Summary of
BSEE's Real-Time Monitoring study, completed March 2014

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I. Executive Summary

BSEE's internal Real-Time Monitoring (RTM) Team met from November 2012 to June 2013 and developed preliminary findings on how the offshore oil and gas industry, as well as BSEE, can benefit from the use of RTM technologies. The RTM Team also identified many challenges to effectively incorporating RTM technologies to produce tangible, cost effective improvements in offshore safety and environmental protection. This summary documents the RTM Team's preliminary findings and identifies possible topics for ongoing work, within the limits of BSEE's authority, in two primary focus areas:

A. Use of RTM by industry – What minimum requirements should BSEE establish in its regulations for the use of RTM technologies by the offshore oil & gas industry?

B. Use of RTM by BSEE – How should BSEE use RTM technologies to more efficiently and effectively carry out its safety and environmental protection responsibilities?

There are clearly many uses for, and potential benefits from, the various RTM technologies. However, there are also many unknowns about what specifically should be monitored, how it should be monitored, who should monitor the RTM data, how they should use and act upon this data, and the costs of monitoring and using such data. More work is needed to clarify what risk factors RTM technologies can effectively mitigate and to address information technology and other technological requirements and limitations, legal and regulatory issues, the role of automation, and other factors. Ultimately, a comprehensive cost/benefit analysis is needed to determine which RTM options BSEE should consider. BSEE contracted a research project to help address these issues and the final report for this project was received by BSEE in January 2014.

RTM has the potential to be a powerful enabling technology which can radically transform the way safety and environmental oversight of offshore operations is conducted, both by industry and BSEE. However, if not implemented properly, RTM can become a distraction and can provide a false sense of safety and security. Careful and thorough research, along with ongoing dialogue between BSEE and industry experts, are very important to ensure any RTM measures that are implemented will be effective in improving offshore safety and environmental protection.

II. Terminology

In the most general sense, RTM refers to any electronic sensing technology that can produce images or data readings in "real-time" at a remote monitoring station. The images or data can be used for human monitoring and interpretation, and can also be used for automated computer processing with programmed logic to initiate appropriate interventions and alarms.

In the context of the offshore oil and gas industry, RTM commonly refers to the emerging capability for shore-side personnel to be able to monitor the offshore operations in real-time, almost as if they were sitting in the control room of the offshore drilling rig or production platform. Many of the larger oil and gas companies have established specially-designed, specially-staffed RTM Centers to monitor and support their higher risk offshore operations using RTM technology. RTM Centers allow shore-side personnel to monitor equipment readings, pressures, flow rates, and other important parameters including down-hole readings for well-related activities. The RTM Team focused on this more specific meaning of RTM, as it pertains to offshore oil and gas operations, when discussing potential regulatory requirements BSEE may consider for the offshore oil and gas industry.

The term "real-time" suggests instantaneous readings, but in reality there is a measurable delay (fractions of a second or longer) from the moment a sensor acquires the data to the time the data is received at the monitoring station. For RTM systems using offshore sensors that transmit the images and data to onshore monitoring stations, a communication link is needed that may be impacted by weather and other factors, which may cause additional delay and also affect the overall reliability of the RTM system. Therefore, "real time" monitoring actually has some degree of delay associated with it, and availability of the real-time data is not likely to be 100%.

III. Objectives

The RTM Team identified a number of specific questions to investigate for the two RTM focus areas: A.) Use of RTM by industry, and B.) Use of RTM by BSEE. These specific questions are listed in Table 1. The objective of the RTM Team was to address each of these questions and to develop preliminary findings and identify possible topics for follow-up work.

A. Use of RTM by industry – What minimum requirements should BSEE consider establishing in its regulations for the use of RTM technologies by the offshore oil & gas industry?

1) What critical parameters and operations should be monitored using RTM?
   a) For drilling?
   b) For workover and completion?
   c) For production?

2) What criteria, or risk thresholds, should trigger the RTM requirements? Should it be based on water depth, well depth, well complexity, and/or other factors?

B. Use of RTM by BSEE – How should BSEE use RTM technologies to more efficiently and effectively carry out its safety and environmental protection responsibilities?

