Paper #2-7

SAFE AND SUSTAINABLE OFFSHORE OPERATIONS

Prepared by the Offshore Operations Subgroup
of the
Operations & Environment Task Group

On September 15, 2011, The National Petroleum Council (NPC) in approving its report, *Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Task Groups and/or Subgroups. These Topic and White Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic and White Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 57 such working documents used in the study analyses. Also included is a roster of the Subgroup that developed or submitted this paper. Appendix C of the final NPC report provides a complete list of the 57 Topic and White Papers and an abstract for each. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

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North American

Resource Development

Prudent Development of North American

Natural Gas and Oil Resources:

Safe and Sustainable Offshore Operations

Findings and Recommendations of the

Offshore Operations Sub-Group

Operations & Environment Task Group

National Petroleum Council

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EXECUTIVE SUMMARY

The Outer Continental Shelf (OCS) Lands Act allows for mineral rights to be granted on federal submerged lands to explore, develop, and produce oil and/or natural gas. Following the leasing process, offshore oil and gas developments involve four phases with each phase encompassing multiple core topic areas requiring specialized technical knowledge and skills necessary for these offshore operations to occur.

The four development phases comprise (a) Pre-Development Phase (Exploration); (b) Development Phase (Design, Construct); (c) Production Phase (Operations); and (d) Divestiture Phase (De-Commissioning). The seven core topics include (1) Environmental Footprints and Regulatory Reviews; (2) Environmental Management of Seismic and Other Geophysical Exploration Work; (3) Subsea Drilling, Well Operations and Completions; (4) Well-Control Management and Response; (5) Offshore Production Facilities and Pipelines (including specific Arctic designs); (6) Offshore Transportation; and (7) Data Management.

The complex regulatory processes that affect offshore developments involve at least nine federal statutes and just as many different federal agencies. Before the Gulf of Mexico *Deepwater Horizon* drilling accident and associated Macondo well blowout of 2010, the Minerals Management Service (MMS) -- now replaced by the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) -- and the US Coast Guard (USCG) were the two key agencies involved in regulating all OCS development phases. Other Federal agencies included US Department of Transportation (DOT); Environmental Protection Agency (EPA); National Oceanic and Atmospheric Administration (NOAA); National Marine Fisheries Service (NMFS); Federal Energy Regulatory Commission (FERC); US Fish and Wildlife Service (USFWS); and the US Army Corps of Engineers (USACE). Post-Macondo, the same agencies are expected to remain involved but with MMS replaced by at least two new agencies derived from BOEMRE: Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE).

The anticipated, ongoing regulatory complexities will perpetuate challenges to effective offshore resource development. Therefore, it is appropriate and timely that recommendations from the National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling (January 2011) included advocacy of better coordination among Federal government agencies that regulate offshore developments. Further improvements would be expected through industry participation, including joint industry programs, to develop standards and best practices.

Development of offshore oil and gas resources involves technological and policy considerations that distinguish the offshore from onshore planning themes:

- Complexity of overlapping statutes and regulatory agencies.
- The emerging concept of ocean resource management as a broad multi-use spatial planning challenge.
- Environmental rigors of subsea operations, including pipeline integrity.

- Challenging offshore conditions such as in the Arctic and deepwater developments.

To be effective, national policies and plans for hydrocarbon resource developments must recognize and accommodate those four themes with regard to the following findings:

Major Findings for Prudent Hydrocarbon Resource Development	Key Findings Specific to Offshore Developments
1. Prudent development of natural gas contributes to a clean energy economy.	• Natural gas will continue to be either a targeted or an associated product of offshore oil and gas development.
2. As technology and resource development matures, so does our understanding, continuous improvement and mitigation of risk.	• Seismic methods will continue to be the primary geophysical tool used to discover, evaluate and enable responsible production of offshore oil and gas resources but additional technological refinement can supplement current seismic acquisition & mitigation methods. • Seismic noise is recognized as a concern for whale populations and other marine life, including fish. • Pipelines have proven to be the safest, most reliable, economical and environmentally favorable way to transport oil and gas throughout the U.S. The aging of the pipeline infrastructure suggests that continual improvement in system integrity, monitoring, and leak-detection is necessary. • Decommissioning offshore platforms includes beneficial options such as "Rigs to Reefs" that have been underutilized.
3. Pre-development planning and new technologies will minimize the risks in developing highly sensitive areas and frontier resources plays.	• Scientific understanding of environmental conditions in sensitive environments in deep Gulf waters, along the regions' coastal habitats, and in areas proposed for more drilling, such as the Arctic, must be enhanced to meet the expectations of stakeholders. • Oil-spill response (OSR) includes multiple methods/tools such as: (1) oil sensing and tracking; (2) dispersants; (3) in-situ burning; (4) mechanical recovery; and (5) shoreline protection and clean-up. These methods/tools must be properly developed, available, and pre-approved to effectively respond to a large event. • Improvements are needed in predictive capabilities of drilling abnormalities.

Major Findings for Prudent Hydrocarbon Resource Development	Key Findings Specific to Offshore Developments
4. Broad systems within the industry must work together for prudent development.	• The explosive loss of the Macondo well placed in doubt the safety culture of the entire industry. • Because regulatory oversight alone will not be sufficient to ensure adequate safety, the oil and gas industry will need to take its own, unilateral steps to increase dramatically safety throughout the industry, including self policing. • The multiplicity of US government regulatory agencies involved in setting data reporting requirements has led to inefficiencies. • Many of the oil and gas data-management issues identified previously (US Department of Energy [DOE], 2004) remain unresolved and problematical today.
5. Balanced and optimized regulatory process is critical to prudent development of resources.	• The oil spill financial liability limit in the OPA '90 for environmental damages and third-party claims is too low, as revealed by the Macondo well incident, and must be revised. • The Federal government ESA policy has restricted oil and gas development both onshore and offshore. • Air emissions from offshore production facilities include several different combustion, venting, and flaring sources. These have been found to not significantly affect coastal areas but should continue to be monitored to ensure this does not change. DOI/BOEM have a good system of permitting air emissions from offshore platforms that is protective of onshore air quality and has made significant progress in reducing natural gas (methane) venting emissions. • To assure human safety and environmental protection, regulatory oversight of leasing, offshore energy exploration and production require significant reforms. The DOI has put in place those reforms needed for deepwater drilling to commence. • Conflicting statutory mandates make it difficult to achieve a balanced and predictable federal offshore policy. • Federal regulatory agencies lack technical expertise to oversee complex technical systems and operations.

Major Findings for Prudent Hydrocarbon Resource Development	Key Findings Specific to Offshore Developments
6. Redefined and enhanced partnership between regulator, regulated and stakeholder groups is necessary to enable prudent development.	• BOEMRE changed its review policies under the National Environmental Policy Act (NEPA) to limit the use of categorical exclusions (CE). The preparation of more time consuming environmental documents has stalled operations in the Gulf of Mexico with no commensurate environmental or safety protections.

The findings presented here were developed through independent research and analysis. Nonetheless, they bear some similarities with, and are complementary to, findings from external studies focused on the *Deepwater Horizon* incident and the associated Macondo well blowout. Those external studies, which include but are not limited to the January 2011 report of the Presidential Oil Spill Commission, share common threads in finding that the *Deepwater Horizon* incident resulted from a combination of failures in equipment (including the subsea BOP), procedures and overall risk management by the operators and their partner companies – plus ineffective regulatory oversight. In that context, those external findings generally align with findings reported in this study that are aimed at prudent offshore operations. Specifically, the current report finds that key aims for sustainable future offshore operations must include better coordination among regulatory agencies and attention to honing best practices both in equipment and operational risk management.

STUDY OBJECTIVES

A. Offshore Developments within the Framework of Key Questions

DOE Secretary Steven Chu's letter of September 2009, which led the National Petroleum Council (NPC) to initiate a study on North American Natural Gas and Oil Resources, included the following point of emphasis in his request to the NPC:

> "Your study should describe the operating practices and technologies that will be used to minimize environmental impacts, and also describe the role of technology in expanding accessible resources. Of particular interest is the Council's advice on policy options that would allow prudent development of North American natural gas and oil resources consistent with government objectives of environmental protection, economic growth, and national security." (Chu, 2009).

The current report comprises one of the Operations & Environment Task Group (OETG) assignments (Appendix 2) within the larger NPC study. This report is focused on offshore development of hydrocarbon resources within the context of the following five framing questions identified by the OETG:

- What is the environmental footprint of upstream and midstream natural gas and oil operations, including greenhouse gas (GHG) emissions, compared to other energy sources?
- What is the evolution of environmental improvements in operating practices and technologies used across the range of resource plays and regional differences?
- What technological and operational advances are on the horizon to improve efficiency and environmental performance in offshore and onshore operations?
- What sustainable development principles and practices will enhance and demonstrate North American environmental leadership into the future?
- What is the environmental and regulatory framework for growth and development of North American natural gas and oil resources?

B. Additional Considerations Related to the Macondo Well Blowout of 2010

Less than one year after Secretary Chu's 2009 request, an offshore accident in the Gulf of Mexico (GOM) created an additional, imperative dimension to the review of offshore oil and gas technologies and policies. On April 20, 2010, during drilling of an oil well in the deep water of the GOM, an uncontrolled kickback of natural gas led to an explosion and fire on the *Deepwater Horizon* drilling rig with subsequent loss of 11 lives, sinking of the rig and, over the next three months, the release of approximately five million barrels of crude oil from the out-of-control Macondo well (Presidential Oil Spill Commission, 2011).

BP Plc. was the offshore lease holder, majority partner and managing operator of the Macondo project and conducted its own review of the accident (Bly Report, 2010). But two other independent investigations also were conducted. First, based on the prevailing regulatory authorities for GOM offshore operations, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) and the US Coast Guard (USCG) convened a Joint Investigation Team (JIT) with emphasis on technical and operational matters, including forensic analysis of the blowout preventer (BOP) recovered from the Macondo wellhead (JIT, 2010). As of March 2011, the JIT work is still in progress. Second, President Barack Obama convened a separate panel of experts to review the accident from a broader perspective that included the role of offshore oil drilling in domestic energy policy and the regulatory oversight of offshore drilling. The commission issued its report in January 2011 (Presidential Oil Spill Commission, 2011).

Although Secretary Chu's request to the NPC was distinct from the Presidential Commission's charter, there are significant areas of topical overlap regarding best practices in the offshore technological and regulatory arenas. Appendix 3 of this report summarizes external findings to date about the Macondo well blowout and provides additional context for the findings presented here as part of the OETG analyses, as well as potential responses the NPC may want to consider to the commission recommendations. The Presidential Oil Spill Commission (2011) made recommendations that are briefly reviewed in Appendix 3 and that are referenced through the remainder of the current report.

C. Synthesis of Core Topic Studies and Development Phases

Figure 1 identifies the relationships among the seven core topics that were analyzed individually by teams of subject-matter specialists to provide the substance of the results presented in this report. Each analysis was documented as a separate topic paper (Appendix 4) so that the collection covers all aspects of exploring for subsea oil and natural gas, constructing wells needed to recover those resources and operation of the wells in production mode.

Figure 1. Relationships Among Core Topics in Offshore Oil and Gas Developments.

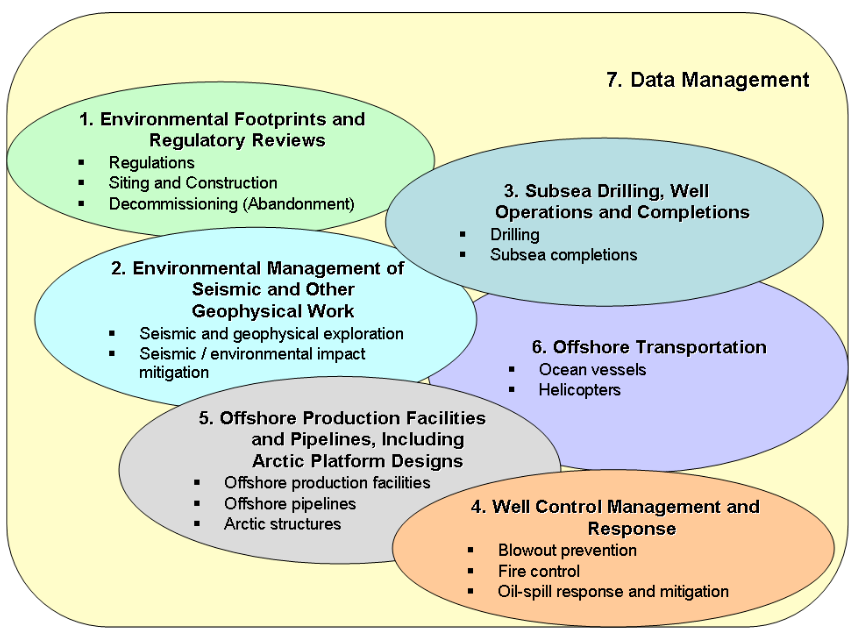


Figure 1 shows interconnectedness of all topical areas but with particular overlaps among some areas. “Data Management” wholly overlaps with all other topics.

Offshore oil and gas developments are separable into the following four consecutive phases:

- Pre-Development Phase (Exploration)
- Development Phase (Design, Construct)
- Production Phase (Operations)
- Divestiture Phase (De-Commissioning)

Each of those four phases interacts to some degree, although not equally, with each of the seven core topic areas (Fig. 1). For example, “Subsea Drilling, Well Operations and Completions” comprises activities mainly in the Development Phase and the Production Phase whereas “Environmental Management of Seismic and Other Geophysical Work” is almost totally within the Pre-Development Phase. However, “Environmental Footprints and Regulatory Reviews” and “Data Management” occupy important places in each of the four development phases.

Historically, a multitude of different US government regulatory agencies have held authority for each development phase although the mix of authorities has differed by phase. Furthermore, each agency has differed in its capability and focus on different topical areas. As a result, the regulatory landscape has been complex and uneven with regard to the topical expertise associated with permitting rules and approvals pertaining to offshore oil and gas developments.

This report highlights current technologies and practices in each of the core topics as well as forward-looking prospects for improvements in corresponding development phases. Safety and environmental sustainability are featured considerations as are technological and regulatory barriers and challenges. This report is not a primer on the oil and gas industries or a tutorial on the basic technologies; that information is readily available in public literature (for example, PETEX, 1998). Instead, emphasis is on safe and sustainable offshore oil and gas operations.

D. Special Considerations in Planning Future Offshore Developments

Development of offshore oil and gas resources involves several technological and policy considerations that distinguish the offshore from onshore planning themes:

- Complexity of overlapping statutes and regulatory agencies.
- Ocean management as a broad multi-use spatial planning challenge.
- Environmental rigors of subsea operations, including pipeline integrity.
- Arctic offshore developments.

National policies and plans for hydrocarbon resource developments must recognize and accommodate those four themes which are referenced repeatedly in this report.

