The Coast Guard Journal of Safety & Security at Sea
PROCEEDINGS
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Winter 2013–2014

The Outer Continental Shelf

One shelf, one standard

- *The Players*
- *Prevention*
- *Response*
- *Emerging Issues*

PROCEEDINGS

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Assistant Commandant's Perspective

by Rear Admiral Joseph A. Servidio
U.S. Coast Guard
Assistant Commandant for Prevention Policy

The many technological advances we have seen in the offshore industry are truly amazing, for example, remote operations, dynamic positioning, and system automation—unimaginable just a few decades ago. These rapid technological advances have opened up the deepwater frontier and likewise potentially opened up new risks and new challenges. The mobile offshore drilling unit explosions at Mississippi Canyon, 2010, and Timbalier, 2013, and the production platform explosion at West Delta, 2012, highlight potential risks to people, property, the environment, and our need to keep pace with technological advancements and ensure we are adequately addressing deep water and shallow water risks on the U.S. outer continental shelf (OCS).

We must reassess and revise our OCS standards, because Coast Guard requirements are dated in several areas. We have begun this work in critical areas, proposing regulations for safety and environmental management systems and preventing explosions as well as issuing guidance for dynamic positioning, firefighting, and lifesaving systems. Our new regulations will incorporate international and industry consensus standards and establish a framework focused on performance and keeping pace with rapidly evolving OCS technology. The framework will require all mobile offshore drilling units, floating facilities, and vessels operating on the U.S. OCS to satisfy the same standards regardless of flag.

Additionally, we recognize the expanding use of autonomous systems and other cutting-edge technology within the industry potentially creates greater cyber security vulnerabilities. We must address these risks before casualties occur that dictate we develop new regulations and associated requirements in a reactive manner. We wish to address these risks proactively in a deliberate, thoughtful manner that values the important role our stakeholders play in the development of effective standards and regulations. We will continue to seek input through our federal advisory committees, industry partnerships, and regulatory development processes.

The Coast Guard must ensure it acts in concert with other government agencies that have authority and responsibilities on the U.S. OCS, particularly the Bureau of Safety and Environmental Enforcement. It is critical that we collaborate with one another to maximize efficiency and effectiveness and develop compatible regulations and policies. We have completed a memorandum of understanding and several memoranda of agreements that reinforce our shared commitment to synchronize OCS requirements.

In summary, the Coast Guard recognizes its need to ensure regulations and standards keep pace with industry developments on the outer continental shelf, and that its strategy will direct finite resources toward the highest areas of risk.

Champion's Point of View

by Mr. Francis J. Sturm
Deputy Director, U.S. Coast Guard
Commercial Regulations and Standards

The outer continental shelf (OCS) is a challenging environment; however, the maritime industry has developed specialized equipment and processes to find and produce oil and natural gas there. Our vision for this edition is to provide information about facilities and vessels engaged in these types of operations on the U.S. OCS, with a particular emphasis on the efforts to ensure the safety of life and property there.

This vibrant, innovative industry is constantly looking forward. Read how industry leaders are adapting the latest advancements in commercial diving and in technologies like dynamic positioning systems and system verification evolution to make offshore energy development safer, more efficient, and more effective. Other articles provide insight into Coast Guard and industry efforts to create centers of expertise that can offer specialized advice.

Outer continental shelf development is constantly expanding into deeper water and into areas like the Arctic. One of our authors explains the purpose and authority for safety zones around oil drilling and production vessels in the Arctic. Others highlight challenges and advances in constructing floating offshore installations and mobile offshore drilling units.

Oil spills from offshore facilities and submerged pipelines often present different challenges than spills from many shipboard or land-based sources. We have a group of articles that focus on research and equipment devoted to these challenges and that explain the role of the Interagency Coordinating Committee on Oil Pollution Research.

Oil drilling and production is not the only energy-related activity taking place on the OCS. You can read about deepwater port facilities situated miles offshore that receive liquefied natural gas from ships arriving from outside the U.S. and move it through pipelines to storage facilities ashore and into the nation's gas pipeline infrastructure. You can also learn more about plans to establish wind-generated power stations on the OCS.

Even the offshore supply vessel (OSV), the traditional workhorse of the offshore industry, has changed dramatically in size and complexity during the last decade. You can read about where OSV design is headed, including efforts to build OSVs that run on liquefied natural gas.

We hope these articles give you a better understanding of some of the aspects of work on the OCS, the dynamic nature of the offshore industry, and an appreciation for the efforts to keep this industry safe, secure, and environmentally responsible.

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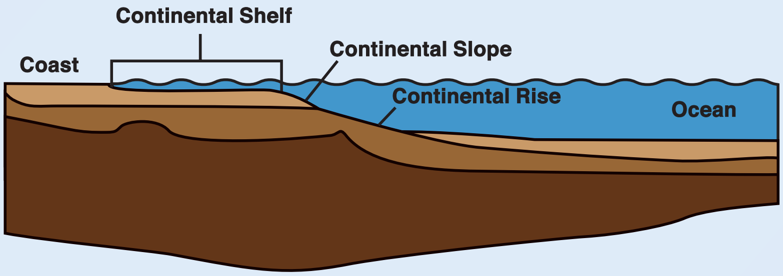
The Outer Continental Shelf

What is the Outer Continental Shelf?

The Submerged Lands Act defines the outer continental shelf as all submerged lands, the subsoil and seabed, lying seaward and outside of the area of lands beneath navigable waters.

The U.S. OCS is divided into four regions:

- the Gulf of Mexico,
- Atlantic,
- Pacific,
- Alaska.



Graphics courtesy of the Bureau of Ocean Energy Management.

The Offshore National Center of Expertise

by CDR Jim Rocco
Supervisor
U.S. Coast Guard
Offshore National Center of Expertise

Maybe you subscribe to geoscientist M. King Hubbert's famous theory of "peak" oil production, where each barrel of oil is marginally more remote and more difficult to find than the previous, now that the theoretical peak has since passed. Or, you marvel at the profound advances in recent technologies that are largely contributing to the current deepwater offshore drilling and production activity.

Or most importantly, you consider Bureau of Safety and Environmental Enforcement (BSEE) data, which states that 78 percent of the total Gulf of Mexico production is generated from just 2 to 3 percent of existing Gulf of Mexico wells. Thus, you begin to understand the implications based on where the biggest "pay zones" or proven reserves remain as well as oil producers' interest to expand their oil exploration areas.

Drilling in the Gulf of Mexico

According to BSEE data, prior to the 2010 drilling moratorium, the Gulf of Mexico deepwater drilling rig count stood at 27. The count plummeted to three during the moratorium, and then rebounded to 34 by the end of 2012, when the moratorium was lifted.

At the time this article was written, the Gulf of Mexico is scheduled to receive six additional drillships and a semisubmersible drilling rig in 2013. In 2014, three more drillships are planned for the gulf. Production activity forecasts are equally robust, with six floating facilities scheduled to begin deepwater service in 2014 and four more coming on line in 2015 and 2016.

While this activity is certainly encouraging for enhancing U.S. energy security and arguably mitigating global market volatility, continued offshore growth will necessitate that government agencies responsible for offshore safety and environmental interest oversight put forth the effort and resources necessary to keep pace with a dynamic and forward-leaning industry. The Coast Guard and other offshore regulatory agencies are challenged like never before to ensure emerging offshore drilling and production integrity.

Future activity will require these agencies to meet an array of novel risks inherent in complex and intricate operations. Technological advancements in areas such as ultra-deepwater facilities, sub-sea infrastructure, and extreme high-pressure, high-temperature equipment capabilities have conspired to draw activities into deeper and more remote areas.

NCOE Efforts

The Coast Guard has sought to leverage its offshore role to meet these challenges through its Offshore National Center of Expertise (NCOE) in Morgan City, La. Serving as a clearinghouse of sorts since 2009, the offshore NCOE

focuses on training Coast Guard offshore inspectors, while also asserting itself as the Coast Guard's primary point of contact for offshore industry outreach and interagency collaboration. At present, the NCOE is bridging the gap between conventional Coast Guard marine inspection knowledge and cutting-edge deepwater and supply boat technology with related emerging offshore safety considerations.

The many contacts the NCOE maintains and perpetually cultivates with industry and government stakeholders are instrumental to obtaining new information with which offshore inspectors can be trained. Such relationships include:

- the Center for Offshore Safety,
- the Offshore Operators Committee,
- the International Association of Drilling Contractors,
- Classification Societies,
- BSEE,
- shipyard and equipment manufacturers,
- commercial diving associations.

The center of expertise leverages these relationships to advance training objectives through hybrid industry/Coast Guard classroom training and impromptu on-the-job experiences offshore and at the corporate level.

Our current efforts to update our offshore qualification program will further support our own inspectors, as we work to keep pace with the evolving industry. The inherent "marine" nature of the industry's operating environment puts the center of expertise at the leading edge of coordinating multiagency efforts to facilitate offshore safety and environmental mandates.

New Technological Challenges Drive Licensing Requirements

A significant segment of the work, beyond training and industry outreach initiatives, is attending to unique and emerging issues of industry-wide significance. The tension leg platform (TLP) life cycle extension issue was recently brought to the attention of the Coast Guard, BSEE, and class societies. Understandably, operators are looking to prolong TLP mooring tendon service beyond originally determined design lives to maximize the value of these highly capital-intensive assets. Consequently, the Coast Guard, BSEE, and class societies are discussing ways to undertake the assessment process to meet this need—in light of more recent applied engineering and design criteria methods.

Other emerging and significant issues involve evaluating qualifications to issue offshore marine licenses, as growing offshore complexities drive the need to re-evaluate the human factor. The NCOE is working with Coast Guard licensing standards program managers to determine what revisions may be necessary to fulfill requirements to obtain licenses as a ballast control officer, barge supervisor, or offshore installation manager.

