U.S. Chemical Safety and
Hazard Investigation Board

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Manny Ehrlich, Jr.
Board Member

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Department of the Interior (DOI)
Bureau of Safety and Environmental Enforcement
Attention: Regulations and Standards Branch
45600 Woodland Road
Sterling, Virginia 20166

July 16, 2015

Attention: Docket No. BSEE–2015–0002

Dear Sir or Madam:

Please find attached the U.S. Chemical Safety and Hazard Investigation Board's (CSB's) response to the Bureau of Safety and Environmental Enforcement's (BSEE's) April 17, 2015, Proposed Rule, "Oil and Gas and Sulphur Operations in the Outer Continental Shelf – Blowout Preventer Systems and Well Control," RIN1014-AA11.

The CSB appreciates BSEE's work to advance safety in offshore operations and we thank BSEE for the opportunity to provide comments on this Proposed Rule. If you have any questions about our comments, or if we may be of further assistance, please contact Ms. Cheryl MacKenzie, Investigator, at 202-299-6011 or via email at: cheryl.mackenzie@csb.gov.

Sincerely,

Rick Engler
Board Member

Manuel Ehrlich
Board Member

Introduction

The U.S. Chemical Safety Board (CSB), an independent federal agency charged with investigating industrial chemical accidents, is concluding its investigation of the explosion and fire that occurred on April 20, 2010, at the Macondo Well, resulting in 11 fatalities and 17 injuries on the Deepwater Horizon Rig, and serious environmental damage. The CSB released two volumes of its Investigation Report on the incident in June 2014,[1] and the final two volumes will be released later this year. Volume 2 of the CSB Investigation Report analyzed the blowout preventer (BOP) failure and explored the need for improved management of safety critical elements for the prevention of major accident events.

The CSB has reviewed the Bureau of Safety and Environmental Managements (BSEE's) Proposed Rule, "Oil and Gas and Sulphur Operations in the Outer Continental Shelf – Blowout Preventer Systems and Well Control," and commends BSEE for its work to advance safety in offshore operations. The CSB agrees with many of the changes and safeguards outlined in the Proposed Rule. The CSB also urges the inclusion of additional provisions to further reduce risks of serious incidents offshore, which are generally consistent with the findings and recommendations of the CSB investigation. Some of these include: incorporation of human factors considerations, clarification on the role of the regulator to ensure industry reduces risks to as low as practical, and the importance of defining and assessing the performance requirements of safety critical equipment. Each of these considerations is briefly addressed below, with references to specific sections of the Proposed Rule identified as relevant.

While the CSB recognizes the need to improve the performance of BOPs and other well control equipment, the agency urges BSEE to strengthen its performance requirements of operational and organizational barriers to major accident events in addition to physical ones addressed in this Proposed Rule. Throughout the entire lifecycle of a drilling operation, there is a large reliance on successful human performance to maintain safe drilling operations. This begins with the initial hazard analysis used to assess and design the well, and continues through the plans and procedures that are developed and subsequently modified in response to the real-time well conditions. This latter reliance places a heavy dependence upon a drilling crew's[2] decisions and actions, which can 1) increase or decrease the risk of a well kick, and 2) compromise or strengthen the effectiveness of various technical barriers[3] intended to prevent or mitigate the effects of a blowout. Therefore, the human plays a direct and indispensable role for preventing or mitigating a major accident event.

As such, it is vital that the controls relying on human performance are explicitly identified, assessed, implemented, and monitored to ensure that they can be reliably executed. For example, if the company is relying upon the crew for timely detection of a kick during the temporary abandonment process, the company must identify the crew's performance expectations. Such performance expectations may include activities the crew would undertake to detect the kick, how quickly detection must occur, and what corrective actions must be taken. In addition, the company must identify the safety systems and

[1] USCSB, 2014. *Explosion and Fire at the Macondo Well, Volume 1, April 20, 2010,* Report No. 2010-10-I-OS, http://www.csb.gov/assets/1/7/Vol_1_Final.pdf, June 2014; USCSB, 2014. *Explosion and Fire at the Macondo Well, Volume 2, April 20, 2010,* Report No. 2010-10-I-OS, http://www.csb.gov/assets/1/7/20140605_Macondo_Vol2_(0605v1).pdf, June 2014.

