Summary of Various Risk–Mitigating Regulations and Practices applied to Offshore Operations

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Abstract

The following work is a brief summary of several of the risk-mitigating regulations and practices as part of the offshore regulatory framework applied in the UK, Norway and the U.S. The outlines described in this work serve only to introduce the reader to some of the various concepts, regulations, and their applications; the information presented is based on the personal interpretations of the author. The reader is encouraged to refer to the sources outlined in this work for further in-depth knowledge of the concepts and regulations mentioned.

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1 Regulations in the UK

1.1 Safety Case Regulations

'Quantitative Risk Analysis' (QRA), also known as 'Quantified Risk Assessment' is a type of risk assessment frequently applied to offshore operations. Following the tragic Piper Alpha incident in 1988, the UK regulations experienced major changes based on the recommendations from the official inquiry lead by Lord Cullen. Lord Cullen recommended that risk assessment practices be implemented into the UK legislation similar to those implemented earlier in Norway. The following regulations have been issued as a result:

- Safety Case Regulations (SCR)
- Prevention of Fire and Explosion, and Emergency Response Regulations (PFEER)
- Management and Administration Regulations
- Design and Construction Regulation

A safety case is a document which provides evidence of a duty holder's ability and means to control the risks of major accidents effectively. According to the HSE, "The Offshore Installations (Safety Case) Regulations 2005 (SCR05) aims to reduce the risks from major accident hazards to the health and safety of the workforce employed on offshore installations or in connected activities." [1] The principle purpose for producing a safety case is to present how the system will be deemed safe in a given context. Therefore, in order to prepare a safety case, it is necessary to understand the levels of risks involved with a system, and whether they satisfy the legal requirements.

In the UK, it is required that all installations must have a safety case in order to operate. The requirements for safety cases differ depending on the type of installation, such as those for production facilities, and those used for drilling, exploration, or accommodation. Submitting a safety case is generally the responsibility of an operator of a production installation and the owner of a non-production installation.

For new installations, operators are required to notify the Health and Safety Executive early in the design phase. This is because incorporating safety in design is an important role of QRA in an effort to reduce accidents rooted in the design of offshore facilities. The notification must be followed by the submission of the safety case, for which the HSE must grant approval before the installation can be operated. Notifications are also required if a production installation is planned to move to a different location, or if a non-production installation is converted to a production installation. Similarly, for an installation with an approved safety case, in the case of change of location, they must submit a revision of the safety case for approval by the HSE. Dismantling of a fixed platform also requires an approved safety case.

In general, safety case regulations require the duty holder to identify hazards, evaluate levels of risk, and demonstrate that the appropriate measures are or will be in place to control the risks to an extent that the residual risk level is as low as reasonably practicable (ALARP). According to Vinnem,

[1] The Offshore Installations (Safety Case) Regulations 2005, Retrieved September 9, 2010. http://www.legislation.gov.uk/uksi/2005/3117/contents/made

"The Safety Case should also demonstrate that the operator has a HES (health, environment, safety) management system which is adequate in order to ensure compliance with all health and safety regulatory requirements."[2]

A safety case is assessed under three principal adequacy criteria:[3]

- Management systems to ensure compliance with statutory health and safety requirements
- Arrangements for auditing and reporting
- Major hazards identification, risk assessment, and control

Further information can be found in the Offshore Installations (Safety Case) Regulations 2005 (SCR05).

1.2 Purpose of a Safety Case Report

The purpose of the safety case as stated by the Lord Cullen Inquiry is:[4]

> *"Primarily the safety case is a matter of ensuring that every company produces a formal safety assessment to assure itself that its operations are safe."*

The safety case report is essentially a document that can be used to ensure the duty holder and HSE that the necessary risk control measures and health and safety management systems are in place, and can operate as intended.

The Safety Case Report, which previously lasted 3 years (before being required to be resubmitted for assessment), now lasts the life of the installation. However, the duty holder is still required to revise and review the safety case at least every five years, or as directed by the HSE as a demonstration of safety to reflect changing knowledge and operational conditions. It is required that HSE accepts the safety case before an installation is permitted to operate. In order to assess the safety case, HSE's offshore division (OSD) uses the principles outlined in the Assessment Principles for Offshore Safety Cases (APOSC).[5] According to the APOSC, "The principles should be widely known by industry managers, technical experts and employees, enabling a common understanding of the process." It is important to understand that the safety case report does not contain any quantitative criteria or formulae for the design of oil and gas installations. A Qualitative Risk Assessment (QRA) approach should be used to demonstrate the level of risk to personnel on the installation is 'as low as reasonably practicable'. Further information and guidance on the

[2] Vinnem, Jan Erik. Offshore Risk Assessment: Principles, Modeling and Applications of QRA Studies. 2nd Ed. London, Springer series in reliability engineering, Limited 2007. p10.

