Executive Summary

The American Bureau of Shipping (ABS) Consulting prepared this report for the Bureau of Safety and Environmental Enforcement (BSEE) to provide support in the development of a lifecycle management (LCM) and failure reporting system. The goal of this report is to enhance efficiency, effectiveness, and reduce risk in the regulated Oil & Gas (O&G) industry.

At its core, the premise of a comprehensive LCM system is simple – how do certain inputs affect potential outputs? A life cycle management system is a process by which inputs are identified, defined, and tracked in the development of outputs. From a user’s perspective, the LCM system itself functions as a way to gather data on a facility or operation. Such data should then inform supply, maintenance, personnel, or general safety management programs to ensure that the exact inputs are provided to generate the desired outputs. Specifically applied to the O&G industry, an LCM system should be a comprehensive plan that encompasses the entire life of a drilling operation.

These programs are designed to enhance operational safety and cost efficiency by ensuring that all aspects of a project are examined, and that, specifically, potential issues and process improvements are identified and addressed. Though economics is not the primary focus of an LCM system, it is clear that economic improvement can also be realized through improved operational efficiency and resource productivity. An effective LCM system with a failure reporting mechanism can help BSEE prioritize safety and environmental risks in regulation and thereby have industry address them in a consistent and efficient manner. High-level failure data for critical systems or hazardous occurrences can give BSEE a tool by which to measure explicitly the effectiveness of any new regulations. An LCM system with integrated failure reporting can assist BSEE by providing a framework of standardization understanding and practice.

As noted in Task 1, many offshore O&G industry organizations are currently engaged in some aspects of LCM and failure reporting and have robust systems in place. The Task 1 report identified and reviewed potential agencies and companies, domestically and internationally, that may have an LCM and/or a failure reporting system in place. ABS Consulting identified over fifty agencies and over eighty associated LCM or failure reporting programs. The approach in Task 1 followed a ‘mile wide, inch deep’ mentality in collecting applicable programs. Each of the top agencies identified also fit qualifications with the guidelines set forth for Tasks 2 and 3. After identifying the various agencies across different industries, the recommended agencies for review provided a top level review of applicability and relevance to BSEE for both LCM and failure reporting.

The review of these organizations led ABS Consulting to conclude that a perfect comparable LCM system was not identified to present a fully developed conceptual framework that is suitable for BSEE’s challenges. However, there are opportunities for BSEE to use aspects or elements of these other models to develop regulatory frameworks of its own. Choosing to build on these existing regulatory frameworks will probably involve less risk and take fewer resources to design and implement and possibly take less time. The price for choosing such an approach, however, is the resulting model may be less than optimal.

In Task 2, ABS Consulting discussed how BSEE can implement LCM and failure reporting regulations within a spectrum of approaches, from more prescriptive regulations, characterized by command and control regulations, heavy inspection schedules, and onerous reporting requirements for industry, to a
regulatory approach with industry-led regulations. The industry-led approach can simply involve the incorporation of industry standards systems, or be based on industry involvement and consensus standards. While this can allow industry more flexibility in defining the compliant system that would meet both their operational needs and the safety of BSEE, liability might fall on BSEE. Moreover, the regulator-led approach may result in compartmentalized or fragmented systems which may not produce usable, industry-wide data. A hybrid LCM approach would be a blend of both prescriptive and industry involved LCM models. It is important to note that most of the agencies reviewed in Task 2 utilized some elements of both approaches, but to varying degrees.

Figure 1: Regulatory Spectrum

In terms of industry standards incorporation to develop LCM regulation, even those best aligned with the offshore industry will require some augmentation to meet the goals of an inclusive regulatory regime. Specifically, ABS Consulting believes that American Petroleum Institute (API) Standard Specification Q1 9th Edition, API Standard Specification Q2, and the International Association of Drilling Contractors (IADC) Health, Safety, and Environment (HSE) Case Guidelines can be incorporated by reference into BSEE regulations for an LCM program, and are discussed more in Sections 2.10, 2.11, and 2.12 of this report. However, all would need to be altered to promote greater uniformity in application and include measures for external reporting on incidents and failures to BSEE.

Feasibility is also a key consideration in developing recommendations that may actually lead to successful implementation. A regulatory framework that meets the needs of BSEE while staying flexible enough for the industry can be difficult to identify and implement; however, this approach may ease implementation difficulties and boost industry acceptance. BSEE’s aim should be to develop a regulatory regime that is robust enough to ensure the safety of employees and the environment while being flexible enough to allow industry to continue with their best practices. In this way, BSEE can avoid creating redundant or onerous resource and financial burdens on industry.

ABS Consulting believes that the best regulatory approach available to BSEE is a hybrid LCM option that incorporates elements of both prescriptive regulations and industry-based programs. The crucial element of developing a functional hybrid LCM regulatory regime will be to identify the specific critical components of an LCM system. BSEE should require industry to identify the critical systems subject to the LCM system for their facilities. BSEE should then specify the minimum elements of an LCM system, including recordkeeping and documentation requirements. Once operations at a facility are underway, BSEE should include periodic audits of the LCM system by reviewing records and documentation. This would ensure industry organizations are adhering to their developed LCM system.

Ultimately, ABS Consulting recommends that BSEE start with a simple pilot LCM program, and then develop over time. ABS Consulting believes that BSEE should start with a pilot program as a clear need to standardize and implement the core ideas of an LCM and failure reporting system was identified.
repeatedly throughout Tasks 1-4. Following that, BSEE should enhance the core ideas by modifying them according to observed successes and failures and adding more elaborate policies and practices.

As we have highlighted before, there is no single model for LCM systems that neatly spans the entire scope of offshore operations. However, when looking at the totality of the models presented in the Task 2 report, there are some overlapping commonalities that can be utilized by BSEE when developing an LCM outline. The following list of LCM model elements (or phases) represents a compilation of the LCM systems discussed in Task 2. These elements include the entire scope of the LCM process, from project planning, to execution, to decommissioning:

Planning:

- **Requirements:** This phase includes analyzing needs and documenting functional requirements. It also includes analyzing current infrastructures and identifying the alignment with strategies.
- **Design:** In this phase, requirements are transformed into detailed system designs and performance criteria that address:
  - Functionality
  - Reliability
  - Survivability
  - Dependency and interaction with other systems
  - Maintenance
  - Prevention of hazards
  - Well containment

Execution:

- **Build and Test:** In this phase, system designs are converted into a functional system and integrate with other systems. Those systems are then tested to determine interoperability. This would include:
  - Perform interdisciplinary design verification
  - Provide for verification by competent third parties
  - Verify the work by contractors and subcontractors
  - Test systems and equipment before installation
  - Test functionality before commissioning
  - Develop inspection and maintenance procedures in advance of commissioning
  - Develop operational procedures specific to systems and equipment

- **Operation and Maintenance:** For this phase, systems or equipment are in operation and carrying out their intended functions. Elements of the LCM should include:
  - System and equipment maintenance data collection and management processes
  - Failure reporting and corrective action systems
  - Predictive/Prescriptive reliability centered maintenance
  - Inspection and audit programs
  - Ongoing risk management evaluations

Decommissioning:
• The system disposed of or land remediated.

The bulk of the work in an LCM system is performed during the project planning and project execution phases. An LCM system should require that the specific inputs for desired outputs are identified and assessed, that a suitable systems are designed to create those outputs given the inputs, and that the systems are tested and maintained to ensure production. At the completion of the project, all systems should be decommissioned appropriately. To conceptualize these ideas more broadly, ABS Consulting has determined that at a minimum, a successful LCM system has four major aspects:

1. Project assessment process,
2. A method of input tracking,
3. Data collection, and
4. A corrective action mechanism.

The question is, then, how these minimum aspects fit into the project planning, project execution, and project completion phases that delineate the basic LCM system. Each aspect listed only addresses the project planning or project execution phase. While project decommissioning is still an important phase in a comprehensive LCM system, ABS Consulting believes that for the purposes of a simple pilot program, the major aspects for the project planning and project execution phases should be implemented in regulation before developing and implementing regulation on the project completion phase. The aspects are discussed further in Section 2.3 of this report.

In terms of facility management and operational integrity in an LCM program, failure reporting plays an important role, but should complement the broader LCM system. As discussed in Task 3, failure reporting should function as a subset of an LCM system. Moreover, it is a basic element of the LCM pilot program that ABS Consulting recommends for BSEE. Failure reporting provides a way for the O&G industry to monitor how well a piece of equipment, or any component on a piece of equipment, performs its job. If failure occurs, failure reporting can provide a signal to other users of similar equipment/components of an exposed problem and gives investigators the best chance to determine the root cause of an incident and make corrections. The one overarching theme of all the models is the goal of reducing the loss of human life, injuries, and incidents of hazardous materials spills that result in environmental damage. As such, the clear linkage between LCM systems and failure reporting is essential. Failure reporting information is used to feed the LCM process so organizations can track trends and identify potential areas for improvement.
If BSEE implements a failure reporting requirement, BSEE should provide clear and uniform standards of incidents to be reported, reporting requirements, and a set data structure. This will aid industry in identifying the specific equipment or components of concern and help ensure applicability across the industry. This data should be used to address past failures, provide feedback to the equipment manufacturers, and allow regulators to have the data analysis capabilities to prioritize concerns, monitor compliance, and assess trends. Many agencies also use risk-based decision-making tools to analyze the failure data to separate pressing issues from non-critical incidents.

At a deeper level, a consistent issue ABS Consulting noted throughout the research conducted was the need for clear, concise definitions of relevant terminology. Accurate definitions are a crucial aspect of functional regulations. With regards to consistent data collection from failure reporting, effective definitions are necessary so that all operators possess a uniform understanding of the information BSEE needs. In Task 4, ABS Consulting evaluated the effectiveness of definitions for the terms critical system, equipment, component; and critical system, critical equipment, and critical component as they are currently used in the O&G industry. This was accomplished by establishing a set of criteria consisting of context, interpretation, meaning, and understanding to determine how functional a current definition was.

Through that analysis, ABS Consulting discovered that the most successful definitions from a regulatory perspective were specific enough to guide readers to an accurate and uniform understanding of the term, without relying on an exhaustive list of examples to determine meaning. Unsuccessful definitions were those that were too vague to produce an accurate or uniform understanding, or that relied almost entirely on a static list to define the term. Other considerations in the development of a successful definition are to address practical concerns. As these definitions underpin regulation, issues with compliance and enforcement were considered. A successful definition should not be burdensome for neither the regulator nor the industry operator.

The problem is not necessarily a lack of understanding of what systems, equipment, and components are in the O&G industry, but rather an ambiguous interchanging of these terms. Some current definitions treat system and equipment interchangeably, while others treat equipment and component similarly, as well. If a system and piece of equipment are the same, and a piece of equipment and a component are the same, then the same definition can be applied across all items. A discussion of the
relationships between these elements in Section 3.1 and their distinct definitions attempts to correct that problem. To phrase it simply, systems are comprised of equipment, and equipment is comprised of components. Critical systems are comprised of both critical and non-critical equipment. Similarly, critical equipment is comprised of both critical and non-critical components.

The hierarchical approach to the definitions can be easily illustrated by a pyramid representation. As an example, ISO 14224 allows this relationship to be structured in relative terms of the subdivisions of elements and dependency on use and location:

![ISO 14224 Pyramid](image)

Figure 3: ISO 14224 Pyramid

The definitions ABS Consulting developed are listed here:

Critical: **Critical is a quality of a process or material that has the highest probability of causing system failure by failing at a given point in time.**

System: **A System is a functionally, physically, and/or behaviorally related group of regularly interacting or interdependent elements; that group of elements forming a unified whole, the major elements being comprised of equipment.**
Equipment: Equipment consists of the articles or implements used or needed in activities that support a specific purpose or effort of a system, the major elements being comprised of components. Equipment is tangible property used in the operations of a business (other than land or buildings); used to assist a person in achieving an action beyond the normal capabilities of a human; having an anticipated useful life of one year or more. Equipment could include; devices, machines, tools and vehicles.

Component: A component, like equipment, is a single part integral to something more complex, A component is any item/element (part of a process, mechanical or electrical system/product, may also be software codes or algorithms) that functionally contributes to continuous operation or performance of something larger (equipment or system).

Critical System: A Critical System is equipment organized to serve a common purpose, which by their failure may cause or contribute to major mishaps that result in loss of life, significant property damage, or damage to the environment. A Critical System is also any safeguard specifically designed to prevent mishaps, which by its failure would result in significant harm to human life or damage to the environment. If the failure of any particular system could lead to consequences that introduce unacceptable levels of risk, then the system is critical by the nature of its importance.

Critical Equipment: Critical Equipment is two or more components that comprise an assembly or apparatus that contains a characteristic such that any failure, malfunction, or absence of it could cause a catastrophic or critical failure resulting in loss or serious damage to the equipment, unacceptable risk of personal injury or loss of life, or damage to the environment. If the failure of any particular equipment could lead to a significant outcome or a high magnitude consequence that introduces unacceptable levels of risk, then that equipment is critical by the nature of its importance.

Critical Component: A Critical Component is any part of a piece of equipment containing a characteristic of which the failure, malfunction, or absence of could cause a major accident or critical failure resulting in serious damage, environmental consequence or unacceptable risk of personal injury or loss of life. Critical components are essential to the function and continuous operation of something larger (equipment or system). If the failure of any particular component could lead to consequences that introduce unacceptable levels of risk, then that component is critical by the nature of its importance.

Moreover, an LCM and failure reporting pilot program in application will face issues such as compliance, enforcement, and effective administration will affect the resources BSEE must devote to maintaining it. In the discussion detailed in Section 4.2 of this report, ABS Consulting lays out specific guidelines for compliance verification; auditing and inspections; program implementation and administration; and data collection requirements.

How can BSEE best address these topics in the scope of an LCM and failure reporting system? Recalling the project planning and project execution phases and subparts that were laid out as basic facets in the development of an LCM and failure reporting system, it is important to note that these topics exist inside of that structure. Compliance verification; auditing and inspections; program implementation and administration; and data collection for both BSEE and industry members are necessary processes that occur in the project execution phase as systems are operated and maintained. From BSEE’s perspective, ABS Consulting believes that a system of third-party auditing or industry self-verification would work the best given BSEE personnel and budgetary constraints.
Many agencies, including BSEE, have difficulties obtaining inspection personnel with the required technical skills or experience needed for effective compliance inspections of the industry. Third-party organizations can leverage the limited number of skill sets among the BSEE inspector workforce and would be particularly beneficial for inspection of specialized components or systems. Crane inspections, for example, should be conducted by third parties trained to API RP2D and designated by BSEE. ABS Consulting developed three alternative risk-based approaches for BSEE to use when considering implementation of self-inspection or self-certification programs. The three tiered approaches discussed below include:

• Inspection type;
• Facility type / safety culture; and
• Components inspected.

It must be noted that communication and cooperation are vital for a system of this nature to be effective. If BSEE chooses the hybrid option, it should consider developing an effective feedback loop with an exchange of information for required data inputs. One way to ensure industry and BSEE communicate openly and routinely would be to establish a program or forum involving operators, contractors, suppliers, trade unions, SMEs, and government working in cooperation. In order to have an effective and functional relationship between industry and BSEE, this type of program or forum should facilitate trust, open communications, functional perspective, and direct feedback for both industry and BSEE. A third party organization could serve as a data repository and information clearinghouse.

In order to be effective for BSEE, an LCM and failure reporting pilot program should be framed around mitigating BSEE’s identified top risks. ABS Consulting recommends that BSEE employ a Risk-Based Decision Making (RBDM) process to complement an LCM and failure reporting program, as it quantifiably allows BSEE to prioritize certain risks and subsequently develop the appropriate regulation to mitigate them. Additionally, such a program must be enforceable without over-extending BSEE’s human and financial resources. For this issue, ABS Consulting recommends that BSEE divest many auditing functions to industry leaseholders and authorized third-parties. In application, regulated industry members would consist of leaseholders, operators, and subcontractors. To illustrate visually, a system of cascading responsibilities was devised with BSEE’s specific constraints in mind, pictured below:
Figure 4: Cascading Responsibilities

The concept of cascading responsibilities may be new, but it is already supported by 30 CFR 250.400, which clearly states that lessees, operators, and their contractors and subcontractors are responsible for safe drilling operations. BSEE could use or modify existing regulations to require lessees to incorporate these functional elements into plans and documentation. For example, BSEE should modify 30 CFR 250.1916 to include these functional elements in their SEMS mechanical integrity requirements. Using 30 CFR 250.201(a), BSEE should require lessees to provide plans that specifically address how these functional elements will be implemented. Additionally, 30 CFR 250.418(j) may support the requirement for lessees to address these functional elements in their APD process.

In a system of cascading responsibility and third-party verification, BSEE should place the responsibility on the lessee for ensuring that an LCM system is in implemented. The lessee would be responsible for guaranteeing that any operator on their lease has implemented the functional elements of an LCM. The operator would be responsible for developing the policies, programs, and management systems that implement the functional elements of the LCM. Contractors hired by the operator would be responsible for knowing, understanding, and abiding by the policies, programs, and management systems of the operator.
operator. The contractors would be responsible for ensuring that their subcontractors know, understand, and abide by the policies, programs, and management systems of the operator. Subcontractors are accountable for knowing, understanding, and abiding by the policies, programs, and management systems of the operator and the contractor.

ABS Consulting believes that BSEE has the regulatory foundation to implement such a framework. However, there are some big challenges in implementing such a scheme, and they could be significant. Chief among these challenges could be charges of regulatory overreach by an industry that is influential and that has enormous legal resources at its disposal. On the other hand, there could be accusations from other camps that such a scheme is too dependent on the industry to police the implementation of requirements. However, this framework could ensure that comprehensive requirements are imposed, while allowing BSEE to conserve human and financial resources.

To reiterate, ABS Consulting recommends that the functional elements in an LCM and failure reporting program should be limited to critical systems, critical equipment, and critical components. Imposing LCM systems that are not focused on critical systems, critical equipment, and critical components places a burden on the offshore O&G industry and could require BSEE to expend time and resources in areas that have limited value in improving safety or reliability.
Table of Contents

Executive Summary....................................................................................................................................... 2

1 Overview ............................................................................................................................................... 1

2 Background ........................................................................................................................................... 2
  2.1 What is an LCM? ........................................................................................................................... 3
  2.2 What is Failure Reporting? ............................................................................................................ 4
  2.3 Minimum Requirements for an LCM ............................................................................................ 4
    2.3.1 Process of Assessment .......................................................................................................... 4
    2.3.2 Identification and Tracking of Systems/Equipment/Components ........................................ 5
    2.3.3 Data Collection ...................................................................................................................... 6
    2.3.4 Corrective Action .................................................................................................................. 6
    2.3.5 Recommended Options ........................................................................................................ 7
  2.4 Minimum Requirements Failure Reporting .................................................................................. 9
    2.4.1 Report a Failure ..................................................................................................................... 9
    2.4.2 Recommended Options ...................................................................................................... 10
  2.5 Data Sharing ................................................................................................................................ 10
    2.5.1 Applicable BSEE Regulations ............................................................................................... 10
  2.6 LCM ............................................................................................................................................. 10
    2.6.1 Applicable BSEE Regulations ............................................................................................... 11
  2.7 Failure Reporting Systems .......................................................................................................... 11
    2.7.1 Applicable BSEE Regulations ............................................................................................... 11
  2.8 Current CFR Regulations ............................................................................................................. 11
    2.8.1 BSEE ..................................................................................................................................... 12
    2.8.2 USCG ................................................................................................................................... 13
    2.8.3 OSHA ................................................................................................................................... 13
  2.9 Industry Standards ...................................................................................................................... 13
    2.9.1 Applicable BSEE Regulations ............................................................................................... 14
  2.10 API Q1.......................................................................................................................................... 14
    2.10.1 Changes between API Q1 8th and 9th Editions ..................................................................... 15
    2.10.2 Standard Language Currently in Use ................................................................................... 20
    2.10.3 Incorporation of Standard Language .................................................................................. 23
  2.11 API Q2.......................................................................................................................................... 25
    2.11.1 Minimum LCM Requirements Embedded in API Q2 ........................................................... 25
### List of Figures

Figure 1: Regulatory Spectrum ................................................................. 3
Figure 2: Failure Reporting Subset .......................................................... 6
Figure 3: ISO 14224 Pyramid ................................................................. 7
Figure 4: Cascading Responsibilities ..................................................... 10
Figure 5: ISO 14224 Terminology Hierarchy ......................................... 43
Figure 6: Responsibility Hierarchy .........................................................
Figure 7: System of Cascading Responsibility and Third Party Verification ........................................ 65
Figure 8: System of Cascading Responsibility and Third Party Verification with the Addition of Critical Material Data Collection ................................................................. 68
Tables

Table 1: LCM Planning Criteria for API Q1 9th Ed. ................................................................. 20
Table 2: LCM Execution Criteria for API Q1 9th Ed. ............................................................ 21
Table 3: LCM Planning Criteria for API Q2 ............................................................................ 27
Table 4: LCM Execution for API Q2 ...................................................................................... 30
Table 5: IRF Countries and Regulatory Agencies ................................................................. 35
Table 6: LCM Criteria for IADC HSE Guidelines ................................................................. 39
1 Overview

The purpose of Task 5 is to provide BSEE with a comprehensive review of the research and findings discussed in Tasks 1 through 4 and apply the lessons learned in currently used BSEE regulations. This report will examine how lifecycle management (LCM) and failure reporting programs affect the Oil and Gas (O&G) industry. Task 5 will discuss current regulations and O&G industry standards, as well as an overview of programmatic themes, such as effective definitions that pertain to LCM and failure reporting, minimum LCM and failure reporting requirements that should be implemented, and recommended data sharing practices. Task 5 will also discuss which program option would be the best for BSEE to implement, given the range of LCM systems observed. Moreover, guidelines for compliance verification through auditing, inspections, or other processes will be outlined, along with an O&G industry impact assessment.

As a background overview, Task 5 will first assess current regulations and industry standards in Section 2 that pertain to LCM systems and failure reporting requirements implemented by BSEE. CFRs for BSEE, the United States Coast Guard (USCG), and the Occupational Health and Safety Administration (OSHA) are discussed and assessed for their applicability to an LCM system or failure reporting. Currently, none of these regulations implement a comprehensive LCM system, but all have some sort of failure reporting system. Another set of guidelines studied are API Specifications Q1 and Q2, in addition to the still-developing 18 LCM standard. As BSEE already incorporates the 8th edition of Spec Q1 into regulation, ABS Consulting assessed how compatible the 9th edition of Spec Q1, along with Spec Q2 and 18 LCM, were with a complete LCM regulatory program. While very little information could be obtained on 18 LCM, Specs Q1 and Q2 should both provide BSEE with a workable foundation on which to develop a comprehensive LCM system. Both address the project planning and project execution phases of an LCM system. However, for BSEE’s regulatory purposes, these guidelines allow too much flexibility in terms of what an operator must conform too. While this flexibility does allow an operator to tailor cases to suit individual need, BSEE would have to be more explicit in its own regulations to further standardize industry practice.

Guidelines developed by the IADC, which are in use by all International Regulatory Forum (IRF) countries, are also discussed in this task report. IADC guidelines mainly focused on reliability and asset management, topics an LCM system encompasses. Specifically, the Health, Safety, and Environmental Case guidelines for both mobile offshore drilling units (MODUs) and land drilling are examined. Overall, the IADC provides a comprehensive set of guidelines that pertain to LCM systems, and the wide acceptance of these guidelines indicates an effort towards industry standardization. However, for BSEE’s regulatory purposes, these guidelines allow too much flexibility in terms of what an operator must conform too. While this flexibility does allow an operator to tailor cases to suit individual need, BSEE would have to be more explicit in its own regulations to further standardize industry practice.

As mentioned previously, Task 5 will also provide a summary of all the findings accumulated in Tasks 2, 3, and 4, outlined in Section 3. In Task 2, ABS Consulting examined current LCM systems across multiple industries, and found a common underlying structure that encompassed project planning, project execution, and project completion. More specifically, within the project planning phases, requirements are identified and system designs are drafted. In the project execution phase, functional systems are built and tested, and, after installation, operations begin and maintenance is conducted as necessary. In the project decommissioning phase, systems are properly disposed of or recycled. ABS Consulting noted that, from BSEE’s perspective, one particular aspect of a successful LCM system would be adequate data sharing. Collecting, analyzing, interpreting, and acting upon data for specific performance measures
would allow BSEE to identify where safety and environmental risks are still too high, make appropriate corrective adjustments at a regulatory level, and track the effectiveness of those changes.