OFFSHORE SAFETY AND ENVIRONMENTAL SUSTAINAB ILITY

A. Hazard Prevention, Detection, Mitigation and Recovery

Any technological endeavor involves risk and there are risks associated with developing offshore oil and gas resources. The benefits of development are the assured supplies of reliable energy while the costs are the provisions and expenses involved in recovering those resources in a safe and environmentally responsible way. Restoring public confidence after the Macondo well blowout will require demonstration that the offshore oil and gas industry has effectively managed and reduced potential risks through the integration of these key planning requirements for hazards management:

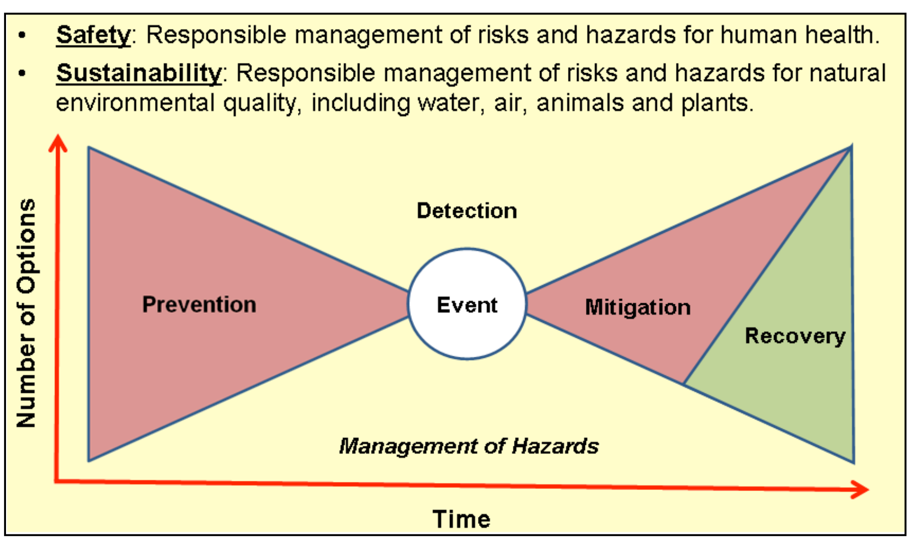
- Prevention (P). Pre-emptive measures to reduce the likelihood of a hazardous event.
- Detection (D). Early identification of a hazardous event.
- Mitigation (M). Effective measures to arrest and control a hazardous event.
- Recovery (R). Restoring normalcy after a hazardous event.

Each of the many complex activities needed to develop offshore energy resources must identify and incorporate appropriate safety-sustainability elements into plans and procedures.

B. Mapping Offshore Work Activities to Safety-Sustainability Elements

Development of offshore oil and gas resources requires that dozens of processes must be completed in concert with each other – each one mapped onto the four safety-sustainability elements to assure that no considerations are overlooked. Figure 2 defines the general safety-sustainability framework.

Figure 2. The safety and sustainability "bowtie" model featuring the P-D-M-R elements.



Every operation, and the supporting regulatory framework, must be mapped stepwise through the P-D-M-R classifications and, at the project level, every P, D, M or R consideration must be clearly visible in the integrated project plan. Furthermore, each accommodation should be clearly identified regarding its purpose relative to a safety or environmental-quality concern.

As shown graphically (Fig. 2), optionality through time takes the shape of a "bowtie". Early planning for prevention of hazardous events offers the largest numbers of options. During the crisis atmosphere of an event, options are reduced as urgency overtakes systematic analysis, planning and thought. Options become more abundant again only long after the event and as the latter stages of the recovery mode lead to detailed retrospectives and root-cause analysis. The P-D-M-R approach to safety and environmental sustainability is to plan early and plan thoroughly for every project. This is the concept behind the American Petroleum Institute (API) Recommended Practice (RP) 75, "Development of a Safety and Environmental Management Program for Offshore Operations and Facilities", which was made mandatory by BOEMRE in a final rule published in October 2010 (75 FR 63610).

Table 1 summarizes one view of how the safety-sustainability elements are incorporated into risk management. P-D-M-R safety-sustainability elements will likely receive different relative proportions of emphasis within different offshore activities, depending on precisely which hazards are being managed.

Table 1. Safety-Sustainability Elements of Emphasis in Different Offshore Operations.

Offshore Operational Topic Area	Safety-Sustainability in Offshore Development: Planning Emphasis P= Prevention, D = Detection, M = Mitigation, R = Recovery			
	Human Health & Safety (Immediate)	Disturbance of Marine Mammals & Fish	Oil & Gas Spills into Marine Environment	Other Pollutant Releases into Air or Water
1. Environmental Footprints and Regulatory Reviews	P, M	P, D, M, R	P, D, M, R	P, D, M, R
2. Environmental Management of Seismic and Other Geophysical Exploration Work	P, D, M	P, D, M	P, D, M, R	P, D, M, R
3. Subsea Drilling, Well Operations and Completions	P, D, M, R	P, M	P, D, M, R	P, D, M, R
4. Well-Control Management and Response	P, D, M, R	P, M	P, D, M, R	P, D, M, R
5. Offshore Production Facilities and Pipelines, Including Arctic Platform Designs	P, D, M, R	P, M	P, D, M, R	P, D, M, R
6. Offshore Transportation	P, D, M, R	P, M	P, D, M, R	P, D, M, R
7. Data Management	P, D	P, D, M	P, D, M	P, D, M

All offshore operational activities must include planning for the Prevention (P) of hazards although not all combinations of activities and issues would necessarily require Recovery (R). Accordingly, Table 1 suggests different combinations of P-D-M-R emphasis for different intersections of the seven topical areas and the four hazard categories. For example, core topic 7 (Data Management) enables the dissemination of essential information used in oil-spill planning, recovery and restoration operations but data management alone cannot implement hazard Recovery measures. Field work required for Recovery from an oil-spill hazard remains the purview of core topic 4 (Well Control Management and Response). Therefore, Table 1 suggests an “R” for Well-Control Management and Response under the “Oil & Gas Spills into Marine Environment” but not so for Data Management.

Comprehensive planning for safety and sustainability of every offshore operation should include explicit consideration of each of the P-D-M-R elements and documentation of how each one is accommodated. Documentation should further include explanation of whether and why any of the four elements is de-emphasized. Toward that end, there will be a need for a standardized and rigorous process for reviewing and documenting the four elements in every operating plan.

C. An Offshore Safety Institute

To realize the intended benefits of P-D-M-R mapping into development plans, a credible infrastructure is needed to assure that effective planning tools are available and that operators accept and demonstrate accountability. The Presidential Oil Spill Commission (2011) endorsed the role of a new Ocean Energy Safety Institute within the DOI (Presidential Oil Spill Commission, 2011, p. 272) but separately called upon industry by stating:

> ”Like the nuclear power industry in 1979 -- in the immediate aftermath of the Three Mile Island accident -- the nation’s oil and gas industry needs now to embrace the potential for an industry safety institute to supplement government oversight of industry operations.” (Presidential Oil Spill Commission, 2011, p. 241)

After an intensive industry-led study, which included review of five other safety programs, including the UK’s Step Change in Safety, the chemical industry’s Responsible Care® program, the Institute for Nuclear Power Operations, the Occupational Safety and Health Administration (OSHA) Voluntary Protection Program, and the Safety Case Regime for international operators, API (2011) announced formation of a Center for Offshore Safety (COS) to be based upon API RP75 (2004). The COS will be administered by the separately-funded standards and certification arm of the API and will be open to all companies exploring and producing oil and natural gas in deep water.

Therefore, it is likely that future implementation of the P-D-M-R methodology, or a closely related methodology, will be a shared responsibility of the DOI Ocean Energy Safety Institute and the API COS.

PRACTITIONER VIEW OF SUSTAINABLE OFFSHORE OPERATIONS

Practitioners are people who do the work. Work sometimes is planned or permitted by non-practitioners although it remains the practitioners who must perform tasks in the field and who become the centers of attention if a hazardous event occurs. To assure the most reasonable and effective synergy of technology and policy, it is important to incorporate inputs from practitioners.

For each of the seven core topics in offshore oil and gas development, the following paragraphs summarize a practitioner-oriented view of the main issues affecting the interface of technology with policy. Additional details are provided in the individual topic papers (Appendix 4).

A. Environmental Footprints and Regulatory Reviews

An environmental footprint is a measurement of how a human activity modifies the air, water or land within its radius of influence. Unlike a "carbon footprint", which is an amount of carbon dioxide (or its greenhouse-gas equivalent) added to Earth's global atmosphere per year by a particular enterprise – usually with little importance attached to the exact source location -- an environmental footprint can include focused attention on physical effects at specific geographic locations. In the context of offshore oil and gas development, the environmental footprint is regarded as the spatial extent of exploration and production activities as perceptible modifications to the sea bottom or sea surface as well as any quality-related influence on air, water or marine ecology. Each phase of development, and each facility that is constructed, can be regarded as establishing an individual environmental footprint and the overall suite of activities can be regarded as establishing a collective footprint. It is intuitively granted that small footprints are better than large footprints although there is a conspicuous absence of standardized methods for defining or objectively intercomparing the environmental footprints of energy-related enterprises.

Three main technologies have been developed to reduce the amount and surface extent of the infrastructures needed to produce subsea hydrocarbon resources. First, extended-reach and horizontal drilling means that more wells can be drilled using lateral boreholes from each vertical borehole, which allows for greater hydrocarbon production with fewer facilities and a smaller environmental footprint. Second, unmanned satellite production systems, which contain wellhead and manifold systems with no or only minimal processing facilities are being utilized to develop smaller fields or sections of larger fields. The production from those satellite facilities flows to a central facility where the produced fluids are processed. Satellite facilities can either be installed on small platform structures or on the seafloor. This satellite/central facility concept eliminates the need for multiple, larger production facilities. Third, floating production systems typically are used in deep water and in conjunction with subsea production or satellite systems. Since fixed structures are not utilized, these systems have the added advantage of being easily removed at the end of the field development

Minimizing and managing environmental footprints is the shared purview of technology and regulations. Prudent development of offshore oil and gas resources requires effective management and safe operation of systems in conjunction with a coordinated regulatory process that can quickly adjust to changing technological capabilities and environmental conditions. Overall vitality of OCS resource development process can be affected as much by inertia in the regulatory arena as by stagnation in the technology

The Federal government's role in managing environmental footprints associated with the extraction of offshore oil and gas resources encompasses many steps that can span several decades starting with pre-lease geological and geophysical surveys; then continuing into leasing, exploration, development, and production; and finally ending with abandonment and decommissioning. Even after replacement of the MMS by BOEMRE/BOEM/BSEE, leadership of the overall management is expected to remain within the DOI, which is the Cabinet-level agency ultimately responsible for those MMS- and BOEMRE-derived regulatory authorities.

(1) Complexity of Overlapping Statutes and Regulatory Agencies

Table 2 summarizes the intricate confluence of federal statutes and regulatory agencies that affect offshore oil and gas developments. The complex regulatory processes involve at least nine (9) federal statutes and just as many different federal agencies. Before the Macondo well blowout of 2010, the Minerals Management Service (MMS) – now replaced by the Bureau of Ocean Energy, Management and Enforcement (BOEMRE) -- and the US Coast Guard (USCG) were the two key agencies involved in regulation of all offshore development phases. The MMS issued the large majority of permits while the USCG focused on safety topics that included inspection and transportation plans for vessels. The Environmental Protection Agency (EPA) was involved in review of environmental impact statements and also in issuance of water-discharge and air-emission permits for eastern GOM locations.

After the Macondo blowout and oil spill, MMS was replaced (June 2010) by BOEMRE which, in turn, was subdivided (January 2011) into the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE). Presumably, the roles formerly played by MMS in Table 2 will be divided between the BOEM and BSEE although it is not yet clear how roles played by other agencies might be affected. In any case, the current post-Macondo outlook for offshore regulations does not make Table 2 any simpler and the complex and overlapping regulatory purviews can be expected to continue.

One major problem faced by BOEMRE that will be difficult to change under any reorganization, is the conflicting goals of OCSLA and other federal statutes. Table 3 provides current examples of these conflicting issues. At the minimum, clarifications are needed for certain overlapping authorities and responsibilities among the BOEMRE, USCG, DOI and DOT. In addition, clarifications would be useful with regard to division of responsibilities and authorities for offshore air-emission regulations. Regulation of air emission from offshore activities should be a BOEMRE function and not an EPA function in all areas of the OCS.

Table 2. US Government Agencies Involved in Offshore Oil and Gas Regulations.

Regulatory Authority (1)	**Federal Statute (2)**	**Offshore Oil and Gas Project Phase**			
		Pre-Development Phase (Exploration)	Development Phase (Design, Construct)	Produce Phase (Operations)	Divestiture Phase (De-Commissioning)
Bureau of Ocean Energy, Management and Enforcement (BOEMRE)[1]	OCSLA, NEPA, NFEA, CAA, NHPA	□	□	□	□
US Coast Guard (USCG)	OPA, PWSA	□	□	□	□
US Department of Transportation (DOT)	HMTA			□	
Environmental Protection Agency (EPA)	CWA, CAA, RCRA	□	□	□	□
National Oceanic and Atmospheric Administration (NOAA)	CZMA	□		□	
NOAA National Marine Fisheries Service (NMFS)	MMPA, ESA, MFC	□		□	□
Federal Energy Regulatory Commission (FERC)	NGPA			□	
US Fish and Wildlife Service (USFWS)	ESA	□		□	□
US Army Corps of Engineers (USACE)	CWA, RHA			□	

(1) BOEMRE replaced the Minerals Management Service (MMS) in June 2010. BOEMRE further was divided (January 2011) into two other agencies: Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE).

(2) Key to Federal Statutes:

CAA	Clean Air Act
CWA	Clean Water Act (also known as the Federal Water Pollution Control Act)
CZMA	Coastal Zone Management Act
ESA	Endangered Species Act
NHPA	National Historic Preservation Act
HMTA	Hazardous Material Transportation Act
MFC	Magnuson-Stevens Fishery Conservation and Management Act
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NFEA	National Fishing Enhancement Act
NGPA	Natural Gas Policy Act
OCSLA	Outer Continental Shelf Lands Act
OPA	Oil Pollution Act
RHA	Rivers and Harbors Act

Table 3. Examples of Conflicting Goals Between BOEMRE and Other Agencies.

Examples of Conflicting Goals	Purpose or Issue	BOEMRE Regulatory Authorities
MOU between MMS* / BOEMRE and USCG (January 15, 1999)	Identifies the division of responsibilities and communication process for these two agencies. Annex 1 of the MOU includes a responsibility matrix for systems and sub systems related to Mobile Offshore Drilling Units	30 CFR Part 250
Notice to Lessees (NTL) No. 2009-N11 (December 4, 2009)	This NTL clarifies air quality jurisdiction on the OCS in the Gulf of Mexico. However, timing of EPA approvals of air emissions is a prolonged process in Alaska. The timing should better coincide with the BOEMRE permit and plan approval process.	30 CFR 250.302, 303 and 304.
Memorandum of Understanding between DOI and DOT (August 17, 1998).	Implements the regulation of OCS pipelines. BOEMRE regulations apply to all OCS oil or gas pipelines located upstream of the points at which operating responsibility for the pipelines transfers from a producing operator to a transporting operator.	30 CFR Part 250
USCG and BOEMRE	Certain security procedures limit BOEMRE's ability to conduct unannounced inspections	30 CFR Part 250

* In June 2010, MMS was replaced by the Bureau of Ocean Energy, Management and Enforcement (BOEMRE) which was further subdivided later into two other agencies: Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE).

To provide checks and balances in its regulatory program, DOI and other agencies have the opportunity to review and comment on proposed rules and the 5-Year OCS Leasing Program. There are existing Memoranda of Understanding (MOUs) and Memoranda of Agreements (MOAs) with other agencies (e.g., USCG, FWS, DOE, and DOT), with states, and with other countries to accomplish this. DOI is also held accountable to the White House, and Congress via multiple avenues such as: (a) the 5-Year OCS Program's planning documents and press releases on specific lease sales, (b) Forms that are submitted to the House, Senate and the Government Accountability Office alerting them of imminent final rules, (c) Information Collection packages (new and updates) that are submitted to the Office of Management and Budget for approval and that provide cost and hour burdens of new and existing rules, (d) An annual publication notice in the Federal Register listing civil penalties, and (e) Annual appropriation reports to Congress on the agency's performance over the past year and its future goals.

The USCG regulates certain activities of mobile offshore drilling units (MODUs) and floating installations operating on the GOM. The USCG also oversees the safety of systems at the platform level of a MODU, as opposed to the sub-platform drilling and production systems overseen by the BOEM/BSEE. Both DOI and USCG recognize that inspections represent only one tool for ensuring safety and that positive inspection results do not guarantee desired performance outcomes. Nonetheless, inspectors are an important line of defense for promoting safety and environmental protection for offshore oil and gas development.

