivation

The goal of this task is to assist RPSEA, NETL and the deepwater drilling community better understand the overall utility of the RLMS technology. To achieve this goal, an analysis of the costs and the benefits of the technology was undertaken. The outcome of this task will be a summary of the overall costs and benefit of the technology to the industry.

8.2 Methodology

One deliverable for Phase 1 of the RLMS project was an initial assessment of the costs and benefits to the industry of a RLMS system. The main findings from Phase 1 were: the target market to be studied is deepwater GoM which helps define drivers for the key costs/benefits that will need to be determined, and that the key benefits of the system are as follows:

- Extending the life of a riser - $2 million/riser
- Riser inventory
- Long term asset management
- Real time data analysis of failure and fatigue
- Post failure analysis

A deeper analysis of the costs/benefits of the proposed RLMS was performed in Phase 2 based on the RLMS field trial test in the GoM. Here we will report on the estimated costs of equipment and the installation thereof and well as a validation of the proposed benefits and high level quantitation thereof.

8.2.1 Costs

The major costs for implementation of the RLMS system were defined in Phase 1 of the program. Here we will define in more detail the costs for the equipment, the installation of the equipment and the demobilization of the system.

The costs for the equipment are estimates based on the RLMS prototype system that was developed and then tested in during a 9-week field trial on an offshore drilling rig. During the development of the prototype system an estimate of the material costs was prepared. For the purposes for this report we will use this estimate to derive a range of costs for the RLMS equipment. There will be some uncertainty with this estimate as some of the components are still at a relatively low TRL and the supply chain for the system is relatively small.

Based on data obtained from the field trial test, it is estimated that the total cost of the system will be in the range of $500,000 to $1,000,000 U.S. dollars. This range is driven by several factors; end user choice of a range of potential features, the relatively lower TRL of some key components and the immaturity of the overall supply chain for the system. As the system is deployed more widely one could expect the range to tighten substantially and for the costs to potentially reduce.

During the RLMS field test in the GoM, data were obtained during the installation and decommissioning of the equipment which allow for estimation of the costs of the installation and decommission of the RLMS. As of August 2016, average day rates for floaters and drillships were in the range of $280,000/day, and there were approximately 30 rigs drilling operating in the GoM at water depths over 1,000 ft. [2]

The installation process consists of two steps: 1) instrumenting select riser joints with the specially designed sensor clamps and, 2) placement of the sensors in the clamps subsea using an ROV. The topside installation was optimized with the help of rig crew and GE Oil and Gas field service technicians. It was found that 2-3 minutes were required per clamp for installation on the riser joint. This translates to 15 minutes of total Non-Productive Time (NPT) for this process. If one uses a range for the day rates of rigs in the GoM as of August 2016, a reasonable range for this cost would be $2000-$3000 per installation. This ascribes the entire 15 minutes to NPT, which is the extreme case. Depending on the size of RLMS system installation (e.g. number of sensor modules) this would simply scale with the number of modules.

The deployment of the sensor modules was performed using an ROV. The total time required for this activity was approximately 5.5 hours. A majority of the time required was moving to the sensor clamp locations along the length of the 6,200 ft riser string, and then securely installing the sensor module into the sensor clamp bucket. It is estimated that the cost for this activity could range from $6000-$10000 US dollars per deployment. The variability in the cost will be driven by ROV service provider prices, the number of sensors deployed, the total depth of the riser and any uncontrolled variables like sea conditions, et al could impact the installation time.

The decommissioning of the subsea sensor assembly was accomplished using an ROV. This process is not required but does simplify the pulling of the riser at the completion of the drilling campaign. It was reported by the ROV vendor that the time required for removal of the sensors and the clamps was three hours. The cost of this process is approximately $2,000-$5,000 U.S. dollars, with the variability driven by the ROV service provider rates, the number of sensors deployed, and other external factors which could influence the time required to complete the sensor assembly removal.

The cost of ownership of the system can be estimated as the sum of the fixed cost of procurement of the system and the variable costs of installation/decommissioning of the equipment. The fixed costs are estimated to be in the range of $500,000-$1,000,000 U.S. Dollars with the variability driven mainly by some low TRL components, an immature supply chain and optionality of features for the end user. The variable component is estimated to be in the range of $8,000-$15,000 U.S. Dollars per deployment. This exact cost will be a function of number of sensors deployed, ROV vendor prices and the depth of the well being drilled. It is assumed the fixed crew costs to receive alerts and observe the RLMS information is negligible, as this will likely be performed by existing personnel who are engaged in monitoring other rig data streams. Likewise, it is assumed that rig facilities costs are negligible (e.g. power and communications) since the overall usage by RLMS is very small compared to the usage required of other rig functions. One potential exception to this would be if the end user wanted to stream the RLMS information to shore. In this case, if an existing network is not utilized, there could be cost incurred for an additional network (e.g. 3rd party satellite company). This cost would need to be further investigated as it was not part of the RLMS field trial test.