Partnerships Aid the Process

Our staff is also working with the BSEE training branch to re-establish the fixed platform training program for BSEE personnel who conduct inspections on behalf of the Coast Guard in accordance with 33 Code of Federal Regulation, Subpart B. A secondary benefit of this effort has been the synergy realized when working collaboratively on matters requiring BSEE and Coast Guard attention.

The NCOE exercises a concerted focus on facilitating a holistic inspector base of knowledge, as it pertains to the entirety of safety and environmental factors associated with deepwater drilling and production. Although the Coast Guard shares overall regulatory responsibilities with several federal agencies, the importance of understanding the entire scope of such operations is vital to the Coast Guard offshore inspector, fully appreciating the critical role with which he or she is entrusted.

As offshore stakeholders work toward the common goal to safely produce the nation's oil and gas reserves, the Offshore National Center of Expertise is intent on leveraging the Coast Guard's resources to this end. Furthermore, the need for promoting collaboration among agency/industry partnerships is readily apparent as technology advances. The center of expertise welcomes robust and open dialogue with stakeholders and encourages cooperation to ensure safe and productive offshore exploits.

About the author:
CDR Jim Rocco is the chief of the Coast Guard's Offshore Center of Expertise. He has 20 years of experience with the U.S. Coast Guard and has served in assignments including commercial vessel inspector, port operations officer, and liaison to vessel and offshore classification societies. He holds an MBA with a focus in finance from Northern Illinois University and a master's of international public policy with a focus in energy resources from Johns Hopkins School of Advanced International Studies.

For more information:

Access Bureau of Safety and Environmental Enforcement data at **www.bsee.gov**.

Safety By Industry, For Industry

The Center for Offshore Safety.

by Mr. Charlie Williams
Executive Director
Center for Offshore Safety

The Center for Offshore Safety (COS) is a new offshore exploration and production industry program that focuses on offshore safety and the safety and environmental management systems (SEMS) regulations that the Bureau of Safety and Environmental Enforcement (BSEE) requires. The center promotes offshore drilling safety through:

- leadership,
- communication,
- teamwork,
- safety and environmental management systems,
- third-party auditing and certification.

The overarching theme for all of these actions is to establish a safety culture, which is the common belief within an organization that creates commitment to continually learn from and improve safety and environmental management system effectiveness.

Regulatory Mandates

Coincident with COS formation, BSEE put in place a new regulation requiring all Gulf of Mexico oil and gas producers to implement safety and environmental management systems and report the results of third-party audits of these systems. Both of these programs had previously been voluntary.

Additionally, the SEMS requirement was the first major BSEE regulation that was performance-based rather than prescription-and-inspection based.[1] In its simplest terms, SEMS includes:

- establishing good technical standards and work practices,
- developing staff skills and assuring their knowledge,
- maintaining management processes that continually support safety.

History

Following the *Deepwater Horizon* incident investigation, the presidential commission concluded that although many operators and contractors have longstanding effective safety programs and good safety cultures, there wasn't an overarching culture of safety in the Gulf of Mexico offshore drilling industry.

Therefore, one of several commission recommendations was to establish a "by the industry, for the industry" safety organization. Thus, the Center for Offshore Safety helps the industry:

- **execute safety and environmental management systems (SEMS),**
- **transition to regulated safety and environmental management systems,**
- **adjust to performance-based safety and environmental management systems regulation.**

The Center for Offshore Safety works to share and transfer SEMS information across the industry, compile "lessons learned" from this information, and develop best practices to address identified gaps or needs.

Membership

The Center for Offshore Safety is governed by a diverse board representing the breadth of the industry, including operators, drilling contractors, service and supply companies, and associations. COS membership is open to all companies that operate, drill, or complete wells, or companies that provide deepwater drilling support services.

Members are expected to:

- **embrace COS guiding principles,**
- **participate in Center for Offshore Safety programs and activities,**
- **share lessons learned with other Center for Offshore Safety members,**
- **conduct COS SEMS audits using third-party auditors and become COS SEMS certified via these audits.**

Although membership is currently limited to companies operating in deep water, the industry task groups are generally open to all stakeholders.

Executive Director Charlie Williams of the Center for Offshore Safety in Houston, Texas. The COS is an industry association with full time and loaned staff from the oil industry. Photo courtesy of the Center for Offshore Safety.

As the regulation doesn't dictate how to implement an effective safety and environmental management system, operators are expected to implement one in a way that is most effective for their businesses. Additionally, operators must conduct periodic safety and environmental management systems audits. Finally, the Bureau of Safety and Environmental Enforcement does not approve the SEMS itself. The bureau measures safety and environmental management system performance and implementation via third-party audits.

COS Core Functions

To assist industry with these processes, the center initially focused on SEMS auditing to support an independent SEMS accreditation process and complement the new regulatory auditing requirements. Staff members at the center developed standard and uniform audit tools and audit documents to assist in SEMS implementation. The Center for Offshore Safety also accredits audit service providers to assure that third-party certification program auditors meet the program's goals and objectives.

Additionally, COS safety and environmental management systems audits allow its staff to certify operators' and contractors' SEMS programs. This ability is of particular importance, because contractor safety program assurance is mandated for each operator and is an operator's responsibility. Therefore, the Center for Offshore Safety certification method has the potential to provide consistent assurance that could eliminate the problem of contractors being audited different ways by different operators.

In addition to the initial focus on auditing, the center's core work falls into the following areas:

- **Data Collection, Analysis, and Reporting**
  - learning from incidents,
  - analyzing key safety performance indicators,
  - identifying opportunities for SEMS improvement.
- **Assistance**
  - continuous SEMS programs improvement,
  - creating good practices to close SEMS gaps,
  - verifying skills and knowledge.

continued on page 12

At the simplest level, SEMS can be described with three elements: standards/work practices, employee skills and knowledge, and operating practices (management processes and practices). These three basic elements form a good SEMS. The diagram shows how these three elements combine to form SEMS and how SEMS are effective when combined with a safety culture. Courtesy of the Center for Offshore Safety.

Resources and Tools

The Center for Offshore Safety provides a number of tools and has more under development to help companies institute SEMS and improve safety.

COS SEMS toolkit: Audit protocols, worksheets, and other documents for SEMS audits.

Auditor and certification body requirements: Information on how to become a COS-accredited audit service provider and the qualifications for COS third-party auditors, including auditor training and qualification, audit team composition, and auditor and audit team experience.

Audit service provider accreditation: Provides a set of COS standards for accrediting audit service providers and their auditors to support the COS SEMS certification program.

SEMS certification program: Center for Offshore Safety member company SEMS program certification via an accredited third-party audit. Includes operator contract and service company certification.

Leadership site engagement: Good practice guidance for senior managers and leaders to demonstrate visible safety and environmental commitment during visits to offshore operating sites.

Safety performance indicators: Establishing clearly defined indicators to determine safety performance and identify concerns and areas of improvement.

Learning from incidents: Developing a methodology to transfer information from key incidents and high-value learning events to promote cross-industry learning.

Contractor skills and knowledge verification: Tools and techniques to provide operators with a common process to verify contractor skills and knowledge management systems.

- **Outreach and Communication**
  - facilitating the sharing and learning process,
  - interfacing with industry leaders to ensure system deficiencies are recognized and addressed,
  - communicating with stakeholders.
- **Accreditation and Certification**
  - ensuring that third-party certification programs meet the audit program's goals,
  - accrediting third-party audit service providers,
  - certifying SEMS skill and knowledge programs.

COS Future Work

The Center for Offshore Safety continues to provide assistance to stakeholders to implement their SEMS programs and will compile and analyze key industry safety performance metrics. The center will also sponsor functions including the annual COS safety forum, and will work with its members to identify and promote opportunities for the industry to continuously improve in SEMS as well as continue its outreach to facilitate communication with external stakeholders.

From its beginning, the Center for Offshore Safety has provided a focal point for the industry to come together, share lessons learned, and collaborate regarding safety and environmental management systems. We share a common goal with our members, the offshore industry, regulators, and the public: to continuously improve safety and environmental performance across the industry.

About the author:
Mr. Charlie Williams is the Center for Offshore Safety executive director. He recently retired from a 40-year career with Shell, where he was the company's chief scientist. He serves on the Department of Interior's Offshore Energy Safety Advisory Committee and has received the DOI Corporate Citizenship Award and the Offshore Technology Conference Special Citation.

Endnote:

1. The regulation uses the American Petroleum Institute Recommended Practice 75 (API RP 75) as its basis. API RP 75 describes components and practices of a good SEMS system. API RP 75 has 13 SEMS elements that define a management system that allows an operator to effectively practice good safety and environmental performance for all company projects.

For more information:

Center for Offshore Safety work products and techniques are available at **www.centerforoffshoresafety.org**.

Partnership with a Purpose

Addressing offshore energy installation challenges.

by CDR Rob Smith
U.S. Coast Guard Liaison
Bureau of Safety and Environmental Enforcement

U.S. federal waters host a complex energy infrastructure of subsea pipelines and production and storage facilities that supply much of the nation's crude oil and natural gas. The U.S. Coast Guard (USCG) and the Bureau of Safety and Environmental Enforcement (BSEE) pursue specific missions to prevent oil spills in offshore waters, limit environmental and economic resource impact in the event of a spill, and ensure safe working conditions on offshore facilities and vessels. BSEE focuses on oil and mineral exploration, drilling and production activities, and regulates offshore oil lease operators through 30 CFR Part 250. The USCG regulates personnel safety, navigation, firefighting, lifesaving, and other marine operations on vessels that operate on the outer continental shelf (OCS) or adjacent waters through regulations promulgated in 46 CFR Subchapter I-A and 33 CFR Subchapter O. Both agencies promote offshore safety and protect the marine environment through regulatory oversight and enforcement.