(2) Prescriptive and Performance-Based Approaches to Offshore Regulations

The desired regulatory approach is to effectively minimize injuries, fatalities, accidents, fires, explosions, collisions, pollution incidents, or damage to the marine environment with respect to all oil and gas operations on the OCS. The regulatory approach also needs to ensure that the respective agency can promptly and thoroughly respond when innovative approaches are developed or when there are technological and environmental changes.

There are two ways to achieve these goals, which can be categorized as either "prescriptive" or "performance-based." These are not mutually exclusive concepts but rather two methods that can be used together in a balanced way to achieve the desired outcomes related to safety, environmental protection, economic growth and national security.

Prescriptive regulations are those that define the minimum requirements to permit an activity. In a complex technically evolving industry, however, these can quickly become outdated and restrictive and make it difficult for industry to propose alternative approaches that can best meet technological or environmental conditions. An effective approach also demands continued growth in regulations because changes in technology will necessitate changes to the regulatory requirements. These changes may lead to inefficiencies in permitting, which also corresponds to significant time to process applications for permits, and greater use of government resources.

It is possible for industry to demonstrate that performance-based regulations can increase the current level of safety and environmental protection. The performance-based approach provides for open access to the best available technologies as long as the operator demonstrates achievement of the required performance. That would also improve the efficiency of the current prescriptive regulatory system by making it more responsive to innovative approaches and technological and environmental changes.

Improved regulatory processes in the US can usefully learn from experiences of other countries. Norway's initial experience with prescriptive regulations was not successful as it hindered new technology, kept the regulators behind the industry on the technology curve, and constantly updating prescriptive regulations proved too burdensome to the agency. Norway has moved to a more performance-based approach as a means to ensure industry keeps up with technological advances. The government initiated a two-year study to assess the program and the results appear positive. The same is true for the approach taken by Britain's regulatory entity, the Health and Safety Executive (HSE), following the *Piper Alpha* incident in the North Sea (July 1988) in which an offshore oil production platform exploded and burned with the loss of 167 lives. Canada is moving in a similar direction. Australia has a performance-based approach whereby operations must submit and justify detailed safety plans. Each of those countries has a rigorous monitoring and inspection program to ensure adherence to approved standards.

(3) Coastal Marine Spatial Planning

On July 19, 2010, President Obama signed an Executive Order that led to the creation of a National Policy for the Stewardship of the Ocean, our Coasts, and the Great Lakes. The policy will be guided by the National Ocean Council (NOC), which has been formed and met for the first time in November 2010. NOC has begun developing the draft strategic action plans and these are expected to be released to the public by summer 2011. These plans will address the nine priority objectives that relate to the most pressing challenges facing the ocean, coasts and Great Lakes. One of the priority objectives is for Coastal and Marine Spatial Planning (CMSP).

Coastal marine spatial planning is an integrated ecosystem-based management strategy with the goal of maintaining the marine ecosystem in a healthy, productive and resilient condition. The intent of CMSP is to identify areas most suitable for various types or classes of activities to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives. The National Ocean Policy states that one of the guiding principles of CMSP is for multiple existing uses (e.g., commercial fishing, recreational fishing and boating, subsistence uses, marine transportation, sand and gravel mining, and oil and gas operations) and emerging uses (e.g., offshore renewable energy and aquaculture) to be managed in a manner that enhances compatibility among uses and with sustained ecosystem functions and services, provides for public access, and increases certainty and predictability for economic investments.

The creation of and strict adherence to "planning or systematic zoning areas" in the ocean environment that preclude oil and gas development could constrain the search for new offshore hydrocarbon resources and limit overall energy development.

Access to offshore areas is needed because the remaining oil and natural gas prospects – particularly larger fields – are likely to be located offshore. The majority of US domestic production, however, consists of modest amounts produced from hundreds of thousands of wells in thousands of onshore and offshore oil and gas fields. The nation's long-term energy security, therefore, depends upon a diversity of supply sources as well as a constant supply of new discoveries to replace declining production from existing and end-of-life wells to meet our growing demand for energy.

(4) Arctic Scientific Knowledge Sufficient to Inform Arctic Regulations

The compilation by Westlien (2010) documented scientific knowledge of the Arctic Ocean surrounding Alaska that has accrued through studies dating from 1900 through 2010. Over the last one hundred years, scientists, using ever-advancing technology, have refined our knowledge of the Arctic resulting in a detailed understanding of the physical environment, biological resources, various ecosystem processes, as well as its human inhabitants. The BOEMRE Environmental Studies Program Information System (ESPIS) contains 700 technical summaries of BOEMRE sponsored environmental research projects as well as over 2,000 entries for research reports, studies, workshops and seminars for Alaska. In addition to BOEMRE supported studies, other Federal agencies and organizations conducting science programs with implications for the Arctic marine ecosystem include the BLM, DOD, EPA, NASA, NOAA, NPS, and Marine Mammal Commission. These government programs are further enhanced by industry supported science, as well as international programs like the Russian-American Long-Term Census of the Arctic.

The Presidential Oil Spill Commission (2011) recognized that significant scientific knowledge exists for Arctic regions and supported the proposition that Arctic oil and gas developments should be qualified on individual merit. Specifically, it was stated that:

> "The existing gaps in data also support an approach that distinguishes in leasing decisions between those areas where information exists and those where it does not, as well as where response capability may be less and the related environmental risks may therefore be greater. The need for additional research should not be used as a de facto moratorium on activity in the Arctic, but instead should be carried out with specific timeframes in mind in order to inform the decision-making process." (Presidential Oil Spill Commission, 2011, p. 303)

Despite some assumptions to the contrary, the case can be made that the scientific data currently available are more than adequate and complete to identify, assess and minimize the potential impacts of limited offshore oil and gas operations of the types previously proposed for the Beaufort Sea and the Chukchi Sea. The Ocean Research and Resources Advisory Panel, a collaborative group consisting of government agencies, academia, non-governmental organizations and the private sector, found that knowledge of the Arctic Ocean has further increased in recent years through additional efforts of the Department of Defense (Navy), the National Research Council, the CIA-funded MEDEA project (an information-sharing program to declassify certain information gathered for military intelligence purposes to be used for science) and other US government activities that have not been widely publicized (ORRAP, 2010).

Although there are ample opportunities to add valuable knowledge through selected studies, the currently available physical and biological science studies from the many scientific research programs have been incorporated into numerous impact assessments conducted to assess the potential negative impact and positive benefit of oil and gas exploration activities in the US Arctic. It is sufficient to support meaningful risk assessments needed to proceed with permitting exploration plans, and developing oil-spill planning and response that include all P-D-M-R elements of the safety-sustainability model.

B. Environmental Management of Seismic and Other Geophysical Exploration Work

(1) Efforts to Reduce Environmental Impacts of Seismic Exploration

Offshore exploration for oil and gas resources employs sound-producing methods, including sonar and seismic techniques. Geophysical prospecting relies heavily on seismic techniques in which sound waves penetrate through, and are reflected from, sub-surface geologic structures and rock units. For discovering, evaluating and producing offshore oil and gas, there are no realistic alternatives to seismic exploration although there are possibilities to further refine and improve specific seismic techniques.

Sound generated from offshore seismic exploration is acknowledged as a potential impact on marine mammals, such as whales and dolphins. The scientific understanding of the potential impacts of anthropogenic sound has expanded significantly in the last two decades as the issue has gained public attention and research prioritization, but important gaps in knowledge still exist. Potential impacts include behavioral changes, masking, auditory injury, physical injury, and stranding and other indirect effects.

There are two primary but distinct issues with regard to fish and seismic surveys. One is the potential for a seismic source to affect fish physically, auditorily, or behaviorally, which in turn could create a significant biological impact. The other issue is commercial in nature, meaning the potential for seismic surveys to impact the catch rate for fishermen.

The US is one of seven countries (also including Australia, Brazil, Canada, Ireland, New Zealand and United Kingdom) that already have national guidelines which require mitigation measures during marine seismic surveys to reduce the potential impacts of seismic sources on marine life. Although formal international requirements do not exist, those seven nations participate in conferences that enable sharing of information. During seismic operations, a primary mitigation is the animals' natural avoidance of the fully operational sound source. In the US and in most of the other countries which have guidelines, the two most commonly used mitigation measures involve (1) visually observing a "monitoring zone" around the array and temporarily suspending seismic activities when a protected species is detected within the zone; and (2) gradually increasing the emitted sound level from the seismic array (called soft-start or ramp-up) before a survey begins or resumes after a period of silence. The intent of a soft-start procedure is to warn marine animals of pending seismic operations and to allow sufficient time for those animals to leave the immediate vicinity. Under normal conditions, it is assumed that cetaceans will find the source sound aversive and will move away before auditory injury or physiological effects occur.

The BOEMRE, together with the International Association of Oil & Gas Producers (OGP) E&P Sound & Marine Life Joint Industry Project (JIP), is currently funding a large research study, the Australian Humpback Whale Behavioral Response Study that includes testing the efficacy of the soft-start procedure. BOEMRE has also encouraged the development and use of technologies like Passive Acoustic Monitoring (PAM) by allowing companies to continue to work in low visibility conditions where the whales otherwise cannot be seen. PAM systems are able to detect, classify and locate vocalizing animals.

Two major reports, one compiled and edited by Wright and Highfill (2007) and the other by Weilgart (2010), highlight the potential in new or improved technologies to reduce the environmental footprint of seismic imaging. The Weilgart (2010) report, which was based on a 2009 workshop of industry experts and biologists, concluded that:

- Airguns produce "waste sound" that is not used by the industry, yet has the potential to impact marine life;
- That this sound (mainly high frequencies and lateral propagation) could be eliminated without sacrificing any data quality for the hydrocarbon industry;
- That reducing peak sound levels is a worthwhile goal even at the expense of requiring a slightly longer signal;
- That technologies are available or emerging that do not introduce any anthropogenic sound, or introduce substantially less sound, into the environment;
- That less sound may be required to gather the same quality of data due to more sensitive receivers;
- That regulatory pressure/incentives and more funding to develop these technologies will expedite their availability and broaden their applications.

To achieve the technological improvements suggested in the Wright and Highfill (2007) and Weilgart (2010) studies, significant research and development (R&D) investments are required over a period of many years. If physical and life sciences projects, as funded by the US National Science Foundation (NSF), are used as a benchmark, minimum investments of three years are recognized as the common expectation for return on funds granted for basic research. The offshore oil and gas industry already has utilized JIPs to explore mutually beneficial technologies and practices and, based on the NSF benchmark, three years should be a reasonable expectation for return of new knowledge from a JIP investment. The next step in the progress is to have environmentally-beneficial JIPs recognized and credited as such by the OCS regulatory processes.

Non-acoustic sources include electromagnetic surveys, which can image the subsurface by relying on differences in electrical resistance among different types of rock; and passive seismic devices, originally developed for land-based exploration, which can assist to delineate and characterize hydrocarbons by measuring the earth's seismic wave field. These technologies have different applications within the exploration and production cycle and different time horizons for commercial use. In general, the non-acoustic technologies, while promising, are less mature than the acoustic ones and are either emerging or in an early stage of development.

(2) Arctic Adaptations and Expanded Significance

Seismic exploration, along with side-scan sonar for detection of underwater hazards, also is essential in offshore exploration in Arctic environments. The technology employed basically is the same as that used in non-Arctic environments but with modifications to acknowledge operational challenges presented by sea ice as well as migratory patterns of marine mammals and seasonal considerations for subsistence hunting. It is recognized that cumulative understanding is increased through combination of geotechnical surveys with traditional (Alaska Native) knowledge.

ORRAP (2010) found that geophysical exploration for oil and gas resources should contribute further to national goals of importance in addition to recovery of hydrocarbons. ORRAP (2010) pointed out that understanding the processes and conditions of the entire Arctic Ocean region – its coasts, seabed, water volume and ice cover – is critically important to understanding climate, exclusive economic zone (EEZ) and territorial claims, resource management, maritime transportation, military security and maritime safety.

C. Subsea Drilling, Well Operations and Completions

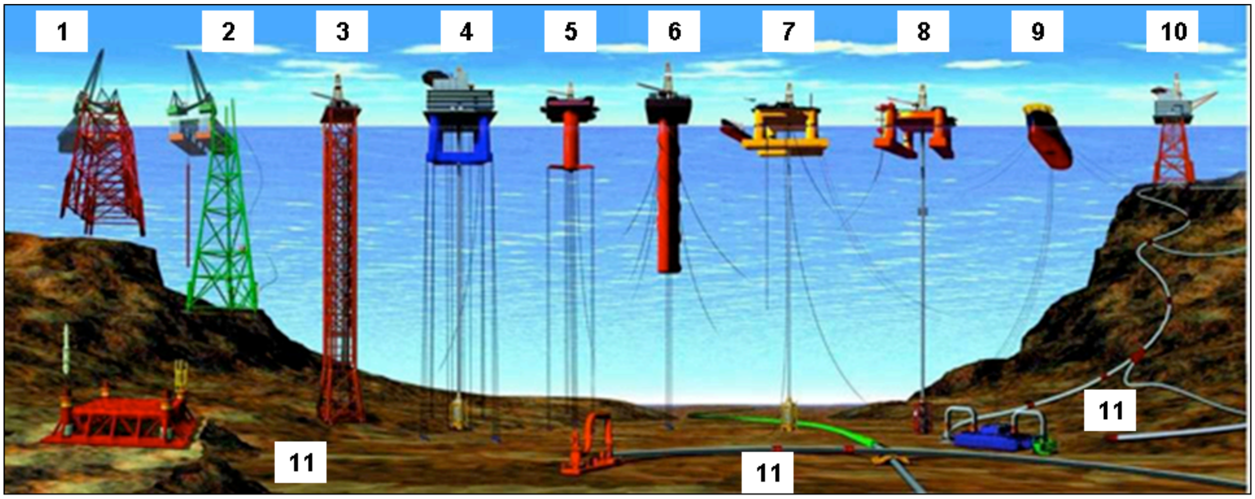
As drilling has extended farther offshore into deeper water, drilling rigs have become larger and more complex with workers who are more highly skilled. Both the equipment and personnel must deal with well-construction conditions that are highly challenging. The combination of deepwater overburden on the wellhead and formation conditions in the deep subsurface place both high-pressure (seafloor and formation) and high-temperature (formation) stresses on materials and equipment. The relative isolation from shore-based resources necessitates work methods that are largely self-reliant.

There are two basic categories of offshore drilling rigs: those that can be moved from place to place (i.e., MODUs), allowing for drilling in multiple locations, and those rigs that are temporarily or permanently placed on a permanent production platform (Fig. 3). The type of rig used for a specific project is chosen based on geographic location, water depth and access to supporting resources, but in all cases, drilling and completion are the two main phases of the well-construction operations. Drilling involves all aspects of creating the borehole whereas completion deals with finishing the well into a system that produces hydrocarbons in a controlled, operational manner. A subsea completion denotes the assembly of equipment that controls and connects individual producing wells into a system that directs the hydrocarbons to a processing or storage facility.

Offshore drilling requires motorized, heavy mechanical equipment and a small fleet of specialized ocean vessels as well as significant volumes of water, mud and other fluids required to construct and clean each borehole. Therefore, waste management is an important part of drilling. Waste generated during drilling falls into four primary categories:

- Residual drilling fluids and cuttings which constitute the largest volume of waste produced during drilling operations.
- Different types of wastewater produced during the drilling process.
- Air emissions generated from the drilling equipment and support vessels and aircraft.
- Industrial or solid waste including paint, spent solvents and packing materials.

Figure 3. Offshore Drilling Rigs and Production Platforms.



1 & 2: Conventional fixed production platforms
3: Compliant tower production platform
4 & 5: Moored tension leg production platform
6: Spar production platform
7 & 8: Semi-submersible drilling rigs
9: Floating production storage and offloading facility
10: Sub-sea completion and tie-back to host facility
11: Sub-sea systems and flow lines

The approach to handling each type of waste depends on the volumes and worksite circumstances and can involve treatment and disposal, waste reduction, recycling and re-use options to reduce environmental impacts. The trend in recent years has been increasingly toward more environmentally sustainable outcomes, including reduction of waste streams and recycling of fluids wherever possible.