1) RTM to supplement BSEE's existing Inspection Program – How could BSEE use RTM technologies to supplement and enhance its existing Inspection Program and reduce the need to fly offshore?

   a) Should BSEE use RTM to witness BOP tests, and complete other inspection activities, without having to fly agency personnel offshore to complete these inspection activities? Could RTM reduce BSEE's offshore travel, while still meeting BSEE's statutory requirement for annual facility inspections?

   b) Should BSEE use RTM to replace or supplement other current safety and environmental enforcement activities without having to fly agency personnel offshore?

2) RTM for new BSEE safety and enforcement missions – How could BSEE use RTM in new applications to expand and enhance its safety and environmental enforcement missions?

   a) What should BSEE's role be with regard to the use of RTM to monitor operational offshore oil and gas activities?
      i. For drilling?
      ii. For completion and workover?
      iii. For production?

   b) Should BSEE use RTM technologies for monitoring the offshore environment, e.g., by using unmanned aircraft systems, satellites, and other remote sensing technologies to extend its "eyes and ears" on the OCS?

Table 1 – Questions considered by RTM Team

IV. Background Information

Many oil and gas companies are already using centralized, land-based RTM Centers on a voluntary basis to provide safety oversight and consulting support for their offshore drilling and production operations. However, although various monitoring provisions in BSEE's rules could be met by the use of RTM, BSEE's current regulations do not expressly establish specific requirements for RTM.

As a result of the Deepwater Horizon disaster in April 2010, a number of investigations and audits were conducted to examine MMS's (and subsequently BOEMRE's) offshore safety program and identify potential areas for improvement. A recommendation relating to RTM came from the U.S. Department of the Interior (DOI) Office of Inspector General (OIG) report No. CR-EV-MMS-0015-2010, dated December 2010:

> *Recommendation 18*: Analyze the benefits of obtaining electronic access to real-time data transmitted from offshore platforms/drilling rigs, such as operators' surveillance cameras and BOP monitoring systems, and/or other automated control and monitoring systems to provide BOEMRE with additional oversight tools.

V. RTM Studies

BSEE's RTM Team was established in October 2012, and in March 2013 the RTM Team formed three sub-teams corresponding to the three general categories of activities performed by the offshore oil and gas operators – (1) drilling, (2) completion and workover, and (3) production. This also corresponds to the three teams of BSEE engineers and subject matter experts that actively meet in the GOM Region: the Drilling Team, the Workover and Completion Team, and the Production Team. The RTM sub-teams were tasked with identifying critical operations and parameters that should be closely monitored during those types of offshore oil and gas activities, potentially using RTM technologies. By June 2013, the RTM sub-teams submitted their feedback on the critical parameters and operations to monitor and on the potential use of RTM by BSEE. This feedback is provided in Annex (1) for drilling, Annex (2) for completions and workovers, and Annex (3) for production.

Additional research on RTM for offshore oil and gas activities was conducted by an independent contractor through BSEE's Technology Assessment and Research (TA&R) Program. The contract for the RTM research project was awarded to 838 Inc. in September 2012 and the project was completed in January 2014. The deliverables for this research project are summarized in Annex (4) and the final report is available on the BSEE website.

VI. Discussion

Use of RTM by the offshore oil and gas industry:

RTM Centers are becoming prevalent for the major oil companies, particularly to monitor their higher risk drilling and production operations, such as those in deepwater. This allows those companies to actively engage a support network of experts, in real-time, to assist with and oversee their offshore operations without having to fly them offshore to the drilling rig or production platform. In addition to providing a "second set of eyes" to monitor the safety of the offshore operations, these experts provide advice and troubleshooting support while in direct communication with the personnel who are actually operating the offshore assets.

In addition to the electronic stream of RTM data, another critical component of an effective RTM Center is a videoconference link with the offshore control room. Constant communications between the RTM Center and the offshore control room is vital so the shore-side personnel can properly understand, interpret, and correlate the RTM data with the current operations. Otherwise, shore-side personnel can easily misinterpret the RTM data.