From the failure reporting aspect of an LCM, discussed in Task 3, any failure reporting system should collect data that is sufficiently comprehensive to cover a wide range of possible analysis. Furthermore, information on the failures of critical facility elements should be communicated to both BSEE and original equipment manufacturers (OEMs). Specific data collection requirements pertinent to BSEE’s regulatory interests are laid out in this report. At a more foundational level, adequate data collection cannot be achieved without clear and uniformly interpreted definitions. The ones devised in Task 4 for the terms critical, system, equipment, component; and critical system, critical equipment, and critical component, are reiterated and discussed in this report, as well.

In addition to developing and implementing regulations for an effective LCM system and failure reporting system, BSEE must also be able to enforce those regulations throughout the O&G industry. BSEE must have a system in place for compliance verification, inspection, and auditing to ensure that any regulations are successfully applied. Ultimately, ABS Consulting recognizes that many agencies, including BSEE, have difficulties obtaining inspection personnel with the required technical skills or experience needed for effective compliance inspections of the industry. This report discusses a tiered system in which BSEE personnel conduct inspections of the highest-priority elements in a facility, medium-priority element inspections are contracted out to a qualified third party, and lowest-priority elements are inspected by the operator.

2 Background

The purpose of this section is to develop a basic understanding of what an LCM and reporting program is and what similar programs currently exist. This section seeks to lay out a baseline for LCM and failure reporting programs by first discussing what ABS Consulting has identified as the minimum requirements for LCM and failure reporting programs, additional recommended options BSEE should incorporate, data sharing suggestions, and an analysis of current regulations and industry standards.

To begin, ABS Consulting recommends that BSEE incorporate all of the minimum requirements for LCM and failure reporting into an LCM pilot program, as they adequately address the main project planning and project execution concepts of:

- Input and output identification and assessment;
- System design based on input and output assessments;
- System construction and testing; and
- System operation and maintenance.

ABS Consulting has determined that the minimum requirements for an LCM system are:

- A clearly defined and systematic process by which the drilling operation’s inputs and outputs are assessed;
- The ability to identify and track all systems, pieces of equipment, and components used throughout the drilling operation;
- A collection system that reports comparable data on facility elements and operational status; and

• A corrective action system that can resolve any mechanical, structural, or other unanticipated functional issues beyond the scope of the LCM plan.

ABS Consulting has determined that the minimum requirements for a failure reporting system are:

• The ability to deliver an accurate report of a failure when one occurs.

In addition to minimum requirements, ABS Consulting also discusses recommended options for LCM and failure reporting program. While these recommendations are not necessary in order to create and implement a successful LCM pilot program, ABS Consulting believes that these recommendations can improve a basic LCM system and provide a better foundation on which BSEE can more easily expand upon.

One significant recommendation that ABS Consulting makes concerns data sharing. Based on how LCM and failure reporting programs function within an industry, ABS Consulting believes that BSEE should promote data sharing amongst industry members through an LCM and failure reporting program. While data sharing can help identify and address recurring problems within an industry, the largest obstacle for industry members would pertain to sharing proprietary or sensitive information. To address this, ABS Consulting suggests that BSEE should:

1. Report only aggregate statistical data;
2. Provide restricted access to failure data or have confidentiality policies that limit disclosure; or
3. Maintain anonymous reporting systems.

Along with these minimum requirements and recommendations, ABS Consulting also discusses current regulations and industry standards and assesses their applicability in an LCM and failure reporting program. The motivation for this lies in the relative ease of taking pertinent language from existing regulations or incorporating industry standards by reference into new regulations for BSEE. In terms of developing LCM and failure reporting regulation, ABS Consulting views existing regulations and standards as low-hanging fruit that BSEE can pick from.

With regards to developing a baseline, this discussion also serves to establish what already exists in terms of LCM and failure reporting programs, both inside and outside of the O&G industry. Current CFRs for BSEE, USCG, and OSHA; API standards Q1 9th edition, Q2, and 18 LCM; and IADC guidelines are discussed specifically, in addition to industry practices and trends observed across several organizations.

The main takeaways are that LCM and failure reporting mechanisms already exist; however, the programs represent incomplete models that do not fulfill the minimum requirements for an LCM and failure reporting program laid out by ABS Consulting. Many of the core concepts and ideas were observed in this analysis, but a cohesive and standardized program implementing them does not exist. API standards Q1 9th edition and Q2, along with IADC Health, Safety, and Environment Case Guidelines, provide the most comprehensive framework that BSEE should incorporate into regulation and build upon in order to create a successful LCM and failure reporting pilot program.

2.1 What is an LCM?
The purpose of an LCM system in the O&G industry is to develop a thorough and comprehensive plan for the entire life of a drilling operation, from project planning to project decommissioning. These
programs are designed to enhance operational safety and cost efficiency by ensuring that all aspects of a project are examined, and that, specifically, potential issues and process improvements are identified and addressed.

As discussed previously, the minimum requirements developed by ABS Consulting do not encompass the project decommissioning phase; however, for the purposes of creating a successful pilot LCM system, addressing the project planning and project execution phases is sufficient.

2.2 What is Failure Reporting?
Failure reporting is a subset of an LCM system. Failure reporting can encompass a simple process by which data is collected, compiled, and published, but is not analyzed. In this capacity, it therefore would not provide any guidance on corrective actions or operational improvement. Failure reporting can also encompass a more complex process that utilizes the collected data to trigger a corrective action system that address the failure immediately. Events that resulted in a failure could then be analyzed to prevent or mitigate the effects of a future event occurring. In this capacity, failure reporting assists in repairing and improving the system.

In terms of facility management and operational integrity, failure reporting plays an important role, but should complement a broader LCM system. Its main weakness is that it is reactive; a failure must occur for the failure reporting system to respond. Consequently, having a failure reporting system that functions as part of an overall process of prevention and improvement is more useful.

2.3 Minimum Requirements for an LCM
ABS Consulting has determined that at a minimum, a successful LCM system has four major aspects:

- A clearly defined and systematic process by which the drilling operation’s inputs and outputs are assessed at every point in the lifecycle;
- The ability to identify and track all systems, pieces of equipment, and components used throughout the drilling operation;
- A collection system that reports comparable data on facility elements and operational status; and
- A corrective action system that can resolve any mechanical, structural, or other unanticipated functional issues beyond the scope of the LCM plan.

The question is, then, how do these minimum aspects fit into the project planning, project execution, and project completion phases that delineate an LCM system’s progression? Clearly, each aspect listed only addresses the project planning or project execution phase. ABS Consulting believes that BSEE can use some of its existing regulatory authorities to require leaseholder to implement a rudimentary LCM plan. In the remainder of this section we will outline the major components of a LCM system and highlight which BSEE regulations contain, or can be modified to contain, the capacity to require such and LCM plan.

2.3.1 Process of Assessment
The input and output assessment process of an LCM occurs during the operation’s planning phase. This process should include analyzing the needs of the particular operation and documenting all functional requirements. Overall, an effective LCM system helps an operator understand how certain inputs can affect the outputs of the operation as a whole. A comprehensive process that accounts for all facets of
an operation minimizes the chance of an unforeseen outcome. For example, a certain piece of equipment in a facility may break down more frequently under the circumstances it is expected to perform in. However, the operator may have initially chosen that piece of equipment when constructing the facility because it was cheaper or easier to use. An LCM system helps an operator understand these outcomes and make more informed decisions. Instead of transferring the risks or cost of that piece of equipment from one phase of the lifecycle to the next, a thorough process that assessed it in the scope of the whole operation would have informed the operator of later potential issues.

Moreover, the assessment process must address the interdependency of certain elements or certain functions in a drilling operation. While it is important to examine these aspects independently, the interaction between two pieces of equipment, or the dependency of one system on another to function properly, must be analyzed in order to develop effective procedures to ensure the overall functionality of a facility. Each element does not function inside a vacuum; if a certain one failed, would the rest of the facility still be able to operate normally? The operator must know which elements can or cannot fail in order to preserve safe functionality and prevent any major hazards or incidents. The assessment process of an LCM system must address performance criteria at this level.

2.3.1.1 Applicable BSEE Regulations
In the broadest context, 30 CFR 250.106(b) and (c) provide BSEE with the authority to require leaseholders to conduct an assessment of the interdependency of certain elements or certain functions in a drilling operation. Additionally, 30 CFR 250.107(2) explicitly requires leaseholders to maintain "all equipment and work areas in a safe condition." Currently, 30 CFR 250.201(b) provides the authority to provide such assessment. Unfortunately, this regulation is very broad and does specifically outline a requirement for assessment. However, 30 CFR 250.201(a) could be modified to require such assessments. Finally, 30 CFR 250.418(j) currently gives the District Manager the authority to any information that they deem necessary as part of the Application for Permit to Drill process. It would appear that the imposition of an assessment is well within the authority of the BSEE District Manager.

2.3.2 Identification and Tracking of Systems/Equipment/Components
The identification and tracking of every system, piece of equipment, and component in a facility is also a necessary step to implement a successful LCM system. This aspect falls under both the project planning phase and project execution phase, as systems, pieces of equipment, and components would fall under an operation’s inputs, while tracking their continued functionality would occur during project execution.

In order for a thorough LCM plan to be developed in the planning phase, an operator must be able to accurately identify every element in a facility. Incorrect identification could lead to an oversight in the assessment process, and thus consequently compound any problems that arise as the drilling operation progresses through its lifecycle. If, for example, an operator misidentifies a critical component as non-critical, or overlooks it altogether, initial risk assessments and later efforts to monitor critical elements would be deficient. To reiterate, the goal purpose of an LCM system is to give an operator the most complete information possible to make informed decisions. At a very basic level, then, proper identification of all systems, pieces of equipment, and components that will be used in a drilling operation is vital. Accordingly, a set of effective definitions must be in place to facilitate this, which are discussed elsewhere in this report.
In addition to identification, the elements must be tracked to maintain the integrity of a drilling operation over the course of its lifecycle. Tracking, necessarily, should occur as the project is being executed and the systems, equipment, and components are performing their intended functions. Tracking allows an operator to monitor how well the elements are performing, and if they are functioning in a manner that conforms to the initial project plan. If substantial deviation occurs, the tracking system then serves to inform the operator that something may be going wrong. Tracking properly identified elements also allows an operator to pinpoint the exact location of a malfunction and make appropriate repairs. If a piece of equipment failed, effective tracking, together with a proper identification method, could isolate the specific component(s) that failed, expediting the repair process.

2.3.2.1 Applicable BSEE Regulations
This aspect of a model LCM plan may be more challenging to impose. As such, there are no specific existing BSEE regulations that could require a leaseholder, and by extension operator, to track critical systems, equipment, or components. Despite this lack of specific regulatory authority, BSEE does have a strong regulatory authority to require leaseholders to report on broadly defined aspects of all offshore operations. Foundationally, both 30 CR 250.106(b) and (c) could apply. Additionally, it would appear that 30 CFR 250.186(a) is written expansively enough that BSEE could require leaseholders to provided reports regarding critical systems, equipment, or components. As with the assessment component of the LCM plan, BSEE should also use their authority under 30 CFR 250.201(b) to require leaseholders to submit reports on critical systems, equipment, or components. Or, as previously mentioned with assessments, BSEE should modify 30 CFR 250.201(a) to require the reporting of critical systems, equipment, or components. As a final point, BSEE should use the all-encompassing 30 CFR 250.418(j) to require such information. As such, none of these existing regulations would directly require leaseholders to track critical systems, equipment, or components, but if leaseholders are required to report on critical systems, equipment, or components, they are in fact required to track them.

2.3.3 Data Collection
Data collection plays an important role in performance improvement for an LCM system and should occur during the project execution phase. One key issue consistently noted by ABS Consulting is that in order for data to be analytically useful, it must be comparable. Thus, a standardized data collection procedure should be implemented to ensure data quality. Given that the purpose of an LCM system is to help operators make more informed decisions, this data should indicate if operational performance does or does not meet expectation. As such, effective data collection should be a way for operators to target specific parts of their drilling operation for performance improvement. However, data collection should also be resource-efficient. Indiscriminate data collection could prove wasteful, as the amount of effort put not only into gathering it, but then analyzing and acting upon it, overburdens the operator.

2.3.3.1 Applicable BSEE Regulations
Of all the characteristics of a model LCM plan, data collection is the easiest to enforce. BSEE may not have the authority to mandate the how data is collected, but clearly 30 CFR 250.186(a) and 30 CFR 250.418(j) are written such that BSEE may require virtually any information related to offshore operations that they require as part of the Application for Permit to Drill process.

2.3.4 Corrective Action
A corrective action system identifies problems that arise during the project execution phase, takes the appropriate actions to amend them, and prevents future occurrences. In the LCM system’s
scope, a corrective action system oversees all operations in a facility, and allows an operator to
gauge how well everything is working. The corrective action system necessarily utilizes data
collected on the operational status to determine if any problems exist. Building on the identification
and tracking of all elements and functions in the facility, a corrective action system also must be
able to identify root causes and implement the steps necessary to mitigate adverse consequences.
Broadly speaking, an effective corrective action system should:

- Document the identified problem
- Assign qualified personnel to investigate problem
- Share findings with impacted parties
- Identify root causes and corrective action
- Verify corrective action is implemented
- Document corrective action information for analysis
- Apply lessons learned from investigation
- Implement preventative actions based on lessons learned
- Verify effectiveness of preventative actions
- Document preventative actions for analysis
- Maintain records of all corrective and preventative actions

It is important to reiterate that an effective corrective action system also functions as a preventative
action system based on knowledge obtained from past problems. The purpose of the corrective action
system is not only to provide solutions and allow normal operation to resume as quickly as possible, but
to thoroughly understand why the problem occurred. Preventative actions and a scheme that verifies
their effectiveness help ensure that a drilling operation adheres to its initial project plan. Rather than
waiting for a problem to occur, preventative actions proactively help maintain the integrity of a facility.

2.3.4.1 Applicable BSEE Regulations
This feature of a model LCM plan will be somewhat challenging to execute because it requires the
complex linkage of several existing BSEE regulations. Under 30 CFR 250.107(2)(b) leaseholders have a
responsibility of “Maintaining all equipment and work areas in a safe condition” and to “…control,
remove, or otherwise correct any hazardous oil and gas accumulation or other health, safety, or fire
hazard.” However, this does not directly translate into a requirement for a corrective action plan.
Current BSEE regulations 30 CFR 250.186(a), 30 CFR 250.201(b), and 30 CFR 250.418(j) (also 30 CFR
250.201(a) if modified) could potentially be used to require a corrective action plan. The difficulty lays in
substantiating this link with industry through a clear policy statement.

2.3.5 Recommended Options
The following sections list the recommended options for an LCM program. While BSEE can still
implement a successful program following the minimum requirements, this discussion lists supplements
to those requirements. Building on the role of failure reporting in an LCM system, ABS Consulting
recommends that, in addition to the minimum requirements laid out, failure reporting processes also
include the following aspects:

- Failure reporting is fully integrated into the LCM system;
- All failure reporting functions in an automated system that can share useful information with
  OEMs and BSEE; and
Process improvements are identified through failure reporting functions

2.3.5.1 Integrate Failure Reporting
ABS Consulting observed that integrating failure reporting fully into the scope of an LCM system was more useful than having the two function separately. Failure reporting should be a subordinate subset of the LCM system, complementing the program in the project execution phase.

Through the research gathered, ABS Consulting believes that stand-alone failure reporting may create gaps in effective data collection, ultimately affecting the overall quality of the data analysis. Integrated failure reporting should also work with the corrective action system in a facility. An obvious relationship between the two would be the failure reporting mechanism activating a corrective action system. Failure reporting that is disconnected from the processes of an LCM system could be less effective because the dialogue between failure reporting and corrective action systems forms the basis for operational maintenance and repairs. Without complete communication between the two, the overall effectiveness of corrective actions, and subsequent preventative actions, could be adversely impacted if a failure is not properly acknowledged or addressed by corrective actions.

2.3.5.1.1 Applicable BSEE Regulations
Unfortunately BSEE's existing regulations regarding incidents in 30 CFR 187 and 188 are written too narrowly to impose a failure reporting systems that would support an LCM system. 30 CFR 186(a) is written very broadly and could be used, but it may take a great deal of policy documentation to make the linkage. We believe that the better bet is to require a systematic failure reporting systems under the authority of 30 CFR 250.418(j) as part of the Application for Permit to Drill process. Specifically, BSEE may consider coupling the broad language of 30 CGR 250.418(j) with the incident reporting requirements of 30 CFR 250.187 and 188 to create a direct linkage between an LCM program and failure reporting mechanisms. As mentioned earlier, the language of 30 CFR 250.187 and 188 would need to be expanded to accommodate the specific requirements for an adequate failure reporting system.

2.3.5.2 Automated Reporting System
With this in mind, automated reporting systems are preferable to non-automated ones, as issues with speed and reliability would be mitigated by an automated system. A non-automated failure reporting system, i.e. one in which almost processes are performed manually, could be significantly slower in relaying failure information to necessary recipients. Additionally, manual processes are more prone to human error in monitoring, recording, and reporting important data or other pieces of information. An automated system could not only reduce the time and improve the reliability of information transmitted; it could also reduce the personnel needs to implement it. In a non-automated process, an extensive team of personnel may be required to perform the tasks of raw data collection, manual data entry, and data processing and delivery. However, with a fully automated system, an operator may only need a few individuals to monitor the continued performance of the system.

Moving one step further, ABS Consulting also recommends that failure reporting systems have the ability to automatically provide failure information to relevant outside parties, such as OEMs or BSEE. While the processing of failure information internally is important to the operator’s LCM system, external analysis that can help further reduce the rate of failures or enhance overall operational safety is also crucial. ABS Consulting noted that many O&G industry operators were reluctant to share proprietary information with non-regulatory organizations, but reports on component or equipment
failures could allow OEMs to detect and correct design flaws within their products. Safer and more reliable products would then subsequently lower the risk of failure without any additional work done by the operator. From BSEE’s perspective, information on system failures would be relevant for safety and environmental concerns, as regulations should be adapted to scrutinize systems that failed the most frequently with the most adverse outcomes.

2.3.5.2.1 Applicable BSEE Regulations
There are no current BSEE regulations that could be used to require the use of an automated failure reporting system. A new regulation or the modification of existing regulation would be required. However, this would be the easy part. The more significant challenge would be establishing the information technology infrastructures that would allow the smooth and secure transfer of information from the leaseholder to BSEE. Without these protocols for the required "digital handshake" any new or modified regulation is worthless.

2.3.5.3 Process Improvement
As addressed previously, a failure reporting system should alert a corrective action system, and the corrective actions should then inform preventative actions to deter future failures of the same nature. Ultimately, this creates a process by which safety and operational performance can be improved upon. Process improvement is a recommended aspect for an LCM system overall, as the documentation process performed during the project execution phase contains a well of material that can better inform the operator. While the initial LCM plan is supposed to be as thorough and comprehensive as possible, there are still tolerable margins of error that can be mended as new information presents itself. The LCM system should not be so rigid as to discourage any alterations to the plan; however, any possible improvements an operator does identify must be closely examined, tested, and reviewed before implementation.

2.3.5.3.1 Applicable BSEE Regulations
Linking failure reporting systems to a corrective action system should be achieved by using the authority of 30 CFR 250.107(2)(b), 30 CFR 250.186(a), 30 CFR 250.201(b) and 30 CFR 250.418(j) (also 30 CFR 250.201(a) if modified). However, as discussed in the section on corrective action systems above, this could require a complex policy statement that may meet with resistance from industry.

2.4 Minimum Requirements Failure Reporting
2.4.1 Report a Failure
The most fundamental requirement for a failure reporting mechanism is that it must be able to provide accurate failure reports. Whether or not the information is used for process improvement, an inaccurate report only compounds the problem at hand. As a corrective action system is a necessary aspect of an LCM system, any failure reporting made within the scope of that plan serves as an impetus for corrective actions. If, for example, a failure occurs such that normal operations are halted, an accurate failure report can tell an operator exactly what went wrong. If a critical system failed, the failure report would detail what pieces of equipment or components also failed to trigger that. Such a report should expedite the repair process by allowing the operator to directly pinpoint the issue, rather than investigating and determining the cause of the shutdown by trial and error.
2.4.1.1  Applicable BSEE Regulations
BSEE may already have the regulatory authority to require failure reports as they relate to LCM systems. 30 CFR 250.188(a)(9) states the leaseholder must report “All incidents that damage or disable safety systems or equipment (including firefighting systems).” What BSEE needs to do is define what “damage” or “disable” means in the context of an LCM system, and then require leaseholders to report such information.

2.4.2  Recommended Options
2.4.2.1  Automatically File Reports
As mentioned previously, ABS Consulting recommends that a failure reporting system be automated. However, should BSEE chose not to mandate this in regulation, ABS Consulting recommends that a failure reporting system has the capability to at least file reports automatically with BSEE. The motivation for this lies in the potential for lapses in failure reporting from an operator to BSEE. Manual report filing runs the risk of being filed incorrectly or simply not filed at all. Such a lapse could negatively impact BSEE’s ability to accurately assess operational failures in the O&G industry, whether due to inaccurate data or an insufficient amount of it. Moreover, automatic report filing would also benefit the operator, as less time or labor would have to be invested in an automated reporting system as opposed to a manual one.

The applicable BSEE regulations mentioned.

2.4.2.1.1  Applicable BSEE Regulations
Assuming that BSEE has the authority to require failure reports under 30 CFR 188(a)(9), it lacks and authority to require those failure reports be submitted electronically. If BSEE choose to require electronic transmission of such reports it would need to create new regulations. The question then becomes where best to place the new regulation within the structure of 30 CFR 250. As electronic submission of important information is a much broader desire than just failure reports it would make more sense to place such a requirement in 30 CFR 250.186. Within the structure of this regulation BSEE could potentially require electronic submission of reports that address LCM systems and well as failure reports.

2.5  Data Sharing
Data from failure reporting can be used by BSEE, industry members, and OEMs to identify risk trends and provide information necessary to make improvements, whether at the regulatory level, the facility and operation level, the equipment and component level, or the manufactured part level. ABS Consulting believes that data generated from consistent and standardized failure reports can provide BSEE, industry members, and OEMs with data more effectively than is currently experienced. It is necessary for individual companies that may be experiencing failure to be able to communicate this information to others to avoid future events that may have negative consequences.

2.5.1  Applicable BSEE Regulations
Assuming that BSEE has the authority to collect LMC and failure systems reports under 30 CFR 188(a)(9), BSEE would need to modify 30 CFR 250.197(a) to make clear that LCM and failure reporting information may be available for public disclosure.

2.6  LCM
Collecting, analyzing, interpreting, and acting on data for specific performance measures allows LCM managers to identify where systems are falling short, to make corrective adjustments, and to track
outcomes. LCM systems that control hazardous processes or critical equipment must have access to accurate data to improve the organization's performance. Data quality is an essential requirement for any performance improvement initiative. The collection of relevant and accurate data is one of the most important aspects in an effective LCM system. Sharing this data with the industry is equally as important as collecting.

BSEE will have to balance the need to collect and preserve the data without unintentionally disclosing data that could be harmful to those who are providing the data. With BSEE’s intention to use the data to communicate risk and educate the industry and the public, BSEE will need to develop clear processes to attain this goal. It must be detailed what data from an LCM system needs to be collected, so the data shared is uniform and is meaningful.

2.6.1 Applicable BSEE Regulations
In certain cases BSEE may wish to limit the public disclosure of certain LCM system information that is collected. To accomplish this BSEE should modify 30 CFR 250.197(c) to make it clear that in these instances the information collected will have limited for public disclosure base upon BSEE’s determination.

2.7 Failure Reporting Systems
The objective of most of the failure reporting systems reviewed is information sharing, and thus relevant information on failures is widely available to the regulatory community, the public, and industry actors. Any failure reporting system should collect data that is sufficiently comprehensive to cover a wide range of possible analysis. At least three mechanisms are utilized to maintain anonymity in reporting failures. The first mechanism is that several of the agencies reviewed reported only aggregate statistical data. The second is that many agencies provide restricted access to failure data or have confidentiality policies that limit disclosure. The third mechanism is that some agencies maintain anonymous reporting systems.

2.7.1 Applicable BSEE Regulations
If BSEE chose to use the authority of 30 CFR 186(a) or 30 CFR 250.418(j) to impose a failure reporting system and collect information from those systems BSEE would also need to modify either 30 CFR 250.197(a) or 30 CFR 250.197(c). BSEE’s choice would be predicated on how much they wish to limit the public disclosure of such information. 30 CFR 250.197(a) should be used for broader disclosure, while 30 CFR 250.197(c) should be used to limit disclosure.