A subsea completion is one in which the producing well does not include a vertical conduit from the wellhead back to a fixed access structure. A subsea well typically has a production tree to which a flowline is connected allowing production to another structure, a floating production vessel, or occasionally back to a shore-based facility. Subsea completions may be used in deep water as well as shallow water and may be of any pressure and temperature rating including high-pressure, high-temperature (HPHT) ratings. Subsea completions consist of a production tree sitting on the ocean floor, an upper completion connecting the production tree to the lower completion and the lower completion which is installed downhole through the producing intervals. The true success of a subsea completion lies in its ability to continue to produce over time. Any interruption of the production stream (particularly from deepwater, high-producing wells) can quickly affect the economic recovery of a project. Fortunately, subsea completions are relatively trouble-free after the initial installation.

The barriers and opportunities for subsea completions can be viewed as opportunities for increased commercial efficiency and environmental protection hindered by barriers to on-demand fabrication and acquisition of the necessary equipment.

The first opportunity is to reduce overall resources needed to develop the hydrocarbon production. Considering the size and mass of steel required to construct an offshore platform, the development of a series of wells using subsea completions makes an attractive alternative. Similarly, the economic abandonment point for well production can be optimized with subsea completions because maintenance requirements of a significant top-sides structure and the potential cost of de-commissioning a structure are avoided. As a counterbalancing consideration, top-side structures facilitate well interventions, such as maintenance of the wellbore to seal off unwanted production or to permanently abandon production. To perform equivalent well intervention on a subsea completion, without the ability to stage the work from top-side structures, means bringing in a support vessel or removing production equipment – both of which can be cost-prohibitive relative to simple abandonment. Advances in well intervention without the use of support vessels are required to overcome those constraints.

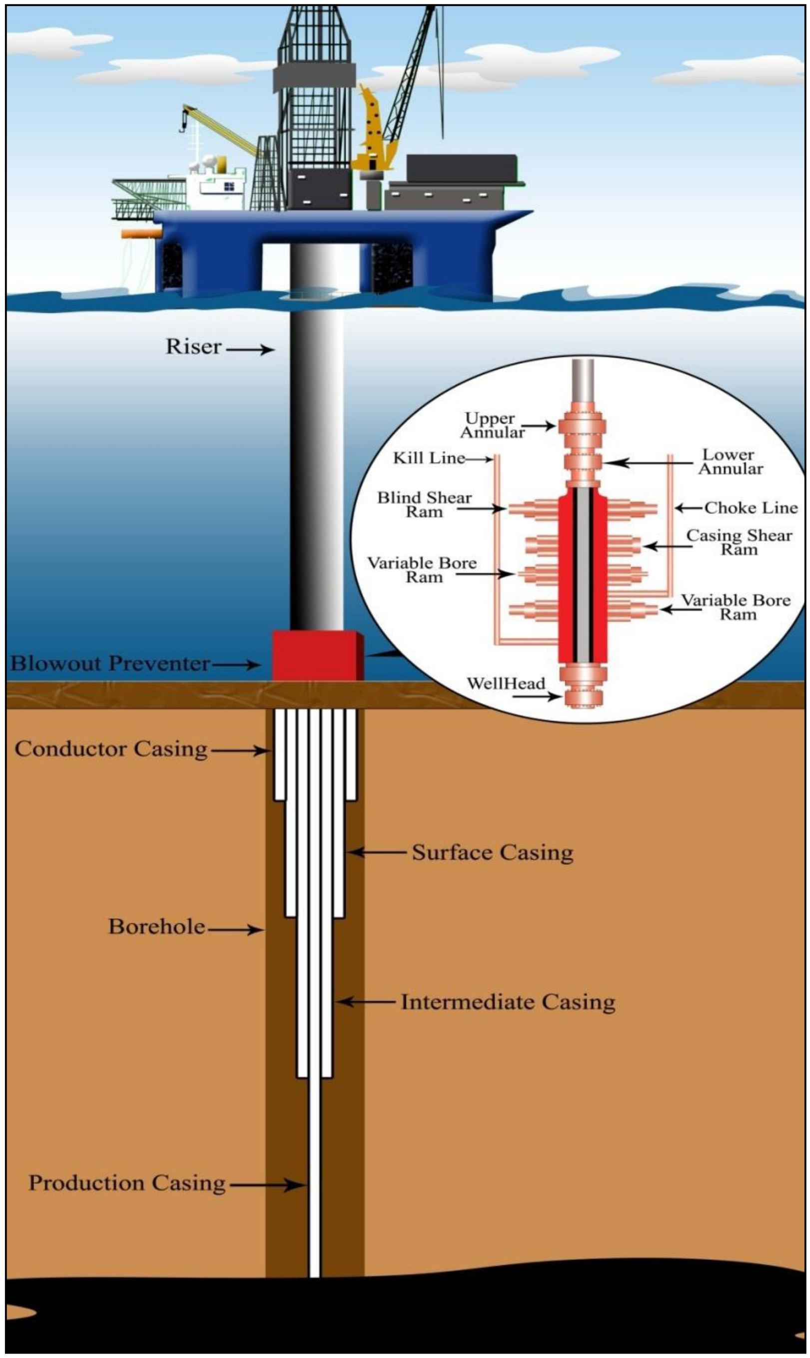
The second opportunity presented by subsea completions is the potential for reduction of spills, leaks, and other releases of hydrocarbons during well construction and production. A subsea completion must be designed to operate at significant under-water pressure which requires sealed connections to prevent water from entering and hydrocarbons from escaping. Therefore, subsea completions offer a significantly ruggedized and leak-resistant infrastructure. Similarly, subsea processing of produced fluids, with subsequent re-injection of unwanted fluids for pressure maintenance in the hydrocarbon reservoir, further reduces the potential for spills, leaks, and other releases of hydrocarbons compared with bringing those fluids to the surface for processing.

One barrier to expanded use of subsea completions is availability of specialized materials and their costs. The cost of interventions in any subsea equipment drives operators to select materials that have reliable survival rates in the estimated downhole environment, meaning preference for special high-performance metal alloys that have large cost multipliers relative to conventional alloys. Limited availability of such high-performance alloys in large-bore components can sometimes be an issue as well as delivery of those components in volumes as required for subsea field development.

D. Well-Control Management and Response

Well control is a multifaceted endeavor that is meant to assure commercially successful and environmentally responsible drilling and completion of hydrocarbon wells and the subsequent safe operation of such wells after they are placed into production. Although well control is focused on prevention of uncontrolled hydrocarbon releases ("blowouts") of wells, it is closely associated with planning for response to oil spills and prevention or control of fires that might occur during a loss-of-control event. Therefore, the integrated view of well-control management and response includes the contingency plans for responding to spills, if necessary, and the prevention or control of fires that could be fueled by uncontrolled releases of oil or gas.

Figure 4. Diagram of Well and Blowout Preventer (BOP).



Blowout prevention technology and practices are designed to prevent direct environmental impact by escape of hydrocarbons during the drilling process. The blowout preventer (BOP) system keeps drilling fluids and reservoir flows within the well to maintain proper well-control pressures and to prevent uncontrolled discharges into the water and air. Subsea BOP technologies locate the well-control hardware at or near the seafloor wellhead, thereby reducing the bulk otherwise required on the surface platform (Fig. 4) and improving safety on the platform.

Blowout prevention technology and practices have been studied intensively by many different groups both as part of ongoing industry research and development efforts and also in response to the Macondo well blowout of

2010. In late 2010, BOEMRE issued two new rules pertaining to well control. The core of the new BOEMRE rules was prescriptive use of American Petroleum Institute (API) Recommended Practices 65 (Part 2) and 75. RP 65 addresses drilling activities including BOP attributes and operational practices, while RP 75 pertains to safety and environmental management programs.

(1) Blowout Prevention

There are a limited number of deepwater drilling blowout control options. In controlling blowout risk it is imperative that every preventive measure available is considered and planned in advance. It is imperative to detect and mitigate a blowout as early as possible to prevent the actual event or to bring it under control as quickly as possible. Once a blowout becomes uncontrollable, mitigation becomes very difficult. Proper well design along with planning for a worst-case scenario can ensure a safe operation.

It is recognized within the petroleum industry that deepwater conditions create special challenges for critical equipment, including the blowout preventer (BOP). A subsea BOP can be required to operate in water depths greater than 10,000 ft, at pressures of up to 15,000 psi (and even 25,000 psi), with internal wellbore fluid temperatures up to 400° F and external immersed temperatures close to freezing (34° F). Since at least 2007, subsea engineers have sought enhanced hardware through advances in metallurgy to use higher-strength materials in ram connecting rods or ram-shafts in the BOP to deal with deepwater conditions.

Even with advances in subsea equipment, successful well control involves more than just technology. Important elements include organizational effectiveness and operational rigor. An effective organization has highly knowledgeable personnel in key positions, and with necessary decision-making authority, while operational rigor insists on unrelenting dedication to high performance conduct of all work activities.

(2) Fire Control

In the context of well control, fire control focuses on preparedness to prevent, contain, eliminate or suppress fires that might erupt in the aftermath of an uncontrolled release of oil or gas. Fire control will be most effective when it is fully integrated into planning for blowout prevention, spill prevention and spill response.

The management dimensions of fire control span the expected physical factors but also strategic and tactical decisions about suppression of active fires. Physical factors include prevention of release, minimization of release volumes, and management of flammable atmospheres. Strategic and tactical decisions involve commitment to extinguish, rather than allow the fire to burn out, and the precise approach to extinguishing a fire, such as cooling or chemical-reaction chain control. The latter decisions also include considerations of the fuel that is burning and the structure and status of the facility that is involved.

An area of improvement needed for fire control is an objective, scientific approach to assessing the environmental trade-offs between potential air and water pollution based on a range of fire-management strategies. Because fire suppression typically involves emergency decisions, a preexisting body of knowledge about options and consequences would provide for improved on-scene decision-making for a better overall event outcome.

(3) Oil-Spill Prevention and Response

Spill prevention is accomplished through both design specifications and operational practices such as: well construction with multiple stop variables, leak detection systems, and blowout prevention systems with multiple triggering options. Operational practices include integrity testing of well casing and cementing activities, training of personnel, and assessment and mitigation of risks.

For offshore operations, oil-spill response plans (OSRP) are submitted to and approved by the BOEMRE or its successors. The plans must be consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and applicable Regional and Area Contingency Plans (RCPs and ACPs). Planning for an effective spill response encompasses a variety of aspects including, but not limited to: Spill detection and source control; Initial actions and assessment; Internal and external notification requirements; Incident management team(s) and processes; Response techniques including dispersants and in situ burning; Sensitive areas and protection measures; Wildlife rescue and rehabilitation; and Technological aspects of response communication and information exchange.

OSRPs are routinely tested through drills and exercises. Lessons learned are then incorporated into the plans. The experience of plan holders and agency personnel in executing strategies and tactics and adapting them to various scenarios during drills or exercises has improved the functionality of plans across the response community. However, one of the primary areas for improvement is the need to comprehensively ramp up the level of response effort for a Spill of National Significance (SONS). This includes initially utilizing resources from the region, then cascading in additional resources from elsewhere in the US and finally from international sources. Most plans only identify internal local and regional oil spill personnel for initiation and longer term management of a response, respectively. This may not be adequate to manage very large incidents. The Joint Industry Oil Spill Preparedness and Response Task Force (JITF, 2010) identified several potential solutions to this problem that included:

- Creating an inter-industry memorandum of understanding to provide personnel trained in spill response.
- Including in the planning requirements a process for identifying and cascading in resources.
- Addressing, in advance, processes for waivers and approvals and Jones Act limitations.

The Presidential Oil Spill Commission (2011) agreed that OSPR planning needs improved interagency coordination. Specifically, it was stated that:

> "Oil spill response planning and analysis across the government needs to be overhauled in light of the lessons of the Deepwater Horizon blowout. A common interagency approach to analyzing oil spill risks and a common understanding of

> the issues and impacts involved are needed and must be consistently incorporated in environmental reviews, consultations, and authorizations. Environmental review and spill planning currently occurs at different levels within the government and industry, and these reviews and plans have not been sufficiently coordinated to ensure either searching review of industry plans or adequate preparation." (Presidential Oil Spill Commission, 2011, p. 265)

Indeed, the Presidential Oil Spill Commission (2011) issued no less than nine (9) recommendations related to OSPR. Although most of those recommendations advocated more resources for oil-spill planning and mitigation, they also suggested rearranged lines of authority beyond BOEMRE and the USCG, specifically with greater involvement by the EPA.

Emphasis by the Presidential Oil Spill Commission (2011) on better OSPR coordination is timely and appropriate. To realize such recommendations, the historical and ongoing role of industry, as well as non-governmental organizations, must be recognized and utilized appropriately.

The majority of marine oil-spill response capability in North America is provided by not-for-profit corporations established and funded by industry, as well as for-profit companies that contract response equipment and services. In planning any prescribed changes to oil-spill response functions, regulatory agencies should find it important to include the knowledge and experience of the following organizations:

- The Marine Spill Response Corporation (MSRC)
- Clean Gulf Associates
- Alaska Clean Seas
- The National Response Corporation (NRC)
- The Marine Well Containment Company (MWCC)
- Helix Energy Solutions Group (HESG)

The Macondo well blowout underscored the need for incident response techniques and technologies to keep pace with advances being made in deepwater exploration, drilling and production. More than one type of response is needed and the following capabilities were highlighted by the JITF (2010):

- Oil Sensing and Tracking to plan in spill countermeasure options through reliable identification of where oil is located and how it is moving.
- Dispersants to convert surface oil slicks into tiny droplets (<100 micrometers in diameter) that mix into the water column, where oil can more easily undergo natural biodegradation.
- In Situ Burning (controlled in-place burning) of oil spilled from a vessel, facility, pipeline, or tank truck where such burning might be the environmentally least offensive solution, compared with mechanical intrusions.

- Mechanical Recovery of oil spills using containment booms, and/or recovering it with a skimming devices or sorbent materials that physically collect the oil for storage or disposal.
- Shoreline Protection and Cleanup using variations or combinations of other response techniques to reduce the amounts of shoreline areas affected by oil that cannot be addressed by purely open-water techniques.

Although some observers consider mechanical recovery to be the principal or only response to an oil spill, effective responsiveness requires matching the remediation approach with the circumstances. When properly used, dispersants and in-situ burning are proven approaches to remediation. Accordingly, any revised regulatory prescriptions for oil-spill response should keep in mind the need for options in dealing with circumstances that can vary significantly from one spill to another.

(4) Arctic Oil-Spill Prevention and Response

In view of the tremendous potential of subsea oil and gas resources in Arctic regions, many different oil-producing countries eventually will develop those resources despite the challenges of working in those difficult and potentially fragile environments. Oil spill response options in Arctic environments will vary depending on seasonal oceanographic and meteorological conditions. Each season presents different advantages and drawbacks for spill response. Oil spill response strategies and tactics for cold climates must be designed to deal with a mix of open water and ice conditions that could occur throughout any portion of the operating period. Crude oil and oil products will also behave different in cold water environments due to the physical and chemical properties of the oil spilled.

Nonetheless, significant knowledge already exists regarding the adaptation of oil-spill response capabilities for Arctic applications (Hänninen and Sassi, 2010). As reviewed by Sǿrstrǿm et al. (2010), The Joint Industry Program on Oil in Ice produced over 33 reports based on research activities conducted between 2006 and 2009. All of the response techniques highlighted by JITF (2010) will be needed in Arctic developments and it would be most beneficial to US interest to have proactive leadership in development of those Arctic-oriented refinements.