Another critical component of an effective RTM Center is for it to be staffed with properly trained, qualified, and experienced personnel. Not only do these individuals need to have detailed knowledge and experience about offshore drilling, but they also need to know all the specifics about the current well activities being conducted. The RTM Center personnel must have clear protocols and procedures on how to interact with the offshore personnel, and how to properly identify, verify, and elevate safety concerns. Also, to achieve effective communications between the RTM Center and the offshore control room, it can be very beneficial to specify who should talk to whom, and to have these people work together for a period of time to establish trust and confidence. The RTM Center personnel who interact with offshore control room typically work in a specially designed office space with restricted access.

Certain RTM practices, techniques, or technologies may even rise to the level of best and safest technology (BAST), which is mandated for use by the offshore oil and gas industry in the OCS Lands Act Amendments of 1978.

Use of RTM by BSEE:

The RTM Team also considered what role BSEE should play in monitoring the RTM data from an offshore drilling rig or production platform, accounting for all the factors listed above that are vital for an effective RTM program. Below is a summary of key issues that were discussed:

A. RTM has the potential to be a powerful enabling technology which can radically transform the way safety and environmental oversight of offshore operations is conducted, both by industry and BSEE.

1) BSEE's RTM initiative should consider, and where appropriate, develop, test, and implement reforms that could improve BSEE's Inspection and Enforcement Program, using innovative RTM technologies and risk-based inspection criteria to supplement BSEE's current inspection program.
2) One specific initiative could be to develop a risk-based strategy for determining which available RTM opportunities would provide the best return on the investment, and which activities would still require on-site inspections. The likely focus will be on high risk activities involving deepwater drilling and casing/cementing, with possibly additional focus on those facilities and operators that have proven to be problematic.
3) The overall objective is to improve BSEE's regulatory oversight over critical operations and equipment. The use of RTM could allow BSEE to quickly shift technical resources to evaluate these operations and equipment wherever they occur.
4) Implementation of a RTM program would be a significant departure from BSEE's current inspection program, and would require a different skill set than is needed for BSEE's traditional inspection activities.
5) A new program such as this, if adopted, should be implemented in phases, with careful consideration for managing the workload and hiring adequate staff.

B. The critical operations and parameters for drilling, completion, workover, and production activities need to be identified.
    1) The RTM Team decided that before there could be meaningful discussion about BSEE's potential role with RTM data, as well as potential requirements for the use of RTM by industry, an important first step is to identify what are critical operations and parameters that should be monitored.
    2) Since BSEE has limited resources, it is assumed any RTM oversight program by BSEE would have to focus on the critical operations – e.g., those that pose the greatest risk for a loss of well control event. However, it may be difficult to precisely define a critical operation, since a loss of well control event can occur at almost any point during downhole activities.
    3) The RTM Team and its sub-teams spent a considerable amount of time and effort identifying the critical operations and parameters to monitor during drilling, completion, workover, and production activities. As noted in the previous section, this feedback from the three RTM sub-teams is provided in Annexes (1) through (3).

C. Consideration needs to be given to what "value-added" BSEE personnel could provide by taking on an oversight role during critical drilling, completion, and workover operations.

1) This would be a new role for BSEE, since BSEE's current safety program for well drilling and well operations primarily focuses on the review and approval of drilling plans and the inspection and testing of drilling and production safety equipment, but not the active oversight of downhole operations.
2) Any BSEE personnel providing oversight would need to have the proper qualifications, experience, and technical training to contribute to the safety of the offshore operations and not become a distraction, especially during critical downhole operations. However, it can be very challenging for the federal government to recruit and retain personnel with these highly specialized skills and knowledge.
3) It could be challenging for government personnel, even with the right expertise, to take on an oversight role during a complex drilling, completion, or workover operation and to quickly assimilate all the safety issues and risk factors for that particular well operation.
4) In addition, legal consideration must be given to potential legal implications from BSEE oversight of any critical operations.