[2] While the drilling crew members often get credit for making decisions and taking direct action to conduct the drilling activities, a number of management and engineering personnel play a role in the decision-making/action-taking process through various means, such as providing leadership instruction, guidance, and technical analysis of the well.

[3] Technical barriers are physical in nature, such as the BOP or drilling mud, either of which can be used to physically stop the flow of hydrocarbons from a well. The CSB Macondo Investigation Report, Volume 2, Chapters 2 and 4 provide further details on physical, operational, and organizational barriers.

additional controls that will be used to ensure that those human performance expectations are fulfilled. These additional safety systems and controls may include alarm systems, well data control board interface design and use, defined communication expectations/responsibilities, operational procedures identifying safety-critical steps and indicators of unsafe process deviations, and workload assessments. In order to ensure that the Proposed Rule adequately improves safety for offshore operations, the CSB encourages BSEE to explicitly require companies to manage such controls relying on human performance.[4]

§ 250.107 (What must I do to protect health, safety, property, and the environment?)

The CSB recognizes and commends BSEE's proposal to modify 30 C.F.R. § 250.107 to include a general performance-based requirement to reduce risks to their lowest practicable levels. The CSB has studied other global regimes that incorporate similar requirements,[5] and notes that regulators can play a vital and active role in defining and challenging companies' risk control measures. It is this active engagement with industry that continually drives down risk. It is unclear in the Proposed Rule how BSEE intends to establish its participation in such a role. Typically, the regulator would set goals and ensure companies meet them through both proactive (i.e. audit/inspection/data collection and analysis) and reactive (i.e. incident investigations, citations) methods. The Proposed Rule asserts that BSEE will "issue orders when necessary to protect health, safety, property, or the environment," and that "BSEE may order that operations of a component or facility be shut-in because of a threat of serious, irreparable, or immediate harm to safety, property, or the environment posed by those operations or because those operations violate law, including a regulation, order, or provision of a lease, plan, or permit." The CSB understands that BSEE can use this primarily reactive method to enforce the performance-based requirement of 30 C.F.R. § 250.107, as well as third-party verification; however, reactive methods alone are not enough to reduce risks to the lowest level, and as such, the CSB is interested to know what proactive mechanisms BSEE will use to interact directly with companies operating offshore to ensure they are actively reducing risks to their lowest practical levels.

Despite the performance-based requirements contained within the "Blowout Preventer Systems and Well Control" Proposed Rule, many of the proposed requirements are prescriptive and refer to specific standards. While CSB acknowledges that it is often appropriate to incorporate prescriptive requirements into a performance-based regime, there are opportunities for BSEE to strengthen its Proposed Rule in a manner that will encourage additional safety advances beyond the circumstances that led to the *Deepwater Horizon* incident. While the identification of minimal compliance requirements may be necessary, prescriptively requiring them can also lead to safety "plateaus" rather than continual safety improvements that meet or exceed the engineering practices or standards identified in the Proposed Rule. Considering the dynamic and technically complex nature of offshore exploration and production, the CSB is concerned that some of the prescriptive requirements, and even the standards themselves, that are identified in the Proposed Rule may not always reflect current industry best practices. Two challenges may emerge: (1) innovation is not encouraged, as companies can simply aim towards minimal compliance to the identified standards and specific requirements of the Proposed Rule even where advances in good engineering practice are possible; and (2) BSEE may not have formal mechanisms in place that will allow it to require companies to maintain lowest practical risk levels as defined by those more advanced practices.

[4] This human factors issue will be explored in-depth within Volume 3 of the CSB Macondo Investigation Report to be published later this year.
[5] The CSB will be publishing it findings related to this point in Volume 4 of its Macondo investigation.