E. Offshore Production Facilities and Pipelines, Including Arctic Platform Designs

(1) Progress in Subsea Design and Performance

The development of offshore oil and gas reserves requires the construction and installation of facilities to produce and process the oil and gas. The purpose of production facilities is to provide for the necessary separation of oil from natural gas and water – all of which commonly flow upward as raw petroleum through the same wellbore – plus suitable direction of the separated streams to other gathering or storage systems. Historically, this has required the installation of numerous platforms on structures fixed to the seafloor and located in the immediate proximity of the target reserves. Over the past one to two decades, technologies have been developed that reduce the number facilities required and thus reduce the physical footprints of oil and gas facilities. Several of those technologies can play major roles in reducing the environmental impact of oil and gas production.

Pipelines are the safest, most reliable and economical method to transport oil and gas from offshore waters around the United States. There are approximately 33,000 miles of liquid and gas pipelines in the US OCS and many more miles in shallow, offshore waters and coastal areas.

Pipeline operators spend millions of dollars annually to design, construct, operate and maintain their assets and comply with Federal and State laws and regulations. Pipeline operators continually seek to reduce the risk of accidental releases by taking measures to minimize the probability and severity of incidents. Key measures include proper route selection, design, construction, operation, maintenance and inspection.

As mentioned previously, progress in development of offshore facilities has included benefits through reduction of overall environmental footprints. First, thanks to horizontal drilling, several lateral boreholes can be connected to a single vertical borehole. Second, using unmanned satellite production systems placed on the seafloor, produced hydrocarbons can be gathered with many fewer topside structures at the ocean surface. Finally, floating production systems are not permanent fixtures but can be moved between locations as various projects mature.

The Presidential Oil Spill Commission Report (2011) made only one recommendation that specifically mentioned offshore facilities although technological advances in such facilities are key avenues for improving safety and assuring sustainability. In fact, the same recommendation can be interpreted as addressing regulatory issues as much as or more than technical issues. As mentioned in the former context, there is cause for concern regarding how the new regulatory agency will build and maintain the necessary technical capacity to perform the implied permitting and inspections.

(2) Subsea Pipeline Integrity

Sustainable use of subsea pipelines requires that working lifetimes are maximized for commercial success at the same time that environmental risks are minimized through robust designs, conservative operations, regular inspections and detailed planning and scheduling of maintenance. Proper management of risk can provide subsea pipelines with safe a reliable working lifetimes of 30 years or longer.

Routine maintenance items include inspection and calibration of overpressure protective devices at least yearly including pressure sensors, relief valves, and shutdown valves. The cathodic protection system is also evaluated to ensure it is working properly. Inspections of pipeline components on a platform above water are completed as part of routine surveillance checks. At least yearly, a detailed assessment of components above water (risers and topside facilities) is completed to ensure there are no issues with the protective coatings. Aerial surveillance using fixed wing aircraft or helicopters is also completed on a periodic basis to note any encroachments on the pipeline route or any signs of leakage. Where offshore pipelines transition to land, depth of cover surveys are completed to ensure pipelines are buried adequately to at least 15 feet water depth so they do not pose a hazard to marine traffic.

Cleaning tools know as "pigs" are routinely run through pipelines to remove wax that may have deposited on the pipe walls along with any sediments associated with the production stream. Pigging tools also remove any water from the line to prevent it from causing internal corrosion. Internal Line Inspection (ILI) tools, also known as "smart pigs," are also run on critical systems to identify any internal or external corrosion and/or damage from third parties such as dents, gouges, etc.

A case study of the Forties Field pipeline system in the North Sea (Marsh et al., 2008) included both oil and multiphase lines with proven service of 33 years and potential service as much as another 20 years beyond their design lifetimes. As emphasized by Marsh et al. (2008), lack of obvious degradation in topside components of riser connections is no guarantee of integrity in subsea components; direct subsea inspections are essential. Factors needed for success include intelligent pigging and the establishment of key performance indicators for corrosion resistance.

(3) Arctic Adaptations

Although oil and gas offshore operations within Arctic regions often are treated as a separate subject, in fact, the same basic objectives apply as for non-Arctic regions. Platforms and pipelines around the world are designed to resist location-specific environmental forces, ranging from hurricane winds, waves, currents, tides, mudslides, earthquakes and ice. Differences in Arctic regions mostly reflect special, ice-related environmental adaptations needed for technologies and procedures applied to construction and operation as well as some modifications to permitting processes.

ORRAP (2010) stated that it "was impressed by a presentation from the oil extraction industry in Alaska regarding its ocean, coastal and ice observing capabilities and investments" and further commented that the industry-developed knowledge and capabilities, although driven by NEPA-EIS requirements, offers wider and longer-term benefits to Arctic knowledge. Therefore, baseline environmental knowledge required to design, build and operate offshore structures in the Arctic already is recognized by authorities on the Arctic environment.

F. Offshore Transportation

The development and maintenance of offshore oil and gas facilities requires a fleet of offshore service vessels specially suited to the demands of the marine environment. From the initial exploratory work to the long-term deployment of oil and gas installations, offshore service vessels may include crew and supply boats, utility boats, seismic ships, anchor handling tugs, diving support, well stimulation ships, lift boats and pipe laying vessels. As field developments move farther offshore and the cost and complexity of services increase, there is an increasing demand for larger-sized and multi-tasking capabilities of these vessels to not only transport cargo to deep water facilities but to also conduct mooring, installation, and fire fighting operations in a wide variety of offshore environments.

Over 95% of the service vessels that serve the offshore industry are US flagged, as compared to the over 95% of deep draft cargo ships and tankers that are foreign-flagged when entering US ports carrying international cargoes of merchandise and oil. US offshore support vessels are highly regulated; falling under the jurisdiction of US Coast Guard (USCG) for safety, construction, manning, operations and pollution prevention, EPA for pollution prevention, DOT for cargo carriage, DOT for drug and alcohol programs, OSHA for safety and also state agencies.

All offshore support vessels whether US or foreign flag are subject by treaty to international conventions on maritime safety developed by the International Maritime Organization (IMO). IMO conventions on crew competence (STCW), security (ISPS), safety (SOLAS), pollution prevention (MARPOL) and cargo (packaged, liquid or bulk dangerous goods codes) are generally much more stringent than their domestic (US) counterparts.

Vessels supporting offshore activities are required to carry oil-spill liability insurance and hold USCG approved spill response plans.

All offshore support vessels (US and foreign flag) are subject to annual regulatory compliance inspections by the USCG and their flag state. In the case of regulatory inspections designated commercial organizations called classification societies may be authorized to conduct annual compliance inspections and issue compliance documents on behalf of the vessel's flag state government. While world-wide there are over 40 classification societies only three (ABS, DNV, Lloyds) meet the high standards set by the USCG to conduct inspections on behalf of the US government.

Environmental issues associated with offshore transportation include noise and air emissions (Table 4), including possible effects on coastal environments and wildlife habitats. A possibly unique environmental issue associated with transportation is invasive species. Vessels that travel to ports outside of their local regions can return with alien marine species from ballast-water discharges, hull fouling, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays). Once introduced, these aquatic invasive species can displace native species and significantly affect the local ecosystems. Harmful aquatic organisms have been identified by the International Maritime Organization as a substantial threat to the world's oceans and waterways. Given the global nature of the oil and gas industries, the issue of invasive species probably will continue to grow in profile.

Table 4. Emissions Estimates (in tons per year) of Certain OCS Source Categories in 2008.

Source Type	CO	NOx	PM10	SO_2	VOC
Support vessels	12,880	135,222	2,342	18,221	2,342
Pipe-laying operations	2,186	10,535	398	1,789	398
Survey vessels	141	1,690	26	204	26
Commercial marine vessels	6,593	79,329	6,603	49,009	2,794
Commercial fishing vessels	681	8,120	124	988	124
Support helicopters	13,636	1,114	217	275	2,693

Service vessels transmit noise through both air and water. Propeller cavitations are generally the dominant noise source on vessels. The intensity of noise from service vessels is roughly related to ship size, laden or not, and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. For a given vessel, relative noise also tends to increase with increasing speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean and offshore service vessels comprise a minor component of this total ambient level. For purposes of preventing, detecting or mitigating potential environmental impacts of noise related to offshore developments, any programs to collect baseline data and develop avoidance criteria should consider integrating such efforts with similar efforts that pertain to seismic exploration. Namely, the most useful scientific survey of noise effects should cover the largest possible number of noise sources.

Vessel collisions with marine mammals can cause major wounds and/or be fatal to the animals. All sizes and types of vessels can collide with whales but the most lethal or severe injuries tend to be caused by ships that are 80 meters (262 feet) in length or longer and those traveling 14 knots or faster. The majority of collisions appear to occur over or near the continental shelf at times when the whales are not seen beforehand or are seen too late to be avoided. Slow moving cetaceans or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale) might be the most vulnerable to collisions with vessels.

Due to the growth of oil and gas exploration in colder climates, there is an increasing demand for offshore support vessels built to ice class. Ships navigating in ice prone areas can risk stressing the hull and propulsion failures. New developments in ice navigation and winterization are generating a new challenge for shipping and shipbuilding industries all over the world.

The International Association of Classification Societies (IACS) requirement concerning Polar Class is a set of rules for designing and outfitting vessels for navigation in ice and polar waters. These rules are proposed to be uniformly applied by classification societies on ships contracted for construction on and after 2012. The IACS Polar Class requirements are being created in line with the IMO Guidelines for Ships Operating in Arctic Ice Covered Waters to provide comprehensive requirements for the safe navigation of ships in Arctic waters. Ice class rules are categorized into various levels depending on area of operation, time of year, and service. As ice conditions and service requirements increase, the requirements for strengthening the hull, increasing the horsepower and strength of the propulsive system, toughening of the hull and superstructure steel, and providing ancillary systems that protect the crew and vessel from cold weather also increase. Vessels that need to operate independently or as an escort of less capable vessels have more stringent requirements.

Helicopters are also routinely used to service offshore facilities, primarily for transporting crew and conducting emergency evacuations but they may transport equipment and supplies, as well. Deep water operations have likewise lead to increased demand for enhanced helicopter capabilities; such as the ability to travel farther and faster, carry more personnel, have all-weather capability, and reduce operating costs. The FAA, which regulates helicopter traffic, is proactively moving away from compliance–based safety surveillance programs to Systems

Safety Risk Management programs to eliminate air carrier's accidents and incidents. The FAA has found that the compliance-based oversight system was not an effective means in reducing the causal factors that lead to air carrier accidents.

Terrestrial wildlife disturbances from aircraft noise range from mild, such as an increase in heart rate to more damaging effects on metabolism and hormone balance. Long term exposure to noise can cause excessive stimulation to the nervous system and chronic stress that is harmful to the health of wildlife species and their reproductive fitness. Many factors influence an animal's response to noise. These include distance to the aircraft, type of aircraft, suddenness of its appearance and the frequency of overflights. Aircraft that are closer generally are more likely to produce a response, although there is no minimum distance that has been found to produce no effects, and the responses are highly dependent on the species. Some tolerance for overflights has been observed when flights are frequent or regular but this is also not consistent among all species.

G. Data Management

Important data are generated in overwhelming volumes from beginning to end of an offshore oil or gas project. The data are essential not only for commercial and economic decisions but for monitoring and detection to assure compliance with safety-sustainability elements. A data management process to collect, secure, distribute, analyze, store, retrieve, and archive information is imperative to improve real-time and long-term decision making. The ability to manage data across industry, regulators and other interested groups requires a data management plan.

A common issue in data management is that organizations have only recently begun looking at standard data management processes and programs across their own organization. It is common that data management was done at a local level with each office defining their process and technology. The end result is many technologies that do not share data. Now those organizations are optimizing their data management across the entire organization either by introducing common technologies and processes or linking the current systems. In the future, data management should be considered across all regulatory agencies so that common data and information is easily transferred from the lease operators to the various regulatory organizations and among the regulators.

The Microsoft and Accenture Upstream Oil & Gas Computing Trends Survey 2010, which polled 172 upstream oil and gas professionals within national, international and independent oil companies and service and supply companies worldwide, found that for 44 percent of respondents, the upstream data explosion continues to have a negative effect on their ability to get their work done. Forty-four percent of professionals surveyed reported a difficult and time-consuming search of diverse systems to find information; and data appearing in unstructured forms not easily captured or archived. Forty-three percent of those surveyed reported that data stuck in individual repositories and not easily shared was a common challenge across disciplines, and 35 percent reported too much redundant and/or unnecessary data available.

Indeed, a study published by DOE in 2004 identified several issues that remain problematical today:

- Better processes and practices are needed to alleviate the difficulty in obtaining source data.
- The need to manage and preserve data should be explicit considerations in project planning and management.
- Better processes and practices are needed to alleviate the difficulty of obtaining documentation.
- Technology provides new opportunities to address data management issues, but it cannot provide solutions without thoughtful planning and application.
- Data retention (what to archive and for how long) should be addressed discipline by discipline.
- Metadata must be optimized for future retrieval, assimilation, and re-use.
- Data sets need to be referenced in order to be easily located by users
- Retention and re-use of data need to be addressed in the context of emerging needs for long-term management and curation.
- Data, like information, should be widely accessible and available at no cost to the user.

The key elements of progress for improved data management are centered on development and adoption of standards for data organization, formatting and exchange. Even though government regulatory agencies define reporting requirements, development of data standards has been led by non-government organizations. Future effectiveness of data management programs and systems will require closer collaboration among government regulatory agencies and also between the regulators and the non-governmental standards developers.

The Presidential Oil Spill Commission Report (2011) did not include any recommendations that specifically addressed data management. Even so, the need for improved data-management programs and systems is implied in several recommendations that ostensibly address other topics. For example, scientific-based decision-making and rapid, criteria-based mitigation responses can function only if the requisite information is readily available – meaning that the underlying data are up-to-date and accessible on demand.

FINDINGS PERTAINING TO OFFSHORE DEVELOPMENTS

A. Synthesis of Findings from Topical Areas

All topical areas in offshore oil and gas development are affected both by technology and policy. Each topical area is affected in specific ways and some effects are common to all topical areas. For each of the seven topical areas, Appendix 5 summarizes findings derived within the individual topic papers described in Appendix 4. The sense of each finding is an observation by subject-matter specialists and practitioners on how development is generally conducted in the offshore context and whether significant gaps exist between what currently is done and what might be developed by industry and/or government into an improved best practice.

The findings made specifically for offshore oil and gas developments can be categorized according to the six core findings recognized by the larger OETG study. Although Appendix 5 offers many additional topic-specific findings with supporting details, the key general findings for offshore development, as synthesized from the topical findings (with correlation to the OETG core findings), are as follows:

- Natural gas will continue to be either a targeted or an associated product of offshore oil and gas development. (OETG 1)
- Seismic methods will continue to be the primary geophysical tool used to discover, evaluate and enable responsible production of offshore oil and gas resources. (OETG 2)
- Seismic noise is recognized as a concern for whale populations and other marine life, including fish. (OETG 2)
- Pipelines have proven to be the safest, most reliable, economical and environmentally favorable way to transport oil and gas throughout the U.S. The aging of the pipeline infrastructure suggests that continual improvement in system integrity, monitoring, and leak-detection is necessary. (OETG 2)
- Decommissioning offshore platforms includes beneficial options such as “Rigs to Reefs” that have been underutilized. (OETG 2)
- Scientific understanding of environmental conditions in sensitive environments in deep Gulf waters, along the regions coastal habitats, and in areas proposed for more drilling, such as the Arctic, must be enhanced in order to meet the expectations of stakeholders. (OETG 3)
- Oil-spill response (OSR) includes multiple methods/tools such as: (1) oil sensing & tracking; (2) dispersants; (3) in-situ burning; (4) mechanical recovery; and (5) shoreline protection and cleanup. All of these methods/tools must be properly developed, available, and pre-approved effectively respond to a large event. (OETG 3)
- Improvements are needed in predictive capabilities of drilling abnormalities. (OETG 3)

- The multiplicity of US government regulatory agencies involved in setting data reporting requirements has led to inefficiencies. (OETG 4)
- Many of the oil and gas data-management issues identified by the US Department of Energy (DOE) in 2004 remain unresolved and problematical today. (OETG 4)
- Conflicting statutory mandates make it difficult to achieve a balanced and predictable federal offshore policy. (OETG 5)
- Federal regulatory agencies lack technical expertise to oversee complex technical systems and operations. (OETG 5)
- DOI/BOEMRE has implemented a NEPA policy which limits the use of categorical exclusions (CE). The preparation of more time consuming environmental assessments has further stalled the commencement of drilling in the Gulf of Mexico with no commensurate environmental or safety protections. (OETG 6)

B. Findings Compared with Results from External Studies

The findings presented above were developed through independent research and analysis. Nonetheless, during the course of work reported here, similarities were noted with regard to findings from studies focused on the *Deepwater Horizon* incident and the associated Macondo well blowout. Appendix 3 summarizes main features of those external reports, including the National Academy of Engineering Macondo Study, the report of the Presidential Oil-Spill Commission (2011) and early indications from the (as yet incomplete) Joint Investigation Team (JIT) study by the Bureau of Ocean Energy Management (BOEM) and U.S. Coast Guard (USCG).