Seminal catastrophic events, including Hurricanes Katrina and Rita and the Macondo well blowout, highlight the unique roles these two agencies perform during emergency response and demonstrate how important it is to coordinate government action involving offshore energy infrastructure. Additionally, aging facilities, evolving workforce safety cultures, emerging technologies, and advances in deep water drilling have further underscored the need for integrated USCG/BSEE oversight cooperation and alignment.

The History

Considering the potential for duplicative or conflicting regulations, these agencies have formed a longstanding partnership to coordinate activities. For example, the U.S. Coast Guard has overseen offshore operations with the BSEE's precursor agencies—the Bureau of Lands Management and U.S. Geological Survey—since the 1950s. In 1982, the two Department of Interior agencies merged to form the Minerals Management Service or MMS. Following the Macondo well blow-out in April 2010, MMS became the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). Then on Oct. 1, 2011, the Department of Interior again reorganized to replace the BOEMRE with BSEE and the Bureau of Ocean Energy Management.

Through all the reorganizations, the USCG/DOI commitment to cooperative oversight has remained unchanged and is organized under a memorandum of understanding(MOU) and several memoranda of

A semisubmersible hull arrives at the fabrication yard in Ingleside, Texas. U.S. Coast Guard photo by CWO Joel Smith.

Signing a memorandum of understanding at the Department of Interior, Washington, DC. From left: Mr. David Moore, BSEE; VADM Peter Neffenger, USCG; Director James Watson, BSEE; and CDR Rob Smith, USCG. All photos courtesy of BSEE unless stated otherwise.

VADM Peter Neffenger, USCG, and Director James Watson, BSEE, shake hands following the memorandum of understanding signing.

USCG/BSEE MOU contributors from left, starting with back row: Ms. Kelly Schnapp, BSEE; Mr. Lane Nemirow, DOI; Ms. Jeanmarie Nicholson, USCG; Mr. John Cushing, BSEE; CDR Ed Bock, USCG. Front Row: Mr. David Moore, BSEE; VADM Peter Neffenger, USCG; Director James Watson, BSEE; and CDR Rob Smith, USCG.

agreement (MOA) that establish a cooperative interagency partnership to increase communications, manage shared responsibility, and minimize duplicative or conflicting regulations on the affected industry. In recent years, these have been updated to reflect current industry trends and regulatory standards. For example:

- On July 27, 2011, the newly established BOEMRE and the USCG signed MOA OCS-06 to clarify agency roles associated with issuing and approving offshore renewable energy installations.
- On April 30, 2013, BSEE and the USCG signed a new MOA to clarify safety and environmental management systems and safety management systems oversight. Current efforts focus on developing standards related to outer continental shelf activities to ensure a level playing field among foreign and U.S. registered vessels by implementing a "One Gulf, One Standard" regulatory approach. This is paramount to meeting public expectations for enhanced OCS safety and environmental protection.

Interagency Coordination

The U.S. Coast Guard and the Bureau of Safety and Environmental Enforcement achieve these goals by operating on three distinct levels of interagency cooperation and coordination. The first level is executed at quarterly senior leadership meetings among senior executives. This senior leadership group focuses on establishing priorities for improved interagency cooperation and addressing emerging challenges.

The second level occurs within two established BSEE and USCG work groups focused on response and prevention, respectively. While the memorandum of understanding establishes a general framework and outlines overarching goals and objectives for the two agencies to work together collaboratively, the response and prevention work groups use calculated charters that charge specific agency headquarters offices and designated program managers to address emerging issues, coordinate regulatory actions, enhance information sharing opportunities, engage in joint training and field inspections and responses, and continually familiarize agency personnel with frequent interaction.

The final type of coordinated cooperation occurs at the field level. Here BSEE and USCG field offices work collaboratively during hurricanes, joint investigations, oil spill response planning, joint training sessions, and such.

A generation module hull. U.S. Coast Guard photo by CWO Joel Smith.

The Future

The list of emerging outer continental shelf regulatory and technological challenges is daunting, and both agencies regularly meet to discuss and collaborate on safety and environmental management systems, safety management systems, new standards for Arctic oil spill response and preparedness, Arctic vessel operating and engineering standards, marine casualty reporting, training and manning standards for outer continental shelf personnel, dynamic positioning systems, standards for blowout preventers, seismic research, and more.

The Coast Guard and the Bureau of Safety and Environmental Enforcement are also examining several areas for improvement within the interagency partnership, such as addressing mobile offshore drilling unit and fixed facilities oversight and improving information exchange. Further, within the next few years, the Coast Guard and BSEE will update and revalidate legacy USCG/MMS agreements, including MOA OCS-06 (offshore renewable energy installations), OCS-02 (civil penalties), OCS-04 (floating offshore facilities), and OCS-05 (incident investigations). Additionally, the agencies will work toward a new MOA to address the inspection responsibility overlap for offshore vessels that service and/or construct renewable offshore energy installations.

With a strong interagency partnership and established, effective cooperation and coordination, the USCG and BSEE are uniquely equipped to address emerging challenges and are effectively poised to deliver unprecedented support to the offshore industry through modern standards, improved guidance, and improved federal coordination in this shared regulatory space.

About the author:

CDR Rob Smith is the division chief of Commercial Vessel and Facility Operating Standards at U.S. Coast Guard headquarters and serves as the liaison to the Bureau of Safety and Environmental Enforcement. He has served in the U.S. Coast Guard for 21 years as a commercial vessel marine inspector, oil and chemical pollution responder, casualty investigator, maritime educator, port security specialist, and regulatory and standards development program manager. He is a 1992 U.S. Merchant Marine Academy graduate with a B.S. in maritime transportation; a M.S. in environmental management from the University of Houston-Clear Lake; and an M.S. in quality management systems from the National Graduate School.

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A spar arrives at the fabrication yard. U.S. Coast Guard photo by CWO Joel Smith.

A New Frontier in the Last Frontier

Safety zones on the Arctic outer continental shelf.

by CDR William Dwyer
Staff Judge Advocate
U.S. Coast Guard District 17

In the Arctic region, what was once perennially covered in ice and snow is now blue water for most of the year. Because of this drastic climate change, the region has seen a strong uptick in maritime traffic from commercial and scientific research vessels, cruise ships, and Arctic adventure seekers. Additionally, this "last frontier" contains its fair share of untapped, high-demand natural resources.

Whether it is due to oil on the outer continental shelf (OCS) or gold in Nome, Alaska, commercial interests are drawn to the Arctic. For example, several oil companies have made plans to drill on the U.S. outer continental shelf off the Alaskan coast. The U.S. Coast Guard, working in conjunction with other federal agencies, has safety and security oversight for these types of activities.

One of the issues addressed in the planning process for these drilling operations was the scope of Coast Guard authority to ensure safe drill rig operation. The Coast Guard's authority is greatest within the territorial sea (12 nautical miles from the shore), and less in the contiguous zone (24 nautical miles) and beyond. Congress passed the Outer Continental Shelf Lands Act (OCSLA) in 1953, which provides for U.S. jurisdiction over the submerged lands of the outer continental shelf and, consistent with international law, authorizes the Department of Interior secretary to lease such submerged lands for purposes such as extracting natural resources.

OCSLA Safety Zones

The U.S. exercises its authority to establish safety zones around OCS facilities via the Outer Continental Shelf Lands Act. For example, according to 43 U.S.C. §1333(d)(1), the Department of Homeland Security secretary may "promulgate and enforce reasonable regulations with respect to … the promotion of safety of life and property on the artificial islands, installations, and other devices referred to in subsection (a) of this section or on the waters adjacent thereto … ." Subsection (a) provides jurisdiction over "all installations or other devices permanently or temporarily attached to the seabed, which may be erected thereon for the purpose of exploring for, developing, or producing resources there from … ."

Via 33 C.F.R. 147.5, the secretary delegates the authority to establish safety zones under OSCLA to Coast Guard district commanders. Furthermore, the U.S. Coast Guard *Maritime Law Enforcement Manual* guides U.S. Coast Guard policy to exercise this authority. It is worth noting that establishing safety zones does not limit or restrict the Coast Guard's ability to engage in law enforcement actions, address threats outside the safety zones, take action in self-defense, protect others, or engage in other measures as circumstances warrant.

Additionally, a safety zone under OCSLA should not be confused with a safety zone established under the Ports and Waterways Safety Act (PWSA) , 33 U.S.C. s1221 et seq. As noted under 33 U.S.C and 33 CFR, PWSA safety zones are enacted for safety and environmental protection. While these zones can be fixed or moving, they cannot be established beyond 12 nautical miles. Outer Continental Shelf Lands Act safety zones are intended to protect life and property on facilities fixed upon the outer continental shelf. And, in accordance with U.S. and international convention, OCSLA zones may not interfere with established shipping lanes, subject to certain restrictions.

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For instance, the 1982 Law of the Sea Convention and the 1958 Geneva Convention provide exceptions to the general allowance of freedom of navigation for safety zones around OCS facilities, allowing for a safety zone of up to 500 meters around such facilities.[1]

Safety Zone Application

The Outer Continental Shelf Lands Act provides for civil and criminal penalties for failing to follow regulations, including those related to safety zones on the OCS. For example, a person failing to comply with a safety zone, after having been given notice and a reasonable period to take corrective action, may be liable for a civil penalty of up to $40,000 per day.[2] If the violation constitutes a threat of serious, irreparable, or immediate harm or damage to life or property, a civil penalty may be assessed without the requirement of allowing a period for corrective action.

Additionally, the Outer Continental Shelf Lands Act provides criminal penalties. For example, any person knowingly and willfully violating an OCSLA regulation designed to protect health, safety, or the environment, or conserve natural resources, including safety zone regulations may, upon conviction, be fined up to $100,000 and/or be imprisoned for up to 10 years.