8.2.2 Benefits

In Phase 1 of the project, the initial anticipated benefits of the technology were identified and are summarized below:

- Enhanced safety and risk management - improved safety through reduction in unplanned incidents and maximizing the time available in the event of an emergency disconnect situation
- Ability to operate in increasingly deeper and harsher offshore environments- increasing operating windows, enabling longer drilling operations and increasing confidence to drill during high currents with less risk of VIV
- More accurate riser life models - better understanding of stress and fatigue using accurate modelling based on real-time measurements
- Reduced costs through optimization of riser maintenance and inspection programs – this could also possibly extend the current 5-year life of risers before they need inspected.

In Phase 2, the potential benefits of the RLMS were refined and verified through interviews with industry subject matter experts and potential users of the technology, including operators and drilling contractors. On the basis of this input, it was decided to focus on quantifying the impact of improved uptime through the use of RLMS and reduced number of inspections per year.

The financial benefit of reduced downtime through the use of RLMS is a function of the day spread rate at any given time and the number of events that can potentially cause downtime. The day spread rate is defined as the total cost for running the drilling rig, all inclusive. The current market conditions are dictating day spread rates between $750,000 to $1,000,000 US dollars per day. Thus avoiding even one day of unplanned downtime per year per rig will result in a significant cost savings to the drilling contractor and hence operator.

The RLMS system is also capable of providing the data required to allow for keeping riser joints in service by extending the maintenance intervals of an individual joint. The knowledge of the damage incurred during any given deployment allows for a determination of the remaining useful life of a given riser joint. This knowledge enables condition-based instead of time-based inspection and maintenance.

The cost of riser inspection is driven by the cost of shipping to shore and the cost of the maintenance required post inspection. If one assumes a standard deepwater rig having 120 riser joint and assumes a 20% per year inspection rate then if RLMS can reduce the number of joints per year by half (24-12 joints) then this would result in an annual cost saving od $500,000-$1,000,000 US dollars per rig. The range of this estimate is driven by variability in the cost to ship riser assets to shore and the cost of the maintenance required post inspection.

In summary, during Task 8 we investigated the costs and the benefits of the RLMS system in more detail. The costs were verified by the field trial procurement and deployment of the RLMS system. The benefits were quantified and verified through interviews with industry subject matter experts and potential users of the system. The potential benefits of the RLMS system are significant and in many cases would result in payback periods of 1-3 years depending on external variable such as rig use, well depth and market conditions.

Task 9 — Define integrated generic solution for industry

9.1 Motivation

A primary goal of the RLMS program is to deliver a technology that could be generic to the offshore drilling industry. The proposed solution should be applicable to any and all riser systems that are currently in use. The RLMS prototype deployed for the field trial had this objective.

The technology employed in the field demo can be obtained from multiple sources. The hardware is completely riser agnostic. The software can be configured for a riser from any vendor and requires only some vendor data for each riser that is to be monitored.

9.2 Methodology

The fully integrated RLMS prototype tested in this program was designed to be agnostic to the riser vendor and easily retrofittable onto existing systems as well as greenfield deployable. This was achieved by focusing on the following: 1) use of hardware of relatively high TRL (5 or greater), 2) development of the RLMS using an Agile methodology that relied on constant end user feedback, and 3) creation of installation/decommissioning processes the people who would be executing the tasks. The field deployed hardware is represented in the figures below (Figures 1 and 2).