All of the external studies summarized in Appendix 3 share common threads in their findings, namely that the *Deepwater Horizon* incident resulted from a combination of failures in equipment (including the subsea BOP), procedures and overall risk management by the operators and their partner companies – plus ineffective regulatory oversight. In that context, those external findings generally align with findings reported in this study that are aimed at prudent offshore operations. Specifically, the current report finds that key aims for sustainable future offshore operations must include better coordination among regulatory agencies and attention to honing best practices both in equipment and operational risk management.

Recommendations from Presidential Oil Spill Commission (2011) featured a programmatic focus and can be usefully complemented by findings in the current report that carry a practitioner focus. Some of those possible synergisms are briefly summarized below.

<u>Improving the Safety of Offshore Operations</u>. The Commission recommended that industry demonstrate how their processes and procedures will better manage risk to achieve safer outcomes, including adoption of a collective culture of safety and self-governance by an authoritative "Safety Institute" that assures uniform practices at high standards. The findings presented here are consistent with a "risk-based" regulatory approach that includes a prudent

balance of prescriptive and performance-based regulations that are developed using the best practices of existing safety programs and international benchmarks. A system that requires all offshore operators to demonstrate analysis, planning and preparedness as well as promote the highest level of safety for offshore drilling, completions, and operations, while enhancing and continuously improving industry's safety and environmental performance, is an expected outcome of the industry-sponsored Center for Offshore Safety (COS).

Safeguarding the Environment. The Commission recommended that broader consultations among federal agencies, including the USCG and NOAA, should occur prior to leasing and exploration to help identify and address risks. The findings presented here agree that regulatory decisions must be based on sound science but also point out that substantial scientific studies have been performed in the OCS, including the well-developed areas of the Gulf of Mexico as well as the Arctic, and that baseline science studies should be developed with participation by industry experts wherever possible.

Strengthening Oil Spill Response, Planning, and Capacity. The Commission recommended that spill response planning by both government and industry must improve and that government review of plans must be rigorous and involve all federal agencies with responsibilities for oil spill response, including a better job of integrating state and local officials into spill planning and training exercises. The findings presented here agree that spill response capability must improve and will involve a concerted effort by both industry and government, including additional funding for oil spill research and development. Primary Oil Spill Response Organizations (for example, Marine Spill Response Corporation and Clean Gulf Associates) have coordinated efforts to significantly improve capabilities.

Advancing Well-Containment Capabilities. The Commission recommended that industry must develop well-containment technologies that are rapidly deployable and must demonstrate their effectiveness in deep water; to effectively oversee such operations, the government must develop in-house expertise. The findings presented here emphasized the self-initiated capability developments accomplished by industry, including notable new systems developed by the Marine Well Containment Company (MWCC) and separately by Helix.

VISION 2030-2050

The findings presented above serve to identify opportunities for improvement. Given current realities, desired aim points for best practices and anticipated rates of progress for technologies, visions for improvements in offshore operations can be realistically projected for the year 2030 and, with a stretch, for the year 2050 (Table 5).

Table 5. Vision of the Path Forward for Offshore Oil and Gas Developments.

Offshore Operational Topic Area	Reality in 2010	Vision for 2030	Vision for 2050
1. Environmental Footprints and Regulatory Reviews	• Subjective footprint metrics • Complex, overlapping regulatory oversight	• Quantitative footprint metrics • Streamlined regulatory oversight	
2. Environmental Management of Seismic and Other Geophysical Exploration Work	• Incomplete and conflicting views on severity of E&P impacts on marine life	• Significant and consistent baseline data • Fact-based avoidance criteria • Seismic sources with reduced waste energy	
3. Subsea Drilling, Well Operations and Completions	▪ Challenges for longevity and serviceability of downhole equipment	▪ Advanced, corrosion-resistant alloys	▪ Self-diagnostic & self-correcting downhole and surface controls
4. Well-Control Management and Response	• Prescriptive rules running ahead of performance standards	• Performance standards supported by prescriptive rules	▪ Self-diagnostic & self-correcting downhole and surface controls
5. Offshore Production Facilities and Pipelines, Including Arctic Platform Designs	• Misunderstanding of Arctic offshore capabilities	• Acceptance of Arctic facilities per current level of GOM facilities	• Self-diagnostic & self-correcting downhole and surface controls
6. Offshore Transportation	• Various vessels and inspection / certification regulations • Inadequate baseline data on emissions	• Baseline science data include emissions data (air and fluids)	
7. Data Management	• Multiple government data systems that do not cross-communicate	• Coordinated data systems with consistent standards	• Unified data system with global standards

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APPENDICES

Appendix 1: Glossary

BOEM. US Bureau of Ocean Energy Management. A part of the DOI and one of two agencies formed by splitting the BOEMRE. BOEM is responsible for managing development of the nation's offshore resources in an environmentally and economically responsible way. Functions include: leasing, plan administration, environmental studies, NEPA analysis, resource evaluation, economic analysis and the renewable energy program.

BOEMRE. US Bureau of Ocean Energy Management, Regulation and Enforcement. An agency within the US Department of Interior (DOI). As of June 2010, BOEMRE was created to succeed the former Minerals Management Service (MMS). BOEMRE itself was divided into two different agencies (BOEM and BSEE) in January 2011.

BOP. Blowout preventer. An assembly of ram-driven pipe cutters, connectors and valves that functions as an emergency system for shutting off hydrocarbon flow from a well. BOPs can be configured to sit directly atop the wellhead or at some distance above the wellhead.

BSEE. US Bureau of Safety and Environmental Enforcement. A part of the DOI and one of two agencies formed by splitting the BOEMRE. BSEE is responsible for enforcement of safety and environmental regulations. Functions include: All field operations including permitting and research, inspections, offshore regulatory programs, oil spill response, and training and environmental compliance functions.

CAA. Clear Air Act. US federal legislation, dating from 1970 and with major amendments in 1990, that prescribes the regulatory structure for protecting US protecting and improving the nation's air quality and with extensions to the stratospheric ozone layer. The EPA is responsible for administration of the CAA although, for offshore sources of emissions, certain permitting authorities are delegated to the DOI and USCG.

CMSP. Coastal Marine Spatial Planning. A comprehensive, adaptive, integrated, ecosystem-based, and transparent spatial planning process, based on sound science, for analyzing current and anticipated uses of ocean, coastal, and Great Lakes areas. CMSP identifies areas most suitable for various types or classes of activities in order to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives. In the US, it is manifest as a Federal government policy that prescribes establishment of "planning areas" to manage multiple existing uses (including fishing and boating in addition to oil and gas operations) and emerging uses (for example, offshore renewable energy and aquaculture) of US coastal and marine waters.

Completion. Used alternately to describe (a) an individual well that is finished to the state of operationally producing hydrocarbons, and (b) the assembly of equipment that controls and connects individual producing wells into a system that directs the hydrocarbons to a processing or storage facility ("Subsea completion" refers to the latter infrastructure-based definition for offshore hydrocarbon production.)

COS. Center for Offshore Safety. An industry-sponsored organization, formed in March 2011, with a mission to promote the highest level of safety for offshore drilling, completions, and operations through leadership and effective management systems addressing communication, teamwork, and independent third-party auditing and certification.

CWA. Clean Water Act. Sometimes also known as the Federal Water Pollution Control Act. US federal legislation, dating from 1972, that prescribes the regulatory structure for protecting US water from pollution. Section 301(a) of the CWA, 33 USC 1311(a), renders it unlawful to discharge pollutants to waters of the United States in the absence of authorizing permits. The EPA is responsible for administration of the CWA.

CZMA. Coastal Zone Management Act. US federal legislation, dating from 1972, that prescribes the regulatory structure for management of coastal resources, including the Great Lakes, and balances economic development with environmental conservation. It provides for two national programs: National Coastal Zone Management Program and the National Estuarine Research Reserve System. The NOAA is responsible for administration of the CZMA.

DOE. US Department of Energy.

DOI. US Department of the Interior.

DOT. US Department of Transportation.

E&P. Exploration and production activities involving discovery, evaluation and recovery of oil and gas resources.

EPA. US Environmental Protection Agency. This independent agency is responsible for rulemaking and enforcement of environmental regulations.

ESA. Endangered Species Act. US federal legislation, dating from 1973, which provides for the conservation of threatened and endangered plants and animals and the habitats in which they are found, including both onshore and offshore environments. Administration of ESA is divided between the FWS and NOAA based on continental or oceanic occurrence.

FWS. US Fish and Wildlife Service.

G&G. Geological and geophysical. An abbreviation favored in some MMSW or BOEM documents with reference to offshore oil and gas exploration otherwise abbreviated as E&P.

GOM. Gulf of Mexico.

HMTA. Hazardous Material Transportation Act. US federal legislation, dating from 1975, that provides for regulations to protect against the risks to life and property inherent in the transportation of hazardous material in commerce. Hazard material is defined as any "particular quantity or form" of a material that "may pose an unreasonable risk to health and safety or property." The DOT is responsible for administering the HMTA.

JIP. Joint industry program (project).

MFC (or MSA). Magnuson-Stevens Fishery Conservation and Management Act. US federal legislation, dating from 1976 and amended in 1996 and 2006, which provides for regulatory, marine fisheries management in US federal waters. Areas of focus include development of baseline scientific data, establishment of catch limits and international coordination. The NOAA is responsible for administering the MFC (MSA).

MMPA. Marine Mammal Protection Act. US federal legislation, dating from 1972 and significantly amended in 1994, which prohibits, with certain exceptions, the "take" (hunting and killing) of marine mammals in US waters and by US citizens on the high seas, and the importation of marine mammals and marine mammal products into the US. The exceptions are for Alaska Native subsistence hunting and limited scientific research. The NOAA is responsible for administering the MMPA.

MMS. US Minerals Management Service (MMS). As of June 2010, it was replaced by the BOEMRE.

MODU. Mobile drilling unit.

NEPA. National Environmental Policy Act (NEPA). US federal legislation, dating from 1970, that provides for an environmental impact statement (EIS) as a core requirement of federal regulatory agencies that are responsible for permitting infrastructure projects, including oil and gas exploration and development.

NFEA. National Fishing Enhancement Act. US federal legislation, dating from 1984, that provides for regulations to establish national standards for the construction and siting of artificial reefs in US waters to enhance fishery resources and fishing opportunities. The NOAA, and especially NMFS, is responsible for administering NFEA.

NGPA. Natural Gas Policy Act. US federal legislation, dating from 1978, which provides for Federal regulation of interstate oil and gas pipelines. The Federal Energy Regulatory Commission (FERC) is designated to administer the NGPA.

NHPA. National Historic Preservation Act. US federal legislation, dating from 1966 and amended in 1992 and 2006, which commits the Federal government to "provide leadership" for preservation, "contribute to" and "give maximum encouragement" to preservation of pre-historic and historic sites of cultural significance. The significance to offshore developments is that NHPA requires all Federal agencies to take into account the effects of their actions on historic properties. The US National Park Service (NPS) was designated as the coordinator of Federal support with State and Native American cultural organizations.

NMFS. US National Marine Fisheries Service. A part of NOAA.

NOAA. US National Oceanic and Atmospheric Administration. An agency within the US Department of Commerce that is responsible for collecting, organizing and distributing oceanographic, weather and climate data for US states and territories.

NPS. US National Park Service.

OCS. Outer Continental Shelf. By physiographic definition the continental shelf is the expanse of seafloor between the shoreline and the break in slope at the continental margin that defines the continental slope and the more distant benthic regions of the ocean bottom. The continental shelf varies in width and depth. For US regulatory purposes, the OCS is defined as “an offshore area in the United States that begins where state ownership of mineral rights ends and ends where international treaties dictate". The OCS includes both shallow and deepwater developments.

OCSLA. Outer Continental Shelf Lands Act. US Federal legislation, dating from 1953 and amended through 2002, which provides for regulation of the use of" submerged lands" of the Outer Continental Shelf that are defined as US land. The original Act designated the DOI to administer the regulations and currently BOEMRE (formerly MMS) is the administrator.

ONRR. US Office of Natural Resources Revenue. The revenue-collection agency, formerly part of MMS that collects royalties and other payments from offshore oil and gas producers.

OPA. Oil Pollution Act. US Federal legislation, dating from 1990, which requires oil-spill contingency planning both by government and industry and prescribes fines and other legal penalties for operators whose actions create oil spills. Administrative authority for OPA is shared between the US Coast Guard (USCG) and the US Environmental Protection Agency (EPA).

OSRP. Oil Spill Response Plan.

Platform. An immobile offshore structure from which development wells are drilled or produced. Some platforms are dedicated to drilling while other platforms are dedicated only to production from completed wells. Unlike a MODU, a drilling platform is built for a fixed location.

RHA. Rivers and Harbors Act. US Federal legislation, dating from 1899, which provides for regulation of projects and activities in navigable waters, including and harbors and rivers. In 1966, authority over bridges and causeways was transferred to the US Department of Transportation (DOT) but other administrative authority for the RHA remains with the US Corps of Engineers (USACE).

Rig. A structure, and all associated equipment, that is used to drill exploration or production wells. In contrast with an offshore platform, an offshore rig is mobile, meaning that it can be moved from one location to another. MODU is a common terms applied to rigs.

ROV. Remotely-operated vehicle. An underwater vehicle equipped with cameras and other sensors, as well as some external manipulators, which is operated from shipboard work stations in order to accomplish sub-sea observations and inspections.

Seismic. Physical analyses involving transmission and reflection of sound waves ("sounding") to decipher sub-surface geologic structures. Natural seismic waves are generated by geologic phenomena that include earthquakes, landslides and volcanic eruptions. Anthropogenic (human-generated) seismic waves, as used in subsea exploration, include those generated by air guns and vibrators operated from ships.

SIMOPS. Simultaneous operations. Generally refers to a coordinated plan to assure that multiple offshore activities and vessels do not create interferences during subsea construction work.

Sonar. Physical analysis involving transmission and reflection of sound waves to determine ocean bottom depths and sub-sea topography. Sonar waves are distinguished from other seismic waves by frequency and intensity. In offshore oil and gas activities, sonar commonly is used to detect and map underwater hazards prior to subsea construction work.

USACE. US Army Corps of Engineers.

USCG. US Coast Guard.

Appendix 2: Charter of the Operations & Environment Task Group

National Petroleum Council
North American Natural Gas and Oil Resources Study
Operations & Environment Task Group (OETG) – Final Charter
August 13, 2010

<u>Operations & Environment Task Group Objective:</u> Describe operating practices and technologies used to minimize environmental impacts from oil and gas development, and discuss future mitigation and enhancement options.

