The Bureau of Safety and Environmental Enforcement

Summary of OESI Report:
"Best Practices for Real Time Monitoring of Offshore Well Construction"

Introduction

In April of 2016, the Secretary of the Interior and the Director of the Bureau of Safety and Environmental Enforcement (BSEE) announced BSEE's publication of the final Well Control Rule[1]. The new regulations are aimed at reducing the risk of offshore oil or gas blowouts that can result in the loss of life, serious injuries or substantial harm to the environment. Some key additions to the regulations include requirements for operators to use real-time monitoring (RTM) in their offshore operations. The RTM requirements are contained in 30 CFR 250.724 and generally apply to critical well operations (drilling, completions, workovers, and decommissioning) using subsea BOPs, surface BOPs on floating platforms, and well operations in high-pressure and high-temperature (>15,000 psi, 350^{o}F) environments. In this rulemaking, BSEE is laying the groundwork for further development and use of RTM to help industry to continue improving offshore safety and environmental protection. As viewed by BSEE, the new RTM requirements reflect the reality of a changing offshore oil and gas environment and upholds national interests in safety, security, and environmental protection.

Starting on April 29, 2019, BSEE regulations require operators to use RTM during well operations, as previously described. RTM is intended to be used as a tool to improve safety and environmental protection but not to shift responsibility from the rig to onshore personnel. Onshore staff can use RTM data to help rig personnel conduct their operations safely, reduce daily burdens, and assist in identifying and evaluating abnormalities and unusual conditions before they become critical issues. For example, RTM can effectively be used to monitor and interpret data from areas such as BOP testing, cementing and zonal isolation, drilling margin management, riser stress, borehole surveying, and eventually used for condition based maintenance and health monitoring of select equipment. There have been numerous cases where the use of RTM data in conjunction with wellbore modeling and analysis has been used to successfully manage, and better understand very narrow drilling margins, kicks, lost circulation, wellbore breathing, and wellbore instability. In addition, operators can review stored RTM data after operations are complete to improve well-control efficiency, training, and incident investigation. Reviewing past data can help to improve operations (e.g., understanding well conditions in certain geological formations assists in the collection and use of well data to make drilling in similar formations more efficient) and establish well control best practices to advance safety and protection of the environment.

Background

There is nothing fundamentally new about RTM, which is a tool that has been around since the early 1960's. The U.S. Government has employed its use extensively, and agencies such as the NRC, NASA, FAA, USGS, USCG and several others have successfully increased efficiency, improved safety, and enhanced maintenance practices by embracing

[1] https://www.federalregister.gov/d/2016-08921

this technology. In other industries, RTM grew from the need of separating personnel from direct physical contact with operating machinery and systems while still gathering and interpreting information in a timely manner. RTM is a process through which operational personnel can observe, review, and evaluate data remotely, and has actually been used in the oil and gas industry since the early 1980's. Today's technology allows real-time data to be reported at, or very near the time at which the specific process or event occurs, rather than being recorded and reported after an extended delay. Innovations in sensor technology, data transmission, and leaps in storage capability allow for enormous amounts of data collection, transfer and storage. Data is typically collected from multiple offshore sources and integrated at a central onshore hub, where it is reviewed and analyzed by authorized users. Algorithms and software programs analyze and interpret the data with tremendous speed and accuracy to provide visual insights and deliver high-quality annotated data and trends to decision makers worldwide. RTM can also provide instant notifications and alerts concerning specific data-driven or administrator-specified events. Having the ability to see and monitor operational data from remote locations continues to prove worthwhile with increased efficiency, productivity and safety in oil and gas operations.

Approach

BSEE established a performance-based approach to their RTM expectations and requirements in the Well Control Rule. Performance-based requirements are written such that the requirement and the criteria for verifying compliance are not specifically stated; rather, they state the results that must be achieved, such as required capabilities, interfaces, and/or products. Prescriptive requirements describe exactly how the requirement must be met and provide preconceived solutions. Prescriptive requirements also tend to lock-in solutions that, over time, may not be the best technical or cost-effective solution. With specific regard to the BSEE's RTM requirements; detailed parameters are not provided in the rule, and the key performance indicators, and critical parameter dataset definition is left to the operator. Having performance based RTM requirements allows for the flexibility of each operator to tailor their RTM plan to their individual operations, equipment, and environment. This creates opportunities for technology advancement and for practical solutions to be presented to meet the requirements. Performance-based RTM requirements also broaden the potential solutions, since the requirements are not built around specific parameters, equipment, and/or technologies that may only apply to a limited number of operations. This flexibility allows for new technology, more suppliers, reduced costs, better product availability and support, a stronger and more reliable industrial base, and fewer obsolescence issues. Further discussion of critical parameters and datasets can be found in subsequent sections of this document. In addition, the OESI publication "Best Practices for Real Time Monitoring for Offshore well Construction[2]" includes significant detail about this topic and is viewed by BSEE as a good example of what an RTM program should encompass.