[3] Bureau Veritas Website, Retrieved September 9, 2010, ref. http://bureauveritas.com/wps/wcm/connect/bv_com/Group/Home/bv_com_serviceSheetDetails?serviceSheetId=1102&serviceSheetName=Offshore+Safety+Case+Management+and+Review

[4] Maguire, Richard. *Safety Cases and Safety Reports: Meaning, Motivation and Management*. Abingdon, Oxon, GBR: Ashgate Publishing, Limited, 2008. p 46.

[5] Health and Safety Executive (HSE) 2006, *Assessment Principles for Offshore safety Cases (APOSC),* Retrieved September 9, 2010. http://www.hse.gov.uk/offshore/aposc190306.pdf

application of QRA methods can be found in the HSE Offshore information sheet No. 3/2006 titled: "Guidance for Risk Assessment for Offshore Installations." [6]

Every system of regulations however, has its own set of challenges and difficulties in its implementation and effectiveness; hence it is important to understand those challenges in order to optimize the effectiveness. According to the HSE Offshore Health and Safety Strategy to 2010,[7] such challenges/barriers for improving safety performance on the UKCS are as follows:

> *"A number of barriers appear to inhibit improvements in the safety performance on the UKCS. The UKCS has developed relatively sophisticated safety policies and procedures, which have served to improve the technical integrity of installations, yet have failed to instill, at all levels, personal accountability and responsibility for safety. More importantly visible safety leadership from senior players in the oil and gas industry is not consistent. As a result many workers do not believe it to be the high priority that duty holders claim it to be."*

1.3 PFEER Regulations

The Prevention of Fire and Explosion, and Emergency Response (PFEER) Regulations,[8] according to the HSE, outlines the requirements necessary to:

- Prevent fires and explosions, and provide protection to persons from the effects of those which occur;
- Secure effective arrangements for emergency response.

The purpose of the PFEER regulations is to ensure that the residual risk levels are 'as low as reasonably practicable' (ALARP) in the case of a fire or explosion, and to ensure effective emergency response arrangements that would allow for the safe rescue of personnel, for all possible scenarios. The regulations apply to both fixed and mobile installations (however for mobile installations it does not apply when they are in transit). Also important in these regulations is that according to the HSE "The duty holder has a responsibility to all people on the installation - not just their own employees."[8] According to PFEER Regulation 5 [8]:

> *"The regulation requires the duty holder to repeat the assessment as often as may be appropriate. This would include, for example, taking account of changes to the installation or to working activities, and the introduction of new equipment or systems."*

> *"The regulation does not itself stipulate the measures to be taken and the arrangements to be made as a result of the assessment. But the assessment should be used as the basis for determining the detailed measures and arrangements to be made to comply with the other PFEER Regulations."*

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[6] Health and Safety Executive (HSE) 2006, *Guidance on Risk Assessment for Offshore Installations, Offshore Information Sheet No. 3/2006*, Retrieved September 9, 2010. http://www.hse.gov.uk/offshore/sheet32006.pdf

[7] Health and Safety Executive, *HSE Offshore Health and Safety Strategy to 2010*, Retrieved September 10, 2010, ref. http://www.hse.gov.uk/consult/disdocs/offshore2010.pdf (pg8).

[8] Health and Safety Executive, HSE *Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995. Approved Code of Practice and Guidance,* Retrieved October 10, 2010. http://www.hse.gov.uk/pubns/priced/l65.pdf

Reducing risks to personnel to 'as low as reasonably practicable' requires the application of risk-based design practices and the use of QRA for fire and explosion evaluations.

1.4 ALARP (As Low as Reasonably Practicable)

Duty holders use various methods to reduce the levels of risk to a system, however as it is not possible to completely eliminate all risks involved, there will always be a certain level of risk remaining known as residual risk. "As low as reasonably practicable" (ALARP)[9] is a term used to express an expected level of residual risk involved with a system or set of operations. What this means, is that the duty holder, overseen by the regulatory authorities, is responsible for exercising good practice and judgement to ensure the necessary measures have been taken in order to reduce the levels of risk, such that the residual risk levels are 'as low as reasonably practicable'.

ALARP fundamentally has the same meaning as "so far as is reasonably practicable" (SFAIRP). The meaning of the two terms involves weighing the risk against time, effort, and the money required to control it. Thus, ALARP is a term used to describe the level for which risks are controlled. Figure 1.1 and Figure 1.2 show how the level of risk assessment applied should be proportionate to the magnitude of the risk.