Enforcement Options

While Coast Guard regulations and operations may not unjustifiably infringe on free speech, potential protestors have plenty of means, outside of violating a safety zone, to reach their intended audience, including public meetings, letter writing, online campaigns, or peaceful protest outside the 500 meter zone. Moreover, implementing and enforcing an outer continental safety zone furthers a substantial government interest in protecting the safety of persons and property aboard and in the vicinity of an outer continental shelf installation.

Three courses of action exist for addressing OCSLA safety zone violations. First, violators could be interdicted and detained for eventual transfer to the Department of Justice for criminal prosecution. This requires coordination with the DOJ to establish the willingness to move forward with prosecution for the violations and to ascertain what evidence is required to pursue a conviction. It is also prudent to enlist other state and local law enforcement authorities to assist with logistics in the event of a criminal prosecution. Those efforts should be pre-coordinated with state and local law enforcement agencies to ensure a suspected offender is brought before a magistrate in a timely manner (see sidebar).

Second, pursuant to OSCLA's civil penalties provisions, violators could be interdicted, given written notice of the violation, and subjected to an administrative hearing. The *Federal Register* notice regarding the safety zone creation should include provisions for administrative penalties.

Third, the Coast Guard could issue warnings, but take no further legal action against the violators. This would alleviate the immediate threat and preserve Coast Guard resources, but would withhold punitive action, thus potentially mitigating the deterrent effect desired through interdiction.[3]

Future Trends

Since Arctic commercial maritime activity is expected to increase, the Coast Guard will be called with increasing frequency to establish safety zones under OCSLA. It is critical that our operators understand the means and methods of enforcement under OCSLA to ensure the safety of the rigs and associated workers as well as the safe navigation of vessels transiting Arctic waters.

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CDR William Dwyer is the staff judge advocate for the 17th District in Juneau, Alaska. He previously served on the staff of U.S. AFRICOM's Office of Legal Counsel. He is a graduate of the U.S. Coast Guard Academy and Rutgers Law School.

Endnotes:

1. See Geneva Convention on the High Seas, arts. 2 & 22, Apr. 29, 1958, 450 U.N.T.S. 11; Geneva Convention on the Continental Shelf art. 3, Apr. 29, 1958, 499 U.N.T.S. 311; United Nations Convention on the Law of the Sea (UNLOS). Articles 58, 87, 92, Dec. 10, 1982, 1833 U.N.T.S. 397.

   The United States has not yet ratified the UNCLOS. The U.S. recognizes and adheres to the operative sections of UNCLOS to the extent they reflect customary international law. Similar provisions are also found in Article 5 of the Geneva Convention on the Continental Shelf. Although the zone is limited to 500 meters, prudent mariners should evaluate the speed and control of the drilling rig to prevent collisions beyond the 500 meter zone.

   The Geneva Convention on the Continental Shelf also provides: "[T]he coastal State is entitled to … establish safety zones around such installations … . The safety zones … may extend to a distance of 500 meters around the installation … ." —Geneva Convention on the Continental Shelf, art. 5.

   Specifically, article 60(4) of UNCLOS provides "the coastal state may, where necessary, establish reasonable safety zones around such artificial islands, installations and structures in which it may take appropriate measures to ensure the safety both of navigation and of the artificial islands, installations and structures."

2. 43 U.S.C. §1350(b)(1) (2010). The statute provides that the statutory $20,000 per day civil penalty be adjusted every three years for inflation. The most recent inflation adjustment raised the maximum penalty to $40,000 per violation per day. 76 Fed. Reg. 38294 (June 30, 2011).

3. The Maritime Law Enforcement Manual Appendix O.8 and Appendix O.9 set out the various enforcement tools available for safety zones.

Offshore Oil Drilling

New vessel designed as a well control solution.

by LT Jan League
Senior Marine Inspector and Investigator
U.S. Coast Guard Activities Europe

Just as the *Exxon Valdez* grounding demonstrated oil spill response challenges, the *Deepwater Horizon* incident revealed the extreme challenges involved with stopping oil pollution after an offshore wellhead failure.

In the aftermath, industry searched for ways to contain similar incidents. Over time, several systems have been tested, and one company has partnered with well owners to make its system available for more than 70 percent of the deepwater wells in the U.S. Gulf of Mexico outer continental shelf.[1]

The system is designed around two elements: the surface component or modular capture vessels (MCVs) which are based on two dynamically positioned (DP) converted shuttle tankers; and the subsea component, with containment equipment to direct the flow of hydrocarbons from the seabed.

USCG Review and Oversight

The Coast Guard approved the vessel portion of the system for work on the U.S. Gulf of Mexico outer continental shelf. These vessels were vetted through a three-layered process to protect the ships, sailors, and environment. Staff at the USCG Office of Design and Engineering Standards provided strategic guidance, using a regulatory compliance matrix to identify applicable design and engineering standards while operating in well intervention mode.

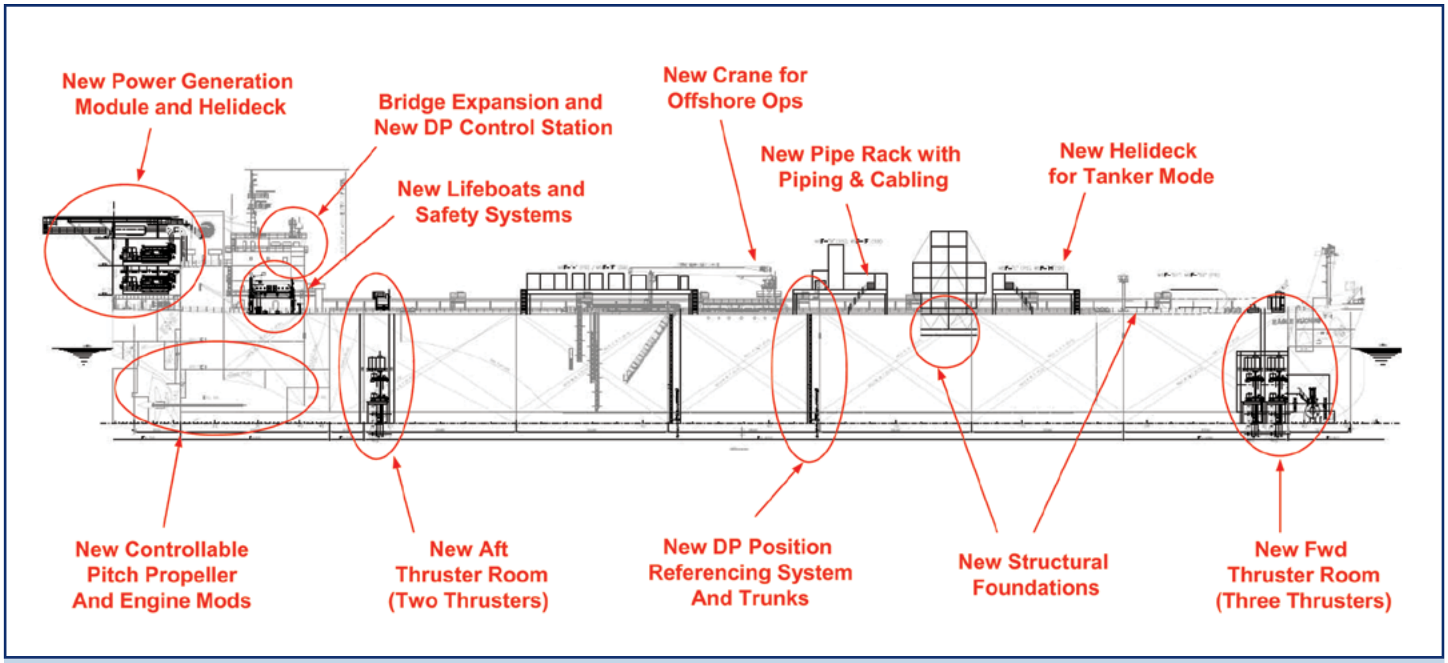
Coast Guard Marine Safety Center (MSC) personnel reviewed and provided technical feedback to the vessel owners on drawings and plans in accordance with the regulatory compliance matrix and U.S. and international regulations. MSC also provided guidance to Coast Guard Activities Europe marine inspectors conducting verification and compliance exams.

Coast Guard Activities Europe, working out of their offices in Rotterdam, Netherlands, provided a team of experienced senior marine inspectors for this large conversion project that took place in a Dubai shipyard, to verify that the vessels were built according to the MSC-approved plans. The inspection team collaborated with the American Bureau of Shipping, Coast Guard headquarters, Marine Safety Center personnel, vessel owners, and the shipyard; and the parties created a communications conduit of regular conference calls as each change brought stringent requirements including ventilation, electrical, and other new regulations. Activities Europe personnel also implemented a systematic oversight and compliance tracking program that formally delegated partner roles and responsibilities to ensure vessels were built to a high level of safety.

USCG inspections covered structural integrity, vital systems, propulsion, seaworthiness, lifesaving, firefighting, hazardous conditions, work procedure tracking and tracing, worker qualifications, material specifications, and testing. Due to the extreme distances involved, personnel "batched" inspections to optimize inspection time. During the course of the conversion, inspectors conducted multiple site visits, which provided feedback on emergency egress, electrical installation, and structural and lifesaving challenges identified during inspection.

Vessel Specifications

Each vessel underwent a huge transformation from shuttle tanker to modular capture vessel, while still retaining functionality as a lightering shuttle tanker. The stern now houses a multi-story auxiliary engine room topped with a helideck. A look down the vessel's side reveals an 80-person lifeboat, and an array of wires and cables that lead from the machinery spaces to the process equip-



Changes from shuttle tanker to modular capture vessel. Graphics courtesy of ExxonMobil.

ment and thrusters. The deck was strengthened at the turret assembly, flare tower, and at each of the modular support frames. Also, a new engine room was added to house additional generators, the existing pipe rack was expanded to more than twice the original height to allow for additional piping and electrical wiring trays, and berthing increased to accommodate additional incident response personnel.