Consider the following example: API Recommended Practice 53, *Blowout Preventer Equipment System for Drilling Wells,* was the globally recognized standard for BOPs at the time of the Macondo blowout and was incorporated by reference in offshore US regulations.[6] The edition of API RP 53 referenced in the 2010 regulations did not discuss or require AMF/deadman systems,[7] and this was not amended until after the incident, yet companies were incorporating these emergency response systems on BOPs. BSEE's Proposed Rule just now, almost five years after the Macondo blowout, recommends incorporating the latest edition of API Std 53, but BSEE does not agree with all the recommended testing practices in API Std 53 and is proposing to layer additional provisions on top of API Std 53. For example, **§** 250.737 (d), states: "If there is a conflict between API Standard 53 testing requirements and this section, you must follow the requirements of this section." Scaffolding requirements in this manner will address the current state of technology in the industry today, but may not effectively influence companies to drive their risks to levels as low as practical as innovations are developed and regulations become outdated. It would be better for BSEE regulations to have provisions in place to adapt in real-time with industry best practices and innovations

§ 250.734 (What are the requirements for a subsea BOP system?)
The CSB commends BSEE for taking a proactive role to encourage innovation from industry that will advance safety in offshore operations with proposed changes to 30 C.F.R. § 250.734. Specifically, the CSB notes the following requirements:

§ 250.734 (a) (6) (iv) *Each emergency function must close at a minimum, two shear rams in sequence and be capable of performing their expected shearing and sealing action under MASP conditions as defined for the operation.*
In Volume 2 of its Macondo Investigation report, the CSB identified that for most of the drilling operations at Macondo, drill pipe was used that exceeded the reliable shearing capability of the blind shear ram in the Deepwater Horizon's BOP.[8] The crew had determined it would use a two-step work around where the casing shear ram and then the blind shear ram would be closed in the event of an EDS operation, but the AMF/deadman system and the autoshear function were not programmed to close both rams. The BSEE proposed change to close a minimum of two shear rams, one which must seal the well, will increase the availability of all the emergency BOP functions.

§ 250.734 (a) (6) (v): *Your sequencing must allow a sufficient delay for closing the upper shear ram after beginning closure of the lower shear ram to provide for maximum shearing efficiency.*
The CSB agrees with the above requirement and believes the sequencing is valuable to help ensure that at least one of the shear rams will seal. For example, if the drill pipe is under high pressure during initial shearing (as was the case at Macondo), the resulting initial high fluid release may erode a shear ram seal; allowing some time for the pressure to decline and reduced flow will increase the likelihood that the blind shear ram seal will work.

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[6] API Recommended Practice 53, 3rd ed. *Blowout Prevention Equipment Systems for Drilling Wells,* March 1997; 30 CFR §250.442(b-d) (2010).
[7] USCSB, 2014. *Explosion and Fire at the Macondo Well, Volume 2, April 20, 2010,* Report No. 2010-10-I-OS, pg 73, http://www.csb.gov/assets/1/7/20140605_Macondo_Vol2_(0605v1).pdf, June 2014
[8] USCSB, 2014. *Explosion and Fire at the Macondo Well, Volume 2, April 20, 2010,* Report No. 2010-10-I-OS, pg 67, http://www.csb.gov/assets/1/7/20140605_Macondo_Vol2_(0605v1).pdf, June 2014.

§ 250.734 (a) (16) (i) *§ 250.734 (a) (16) (i) (Use a BOP system that has the following mechanisms and capabilities): A mechanism coupled with each shear ram to position the entire pipe, including connection, completely within the area of the shearing blade and ensure shearing will occur any time the shear rams are activated. This mechanism cannot be another ram BOP or annular preventer, but you may use those during a planned shear. You must install this mechanism within 7 years from the publication of the final rule;*

BSEE explicitly notes that this requirement is designed to "encourage further technological development," driving safety improvements beyond current industry practice. This inherently safer blind shear ram design initiative spurred by BSEE is reminiscent of a technology advancement initiated by Norway's Petroleum Safety Authority that required companies to develop and implement a remotely operated pipe-handling system for rigs. While originally considered controversial, the system has now been globally adopted. The BSEE's initiative could have similar results.[9] If the final version of the Proposed Rule maintains requirements such as this, it will demonstrate an advanced level of regulatory engagement with industry to further reduce risk.