2.8 Current CFR Regulations
The structure of regulations fluctuates across the industry depending on the regulator. ABS Consulting reviewed various industries to evaluate which regulations are relevant and useful for BSEE’s objectives. Specifically, current BSEE, USCG, and OSHA regulations are discussed below in terms of how they may be modified or adapted to be better utilized by BSEE. Generally speaking, a set of comprehensive LCM regulations are not currently employed by any of these agencies. What does exist are a series of failure reporting systems that pertain to casualties and pollution incidents for the Coast Guard, and safety incidents for OSHA. As a baseline, these systems are adequate for failure reporting, but in the scope of an LCM system that incorporates failure reporting as a subsystem, extensive additional work would need to be done.
BSEE

BSEE does not have an LCM system implemented at this time. However, their previous failure reporting system was known as the Safety Device Failure and Inventory Reporting System (FIRS). This was a required system that mandated industry to provide reliability and safety data to BSEE. The motivation for this was to enhance these two factors by developing reliability data on key safety devices.

Specifically, “FIRS required periodic inventory and failure reports to be submitted on safety and pollution prevention devices on offshore structures” (The Marine Board of the National Research Council, 1984).

FIRS relied on drilling companies and the Original Equipment Manufacturer (OEM) to provide their own definitions of critical equipment, and submit data on what they determined to be critical. This led to a collection of non-congruous data that was unable to be processed and utilized effectively. Therefore, this data is no longer collected, FIRS was shut down, and is now defunct (Levine, 2014) (The Marine Board of the National Research Council, 1984).

The FIRS program required substantial amounts of paperwork, which created a burden on the program overseer, as well as on the drilling companies. This is a key lesson to be noted regarding implementation of the next Failure Reporting System for BSEE. The documentation required cannot be too cumbersome for either party involved.

Another key issue of this program was the inconsistencies in reporting requirements. There was no standard on the information that was requested, so each operator sent in varying reports. The information did not match up with data from other operators’ reports. Therefore, analysis of the data was virtually impossible, because data categories did not align with each other.

It is important for BSEE to consider the shortcomings of their previous Failure Reporting System when developing a new system. The lessons to be learned from FIRS are to ensure the data collected is able to be analyzed and made actionable. This is achieved by establishing a prescriptive system that details what data is to be collected. One of the reasons FIRS was unsuccessful was due to the drilling companies and OEM to provide their own definition of critical equipment. Consequently, the system requested data to be submitted based on what each one determined to be critical. In order for the data collected to be consistent, there must be clear definitions defining what should and should not be consider critical. This ensures data collected across the industry is relevant and applicable to the same pieces of critical equipment.

In developing a new Failure Reporting System, BSEE should clearly define the term critical equipment for the industry to abide by. This enables data collected from each drilling company and OEM to be comparable. In the same lens, BSEE should define what is to be considered critical as well. This removes the burden from the drilling companies and OEMs and makes it more likely for them to abide by these clear guidelines and submit the appropriate data.

30 CFR 250 Subpart S discusses BSEE’s current Safety and Environmental Management System (SEMS), put in place to promote safety and environmental protection. While it is not directly a Failure Reporting System, it does have an overlapping function for owners to provide safety measures and investigations of incidents. This hybrid approach to regulation requires OCS operators to internally audit their SEMS system. 30 CFR 250.19 discusses the mechanical integrity pieces that must be included in a SEMS
program. This is a logical area to incorporate the cascading responsibilities concept as outlined in Section 4.2.1. This would allow BSEE to establish an LCM within the existing regulations and form statutory authority over the programs.

Current regulations do not provide direct authority to BSEE to implement an LCM or Failure Reporting System. However, the CFR in general does give OCS owners and operators explicit direction to “[maintain] all equipment and work areas in a safe condition” (30 CFR 250.107 (2)). BSEE has the regulatory auditing authority vested in the current regulations. BSEE also has authority to issue requirements to O&G industry partners through 30 CFR 250.101(b)(2). Finally, current regulations need only to be slightly altered to include the framework that ABS suggests. This framework gives clear lines of responsibility down from BSEE to the leaseholders to execute a proper LCM and Failure Reporting System.

2.8.2 USCG
BSEE can look towards USCG’s pollution incident reporting requirements for failure reporting level criteria, found and detailed in 33 CFR 153.203, Procedures for the Notice of Discharge. This is enforced by either the USCG or the EPA depending on jurisdiction at the point of discharge/release. Responsible vessels or marine facilities must notify the National Response Center immediately of a discharge of oil or release of a hazardous material occurs. A report filed according to this regulation covers requirements for Notice of Marine Casualties (46 CFR 4.05-1).

2.8.3 OSHA
BSEE can review the OSHA Oil and Gas Well Drilling and Servicing eTool for an electronic input tool for common hazards and possible solutions to reduce incidents that could lead to injuries or fatalities with each drilling and servicing company having their own safety program. The eTool does not establish industry consensus standards, however it can be used as a resource in identifying workplace hazards and providing possible solutions. It is important to note this eTool should not be considered a replacement for safety programs safety (Occupational Health and Safety Administration, 2009).

2.9 Industry Standards
The following sections discuss API Standards Q1 9th edition, Q2, and 18LCM (under development), both in a broader context of their overall usability, and in more specific terms of developing an LCM system. These standards are being considered because BSEE already incorporates the 8th edition of Q1 into regulation, and, moreover, incorporating Q2 or 18LCM by reference should provide a simpler solution to LCM regulation development. Incorporating industry standards into regulation is the easiest approach BSEE should take; in addition to already being written, these standards are also already utilized by industry members. O&G product or service providers that API acknowledges as compliant with Q2, 18LCM, or the 9th edition of Q1 would be relatively unaffected by a new regulation incorporating those standards.

With that in mind, the most important aspect to examine is whether or not these standards are even useful to BSEE. Though their incorporation would be the least burdensome for BSEE and the O&G industry, the question to answer is how these standards could positively impact BSEE’s regulatory objectives. Should an entire standard be incorporated, or should BSEE only be concerned with specific parts? More precisely, how useful are these standards in the development of a comprehensive LCM and
failure reporting program? ABS Consulting believes that virtually all of Q1 9th edition and Q2 can be incorporated by BSEE to help develop LCM and failure reporting regulations.

The four major LCM system aspects that ABS Consulting identified were:

- A clearly defined and systematic process by which the drilling operation’s inputs and outputs are assessed at every point in the lifecycle;
- The ability to identify and track all systems, pieces of equipment, and components used throughout the drilling operation;
- A collection system that reports comparable data on facility elements and operational status;
- A corrective action system that can resolve any mechanical, structural, or other unanticipated functional issues beyond the scope of the LCM plan.

Both API Q1 9th edition and Q2 satisfy three of the four major aspects of a basic LCM system that ABS Consulting believes are necessary. An effective data collection system is not developed in either standard. It is once again important to note that neither of the standards presents a complete outline for an LCM system; the project planning and project execution phases are addressed, but project decommissioning is not.

Unfortunately at this time, too little is known about 18LCM to make conclusive recommendations.

2.9.1 Applicable BSEE Regulations

If BSEE chose to incorporate by reference the either of the API Standards Q1 or Q2 the most logical place to include them would be in one of the reserved section of 30 CFR 250.115, 117, or 123.

2.10 API Q1

The 9th edition of API Q1 addresses quality management systems (QMS) for product manufacturing organizations and organizations providing related services under a product specification for the Oil and Gas (O&G) industry. It defines the fundamental requirements for a QMS that an organization, upon satisfying those requirements, can claim conformity to this specification.

This specification’s requirements are consistent with the requirements of other quality management system documents and are structured to minimize nonconformity. It is important to note that this specification does not include all requirements specific to other management systems; however, it does include some elements of these other management systems. As such, it may be used with or independently of other industry-specified documents, giving this specification a broader range of relevance.

For the scope of this report, ABS Consulting considers this specification’s relevancy to internal as well as external bodies its most important facet. This ensures the specification’s applicability to whoever is referencing these requirements, regardless of their affiliation with the organization or industry.

The specification’s structure enables the integration of a process approach to apply a specific section during development, implementation, and improvement of a QMS. This promotes control over the requirements and facilitates overlapping processes.

This specification does not imply a uniform structure to the management system, a technique which has both advantages and disadvantages. One advantage is that it develops minimum requirements to
develop a system, but enables enough flexibility to be applicable to a variety of operators in the industry. This means it can be adapted to fit the environment in which it is being used without being too rigid of a structure to be relevant.

However, uniform documentation is one of ABS Consulting’s recommendations from lessons learned in Tasks 2 and 3. It is important to have documentation that is uniform across the industry, regardless of the system imposed. This creates analogous data that is able to be analyzed and is useful for future planning. ABS Consulting requires a prescriptive format to obtain consistent and comparable data. A structure with uniform structure will ensure consistent data from the organization however, without uniform documentation the data may not be comparable.

2.10.1 Changes between API Q1 8th and 9th Editions
Various changes occur between the 8th and 9th edition of API Q1 that expand the specification’s scope to include things like risk assessment and management, preventative maintenance, and management of change (MOC). These changes range from minor additions of a few words in certain sections, to the addition of entirely new sections to the specification. ABS Consulting reviewed these changes and identified those most relevant and applicable to BSEE’s needs, specifically those that can be utilized in the development of an LCM system and are good practices to include. The following analysis addresses these topics primarily through the lens of our recommended minimum requirements and best practices for an LCM system.

2.10.1.1 Section 4: Quality Management System Requirements
Section 4.1.5.1 (Quality Management System: Communication: Internal) requires data analysis results to be distributed among the relevant levels and departments within the organization. It is important for these processes to not only establish how to collect data, but also to address what to do with the data. In Task 2, we highlight the importance of collecting usable data. The data must be analyzed and actionable for it to hold value and warrant collection efforts. By internally communicating results of a data analysis, the entire organization is aware of the results of a certain data set. This creates a foundation of what work needs to be done from that point forward, and may allow others to compare the data they attained from a similar analysis. Ultimately, it may also encourage conversations about why the results may be the way they are. Communicating results of data analysis enables discussion within the organization revolving around the data, such as what was done right, what was done wrong, and how to improve. The analysis may also assist someone else doing a similar analysis with similar data complete his or her task.

The change in 4.1.5.2 (Quality Management System: Communication: External) requires the organization to provide its quality information when under contract to do so. Product quality is essential for both the manufacturer and the customer. It ensures both parties are satisfied with the production and function of the product. For the manufacturer, it signifies the production facility is operating as it should be and everything is in proper working order. Similarly, it allows the customer to be comfortable using the product as it was intended without concern of incident or accident occurrence due to a defect.

It is important for everyone to have the same level of knowledge regarding the product quality plan and any changes that may occur to this plan. This way, both the operator and the customer are aware of the expectations of the product and can verify whether the product meets these requirements. This avoids miscommunications regarding the performance of the product in the future and accidents that may
occur due to one person’s concept of the product quality differing from another’s. It is important for everyone to know how the product will perform so the correct steps can be taken to replace it when the quality begins to diminish.

Section 4.2.3.C (Management Responsibility: Management Representative) states, “top management shall appoint and maintain a member of the organization’s management who... shall have responsibility and authority that includes: c) ensuring initiation of action(s) to minimize the likelihood of the occurrence of nonconformities.” Nonconformities should be avoided when creating products. It leads to both inefficiencies in resources and time. By having a member of the organization’s management present to ensure actions are initiated to minimize nonconformities, time and resources are allocated efficiently to prevent future mistakes. This responsibility ensures products will be created to the correct standard and minimize the occurrence of nonconformities. It is important to assign this responsibility to management personnel, as it creates accountability as well as a specific high level contact for employees in the event of any problems.

For example, if the appointed management person is taking actions to minimize nonconformities and another employee notices a new action that is leading to nonconformities, the employee will know exactly who to contact to make management aware of this action and create a new action to reduce its effects. In a system, it is important to have specific contact people with detailed responsibilities so other employees know who to contact in certain events. This reduces activities and mishaps going unnoticed because the employee simply did not know the correct individual to report to in order to solve the problem.

Section 4.3.2.2 (Organization Capability: Human Resources: Personnel Competence) states, “Evidence of the determination of competence of personnel shall be recorded and maintained.” Knowledge of staff’s levels of competency and skills is extremely important. It verifies whoever is performing a specific job is qualified to do so and staff isn’t relocated without having the proper training and skills to fulfill that position. Requiring record of staff’s education, training, skills, and experience is a necessary addition to the 8th edition of API Q1. This record allows anyone to access it long after the person is hired. Skills may be apparent and duties assigned upon hire but as progression through the organization over time, the duties may change and the person may not be properly trained for the new position. A record of this enables a person to know exactly what training is necessary to make an employee qualified to change positions or add responsibilities.

Section 4.3.2.3 (Organization Capability: Human Resources: Training and Awareness) states, “the organization shall ensure that customer-specified training and/or customer- provided training, when required, is included in the training program.” It is important to make note of processes that require validation as they are necessary for someone else to check in order to be successful. This prevents steps from being looked over or forgotten to be double checked. A process that requires validation requires it for a reason. It may be especially important, or if it was not properly executed could lead to a large issue further on. Therefore, it is important to note these processes requiring extra attention to prevent problems in the future.

Section 4.5 (Control of Records) requires, “Records, including those originating from outsourced activities (see 5.6.1.6), shall be established and controlled to provide evidence of conformity to requirements and the organization’s quality management system.” Records are necessary for future implications as well as for auditing and referencing. It is important to be able to show the organization
and product complied with requirements and the system. In the case of an incident, the records will be able to maintain that the organization acted as was required and the problem may be elsewhere. Also, if changes are to be made, it is important to have record of what was occurring before the changes were made. Therefore, records of conforming to the system are necessary to reference in the event of future changes.

2.10.1.2 Section 5: Product Realization

The additions to Section 5.2 (Planning) include, “c) legal and other applicable requirements; d) contingencies based on risk assessment; g) management of change (MOC); and the output of planning shall be documented and updated as changes occur.” It is important for the planning stages to include how they will address certain key aspects and situations that may arise. By including legal requirements, contingencies based on risk assessment, and management of change, the planning stage is successful in covering potential future complications. By requiring the output of planning to be documented and updated as changes occur, it ensure the planning is followed through. It also provides a basis for which records can be checked to see if and when they were completed and provides accountability to whoever completed such task. It also enables the organization to always be current with any changes that may occur to the plan. The status of any activity can be checked with accuracy when these steps are followed.

Section 5.3 (Risk Assessment and Management) is new in its entirety. The addition of risk assessment and management is a vital inclusion to the 9th edition. It is crucial to know what aspects or component of a program or product is a potential risk. In addition, it is necessary to be able to quantify and compare risks to one another to be able to most effectively and efficiently mitigate said risks. This is crucial when developing any type of program but especially applicable to an LCM system as they are designed to reduce and mitigate risks. It must be known where these risks exist in order to take preventative action in reducing their occurrence and prevalence in the system.

Section 5.4.3 (Design and Development: Design and Development Outputs) states, “Output shall: d) include identification of, or reference to, products and/or components deemed critical to the design.” Identifying critical components and products is necessary in order to mitigate and reduce risks. This is a very important aspect to be included in the specification. If it is not commonly known what parts of the system are critical, they may be overlooked and not attended to as frequently as necessary. This could lead to errors occurring in the future, especially if these critical components and products have high risk assessments associated with them. The failure of one of these aspects could lead to a failure of the entire structure. Anyone who works with or in relation to such objects must be aware of their critical nature so the necessary precautions can be taken to ensure their optimal operation.

Contingency planning is a useful addition to the 9th edition. This enables a procedure to be put in place that is based on risk assessment. The planning output is required to minimally include response actions to mitigate effects of disruptive incidents, identification and assignment of responsibilities and authorities, and communication controls. When output is documented, updated, and communicated to relevant personnel, it is easier to manage and maintain. Documenting output allows an organization to keep track of what is being produced and have a baseline to reference in the event of an incident or problem with production. It is important to know how the organization operates on a daily basis, but it is equally as important to know what to do in the presence of a particular risk scenario. Contingency planning addresses these scenarios.
Section 5.6.1.1 (Purchasing: Procedure: Determine criticality) states, “Procedure for control of purchase products and outsourced activities a) Determine criticality.” Determining criticality is a necessary step when purchasing products and outsourced activities. Certain actions must be taken when these products and activities are deemed critical. It must be ensured that they are of the appropriate quality and will perform to the standard. Depending on how the organization defines “critical,” these products and activities may be crucial for the operation to function. As such, it must be carefully taken into consideration the procedure for how these purchased products and outsourced activities will be acquired.

Section 5.7.2 provides stipulations on an organization providing “a product quality plan that specifies the processes of the quality management system (including the product realization processes) and the resources to be applied to a product” when required by contract. The product quality plan should, at a minimum, include a description of the product, the “required processes and documentation,” and an identification of outsourced activities and controls over them; the procedures and specifications used; and “the required hold, witness, monitor, and document review points.” These stipulations are included as they allow the customer to verify that a contract is being executed according to their requirements. The product quality plan can help facilitate better communication between an organization and its client as the client has a complete and concise overview of how the desired product is being created. Should any concerns be raised, the client can point to a specific aspect of the product quality plan for the organization to revise in order to deliver a better final product.

Section 5.7.8 (Production and Servicing Provision: Preventative Maintenance) states, “the organization shall maintain a documented procedure for the establishment of preventive maintenance for equipment used in product realization. The procedure shall identify requirements for: a) type of equipment to be maintained; b) frequency; and c) responsible personnel. Records of preventive maintenance shall be maintained (see 4.5).” Preventative maintenance is a concept that ABS Consulting deems beneficial and necessary to include in future regulations. By establishing requirements for the type of equipment to be maintained, frequency, and the responsible personnel you are implemented an important aspect of lifecycle management. This process establishes responsibility as well as accountability to make sure the equipment is properly maintained to avoid unnecessary risks. It also establishes a regular schedule for a piece of equipment to be thoroughly checked and maintained. If there are any issues with the equipment, it can be noticed and addressed before the issue surfaces in a different aspect of the process.

In section 5.11.3 (Management of Change (MOC): MOC Notification) states, “The organization shall notify relevant personnel, including the customer when required by contract, of the change and residual or new risk due to changes that have either been initiated by the organization or requested by the customer.” In order to achieve coordination within the organization, it is important for changes that are being made to be communicated to personnel involved in the operation. This ensures the relevant personnel are aware of the changes and any intended or unintended consequences that may result. This ensures the proper steps can be mitigated to resolve any issues that may result. If personnel and the customer aren’t aware of changes, there is the possibility for misunderstandings to result. These misunderstandings can lead to further issues within the organization that may not be recognized until much later problems surface.
Section 6: Quality Management System Monitoring, Measurement, Analysis, and Improvement

The addition to Section 6.2.1 (Monitoring, Measuring, and Improving: Customer Satisfaction) states, “Records of the results of customer satisfaction shall be maintained (see 4.5).” This creates accountability. If records are maintained, a past performance of customer service is available to be referenced in the future. If an organization is constantly receiving complaints, they may need to reevaluate the structure of the organization or a product’s quality to attain satisfaction.

If an organization has repeated customer complaints from the same customer, it may be apparent that it is simply a hard to satisfy customer. However, if there is a consistent complaint regarding a specific product, that product may need to be reevaluated to promote customer satisfaction. Furthermore, an organization can use customer satisfaction as a reference regarding how well their products are performing and whether they need to make any changes to increase satisfaction or if customers are effectively satisfied.

Records are also helpful in the event of an accident. If a customer complained about a product and then an accident occurred, it may prove their concern about the product. It may also demonstrate signs about what might have been occurring before the major accident to make the customer not entirely satisfied with its performance. This could indicate what is wrong with the product and be an advisory for other customers.

Section 6.2.2.2 (Monitoring, Measuring, and Improving: Internal Audit: Performance of Internal Audit) states, “All processes of the quality management system required to meet this specification shall be audited prior to claiming conformance to the requirements of this specification.”

In order to convey the appropriate message, a product should not be able to claim conformance until the audit verifies it does in fact meet the requirements. This prevents products from being sold as compliant without being audited first. Also, it makes sure that all products are audited and there is no confusion as to whether one has been or hasn’t been.

Section 6.3.c (Analysis of Data) states, “The data analysis output shall provide information relating to: c) nonconformities and product failures identified after delivery or use, provided the product or documented evidence is available to facilitate the determination of the cause (see 5.10).” This is useful for determining what went wrong and what can go wrong. Also important for notifying others using the product of what can potentially go wrong. This is important for identifying trends with a product. If there is a consistent malfunction, it is important to be able to track it and identify what may be the source of this malfunction. Was it manufactured incorrectly? Did an incident occur during transport? Was it misused or installed improperly? It is important to know what went wrong in order to mitigate it in future events and solve the problem at the source.

Section 6.3.f (Analysis of Data) states the data analysis output shall provide information relating to: f) quality objectives (see 4.1.3). Not only is it vital to establish product quality objectives but it’s important to make sure the product is meeting such objectives.

The changes in this section occur in section 6.4.3.a, 6.4.3.d, and 6.4.3.f (Improvement: Preventative Action). It states the procedure shall identify requirements for a) identifying opportunities for improvements d) identifying the timeframe and responsible person(s) for implementing a preventative action and f) MOC (see 5.11) when the preventive action require new or changed controls within the
quality management system.” Timeframes are important aspects that are oftentimes not included. A timeframe provides an actionable window of opportunity for a task to be achieved. If it is not achieved in this timeframe, the person responsible is held accountable. Without a timeframe, a person may not understand the emphasis on a certain action and it may take a significant amount of time before it happens. With a timeframe, the person is aware that this task is a top priority and must be accomplished within a certain amount of time.

Similarly, providing the responsible person enables the organization to reference a specific point of contact of who is responsible for this being done. The task does not get lost by being passed on to other people and become confusing as to who did or did not accomplish the task. The responsible person is in charge of making sure it is accomplished regardless of other circumstances that may occur.

Section 6.5.2.f (Management Review: Input Requirements) states, “The input to management review shall include, as a minimum: f) results of risk assessment (see 5.3).” One of our recommendations in Task 3 is for senior management to have the results of data analysis in order to make informed decisions and be able to focus resources effectively.

2.10.2 Standard Language Currently in Use

In Task 2, ABS Consulting established three different phases, planning, execution, and decommissioning, essential for a Life Cycle Management program. Each phase contains various activities deemed essential for long term success. This analysis will evaluate how successfully API Q1 9th edition addresses these previously established guidelines.

2.10.2.1 Planning

Table 1: LCM Planning Criteria for API Q1 9th Ed.

<table>
<thead>
<tr>
<th>Planning</th>
<th>Spec Q1 Corresponding Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify Inputs/Outputs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This phase includes analyzing needs and documenting functional requirements. It also includes analyzing current infrastructures, as well as identifying the alignment with strategies.</td>
</tr>
<tr>
<td>Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>General:</td>
</tr>
<tr>
<td></td>
<td>In this phase, requirements are transformed into detailed system designs and performance criteria that address:</td>
</tr>
<tr>
<td></td>
<td>• Functionality</td>
</tr>
<tr>
<td></td>
<td>• Reliability</td>
</tr>
<tr>
<td></td>
<td>• Survivability</td>
</tr>
<tr>
<td></td>
<td>• Dependency and interaction with other systems</td>
</tr>
<tr>
<td></td>
<td>• Maintenance</td>
</tr>
<tr>
<td></td>
<td>• Prevention of hazards</td>
</tr>
<tr>
<td></td>
<td>• Well containment</td>
</tr>
</tbody>
</table>
The 9th Edition of API Q1 includes sufficient requirements regarding the planning phase. ABS Consulting regards input and output identification and system designs as components of the planning phase. This specification addresses both throughout the document and is present specifically in Section 4: Quality Management System Requirements and Section 5: Product Realization.

Section 4.1.4 (Quality Management System: Planning) details the general requirements for management to follow. These general requirements explain that all methods and operations controlling the processes must be determined, managed, and effective, and that the planning must be carried out to meet the requirements of this specification.

In Section 5.2 (Product Realization: Planning) important requirements addressed include customer requirements, legal requirements, contingencies based on risk, and records proving product realization. Additionally, each of the requirements reference a section contained within the specification for further requirements of meeting that item. For example, within the Planning section, the document states, “the organization shall address...product and customer-specified requirements (see 5.1).” Stating this requirement in the Planning section and referencing another section’s requirements to be included creates a robust and thorough planning component of the document.

In addition, there is also a subsection entitled Contingency Planning (5.5). This section includes both the general requirements such as a documented procedure for identifying risks as well as specific planning output in Section 5.5.2.

Design is discussed in Section 5.4 (Design and Development) and more specifically in Section 5.4.1 (Design and Development: Design and Development Planning). This section requires to organization to, “maintain a documented procedure to plan and control the design and development of the product.”

Section 4.1.2 addresses functionality by stating the quality policy must be reviewed to make sure it is, “appropriate to the organization.” It must also be, “communicated, understood, implemented, and maintained,” all features that act to improve a policy’s function in an organization.