The engineering side was also radically changed to meet the increased power requirements of a dynamically positioned vessel. The 12.2 megawatt slow-speed diesel engine was modified to operate in one direction at continuous revolutions per minute, with a new tail shaft and controllable pitch propeller. Four medium-speed diesels—housed in the new engine room over the stern—were added to augment the three original 640-kilowatt generators. Some 181 kilometers of new wiring ties this all together.

A new controllable pitch propeller, four 2.15 megawatt retractable Rolls-Royce thrusters with redundant hydraulic power units midship, and a two megawatt Rolls-Royce tunnel thruster in the bow put all the power to work.

An 800-ton turret and buoy assembly ties the surface and subsea components together. It is important to note that the assembly is designed for liquid transfer only, not as a mooring device. The turret is fitted with a motorized slewing drive. As the vessel alters heading, the slew drive maintains a constant riser heading, which keeps torsional stresses off the riser. The subsea part of the system can be set on the site in advance with a floating mooring buoy, which the modular capture vessel will pick up.

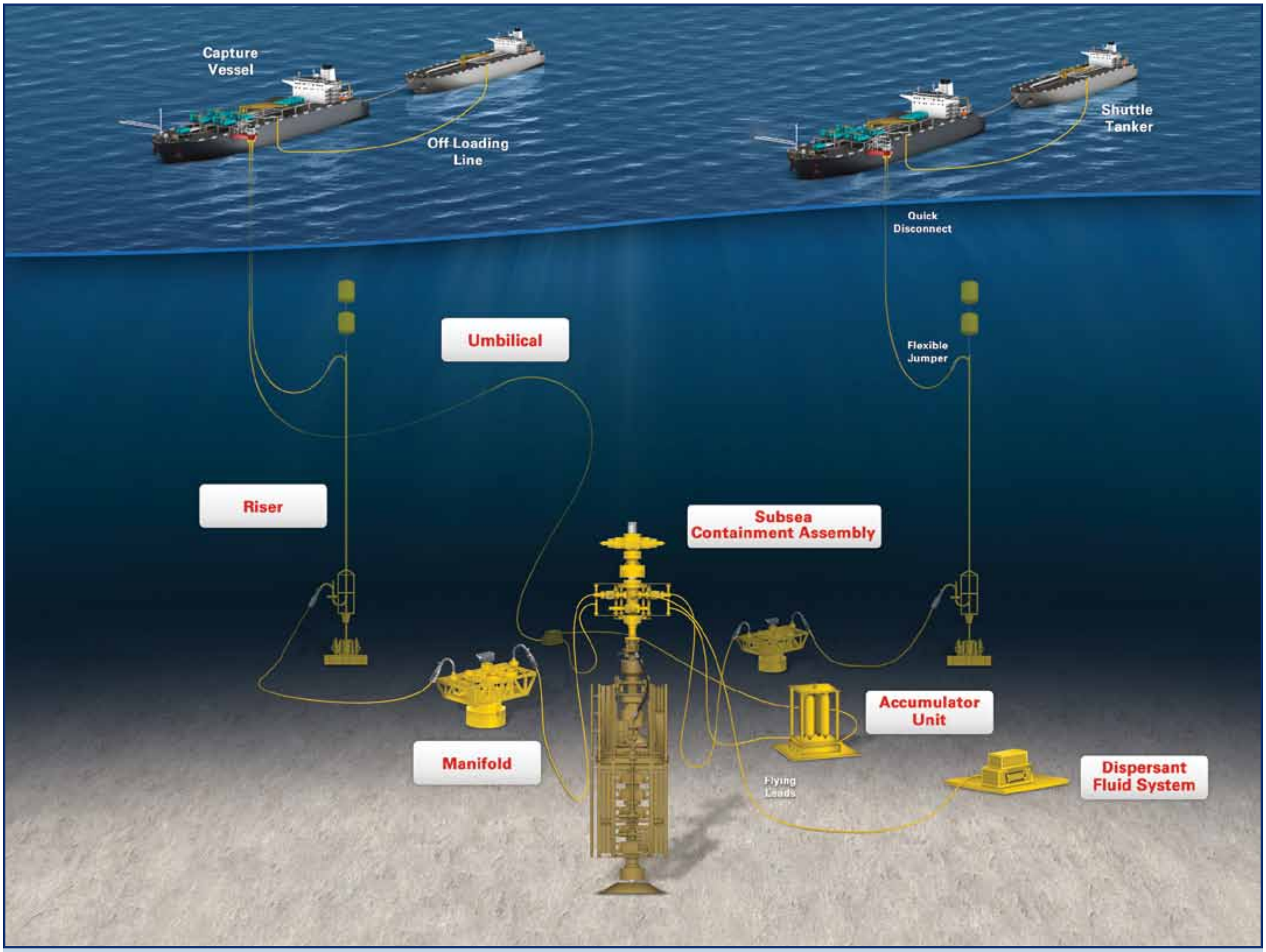
Subsea Components

The subsea system connects the well to the modular capture vessel, using a free-standing hybrid riser, which is an insulated pipeline suspended by large submerged buoys that connect the surface component to the subsea containment assembly on the seabed. The insulation keeps the well fluids warm, so gas hydrate crystals will not form and block the flow.

The surface buoy nests into the turret assembly and carries the well fluids up to the MCV. An umbilical controls the subsea containment assembly and delivers chemicals into the well fluids for hydrate and oil dispersant management. In water depths less than 2,000 feet, the freestanding hybrid risers are replaced with a flexible pipe riser to absorb MCV vessel motion and the force from ocean currents.

The subsea containment assembly collects or redirects well fluids, depending upon the wellhead pressure and well integrity. It can interface with the well in three ways:

- over the blowout preventer,
- over the lower marine riser package on top of the blowout preventer,



Containment system overview.

- over a wellhead after the blowout preventer and lower marine riser package have been removed.

The bottom line is that the system offers specialty equipment pre-engineered, constructed, and tested for Gulf of Mexico deployment. The goal is to prevent or dramatically decrease the volume of oil escaping into the ocean. In July 2012, the Department of Interior Bureau of Safety and Environmental Enforcement successfully tested and approved a similar system design.[2]

About the author:
LT Jan League is a senior marine inspector and investigator assigned to U.S. Coast Guard Activities Europe. LT League graduated from Texas Maritime Academy and previously worked as a vessel master, supporting the oil and gas industry.

Endnotes:

1. *Marine Well Containment Company Establishes Membership.* Marine Well Containment Company, April 19, 2011. Available at http://marinewellcontainment.com/pdfs/US-MWCC_Establishes_Membership_041811.pdf.
2. Huselton, L. *Marine Well Containment Company and Shell complete successful demonstration of capping stack in the U.S. Gulf of Mexico.* Marine Well Containment Company, July 3, 2012. Available at http://marinewellcontainment.com/pdfs/mwcc_release_07_30_12.pdf.

Submerged Oil Response

by Mr. Kurt A. Hansen
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Although there have only been a small number of submerged oil spills,[1] the environmental and economic consequences resulting from these types of spills can be large. The underwater environment poses major response challenges such as poor visibility, difficulty in tracking oil spill movement, colder temperatures, inadequate containment methods and technologies, and problems with equipment interaction with water.

Sorbent material submerged oil recovery in the field. U.S. Coast Guard photo.

In the U.S. Coast Guard's experience, the first oil spills that generated a large amount of sunken oil (oil that accumulates on the seafloor) were in 1993, when three vessels collided off of Tampa Bay, and a spill in Puerto Rico in 1994. More recently, spills occurred when a bulk carrier punctured a fuel tank in the Delaware River in 2004, and a barge capsized off of Texas in 2005.[2]

The techniques used to find oil in these cases and similar ones included using divers, sonar, and water sampling. Each method had its challenges, such as the time involved and inconclusive results. For example, sonar could identify changes in mass density, but its readings were uncertain once the oil mixed with sediment.

Oil recovery was fairly primitive—using weighted sorbent materials and dragging them along the sea floor. After the first two spills, the National Academy of Science recognized these issues and developed a report that provided a baseline for responders, and subsequently the Coast Guard's Research and Development Center (RDC) launched a multi-year project to identify and develop techniques to better detect and recover sunken oil.

Developing New Detection Systems

The RDC developed various requirements for the new detection systems including:

- 80 percent detection probability,
- locate oil remotely from at least one meter away,
- provide near-real-time data,
- reasonable setup time,
- able to accommodate five-foot seas and 1.5 knot currents,
- able to cover a square mile area within a 12-hour shift.

From 2008–09, personnel at the Bureau of Safety and Environmental Enforcement Ohmsett facility tested four prototype sensors. These sensors located oil under testing conditions—clear water with a limited amount of turbidity or sand covering the oil.

In another test, a real-time mass spectrometer system detected oils in a calm water column. But it is not clear how much oil would be in the water column under more realistic circumstances, especially after several days or weeks or with current flow. This method would be useful for other applications like finding oil in the water column. A system laser fluorometer, adapted from an existing system, appeared to work in low light conditions. However, work is needed to reduce background light interference.

Although sonar systems have been used to locate submerged oil, the issue of concern is the turn-around time for interpretation. One manufacturer is addressing that issue; however, it is not clear how this system will perform in muddy conditions, where the difference in density between the oil and the bottom is closer than the conditions documented in this test.

Laser fluorometer equipment that projects a laser light out to 10 meters in clear water and the sonar system were chosen for further evaluation and testing. Both systems need further testing, evaluation, and development to become practical tools.

Generally speaking, the tests conducted for detection and monitoring showed:

- There is no single method that can cover 100 percent of the area with no false alarms.
- Resolution is still an issue:
  - o easier if oil stays together,
  - o random hits must be correlated.
- Turbid water and very soft bottom (such as in rivers and harbors) are also issues.
- Additional research is needed for real-time mass spectrometry systems.
- Use of multiple sensor types should reduce false detections.