D. RTM data could have limited usefulness, and could be easily misinterpreted, without direct communication by BSEE with the control room on the offshore drilling rig or production platform.
    1) However, providing BSEE personnel with a direct communication link to the control room on an offshore drilling rig or production platform could become a distraction, especially if BSEE's communication link is in addition to the videoconference link that already exists to the company's RTM Center.
    2) Companies may be reluctant to share RTM data with outsiders, due to concerns regarding revealing proprietary economic or technological information and potential exposure of the companies to legal liability for damages or for noncompliance with regulatory requirements.

E. The technological and legal aspects of obtaining RTM data from the various operators is a challenging area with many unknowns.
    1) Would need to resolve technical issues regarding compatibility of any BSEE monitoring system with the various RTM systems and data formats being used offshore (e.g., connectivity issues, bandwidth limitations, cost factors).
    2) Would need to resolve legal issues regarding protection of proprietary info, legal implications of collecting/storing RTM data, etc.
    3) Any new requirements for industry to provide BSEE with access to RTM data could require a rulemaking by BSEE with an opportunity for public comment, during which additional concerns or technical issues might be raised.

F. Daily Drilling Reports can provide useful information for BSEE oversight of drilling operations.
    1) BSEE should consider whether review of International Association of Drilling Contractors (IADC) Daily Drilling Reports could provide adequate oversight of drilling operations as a low-cost, low-tech alternative to BSEE monitoring of RTM data feeds.
    2) BSEE regulations require operators to submit to the District Manager a "Well Activity Report" (BSEE-0133 form) for drilling operations as follows:
    3) The IADC publishes a Daily Drilling Report form, which provides more detailed drilling information than the BSEE-0133 form.
    4) It may be beneficial to require the IADC Daily Drilling Report form to be submitted electronically to the District Manager on a daily basis for BSEE review. However, such a requirement might require a rulemaking project by BSEE.

In addition to the specific topics listed above, the RTM Team discussed various scenarios for how BSEE potentially could incorporate RTM oversight into its safety regime. Below are the three main options that were identified for further consideration:

Option #1: Oversight via RTM Centers – BSEE personnel could travel to the RTM Center of each offshore operator to access the RTM data and monitor their offshore activities whenever needed, such as for routine oversight inspections or Safety and Environmental Management System (SEMS) audits, during critical well operations, or during emergency response activities. This option would be relatively quick and easy to implement, and may not require any changes to the current regulations. The relative cost for this option would be "low to medium" – BSEE would need to hire and train additional personnel for this purpose, and there would be some travel costs, although the travel would not involve offshore flights.

Option #2: RTM internet portal – BSEE could establish an RTM internet portal (a specially-designed, password-protected website) so BSEE personnel could access RTM data from offshore operators whenever needed by logging onto this internet portal. This would likely require a significant investment of time and money to implement, and may require a rulemaking project to require the offshore operators to provide RTM data feeds to BSEE. The relative cost for this option would be "medium to high" – it would be a significant IT project, and it would also require training for the BSEE personnel who would be accessing the RTM data. However, there may be significant concerns (legal/regulatory issues, industry concerns about misinterpretation of the RTM data, etc.) that could make it difficult to choose this option.

Option #3: BSEE RTM Center – BSEE could establish and staff its own centralized RTM Center, similar to an Air Traffic Control Center used by the FAA or a Vessel Traffic Service (VTS) Center used by the USCG. This would take a substantial investment of time and money to implement, and might require a rulemaking project to require the offshore operators to provide RTM data feeds to BSEE. The relative cost for this option would be "high" – BSEE would need to obtain and furnish suitable office space, obtain the necessary computer hardware and software, obtain suitable videoconferencing equipment for communicating with offshore personnel, develop an RTM data gathering and storage system compatible with all the various RTM systems and data formats being used offshore, hire and retain a staff of specially trained and qualified personnel, etc. BSEE would also need to establish clear protocols and procedures for how the BSEE personnel would interact with offshore personnel, how they are to properly identify, verify, and elevate safety concerns, etc. This would largely mirror what industry already has in place with their RTM Centers, and it is not clear how much "value added" this option would provide with regard to offshore safety.