Reliability can be related to Section 5.7.7 in which auditing and inspections are addressed. These inspections and audits are in place to ensure the operations of the organization are functioning properly. It also makes sure any issues are found and resolved, increasing reliability on performance in the future. However, although the concept of reliability is touched upon throughout the inspection and auditing sections, it is not explicitly addressed.

Planning Output (5.5.2) further explains that at a minimum, a contingency plan must include, “actions required in response to significant risk scenarios to mitigate effects of disruptive incidents; identification and assignment of responsibilities and authorities; and internal and external communication controls (see 4.1.5).” An important aspect of planning is knowing exactly what is needed as an output so the plans are accurately constructed to meet these needs.

2.10.2.2 Execution

Table 2: LCM Execution Criteria for API Q1 9th Ed.

| Build and Test | In this phase, system designs are converted into a functional system and integrate |
with other systems. Those systems are then tested to determine interoperability. This would include:

<table>
<thead>
<tr>
<th>Spec Q1 Corresponding Section</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Execution</strong></td>
</tr>
<tr>
<td>• Performing interdisciplinary design verification</td>
</tr>
<tr>
<td>• Providing for verification by competent third parties</td>
</tr>
<tr>
<td>• Verifying the work by contractors and subcontractors</td>
</tr>
<tr>
<td>• Testing systems and equipment before installation</td>
</tr>
<tr>
<td>• Testing functionality before commissioning</td>
</tr>
<tr>
<td>• Developing inspection and maintenance procedures in advance of commissioning</td>
</tr>
<tr>
<td>• Developing operational procedures specific to systems and equipment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Operation and Maintenance</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>For this phase, systems or equipment are in operation and carrying out their intended functions. Elements of the LCM should include:</td>
</tr>
<tr>
<td>• System and equipment maintenance data collection and management processes</td>
</tr>
<tr>
<td>• Failure reporting and corrective action systems</td>
</tr>
<tr>
<td>• Predictive/Prescriptive reliability centered maintenance</td>
</tr>
<tr>
<td>• Inspection and audit programs</td>
</tr>
<tr>
<td>• Ongoing risk management evaluations</td>
</tr>
</tbody>
</table>

The execution phase is composed of two activities, Build & Test and Operation & Maintenance. These aspects are addressed specifically in Section 5: Product Realization and Section 6: Quality Management System Monitoring, Measurement, Analysis, and Improvement. Specification Q1 addresses Operation & Maintenance more thoroughly than the Build & Test component.

The Build & Test aspect of the execution phase includes various activities that the program should include. Although these activities are recommended to be addressed in the LCM system, API Q1 addresses two out of the seven activities.

Sections 5.7.7.2 addresses the aspect of testing functionality before commissioning. It is concerned with inspecting and testing the product at planned stages as it is required by the product quality plan. It states the evidence of conforming to such acceptance criteria shall be maintained.

Section 5.8 covers developing inspection and maintenance procedures in advance of commissioning. This section explains, “The organization shall determine the testing, monitoring, and measurement requirements and the associated equipment needed to provide evidence of conformity to those requirements.” Furthermore, the organization must maintain a documented procedure of this occurrence and ensure it is used in a way that is consistent with monitoring and measurement requirements, at a minimum to conform to this specification.
ABS Consulting includes five activities in the Operations & Maintenance aspect of the execution phase. API Q1 specifically addresses four of these five activities in the specification.

System and equipment maintenance data collection and management processes are addressed in Sections 5.8 and 6.3. Here it is stated that, “the organization shall maintain a registry of the required testing, measurement and monitoring equipment used to determine product conformity to requirements that includes a unique identification, specific to each piece of equipment.” They must also maintain records of these results. In Section 6.3, “the organization shall maintain a documented procedure for the identification, collection, and analysis of data to demonstrate the suitability and effectiveness of the quality management system. The analysis shall include data generated from monitoring and measurement, internal audits (see 6.2.2), management reviews (see 6.5), and other relevant sources.”

Failure reporting and corrective action systems are mentioned in section 6.4.2. Here the organization, “shall maintain a documented procedure to correct nonconformities and to take corrective actions, both internally and within the supply chain, to eliminate the causes of nonconformities in order to minimize the likelihood of its recurrence.” It further states that corrective actions must be appropriate to the nonconformity.

Predictive and prescriptive reliability centered maintenance is addressed in Sections 5.7.1.2, 5.7.8, and 6.4.3. Section 5.7.1.2 states, “The organization shall maintain a documented procedure that describes controls associated with the servicing (see 3.1.21) of products.” Section 5.7.8 states, “the organization shall maintain a documented procedure for the establishment of preventive maintenance for equipment used in product realization.” This procedure must include requirements for the type of equipment, frequency and responsible personnel. Section 6.4.3 includes information regarding a documented procedure for preventative actions internally and within the supply chain.

Lastly, inspection and audit programs are addressed in Section 6.2.2: Internal Audit. This section contains general information, performance procedures, and review and closure procedures.

2.10.3 Incorporation of Standard Language
Incorporating these standards into BSEE’s regulations is beneficial for the Oil and Gas industry as a whole. Having regulations that are aligned with specifications already being enforced encourages uniformity and compliance with such regulations. Promoting standardization is a concept that has been encouraged throughout the Tasks 1-4 reports and incorporating these standards as regulations would be the next steps in achieving such standardization.

BSEE currently incorporates Q1 8th edition in its regulations by reference in 30 CFR 250.806 entitled, "Safety and pollution prevention equipment quality assurance requirements." In 2.10.1 we highlighted the changes that occurred between the 8th and 9th editions of the standard. In 2.10.2 we analyzed the specific changes that were relevant to the three phases ABS Consulting deems essential for a Life Cycle Management program. This section will give recommendations as to where to best incorporate these specific changes into 30 CFR 250.

2.10.3.1 Planning
Consistent with planning, Sections 4.1.4, 5.1, and 5.2 should be incorporated into Subpart B “Plans and Information” 250.201 entitled, “What plans and information must I submit before I conduct any
activities on my lease or unit?” This will provide more specific guidelines and requirements for accomplishing this requirement of the regulations and will encourage more consistency in complying with such requirements. Similarly, Sections 5.4 and 5.4.1 refer to design planning and can also be included in Subpart B. As such, standard language with respect to the planning stage of the Life Cycle Management plan will appropriately be encompassed in the Plans and Information section of the document.

Sections 5.5 and 5.5.2 address contingency planning and would be best incorporated into Subpart A “General” 250.107 entitled, “What must I do to protect health, safety, property, and the environment?” and Subpart C “Pollution Prevention and Control.” This encourages a robust contingency be in place in the case a variety of emergencies that may occur during operations. These sections can also be included in Subpart B and reference one other to promote consistency throughout the document.

The 9th edition of API Q1, Section 5.7.7 discusses auditing and inspections. This is best included in Subpart A “General” under sections 250.130-250.133 which address various aspects of Inspections of Operations.

2.10.3.2 Execution
The execution phase can be included in a variety of Subparts within 30 CFR 250. Primarily, testing functionality before commissioning is discussed in Section 5.7.7.2 and should be included in Subpart D “Oil and Gas Drilling Operations.” Specifically, it is most relevant to section 250.460, “What are the requirements for conducting a well test.”

Both sections 5.8 and 6.3 regard system and equipment maintenance data collection and management processes. Section 5.8 details inspection and maintenance procedures in advance of commissioning. Section 6.3 requires organizations to maintain a registry of the required testing, measurement and monitoring equipment used to determine product conformity. These sections can be best incorporated into a number of subparts of the document. They are appropriate to be included in Subpart D “Oil and Gas Drilling Operations” 250.466, “What records should I keep?” They are also appropriate to include in Subpart H “Oil and Gas Production Safety Systems” 250.804, “Production safety-system testing and records.” Both sections can be fully incorporated into the Inspection, Maintenance, and Assessment of Platforms part of Subpart I “Platforms and Structures.” This includes sections 250.919-250.921.

Section 6.4.2 requires operators to maintain a documented procedure to correct nonconformities and to take corrective actions. This section is most applicable in Subpart D “Oil and Gas Production Safety Systems” 250.408, “May I use alternative procedures or equipment during drilling operations?” A procedure to correct a nonconformity would be appropriate to have listed here in the event of its occurrence.

Sections 5.7.1.2, 5.7.8, and 6.4.3 address predictive as well as prescriptive reliability centered maintenance. These sections are appropriate in Subpart D “Oil and Gas Drilling Operations.” Here, section 250.446 asks, “What are the Blowout Preventer (BOP) maintenance and inspection requirements?” This subject is also addressed in 250.517 in Subpart E “Oil and as Well-Completion Operations,” and 250.618 of Subpart F “Oil and as Well-Workover Operations.” This would be an important aspect to include in all of these subparts as it is repeatedly addressed throughout the regulations.
The discussion of internal audits in Section 6.2.2 is important to include in Subpart A “General” under the discussion of Primary Lease Requirements, Lease Term Extensions, and Lease Cancellations. Subpart 250.180 asks, “What am I required to do to keep my lease term in effect.” It would be beneficial to require operators to perform internal audits in order to keep their lease requirements satisfied.

2.11 API Q2

API Specification Q2 addresses quality management systems as they pertain to service supply organizations. With the intent of furthering O&G industry standardization, API states that the requirements of Spec Q2 “are structured in a way to minimize the likelihood of nonconformity in the execution of a service.” More specifically, Spec Q2 focuses on the project planning and project execution phases of an LCM system. Overall, the goal of Spec Q2 is to frame the requirements for a quality management system that “provides for continual improvement, emphasizes defect prevention, and strives to minimize variation and waste from service supply organizations.” The lifecycle completion phase and decommissioning processes are not addressed in the Specification.

Therefore, Spec Q2, in and of itself, does not provide adequate guidance to form a comprehensive LCM system, but it does satisfy most of the minimum LCM requirements ABS Consulting identified. Its focus on standardizing industry practice is manifested in the extensive documentation requirements for both the planning and execution phases. The documentation procedures encourage an organization to completely conceptualize a service in the planning phase, and then constantly review and revise activities in the execution phase to stick to that plan. Through Spec Q2, the API clearly employs lifecycle thinking, as the considerations that go into a service plan, along with the checks that ensure it is not deviated from, reflect the broader goals of an LCM system.

In order to promote reliability and conformity in service supply, Spec Q2 more heavily emphasizes the planning phase of the quality management system. Management responsibilities include establishing and communicating all objectives of the system, in addition to maintaining and improving it. Customer requirements and feedback are also constant factors to be considered in the development of the quality management system. The planning phase, as per Spec Q2, involves extensive documentation requirements, such as: a manual and documented procedure for a quality management system, an initial risk assessment, a product design, and a contingency plan, to list several.

While the project execution phase is given slightly less berth in Spec Q2, it also includes a large amount of documentation, a feature reflective of the lifecycle approach taken. For example, to begin the execution of service, an organization must develop a service quality plan, and continually document and verify internal conformity to that plan. Service improvement through auditing, corrective actions, and management review are also laid out. Though the project completion phase is not addressed, Spec Q2 nevertheless provides a workable structure for that expansion, in order for BSEE to later form a more comprehensive LCM system.

2.11.1 Minimum LCM Requirements Embedded in API Q2

The following discussion of API Q2 1st Edition is structured to assess how this standard should fit into an LCM system. The structure follows the linear progression laid out in an LCM system’s planning and execution phases. First, the project planning phase will be discussed. Within that discussion, the content of Q2 will be analyzed for requirements on assessing all inputs and outputs of a service and designing an appropriate system to fulfill identified needs. Next, the project execution will be discussed in the scope
of Q2. How Q2 addresses system building and testing, along with operations and maintenance, will be assessed.

2.11.1.1 Project Planning
2.11.1.1.1 Identify Inputs/Outputs
Spec Q2 addresses planning requirements in a thorough manner. Quality policies, organization capability, and documentation requirements for both a quality management system and specific project plans are all included in Section 4 of the document. First and foremost, Spec Q2 emphasizes that a quality management system must be developed and implemented at a management level. It states that organizational management must furthermore “provide evidence of its commitment,” although specifications on evidence are vaguely stated. Mostly as a mechanism for internal assurance, this evidence could be communication with other members of the organization, the establishment of measures of adherence to the QMS, or internal managerial reviews. If BSEE were to adopt Spec Q2 as a foundation for an LCM system, evidence of commitment in development and implementation should be more explicit and involve external communication to BSEE.

In assessing infrastructure for a quality management system, Spec Q2 requires an organization to broadly determine an appropriate provision of resources in Section 4.3. These include human resources such as personnel competency, all work environments the service will be performed in, and rigorous documentation requirements. The documentation requirements can be utilized as a QMS guideline when an organization plans for a specific project. Spec Q2 states in Section 5 that the organization shall identify all requirements related to the project, whether from a customer, a regulation, or some other legal requirement, and then review its own capabilities to address these requirements. Section 5.1 of Spec Q2 is devoted entirely to planning, in which an organization should create project-specific documents that discuss key performance indicators, an initial risk assessment, contingency planning, management of change plans, product design, and, overall, a record of evidence that this plan can be realized.

2.11.1.1.2 Design
Building on the product design aspect of project planning, Spec Q2 places heavy emphasis on evaluating a service plan in Section 5.4 through the scope of all inputs needed and all outputs generated to deliver a service. While a true LCM system would address outputs that arise in both the project execution phase and project decommissioning phase, Spec Q2 only addresses outputs in the scope of project execution. In addition to providing controls and establishing acceptable variation in the execution of a service, Spec Q2 stipulates that an organization must “identify critical service-related products.” From BSEE’s perspective, this aspect is highly relevant as Spec Q2 should be elaborated on to have organizations report those critical service-related products to BSEE.

In terms of LCM system facets that ABS Consulting discussed in Task 2, Spec Q2 does not sufficiently discuss the functionality, reliability, or survivability of a service. In reading Spec Q2, it is reasonable to infer that in identifying all the requirements for a service, those aspects would arise and be addressed; however, if BSEE does adopt Spec Q2, these requirements need to be made explicit to ensure they get addressed uniformly by all organizations. Additionally, recognizing and addressing the interactions and dependencies between certain service products or processes is not adequately discussed in Spec Q2. While the organization does have to identify critical service-related products, how these products function collectively in a service with other critical or non-critical products is not mentioned.
Maintenance procedures are addressed in the planning phase, but the requirements outlined in section 5.8 are somewhat limited in that this planning is built into the requirements for the controls of proper service execution. Hazard prevention, on the other hand, receives a more comprehensive discussion. Spec Q2 examines hazard prevention in terms of risk assessment and contingency planning in Sections 5.3 and 5.5, respectively. While neither is specifically identified as hazard prevention, taken together, they form an adequate system by which hazards are identified and managed. According to Spec Q2, a risk assessment should include identify risks and risk management tools, and select measures that can prevent or reduce the severity of an incident. The contingency plan goes further than incident prevention, and requires an organization to develop mitigation measures that include a plan for the actions required and appropriate responsibilities each party in an organization holds in the case of an incident.

Overall, Spec Q2 does provide a useable framework for BSEE to then develop into the project planning requirements of an LCM system. It places a large amount of emphasis on documenting all facets of a project plan, and clearly employs lifecycle thinking, as it makes an organization consider the impacts of planning decisions in the project execution phase. What BSEE can improve upon is making certain requirements more specific, particularly when service-critical products are assessed, or when the functionality, reliability, and survivability of a service are examined. While Spec Q2’s quality management system implicitly does this, from BSEE’s regulatory perspective, it is inadequate to put into regulation because it is too vague. A lack of uniformity or difficulties in enforcing compliance could consequently occur.

To summarize, here are specific project planning facets that can characterize minimum requirements for an LCM system, along with the sections of Spec Q2 that address them:

### Table 3: LCM Planning Criteria for API Q2

<table>
<thead>
<tr>
<th>Planning</th>
<th>Spec Q2 Corresponding Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>4.1, 4.2, 4.3, 4.4</td>
</tr>
<tr>
<td></td>
<td>5.1, 5.2</td>
</tr>
<tr>
<td>Design</td>
<td>5.4, 5.7</td>
</tr>
<tr>
<td>• Functionality</td>
<td></td>
</tr>
<tr>
<td>• Reliability</td>
<td></td>
</tr>
<tr>
<td>• Survivability</td>
<td></td>
</tr>
<tr>
<td>• Dependency and interaction with other systems</td>
<td></td>
</tr>
<tr>
<td>• Maintenance</td>
<td>5.8</td>
</tr>
<tr>
<td>• Prevention of hazards</td>
<td>5.3, 5.5</td>
</tr>
<tr>
<td>• Well containment</td>
<td></td>
</tr>
</tbody>
</table>
2.11.1.2  Project Execution

2.11.1.2.1  Building and Testing

While project execution receives slightly less attention than project planning, Spec Q2 still addresses many basic LCM aspects in sufficient detail. In terms of building and testing, Spec Q2 has stipulations in Section 5 that ensure an organization verifies the work done by contractors or subcontractors, covers inspection and maintenance procedures prior to commissioning, a facet that was addressed in the project planning phase. It also has operational requirements that facilitate the development of procedures specific to different systems or pieces of equipment. For example, all testing, measuring, and monitoring equipment must be deemed appropriate for the facility elements evaluated, and must also be calibrated and verified before use, as discussed in Section 5.8.

Aspects lacking in these requirements reflect the gaps noted in the project planning phase, specifically as applied to the functionality, reliability, and survivability of a service under a QMS plan. Here, things such as interdisciplinary design verification and testing functionality prior to commissioning are not adequately addressed. BSEE could improve upon the building and testing stages by requiring organizations to first consider those aspects in the planning phase, and then adding in complementary requirements to verify that, for example, a service is reliable under several types of working conditions associated with it. In the scope of an LCM system, functionality, reliability, and survivability must be explicitly addressed, whether for a product or a service.

Section 5.8 of Spec Q2 additionally requires organizations to verify that all computer software can perform its “intended application” prior to initial use, and should be reconfirmed as necessary. Moreover, in the case the equipment is procured externally, the organization must verify that “the equipment is suitable” and provide evidence that the service render using that equipment conforms to the QMS plan. Details such as these should be retained if BSEE were to develop an LCM system based on Spec Q2. The purpose of an LCM system is to recognize and address every facet of a project, so requirements on easily overlooked elements in an operation help ensure that the program is implemented correctly. Moreover, if issues are discovered with software or purchased equipment, BSEE should develop a reporting requirement that can alert other organizations and OEMs to the problems.

2.11.1.2.2  Operations and Maintenance

For operations and maintenance, Spec Q2 sufficiently addresses maintenance data collection, failure reporting and corrective action systems, and predictive reliability-centered maintenance. However, inspection programs and ongoing risk management evaluations need to be expanded upon in order for BSEE to utilize and regulate them in an effective LCM system. To begin with maintenance data collection, Section 6.3 of Spec Q2 allows the organization to “determine, collect, and analyze appropriate data to demonstrate the suitability and effectiveness” of a quality management system. It also emphasizes that this data should be used to determine where improvements can be made in the QMS. The only alteration BSEE would need to make in adapting this to an LCM system would be specifying what data an organization needs to collect, and what analytical processes must happen in order to ensure a standardization method of operational evaluations and improvement.

Failure reporting is addressed through Sections 5.10 and 6.4 on nonconforming service execution, in which an organization must address nonconforming services by taking corrective actions, precluding the use of the affected service, or, if the first two are not appropriate, performing the service under an authorized concession. Spec Q2 further elaborates on corrective action by requiring an organization to
follow the documented procedures of the QMS plan to both “eliminate the causes of nonconformities” and “minimize the likelihood of their recurrence.” The actual procedure must align closely with what ABS Consulting noted as basic aspects of an effective failure reporting and corrective action system, including root cause analysis, identification of the appropriate personnel and timeframe to correct the issue, review of the effectiveness of the corrective action, and a maintained record of all corrective actions taken. However, in regulation, significant failures and the actions taken to correct them should be reported to BSEE.

Spec Q2 encompasses preventative maintenance in Sections 5.7 and 6.4 through a preventative maintenance, inspection, and test program (PMITP). Such a program could be easily incorporated into an effective LCM system, as it builds on the corrective action system and requires an organization utilize records of previous failures to provide verification for continued service use, lists of critical spare parts used in repairs, and controls that ensure equipment integrity after repair. Overall, BSEE would only need to collect the verifications of continued service and confirm that the list of critical spare parts is accurate in the scope of the initial LCM plan. While reliability, i.e. measures that minimize the likelihood of repeated failures, is once again not explicitly addressed here, the requirements for post-repair service integrity and equipment integrity address functionality. However, the corrective action process just discussed has measures built in that do address reliability. In regulation, BSEE should emphasize the connection between corrective and preventative actions, specifically that the lessons learned from corrective actions should inform preventative actions.

In regards to inspection programs and auditing, Spec Q2 provides sufficient requirements for internal auditing in Section 6.2, but does not include measures for reporting those audits externally to a regulator. Moreover, BSEE or a contracted third party should conduct periodic audits of LCM systems in order to verify that internal audit results are objective and accurate. As it currently stands, the internal auditing sections in Spec Q2 function as another check to ensure that an organization’s services conform to its QMS plan. Additionally, requirements for ongoing risk management evaluations are limited. Spec Q2 outlines a Management of Change (MOC) procedure in Section 5.11, in which an organization is required to re-evaluate the associated risks of a planned change before it is enacted. BSEE should improve upon Spec Q2 by requiring organizations to run risks assessments in order to catch unplanned changes in the scope of operations.

For the project execution phase of an LCM system, Spec Q2 once again provides a usable framework for BSEE to expand upon. Things BSEE should address that are not present in Spec Q2 pertain to ensuring the functionality, reliability, and survivability of a service. Spec Q2 partially or implicitly addresses these facets, but in regulation, BSEE should be explicit in performance expectations as they apply to human and environmental safety. Additionally, reporting requirements to BSEE should be made, specifically for failure reporting, but also for the results from internal audits. In order to monitor compliance to an LCM system, BSEE should also conduct independent inspections or audits to verify the results of internal audits. Also, ongoing risk assessments, something Spec Q2 does not adequately address, should be conducted in order to better minimize the likelihood of adverse incidents.

To summarize, here are specific project execution facets that can characterize minimum requirements for an LCM system, along with the sections of Spec Q2 that address them:
Table 4: LCM Execution for API Q2

<table>
<thead>
<tr>
<th>Execution</th>
<th>Spec Q2 Corresponding Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build and Test</td>
<td></td>
</tr>
<tr>
<td>In this phase, system designs are converted into a functional system and integrate with other systems. Those systems are then tested to determine interoperability. This would include:</td>
<td></td>
</tr>
<tr>
<td>• Performing interdisciplinary design verification</td>
<td></td>
</tr>
<tr>
<td>• Providing for verification by competent third parties</td>
<td></td>
</tr>
<tr>
<td>• Verifying the work by contractors and subcontractors</td>
<td>5.7</td>
</tr>
<tr>
<td>• Testing systems and equipment before installation</td>
<td></td>
</tr>
<tr>
<td>• Testing functionality before commissioning</td>
<td></td>
</tr>
<tr>
<td>• Developing inspection and maintenance procedures in advance of commissioning</td>
<td>5.8</td>
</tr>
<tr>
<td>• Developing operational procedures specific to systems and equipment</td>
<td>5.8</td>
</tr>
<tr>
<td>Operation and Maintenance</td>
<td></td>
</tr>
<tr>
<td>For this phase, systems or equipment are in operation and carrying out their intended functions. Elements of the LCM should include:</td>
<td></td>
</tr>
<tr>
<td>• System and equipment maintenance data collection and management processes</td>
<td>5.7, 6.3</td>
</tr>
<tr>
<td>• Failure reporting and corrective action systems</td>
<td>5.10, 6.4</td>
</tr>
<tr>
<td>• Predictive/Prescriptive reliability centered maintenance</td>
<td>5.7, 6.4</td>
</tr>
<tr>
<td>• Inspection and audit programs</td>
<td>5.10, 6.2</td>
</tr>
<tr>
<td>• Ongoing risk management evaluations</td>
<td>5.11</td>
</tr>
</tbody>
</table>

API Specification Q2 provides a usable framework for BSEE to build an effective LCM system on. Overall, BSEE should take the entirety of Spec Q2’s quality management system program and incorporate it into an LCM-based regulation. However, additional work would need to be done to supplement its requirements and make them useful for BSEE’s regulatory purposes. Spec Q2 does not contain any requirements in which an organization must report plans, gain approval, report accumulated data, or receive inspects or audits from a regulatory body. BSEE would need to supplement the existing material with a series of external checks to ensure that a suitable LCM project plan was established and adhered to throughout the duration of a project.

As mentioned earlier, the largest gap Spec Q2 has in the scope of a comprehensive LCM system is the project completion phase. BSEE would need to draft regulations from scratch in order to correct that issue; however, ABS Consulting believes that for the purposes of creating a simple LCM pilot program, it is not necessary the project decommissioning phase in order to have a successful program.