Recovery Techniques

Existing oil recovery methods vary greatly, depending upon conditions. Most approaches are based on diver-assisted suction heads; however, this method becomes more difficult offshore and in deeper waters. When the location of the oil is known and the seabed is not particularly sensitive, large dredges can be brought in. Both of these methods tend to collect a large amount of silt and water that must be processed. To address these issues, the RDC developed specifications and awarded three

The Ohmsett facility uses a test tank filled with sand, rocks, oil, and seaweed to test recovery methods. U.S. Coast Guard RDC photo.

Updated system uses three ROVs. Photo courtesy of Alion Science and Technology.

View of submersible with the skimmer head pointing backward. Photo courtesy of Marine Pollution Control.

Underwater view of the rig fabricated for use in the Ohmsett test tank. Photo courtesy of Marine Pollution Control.

contracts to design a complete detection and recovery system.

Remotely Operated Vehicle Based System
A concept built around two remotely operated vehicles (ROVs) should be able to deploy multiple small systems and to respond rapidly. The sonar data appears to be capable of identifying clumps of oil or other objects.

In testing, however, it appeared that the system was underpowered to balance the weight of the hydraulic and recovery hoses and could only handle currents of less than 1.5 knots. The pump moved the test oils, but some oil did not make it all of the way to the recovery tank and remained in the recovery hose. The manufacturer has since built an updated version, using three ROVs to address performance.

Another manufacturer developed a system composed of a manned submersible with recovery capability and additional sensors, including an oil-discriminating sonar and fluorescence polarization sensor. Since the Ohmsett tank was too shallow to deploy the submersible, company personnel configured a test rig to represent the operational parts. The system easily picked up the oil, but also a large amount of sand and water. Testers then reduced the nozzle opening and pump power, which improved performance.

Auxiliary equipment interfered with the real-time sonar, but the sensor was successful in sensing oil in front of the nozzle as well as in the pump hose. Additionally, the oil separator system worked well, permitting water to be re-introduced into the Ohmsett tank.

A remote-controlled pumping vehicle relies on an external detection system for initial detection and utilizes underwater cameras mounted on the pump for recovery. This system was also too large to test in the Ohmsett tank, so the pump was mounted on an excavator and the mounted system, used for control with a closed-circuit monitor, was installed in the excavator cab. In

View of excavator-mounted recovery system. U.S. Coast Guard RDC photo.

the excavator configuration, the system is proposed as a viable oil removal tool in water depths up to 15 meters.

The manufacturer also deployed a full oil separation system that utilized a settling tank, mesh filter cloths, and two surface skimmers. Initially this system also recovered oil with a large amount of water, but refinements and increased operator experience resulted in better output later in the testing period.

Ongoing Development

All of these systems meet the required specifications for submerged oil detection and recovery. In addition, all of the vendors indicated that larger and possibly multiple collection tanks would be needed for a large spill.

For actual spill recovery, responders may need to adjust filter system size and utilize multiple steps to separate oil and sand. These systems can be also useful in combination for unique scenarios, such as deep water or in a surf zone.

Testing and developments are ongoing, as is another RDC effort aimed at ways to detect and mitigate oil in the water column.

About the author:

Mr. Kurt Hansen has served at the RDC for 20 years and has spent 15 years working on projects dealing with oil spill response. During the Deepwater Horizon *response, he served on the alternative response technology team. He is a member of the ASTM Hazardous Substances and Oil Spill Response Committee.*

Endnote:

1. For the purpose of this document, "submerged oil" is any oil that is not floating at or near the surface. Sunken oil describes the accumulation of bulk oil on the seafloor.
2. Visit www.uscg.mil/hq/cg5/cg545/ for more information.

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Improving Mechanical Oil Spill Response Equipment Standards

by LCDR Drew Casey
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In response to the 1989 *Exxon Valdez* incident, Congress enacted the Oil Pollution Act of 1990, which established the U.S. oil spill prevention, preparedness, and response framework and mandated vessel and facility response plan regulations. Moreover, as part of this massive regulatory project, the U.S. Coast Guard and other members of the oil spill response community worked to quantify the effective daily recovery capacity (EDRC) that plan holders need to respond to various categories of oil spills, including a worst-case discharge.

Developing a Planning Standard

The 1992 final negotiated rulemaking contains the following formula to calculate effective daily recovery capacity:

$$R = T \times 24 \text{ hours} \times E$$

$$\text{Where } R = \text{EDRC}$$

T = Throughput rate in barrels per hour
E = 20 percent efficiency factor (or lower factor as determined by the U.S. Coast Guard).

This formula for effective daily recovery capacity has not changed since its institution in 1992. It is a simple method for plan holders to calculate their mechanical recovery equipment needs and provides an estimate of how many skimmers are required by regulation to respond to a worst-case discharge scenario for a facility or vessel.

Furthermore, this regulation is a planning standard and is not intended to mirror skimmer system performance during an actual spill. The EDRC calculation method is an integral component of plan holder and oil spill response organization (OSRO) business models and has directly influenced oil spill recovery equipment inventories.

EDRC During *Deepwater Horizon*

However, recent incidents have challenged the measurement's accuracy in determining oil spill response equipment needs. In particular, the 2010 *Deepwater Horizon* oil spill certainly exposed its flaws.

For example, the effective daily recovery capacity on the scene during this incident not only far exceeded BP's oil spill response plan requirements, but it was also almost twice the flow rate for the Macondo well. Early on, the Coast Guard and BP developed an oil budget to track the oil's final disposition including evaporation, natural and chemical dispersion, weathering, biodegradation, and other means. Through careful analysis, the response organization estimated that only three percent of the total amount of oil released was mechanically recovered.

Observations, Recommendations

Following the spill, various reports and publications focused on the effective daily recovery capacity calculation. Most notably, the National Commission on the *Deepwater Horizon* Oil Spill and Offshore Drilling Report, the BP *Deepwater Horizon* Oil Spill Incident Specific Preparedness Review (ISPR) report, and the Joint Industry Oil Spill Preparedness and Response Task Force (JITF) report discussed this issue in more detail and made recommendations regarding how to improve planning standards and mechanical recovery performance.

The national commission report stated that the Coast Guard should revise EDRC to encourage development of more efficient skimming systems. The incident specific preparedness review report also included a recommendation to encourage more effective skimmers, as EDRC on the scene far exceeded plan requirements, yet mechanical recovery accounted for only a small amount of oil recovered. The JITF report stated that the oil spill response community must recognize the practical limitations of mechanical response equipment, and that there are opportunities for improvement in boom and skimmer design, especially in the offshore environment. Furthermore, the JITF report recommended that government and industry should revisit the EDRC regulations and determine if improvements to the planning standard are necessary.

A Coast Guard Cutter deploys a skimming system. U.S. Coast Guard photo.

EDRC Advantages and Limitations

Although it was developed for simplicity, there are several shortcomings associated with the planning standard. First, the calculation method is excessively influenced by skimmer pump nameplate capacity, but it does not address most other skimmer system components that are critical to effective oil recovery. Since the formula is dependent upon pump capacity, a plan holder can simply increase total effective daily recovery capacity by substituting a larger pump. This aspect of the calculation is significant, because it provides no incentive for industry to employ more advanced (and expensive) skimming technology.

Second, the 20 percent efficiency factor only accounts for a few variables—weather, sea state, and daily operating period. It is not based on historical oil spill data, and it is generally understood that the efficiency factor was determined by committee consensus during the OPA 90 negotiated rulemaking. EDRC does not account for other important external influences on mechanical recovery, including encounter rate (access to the oil itself); oil type and thickness; operating environment (offshore, inshore, inland); storage capacity; and human factors (skimmer operation). In this sense, the calculation does not take into account a system's approach to skimming effectiveness.

Lastly, effective daily recovery capacity is intended to estimate only the effectiveness of mechanical equipment recovery, it does not estimate effects on surface oil from dispersants, *in-situ* burning, or other response options that may be employed during an oil spill. Especially in the offshore environment, mechanical oil recovery may be severely restricted or ineffective due to adverse weather, reduced oil thickness due to surface spreading, or the challenges associated with spotting recoverable oil. However, when planning for a spill scenario that reflects these circumstances, EDRC does not incorporate the influence of other response options used in conjunction with mechanical recovery.

Improving Mechanical Recovery Planning Standards

As the oil spill response community takes a closer look at effective daily recovery capacity, there has been

A fixed wing aircraft releases oil dispersant. U.S. Coast Guard photo by Petty Officer Stephen Lehmann.

noteworthy progress in designing a new regulatory framework.

For the past three years, the JITF has promoted information and knowledge sharing regarding best available mechanical recovery technologies to optimize skimming systems in the appropriate operating environments. This industry group has also carefully tracked and monitored research and development efforts to ensure visibility among plan holders, OSROs, and other key industry stakeholders.

At the 2011 International Oil Spill Conference, the U.S. Coast Guard, the Bureau of Safety and Environmental Enforcement (BSEE), and the American Petroleum Institute sponsored an EDRC workshop with presentations and facilitated discussion with other members of the oil spill response community including representatives from the federal government, oil industry, shipping industry, and the OSRO community. This event served as a forum to exchange information, observations, and experiences related to EDRC and mechanical recovery. Workshop participants agreed that the effective daily recovery capacity is not an accurate planning tool to determine oil spill response equipment needs. In addition, many attendees concluded that EDRC should account for the skimmer system as a whole, not individual skimmer components such as pump capacity.

A vessel crew deploys a skimmer off the coast of Brazil. Photo courtesy of Elastec/American Marine.

In 2010, the Coast Guard and BSEE formed a joint response workgroup to improve interagency partnerships and oil spill preparedness efforts in several key areas. One of the major tasks associated with this effort was to review existing regulations for calculating mechanical oil spill response equipment effectiveness. In 2012, the agencies completed a third-party, independent research contract to review existing EDRC regulations and make recommendations for improving planning standards for mechanical recovery. The contractor based its final report methodology on oil spill thickness as a fundamental component in calculating mechanical recovery potential and emphasized the importance of on-scene response time and storage for recovered oil.