VII. Topics for Further Consideration

Options #1 and #2 discussed above appear to the RTM Team to be the most promising scenarios for how BSEE could incorporate RTM oversight into its safety regime at this point. Option #1, oversight via industry RTM Centers, is likely to be the easiest and fastest option for BSEE to implement. Option #2, establishing a RTM internet portal, could provide useful data to BSEE personnel for monitoring offshore well activities. Also, any existing command center or conference room with a computer and display screen could be used to log onto this internet portal and view the RTM data, and this capability could be very useful during an offshore well control emergency. However, as noted in the previous section, there are potentially significant concerns and challenges with obtaining and providing meaningful oversight for RTM data streams from the various offshore drilling rigs and production platforms. Therefore, this may not be a viable option and more research is needed.

Additionally, more research and outreach to industry and other subject matter experts would be beneficial to determine how best to potentially implement any RTM technologies to effectively mitigate risk. A public workshop would be very beneficial to discuss the final report from the RTM TA&R study by 838 Inc., along with this RTM study by BSEE, and obtain industry feedback and attempt to build consensus on a recommended path forward for BSEE. The feedback from such a public workshop could provide valuable input to help guide the future direction of BSEE's RTM initiative and identify gaps that require follow-up research.

The RTM Team also recommends more work be done to evaluate potential use of the IADC's Daily Drilling Reports as a low-cost, low-tech alternative to RTM technologies for providing oversight to drilling activities. The IADC Daily Drilling Report includes more information than BSEE-1033 form, and since the IADC form appears to be widely used by industry it may make sense to update BSEE's regulations and require electronic submission of the IADC form on a daily basis for all BSEE Regions.

Based on the discussion above, the RTM Team recommends further consideration of the following topics:

Topic #1 – Consider whether to implement a BSEE oversight and emergency response capability for monitoring critical offshore oil and gas activities via the RTM Centers already being used by offshore oil & gas operators – this is described above as Option #1.

Topic #2 – Conduct research on the feasibility of collecting RTM data streams from offshore drilling rigs and production platforms and developing an internet portal so BSEE personnel can access the RTM data – this is described above as Option #2.

Topic #3 – Conduct a more detailed evaluation of RTM technologies and best practices for drilling, completion, workover, and production operations by holding a public workshop and conducting follow-on research. The purpose of the public workshop and follow-on research would be to more clearly define:

1. What are critical operations and parameters to monitor using RTM technology?
2. What should industry's role be in monitoring RTM data, and what should be the minimum requirements?
3. What should BSEE's role be in monitoring RTM data?

Topic #4 – Evaluate the potential use of IADC's Daily Drilling Report for drilling safety oversight by BSEE.

VIII. Conclusion

BSEE's RTM Team made progress in evaluating RTM technologies to identify best practices, to consider potential options for use of RTM by the offshore oil & gas industry, and to consider BSEE's possible role in using RTM technologies to enhance its safety and environmental enforcement missions. This summary documents the RTM Team's preliminary findings and topics for follow-up work. As stated earlier, RTM technologies have the potential to be a powerful enabling technology that can radically transform the way safety and environmental oversight of offshore operations are conducted, both by industry and BSEE. However, as with

any major safety innovation, the evaluation and implementation of RTM technology should be conducted with full and thorough consideration of all the benefits as well as all of the potential pitfalls.

ANNEX 1

Feedback from RTM sub-team – Drilling

Feedback by RTM sub-team - Drilling

Real Time Monitoring for Drilling Operations

Critical Operations	Critical Parameters
BOP, autoshear, and deadman testing	• Digital recording results of pressure tests vs. required testing pressures • Closing times of components • Video feeds of operations on floor or at surface stack or at seafloor. • Deadman and autoshear testing data
Well control	• Fluid densities in/out • Required fluid density per APD approval • Fingerprinting connections • Daily review of IADC reports • BOP status/health reporting • Lineup diagram for fluids
Accumulator pressure monitoring	• Monitor BSEE approved pressure settings primary and secondary, pump pressure settings, fluid low level alarm
negative tests	• Pressure vs Time readings • Fluid weights • What mechanical barriers are set • BOP ram status
casing tests	• Test fluid weight and test pressure vs time • Tubular type and size • Testing dates and time
Kick detection	• Fluid gains in trip tanks • Gas detection data • Monitor fingerprinting of connections • H2S