BSEE's use of RTM data is being developed and several initiatives are underway to evaluate and determine how it will be used by the regulator. BSEE's goal is to use RTM as new tool allowing the agency to improve safety and oversight, and enhance inspections beyond compliance inspections to ensure that safety risks are managed in a comprehensive manner. Remote regulatory oversight of offshore operations will enhance BSEE engineer and inspector capabilities and enable them to perform remote focused inspections, audits, and/or hybrid reviews that concentrate on critical operations, equipment and systems. Further, the collected and stored data can be used to develop industry best practices and promote awareness to enhance decision making across the offshore industry.

[2] http://oesi.tamu.edu/

Guiding the development of RTM criteria are the following considerations:

- RTM should be conducted for offshore operations "events" that are relevant to safety and that have historically been associated with loss of well control.
- It is possible for all operators to develop and implement an RTM plan, thus achieving compliance with the Well Control Rule. This includes operators who currently do not operate real-time operations centers or conduct other remote monitoring operations.
- RTM-related data-gathering must be streamlined such that access by third parties can be conducted with minimal interference in offshore operations, while still guaranteeing third party access to high-quality, secure data in near real-time.

The report "Best Practices for Real-Time Monitoring for Offshore Well Construction" addresses best practices for the use of RTM during multiple operations. BSEE encourages operators to consider these recommendations when developing their RTM plans and programs.

Best Practices

1. RTM Events of Interest

The requirements housed in the Well Control Rule set the framework for BSEE's RTM events of interest, and provide the flexibility for operators to decide which data-parameters fall within this framework. The OESI publication provides recommendations for data-parameters that should be gathered to characterize critical events of interest such as cementing, BOP testing, casing pressure testing, and several others. These events are addressed in detail, as well as certain key attributes of the data (e.g. format, quality, metadata, etc.) and data-interpretations that can be used as a common standard by all operators. The report recommends gathering and monitoring well data for the following events:

a. Wellbore Positioning
b. Blowout Preventer (BOP) Testing
c. Casing/Liner Pressure Testing
d. Formation Integrity Test (FIT)
e. Leak Off Test (LOT)
f. Positive and Negative Pressure Tests of Well Barriers
g. Cementing and Zonal Isolation
h. Cement Logging
i. Drilling Margin Events
j. Station Keeping, Dynamic Positioning, Motion Compensation
k. BOP Health Monitoring and Condition Based Monitoring (CBM)

2. Key Data and Performance Indicators

Specific data can be gathered from hardware (i.e., downhole and surface monitoring equipment, sensors, etc.) installed at the rigsite to characterize critical events such as cementing, BOP testing, and casing pressure testing. The OESI publication provides recommendations for the minimum set of data parameters that should be gathered for the events of interest, as well as certain key attributes of the data (e.g. format, data-quality requirements, minimum metadata to be provided, etc.) and data-interpretations to guarantee uniform adherence to a common standard by all operators. It is assumed that all data provided will be sampled with respect to time, and that common industry data-standards such as WITS and WITSML are used for data-formatting. Examples of such data parameters and performance indicators that should be of interest to RTM include:

- Pressures
  - Pump and standpipe pressures
  - Cement pump pressures
  - BOP test pressures
  - LOT/FIT pressures (surface and downhole)
  - Casing/liner test pressures
  - Accumulator pressures
  - Pore pressure and fracture pressure, bounding the pressure range of the “drilling margin”
  - Equivalent downhole static mud pressure and equivalent circulating pressure
- Volumes
  - Pit volumes
  - Trip tank volumes
  - Cementing volumes
- Flow Rates
  - Flow rate in/out
  - Cement displacement rates
  - LOT/FIT pump rates
- Densities
  - Fluid densities (surface/downhole)
  - Cementing fluid densities (spacers, lead/tail cement, displacing fluid)
- Temperatures
  - Surface/downhole temperatures
- Control Parameters
  - BOP control parameters
    - Pod availability, pod communication, BOP element status, etc)
  - Station keeping control parameters
    - Riser stress, wellhead stress
- Survey parameters
  - TVD, azimuth, deviation; MD, northing, easting
  - Collision avoidance
- Miscellaneous
  - Locations, e.g. top of cement (TOC)
  - Equipment health and CBM parameters

For the data to be useful and serve the purpose of enabling remote monitoring for offshore safety, the data should be:

- Provided with the proper context, i.e. include appropriate “metadata” (such as relevant sensor calibrations/validation, labeling, data frequency etc.)
- Of high quality and reliability
- Gathered and accumulated at a certain frequency in time

- Stored consistently and securely for future evaluation
- Communicated to shore using highly reliable, efficient and secure means
- Accompanied by appropriate operator interpretation, such as actual vs. plan comparisons of cementing operations and the interpretation of LOT test results.