The Coast Guard and BSEE have initiated discussions with the oil industry, OSRO community, other federal agencies, and other interested parties regarding the practicality of the contractor's final report methodology. The agencies will continue this dialogue with appropriate government and industry stakeholders to evaluate potential courses of action. This body of research may influence future improvements to the existing EDRC planning standards.

Ongoing Efforts

As the Coast Guard moves forward to address the highly complex issue of developing a new planning standard for mechanical recovery, there are several considerations that must be addressed.

First, there is a general understanding that the more factors that are incorporated into an improved planning standard, the more tenuous and complex the methodology will become. Although there is a need for more scientific validity in determining equipment response capability, the Coast Guard recognizes that vessel and facility plan holders must have an understandable, user-friendly methodology to determine their own equipment requirements for oil spill scenarios.

A new planning standard must also contain a methodology to determine a reasonable level of mechanical response equipment and it should recognize the effectiveness of skimming systems in conjunction with response tools like dispersants and *in-situ* burning—especially in offshore environments. It also must provide incentives for industry to develop and employ the most effective skimmer system technology.

Furthermore, a new standard should emphasize rapid response time on the scene and include skimmer system classification for use in particular operating environments. From an economic perspective, any future EDRC improvements could immediately impact contractual relationships among plan holders and the OSRO community. For example, a new regulation that requires industry to increase skimmer system inventories could directly influence business models and operating expenses.

The Coast Guard looks forward to collaborating with its government partners and industry to design a new planning standard that will accurately reflect actual skimmer system oil spill performance.

About the author:
LCDR Drew Casey has served in the U.S. Coast Guard for 14 years. His experience includes operations afloat, oil and hazardous material incident response, salvage operations, disaster recovery, and contingency planning. Previous tours include USCGC Steadfast, Marine Safety Office Jacksonville, and Sector Mobile. He is the lead project officer for the Coast Guard's Spill of National Significance Exercise Program and manages the Government Initiated Unannounced Exercise Program. He holds a B.S. in civil engineering from the U.S. Coast Guard Academy and an M.S. in environmental policy/planning and sustainable systems from the University of Michigan.

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Oil Spill Research

The Interagency Coordinating Committee on Oil Pollution Research.

by CDR Eric Miller
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U.S. Coast Guard Office of Marine Environmental Response Policy

In 1989, Rear Admiral Joel D. Sipes, then chief of the Coast Guard Marine Safety, Security, and Environmental Protection Directorate, testified before Congress about the need for better organized oil spill research. He stated:

"The Coast Guard recognizes that the oil industry and other federal departments and agencies, such as the Environmental Protection Agency, Department of the Interior, National Oceanic and Atmospheric Administration, and Department of Energy, have their own oil spill technology research and development needs and plans. Because of this wide and varied interest, federal research and development in the future must be coordinated to prevent duplication of effort. The Coast Guard, as the agency responsible and accountable for response in the Coastal Zone, is prepared to take the lead, under Secretary Skinner's [Department of Transportation] direction in coordinating research and development efforts in oil spill response."

Congress passed the Oil Pollution Act of 1990 in the wake of the *Exxon Valdez* oil spill, thus creating the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR), which consists of 15 members representing federal independent agencies, departments, and department components including the U.S. Coast Guard (USCG), the National Oceanic and Atmospheric Administration (NOAA), the Bureau of Safety and Environmental Enforcement (BSEE), and the Environmental Protection Agency (EPA).

The committee's purpose can be summarized in two objectives:

- prepare a comprehensive, coordinated federal oil pollution research and development plan;
- promote cooperation with industry, universities, research institutions, state governments, and other nations through information sharing, coordinated planning, and joint project funding.

Through these objectives, the ICCOPR is able to spread awareness of the latest research advances in controlling oil pollution in a number of environments, including the outer continental shelf (OCS).

Capitalizing on Membership Expertise

Congress established the ICCOPR's membership to address all aspects of oil pollution research. As such, ICCOPR agency involvement includes NASA and the U.S. Fire Administration.

NASA provides resources and expertise related to satellite remote sensing applications and problem solving for complicated technological issues. Similarly, the U.S. Fire Administration helps develop accident-prevention measures and advises on *in-situ* burning for oil spill response.

A newer addition to the committee is the U.S. Arctic Research Commission, which provides a wealth of knowledge related to issues involving oil exploration and commerce activities, which are steadily increasing in the Arctic. When the ICCOPR must focus on OCS issues, five members play prominent research roles: the Department of Energy, the Bureau of Ocean Energy Management, NOAA, BSEE, and the USCG.

The Interagency Coordinating Committee on Oil Pollution Research meets quarterly to coordinate activities and address new research from industry and academia. U.S. Coast Guard photo.

All of these parties use ICCOPR to:

- share research information and findings,
- avoid unnecessary project duplication and potential excessive government expenditure,
- leverage mutual resources for better research.

These aims are achieved through the ICCOPR's quarterly and special meetings, research conferences and workshops, and specific interagency communications and engagements.

The ICCOPR Oil Pollution Research and Technology Plan

The Interagency Coordinating Committee on Oil Pollution Research is required to prepare an oil pollution research and technology (R&T) plan pursuant of Title VII of the Oil Pollution Act of 1990.[1] In April 1992, the committee submitted the original R&T plan. The National Research Council's Committee on Oil Spill Research and Development, under the auspices of the marine board of the National Academy of Sciences, reviewed the 1992 R&T plan and provided several suggestions for improvement. The ICCOPR revised the plan to address spill prevention, human factors, and response technology field testing/demonstration and published an updated version in April 1997.

The concept of oil pollution research covers an array of subjects, depending on the needs and perspectives of research stakeholders or practitioners. Not only does oil pollution research focus on removing or mitigating spilled oil from the environment, but it also involves other themes such as developing new means for preventing oil spills, assessing the environmental and societal impact, and restoring the environment as best as possible to pre-spill conditions.

Ongoing Plan Improvements

The Interagency Coordinating Committee on Oil Pollution Research restructured its 2013 R&T plan to create a six-year research review cycle and to establish a categorization scheme and lexicon for addressing oil spill research subjects. This new approach is critical, as it provides a common language and planning framework that

Mr. John Kessler, an assistant professor of Oceanography at Texas A&M University in College Station, studies oceanic methane from the *Deepwater Horizon* spill. Photo courtesy of NOAA.

Recent OCS Research Coordination through ICCOPR

The ICCOPR membership has recently engaged in a number of projects related to OCS oil pollution research.

- **BSEE developed an interagency agreement with the EPA to conduct research in a Canadian experimental wave tank to simulate deep sea injection of dispersants into leaking oil to determine the difference between physically and chemically dispersed oil at depth.**
- **The Department of Energy's ultra-deepwater research program was established pursuant to Title IX, Subtitle J of the Energy Policy Act of 2005. The department submitted its annual plan to Congress in 2013 that describes planned research investments related to oil and gas spill prevention and risk mitigation associated with oil and gas drilling and production operations.**
- **BSEE has provided funding for NOAA, in coordination with Louisiana State University, to conduct a study on the residue (tar balls) produced from *in-situ* burning applications during the 2010 Gulf of Mexico *Deepwater Horizon* spill.**
- **The Bureau of Ocean Energy Management is sponsoring a study to characterize deep circulation in the Gulf of Mexico. This study involves deploying approximately 60 deep floats that record sound from multiple fixed sound-generating sources. These floats are designed to stay at a certain depth and record drift patterns.**
- **The oil and gas industry convened the Joint Industry Oil Spill Preparedness and Response Task Force in June 2010 to evaluate procedures and lessons learned during the 2010 *Deepwater Horizon* oil spill response. For example, several American Petroleum Institute projects were funded to tackle various topics including preparedness planning, *in-situ* burning, and dispersant use. One specific workgroup, the Subsea Dispersant Injection Workgroup, requested ICCOPR's support to provide federal science technical advisors to comment on the workgroup's evolving research. USCG, NOAA, EPA, and BSEE all provided technical advisors for this initiative.**
- **The USCG Research and Development Center recently completed a multi-year project to find new technologies to detect and mitigate heavy oil spills affecting benthic (sea bottom) environments. The center has now turned its attention to responding to oil spills suspended in the water column (see related article).**
- **In early 2013, BSEE organized a $6 million budget and solicited proposals for nine different research subjects supporting OCS oil spill research operations. At BSEE's invitation, several ICCOPR member organizations participated in evaluating the different submissions to determine which ones should be funded.**

will improve communication with Congress, industry, academia, and the public.

The R&T plan will also help the ICCOPR provide guidance and advice to the newly created National Academy of Sciences' (NAS) Gulf Research Program. As part of a Department of Justice settlement with the responsible parties of the 2010 *Deepwater Horizon* incident, the NAS was asked to create a $500 million research program that addresses human health and environmental protection issues in the Gulf of Mexico and the outer continental shelf. The settlement requires NAS to consult with the ICCOPR about its proposed projects throughout the program's 30-year lifespan.

The ICCOPR continues to serve as a forum for its federal members to coordinate and maintain awareness of ongoing oil pollution research activities, including those focused on the OCS.