Feedback by RTM sub-team - Drilling

Leak off tests	● Digital pressure decline data ● Ensure operator drills 10-50’ of new formation to verify fresh formation is being tested
Drilling riser integrity	● Video feed of ROV inspection
Pit drills (well control drills)	• Video feed of drill
Well logging	● MWD/LWD/casing caliper results, mud logging data (if available), temperature/noise logs, etc.
cementing	● Time lapse data on bumping plug to ND BOP’s in cases where surface hole is drilled w/o BOP’s. ● Approvals vs. volumes pumped
Station keeping for DP units	● Number of operational thrusters for DP vessels vs. total number of thrusters on unit at any given time ● Number of GPS systems operational out of total available at any given time ● Position and excursion tracking data

ANNEX 2

Feedback from RTM sub-team – Completions and Workovers

Feedback by RTM sub-team - Completions & Workovers

Critical Operations	Critical Parameters
BOP, autoshear, and deadman testing	• Digital recording results of pressure tests vs. required testing pressures • Closing times of components • Video feeds of operations on floor or at surface stack or at seafloor. • Deadman and autoshear testing data • Monitor Containment
Well control	• Fluid densities in/out • Required fluid density per APM approval • Video feeds of operations on floor or at surface stack or at seafloor to monitor leakage issues. • Monitor coil tubing pressures/temperatures
Kick detection	• Fluid gains in trip tanks • Gas detection data • Other?
Various Pressure Tests (Casing, tubing, packers, etc.)	• Digital pressure decline data
Workover riser integrity	• Video feed of ROV inspection
Well logging	• Casing caliper results, temperature/noise logs, CBL's, pulsed neutron logs, gamma ray logs, etc.
Cementing/squeezing and pressure testing	• Digital pressure decline data? • Pumps on/off?
Station keeping for DP units	• Number of operational thrusters for DP vessels vs. total number of thrusters on unit at any given time • Number of GPS systems operational out of total available at any given time • Position and excursion tracking data
IADC reports	
Wireline Tickets/reports	
Perforation	• Length of perforation. • Monitor flowback. • Well testing.

Feedback by RTM sub-team - Completions & Workovers

Reverse Circulation during Coil Tubing operation	• Monitor returns, gas cut, and pressures.

ANNEX 3

Feedback from RTM sub-team – Production

Feedback by RTM sub-team - Production

From a deep water production platform perspective, we would like to have the following information available to us via real time monitoring:

a. **ESD/TSE Status**
b. **Safety Device By-bass tally (i.e., total number of safe chart safety devices currently bypassed)**
c. **Departing Oil and Departing Gas pipeline pressures**

We would call this a platform health check.

ANNEX 4

Deliverables for RTM research project

Deliverables for RTM research project

Task 1: What is the current state of RTM technology? Perform an independent assessment of the various RTM data systems available for offshore oil and gas operations, with a focus on:

a) drilling activities and
b) production technologies.

Task 2: What is the cost-benefit of RTM? Perform a cost benefit analysis of the systems identified that details:

a) potential costs to industry,
b) potential increases in safety performance,
c) government resources needed for implementation, and
d) necessary training for all parties involved.

Task 3: What training is needed for RTM? Discuss options for training programs or contracted services which would be needed to incorporate the identified systems into BSEE's processes.

Task 4: What are critical parameters and operations to monitor? Identify all necessary information which needs to be collected, calculated, or monitored during operations to improve the current level of safety.

Task 5: How can RTM be used for condition monitoring? Identify technologies and data that might be helpful in measuring field performance of critical equipment with the goal of predicting potential failures.

Task 6: What RTM requirements should be incorporated into BSEE's regulations? Identify how RTM could be incorporated into the BSEE regulatory regime in either a prescriptive or performance based manner.

Task 7: How can automation enhance RTM? Perform an assessment of automation technologies and their impacts on:

a) human and environmental safety,
b) efficiency improvements, and
c) cost to industry.

Task 8: Final Report & Presentation of Findings. Presentation of Findings shall be accomplished within one week after the submission of the final report.