In terms of the planning phase of an LCM system, Spec Q2 has sufficient requirements to address most of the LCM minimum requirements. The heavy emphasis placed on documenting all facets of service execution in the project plan underscore the lifecycle thinking employed in Spec Q2. Building on that,
Spec Q2 also provides sufficient requirements to address the minimum project execution phase requirements of an LCM system. However, explicitly defined expectations for the functionality, reliability, and survivability of a service or product should be created. These items are implicitly addressed by Spec Q2, but further clarity would help BSEE enforce a more effective and uniform regulation.

2.11.1.3 Definitions
Spec Q2 defines the term critical as: “that deemed by an organization or customer as indispensable or essential, needed for a stated purpose or task, and requiring specific action.” In the context of service-based quality management systems, the definition is too vague for BSEE’s regulatory purposes. For example, in the planning phase of the quality management system, Spec Q2 requires an organization to “identify critical service-related product” for project execution. Moreover, organizations must also determine the “criticality of services or service-related products obtained” from outside parties. As discussed in Task 4, the given definition of critical does not create a sufficiently uniform understanding for industry organizations to all provide comparable lists of these products to a regulatory body.

It is not clear at what level an organization is supposed to examine a product for its criticality in a service. If it purchases a piece of equipment from a supplier that is deemed critical, that equipment should also be examined for critical and non-critical components. In the event of a failure, the corrective action requirements in Spec Q2 stipulate that an organization must conduct a root cause analysis. If the component or components that failed go unrecognized, then subsequent actions and preventative measures will continue to overlook those weaknesses. Additionally, since Spec Q2 also states that services can be critical, clarification must be made if the personnel overseeing those services can also be deemed critical, or if critical elements in an organization are purely mechanical. The confusion generated by the current definition applied in Spec Q2 must be corrected before it is incorporated in regulation.

2.11.2 Recommended LCM Features
In addition to the minimum requirements of an LCM system that ABS Consulting laid out in Task 2, API Standard Specifications Q1 9th Edition and Q2 will be assessed in terms of how well they satisfy recommended LCM system practices. The two Specifications are extremely similar in structure and content regarding these recommendations, having practically identical language in the same sections addressing them.

Specifications Q1 9th Edition and Q2 also cover most, but not all, of the practices ABS Consulting recommended for an effective LCM system. These practices pertain to in-depth studies of:

- asset integrity,
- audit regimes,
- corrective and preventative action (CAPA) systems,
- hazard identification and risk analysis (HIRA),
- management of change (MOC) procedures,
- contractor management,
- management reviews for continuous improvement, and
- training and performance assurance
While many of these topics were addressed in the previous Specification analyses, the purpose of this section is to elaborate more thoroughly upon them and assess the suitability of Specs Q1 9th Edition and Q2 for these purposes.

2.11.2.1 Asset Integrity
ABS Consulting recommends that asset integrity documentation includes reports on data from initial testing and other verification measures by which a product or service is deemed acceptable for use. Effective asset integrity plans should also ensure that results from ongoing inspections while the product or service is in its execution phase are utilized to take appropriate actions on deficiencies before they result in failures. Any repairs or adjustments made should be controlled and conducted by qualified personnel following authorized procedures. Specs Q1 9th Edition and Q2 address these facets of asset integrity reasonably well, but more emphasis must be placed on continual asset monitoring.

Moreover, while Specs Q1 9th Edition and Q2 do provide adequate guidance on preventative maintenance, BSEE should place more emphasis on the connections between continual risk analyses and deficiency identification. Part of the preventative maintenance plan should also include an assurance of personnel qualification by assigning certain personnel certain responsibilities in the case of deficiency detection. Such measures are only in place under Specs Q1 9th Edition and Q2 if the deficiency causes a failure; a more thorough maintenance plan can cut down the time an organization spends on repairing deficiencies detected in an asset.

2.11.2.2 Audit Regimes
As discussed previously, both Specs Q1 9th Edition and Q2 only provide requirements for internal auditing. While this is a necessary part of an LCM system, BSEE must include requirements that allow it to verify internal audit reports. An audit report, whether conducted internally, by BSEE, or by an third party should include observations, findings, and recommendations for any needed improvements. Additionally, these results should be trended over time to determine the long-term improvement of an organization’s LCM system. Specs Q1 9th Edition and Q2 require organization management to verify any follow-up actions taken after an audit, results that should also be reported to BSEE to further inform a trend analysis.

2.11.2.3 Corrective Action and Preventative Action (CAPA) Systems
Specifications Q1 9th Edition and Q2 address all aspects of a CAPA system sufficiently well. This includes documenting an identified problem, assigning appropriate personnel to detect the root cause, sharing the findings internally, taking corrective action, verifying that the corrective action was effective, and then recording and preserving all information about the corrective action process to inform a preventative action system. Specs Q1 9th Edition and Q2 can be improved by explicitly addressing where preventative information comes from, i.e. information that is accrued from lessons learned in corrective actions. Moreover, for BSEE to successfully implement this in regulation, failure reports must be sent to a regulatory body.

2.11.2.4 Hazard Identification and Risk Analysis (HIRA)
The HIRA process encompasses the entire spectrum of risk analysis, from qualitative to quantitative analyses, and can be performed during any phase of an LCM system. Specs Q1 9th Edition and Q2 only require an initial risk assessment, conducted in the planning phase of a quality management system. Additional risk analyses are only required when a planned change may occur. BSEE should improve on this facet extensively, as unforeseen hazards and risks may never be evaluated under Specs Q1 9th
Edition and Q2 after the initial analysis. Analyses BSEE should use to supplement this include simple ones such as hazard and operability analysis, what-if/checklist analysis, or more complex and thorough ones such as failure modes, effects, and criticality analysis (FMECA) or layer of protection analysis.

2.11.2.5 Management of Change (MOC) Procedures
MOC procedures are addressed by Specs Q1 9th Edition and Q2. As mentioned previously, they require risk re-analyses if a planned change to the QMS plan is going to occur. More broadly, MOC procedures help ensure that changes to a process do not inadvertently introduce new hazards or create an increase in risk amongst existing hazards. Specs Q1 9th Edition and Q2 require that any MOC procedure covers a risk assessment of the proposed change, and, taking those results, notify relevant personnel of new risks, and “ensure that relevant documents are amended.” BSEE should elaborate on this last part, particularly concerning CAPA systems. While the initial project plan should be amended, recognition of new hazards or higher risks should be specially noted and accommodated for in a CAPA system. If a planned change increases the risk of a certain system failing, preventative maintenance measures should be addressed in the MOC report. As mentioned previously, requirements for risk analyses should also be expanded upon and made more specific.

2.11.2.6 Contractor Management
Specifications Q1 9th Edition and Q2 only address contractor management partially through purchasing control requirements. Essentially, an organization must “maintain a documented procedure to ensure that the purchased or outsourced services and service-related products conform to specified requirements.” In the scope of a comprehensive LCM system, ABS Consulting noted that contractor management functions as a system of controls to ensure that any contracted services support both safe facility operations and the organization’s personal safety performance goals. Specs Q1 9th Edition and Q2 do not provide adequate requirements pertaining to contractor management, and BSEE would need to incorporate additional language on contractor reviewing and evaluation in order to effectively address it.

2.11.2.7 Management Review and Continuous Improvement
Management reviews are conducted with the same underlying intent as an audit, specifically to evaluate the effectiveness of the implementation of an entire LCM system. Specs Q1 9th Edition and Q2 have a management review section with a list of necessary inputs and outputs to foster continuous QMS improvement. Input requirements under Q2 include effectiveness assessments from previous management reviews, the results of internal audits, customer feedback, risk assessment results, and the reports and statuses of corrective and preventative action systems. Ultimately, the management review should produce a “summary assessment of the status of the quality management system,” which includes any required changes to the processes and any actionable decisions to the service that should be made. These requirements adequately fulfill management review and continuous improvement aspects in an effective LCM system.

2.11.2.8 Training and Performance Assurance
An effective training program functions to bridge the gap between what skills a qualified job applicant has and what skills are actually necessary to accomplish a specific job. Specs Q1 9th Edition and Q2 require that an organization provide continual job training for both on-site personnel and contractors who contribute to the creation of a product or the execution of a service, and, moreover, require that all personnel are aware of the “relevance and importance of their activities,” both as immediately applied
to their jobs and the overall scope of the quality management system. ABS Consulting recommends that some performance assurance system can test employees periodically over the course of a project, but Specs Q1 9th Edition and Q2 do not contain requires for such a system. BSEE should expand the training and awareness section to include a performance assurance measure for the purposes of assessing a training program’s effectiveness.

In terms of the LCM system recommendations that ABS Consulting noted in Task 2, Specs Q1 9th Edition and Q2 satisfy most of the requirements pertaining to asset integrity, audit regimes, CAPA systems, MOC procedures, contractor management, and training and performance assurance. Specs Q1 9th Edition and Q2 adequately address management review without further work needing to be done by BSEE. However, contractor management needs some additional work. BSEE would need to incorporate language on contractor reviewing and evaluation in order to effectively address it. Both the audit regime and CAPA requirements under Specs Q1 9th Edition and Q2 need to facilitate information being passed between an organization and a regulator. Specifically, the audit regime should be modified to have BSEE verify internal auditing results, and the CAPA system should also report failures to BSEE. Asset integrity requirements in Spec Q2 should be modified to include continual risk analyses, and MOC procedures should also be made more explicit in terms of risk analysis. Finally, personnel training requirements should include a performance assessment aspect to gauge a training program’s effectiveness.

2.12 API 18LCM
API 18 LCM (formerly API Q3) is a specification from the American Petroleum Institute that is currently under development and review. Fortunately, current ABS SMEs are involved with API Task Groups in the review of 18 LCM and were able to provide some insight in its background and development.

The details and contents of 18 LCM are restricted from distribution due to current ballot comments that are still pending to be addressed. Because of this, our team was unable to access the entire document, but our SME was able to provide us with some basic information regarding the upcoming specification.

API 18 LCM is the next specification in line from API Q1 and Q2 with compliance with Q2 being a specific prerequisite for 18 LCM. The standard looks to introduce 5 LCM levels to what a product can be certified. The certification for each product is to be completed by a service provider with each LCM level having specific documentation requirements. The maintenance and management of each certified product will be conducted through a lifecycle management plan. Based on the current progress in the review process, our SME has pointed out that the five LCM levels may be reduced to three.

As part of an API subcommittee, our SME pointed out that there was concern with this specification regarding the practical implementation of the standard. There seemed to be some apparent difficulties in implementation as well as a lack of a clear process to grandfather in existing equipment. Furthermore, there was also currently a lacking for a clear understanding of which LCM level can be applied to existing products as well as how each LCM level may be applied to components, equipment, systems, or product lines. Although this specification is still in review, our team will work with our SMEs to gather updated information as it can become available.

2.13 IADC
The International Association of Drilling Contractors (IADC) has published Health, Safety, and Environment (HSE) Case Guidelines that pertain to LCM systems for both Mobile Offshore Drilling Units (MODU) and Land Drilling. These guidelines serve as a general framework upon which drilling
contractors develop an HSE case tailored to their individual practices. As the IADC is an international body, the varying jurisdictions its members may fall under is acknowledged with a strong emphasis on multi-party communication to generate the specifics of an industry member’s HSE case. With that being said, all IRF countries accept the guidelines of the International Association of Drilling Contractors (IADC) in an effort to standardize industry practices. The IRF countries and their regulators include:

**Table 5: IRF Countries and Regulatory Agencies**

<table>
<thead>
<tr>
<th>Country</th>
<th>Regulator</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>National Offshore Petroleum Safety Authority</td>
<td>IADC Guidelines</td>
</tr>
<tr>
<td>Cuba</td>
<td>Ministry of Science, Technology, and Environment</td>
<td>IADC Guidelines</td>
</tr>
<tr>
<td>Denmark</td>
<td>Danish Energy Authority</td>
<td>IADC Guidelines</td>
</tr>
<tr>
<td>Faroe Islands</td>
<td>Ministry of Petroleum</td>
<td>IADC Guidelines</td>
</tr>
<tr>
<td>Germany</td>
<td>Landsemat fur Bergbau, Energie, und Geologie</td>
<td>IADC Guidelines</td>
</tr>
<tr>
<td>Ireland</td>
<td>Department of Communications, Energy, and Natural Resources</td>
<td>IADC Guidelines</td>
</tr>
<tr>
<td>Netherlands</td>
<td>State Supervision of Mines</td>
<td>IADC Guidelines</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Department of Labor</td>
<td>IADC Guidelines</td>
</tr>
<tr>
<td>Norway</td>
<td>Petroleum Safety Authority</td>
<td>IADC Guidelines or Acknowledgement of Compliance</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Health and Safety Executive</td>
<td>IADC Guidelines</td>
</tr>
</tbody>
</table>

(International Association of Drilling Contractors, 2014)

The IADC proposes a series of expectations and possible demonstrations an operator may undertake in order to prove it possesses a sufficiently comprehensive HSE case. The guidelines state that “the scope and arrangements for providing assurance internally and a demonstration externally [is] that:

- There is an effective HSE management in place for managing major hazards, other workplace hazards, and environmental aspects;
- All potential hazards have been identified; and
- Risks associated with these hazards have been identified, assessed, and managed with any residual risks reduced to tolerable levels.” (IADC, 2014)

The IADC developed the HSE Case guidelines in response to a recognized and ongoing need in the O&G industry to “to improve the cooperation amongst Drilling Contractors, oil and gas producers, and national regulators to further promote the harmonization of requirements” (International Association of Drilling Contractors, 2009). Prior to this, industry members attempted to create tailored frameworks to formalize risk management processes and foster more consistent internal application of those processes. The IADC created the Land Drilling and MODU HSE Safety Case guidelines in order to further standardize these ideas and provided detailed best practices for the entire O&G industry. The guidelines have gone through a number of revisions, indicating the IADC needed to provide updates to adapt to the changing needs of the industry.
The IADC developed the HSE Safety Case guidelines based on a methodology of recognized standards and practices and guidelines provide a framework for a systematic risk management program. The guidelines cite ISO 14001, OSHAS 18001, and ISO 17776 as relevant standards for which it developed some of its recommendations. The IADC states that “developing and maintaining an HSE Case provides continuous assurance that existing HSE risks are effectively managed and provides assurance that systemic weaknesses identified by incident analyses and audits will be effectively managed” (IADC, 2014). This LCM-based system can be measured by the continual increase in members and the decrease in the frequency of both injuries and operational failures in the participating drilling industry.

The guidelines are broken into six parts detailing management systems, rig descriptions, risk management, emergency response, and performance monitoring:

2.13.1 Part 1: HSE Guideline Introduction
Part 1 introduces HSE methodology and the overall intent for an effective HSE case. It demonstrates that LCM and failure reporting ideology are present in the development of these guidelines, as the scope of an HSE case closely aligns to that of the LCM and failure reporting program outlined by ABS Consulting.

While the guidelines define major hazards, various types of risk, and other similar vocabulary, they do not give a qualitative or quantitative measure on program effectiveness. Once again, as IADC members interact with different regulators and experience non-uniform policies and legislation, the guideline emphasize that, in terms of regulatory requirements, “arrangements for monitoring and confirming that effective HSE management has been implemented and maintained … [in] compliance with applicable regulatory requirements” must be pursued. (IADC, 2014)

The lack of explicitly stated standards of effectiveness or success of a particular HSE case proves the biggest drawback of these guidelines. While the IADC has made considerable efforts in standardizing the creation and implementation of an HSE case, the relative capabilities of these cases do not even have a baseline against which they can be assessed. The guidelines nevertheless offer a thorough framework, and, to their credit, enable a large degree of flexibility when developing an HSE case to suit the contractor’s needs. However, in order to assure consistency in execution amongst its members, BSEE should consider developing measures in regulation that ascertain successful and unsuccessful practices.

2.13.2 Part 2: Drilling Contractor’s Management System
Part 2 describes the Drilling Contractor’s management system and presents HSE management objectives that must be met to demonstrate assurance that HSE risks are reduced to a tolerable level. The methods of achieving the HSE management objectives are detailed later in Part 4. From the perspective of the LCM and failure reporting requirements described by ABS Consulting, Part 2 adequately addresses most of those requirements in both the project planning and project execution phases. Additionally, it also covers all of recommended practices described by ABS Consulting:

- asset integrity,
- audit regimes,
- corrective and preventative action (CAPA) systems,
- hazard identification and risk analysis (HIRA),
- management of change (MOC) procedures,
• contractor management,
• management reviews for continuous improvement, and
• training and performance assurance

BSEE should use Part 2 of the guidelines for an LCM and failure reporting program and improve it by adding more explicit language on how an operator can demonstrate all necessary requirements are addressed in their LCM project plan.

2.13.3 Part 3: Rig Description and Supporting Information
Part 3 describes the equipment and systems necessary to meet the HSE management objectives described in Part 2 and to fulfill the requirements of the Drilling Contractor’s Scope of Operations. The equipment and systems must be considered in in the risk assessments outlined in Part 4.

In addition to thorough descriptions of the major equipment being used in the drilling process, Part 3 also includes guidance for the selection of equipment and systems deemed HSE critical. Part 3 contains the most technical material in regards to the HSE case, and discusses topics such as hoisting and pipe handling, mud systems, blowout preventer systems, emergency systems, and other similar facility elements already addressed in BSEE regulation. However, it also addresses testing system functionality in section 3.8, a basic requirement in the early stages of project execution. BSEE should consider this section alone as it applies most directly to a basic LCM and failure reporting pilot program.

2.13.4 Part 4: Risk Management
Part 4 describes the risk management process for assuring that the risks associated with facility operations are reduced to a tolerable level. The risk management process must consider the HSE management objectives described in Part 2 and the systems and equipment described in Part 3. Any gaps related to the HSE management objectives in Parts 2 and 3 that are identified in Part 4 must be addressed in the Drilling Contractor’s management system.

Risk Management is defined in the guidelines as “the coordinated activities to direct and control an organization or activity with regard to risk.” (IADC, 2014) Refining this broad interpretation, the guidelines recommend the application of the Structured Hazard Identification and Control (SHIDAC) Process. After employing this process of identifying hazards, evaluating risk, and identifying risk reduction measures, the final outcome in the HSE case should include:

• “The identification method used to make the inventory of Hazards.
• Listings of hazards, equipment, areas, chemicals and substances, responsibilities, tasks and measures of control to limit the exposure from such hazards.
• Through a baseline survey, exposure levels, as appropriate, should be assessed against a relevant standard to determine if they are tolerable and safe.
• Identification of Company exposure/risk tolerance level standards.
• How and at what exposure/risk level actions are taken and where improvement is necessary.” (IADC, 2014)

Part 4 specifically covers basic requirements in the project execution phase related to operations and maintenance, such as predictive maintenance procedures, inspections and audit programs based on risk,
and ongoing risk management evaluations. ABS Consulting recommends that BSEE incorporate these to satisfy the basic requirements for an LCM and failure reporting pilot program. The additional risk assessment procedures detailed in Part 4 go beyond the basic requirements listed by ABS Consulting and extend to include risk estimations, risk evaluations, risk treatment, risk acceptance, and risk communication. ABS Consulting recommends that BSEE consider these as best practices to incorporate later into regulation as the LCM and failure reporting program matures and is expanded upon.

2.13.5 Part 5: Emergency Response
Part 5 describes the HSE management objectives for emergency response policies in order to mitigate the consequences of the risks identified in Part 4 and the measures to recover. The HSE management objectives included in Part 5 are also considered in Part 4.

The emergency response section of the guidelines offers a generalized approach that emphasizes proper management, effective communications and an emergency command hierarchy, as well as proper training and drilling of workers and an evacuation plan. The contents of Part 5 are already addressed in BSEE regulation, and, moreover, rely heavily on the operator to develop specific practices and plans in order to effectively respond. While this, yet again, does allow for tailoring to suit the operator’s distinct needs based on the facility or mode of operation, were BSEE to incorporate this into regulation, it would need substantial work to make requirements more explicit and consistent in application.

2.13.6 Part 6: Performance Monitoring
Part 6 describes arrangements for monitoring to ensure that the risk management measures identified in Part 4 are implemented and maintained. Regular performance monitoring and review is also a risk reducing measure considered in Part 4. The guidelines break performance monitoring into three parts: periodic monitoring; audit and audit compliance; and verification of HSE critical activities, tasks, equipment, and systems.

The objectives detailed in Part 6 were determined through experience by IADC members as those necessary to demonstrate assurance that risks in the operator’s scope of operation will be maintained at a tolerable level. Part 6 also ensures that the barriers identified in Part 4 (considering Parts 2, 3, and 5) are effectively implemented and that the effectiveness of the barriers will be maintained for the life of the facility or the duration of the drilling operation. As applied to the LCM and failure reporting basic requirements, this Part 6 addresses third party verification, failure reporting and corrective action verification, and inspections and auditing.

The following table summarizes the relevant content of the IADC HSE guidelines as applied to the basic requirements for a basic LCM and failure reporting pilot program:
### Table 6: LCM Criteria for IADC HSE Guidelines

<table>
<thead>
<tr>
<th>Planning</th>
<th>Design</th>
<th>Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify inputs/outputs</td>
<td>This stage includes analyzing needs and documenting functional requirements. It also includes analyzing current infrastructures, as well as identifying the alignment with strategies.</td>
<td>2.1, 2.3</td>
</tr>
<tr>
<td>Design</td>
<td>In this stage, requirements are transformed into detailed system designs and performance criteria that address:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Functionality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reliability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Survivability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Dependency and interaction with other systems 2.3.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Maintenance 2.3.1, 2.3.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prevention of hazards 2.3.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Well containment 2.3.3</td>
<td></td>
</tr>
<tr>
<td>Execution</td>
<td>Build and Test</td>
<td>In this stage, system designs are converted into a functional process and integrate with other system processes. Those systems are then tested to determine interoperability. This would include:</td>
</tr>
<tr>
<td></td>
<td>• Perform interdisciplinary design verification 2.3.1, 2.3.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Provide for verification by competent third parties 2.4.6, 6.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Verify the work by contractors and subcontractors 2.2.4, 2.3.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Test systems and equipment before installation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Test functionality before commissioning 3.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Develop inspection and maintenance procedures in advance of commissioning 2.3.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Develop operational procedures specific to systems and equipment 3.2.1</td>
<td></td>
</tr>
<tr>
<td>Operation and Maintenance</td>
<td>For this stage, systems or equipment are in operation and carrying out their intended functions. Elements of the LCM should include:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• System and equipment maintenance data collection and management processes 2.3.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Failure reporting and corrective action systems 2.4.2, 6.2.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Predictive/Prescriptive reliability centered maintenance 4.2.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Inspection and audit programs 2.4.5, 4.9.3, 6.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ongoing risk management evaluations 4.2</td>
<td></td>
</tr>
<tr>
<td>Completion</td>
<td>Decommission</td>
<td>• Materials are disposed of properly 2.3.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Land is remediated</td>
</tr>
</tbody>
</table>

Overall, the IADC provided a very comprehensive set of guidelines that delineate health, safety, and environmental cases for drilling contractors. Their international clout is evidenced by the regulatory bodies that hold these guidelines as a requirement, and accordingly BSEE should take note of the attention to detail that the IADC employed when developing said guidelines. They allow for a certain
level of flexibility in tailoring the HSE cases for specific operations of varying scales, and in doing so promote efficiency and avoid redundancy and unnecessary paperwork. The crucial drawback is that these guidelines only have a binary measure of success. The biggest improvement would be to introduce a more widespread measure of success for HSE cases, in order to promote higher standards of execution and encourage more effective practices.

2.14 Current Industry Practices
Most of the regulatory organizations reviewed for this study require the development of LCM systems in some form. It is also apparent that all of the regulatory communities reviewed for this study are supplementing their regulatory structures with references to standards or guidelines developed by well-known domestic and international standards organizations. Where the regulatory approaches differed widely were the degrees of prescriptiveness applied to the design of LCM systems. The regulatory communities’ approaches to LCM systems represent a spectrum that ranges from comprehensive and specific regulations, to less prescriptive and open-ended performance or risk-based regulations. It is important to note that most of the agencies reviewed for this study utilized some elements of both approaches, but to varying degrees.

Agencies like the Nuclear Regulatory Commission (NRC) and the Pipeline and Hazardous Materials Safety Administration (PHMSA) have taken an approach that lends toward detailed regulatory criteria for the development of LCM systems, but nevertheless with some elements of risk-based criteria. Towards the middle of the spectrum is the USCG, which has regulations that are in equal parts prescriptive and risk-based, in an approach that strongly resembles an LCM. However, the USCG’s approach is less comprehensive and has a less coherent application when compared to the NRC’s and PHMSA’s LCM systems.