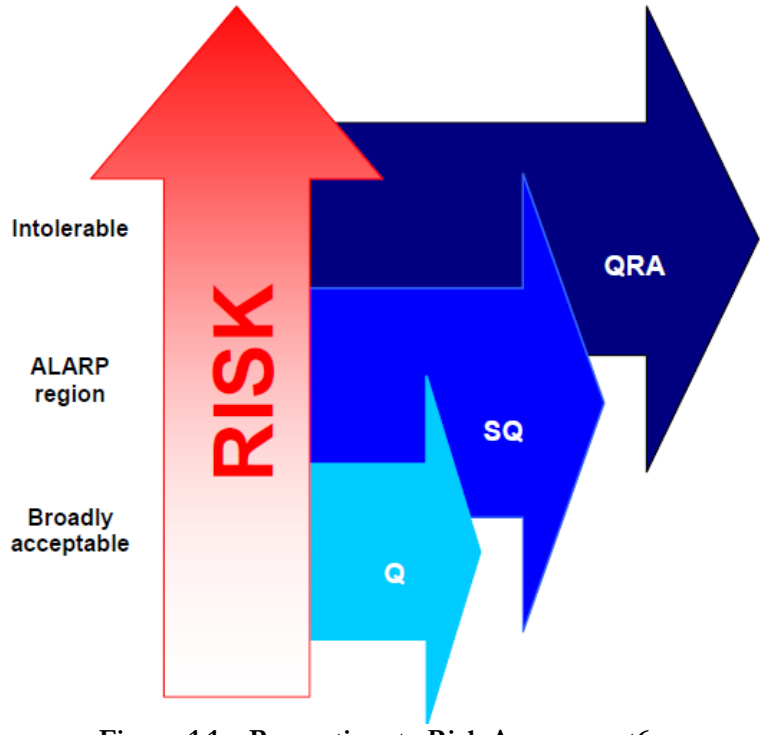

Figure 1.1 – Proportionate Risk Assessment6

[9] Health and Safety Executive (HSE), *Principles and Guidelines to assist HSE in its judgements that dutyholders have reduced risk as low as reasonably practicable,* Retrieved September 12, 2010. http://www.hse.gov.uk/risk/theory/alarp1.htm

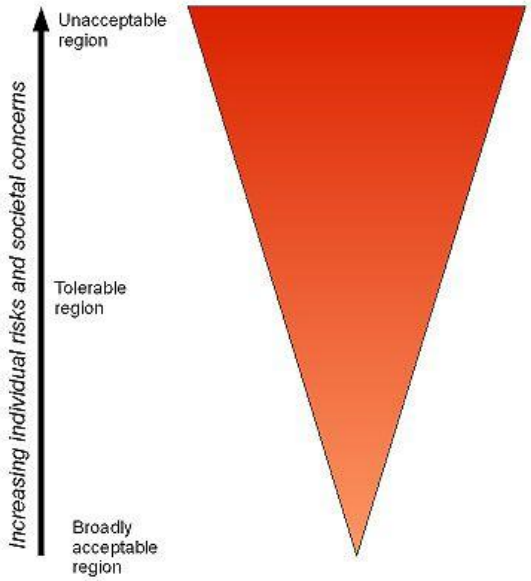

Figure 1.2 – ALARP Carrot Diagram (Source: Wikipedia)

The definition of "reasonably practicable" as stated by the UK's Court of Appeal in its judgement in Edwards v. National Coal Board, is:[10]

> *"'Reasonably practicable' is a narrower term than 'physically possible' … a computation must be made by the owner in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other, and that, if it be shown that there is a gross disproportion between them – the risk being insignificant in relation to the sacrifice – the defendants discharge the onus on them."*

There are three documents which provide guidance on what constitutes good practice or demonstrates that risks have been reduced ALARP, which are "Principles and Guidelines to assist HSE in its judgements that dutyholders have reduced risk as low as reasonably practicable," [9] "Assessing compliance with the law in individual cases and the use of good practice,"[11] and "Policy and guidance on reducing risks as low as reasonably practicable in Design." [12]

1.5 How ALARP is Applied

The Health and Safety Executive of the UK, is ultimately responsible for enforcing that duty holders reduce risks ALARP. The term ALARP is used to set goals for the duty holders, rather than providing prescriptive outlines. HSE admits that "There is little guidance from the courts as to what reducing risks 'as low as is reasonably practicable' means." [9] Because ALARP is not outlined explicitly in regulations, the challenge with determining whether a risk is ALARP relies on the judgement of both the duty holders and regulators. As stated by the HSE[10]:

[10] Health and Safety Executive (HSE), *ALARP at a glance*, Retrieved September 12, 2010, ref. http://www.hse.gov.uk/risk/theory/alarpglance.htm

[11] *Assessing compliance with the law in individual cases and the use of good practice*, Health and Safety Executive website, Retrieved September 12, 2010. http://www.hse.gov.uk/risk/theory/alarp2.htm

[12] P*olicy and guidance on reducing risks as low as reasonably practicable in Design*, HSE website, Retrieved September 12, 2010. http://www.hse.gov.uk/risk/theory/alarp3.htm