§ 250.734 (a) (16) (iii) *If your control pods contain a subsea electronic module with batteries, a mechanism for personnel on the rig to monitor the state of charge of the subsea electronic module batteries in the BOP control pods.*

The CSB has concerns regarding the Proposed Rule's management of the lifecycle of safety critical equipment and will use the proposed battery requirements to illustrate this point. The CSB concluded in Volume 2 of its Macondo Investigation Report and advises here that it would be more effective to require companies to explicitly define performance requirements of safety critical elements (SCEs), including information concerning the functionality, availability, reliability, survivability, and interactions with other systems that may reasonably affect the SCE's ability to function properly. This information is collectively referred to as a SCE's performance standard and it is the basis for how an SCE will reduce the risk of a major accident event. A SCE's performance standard may be based on nationally or internationally recognized industry standards; yet, the process itself of defining a SCE's specific performance requirements may also spur a company to innovate methods or technical solutions that divert from or go beyond industry standards. Companies should be required to identify verifiable assurance activities to demonstrate that safety critical equipment meets these defined performance requirements, as the mere act of doing so may reveal shortcomings in the SCE's performance. Stating that personnel on the rig should "monitor the state of charge of the subsea electronic module batteries," without requiring clear performance requirements of the battery or its monitoring system, may result in safety gaps. In contrast, when a company defines its control pod performance requirements, it can explicitly state how the monitoring process will alert the crew to its battery charge status, such as the installation of an audible and visual alarms or the adoption of operational requirements for the review of the batteries as part of normal daily operations. Ultimately, the solution to a performance limitation like this one will be determined by the company, but BSEE can encourage robust SCE management by requiring companies to define the performance requirements, implement the identified solutions, and actively verify that those solutions are effective.

[9] Mechanical Pipe Handling: Reviled Requirements Paid Off (2011) , http://www.ptil.no/news/mechanical-pipe-handling-reviled-requirements-paid-off-article7666-79.html?lang=en_US ; Invented Safety, Reaped Values (2007), http://www.ptil.no/news/invented-safety-reaped-values-article3341-79.html; USCSB, 2014. *Explosion and Fire at the Macondo Well, Volume 2, April 20, 2010*, Report No. 2010-10-I-OS, pg 60, http://www.csb.gov/assets/1/7/20140605_Macondo_Vol2_(0605v1).pdf, June 2014.

Additionally, the CSB's post-incident assessment of the *Deepwater Horizon* pod batteries demonstrated that the operating condition of its batteries was not apparent unless the battery was under a representative demand that would be required in the event of the initiation of the AMF/deadman sequence.[10] So, merely monitoring the no-load voltage of a battery may not be sufficient to determine its availability when called upon in an emergency. However, it appears that BSEE's requirements in proposed § 250.734 (a) (16) (iii) could be met despite this shortcoming.

Furthermore, performance standards and verification schemes aid in the management of safety critical equipment *particularly* where safety concerns have been discovered but alternative technological options do not yet exist, such as during the seven year period allowed by BSEE in the Proposed Rule for the development of new blind shear ram design. In the interim, a performance standard, developed in conjunction with a hazards analysis, could review the centering effect of other closed ram BOPs. The analysis could lead to any appropriate well control procedure steps that minimize the likelihood of an off-centered pipe. For example, as discussed in Volume 2 of its Macondo Investigation Report, if the *Deepwater Horizon* crew had closed the upper pipe ram, in addition to, or instead of, the middle pipe ram, the blind shear ram would have likely sealed as the centering assist would have brought the drill pipe within the cutting blade area, allowing for full closure of the seals.[11]

§ 250.737 (What are the BOP system testing requirements?)

§ 250.737 (d)(13): *Function test autoshear, deadman, and EDS systems separately on your subsea BOP stack during the stump test. The District Manager may require additional testing of the emergency systems. You must also test the deadman system and verify closure of the shearing rams during the initial test on the seafloor.*

The proposed function testing states that test procedures must be submitted in an Application for Permit to Drill (APD) or Application for Permit to Modify (APM), but are not explicit about what the goal of the test is. As described by the CSB,[12] the problems present in the *Deepwater Horizon* BOP would not have been detected by simply removing the electrical power and hydraulic supply to the BOP, as stipulated in a testing procedure described in API's *Blowout Preventer Equipment System for Drilling Wells* (API Standard-53, 4th edition). In the case of the *Deepwater Horizon* BOP, there were redundant systems intended to increase the reliability of the BOP during emergency systems. The test procedures described in API Standard 53 could miss failures within the redundant controls. Consequently, the CSB recommends that BSEE state the goal(s) of the function testing of emergency systems.[13]