Alternatively, at the other end of the spectrum is Norway’s PSA, the New Zealand’s Petroleum and Minerals agency, and the U.K.’s Health and Safety Executive “Safety Case” approach. This approach constructs an LCM framework through the perspective Health, Safety, and/or Environmental goals. These agencies also utilize approaches that are more dependent on risk-based guidance than on specific regulations. For example, the “Safety Case” approach requires the operator of an offshore facility to identify the hazards and risks and then leaves it to the operator to describe how they control risks.

These findings make sense when viewed in the context of a holistic risk spectrum. The NCR and PHMSA regulate industries that deal with exceptionally hazardous materials and processes that have the potential for serious consequences to large populations. As a result of the associated dangers, these activities are highly scrutinized. Though the offshore industry has its unique risks and the potential for inordinate public scrutiny, when compared to nuclear power plants the offshore industry’s risk is relatively lower. Consequently, industry’s willingness to strictly adhere to regulation and guidance may appear diminished when compared to the nuclear and hazardous materials industries. The variation noted in the prescriptiveness or flexibility in LCM systems reflects the regulatory bodies’ attempts to maximize compliance from industry.

For failure reporting processes, larger industry organizations rely on industry standards like the ones developed by IADC, API, or the ISO for guidelines to use as a framework. These programs are voluntary, though they may be a condition requirement for membership. Internationally, if these standards are incorporated by reference in the regulatory framework, then the specific standards must be addressed
when developing a Safety Case. Often, failure reporting is incorporated as part of the regulatory mandates requiring the development of a Safety Management System or in the case of the international regulators reviewed, the requirement for industry to develop a Safety Case.

2.14.1 Software

Software and other tools can help implement and comply with any new LCM or failure reporting requirements. In Task 3, ABS Consulting reviewed LCM and failure reporting software packages in common use. While these packages are not unique to the O&G industry, ABS Consulting specifically studied those that are commercially available and tended to provide a broader software solution for failure reporting. In most cases, and especially in larger organizations, ABS Consulting noted that some form of failure reporting is used in the O&G industry. However, many organizations have developed company-proprietary systems that are tailored to individual specifications. Such software packages are more likely to be utilized by larger industry operators, mostly due to the relatively high costs of purchase and implementation.

Many of the failure reporting software identified for commercial use was designed to comply with the Department of Defense’s Failure Reporting, Analysis, and Corrective Action System (FRACAS). API and ISO standards should also be implemented with these software solutions; however, all guidelines or standards set forth by industry standard organizations tend to focus primarily on equipment malfunctions or failures, not safety or environmental concerns. Moreover, while these industry-focused systems emphasize failure reporting to enhance system performance, they typically do not inform regulator bodies or OEMs when failures do occur.

Many of the software packages have similar components such as user configurability and ease of use, reliability and risk analysis, and a closed-loop corrective action process. From the guidelines set down by the DoD, a closed-loop corrective action system is one of the most important aspects of FRACAS. Specifically, the DoD defines a closed-loop failure reporting system as “a controlled system assuring that all failures and faults are reported, analyzed (engineering or laboratory analysis), positive corrective actions are identified to prevent recurrence, and that the adequacy of implemented corrective actions is verified by test” (Department of Defense, 1985). While ABS Consulting was unable to obtain extensive product information in terms of real-world performance and review, it is assumed that all these software packages follow this basic closed-loop failure reporting guideline.

ABS Consulting also studied software developed specifically for the O&G industry by regulatory bodies or industry associations. In contrast to the commercial products, these software packages address more than equipment failures, recording safety or environmental incidents. For example, RIMDrill, developed by the International Association of Drilling Contractors (IADC), is a software package that serves as a reporting system through which IADC members submit data on operational safety and environmental performance. RIMDrill can also utilized to provide reporting data to national regulatory bodies. Another example of safety-based reporting software is the UK’s Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations (RIDDOR) database. RIDDOR is widely used by O&G industry operators in the UK Health and Safety Executive’s (HSE) jurisdiction because it is mandated.

3 Programmatic Themes

As previously mentioned, there is no single model for LCM systems that adequately spans the entire scope of offshore operations. However, when looking at the totality of the models presented in this
report, there are some overlapping commonalities. LCM systems that approach “management” beyond just maintenance or safety are better suited to BSEE’s goals. The following list of LCM model elements (or phases) represents a compilation of the LCM systems discussed in this report. These elements include the LCM process from planning to decommissioning:

- **Requirements**: Analyzing needs and documenting functional requirements, analyzing current infrastructures, identifying the alignment with strategies.
- **Design**: Requirements are transformed into detailed system designs and performance criteria.
- **Build and Test**: System designs are converted into a functional system and integrate with other systems. Those systems are then tested to determine interoperability.
- **Operation and Maintenance**: Systems or equipment are in operation and carrying out their intended functions.
- **Decommissioning**: The system disposed of or land remediated.

ABS Consulting views failure reporting systems as a model for identifying and making notification of incidents. As mentioned previously, failure reporting can range from a simple notification of a failure to an iterative and closed loop process. A failure reporting system that includes the corrective action element can be a more complex model that includes identification and notification, but it also imposes additional requirements for investigation, mitigation, analysis, and on-going assessment by those making the report.

### 3.1 Definitions

Accurate definitions are a crucial aspect of functional regulations. In Task 4, ABS Consulting evaluated the effectiveness of definitions currently used in the O&G industry. This was accomplished by establishing a set of criteria consisting of context, interpretation, meaning, and understanding to determine how functional a current definition was.

Through this discussion, ABS Consulting discovered that the most successful definitions from a regulatory perspective were specific enough to guide readers to an accurate and uniform understanding of the term, without relying on an exhaustive list of examples to determine meaning. Unsuccessful definitions were those that were too vague to produce an accurate or uniform understanding, or that relied almost entirely on a static list to define the term. Other considerations in the development of a successful definition are to address practical concerns. As these definitions underpin regulation, issues with compliance and enforcement were considered. A successful definition should not be burdensome for neither the regulator nor the industry operator.

Going one step further, it is also necessary to discuss the relationships between systems, equipment, and components; in addition to the relationships between those and critical systems, critical equipment, and critical components. From the research conducted, ABS Consulting noticed that original equipment manufacturers (OEMs), industry members, industry support organizations, and industry organizations define critical, critical equipment, critical systems, and critical components in drastically different ways, and sometimes not at all.
The problem is not necessarily a lack of understanding of what systems, equipment, and components are, but rather an ambiguous interchanging of these terms. Some current definitions treat system and equipment interchangeably, while others treat equipment and component similarly, as well. If a system and piece of equipment are the same, and a piece of equipment and a component are the same, then the same definition can be applied across all items. A discussion of the relationships between these elements attempts to correct that problem. To phrase it simply, systems are comprised of equipment, and equipment is comprised of components. Critical systems are comprised of both critical and non-critical equipment. Similarly, critical equipment is comprised of both critical and non-critical components.

The hierarchical approach to the definitions can be easily illustrated by a pyramid representation. As an example, ISO 14224 allows this relationship to be structured in relative terms of the subdivisions of elements and dependency on use and location:

**Figure 5: ISO 14224 Terminology Hierarchy**

This pyramid structure can also be arranged in several ways. Refinements of the pyramid, such as adding Subsystems below Section/System, or dropping Part and identifying a Component/Maintainable Item as the most basic element of a structure, are also viable representations. While this structure does
highlight the basic facets of ABS Consulting’s approach, it cannot be used in lieu of clear, concise definitions. A key aspect to the definitions developed by ABS Consulting is that each element of a facility can be uniquely identified by a single term.

We applied our effectiveness evaluation criteria to the IADC definitions for several terms that are crucial for a comprehensive LCM system to operate optimally. Given that IADC guidelines are accepted by all IRF countries, ABS Consulting reasoned that those definitions were the most widespread in use throughout the O&G industry. However, ABS Consulting determined the most common definitions currently in use are not effective enough to be used in regulations. Therefore, ABS Consulting developed definitions that are clear and understandable for BSEE to utilize in place of the wide variety industry definitions currently in use, listed in Task 4 Appendixes A-D. These definitions established by ABS Consulting should be listed in the "definitions" section of Subparts A-S of 30 CFR 250. Our main definitions for the terms critical, system, equipment, and component are listed below:

3.1.1 Critical
Critical is a quality of a process or material that has the highest probability of causing system failure by failing at a given point in time.

3.1.2 System
A System is a functionally, physically, and/or behaviorally related group of regularly interacting or interdependent elements; that group of elements forming a unified whole, the major elements being comprised of equipment.

3.1.3 Equipment
Equipment consists of the articles or implements used or needed in activities that support a specific purpose or effort of a system, the major elements being comprised of components. Equipment is tangible property used in the operations of a business (other than land or buildings); used to assist a person in achieving an action beyond the normal capabilities of a human; having an anticipated useful life of one year or more. Equipment could include; devices, machines, tools and vehicles.

3.1.4 Component
A component, like equipment, is a single part integral to something more complex, A component is any item/element (part of a process, mechanical or electrical system/product, may also be software codes or algorithms) that functionally contributes to continuous operation or performance of something larger (equipment or system).

Though these definitions are not completely independent of one other, they seek to minimize the ambiguous interchange of terms. Given the hierarchical relationship ABS Consulting has noted between the terms, true independence is not possible without acknowledging that systems are comprised of equipment and equipment is comprised of components. The definitions developed seek to create exclusive understandings of each term, regardless of the term’s relationship to others.

Definitions for the terms critical system, critical equipment, and critical component build on this notion. The reader should not, for example, have to reference the definitions for critical or system to understand what a critical system is. For further clarification, ABS Consulting instead provides more specific conditions that make a system, piece of equipment, or component critical. The definitions for these terms are stated below:
3.1.5 **Critical System**

A Critical System is equipment organized to serve a common purpose, which by their failure may cause or contribute to major mishaps that result in loss of life, significant property damage, or damage to the environment. A Critical System is also any safeguard specifically designed to prevent mishaps, which by its failure would result in significant harm to human life or damage to the environment. If the failure of any particular system could lead to consequences that introduce unacceptable levels of risk, then the system is critical by the nature of its importance.

3.1.6 **Critical Equipment**

Critical Equipment is two or more components that comprise an assembly or apparatus that contains a characteristic such that any failure, malfunction, or absence of it could cause a catastrophic or critical failure resulting in loss or serious damage to the equipment, unacceptable risk of personal injury or loss of life, or damage to the environment. If the failure of any particular equipment could lead to a significant outcome or a high magnitude consequence that introduces unacceptable levels of risk, then that equipment is critical by the nature of its importance.

3.1.7 **Critical Component**

A Critical Component is any part of a piece of equipment containing a characteristic of which the failure, malfunction, or absence of could cause a major accident or critical failure resulting in serious damage, environmental consequence or unacceptable risk of personal injury or loss of life. Critical components are essential to the function and continuous operation of something larger (equipment or system). If the failure of any particular component could lead to consequences that introduce unacceptable levels of risk, then that component is critical by the nature of its importance.

3.2 **How to Use the Definitions**

A set of useful definitions is important because without a coherent foundation, BSEE will struggle to promote consistency in the application of its regulations for the O&G industry. Overall, ABS Consulting recommends that BSEE institute a new set of definitions that promote a more standardized understanding of basic terminology and lay a foundation for the consistent interpretation, application, reporting, and data collection for any regulatory regime BSEE implements. These definitions should be established in the "definitions" section of Subparts A-S of 30 CFR 250 and used consistently throughout 30 CFR 250.

Supposing that BSEE implemented an LCM program with a failure reporting mechanism in regulation, how would effective definitions help it? As noted in Tasks 2 and 3, clear and understandable definitions set forth by a regulatory agency positively correlated with better industry compliance in regulatory programs. An LCM program with failure reporting allows the O&G industry to monitor how well a system, piece of equipment, or component performs. If that element does fail, the failure reporting mechanism alerts the operator and can assist in the inspection and root cause analysis.

3.2.1 **Regulatory Program**

Given these program objectives, clear definitions for the terms system, equipment, and component are necessary, as using these terms interchangeably could make the failure reporting mechanism less effective. When identifying the cause of a failure and attempting to correct it, an operator must be able to classify all elements in a facility accurately. If a component triggered an equipment failure, and then subsequently an incident or a system failure, a root cause analysis may only be able to detect the
equipment failure, not the component failure. Adding additional complexity, if this component failure directly resulted in an accident, it should be considered a critical component of a critical piece of equipment. That level of specificity must be addressed if the risk of such an accident occurring again is going to be lowered. Just examining the piece of equipment alone is not sufficient, as the critical and non-critical components used to build it will be overlooked.

3.2.2 Permitting/Plan Approval Process
As a regulatory body, BSEE would have to review submitted LCM program plans from O&G industry operators. While ABS Consulting has argued against using a static list as a definition, critical elements based on facility type and mode of operation were enumerated and discussed. With that knowledge as a framework, BSEE already possesses an idea of what facility elements should be considered critical. Therefore, when reviewing an LCM plan, BSEE can more easily determine if all critical elements particular to a facility type or mode of operation are accounted for.

Furthermore, the greater level of standardization provided by the definitions could allow for a more standardized approach to permitting. With a set of definitions that adequately address each element in a facility, the need for BSEE to examine them on a case-by-case basis may no longer necessary. If all elements in a facility meet BSEE’s definition, the operator will have little difficulty in determining whether or not each element is up to the standards set in regulation. On BSEE’s part, granting approval for a permit would be expedited, as once again, the operator’s accountability of all critical elements will be readily apparent.

3.2.3 Inspection Program
The level of standardization created by an effective set of definitions can also enhance direct communication between BSEE and industry operators, including facilitating incident investigations and other discussion of failed or suspect systems/equipment/components. In the inspection process, both the regulator and the operator should know what is being examined and why. However, in the event that an operator is not in full compliance or generally has room to improve, a standard lexicon ensures that all issues brought up by the regulator can be easily understood and addressed by the operator. Additionally, the discussion of elements specific to certain facilities and modes of operation would allow flexible inspects to take place that are relevant to the operator’s unique circumstances.

From BSEE’s perspective, an effective set of definitions also make the overall inspection process more efficient, as it could eliminate redundant or unnecessary inspecting. If BSEE were interested in inspecting critical facility elements in an LCM program, then inspecting an element as both a piece of equipment and a component, or looking at all the pieces of equipment within a critical system, would be superfluous. Knowing what elements should be inspected as is vital for BSEE to enforce compliance and ensure that the information gained during an inspection is comparable to that of other inspections.

3.2.4 Subpart S - Safety and Environmental Management Systems (SEMS) Audit Program
According to the requirements for a SEMS audit program, an operator must have the audit conducted by either an independent third-party or designated and qualified personnel. In the case of a third-party audit, a standard lexicon is once again necessary to promote thoroughness and efficiency. With reference to the benefits provided by effective definitions, the third-party auditors could conduct a faster investigation, as they know exactly what to examine, and provide more insightful feedback. Both BSEE and the operator, given a standardized understanding of the elements inspected, could more
readily assess the findings reported in the audit. In the case where the audit is conducted by qualified personnel, BSEE can expect that the same quality of results will be delivered, as the personnel’s understanding of what is to be investigate will be comparable to some other outside party’s understanding.

4 Approach

Based on ABS Consulting’s findings, no single approach will work seamlessly for BSEE in the development of a pilot LCM and failure reporting system. Given the diversity of regulatory programs noted, LCM systems and failure reporting systems cannot be effectively incorporated from elsewhere in a blanket method.

To reiterate, the regulatory communities’ approaches to LCM systems represent a spectrum that ranges from comprehensive and specific regulations, to less prescriptive and open-ended performance or risk-based regulations. It is important to note that most of the agencies reviewed for this study utilized some elements of both approaches, but to varying degrees. For failure reporting processes, larger industry organizations tend to rely on industry standards like the ones developed by IADC, API, or the ISO for guidelines to use as a framework.

ABS Consulting recommends that BSEE create its own approach due to the challenges that face BSEE and the regulated industry, along with the unique factors that provides BSEE its jurisdiction and role. The following discussion will highlight our findings regarding the path BSEE should follow in implementing a successful LCM and failure reporting system.

4.1 Regulatory Options

In Task 2, we provided 3 distinct approaches that BSEE could follow – 1) the prescriptive option, 2) the industry-based option, and 3) the hybrid option. Within each approach, there can be several variations of implementation. We believe that one single approach will not be an effective approach for BSEE, therefore we have chosen to use the hybrid approach to highlight aspects that can be used to create a regulatory structure for an integrated LCM and failure reporting system. We recommend the hybrid approach and selecting aspects of prescriptive requirements to set consistency and establish a baseline, but use industry-based to allow for flexibility and compliance. We will explore further in this report to highlight action items, next steps, and potential implementation activities.

In Task 2, our team highlighted three industry-led approaches to LCM systems and failure reporting systems: Safety Case, industry standards, and third party oversight. Individually, these three systems cannot work for BSEE’s specific purposes. Each has distinct advantages, and yet major disadvantages, when used on their own, making them impracticable for use by BSEE.

The first industry-led approach discusses a Safety Case option, in which owners or operators submit the safety case as the design matures and identify arrangements that are in place to comply with all regulatory requirements. Under a Safety Case regime, the company would outline what its activity will be, how to implement a system, and how the company will operate. An advantage of the Safety Case system is it significantly reduces the operation load of the regulator. However, the major downfall of this option is the inability of regulator to control and affect change throughout the industry.

Another industry-led approach discussed in our Task 2 report was centered on industry standards. Industry organizations, such as IADC and API, have set standards regarding the maintenance needs of
various types of equipment and systems. This was discussed as a possible source of a standardized, industry-wide LCM system. The advantages of this approach pertain to their current utilization by industry members. Because many owners and operators already look for guidance from industry organizations regarding maintenance and upkeep measures, incorporating these standards by reference allow pre-existing best practices to carry the force of regulation. However, these standards become ineffective if owners and operators lack commitment to carrying them out. BSEE would need to ensure that auditing and enforcement of these standards is strong to avoid owners or operators simply going through the motions of meeting standards set by organizations such as IADC and API.

Finally, third party oversight of LCM systems was explored by our team, providing both a representation of the industry and a semi-regulatory authority of the industry. Third party oversight gives an unbiased independent organization the ability to gather information regarding industry requirements. However, this system potentially faces the obstacle of receiving authorization from the Office of Management and Budget to use a third party organization to manage a regulated data collection and dissemination program.

As mentioned previously, because of the inherent flaws each option has individually, it is best for BSEE to select aspects of each of these practices. Without modification, these industry led approaches have the potential to leave BSEE with a lack of clear authority. However, implementing industry standards provides a starting point and a baseline. Once implemented, BSEE should implement prescriptive requirements to improve data consistency and quality as well as establishing standardized requirements across the industry.

Aspects of the Safety Case can provide guidelines for the industry the flexibility to implement an LCM system that is specific to their internal operations, particularly given the variation from rig to rig. The Safety Case also shifts responsibility to the industry, but this requires BSEE to set clear regulations to set compliance requirements.

Given a Safety Case, using third party verifiers will also reduce the implementation and compliance verification burden by shifting BSEE’s role in verifying compliance to auditing third party verification. Each of these regulatory options require clear regulatory language to provide prescriptive standards to ensure a functioning system.

4.1.1 Industry Incorporation and OEM Requirements
A regulatory approach available to BSEE is a hybrid LCM option. The crucial element of developing a functional hybrid LCM regulatory regime will be to identify the specific critical components of an LCM system. BSEE could require industry to identify the critical systems subject to the LCM system for their facilities. BSEE should then specify the minimum elements of an LCM system, including recordkeeping and documentation requirements. Once operations at a facility are underway, BSEE should include periodic audits of the LCM system by reviewing records and documentation. This would ensure industry organizations are adhering to their developed LCM system. In addition, it would be beneficial if industry provided LCM and failure data to the OEMs so that reliability enhancements should be implemented.

Communication and cooperation are vital for a system of this nature to be effective. There must be an effective feedback loop with an exchange of information for required data inputs. One way to ensure industry and BSEE communicate openly and routinely would be to establish a program or forum involving operators, contractors, suppliers, trade unions, SMEs, and government working in cooperation.
In order to have an effective and functional relationship between industry and BSEE, this type of program or forum could facilitate trust, open communications, functional perspective, and direct feedback for both industry and BSEE. A third party organization should serve as a data repository and information clearinghouse.

In order for industry to provide accurate information, there would have to be a non-retribution process in which to make reports, especially if self-reporting is possible. If industry feels they will be subject to negative impacts from data collected, they will not make accurate reports. Such a hybrid solution does offer a number of practical advantages, including industry collaboration, monitoring efficiency, and regulatory adaptability.

4.2 Implementation
This section follows our discussion of specific LCM and failure reporting system options as it pertains to how BSEE may implement such a system. Regardless of the approach BSEE chooses, issues such as compliance, enforcement, and effective administration will affect the resources BSEE must devote to maintaining it. Whereas the previous LCM and failure reporting system discussions focused more on system development, this section will lay out specific guidelines for compliance verification; auditing and inspections; program implementation and administration; and data collection requirements.

This discussion will focus on how BSEE can best address these topics in the scope of an LCM and failure reporting system. Recalling the project planning and project execution phases and subparts that were laid out as basic facets in the development of an LCM and failure reporting system, it is important to note that these topics exist inside of that structure. Compliance verification; auditing and inspections; program implementation and administration; and data collection for both BSEE and industry members are necessary processes that occur in the project execution phase as systems are operated and maintained. From BSEE’s perspective, ABS Consulting believes that a system of third-party auditing or industry self-verification would work the best given BSEE personnel and budgetary constraints.

4.2.1 Compliance Verification
To begin, compliance verification is an auditing function that allows BSEE to ensure industry members are continually complying with regulation. Its benefits include consistency in program execution and a way for BSEE and the regulated industry to further homogenize industry practice in line with LCM and failure reporting concepts. In application, regulated industry members would consist of leaseholders, operators, and subcontractors. To illustrate visually, the hierarchy of responsibilities each party has to the next can be understood as such:
ABS Consulting has delineated specific requirements that each party should be held to in terms of compliance verification. As compliance verification overlaps with larger auditing measures, a more in-depth discussion of those topics beyond compliance verification can be found in Section 5: Recommendations for Implementation.

Additionally, specific requirements for contractor and subcontractor management are discussed in this section. ABS Consulting recognizes that contractors and subcontractors pose a challenge to operational compliance, as a lack of familiarity with LCM and failure reporting systems and policies in place under a leaseholder or operator can lead to unintentional compliance infractions. In order to help mitigate this problem, ABS Consulting has developed a series of checks that a leaseholder or operator should follow when selecting and working with a contractor or subcontractor.

4.2.1.1 Leaseholder
Leaseholders should be able to verify that their operators, contractors, and subcontractors understand and abide by the LCM and failure reporting policies laid out that conform to BSEE regulation. In order to verify compliance by all parties, the leaseholder should directly verify that all operators under their leases are in compliance, and receive verification of contractor and subcontractor compliance from the operators. BSEE, in turn, should verify that the leaseholder has the necessary processes and measures in place to complete compliance verification in accordance with BSEE regulation.

Figure 6: Responsibility Hierarchy

ABS Consulting has delineated specific requirements that each party should be held to in terms of compliance verification. As compliance verification overlaps with larger auditing measures, a more in-depth discussion of those topics beyond compliance verification can be found in Section 5: Recommendations for Implementation.

Additionally, specific requirements for contractor and subcontractor management are discussed in this section. ABS Consulting recognizes that contractors and subcontractors pose a challenge to operational compliance, as a lack of familiarity with LCM and failure reporting systems and policies in place under a leaseholder or operator can lead to unintentional compliance infractions. In order to help mitigate this problem, ABS Consulting has developed a series of checks that a leaseholder or operator should follow when selecting and working with a contractor or subcontractor.

4.2.1.1 Leaseholder
Leaseholders should be able to verify that their operators, contractors, and subcontractors understand and abide by the LCM and failure reporting policies laid out that conform to BSEE regulation. In order to verify compliance by all parties, the leaseholder should directly verify that all operators under their leases are in compliance, and receive verification of contractor and subcontractor compliance from the operators. BSEE, in turn, should verify that the leaseholder has the necessary processes and measures in place to complete compliance verification in accordance with BSEE regulation.
4.2.1.2 Operator
Along the same lines, operators should be able to verify that they and their contractors and subcontractors understand and abide by the LCM and failure reporting policies developed by the leaseholders and that are in conformance with BSEE regulation. To verify compliance, an operator should submit a report to the leaseholder demonstrating that all practices and policies implemented in a facility by them, their contractors, and subcontractors conform to the expectations of the leaseholder.