3. Operator RTM Plan Elements

Based on the critical data sets and key performance indicators, operators should formulate and implement a performance-based RTM plan[3] that addresses the following elements for all RTM events of interest:

A description of your RTM capabilities, including the types of the data collected.

- Types of data (e.g. static/dynamic, depth-based, time-based, etc.)
- Data measurement, including data frequency, format, labeling etc.
- Data security
- Data quality and reliability

A description of how your RTM data will be transmitted onshore during operations, how the data will be labeled and monitored by qualified onshore personnel, and how it will be stored onshore.

- Data aggregation/accumulation at the rigsite
- Data transmission (e.g. bandwidth, rate)
- Data storage and retrieval
- Data reporting, display and visualization
- Data interpretation and analysis

The qualifications of the onshore personnel monitoring the data.

- Definitions of roles and responsibilities for all parties involved in RTM
- Training, qualifications, certifications, licensure
- Relevant experience

Procedures for, and methods of, communication between rig personnel and the onshore monitoring personnel, and actions to be taken if RTM capabilities or communications are lost.

- Data/information decision-making
- Data/information alarming and alerting
- Data/information communication to stakeholders
- Lost communication protocols, alerting, decision making

Note that such a plan should be developed and implemented by all operators, including those that have not (yet) integrated RTM in their day-to-day operating practices and decision-making. The plan should include definition of the minimum dataset to be gathered and how the operator will provide access to the data. Moreover, once an RTM plan has been developed, it can be replicated with only minor modifications from well-to-well.

Once operators establish their RTM programs, they will have the ability to compare and agree on common best practices for developing and implementing RTM plans, as well as defining minimum data and data-interpretations that should be monitored during well operations. BSEE encourages industry to develop a consistent approach,

[3] 30 CFR 250.724 (c)

through guidance or a new standard that addresses the development and use of RTM in critical offshore well operations.

4. Data Communication and Third Party Access

Offshore data is accumulated at the rigsite and streamed real-time, or near real-time, to operator and service provider/OEM monitoring personnel onshore. Many service providers offer links to their data streams and allow operators access to their systems to monitor data from the remote (onshore, worldwide) locations. Data can be visually customized, combined and displayed in a variety of ways, and in many cases service provider data is integrated with operational data from separate systems and monitored simultaneously. The well control rule requires operators to have an RTM plan that includes a description of how they will provide third-party access to the data, in real-time and archival formats. Operators will define a method for data access that best fits their RTM program's structure. To avoid unnecessary interference with operator RTM centers, operators could provide credentials according to pre-defined agreement, and allow third parties to access the WITS and/or WITSML data store(s) containing relevant datasets. These third parties could then poll the data stores during periods of interest such as during pressure testing or well control events. This approach also enables all operators, whether they are operating remote monitoring centers or not, to allow third parties to access data with minimal cost and administrative burden. Moreover, it will allow access to data using industry accepted tools (for e.g. data visualization and analysis) and security models. Note that this approach does not rely on any site-visits to operator-based remote monitoring centers. Since not all operators employ RTM centers, a policy that relies on such visits cannot be consistently implemented among the entire offshore operator group.

Security of data transmissions is also a critical function of RTM. The operators are responsible for ensuring that security protocols define the monitoring and control systems of the networked infrastructure and address the most critical access points and resilience issues for the specific systems used for data transmission. Tools and resources should be established to ensure comprehensive and resilient protection against faults and intrusions. Measures must be implemented to protect control system two-way transmission modes (e.g. half-duplex, full-duplex) from interception and exploitation. Provisions for data storage, redundancy and access should be included.

Conclusion

The use of RTM is highly variable across the oil and gas industry. However, over the past few years, more offshore operators have implemented RTM systems in their daily operations, and its use is growing rapidly. While some operators have been using comprehensive RTM programs continuously for many years, others have not adopted it into their normal operating procedures. All operators however, are using some form of remote data-monitoring, even if it is very basic. Technological advancements are changing offshore oil and gas environment, and RTM can improve safety and environmental protection of offshore operations when used effectively. Enhanced communication, better-informed critical decision making, increased efficiency, and improved maintenance practices are just a few of the benefits of a robust RTM program. BSEE's performance based RTM requirements allow all operators to develop their own RTM programs based on their individual organizations. When used effectively, real-time monitoring is a tool that can be used to improve safety, protect the environment, and conserve resources offshore. BSEE believes that the RTM requirements reflect the changing oil and gas exploration environment, and are a necessary step to uphold national interests in safety, oversight, and environmental protection.