§ 250.724 (What are the real-time monitoring requirements?):

§ 250.724 (a): *When conducting well operations with a subsea BOP or surface BOP on a floating facility or when operating in an HPHT environment you must, within 3 years of publication of the final rule,*

[10] USCSB, 2014. Explosion and Fire at the Macondo Well, Volume 2, April 20, 2010, Report No. 2010-10-I-OS, pg 38, http://www.csb.gov/assets/1/7/20140605_Macondo_Vol2_(0605v1).pdf, June 2014.

[11] USCSB, 2014. Explosion and Fire at the Macondo Well, Volume 2, April 20, 2010, Report No. 2010-10-I-OS, Appendix A, http://www.csb.gov/assets/1/19/Appendix_2_A__Deepwater_Horizon_Blowout_Preventer_Failure_Analysis1.pdf.

[12] USCSB, 2014. *Explosion and Fire at the Macondo Well, Volume 2, April 20, 2010,* Report No. 2010-10-I-OS, pg 73, http://www.csb.gov/assets/1/7/20140605_Macondo_Vol2_(0605v1).pdf, June 2014.

[13] The CSB suggests that the goals of the function testing of the emergency systems should be to verify the functionality of individual redundant systems (if any) and to perform a system-integrated test. This could be performed on the rig separate from the subsea tests. See the CSB Macondo Investigation Report, Volume 2, pages 72-75.

gather and monitor real-time well data using an independent, automatic, and continuous monitoring system capable of recording, storing, and transmitting all aspects of: (1) The BOP control system;

The CSB agrees that knowledge of BOP operability is important, and believes monitoring by qualified personnel is needed to detect an indicated problem. For example, indicators such as a change in battery status (dying battery), anomalous increase in operating SEM temperature (short circuit), and operating/accumulator pressures behavior (improper discharge pressure behavior during operation), require qualified analysis as opposed to simple real-time monitoring. In addition, if the BOP control system includes BOP stack pressure sensors, there is benefit from real-time analysis, alarming, and remote monitoring in order to detect and understand anomalous declines in pressure. Such declines may indicate entry of free gas or dissolved gas into the drilling marine riser, a serious hazard, as demonstrated by the Macondo incident where several hundred barrels entered the riser without the crew's knowledge and directly led to the explosion and fatalities. Real-time monitoring can also provide additional pressure information to help properly diagnose unexpected drill pipe and/or kill line pressures during a negative pressure test, an interpretation error that contributed to the Macondo incident.

§ 250.731 (What information must I submit for BOP systems and system components?):
§ 250.731 (a) (7-9): (7) Accumulator pre-charge calculations (for subsea BOP, include both surface and subsea calculations); (8) All locking devices; and (9) Control fluid volume calculations for the accumulator system (for a subsea BOP system, include both the surface and subsea volumes).

These calculations should show that the available pressure to operate each item, especially shear rams, is adequate. The CSB suggests adding information into the final version of the Proposed Rule that states this purpose for conducting the calculations, and notes that the calculations should take into account the actual planned sequence of BOP operation for deadman, autoshear, and any emergency disconnect programmed operations.[14]

Conclusion
BSEE's Proposed Rule includes several important provisions meant to ensure safe offshore operations, particularly those that require technological innovation to drive safety improvements beyond current industry practice. Although the Proposed Rule has several laudable aspects, as we identify, the CSB urges BSEE to identify its own role in ensuring that the proposed performance-based requirements will actually reduce risks as low as practical. CSB also urges BSEE to incorporate human factors requirements into its safety management regulations and strengthen its language regarding performance requirements of safety critical elements to address safety concerns that extend beyond the specifics of the Deepwater Horizon incident. Again, the CSB appreciates the opportunity to provide comments and looks forward to reviewing the Final Rule.

[14] For example, the blind shear ram typically will be initiated after some other functions have used up some of the available accumulator fluid.