4.2.1.3 Contractor and Sub-contractor
For contractors and subcontractors, ABS Consulting has developed specific requirements that BSEE should impose on a leaseholder or operator to ensure that the use of outside parties or services does not jeopardize the integrity of an LCM and failure reporting system. Industry often relies upon contractors for very specialized skills, the accomplishment of particularly hazardous tasks, and assistance in periods of intense activity, such as maintenance turnarounds. Such considerations, coupled with the potential lack of familiarity that contractor personnel may have with facility hazards and operations, pose unique challenges for the safe utilization of contract services in the scope of an LCM and failure reporting system. Necessarily, measures for contractor management must be in place in order to further diminish the risk of a major safety incident.

Contractor management is a system of controls to ensure that contracted services support both safe facility operations and the company’s process safety and personal safety performance goals. The use of contractors can place personnel who are unfamiliar with the facility’s hazards and protective systems into locations where they could be affected by process hazards. Conversely, as a result of their work activities, the contractors may expose facility personnel to new hazards. Also, their activities on the site may unintentionally defeat or bypass facility safety controls. Thus, companies must recognize and address new challenges associated with using contractors. For example, training and oversight requirements will be different from those for direct-hire employees. Companies need to carefully select contractors and apply prudent controls to manage their services. Contractor management begins well before the issuance of any service contract. Systems should be established for qualifying candidate firms based upon not only their technical capabilities, but also their safety programs and safety records.

Orientation and training of contractor personnel should be accomplished before they begin work. Responsibilities for this training should be defined, with some training provided by both the contract employer and the contracting company. The boundaries of authority and responsibilities should be clearly set for any contractor that works at the facility. Periodic monitoring of contractor safety performance and auditing of contractor management systems is required. At the end of each contract period, evaluation of a contractor’s safety performance should help determine whether the particular contractor is retained or considered for future work. While some responsibilities for implementing the contractor management element are assigned to contractor personnel, many tasks are assigned to company staff at either the offshore facility or corporate level. Specific delegation of responsibilities between contractor, corporate, and offshore facility personnel needs to be resolved prior to the start of a contractor company relationship. The anticipated work results of a contractor management program include:

- The creation of a list of pre-qualified candidate contract firms.
- The selection of specific contractors with strong safety programs and good safety records.
• The preparation of contract employers and their employees to safely provide their services based upon an understanding of relevant risks, offshore facility safety controls and procedures, and their personal safety responsibilities.
• The safe delivery of the contracted services, with improved quality and productivity.
• Appropriate documentation of the contractor screening and selection process, the contractor’s safety performance during the performance of its services, and any other issues relevant to the evaluation of the contractor for potential selection for future services.
• Outputs of the contractor management program can also be used to facilitate the performance of other elements; for example, contract workers must be trained to implement proper safe work practices and contract workers should be effectively integrated into the workforce involvement program.

The scope of contracted services can encompass a broad spectrum, ranging from contracting with an individual to provide a very specialized service, to contracting with a large firm (perhaps with many subcontractors) who will provide hundreds of workers with diverse skills for a major construction project or maintenance turnaround. A contracting firm could be on site for only a few hours and never return, or could have a continuing presence at an offshore facility for decades. Some contractors will be directly exposed to the process and its hazards, while in other situations, such as new project construction adjacent to an operating unit, effective controls will be required to isolate the contractors from hazards. Finally, some contract service companies have a very stable workforce, while others have a high rate of turnover. The contractor management program should be well-defined and flexible enough to handle this gamut of potential circumstances. The responsibilities and procedures for implementing these activities should be documented in a written program description with specific criteria for screening and selecting contract service providers.

This potential gap lies in the relationship between operators and subcontractors in deep water drilling. If an operator institutes a comprehensive LCM and failure reporting system that is supported by a strong safety culture, but use a subcontractor who does not participate in or is not actively monitored by that LCM and failure reporting system, the operators may expose themselves to potential liabilities. This is why ABS Consulting recommends contractor management is a best practice if BSEE chooses to develop LCM and failure reporting system regulations.

4.2.2 Performance of Auditing, Inspections, or Other Verification Processes

Many agencies, including BSEE, have difficulties obtaining inspection personnel with the required technical skills or experience needed for effective compliance inspections of the industry. Third-party organizations can leverage the limited number of skill sets among the BSEE inspector workforce and would be particularly beneficial for inspection of specialized components or systems. Crane inspections, for example, should be conducted by third parties trained to API RP2D and designated by BSEE. ABS Consulting developed three alternative risk-based approaches for BSEE to use when considering implementation of self-inspection or self-certification programs. The three tiered approaches discussed below include:

• Inspection type;
• Facility type / safety culture; and
• Components inspected.
These approaches should be adopted independently or in combination with one another.

4.2.2.1 Develop a Tiered Approach – Type of Inspections
BSEE should consider a tiered approach to implementing self-inspection/ self-certification programs given its current inspection regime. This three-tiered approach is based upon the scope of an inspection and its overall impact on BSEE’s safety and environmental protection mission.

Category 1 – High Impact Inspections: The high impact inspections would be those that required a dedicated BSEE inspector team. For example, rig inspections that might fit into the high impact category are drilling, well-completion, and well work-over. These inspections would focus on verifying compliance with critical operations and systems.

Category 2 – Medium Impact Inspections: The medium impact inspections should be conducted by an independent, third-party inspector designated by BSEE. These inspections would have a medium impact on BSEE’s mission and would therefore still warrant some form of independent assessment by technically qualified inspectors. The BSEE designated inspector would verify the lease holder’s compliance with regulations. Facility inspections that should be conducted under this category include abandonment, metering, or flaring inspections.

Category 3 – Low Impact Inspections: The low level of impact inspection would be those inspections that have been determined to be within the scope of a lease holder self-conducted audit or inspection and within the capability of lease-holder designated employee inspector. Facility inspections may include crane, lifting device, and material handling equipment inspections conducted in accordance with the appropriate API recommended procedure or specification. Rig inspections should include secondary inspection such as paper inspections. Inspections may include measurements and site security inspections, crane and lifting device inspections, electrical inspections, and personal safety inspections.

The individuals authorized to perform, document, and certify the inspections may be lease holder employees trained and qualified by an accredited organization and specifically sanctioned by BSEE. Another option would be independent, third-party designees of BSEE who are authorized to perform, document, and certify inspections, and authorized to charge reasonable fees for their work. The inspectors and inspection documentation would be subject to evaluation and oversight of BSEE inspectors.

4.2.2.2 Develop a Tiered Approach – Facility/Leaseholder Complexity Approach
A second approach for BSEE to consider is based on the type of facility operated by the leaseholder and their safety culture record. This is a three-level approach based upon the type and complexity of the facility and the leaseholder’s record of compliance, number of incidents of non-compliance (INC), and safety culture. Collectively, these measures dictate the riskiness factor to BSEE’s safe and clean mission.

Category 1 – High Exposure / Poor Safety Record Facilities: High exposure/high complexity facilities are those employing new or highly complex technology; combinations of multiple high-value or high-risk platforms; significant numbers of personnel living permanently on the facility; operating in very deep water and at extreme distances from shore. These facilities require the experience and authority of a dedicated BSEE team of inspectors.
High risk lease holders are those which have earned a significant number of INCs; those who have had a significant number of incidents involving personnel safety or safe operating practices; or incidents in which the environment was damaged or placed in significant jeopardy.

New entrants to the OCS should also be included in the high risk category because they have not demonstrated the ability to actively manage risks, and therefore do not have the performance records to demonstrate their safety and compliance culture. The high risk leaseholder requires dedicated BSEE inspector oversight. The scope of the necessary evaluations is beyond that which can be properly delegated to a third-party or designated inspector.

**Category 2 – Medium Exposure / Satisfactory Safety Record Facilities:** Medium exposure facilities are those small clusters of platform that are well established, employ traditional equipment and operational techniques, and are in medium depth water. These facilities should be routinely inspected by designated inspectors empowered to perform comprehensive inspections and recommend enforcement actions. They would be subjected to some BSEE oversight and inspections.

A leaseholder with a satisfactory safety record has demonstrated a commitment to establishing a strong safety culture and compliance commitment, but has had few incidents involving personnel safety or negative impact to the environment. The medium risk operator has also had larger numbers of INCs with no active enforcement actions. These leaseholders should be allowed to contract with designees for all inspections, barring those that pertain to critical elements, such as blowout preventers.

**Category 3 – Low Exposure Facilities:** Low exposure facilities are those that involve single production wells and unmanned platforms. These facilities would be inspected exclusively by designated examiners with infrequent BSEE oversight or inspections.

A low risk leaseholder is one with a substantial track record of a robust safety culture and demonstrated commitment to compliance. These leaseholders have met or exceeded the expectation to act in the public interest, as demonstrated by focused attention on their safety management policies and procedures. Their safety management documents should comprehensively identify the hazards and risks, describe how those risks are controlled, and describe the safety management system in place to ensure the controls are effectively and consistently applied. They aggressively seek and implement current industry standards and best practices.

These leaseholders require a minimum amount of BSEE scrutiny and are able to conduct self-audits and inspections. They are also able to contract with designees for inspections that are determined beyond the scope of leaseholder capability.

In practice, a leaseholder may meet the criteria for multiple categories. An operator of a deep-water, highly complex facility with a large permanent personnel contingent may have an exemplary safety record, comprehensive safety management documents, and demonstrate a high level of compliance. BSEE could confidently allow a great degree of self-inspection or designee inspection by this type operator.

Conversely, an operator of a small, shallow-water facility with simple technology may warrant dedicated BSEE scrutiny based upon a track record of non-compliance or evidence of financial distress. These operators would benefit from a close scrutiny of their adherence to their safety management policies and procedures.
4.2.2.3  Develop a Tiered Approach – Inspection/ Component Complexity Approach

The third approach for BSEE to consider is based on the types of components, equipment, and systems currently regulated by BSEE. BSEE inspectors use potential incidents of noncompliance (PINC) during their inspections as job aids in inspecting a particular component, piece of equipment, or system. Should the inspector find a deficiency, PINCs are also used to determine the type of enforcement that should be implemented. BSEE currently utilizes approximately 770 PINCs, which do not appear to be prioritized based on risk, other than the type of enforcement actions suggested in each PINC. For example, a facility shut-in enforcement action listed on PINCs probably present the highest level of risk.

BSEE could consider establishing a tiered approach to conducting inspections based on the risk-level of the elements. In other words, risk-ranking the PINCs would enable BSEE to establish tiers of PINCs, which should help identify components, equipment, or systems of highest risk. This would help BSEE inspectors take a risk-based approach to conducting the inspection and authorize leaseholders or third parties to focus on lower-risk components during self-inspection or third-party inspections. An alternative would be to conduct a risk assessment of the elements associated with the primary barriers used in typical offshore drilling and production operations. Using the concept of risk-ranked elements, BSEE should establish three element tiers.

**Category 1 – High Risk Elements:** The high risk components include those components, pieces of equipment, or systems that play a critical role in barrier protection. These elements have been found to be involved in catastrophic incidents such as blow outs, loss of well control, fires, explosions, or other significant events. These elements must be inspected by BSEE personnel to ensure adequate oversight by the government.

**Category 2 – Medium Risk Elements:** The medium risk elements include those that play a significant, but not critical, role in barrier protection. These elements, while important, should still be inspected by an independent agent but could be delegated to a third-party who would act on behalf of BSEE. The BSEE designated inspector/examiner would be empowered to evaluate overall lease holder compliance and recommend enforcement or lowering the risk rating of the lease holder.

The inspections that should be included in the medium impact category are general inspections, pollution inspections, or hydrogen sulfide inspections.

**Category 3 – Low Risk Elements:** Elements that present little or low risk to barrier protection should be part of Category 3 elements. The failure of these components, pieces of equipment, or systems would include those that have never been involved with a catastrophic incident or are part of secondary barrier systems. These elements should become part of a lease holder’s self-conducted audit or inspection and within the capability of lease-holder designated employee inspector or BSEE designated inspector or auditor. These elements should include those covered in BSEE’s General PINC categories.

The individuals authorized to perform, document and certify the inspections may be lease holder employees that have been trained and qualified by an accredited organization and specifically sanctioned by BSEE. The inspectors and inspection documentation would be subject to evaluation and oversight of BSEE inspectors.

Use of any of the three approaches discussed above, or the combination of these approaches, should help BSEE leverage its available inspectors and encourage and incentivize lease operators to move
towards the safety culture ultimately desired. Lease holders could avoid targeted BSEE scrutiny by demonstrating their commitment to compliant performance over sustained periods.

4.2.3 Implementation and Administration

4.2.3.1 Staffing

When examining how a third-party approach would work with the various types of inspections, facilities, or elements inspected, it becomes clear that training programs would need to be developed to teach third-party inspectors to operate as BSEE inspectors. Detailed training curricula and performance standards for such delegates and designees would need to be developed. ABS Consulting recommends a multi-level system, with lease holder inspectors and designees at the lowest level, assigned to supervising BSEE inspectors (with no more than five designees per BSEE inspector). Additionally, there should be no more than five BSEE inspectors assigned to a third level of supervising inspectors. Training and qualification of designees should be performed by a separate training department or division. In addition, appropriate training documents must be reviewed and accepted by BSEE before designees are allowed to audit or inspect lease holder operations.

4.2.3.2 Positions and Skillsets

Any shift from a BSEE-led inspection program to a program involving self-inspection or self-certification by the industry or by independent third parties will require a change in the skill of BSEE personnel since BSEE will remain the government agency responsible for safe and clean operation on the OCS. The shift in skill will mainly be from that of a ‘compliance inspector’ to that of an ‘auditor’. Compliance inspectors have the necessary skills to examine components, equipment, and systems to ensure compliance with the established regulations. Auditors, on the other, need to have skills in evaluating actual practices against established procedures. Each of these tasks requires a different set of skills, and with that in mind, BSEE should consider the following recommendations:

- Implement training programs designed to improve BSEE inspectors’ technical skills related to conducting high risk inspections. This training should be aimed at ensuring a high level of expertise and proficiency when conducting these high impact inspections. BSEE inspectors should be trained to become ‘masters’ at the high-impact inspections, rather than generalists across all of BSEE’s current primary and secondary inspections.
- Provide training to assist inspectors and supervisors on how to conduct risk assessments on the different types of facilities and the leaseholder’s safety culture in order to identify high-risk facilities. These skills would enable BSEE inspectors to focus on the facilities with the highest risks rather than meeting inspection quotas by inspecting any type of facility.
- Provide training to improve the inspectors’ knowledge and understanding of the high risk elements and barriers involved in well control and other critical systems that are in place to ensure safe and clean operations. These skills will enable BSEE inspectors to recognize and focus on the most critical elements during inspections, rather than randomly selecting ones from among the 770 PINCs.
- Provide training to BSEE inspectors and program managers in the approval procedures for self-inspection or self-certification and third-party programs, and how to conduct audits of these systems. This would then ensure BSEE oversight of these systems and confirm industry delegates are certified to conduct inspections and certifications.
• BSEE should require, through regulation, training for each company delegate involved in a self-inspection or self-certification system, as well as third-party organizations, so that they understand the regulatory and reporting requirements specific to the systems to be inspected and certified. Company delegates should be required to recertify based on BSEE certification requirements, e.g. annual or semi-annual.

4.2.4 Data Requirements
In the scope of LCM and failure reporting system management, data plays a vital role in informing BSEE and industry members of the actual state of a system or operation. ABS Consulting has previously discussed at a high level that any data collected by BSEE must be comparable in order to be analytically useful, regardless of what purposes BSEE would use the data for. This section, then, will discuss data requirements at a lower level, specifically with regulatory goals in mind. From BSEE’s perspective, any regulation pertaining to data collection must be enforceable, and therefore must have an efficient mechanism by which BSEE can monitor compliance. There must also be some way for BSEE to assess the effectiveness of regulatory measures. Accordingly, the data collected and subsequent analysis must be able to function as a gauge for the success of BSEE’s programs. From both the perspective of a regulator and an operator, data should be able to identify areas of further improvement. Moreover, issues pertaining to sensitive or other proprietary data BSEE hopes to collect from an operator must be addressed.

ABS Consulting recommends that BSEE employ a Risk-Based Decision Making (RBDM) process as the foundation of any data collection initiative. The motivation for this hinges on the desired outcomes for BSEE, specifically mitigating incidents related to operational safety or environmental protection. The RBDM process can help BSEE and industry operators make choices that minimize the likelihood and the severity of consequence of such incidents. As discussed previously, the overarching goal of an LCM system is to enable an operator to make more informed decisions on cost efficiency, operational safety, or some other measurable objective. Applying the RBDM process to data collection complements an LCM system by quantifiably allowing the user to prioritize certain risks and allocate resources in the most efficient and effective way possible.

With the risk model in mind, an LCM system with an integrated failure reporting system should collect data that is sufficiently comprehensive to cover a wide range of possible analysis. At a minimum, ABS Consulting recommends that BSEE include the following information as part of any failure reporting system for the offshore industry:

• Unique failure incident identifier: For database management purposes, BSEE should assign a unique identifier to each identified failure.
• Operator data: Operator, name, field/area, lease name and well number, operator signature and date, operating facility type, whether subcontracting companies were involved.
• Well data: Well test rate, environmental conditions, percent sand, H2S, CO2, pressures and temperatures, surface, bottom hole, SSSV equipment settling depth and installation rate, time equipment is in service and presence of unusual operating conditions, well operating data: flow, percent flow rate Gas, Oil, H2S, CO2, percent sand, PPM chlorine, PPB oxygen, PPM mercury, PPM elemental sulfur, flowing and shut-in.
• Facility data: Information about the facility where failure occurred: including facility type and location (that is, whether drilling boat, offshore rig, type of rig, etc.).
• Failure data: Description of failure, nature of failure, latitude and longitude where failure occurred, observed conditions which could have caused failure, probable and secondary cause of failure, type of equipment failed: model, part number, manufacturer, SSSV lock & landing nipple number, irretrievability of SSSV tubing, wiring and equipment, serial number, working pressure, service class and redress history records, nature of failure, observed conditions which could have caused failure, probable and secondary cause of failure, failure consequence data should also be included.

• Previous repair data: If any. This should include: Identification Information: operator name, date of occurrence, field/area, lease name/platform/well number, equipment identification part vendor, model, size, part number, serial number, data on operating pressure and control fluid, actual installed water depth, part size/pressure rating, corrective action taken during repairs to prevent recurrence, name of persons performing repairs: Name, title, company, signature and date. Replaced components list: part number and serial number of replaced parts, number of parts replaced, description, part number and serial number of new parts, manufacturer of new parts.

• Test results: If the test was furnished by the operator or conducted by the manufacturer, failure mode, leakage rate, control fluid, and operational data (opening and closing pressures).

• Causality and Consequence data: This field should contain data fields for any deaths or injuries regardless of how severe and should specify the causes of death or type of injury (e.g., whether burn, blunt force trauma, pressure overload, etc.). In addition, information regarding environmental damage (e.g., petrochemical leakage or other environmental impacts) as well as property damage, business disruption costs or other associated monetary losses should be included. Causality information should be given to integers (e.g., 1, 2, 3, etc.) and environmental costs should note the amount and type of commodity released into the environment (e.g., number of barrels). Damage and property costs should be in non-inflation adjusted U.S. dollars to facilitate consequence comparisons.

In order to successfully implement and enforce regulations on data collection, BSEE must have the ability to monitor industry compliance. Two specific measures that operators should adhere to are data accuracy and data relevance. Data accuracy is the degree to which the data reflects reality. Inaccurately reported data will only encumber BSEE’s efforts to create useful regulations in response to perceived industry need. In order to monitor this, BSEE must first lay down clear and explicit expectations for the data to be gathered. From the operator’s perspective, confusion or ambiguity of interpretation could lead to unintentionally inaccurate reporting. The next step in compliance monitoring would be for BSEE to conduct periodic inspections, ascertaining that all data collection and reporting mechanisms in a facility are functioning properly. Accurate data must be observed, recorded, processed, and transmitted accurately; therefore, BSEE should be able to verify every step in that process.

Data relevance, on the other hand, is how closely data fits the purpose for which it is going to be used. Data relevance is important because an operator may be providing highly accurate information, but still fail to comply with regulation if that information does not pertain to BSEE’s intended purpose. If data is only approximately relevant, any analysis performed on it may not yield tolerably accurate results for model development, forecasting, and eventually regulation development. Once again, BSEE must first communicate effectively what information it is trying to obtain. In terms of sustained compliance monitoring, a clear understanding of what should and should not be reported on will only expedite inspection or verification processes. From BSEE’s perspective, regulations on data collection should be as explicit as possible to ensure higher levels of data relevance.
BSEE is likely concerned with at least five different types of analysis queries. These should help BSEE determine the types of end-user tools required to analyze and report on the data and should support BSEE’s regulatory mission.

- Simple descriptive queries: These are the simplest queries. They involve simple counting, summing and averaging. A sample verification query might be, “How many failures occurred in a given month in the Gulf of Mexico?” or “What is the mean number of failures in all petrochemical companies in the Gulf of Mexico?” This information could be very important for baseline reporting and accordingly for BSEE regulatory evaluation studies.

- Analysis of Change Queries: These queries involve manipulating the data to provide measures of business performance. A sample analysis of change query is "What is the percent change in the number of failures in the past three years?" or “Which oil well operators had the largest failure reduction in the past three years?” This kind of analysis can be important in determining the effectiveness of new regulations.

- Basic Exception Reporting: These queries involve creating lists based on attributes or behaviors. A sample exception report query is “What are the top 10 companies with the most failures?” Reports can be useful in allowing BSEE to assign enforcement or inspection staff resources.

- Intensive Reporting: These queries include complex metrics and reports and can supplement existing BSEE reports. For example, BSEE produces an accident report for major significant events in their area of jurisdiction. Intensive reporting in the form of perhaps a “major critical incidents” annual report with data tables could supplement existing BSEE reporting and may be useful in meeting legislative oversight or “sunshine” requirements.

- Correlative or Causal Analysis: These are complex queries that try to associate or predict events. These queries are harder to answer using standard structured query language statements and often require specialized statistical operations. This type of analysis can answer questions like, “Can improper previous repair cause different failure types to occur?” or “Are different operators associated with different types of failure?” This type of analysis will be helpful in determining whether the action on new regulations is required.

Ultimately, the data collected and analyzed should indicate areas of improvement. From industry’s perspective, data that must be collected purely for regulatory purposes may seem burdensome. Therefore, in order to encourage compliance within the O&G industry, BSEE must provide useful feedback in a timely manner. BSEE benefits from having the unique ability to analyze data drawn from many industry operators, especially using data that may otherwise not be shared. While issues about proprietary data will be addressed later, such a sample to pull from allows BSEE to, for example, conduct extensive trend analyses for certain types of failures, whether general or specific to a facility type. BSEE could also have a sufficient amount of data to undertake something far more complex, such a change analysis that investigates several solutions to mitigating a safety risk.

Additionally, BSEE should collect data in order to evaluate the effectiveness of a regulated LCM and failure reporting system. Two questions to consider are:

- Does the data fully represent the regulated bodies?
- Can the data show the difference between BSEE’s LCM and failure reporting system and similar systems used by industry members?
From BSEE’s perspective, concrete data that demonstrates BSEE’s LCM and failure reporting system is more effective than industry-developed alternatives that do not conform to regulation would be highly useful. Clear effectiveness measures not only provide a way to identify areas of improvement, but can also help cultivate the regulated industry’s willingness to comply with BSEE initiatives. ABS Consulting recommends that BSEE include system effectiveness measures into its data collection plan.

Issues with keeping proprietary data relate to the sensitivity of that information. The level of operator anonymity preserved in, for example, a published report by BSEE, could greatly impact how willing operators are to provide certain types of data. However, most of the failure reporting systems reviewed in Task 3 do not appear to make a substantial accommodation for proprietary data. A common objective these systems tended to have was information sharing, and thus relevant information on failures is widely available to the regulatory community, the public, and other industry members in successful implementations. Clearly then, for the O&G industry, non-anonymous reporting can still be effective, principally because information that is considered proprietary would not necessarily be included in BSEE’s requirements.

Interviews with SMEs indicated to ABS Consulting that proprietary data about exploration and drilling is largely confined to drilling and well completion techniques. SMEs reported that regardless of the type of failure reporting system (e.g., mandated or voluntary), any information related to equipment failure, safety, or petrochemical spills would very likely be promptly and accurately reported. The legal and financial liabilities associated with false reporting or underreporting are too great for industry operators to disregard (SME, 2014). However, ABS Consulting noted that industry SMEs did voice concerns regarding the issue of liability in certain scenarios. For non-critical health, safety, or business operations issues, SMEs felt that disclosure of a failure incident could subject the reporting operator to legal or regulatory action, potentially undermining reporting rates (Anonymous, 2015).