> *"…in ALARP judgements, the rule is that the measure must be adopted unless the sacrifice is grossly disproportionate to the risk. So, the costs can outweigh benefits and the measure could still be reasonably practicable to introduce."*

Principles 8 and 9 of the "Principles and guidelines to assist HSE in its judgements that dutyholders have reduced risk as low as reasonably practicable," outline how it is to be determined whether a risk has been reduced ALARP. According to the HSE, the principles are as follows[9]:

> 8. Thus, determining that risks have been reduced ALARP involves an assessment of the ***risk*** to be avoided, of the ***sacrifice*** (in money, time and trouble) involved in taking measures to avoid that risk, and a ***comparison*** of the two.
>
> 9. This process can involve varying degrees of rigour which will depend on the nature of the hazard, the extent of the risk and the control measures to be adopted. The more systematic the approach, the more rigorous and more transparent it is to the regulator and other interested parties. However, dutyholders (and the regulator) should not be overburdened if such rigour is not warranted. The greater the initial level of risk under consideration, the greater the degree of rigour HSE requires of the arguments purporting to show that those risks have been reduced ALARP.

In most cases, risks that are ALARP can be determined by comparing the duty holder's existing or proposed control measures, with those of which the regulators expect to see, based on experience and 'good practice'. The 'General ALARP Guidance' defines good practice as[10]:

> *"…those standards for controlling risk that HSE has judged and recognised as satisfying the law, when applied to a particular relevant case, in an appropriate manner."*

The decision on whether the control measures are 'good practice' is then made by the HSE regulators through a process of discussion involving various stakeholders, such as employers, trade associations, other governmental departments, safety professionals, etc.

Principles 40 – 45 of the "Principles and guidelines to assist HSE in its judgements that dutyholders have reduced risk as low as reasonably practicable" make clear what should be expected from dutyholders relating to the application of 'good practice'. According to the HSE, sources of written, recognized good practice include the HSC Approved Codes of Practice, as well as HSE guidance documents. Other acceptable written sources can include guidance produced by other governmental departments, standards produced by standard-making organizations, or guidance agreed by a body representing and industrial or occupational sector.[11] Other unwritten sources may be used if they fulfill the necessary requirements as stated in the "Identifying Good Practice" section of the HSE's "Assessing compliance with the law in individual cases and the use of good practice" website.[11]

If duty holders would like to propose different methods other than those decided as 'good practice', they must convince the regulators by demonstrating that the proposed methods are at least as effective (if not better) in controlling the risks.

In the case of major hazard systems or installations, as well as new complex systems, additional methods are used such as cost-benefit analysis to assist regulators with their judgement. When using these methods, health and safety is favored over cost, and therefore in order to avoid further sacrifices, a duty holder must show that the efforts and sacrifices (time, money, etc.) required to reduce a risk is grossly disproportionate to the level of safety gained as a result (i.e., extremely high cost is required, and the benefits of risk reduction are only marginal).[13]

The following table adapted from the HSE[12] shows how ALARP can be applied to the design of new major hazard facilities, and also how it can influence significant modifications to them.

Table 1.1 – Application of ALARP to Design (Adapted from the UK HSE)

Project Stage	Elements in demonstration that risks are as low as is reasonably practicable
Choosing Between Options or Concepts	• Risk assessment and management according to good design principles • Demonstration that dutyholder's design safety principles meet legal requirements • Demonstration that chosen option is the lowest risk or justification if not • Comparison of option with best practice, and confirmation that residual risks are no greater than the best of existing installations for comparable functions. Risk considered over life of facility and all affected groups considered • Societal concerns met, if required to consider.
Detailed Design	• Risk assessment and management according to good design principles • Risk considered over life of facility and all affected groups considered • Use of appropriate standards, codes, good practice etc. and any deviations justified • Identification of practicable risk reduction measures and their implementation unless demonstrated not reasonably practicable.

As mentioned previously, it is not possible to completely eliminate all risks involved, and there will always be a certain level of risk remaining, known as residual risk. Principles 12 and 13 of the 'Principles and guidelines to assist HSE in its judgements that duty holders have reduced risk as low as reasonably practicable', further explain this matter. The principles are as follows[9]:

> 12. The risks must be only those over which dutyholders can exercise control or mitigate the consequences through the conduct of their undertaking. Some risks arise from external events or circumstances over which the duty-holder has no control, but whose consequences duty-holder can mitigate. Such risks should be included in the assessment.
>
> 13. In any given workplace there would be a large number of hazards which dutyholders could address. However, requiring dutyholders formally to address them all would place an excessive and largely useless burden on them. So as not to impose unnecessary burdens on dutyholders, HSE will not expect them to

[13] Health and Safety Executive (HSE), *ALARP at a glance*, Retrieved September 12, 2010, ref. http://www.hse.gov.uk/risk/theory/alarpglance.htm

> take account of hazards other than those which are a reasonably foreseeable cause of harm, taking account of reasonably foreseeable events and behavior.