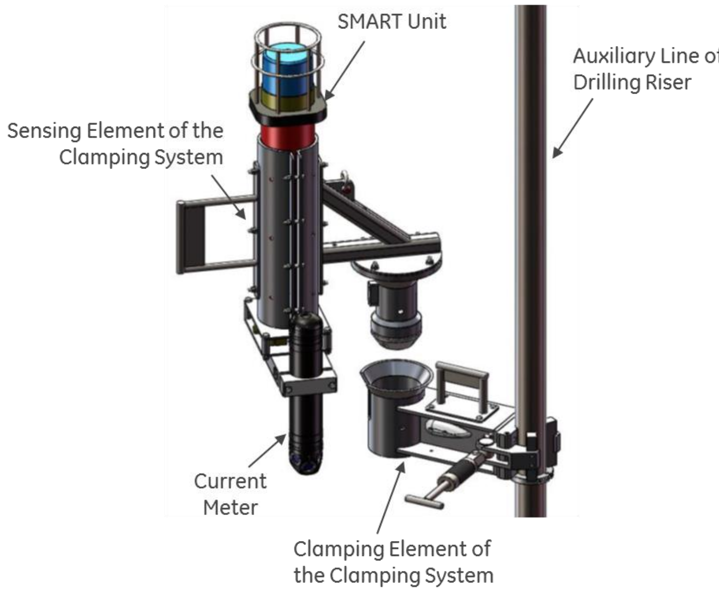
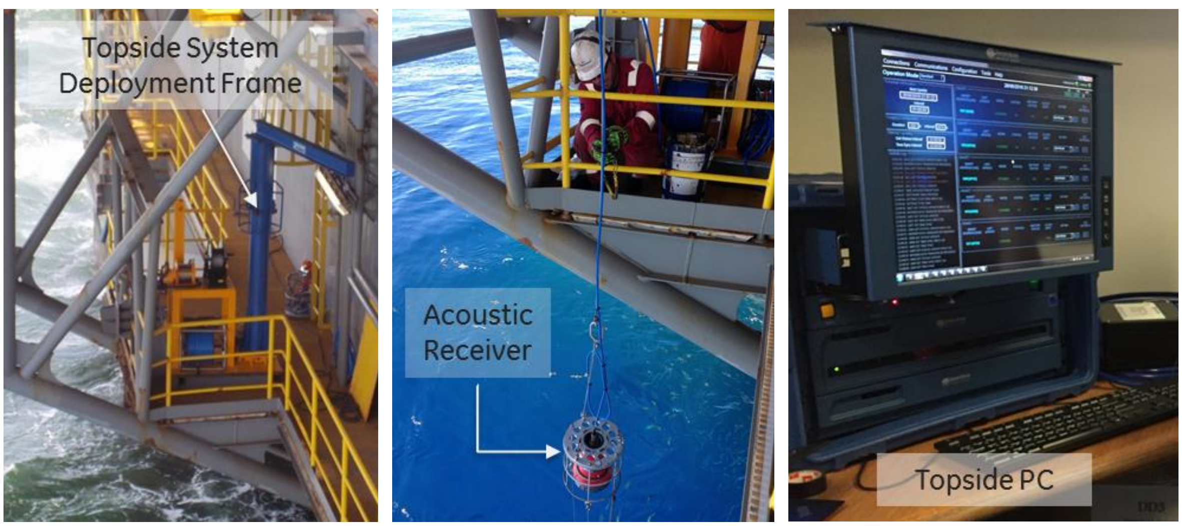


Figure 1.Illustration of the clamping system for deployment of the subsea sensing module



(a) (b) (c)

Figure 2. Topside data acquisition system. (a) Supporting assemble & deployment frame; (b) Acoustic receiver; (c) Topside computer.

The hardware for the RLMS system was selected based upon it being field proven, high TRL technology. The hardware includes Topside data acquisition system consisting of supporting assemble & deployment frame, an acoustic receiver, Topside computer and subsea sensing module assembly. Asset identification technology (RFID) was not included in the scope of the field trial due to the high TRL nature. There is no proprietary equipment required for the RLMS system. As shown in Figure 1, a clamping assembly for attachment of the sensor kit to the riser was designed by the RLMS team to be very flexible to attachment to any riser type (brownfield) and easy to install and retrieve either by ROV subsea or manually topside.

For the RLMS field trial test, Sonardyne Inc. was selected as collaborator on the project to supply the subsea sensing system and acoustic telemetry for the subsea and surface communications. Sonardyne has been successful in delivering reliable and robust dynamic positioning products to the oil & gas offshore industry, and as such have deep technical and field experience in long range acoustic communications. It also enables a fast and viable path to commercialization of the RLMS system.

The software for RLMS was developed using an Agile methodology and designed to run autonomously on the rig. This required the team to have frequent prototype deliveries and regular communication with the RLMS working team. The software can be used with any riser system, brown or greenfield. The analytics will require several riser specific parameters to be configured prior to deployment on each riser system (e.g. riser type, configuration and material properties).

The processes for installation and decommissioning were developed collaboratively with the rig, GE and Sonardyne field service personnel, Seanic Ocean Systems and the ROV service provider for the rig, Oceaneering. The focus of this effort was to minimize the amount of time required for installing and removing the sensors as this NPT is one of the big cost drivers. It was found that installation of the sensor clamps onto the riser could be achieved in 2-3 minutes. This was done while the riser was being run. Sensor deployment was carried out using an ROV with a 5.5-hour installation time for 5 sensor modules. The retrieval was even quicker requiring 3 hours, a reduction of 50% over the time required to install the sensors.

The collaboration across the industry-wide team was strong from the onset of the project and resulted in the development of efficient procedures and a robust RLMS design. As the RLMS system matures toward a commercial product, it is envisioned that the entire deployment and decommission process will be handled by standard rig crew teams with no specialty human skill sets required in order to use the system as intended.

REFERENCES

[1] RPSEA RLMS Phase I Final Report, RPSEA Subcontract 11121-5402-01
[2] IHS Petrodata Offshore Rig Day Rate Trends, August 2016.