For anonymous reporting, ABS Consulting observed three distinct mechanisms by which a regulatory body could preserve operator anonymity at different levels. The first is to preserve individual anonymity by only publishing aggregated statistical data. For example, the UK HSE publishes an annual statistics report that all compliant operators must participate in. The second mechanism is to restrict access to failure data or enforce confidentiality policies that limit disclosure. BSEE could set up a secure database and grant access to approved users for research and analysis. Operator anonymity would then be publicly preserved, but BSEE and other relevant parties would know what incidents occurred for certain operators. The third mechanism would be for BSEE to maintain a completely anonymous reporting system. All data reported to BSEE under such a reporting system would then be confidential, but would also have to be voluntary.

While it may be possible for BSEE to collect all relevant and accurate data the O&G industry may provide, any data collection process is limited by analytical constraints. BSEE must have the capacity to store and analyze all data submitted, processes that can be time and material-intensive. In addition to having qualified personnel to ensure data quality and conduct the analysis, BSEE must also have the appropriate computing power, in terms of hardware and software, for the scope of its operations. In terms of usability, the analytical constraints on large data sets can be understood by the volume, variety, and velocity of the data received.
More specifically, volume is the problem of having a large number of records and/or fields in a dataset. The higher the data volume, the harder it can be to comprehend features of the data, and the longer it may take for computers to process the data. Variety, on the other hand, is the problem of data being inconsistently formatted or unstructured. For example, requiring operators to provide spreadsheet summaries of their operations could yield a lot of informative data; however, if each organization arranges its summary in a different format, it could be difficult to make this data immediately comparable. In addition to inconsistent formatting, another example of variety would be unstructured data, such as free text data, which also presents issues of comparability. Finally, velocity of data occurs when new data is continually becoming available, and therefore must be processed continually to be relevant. Data of a higher velocity can be difficult to manage as it demands a constant allotment of resources to manage.

In the interests of improving data accuracy and relevance, BSEE will probably find it necessary to increase the analytical burden of a data collection system in terms of volume, variety, and velocity. ABS Consulting recommends that BSEE take a balanced approach, and weigh the benefits of data quality improvement against possible strains on available resources. When developing its data requirements, BSEE could consider, as an example, the following benefits of a higher analytical load:

- Increased data volume improves data accuracy and statistical confidence.
- Collecting a higher volume and variety of data increases the probability of collecting data relevant to future, unknown analyses.
- High-velocity data enables real-time decision-making support.

However, it is also important for BSEE to recognize that increasing the analytical load associated with the data does not always lead to improved data quality. For example, poorly-standardized data collection (high variety) might create inconsistent levels of relevance or accuracy in a dataset. If the inconsistencies are too numerous or difficult to correct given BSEE’s available resources, then data quality will be lost, despite an increase in the analytical load.

4.2.5 Impact Assessment

This section will discuss potential impacts on the regulated offshore oil and gas industry if the major LCM and failure reporting program requirements laid out in this report are put into effect by BSEE. Unfortunately, given the range of programs noted in the Tasks 2 and 3 reports, specific values in terms of the time, money, or personnel needed by industry to implement such requirements cannot be derived. The effects on large operators versus small operators, the levels of standardization observed in practice, and general industry trends are the most readily available means to develop this assessment. The main issue is that the difference in size between smaller industry members and very large ones.

Currently, there are no regulations requiring LCM systems in the O&G industry. Because these programs are not required, many of the smaller industry organizations do not have programs, nor do they have a desire to start them. It is believed that only the larger O&G companies are using integrated LCM and failure reporting programs to enhance their business case, but the smaller organizations have a “run things until they fail and then fix it” mentality. Smaller companies typically do not have the resources to manage these programs. It is believed that many of the larger oil companies would be accepting of the requirements for LCM and failure reporting programs, though smaller companies would most likely strongly object to any requirement they believe to be burdensome, costly, and ineffective.
4.2.5.1 API Q1 and Q2
In terms of an LCM system implementation, if BSEE were to incorporate the 9th Edition of API Specification Q1 and the 1st Edition of API Specification Q2, all industry operators may need to incorporate risk assessment and management systems, develop more procedures for purchasing products and outsourced activities, implement more comprehensive preventative maintenance systems, and develop management of change procedures, depending on the state of their SEMS. It is unknown to what extent industry operators, large or small, may already utilize systems or procedures like this. As they are not required under the 8th Edition of API Q1, and SEMS are not functionally verified, it is assumed that any such systems or procedures have been developed more to suit individual need rather than to conform to a standardized protocol. As industry members are hesitant to divulge specific company policies and procedures beyond regulation requirements, open source research did not yield objective information on the actual state of industry practice.

4.2.5.2 Automated Failure Reporting
With regards to failure reporting, most large organizations have already developed company-proprietary systems tailored to the organization’s unique needs and specifications. If BSEE were to require an automated failure reporting system, smaller companies would have to invest in software, technical training, and qualified personnel to operate such systems. Large companies, on the other hand, may only need to adjust their already existing systems to comply with new regulations.

Any automated failure reporting that BSEE implements would then place a disproportionate burden on smaller operators financially and technically. Currently, BSEE requires only written incident reports to be submitted under 30 CFR 250.187 and 188. While automated reports in regulation would be new, given the FRACAS-based software programs discussed in Section 2.15.1, commercially available software packages could assist industry members that do not already have an automated system comply with such a requirement.

However, given that several members of the industry have already invested significant time and resources for custom-built asset management software solutions (which may incorporate LCM and failure reporting along with maintenance planning and requirements like SEMS), the O&G industry may present strong pushback on an approach they deem to be too prescriptive, particularly if it is seen to be duplicative of current systems in use by industry.

4.2.5.3 Data Requirements
In the scope of an LCM system, operational data functions to inform preventative actions and maintenance procedures. A key issue raised by industry representatives and evidenced throughout many of the agencies is how to internally utilize the data collected. An LCM system may not require much data to be submitted to BSEE for review; however, it should be extensively utilized by industry operators to identify trends in manufacturing issues or process improvements. Since maintenance-related data can create a large analytical load, this may pose as a significant time and resource requirement, particularly in starting up a new LCM system. Moreover, any data sharing initiatives would be unprecedented for the industry. If data sharing responsibilities were placed on industry members, further developments in large-scale data analysis and proprietary information protection may need to occur.

However, the impact of more standardized data requirements could vary more. Currently, failure data is reported to BSEE by regulation. While the additional data reporting recommendations made by ABS
Consulting would not directly create a large burden for industry operators, the infrastructure for that data collection and reporting could. The issue is how standardization would affect the industry. Large or small operators could be significantly burdened by a new failure reporting data regulation, depending on how far it deviates from what individual operators already have in place. The lack of standardization currently seen in the O&G industry indicates that most failure reporting systems in use would need to be altered in order to conform to the recommendations provided in this report.

4.2.5.4 Benefits of an LCM and Failure Reporting Program

From BSEE’s perspective, any regulation should positively contribute to its overall goals of human and environmental safety by supporting the identification and analysis of the top risks throughout the O&G industry. Whether those risks pertain to personnel causalities, petrochemical spills, or other major accidents, understanding the failure processes that lead to those outcomes is also crucial in order to mitigate them. An effective LCM system with a failure reporting mechanism can help BSEE prioritize those risks in regulation and thereby have industry address them in a consistent and efficient manner. High-level failure data for critical systems or hazardous occurrences can give BSEE a tool by which to measure explicitly the effectiveness of any new regulations. These measures are, necessarily, contingent upon industry providing accurate and uniform data to BSEE. An LCM system with integrated failure reporting can assist BSEE by providing a framework of standardization understanding and practice.

From the O&G industry’s perspective, LCM and failure reporting systems can be viewed as a planning and maintenance tool that helps an operator make more informed decisions, ultimately promoting workplace safety and operational cost efficiency. An LCM and failure reporting system can help industry members implement better maintenance systems by assessing all pertinent failure risks prior to beginning operations. Overall, lowering the number of failures that occur through preventative maintenance is less costly for an operator in terms of machinery repairs, spill clean-up, and injuries or fatalities. It is important for BSEE to make sure that industry members understand the benefits an LCM system has to offer. As a large regulatory initiative, resistance to investments in new hardware, software, personnel, or training should only be expected. However, emphasizing that such regulations have the potential to maximize facility or operational performance can help abate substantial opposition.

Operators of offshore facilities may be exposed to adverse legal action from a countless number of organizations or individuals following a significant incident. Any LCM and failure reporting system in use will be the subject of a high degree of scrutiny from a host of potential actors. Implementing an industry organization standard from ISO, API, IADC, or others that provide LCM and failure reporting models would show a good faith effort in achieving a higher standard of safety.

For example, offshore operators that implement an LCM system may realize substantial mitigation of potential liabilities because LCM and failure reporting systems provide offshore operators with the ability to make proactive and methodical management decisions about critical and potentially hazardous operations. Therefore, LCM and failure reporting systems may have the effect of limiting organizational liability and increasing compliance with legal requirements. LCM and failure reporting systems provide operators with a degree of defense because having such a system in place demonstrates due diligence. It may be easier for operators to diminish their culpability because they can prove that they use the systematic decision methodologies and documentation procedures provided by an LCM and failure reporting system. LCM and failure reporting systems are, by no means, a panacea for all the potential
liabilities an offshore operator will face. However, the ability to prove that important decisions are comprehensively evaluated before they are made could be invaluable if there is a substantial incident.

5 Recommendations for Implementation

BSEE may already have the statutory authority and, in most cases, the regulatory structures that it would need to impose LCM and failure reporting system requirements on the offshore O&G industry. What BSEE lacks is a conceptual framework to apply these authorities and regulations in a way that is efficient and limits the demand on the human and financial resources of BSEE. In this section, ABS Consulting will offer such a framework for BSEE to consider, and illustrate how BSEE’s existing authorities and regulations may be used, or modified, to support the implementation of such a framework.

ABS Consulting believes that the framework we are presenting in this report cannot be applied without a great deal more research and input from subject matter experts. However, we are confident that this framework should provide a foundation from which BSEE should build and expand to meet its needs.

The conceptual framework that ABS Consulting is offering involves the implementation of a system of cascading responsibility and third party verifications that should support the adoption of LCM and failure reporting systems in the offshore O&G industry. Underpinning of this model is BSEE’s authority to issue requirements to the offshore O&G industry, which is outlined in 30 CFR 250.101(b)(2), 30 CFR 250.106(b),(c), 30 CFR 250.107(a)(1),(2), 30 CFR 250.600 and 30 CFR 250.800(a). In this framework, there would be simple and clear lines of responsibility for the execution of LCM and failure reporting systems. In Figure 7 the lines of responsibility are denoted by the gray descending arrows:
The concept of cascading responsibilities may be new, but it is already supported by 30 CFR 250.400, which clearly states that lessees, operators, and their contractors and subcontractors are responsible for safe drilling operations. In this framework, BSEE is responsible for establishing the functional elements of LCM and failure reporting systems.

With respect to LCM systems, the first building block is the establishment of the elements of an LCM. BSEE should create these elements in the form of broad objectives that an LCM system should achieve. The advantage of developing broad objectives is that they are guiding principles that are not bound by changes in technology or operations. This approach is also in line with other international and domestic schemes such as BSEE’s SEMS, IMO’s ISM Code, and ISO Standards. However, there is one crucial distinction in this scheme: the functional elements should be limited to critical systems, critical equipment, and critical components (see definitions in Task 4 Report). Imposing LCM systems that are not focused on critical systems, critical equipment, and critical components places a burden on the offshore O&G industry and should require BSEE to expend time and resources in areas that have limited value in improving safety or reliability. The following are suggestions for LCM functional elements:
• Establishment of a hierarchy of critical systems, critical equipment, and critical components (see definition in Task 4 Report);
• Incorporation of manufacturers’ specifications into all maintenance plans for critical systems, critical equipment, and critical components;
• Documentation of any work performed on critical systems, critical equipment, and critical components;
• Linkages between relevant documents and critical systems, critical equipment, and critical components;
• Collection of condition and failure data that assesses the reliability of critical systems, critical equipment, and critical components;
• Systems that allow for the comparison of maintenance conditions of similar critical systems, critical equipment, and critical components;
• Systems that allow for the identification of unsatisfactorily performing critical systems, critical equipment, and critical components;
• Systems that link work orders and condition reports to particular pieces of critical systems, critical equipment, and critical components;
• Systems that collect maintenance metrics regarding critical systems, critical equipment, and critical components;
• Systems that create serialized references for specific critical systems, critical equipment, and critical components;
• Systems that track serialized critical systems, critical equipment, and critical components through their entire life cycle from procurement to disposal; and
• Systems that assign maintenance actions and responsibilities for all critical systems, critical equipment, and critical components.

BSEE should use or modify existing regulations to require lessees to incorporate these functional elements into plans and documentation. For example, BSEE should modify 30 CFR 250.1916 to include these functional elements in their SEMS mechanical integrity requirements. Using 30 CFR 250.201(a), BSEE should require lessees to provide plans that specifically address how these functional elements will be implemented. Additionally, 30 CFR 250.418(j) may support the requirement for lessees to address these functional elements in their APD process.

In a system of cascading responsibility and third-party verification, BSEE should place the responsibility on the lessee for ensuring that an LCM system is in implemented. The lessee would be responsible for guaranteeing that any operator on their lease has implemented the functional elements of an LCM. The operator would be responsible for developing the policies, programs, and management systems that implement the functional elements of the LCM. Contractors hired by the operator would be responsible for knowing, understanding, and abiding by the policies, programs, and management systems of the operator. The contractors would be responsible for ensuring that their subcontractors know, understand, and abide by the policies, programs, and management systems of the operator. Subcontractors are accountable for knowing, understanding, and abiding by the policies, programs, and management systems of the operator and the contractor.

As with the system of cascading responsibility for the implementation of LCM systems, BSEE should require the implementation of failure reporting systems whereby lessees would be responsible for collecting the failure reports on critical systems, critical equipment, and critical components. BSEE
should modify 30 CFR 250.188, or it should simply use 30 CFR 250.186(a) to require lessees to collect failure reports from operators, contractors, and subcontractors. The lessee would enforce the collection of these failure reports, in the same way, it shares responsibility for all the other entities in the scheme. The lessee would collect the reports from operators, operators would collect the reports from contractors, and contractors would collect the reports from subcontractors. Lessees should be required to analyze these failure reports and produce trend reports that they submit annually or semiannually to BSEE. BSEE should use these failure reports for broader analysis. BSEE should modify 30 CFR 250.195 to protect proprietary information and allow BSEE to pass on those reports to the appropriate OEMs without disclosing the source. BSEE should also aggregate the failure reports to publish comprehensive reports to inform the O&G industry as a whole. This could promote industry-wide comparisons and performance trending for critical systems, critical equipment, and critical components. This type of failure reporting system should limit the volume of data BSEE would have to collect, analyze, and store. The flow of the failure reports is depicted as yellow arrows in Figure 8 below:
Using some of the same regulatory citations proposed for LCM and failure reporting systems, BSEE should build on this scheme of cascading responsibilities to achieve some of its other goals. For example, this scheme could be expanded to collect information about LCM systems that do not rise to the level of failures. For example, BSEE should impose additional requirements for the collection of data and analysis of LCM systems that could be used to establish a foundation for future analysis. Building on the scheme of cascading responsibilities, BSEE should require lessees to collect data about the performance of LCM systems that specifically targets critical systems, critical equipment, and critical components. BSEE should outline the LCM data parameters that it is most interested in and then require the lessees to collect, analyze, and report to BSEE on those parameters. As with the failure reporting system example, the lessee should be required to collect the data, in the same way, they would collect failure reports. Lessees should be required to analyze and produce trend reports on the LCM performance in
annual or semiannual reports for BSEE. Likewise, BSEE should use these reports to make industry-wide comparisons about the application of LCM systems. Like the failure reporting system example, this type of data collection scheme should limit the volume data that BSEE would have to collect, analyze, and store.

Safeguarding the framework’s integrity should be a system of third-party audits that verify the implementation of LCM and failure reporting systems. This is represented in Figure 8 was descending black arrows. BSEE should appoint third party auditors, or conducts the audits themselves, to ensure that the lessee has confirmed the operator’s implementation of the functional elements. The leaseholder will substantiate the operator’s implementation by appointing a third-party auditor to assess the operator’s LCM system. The operator will ensure that contractors know, understand, and abide by the policy, programs, and management systems of the operator by appointing third party auditors to assess the contractors. The contractor will ensure that their subcontractors know, understand, and abide by the policy, programs, and management systems of the operator by appointing third party auditors to assess their subcontractors. Third party audits should be conducted upon commissioning of a project and at annual intervals thereafter. For each audit conducted, copies of the audit report results would go to the appointing authority and BSEE for review. This process is represented as gray arrows in Figure 8. If the inclusion of the LCM and failure reporting systems were included in 30 CFR 250.1916, some of the groundwork for this system would already be established.

In order to implement a third-party auditing program with self-inspection on the part of leaseholders, operators, contractors, and even subcontractors, ABS Consulting recommends that BSEE consider adding regulatory language that addresses:

- How a leaseholder could apply for a self-inspection option;
- How an independent entity could apply to serve as a third-party auditor;
- The conditions for such approval;
- The role BSEE plays in conducting oversight; and
- Enforcement under a self-inspection or third-party auditing program.

Another example of how this framework of cascading responsibilities and third-party verification should be used involves API Q1 and Q2. As discussed earlier in this report, in API Q1 and Q2 there are requirements for management to review audit or inspection reports and devise new improvements based on those report. Using the cascading responsibilities framework, BSEE should potentially expand this concept require lessees, operators, contractors, and subcontractors to report on new improvements implemented as the result of audits. This type of requirement should enforce a system of continuous improvement base on the multiple layers of audits.

To assess the feasibility of this framework of cascading responsibilities and third-party verification, we should consider the answers to the following questions. These questions are crafted to evaluate these recommendations’ alignment with BSEE’s mission, vision, and strategic goals.

- Does this framework promote safety, protect the environment, and conserve resources offshore through vigorous regulatory oversight and enforcement?
  - Yes, by imposing LCM requirements, BSEE will ensure that critical systems, critical equipment, and critical components are afforded the greatest protection and are being
maintained and monitored. Additionally, the scheme would establish multiple layers of oversight that could potentially detect and respond to issues or problems before they lead to an undesirable event.

- Will this framework foster a culture of risk reduction and compliance among operators?
  - Yes, because the responsibility and accountability are clearly defined and linked, each entity in the chain is responsible for and dependent on the next.

- Does this framework reduce the risk of accidents and spills and enhance the ability to respond?
  - Yes, for two reasons. One, LCM systems will focus on the highest risks. Two, with multiple layers of oversight, there is a higher probability that issues and problems will be detected before they result in an accident or spill.

- Will this framework allow BSEE to define, assess, and differentiate risks?
  - Yes, but it will take additional work to develop systems that can categorize and capture information about LCM and failure reporting systems that will best assist BSEE in distinguishing risks.

- Does this framework allow BSEE to build clear, consistent, comprehensive, and effective permitting processes?
  - Maybe, in principle it would appear that it could be incorporated into all the permitting processes. However, this scheme needs to be evaluated against each of BSEE’s permitting processes.

- Will this framework allow BSEE enough flexibility to create, define, and expand regulatory approaches and tools?
  - Yes, once BSEE has established the fundamental elements of the LCM and failure reporting systems in regulation, they may have the flexibility to use non-regulatory mechanisms like Notices, Letters, and Information to Lessees and Operators (NTL)s to define better or expand the approaches to LCM systems as they gain more experience. This type of framework could also be more responsive to changes in technology or operational methods. It could also be used to implement more quickly emergent best practices.

- Does this framework allow BSEE to refine and enhance continuous offshore safety performance?
  - Yes, one the key driver of the continuous improvement will be the multiple layers of audits that support the scheme.

- Does BSEE have the human capital, expertise, and financial resources to implement this framework?
  - Maybe, since most of the oversight functions are being conducted by third parties, the impact on BSEE’s human resources should be minimal. However, the system of multiple reports coming from lessees may increase workloads in some areas, as they will have to be reviewed and stored. Additionally, the collection of data from the LCM and failure


reporting systems may require analysis, which could represent a demand on the expertise and financial resources.

- Does BSEE have the data systems, knowledge management, and capacity for innovation to implement this framework?
  - No, not at the present time. However, once the operators build and implement LCM systems around the functional elements, BSEE could have a wealth of information that they could then use to define and categorize the types of data they need. This would allow BSEE to build data systems that are more targeted to its goals.

ABS Consulting believes that BSEE has the regulatory foundation to implement such a framework. However, there are some big challenges in implementing such a scheme, and they could be significant. Chief among these challenges could be charges of regulatory overreach by an industry that is influential and that has enormous legal resources at its disposal. On the other hand, there could be accusations from other camps that such a scheme is too dependent on the industry to police the implementation of requirements. However, this framework could ensure that comprehensive requirements are imposed, while allowing BSEE to conserve human and financial resources.

5.1 Use of Guidance Documents (NTLs) in Addition to Regulations

Some recommendations are important to accomplish while other may be categorized as “nice to have.” Some recommendations, regardless of their importance, may be quickly achieved (one to two years), and some will take a long time to realize (two to ten years). Finally, some recommendations may require limited effort or resources whereas others will require a substantial commitment of effort and money. Therefore, it is important that BSEE have a way to evaluate these recommendations.

In this report, we have emphasized what existing BSEE regulations should be used to impose the required elements of a successful LCM system. In some cases, there are current regulatory authorities with clear linkages to aspects of a model LCM that BSEE should use to impose LCM requirements. However, in most cases BSEE’s regulatory authorities are so broadly written that BSEE will need to create policy statements to make the linkages to the specific desired requirements of a model LCM system. Nevertheless, the approach of using existing regulatory authorities has some distinct advantages. First, it would avoid the lengthy and resource intensive requirement of developing and shepherding new regulations through the necessities of the Administrative Procedure Act. Second, by seeking to interpret existing regulations, broadly it establishes a precedent for future actions that should give BSEE the flexibility to impose additional LCM requirements using existing regulations in the future. However, this approach is not without risk. Primarily it opens BSEE to legal challenges from the regulated industry.

Many of these recommendations would most likely require new regulations and new information technology infrastructures to realize these recommendations. Additionally, electronic and automated reporting and data sharing could include numerous pitfalls. First and foremost, BSEE would need the capacity to manage that much information. Without careful planning and costly data infrastructures to manage the data, a system to collect such data could easily become a black hole where data goes in, but nothing useful can be extracted. Assuming that BSEE had a well-structured system for data sharing, BSEE would need to consider committing the resources needed to maintain or use the system. Such a system
could represent a significant investment in personnel to manipulate, archive, extract, and analyze such data. Additionally, policy structures are required to protect the data and decide access.

While the incorporation of industry standards into regulation may be efficient, it may lack specific elements that BSEE desires. We postulated that nearly all of Q1 9th Edition and Q2 should be incorporated as a step towards implementing LCM regulations, but they may not present a complete outline for an LCM system. Since API 18LCM is still under development, we do not make any conclusive recommendations as the standard may change.

We also suggest that the IADC standards provide a comprehensive set of guidelines for presenting Health, Safety and Environment cases. However, ABS Consulting does not recommend the incorporation by reference or the safety case approach. There are distinct advantages when compared to aforementioned evaluation factors of expediency and effort, particularly with the widespread adoption of the IADC standards. Incorporation by reference would most likely be much quicker and require less effort than using existing regulatory authorities that may require heavy policy work or new regulations that would require considerably more time and more effort.

ABS Consulting deemed that other U.S. regulatory and international models for LCM and failure reporting systems reviewed would not be a good fit for BSEE. ABS Consulting concluded that there is no single approach that will work seamlessly for BSEE and that BSEE would need to create its own approach to implementing LCM and failure reporting systems. Other, particularly European, agencies have successfully implemented systems that have addressed LCM and failure reporting system in the offshore O&G industry and they should not be dismissed lightly. However, emulating an existing model would most likely not save BSEE any time or effort.

Definitions currently in use in the industry are not effective enough to be used in regulations. To fill that gap, ABS Consulting developed definitions for BSEE that are clear and comprehensible. The establishment of clear definitions will be foundational to any effort to establish LCM and failure reporting systems, whatever path BSEE may choose. Additionally, when evaluated against the three factors of importance, expediency, and effort this recommendation merits the strong consideration.

The framework of cascading responsibilities and third-party verification presented in Section 5 allows BSEE to select from any of the recommendation that we have presented in this report (or any options that BSEE deems appropriate) and apply them in a comprehensive fashion. The framework is also flexible enough to allow new best practices or methodologies to be adopted as BSEE and the offshore O&G industry mature in their knowledge and expertise with LCM and failure reporting systems.
Works Cited


SME, S. O. (2014, December 8). Interview with senior Oil And Natural Gas Subject Matter Expert. (J. C. Hendrickson, Interviewer)


Venkatramam, V. (2015, January 22). Genesis Solutions Marketing and Sales Senior Director. (J. Hendrickson, Interviewer)