In conclusion, bearing in mind the information provided, a duty holder must understand the responsibilities placed upon him by regulatory authorities to ensure that the required safety levels achieved, reducing the risks 'as low as reasonable practicable'. Because ALARP is not outlined explicitly in regulations the duty holder, overseen by the regulatory authorities, must exercise 'good practice' and judgement to ensure that the necessary measures have been taken in order to reduce the levels of risk 'as low as reasonably practicable', to an extent that the sacrifices burdened by the duty holder do not disproportionately outweigh the benefits to do so.

2 An Overview of Norwegian Regulations

The use of safety cases in Norway is similar to those in the UK. Overall, the Norwegian regulations are mainly performance-based with supplementary prescriptive requirements.[14] This is different than in the US, where OCS regulations are primarily prescriptive. A detailed comparison on the differences between the Norwegian and US regulations for offshore operations can be found in the report issued by DNV: *Summary of differences between offshore drilling regulations in Norway and U.S. Gulf of Mexico.*[14]

According to Vinnem[2], the Norwegian Petroleum Directorate (NPD) issued guidelines in 1981 for safety evaluation of platform conceptual designs. The regulations required QRA to be performed during the conceptual design phase for all new installations, and required a 10^{-4} cutoff frequency per platform per year as the limit of accidents relevant to define design basis accidents, also known as Design Accidental Events. However, notable changes and improvements have been made since the 1981 regulations. In January of 2004, the Petroleum Safety Authority (PSA) was created, which serves as the authority for technical and operational safety, emergency preparedness, and the environment. Currently, there are five regulations relevant to safety for the design and operation of offshore installations as defined by the Petroleum Safety Authority of Norway. These regulations which pertain to the continental shelf are:[15]

- Framework HSE Regulations (PSA, 2002a)
- Management Regulations (PSA, 2002b)
- Information Duty Regulations (PSA, 2002e)
- Facilities Regulations (PSA, 2002c)
- Activities Regulations (PSA, 2002d)

Framework Regulations:

Framework regulations contain the overall principles which are described further in other regulations. The purpose of the framework regulations is to develop and further improve health, environment and safety for petroleum activities. Of particular importance in these regulations, is the

[14] Det Norske Veritas (DNV) 2010, *OLF/NOFO - Summary of differences between offshore drilling regulations in Norway and U.S. Gulf of Mexico,* Report no/DNV Reg No.: 2010-1220/ 12P3WF5-9

[15] Petroleum Safety Authority Norway, Regulations, Retrieved September 8, 2010. http://www.ptil.no/regulations/category216.html

mention of the Norwegian equivalent of 'as low as reasonably practicable' (ALARP) as outlined in Section 9 of these regulations.

Management Regulations:

Management regulations cover various aspects relating to the management of health, environment, and safety (HES) for petroleum activities. Vinnem outlines the importance of this section by referring to Sections 14 and 15 which are of particular importance relating to major accident risk and QRA. In addition Section 2 covers barriers or defenses and pertains to the design and operation of installations. Section 6 of the regulations, covers risk acceptance criteria, including personnel, main safety functions, pollution and damage to third party groups and facilities.[2]

Information Duty Regulations:

Information duty regulations are regulations pertaining to material and information in petroleum activities. Examples of such regulations are regulations on the preparation of materials and information, as well as the material required to be submitted among others.

Facilities Regulations:

These set of regulations govern the design and outfitting of petroleum facilities. ALARP is referred to in Section 4 of these regulations, which state that facilities must be designed such that the major accident risk becomes as low as practically possible. In addition, Sections 6 and 10 of these regulations which govern the main safety functions and the loads and load effects respectively, necessitate the need for risk assessment.

Activities Regulations:

Activities regulations do not contain any relevant requirements relating to risk assessment and management[2]. However, the use of QRA is implicitly mentioned in the emergency preparedness requirements[15]:

> *"The emergency preparedness shall be established on the basis of results from risk and preparedness analyses as mentioned in the Management Regulations Section 15 on quantitative risk analyses and emergency preparedness analyses and Section 16 on environmentally oriented risk and emergency preparedness analyses, the defined situations of hazard and accident and the performance criteria applicable to the barriers, cf. the Management Regulations Section 2 on barriers."*

There is also mention of the use of ALARP as to the content of oil in water that is discharged. This is mentioned in section 55a *Discharge of oil-contaminated water.*

As mentioned previously, the Norwegian Regulations take a performance based approach towards offshore regulations rather than a prescriptive approach. According to the DNV[14], performance based regulation gives the industry a relatively high degree of freedom to selecting the right solutions that will fulfill regulatory requirements.