<u>Deliverables:</u>

- Define the current operating practices and technology used to minimize impacts on the environment in onshore and offshore oil and gas operations in North America
- Define the specialized technology used to minimize impacts on the environment in onshore and offshore operations in North America
- Identify emerging technology that may lead to further reductions in impacts on the environment in onshore and offshore oil and gas operations in North America
- Characterize new or potentially breakthrough technologies that may significantly alter the future environmental footprint of onshore and offshore natural gas and oil development.
- Discuss current regulations and policies that constrain or facilitate environmental protection in oil and gas operations in North America
- Characterize innovative and comprehensive strategies for avoiding and reducing environmental impacts associated with North American oil and gas development
- Define the roles that Project Design, Operating Practices, and Best Management Practices (BMP) play in reducing environmental impacts in natural gas and oil operations
- Describe the environmental footprint of oil & gas operations, compared to other energy sources.
- Evaluate the following concepts and practices:
  - Reducing Regulatory Duplication – State vs. Federal
  - Partnerships for Success
  - Prescriptive vs. Proactive Regulatory Oversight, A Case for Environmental Management Systems
  - Adaptive Management
  - Community Right to Know, Good Neighbor Policy, and Public Affairs – The Challenges of Communicating With a More Informed Public
- Discuss prudent development alignment with national environmental goals
- Discuss ways to stimulate technological innovation and environmental leadership
- Define the scope of regulatory framework considerations that could minimize impacts on the environment in future oil and gas operations in North America
- After analysis of data, recommend policy considerations that will facilitate enhanced environmental performance in future oil and gas operations in North America

<u>Scope Limitations</u>

- **In scope:**
  - Operating practices and technologies that are protective of the environment.
  - Upstream and midstream onshore and offshore operations in US and Canada.
  - US policies, laws, and regulations governing natural gas and oil exploration and production.
  - Best practices and technology (domestic and international)

- **Not In Scope:**
  - Resource or supply related operating practices or technologies that do not have an environmental component.
  - Downstream (refining & marketing) and end user practices and technologies.
  - Operations in Mexico (onshore and offshore)
  - Canadian and Mexican policies, laws, and regulations of natural gas and oil exploration and production.
  - International operations (except for Canada)

NARD OETG FINAL Charter Page 1 of 2 9/8/2010

Time Frame

- Initial Finding due: October 15, 2010
- Group initial report to CSC: October 27, 2010
- Group final draft report to CSC: December 8, 2010

Process:

- Conference call: weekly starting September 1, 2010
- Proposed Meetings:
  - Group Update1: July 12 & 13, 2010 – Fort Worth, TX
  - Group Update2: October 6 & 7, 2010 – Scranton, PA
  - Initial report review October 15-22, 2010
  - Final report review November 15-19, 2010

Group Leadership:

Name	Role
Paul Hagemeier	Chair
Steve Harvey	Gov't Co-Chair
Doug Morris	Alt. to Steve Harvey
Holmes Hummel	Gov't Co-Chair
Bill Fowler	Asst. Chair
Bob Slaughter	Secretary
AiJaz Rizvi	Project Planning & Facilitation

Subgroup Leadership:

Name	Role
Byron Gale	Onshore Ops. Leader
Jill Cooper	Asst. Onshore Ops.Leader
David McBride	Env & Reg Leader
Scott Anderson	Env & Reg Co-Leader
Alan Higgins	Env & Reg Asst. Leader
Dan Arthur	Technology Leader
Bill Hochheiser	Technology Asst. Leader
Kent Satterlee	Offshore Ops. Leader
David Smith	Asst. Offshore Ops.Leader

Appendix 3: Summary of External Reports on the *Deepwater Horizon* Incident

Deepwater Horizon Incident Investigations and Conclusions

The April 20, 2010 drilling rig explosion and resultant loss of life sent shock waves throughout the oil and gas industry, government agencies, and the nation. Prior to that event, despite the challenges of a risky operating environment, the offshore safety and environmental record was commendable with steady improvement witnessed for each succeeding decade. For example, the "lost workday incident rate" fell from 3.39 in 1996 to 0.64 in 2008. Over 42,000 offshore wells had been safely drilled since the 1950's, including over 2,000 in deep water, without a spill commensurate with the size of the one experienced with the BP event. Platforms and mobile drilling rigs in the Gulf have survived multiple major hurricanes without a similar environmental incident. But in the wake of the accident, the OCS program was suddenly rocked with questions and criticisms, including the credibility of the industry's safety culture. How could this happen? Were federal agencies and industry complacent or derelict?

To address the myriad of questions, numerous major studies were commissioned including:

- President Obama's National Commission on the BP Deepwater Horizon Oil Spill and Offshore Safety.
- The Bureau of Ocean Energy Management (BOEM) and U.S. Coast Guard (USCG) Joint Investigation.
- The National Academy of Engineering Macondo Study.
- The Chemical Safety Board Study.
- The OCS Safety Oversight Board Study.
- BP's and Transocean's Internal Investigations.
- Industry Study Group Investigations, and
- Congressional Investigations by: (1) the House Oversight and Government Reform Committee, (2) the House Natural Resources Committee, and (3) the House Energy and Commerce Committee.

Some of these studies and investigations are not yet complete as of March 2011. For others, results have not been released to the public. The significant findings of the following four major completed studies have already influenced private sector and public sector actions.

National Commission on BP *Deepwater Horizon* Oil Spill. On May 21, 2010, President Obama signed Executive Order 13543 establishing the National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling. The Commission's purpose was to examine relevant facts and circumstances concerning the root causes of the *Deepwater Horizon* explosion and develop options to guard against, and mitigate the impact of, any oil spills associated with offshore drilling in the future.

The Presidential Oil Spill Commission (2011) provided a total of 31 individual recommendations that were distributed among seven basic themes:

A. Improving the Safety of Offshore Operations
B. Safeguarding the Environment
C. Strengthening Oil Spill Response, Planning, and Capacity
D. Advancing Well-Containment Capabilities
E. Overcoming the Impacts of the Deepwater Horizon Spill and Restoring the Gulf
F. Ensuring Financial Responsibility
G. Promoting Congressional Engagement to Ensure Responsible Offshore Drilling

The major findings included:

- The spill was the result of a series of specific and preventable human and engineering failures. The inevitable disaster was the result of years of industry and government complacency and lack of attention to safety.

- Errors and misjudgments by three major oil drilling companies—BP, Halliburton, and Transocean—played key roles in the disaster.

- Government regulation was ineffective, and failed to keep pace with technology advancements in offshore drilling. MMS lacked "in-house" technical expertise.

- Both industry and government were unprepared to contain a deepwater blowout.

Although the Commission Report asserted there was a "systemic" problem within industry, the Commission's Chief Council's Report alternatively concluded that the root cause is traceable to a "series of engineering and management mistakes" by BP, Transocean, and Halliburton (available at: http://www.oilspillcommission.gov/chief-counsels-report).

The Commission concluded that fundamental reforms are needed in the management structure of those in charge of regulatory oversight to ensure political autonomy, technical expertise, and full consideration of environmental protection concerns. Industry must take ownership of inadequate safety procedures by establishing a "culture of safety." Industry should establish a "safety institute." Congress must increase the oil spill liability limit. BOEM must enhance their regulatory regime, including both prescriptive and performance based requirements. Many of the recommended reforms have already been implemented through BOEM and industry actions, as follows:

- BOEM has promulgated a Safety and Environmental Management System (SEMS) regulation that includes a risked-based performance approach which incorporates industry's Recommended Practice (RP) 75. BOEM has also promulgated a Drilling Safety rule including new prescriptive requirements for well design, casing, and cementing.

- BOEM and industry are working with members of the International Regulators Forum to examine how best to incorporate international standards.

- DOI has created an Offshore Safety Advisory Committee, comprised of representatives of industry, academia, and other federal agencies to provide engineering and scientific advice for improving offshore safety.

- Industry, through the American Petroleum Institute, has developed the format for a Center for Offshore Safety that will provide independent audits of companies' management systems, best practice sharing, and phased in approach to a "safety case" regime. The International Association of Drilling Contractors (IADC) has published "HSE Case Guidelines for Mobile Offshore Drilling Units" and the "Well Construction Interface Document".

- BOEM has announced a new organization that provides independent authority to the regulatory function and has requested funding to increase the inspection workforce and the funding of environmental and engineering studies.

- Industry has procured large scale response and containment capabilities, such as the Marine Well Containment Company (MWCC) and the HELIX capping stack. The Marine Spill Response Corporation (MSRC) and Clean Gulf Associates (CGA) have more than doubled the industry spill response capabilities. In addition, industry is considering the adoption of new well design standards (RP96).

The National Commission report (Presidential Oil Spill Commission, 2011) has received substantial national attention, and its recommendations are the primary vehicle that the United States government is using to drive changes to improve safety and environmental performance in the production of offshore oil and gas resources. To the extent that the NPC desires to endorse the recommendations of the Commission, Table A3-1 summarizes those recommendations with responses reflective of the objectives of the current study.

Table A3-1. National Commission Comments and Possible NPC Responses.

Commission Recommendation	Possible NPC Response
A. Improving the Safety of Offshore Operations	
Industry must develop the ability to demonstrate how their processes and procedures will better manage risk to achieve safer outcomes. The industry must adopt a culture of safety and move towards developing a notion of safety as a collective responsibility, with a focused commitment to continuous improvement and a zero failure rate. The industry should establish a "Safety Institute" which would be an industry-sponsored entity aimed at developing, adopting and enforcing standards of excellence to ensure continuous improvement in safety and operational integrity offshore. This would assist the U.S. to lead an international effort to develop global best practices for safety that can be adopted and applied worldwide. Scientific and technical research in all areas related to offshore drilling needs to be accelerated since better information is essential to making informed decisions about risk before exploration or drilling commence.	The offshore oil and gas industry has a strong safety culture, but safety programs differ between companies and broad systems (operational, technological, management and communications) may not always be aligned. Agree that an industry safety program, which will drive global best practices, is warranted. Steps have been taken to put such a program in place.

Commission Recommendation	Possible NPC Response
U.S. offshore drilling regulations and enforcement should be the most advanced in the world. Existing conventional or "baseline" safety regulations in the U.S. should be expanded to address all features essential to well safety, and should be updated and enhanced to ensure safer drilling in all US offshore operations. These new, updated regulations should be supplemented by a "risk-based" regulatory approach in the U.S. that requires all offshore drilling companies to demonstrate that they have thoroughly evaluated all of the risks associated with drilling a particular well or other operation), and are prepared to address any and all risks pertaining to that well, a system similar to what exists in Norway and the United Kingdom. Industry should be required to demonstrate how their processes and procedures will better manage risk to achieve safer outcomes and to constantly update its risk management plans to reflect actual experience during the exploration.	Agree with reference to international benchmarks; but specific individual facilities, operations and environments will influence regulatory requirements. Regulations need to have a balance of prescriptive vs. performance-based requirements (e.g., with the adoption of API RP75, BOEMRE now requires a company to have a safety and environmental management system that includes a risk-based performance approach. Standards are typically developed by industry with the strong involvement of seasoned subject matter experts and with the cooperation of government. Regulators can cite industry standards by reference in regulations.
The U.S. should lead an international effort to develop global best practices for safety that can be adopted and applied worldwide. Increased regulator staffing and training and adequate and predictable funding for regulatory oversight is essential. Budgets for the regulatory agencies that oversee offshore drilling should come directly from fees paid by the companies being granted access to a publicly owned resource. An independent safety agency within the Department of Interior should be created with appropriate expertise to oversee all aspects of offshore drilling.	Agree that BOEMRE must increase staffing, training, and adequate and predictable funding for regulatory oversight. The government collects substantial rents, royalties, lease bonuses, and permit fees to adequately fund this increase. The recent reorganization announce by the Department of Interior appears to provide the proper safety oversight provided that experienced and knowledgeable staff can acquired; however, such a massive change will likely further exacerbate permitting delays.
B. Safeguarding the Environment	
Broader consultations among federal agencies, including the Coast Guard and NOAA, prior to leasing and exploration will help identify and address risks. NOAA should receive a more formal consultation role in Interior leasing decisions. A distinct environmental science office should be created within Interior with appropriate expertise and funding and tasks including environmental protection review. Scientific and technical research in all areas related to offshore drilling needs to be accelerated. Better scientific and technical information is essential to making risk decisions before exploration commences. Greater attention should be given to new tools, like coastal and marine spatial planning and ocean observation systems, to improve environmental protection, management of OCS activities and ecosystem restoration efforts in marine environments.	Agree that regulatory decisions must be based on sound science but also point out that substantial scientific studies have been performed in the OCS (over $1 billion). This is equally true in the well-developed areas of the Gulf of Mexico as well as the Arctic. Baseline science studies should be developed with participation by industry experts wherever possible. Agree with focused attention on integrated planning among agencies that share the stewardship of the nation's ocean environment. Caution on use of prescriptive tools, such as coastal and marine spatial planning, that need further development and review prior to widespread use. We acknowledge the value of joint industry projects (JIPs) as sources of baseline environmental information. Congress should provide the resources to establish Coast Guard capabilities in the Arctic, based on the Coast Guard's review of current and projected gaps in its capacity Congress should also provide funding for environmental studies to better understand these regions. The government collects substantial rents, royalties, lease bonuses, and permit fees to adequately fund this increase.

<table>
<tr><th>Commission Recommendation</th><th>Possible NPC Response</th></tr>
<tr><td colspan="2">C. Strengthening Oil Spill Response, Planning, and Capacity</td></tr>
<tr><td>Spill response planning by both government and industry must improve. Government review of plans must be rigorous and involve all federal agencies with responsibilities for oil spill response. The federal government must do a better job of integrating state and local officials into spill planning and training exercise. The government needs to incentivize the next generation of more effective response technologies. The government must develop in-house expertise to estimate accurately flow rates following a blowout.</td><td>Agree that spill response capability must improve and will involve a concerted effort by both industry and government, including additional funding for oil spill R&D. Primary Oil Spill Response Organizations (Marine Spill Response Corporation and Clean Gulf Associates) have coordinated efforts to significantly improve capabilities in the following areas:

• Deepwater mechanical recovery response vessels – increased from 7 to 18, including five large Platform Supply Vessels which will double the pre-Macondo skimming capacity (triple with night operations);
• Detection, monitoring, and sustainability – night spill detection with infrared camera and X-band radar, adverse weather;
• Newer technology skimmers (efficiency of oil vs. water recovery);
• Increased floating inventory of boom for containment and enhanced encounter rate;
• Increased Vessel of Opportunity (VOO) skimming systems;
• Near-shore mechanical recovery – doubled skimming capacity;
• Dispersants – increase in aircraft capacity and inventory for subsea use (with MWCC);
• In-situ Burning – increase in fire boom inventory;
• Increased full-time response personnel.</td></tr>
<tr><td colspan="2">D. Advancing Well-Containment Capabilities</td></tr>
<tr><td>Industry must develop well-containment technologies that are rapidly deployable and must demonstrate their effectiveness in deepwater. Industry spill response plans much provide realistic assessments of response capability including well containment. The government must develop in-house expertise to oversee effectively well-containment operations.</td><td>Agree. Industry has procured large scale containment capabilities, such as the Marine Well Containment Company (MWCC) and the HELIX capping stack.</td></tr>
<tr><td colspan="2">E. Overcoming the Impacts of the Deepwater Horizon Spill and Restoring the Gulf</td></tr>
<tr><td>The penalties paid by BP and other parties responsible for the oil spill should be primarily devoted to Gulf restoration. Congress should dedicate 80% of any Clean Water Act civil and criminal penalties to long-term restoration of the Gulf of Mexico in partnership with the states.</td><td>Generally agree, but the NPC study group has no unique expertise on this subject to warrant a response.</td></tr>
<tr><td colspan="2">F. Ensuring Financial Responsibility</td></tr>
<tr><td>Drilling operators should be financially responsible for the consequences of failure. The current $75 million cap on liability for offshore facility accidents is inadequate and places the economic risk on the victims and taxpayers. The cap should be raised significantly and provisions made to ease burden on small-scale operators.</td><td>Generally agree, but the NPC study group has no unique expertise nor has evaluated studies regarding definition of a new approach to liability.</td></tr>
<tr><td colspan="2">G. Promoting Congressional Engagement to Ensure Responsible Offshore Drilling</td></tr>
<tr><td></td><td>NPC responses have been incorporated into the responses above.</td></tr>
</table>

National Academy of Engineering. At the request of the Department of the Interior (DOI), a National Academy of Engineering/National Research Council (NAE/NRC) committee is examining the probable causes of the Deepwater Horizon incident to identify measures for preventing similar events in the future. The ongoing study will address the performance of technologies and practices involved in the probable causes of the Macondo well blowout and explosion. It will also identify and recommend available technology, industry best practices, best available standards, and other measures in use around the world in deepwater exploratory drilling and well completion.