The Norwegian Petroleum Safety Authority expresses it views of the two methods by favoring the performance based method in the following statement:[16]

> *"A trend has existed among safety regulators worldwide over the past 20-30 years to move their regimes towards a greater degree of functional-based regulation. This is because the prescriptive approach has often turned out to encourage a passive attitude among the companies. They wait for the regulator to inspect, identify errors or deficiencies and explain how these are to be corrected. As a result, the authorities become in some sense a guarantor that safety in the industry is adequate and take on a responsibility which should actually rest with the companies."*

3 Regulations in the U.S.

3.1 Best Available and Safest Technologies (BAST)

Oil and gas operations conducted on the Outer Continental Shelf (OCS) are managed by the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), a bureau within the United States Department of the Interior (DOI). However, prior to the DOI and BOEMRE, the Outer Continental Shelf Lands Act passed in 1953 placed the responsibility on the U.S. Geological Survey (USGS) to develop, administer and enforce regulations pertaining to safe and environmentally sound drilling operations. The OCS Lands Act Amendments on September 18, 1978 were a result of an effort to increase OCS leasing following the 1973 oil embargo. Congress reviewed the OCS lands act of 1953 and the regulations pertaining to drilling operations, in order to determine their effectiveness and adequacy addressing the technical, environmental, and political issues of drilling operations. One of the noticeable additions to the regulations was recognition of the need for a system to constantly update and review OCS technologies through the use the best available and safest technologies (BAST) in OCS operations.

Section 21(a) of the regulations provides:[17]

> *"Upon the date of enactment of this section, the Secretary and the Secretary of the Department in which the Coast Guard is operating shall, in consultation with each other and, as appropriate, with the heads of other Federal departments and agencies, promptly commence a joint study of the adequacy of existing safety and health regulations and of the technology, equipment, and techniques available for the exploration, development, and production of the minerals of the outer Continental Shelf. The results of such study shall be submitted to the President who shall submit a plan to the Congress of his proposals to promote safety and health in the exploration, development, and production of the minerals of the outer Continental Shelf."*

The requirement for the use of BAST is stated in Section 21(b) of the regulations, which states:

> *"In exercising their respective responsibilities for the artificial islands, installations, and other devices referred to in section 4(a)(1) of this Act, the Secretary, and the Secretary of the Department in which the Coast Guard is operating, shall require, on all new drilling and production operations*

[16] Petroleum Safety Authority (PSA), *From Prescription to Performance In Petroleum Supervision,* Retrieved September 18, 2010. http://www.ptil.no/news/from-prescription-to-performance-in-petroleum-supervisionarticle6696-79.html

[17] U.S. Senate Committee on Environment & Public Works, *Outer Continental Shelf Lands Act*, Retrieved September 18th, 2010. http://epw.senate.gov/ocsla.pdf

and, wherever practicable, on existing operations, the use of the best available and safest technologies which the Secretary determines to be economically feasible, wherever failure of equipment would have a significant effect on safety, health, or the environment, except where the Secretary determines that the incremental benefits are clearly insufficient to justify the incremental costs of utilizing such technologies."

3.2 Definition of BAST

"Best available and safest technologies" (BAST) is a term used to describe a program or system to be implemented into drilling and production operations in the OCS, in order to ensure operations which are safe and environmentally conscious. Rather than providing an exact meaning, the term is used to encourage a program which constantly evolves and takes advantage of the advancements in technology.

Because the BAST program was developed under the authority of the USGS, the fundamental definitions as outlined by the USGS are mentioned in this report, with the addition of updated material as provided by the BOEMRE. According to the USGS,[18] the BAST program consists of the following components:

1. Documentation of the BAST requirement.
2. Application of BAST to OCS operations.
3. Development of Information for BAST determinations.
4. Organization and procedures for the BAST program.

The concept of BAST is broad, and therefore it is necessary to understand what the individual terms mean, and how BAST can be applied. The USGS provides the following definitions for BAST[18]:

Best: It may be expected that "best" means that which would most completely fulfill the composite purpose of the legislation, not necessarily the most expensive or sophisticated.

Available: Discussion concerning the term "available control technology" found in the Federal Water Pollution Control Act Amendments of 1977 indicates that the technology does not have to be in actual use somewhere, but the technology must be available at a cost and at a time which the Administrator determined to be reasonable.

Safest: the foregoing comments about the term "best" also apply to the term "safest". The legislative record indicates only that it means something more than "safe" and the exact meaning would be left to administrative discretion.

Technology (and "Technologies"): It was emphasized that more than one technology may be applicable as the best way to achieve a particular objective or to do a particular job. Hence, the word "technologies" was inserted. There was substantial concern about the anticompetitive and innovation-stifling impacts of designating a single technology, technique, or product as "best" and banning the use of any other.

[18] U.S. Geological Survey (USGS), *The Use Of Best Available And Safest Technologies (BAST) During Drilling And Producing Operations Of The Outer Continental Shelf (OCS): Program for Implementing Section 21 (B) OCS Lands Act Amendments of 1978,* Reston Virginia, April 1980

Further definitions of terms used in section 21(b) of the regulations can found in the USGS document titled *The Use Of Best Available And Safest Technologies (BAST) During Drilling And Producing Operations Of The Outer Continental Shelf (OCS): Program for Implementing Section 21 (B) OCS Lands Act Amendments of 1978*)

The BAST requirement applies to technology, and was not created with the goal of mitigating human errors. The goal of designing and implementing BAST is to ensure a reasonable balance between the economic sacrifices required to achieve the "highest degree" of safety, and the benefits gained as a result. In addition, BAST specifications are intended to target industry operations as a whole or classes of operations, and not individual operations, as stated by the USGS[18]:

> *"BAST was not to be applied installation-by-installation, company-by-company, or lessee-by-lessee. Instead, Agencies were to implement the requirement in a reasonable, discreet manner on an industry wide basis or with respect to classes or categories of operation."*

Given the overall definition of BAST, the USGS documents certain overall principles relating to the BAST requirement. Among these principles, it is included that drilling and production operations in the OCS should use technologies that allow for the safest and most reliable operations, which are cost-effective. The USGS also specifies that the application of technologies refers to the equipment, for which "the government should take the initiative in assuring that new technologies are developed, when deficiencies are detected." [18] Additionally, BAST requirements should be applied such that it recognizes the availability of a technology, as well as the consequences of including or omitting it from the requirements. Finally, public participation should be encouraged in the development of BAST requirements.

3.3 Implementing BAST in OCS Operations

As mentioned previously, according to Section 21(b) of the OCS Lands act, the BOEMRE on behalf of the Secretary of Interior requires the use of best available and safest technologies in offshore drilling and production operations. The BOEMRE has the responsibility of determining the best available and safest technologies, and ensuring that they are applied to offshore drilling and production operations. BOEMRE regulations are largely prescriptive, and many of the regulations are based on the use of safe equipment which can meet the BAST requirement.

In order to continually improve the safety to offshore personnel and the environment, the BOEMRE heavily relies on technologies developed by industry. As the BOEMRE is continually seeking to determine the best available and safest technologies, the bureau has implemented a Technology Assessment and Research (TA&R) Program as part of their safety program in which universities, private firms, and government laboratories are awarded contracts to perform such research. According to the BOEMRE:[19] "the TA&R Program was established in the 1970's to ensure that industry operations on the Outer Continental Shelf incorporated the use of the Best Available and Safest Technologies (BAST) subsequently required through the 1978 OCSLA amendments." The Technology Assessment and Research Program (TA&R) is a research and development program implemented by the BOEMRE regulatory program to promote research

[19] Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) website, *Technology Research and Assessment Program: Introduction*, retrieved September 25, 2010, ref: http://www.boemre.gov/tarsafety/

which mainly concentrates on the safety and pollution aspects of drilling operations, including oil spill response and cleanup capabilities. The TA&R Program has two branches of research activities:

- Operational Safety and Engineering Research (OSER)
- Oil Spill Response Research (OSRR)

The BOEMRE outlines the primary objectives of the TA&R Program as follows:[19]

- Technical Support: Providing engineering support to the Bureau decision makers in evaluating industry operational proposals and related technical issues and ensuring that these proposals comply with applicable regulations, rules, and operational guidelines and standards.

- Technology Assessment: Investigating and assessing industry applications of technological innovations and ensuring that governing the Bureau regulations, rules and operational guidelines encompass the use of the best available and safest technologies.

- Research Catalyst: Promoting leadership in the fields of operational safety and engineering research and oil spill response and cleanup research activities.

- International Regulatory: Providing international cooperation for Research and Development initiatives to enhance the safety of offshore oil and natural gas activities and the development of appropriate regulatory program elements worldwide.

Given the prescriptive nature of BOEMRE regulations, in addition to the BOEMRE's responsibility and efforts to determine the best available and safest technologies, it can be concluded that by following the rules and guidelines set forth by the BOEMRE, BAST can be implemented in OCS operations.

3.4 Safety and Environmental Management Plan (SEMP)

In 1991, the MMS (now BOEMRE) introduced the Safety and Environmental Management Plan, also known as SEMP, as a result of the National Research Council's Marine Board findings, which concluded that that the MMS's approach to regulating offshore operations was too prescriptive, and as a result industry had developed a compliance mentality. Having such a mentality where safety improvement efforts stopped at the lower limit of compliance with regulations was unfavorable. Therefore to effectively identify potential operational risks, and encourage industry to develop more effective and comprehensive accident mitigation methods and systems, it was decided that the MMS needed a more systematic approach to manage and regulate offshore operations. As a result, SEMP was developed by the API in cooperation with the BOEMRE which is known as *Recommended Practice 75 - Development of a Safety and Environmental Management Program for Outer Continental Shelf Operations and Facilities*. The application of SEMP is not mandatory and the BOEMRE has asked operators in the OCS to voluntarily make use of SEMP for their operations as a compliment to their compliance with regulations.