Fifteen meetings of the Council have been held since July 2010. The meetings have been conducted in closed sessions and limited details have been publicly provided. However, an interim letter report was issued on November 16, 2010 containing a number of preliminary findings about the probable causes of the Deepwater Horizon explosion and oil spill and potential measures to avoid such events:

- The incident was precipitated by a faulty decision to proceed with temporary abandonment despite negative indications from repeated well integrity tests.
- The failures and missed indicators were not limited to only one series of tests. They were preceded by numerous such failures by management and technical personnel. There were insufficient management checks and balances for making well abandonment and safety decisions.
- The various technical failures indicate lack of appropriate controls for managing risk.
- Government inspectors lack technical expertise. The multiple government agencies did not effectively coordinate on critical safety issues. MMS relied too heavily on industry standards.

BOEM and industry have taken specific actions to address each of these recommendations as indicated above.

Outer Continental Shelf Safety Oversight Board. The OCS Safety Oversight Board (OSB) was established by Secretary Salazar (Order No. 3298) on April 30, 2010. The purpose of the board was to provide recommendations regarding interim measures that could enhance OCS safety and improve the Bureau's overall management, regulation and oversight of OCS operations.

On September 8, 2010, the Board issued a report providing recommendations for improving BOEM's operational and management policies, notably:

- BOEM must enhance personnel training and recruitment to address the lack of technical expertise.
- Increased fines and civil penalties are required to deter to risky industry practices.

- BOEM must address real and perceived conflicts between resource management, safety and environmental oversight and enforcement, and revenue collection responsibilities.

- BOEM must take steps to improve Inter-Agency coordination with federal agencies related to oil spill response and the mitigation of environmental effects of offshore energy development.

Simultaneous with the release of the report, the BOEM Director announced an implementation plan to address each of these issues.

Internal BP Investigation. On September 8, 2010, BP released an internal report on the factors that contributed to the Deepwater Horizon accident. The four-month investigation was led by BP's Head of Safety and Operations along with more than 50 internal and external technical experts. The report concluded that:

- The cement and shoe track barriers, and in particular, the cement slurry that was used at the bottom of the Macondo well failed to contain hydrocarbons within the reservoir as they were designed to do.

- The results of the negative pressure test were incorrectly accepted by BP and Transocean.

- The Transocean rig crew failed to recognize and act on the influx of hydrocarbons into the well until the hydrocarbons was in the riser and rapidly flowing to the surface. After the well-flow reached the rig it was routed to a mud-gas separator, causing gas to be vented directly on to the rig rather than being diverted overboard.

- The flow of gas into the engine rooms through the ventilation system created a potential for ignition, which the rig's fire and gas system did not prevent.

- The rig's blow-out preventer on the sea-bed should have activated automatically to seal the well. It failed to operate, probably because critical components failed.

Based on the key findings, the investigation team proposed 25 recommendations designed to prevent a recurrence of such an accident. The recommendations include measures to enhance the reliability of blow-out preventers, well control barriers, pressure-testing mechanisms, emergency systems, cement testing, rig audit and verification, and to ensure personnel competence.

BOEM / USCG Joint Investigation Team (JIT). The JIT was convened by joint direction of the Departments of the Interior and Homeland Security, April 27, 2010. Originally the JIT had planned to report its findings on the same schedule as the Presidential Commission (January 2011 report). However, laboratory examination of the subsea BOP retrieved from the Macondo wellhead took much longer than anticipated. The BOP report is expected on March 21, 2011 and the final report is targeted for July 27, 2011.

Although the JIT has not released interim reports, it has published transcripts of testimony collected in numerous public hearings. From those transcripts, some likely findings can be inferred, including:

- Operational lines of authority onboard the *Deepwater Horizon* were insufficient relative to an expected best practice.
- Equipment and procedures expected to monitor and prevent blowouts either did not function correctly or were not operated effectively.

Conclusion. The obvious overlap in the major findings of the studies to date indicates a general consensus on many of the root causes of the BP Deepwater Horizon incident and agreement on the necessary reforms. BOEM and industry have taken steps to establish new safety practices and procedures and new response capabilities to address each of the critical recommendations which do not require Congressional action. These steps are now in large part completed and have substantially strengthened the OCS Program. Other steps are ongoing and will arguably work toward making the OCS the safest operating regime in the world and set a new standard that other regimes will emulate. Further Congressional actions are required to address oil spill liability and agency funding to augment federal expertise and assure coordination among agencies.

Cooperation between government regulators and industry with the proper “fire walls” in place is imperative given the complex nature of technologies used in the Deepwater operating environment. It is the advancement of technologies that have enabled the industry to find and recover oil and natural gas that would have otherwise remained locked up. The U.S. energy policy must recognize this synergistic relationship and make provisions to facilitate greater cooperation and partnerships that make sense.

Appendix 4: Topic Papers Developed as Background for this Synthesis Report

The material presented in the main body of this report was synthesized from a series of seven (7) topic papers that were researched and written by subject-matter specialists working in support of the OETG Offshore Operations Subgroup. Each topic paper contains tables, figures and literature citations that substantiate and document the findings made in the paper. The topic papers are available separately from the NPC and are identified as follows, including listings of the main elements contained in each paper:

1. Environmental Footprints and Regulatory Reviews. Total of 26 pages; 9,080 words.

    - Concept of Environmental Footprints
    - Need for Accord Between Regulations and Technology
    - Regulatory and Environmental Process
    - Federal Inspection Program
    - Non-US Offshore Inspection Programs
    - Special Considerations for Abandonment and Reclamation
    - US OCS Regulatory Approach
    - Non-US Regulatory Approach
    - Innovations Related to "Rigs to Reefs" Program
    - Regulation of Oil-Spill Response Plans

2. Environmental Management of Seismic and Other Geophysical Exploration Work. Total of 42 pages; 14,563 words.

    - Recognition of Sound as an Important Environmental Issue
    - Oil & Gas Industry Use of Sound-Active Exploration
    - Underlying Principles of Marine Seismic Methods
    - Non-Seismic Methods
    - Current Applications of Technology in OCS Planning Areas
    - Environmental Impacts of Seismic Surveys
    - Mitigating Potential Impacts of Seismic Surveys

3. Subsea Drilling, Well Operations and Completions. Total of 44 pages; 14,716 words.

    - Drilling, Well Completions and Subsea Completions
    - Common Types of Drilling Rigs
    - Offshore Drilling and Production Platforms

- Sequence of Well Construction Operations
- Drilling Fluids and Cuttings
- Wastewater, Air Emissions and Solid Waste
- Source Reduction, Recycling and Re-Use
- Environmental and Economic Benefits of Subsea Completions

4. Well-Control Management and Response. Total of 45 pages; 14,754 words.

    - Subsea Blowout Prevention Technologies and Practices
    - Industry Assessment of Needs and Directions in Blowout Prevention
    - Oil-Spill Prevention and Response (OSPR) Objectives, Practices and Regulations
    - OSPR Special Considerations in Arctic Conditions
    - Fire Control Strategic and Tactical Considerations and Practices

5. Offshore Production Facilities and Pipelines, Including Arctic Platform Designs. Total of 29 pages; 10,981 words.

    - Overview of Footprint-Reducing Technologies
    - Subsea Flow Assurance and Separation Technologies
    - Produced Water and Air Emissions from Offshore Facilities
    - Pipeline Design, Construction, Operation, Inspection and Maintenance
    - Arctic Offshore Structures and Pipelines

6. Offshore Transportation. Total of 16 pages; 5,646 words.

    - Marine Vessel Environmental Effects on Coastal Habitats
    - Marine Vessel Environmental Effects Involving Air Emissions, Noise and Collisions with Marine Mammals
    - Aircraft Environmental Effects Involving Air Emissions, Noise and Collisions with Birds

7. Data Management. Total of 23 pages; 6,108 words.

    - Technologies and Rationale for Data Management
    - Status of Data Management at Key US Government Agencies
    - Environmental and Economic Impacts of Data Management
    - The UK Oil Portal as a Benchmark for Data Management Programs

Appendix 5: Findings by Topical Areas for Offshore Oil and Gas Developments

Offshore Operational Topic Area	Findings of the Topical Study
1. Environmental Footprints and Regulatory Reviews	A. Conflicting mandates of the various offshore statutes as administered by differing federal agencies make it difficult to achieve a balanced and predictable federal policy. B. Federal regulatory agencies lack technical expertise to oversee complex technical systems and operations. Lack of resources, pay grades, and training are significant barriers. Inadequate funding for inspections and a questionable policy that opposes reliance on industry self-inspection may also pose risks to the environment. Certain security procedures also limit BOEMRE's ability to conduct unannounced inspections. C. Recent industry initiatives in response to the BP spill represent encouraging developments that should provide improved future response. There are certain regulatory barriers concerning EPA approval of burning and dispersant use that pose environmental risks. There is inadequate coordination on OSRP with state and local governments. There is a need for real-time drills to test technology and response coordination that have been successful in other countries and warrant evaluation in the US. D. Decommissioning offshore platforms includes beneficial options in addition to complete removal of "idle iron". Specifically, re-purposing the subsea components of platforms can benefit marine ecology as tested in the US "Rigs to Reefs" program in the Gulf of Mexico through some useful revisions.
2. Environmental Management of Seismic and Other Geophysical Exploration Work	A. Seismic exploration methods will continue to be the key geophysical technologies required to discover, evaluate and enable production of offshore oil and gas resources. Non-seismic methods, although useful in complementary roles, will not supplant seismic methods as the leading exploration technology. B. Seismic noise generated by offshore oil and gas exploration activities is recognized as a concern for whale populations and other marine life, including fish. Research has documented some correlations of biological responses with seismic sources even though the experiments have not always consistently included active and control populations. It is important to recognize, refine and consistently apply mitigation approaches based on high-quality science. C. The US is one of seven nations that individually develop practices that seek to minimize impacts on marine life through limits on seasons, locations and implementation procedures for performance of offshore seismic exploration. D. There is a need for additional technological refinements to supplement current mitigation methods during application of seismic exploration. Those additional considerations include design changes to reduce "waste noise" from airgun seismic sources and refinement of vibroseis devices as limited alternatives to airguns E. There is a need for expanded use of joint industry programs to advance sustainable seismic exploration technologies and to obtain regulatory recognition for the general benefits of such efforts

Offshore Operational Topic Area	Findings of the Topical Study
3. Subsea Drilling, Well Operations and Completions	A. Significant efforts, and considerable progress, have been made in formulating and handling drilling fluids to be more environmentally friendly. Because of the need to optimize drilling techniques during different phases of deep well construction, the chemistry of drilling fluids is expected to be an ongoing variable that will require collaboration between technologists and environmental regulators. B. Disposal of drilling-related wastes currently is done by a variety of permitted processes that are chosen to meet the needs of individual well-construction projects where volumes of wastes, water depths and distance from shore all factor into waste-disposal choices. Ongoing collaboration between technologists and environmental regulators also will be essential with regard to sustainable solutions for waste issues. C. Subsea completions for gathering hydrocarbons from subsea wells have demonstrated both environmental and economic benefits for offshore oil and gas projects. Barriers and opportunities for expanded use of subsea completions involve both technological and regulatory issues. Advanced technologies are needed to assure long-lived and serviceable subsea equipment (especially downhole). Reasonable regulations also are needed to assure that the best available technologies and practices are considered in rulemaking that affects subsea operations.
4. Well-Control Management and Response	A. Particular opportunities exist for research and development related to pre-event detection of indicators and to detect potential environmental impacts due to a blow out. Specific topics in blowout prevention that need focused, development attention include: 1) Multiple control systems to detect undesired events and to deploy last-resort BOP systems. 2) Increased capabilities for remotely-operated underwater vehicles, including untethered operations. B. Fire control is addressed most effectively as an integrated part of blowout prevention. Once a fire has started, additional complicated decisions become necessary. Opportunities for progress in fire control include studies of environmental trade-offs between potential air and potential water pollution based on a range of fire-management strategies, thereby providing for improved on-scene decision-making for a better overall event outcome. C. Oil-spill response (OSR) includes multiple methods/tools such as: (1) oil sensing & tracking; (2) dispersants; (3) in-situ burning; (4) mechanical recovery; and (5) shoreline protection and clean-up. All of these methods/tools must be properly developed, available, and pre-approved effectively respond to a large event.

Offshore Operational Topic Area	Findings of the Topical Study
5. Offshore Production Facilities and Pipelines, Including Arctic Platform Designs	A. Key technological developments for continuing progress on offshore platform operations emphasize equipment and techniques for subsea flow-assurance and separation. Progress in surface-based technologies also is expected but the largest, value-added advancements are needed to lengthen the working lifetimes and reduce the maintenance intensity for subsea systems. B. Wastewater handling on offshore platforms will continue to require site-specific choices among multiple, permitted alternatives; no single waste-disposal approach will be optimum for all situations. C. Offshore wastewater treatment and disposal can be addressed by several different physical and chemical technologies, all of which can be further improved. But a key point of emphasis is work to reduce overall volumes of wastewater generated so that treatment and disposal becomes less urgent overall. D. Air emissions from offshore platforms include several different potential sources although the volumetrically most significant category is natural gas emissions associated with hydrocarbon production. Venting and flaring are permitted methods to manage air emissions and will continue to be important options even though work continues to find alternative techniques that release less methane to the atmosphere. E. Pipelines have proven to be the safest, most reliable, economical and environmentally favorable way to transport oil and gas throughout the U.S. The aging of the pipeline infrastructure suggests that continual improvement in system integrity, monitoring, and leak-detection is necessary.
6. Offshore Transportation	A. Regulation of ocean vessels supporting offshore oil and gas projects in the Gulf of Mexico has been led by the USCG although with a long-standing reliance on various maritime shipping, ship-building and petroleum industry professional groups for support on certification of operating and inspection standards. Future success of offshore development will depend on continuing improvements to communications and collaborations between the USCG and the industry groups. B. Regulation of helicopters supporting offshore oil and gas projects has been led by the FAA but with the benefit of proactive aviation industry groups who track incidents and promote safe operating practices. Future success of offshore development will depend on continuing improvements to communications and collaborations between the FAA and the industry groups. C. Development of baseline data on transportation-related environmental impacts, beyond the limited dimension of air emissions, requires a new source of effort either by BOEMRE or by joint industry-government initiatives.

Offshore Operational Topic Area	Findings of the Topical Study
7. Data Management	A. Many of the oil and gas data-management issues identified by the US Department of Energy (DOE) in 2004 remain unresolved and problematical in 2010-2011. The issues are not related solely to lagging deployment of best technologies but also reflect lagging attention to uniform formatting and portability, reliable retention and critical documentation that would make data seamlessly available and usable as long-term resources. B. The multiplicity of US government regulatory agencies involved in setting data reporting requirements has led to inefficiencies both in the ability of industry operators to file reports and in subsequent retrieval of data for use in decisions about practices, permits and environmental impacts. C. US regulatory agencies have not made maximum use of successful data-management examples offered by organizations in Canada and the United Kingdom. D. Development of standards necessary for improvement of data management has been led by non-governmental organizations although progress has lagged in accomplishing adoption and integration into data systems of government regulatory agencies.