The BOEMRE describes SEMP as "a nontraditional, performance-focused tool for integrating and managing offshore operations. The purpose of SEMP is to enhance the safety and cleanliness of operations by reducing the frequency and severity of accidents."

There are four principle SEMP objectives for the BOEMRE, as stated on their website:[20]

- Focus attention on the influences that human error and poor organizations have on accidents,
- Continuous improvement in the offshore industry's safety and environmental records,
- Encourage the use of performance-based operating practice, and
- Collaborate with industry in efforts that promote the public interests of offshore worker safety and environmental protection.

Finally, SEMP should include methods on how to perform the following tasks:[21]

- Operate and maintain facility equipment,
- Identify and mitigate safety and environmental hazards,
- Change operating equipment, processes, and personnel,
- Respond to and investigate accidents, upsets, and "near misses;"
- Purchase equipment and supplies,
- Work with contractors,
- Train personnel, and
- Review the SEMP to ensure it works and make it better.

Note: On June 17, 2009, the MMS published a set of proposed rules, which would require operators to develop and implement a Safety and Environmental Management System (SEMS) for their operations in the Outer Continental Shelf (OCS).[22] The proposed SEMS system would replace SEMP, and would consist of four elements:

- Hazards Analysis,
- Management of Change,
- Operating Procedures, and
- Mechanical Integrity

MMS proposed that each offshore lessee/operator would be required to develop, implement, maintain, and operate under a SEMS program which included all four elements listed above.[22]

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[20] Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), *SEMP*, Retrieved September 16, 2010, Ref. http://www.boemre.gov/semp/

[21] Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), *What is SEMP?*, Retrieved September 16, 2010. http://www.boemre.gov/semp/what.htm

[22] Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), *Proposed Rules*, Federal Register Vol. 74, No. 115 June 17, 2009, Retrieved September 16, 2010. http://www.boemre.gov/federalregister/PDFs/74FR28639.pdf

Most recently, the SEMS program became mandatory under the Workplace Safety Rule issued by the U.S. Department of interior on September 30, 2010. Further details of the new regulations are mentioned below.

3.5 Recent Regulations

Following the Deepwater Horizon accident, the U.S. Department of Interior issued two new safety regulations known as the Drilling Safety Rule and the Workplace Safety Rule, to improve the safety of drilling operations and the workplace.

According to the U.S. Department of the Interior:[23]

> *"The Drilling Safety Rule, effective immediately upon publication, makes mandatory several requirements for the drilling process that were laid out in Secretary Salazar's May 27th Safety Report to President Obama. The regulation prescribes proper cementing and casing practices and the appropriate use of drilling fluids in order to maintain well bore integrity, the first line of defense against a blowout. The regulation also strengthens oversight of mechanisms designed to shut off the flow of oil and gas, primarily the Blowout Preventer (BOP) and its components, including Remotely Operated Vehicles (ROVs), shear rams and pipe rams. Operators must also secure independent and expert reviews of their well design, construction and flow intervention mechanisms."*
>
> *"The second regulation, known as the Workplace Safety Rule, requires offshore operators to have clear programs in place to identify potential hazards when they drill, clear protocol for addressing those hazards, and strong procedures and risk-reduction strategies for all phases of activity, from well design and construction to operation, maintenance, and decommissioning."*
>
> *"The Workplace Safety Rule requires operators to have a Safety and Environmental Management System (SEMS), which is a comprehensive safety and environmental impact program designed to reduce human and organizational errors as the root cause of work-related accidents and offshore oil spills. The Workplace Safety Rule makes mandatory American Petroleum Institute (API) Recommended Practice 75, which was previously a voluntary program to identify, address and manage safety hazards and environmental impacts in their operations."*

From the descriptions above, it can be seen that the Drilling Safety Requirement implicitly indicates the use of best available and safest technologies (BAST), while the Workplace Safety Case now makes it mandatory for operators to implement SEMS. The BOEM is said to issue additional workplace safety regulations, such as the requirement for third party verification of an operator's SEMS program, in the near future.

[23] U.S. Department of the Interior Press Release, *Salazar Announces Regulations to Strengthen Drilling Safety, Reduce Risk of Human Error on Offshore Oil and Gas Operations,* retrieved October 11, 2010. http://www.doi.gov/news/pressreleases/Salazar-Announces-Regulations-to-Strengthen-Drilling-Safety-Reduce-Risk-of-Human-Error-on-Offshore-Oil-and-Gas-Operations.cfm