About the author:
CDR Eric Miller has served in the U.S. Coast Guard for 19 years. He has operational experience in oil spill and hazardous materials response, salvage operations, environmental protection and emergency management. Previous tours include service aboard USCGC Red Cedar, *at MSO Hampton Roads, and as a chemistry instructor at the Coast Guard Academy.*

Endnote:

1. The ICCOPR is referenced in two pieces of legislation: the original Public Law that mandated its creation and its periodic updates in the United States Code. Consequently, when discussing the ICCOPR, it is generally referenced as: *Oil Pollution Act of 1990, § 7001, 104 Stat. 484, 559-564 (1990) (33 U.S.C. 2761).*

For more information:

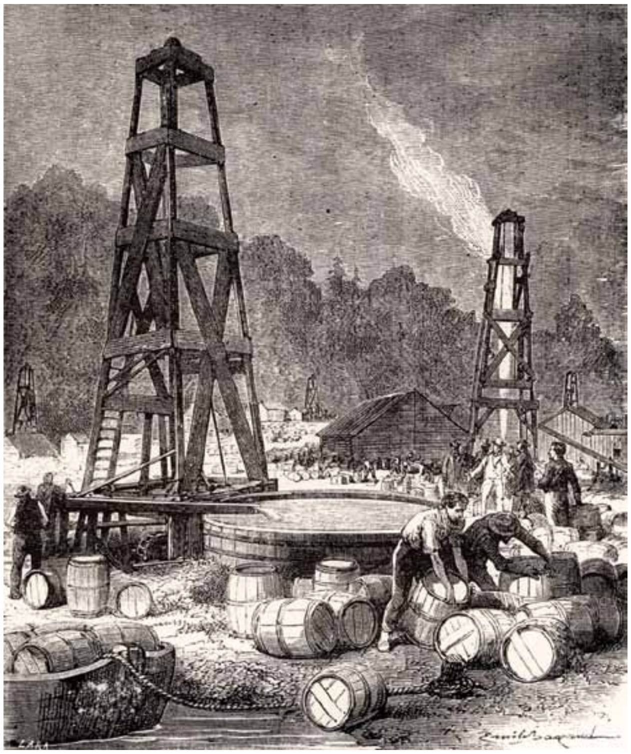
View ICCOPR's activities at **www.iccopr.uscg.gov.**

The Coast Guard and MODUs

by LT Dallas Smith
Supervisor
USCG Marine Safety Detachment Brownsville

CWO2 David Turman
Marine Inspector
USCG Marine Safety Detachment Brownsville

The second Industrial Revolution of the late 1800s brought with it a new demand—petroleum-based fossil fuels. As technology advanced, many industries took advantage of the new, low-cost energy source, and oil demand expanded exponentially. Following World War II, America's economic boom placed even greater pressure on oil companies to develop new oil fields.



1870s oil well along the Allegheny River in Pennsylvania. Copyrighted image.

The petroleum industry quickly realized that oil field exploration and development needed to expand beyond established land-based areas to keep up with global petroleum demands. Consequently, these companies eventually pursued oil exploration in the ocean, including

Old pumpjack. Copyrighted image.

the Gulf of Mexico. Many attempts at traditional means of exploration, such as drilling from long piers, proved ineffective in a fluid environment. Thanks to American ingenuity, an alternative method was found—the mobile offshore drilling unit or MODU.

Two semi-submersible MODUs, with one in dry-dock, and a jack-up rig at the KeppelAmFELS facility in Brownsville, Texas. Photo courtesy of the Port of Brownsville.

MODU Design

According to the Code of Federal Regulations, a MODU is a vessel that is capable of engaging in drilling operations for subsea resources. Early versions varied from towed barges or platforms to submersible barges resting on the bottom. Many of the wells accessed by these early MODUs may have been located out of sight of land, but were still at depths of less than 30 feet.

View of drill floor/cantilever on a jack-up rig in Brownsville, Texas. Photo courtesy of the Port of Brownsville.

MODUs have evolved over time and now look very different from their early predecessors. Today they range in variety from "jack-up" rigs to self-propelled semi-submersibles, to spar-shaped units capable of drilling in water depths up to 10,000 feet.

In recent years, most of the newly constructed MODUs built in Brownsville, Texas, have been registered in foreign countries including the Marshall Islands and Panama.

The U.S. Coast Guard's Role

U.S. Coast Guard involvement during the MODU construction and delivery process varies based on the flag state and upon where the vessel will operate. For foreign-flagged MODUs that intend to operate on the U.S. outer continental shelf, the Coast Guard takes an active role in verifying compliance with international conventions and U.S. regulations.

While not as comprehensive as an inspection on a U.S.-flagged MODU, this type of examination ensures that the administration of the foreign country, the classification society, and the owner and operator of the MODU have met the requirements necessary for operating in U.S. waters. Upon satisfactory completion of a Coast Guard inspection, a certificate of compliance is issued, granting them the ability to conduct drilling operations.

For those vessels that are constructed in the U.S. but will not operate within U.S. waters, the Coast Guard has almost no involvement during the construction and delivery process. Coast Guard efforts in this regard are focused on ensuring safety of navigation during the outbound transit.

About the authors:

LT Dallas Smith is the supervisor of Marine Safety Detachment Brownsville. He has served in the Coast Guard for 13 years, and has worked in the offshore industry since 2005. He is a qualified marine inspector and casualty investigator with an extensive background in commercial vessel safety and electronic engineering.

CWO David Turman has served the U.S. Coast Guard for 18 years and has served the Gulf of Mexico maritime industry for more than six years as a marine inspector and port state control officer.

Bibliography:

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. *A Brief History of Offshore Oil Drilling. August 23, 2010.*

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. *The History of Offshore Oil and Gas in the United States (long version),* November 1, 2011.

The Coastal State Exam

by LCDR Nikki Samuel
Program Manager, Offshore Compliance
U.S. Coast Guard Office of Commercial Vessel Compliance

LCDR Jennifer Hnatow
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Global trade via water makes up 90 percent of all the industrial traffic in the world.[1] Each year, thousands of vessels transit through U.S. waters, for which the Coast Guard has flag state, port state, or coastal state responsibilities.

There are also more than 150 MODUs (mobile offshore drilling units) and floating installations operating on the U.S. outer continental shelf (OCS), with dozens of new projects expected to be in place by the end of 2014. With this increase in offshore units, there will also be a need to provide them with additional personnel and supplies; so there are an estimated 105 new offshore supply vessel construction projects scheduled thru 2015.[2]

As Gulf of Mexico OCS activities are increasing, such activities have also expanded to the Arctic. With the expected growth in the offshore industry, the Coast Guard is preparing for the immense challenges from increased volume and scope of OCS inspection oversight.

In accordance with the Outer Continental Shelf Lands Act (OCSLA), 43 U.S.C. Chapter 29, and with shared oversight with the Bureau of Safety and Environmental Enforcement, the Coast Guard promulgates and enforces safety and security regulations governing vessels and facilities conducting outer continental shelf activities.

The flag state of a vessel operating on the U.S. OCS and the location of the vessel's operations dictate whether the Coast Guard exercises authorities on behalf of the U.S. as the flag state, port state, or coastal state.

Coast Guard Authorities

Flag State

The Coast Guard is responsible for administering certain U.S. duties as the flag state for U.S.-flagged MODUs. Marine inspectors conduct inspections verifying a U.S.-flagged MODU meets domestic requirements and issue certificates attesting to the unit's compliance. Additionally, the Coast Guard issues certificates for U.S.-flagged MODUs operating internationally, certifying that they meet International Maritime Organization standards.

Port State

Prior to 1994, the Coast Guard was heavily invested in ensuring the safety of just the U.S.-flagged fleet, and

Members of Marine Safety Unit Port Arthur following an exam aboard a MODU. Pictured from left: LTJG Greg Svencer, CWO Brian Batt, CWO Brian Millsap, CWO Jay Willimon, CWO Lee Willett, CWO Steve Olivares, and LT Kyle Carter. U.S. Coast Guard photo by Mr. Cal Brown, MSU Port Arthur.

Mobile Offshore Drilling Unit Examinations

Members of Coast Guard CG-ENG and Sector Puget Sound examine pressure vessel placement aboard a MODU. U.S. Coast Guard photos by Mr. Jay Jerome, Sector Anchorage, Alaska.

MSSE3 Harley Bates of Sector New Orleans examines internal structural members during an in service inspection program exam.

Sector New Orleans personnel examine a personnel transfer basket.

foreign-flagged vessel examinations were limited to ensuring that these vessels complied with domestic laws and regulations. In 1994, the Coast Guard developed a more robust port state control program to eliminate substandard foreign-flagged vessels from calling on U.S. ports.[3] Because foreign-flagged MODUs seldom call on U.S. ports, they are not always subject to U.S. port state control. By engaging in seabed activities on the OCS, they typically fall under coastal state authority.

Coastal State

In accordance with the IMO Code for the Construction and Equipment of Mobile Offshore Drilling Units, 2009 (MODU Code), a coastal state is defined as the government of the state exercising administrative control over the drilling operations of the unit. The Coast Guard administers U.S. OCS coastal state authorities through OCSLA statutory authority. This is the authority the Coast Guard most often exercises over foreign-flagged MODUs.[4]

LT Kyle Entzel climbs out of a spar following an in service inspection program exam.


LT Al Giordano witnesses a cold water abandon ship drill aboard a MODU.


MSSE3 Harley Bates of Sector New Orleans witnesses helo deck foam monitor operation.


MSSE4 Tony Pesek of Marine Safety Unit Texas City watches oily water separator operation aboard a jack-up MODU.

The Coast Guard usually recognizes valid international certificates that are issued to show compliance with international instruments for foreign-flagged vessels operating on the U.S. OCS, such as the International Convention for the Safety of Life at Sea, the International Convention for the Prevention of Pollution from Ships, the International Convention on Load Lines, and the MODU Code. The Coast Guard may require additional information if there are clear grounds to believe the condition of the unit or equipment does not correspond substantially with the particulars of the certificate.

Requirement to Undergo Examination

A MODU, foreign or domestic, may not conduct operations on the OCS without first undergoing a Coast Guard examination or inspection. Foreign-flagged MODUs found compliant by the Coast Guard are issued a certificate of compliance that is valid for two years, with a re-examination required within three months of the anniversary of its issuance date. Additionally, foreign MODUs may be targeted for more frequent examinations in accordance with CG-543 Policy Letter 11-06, *Risk-Based*

Targeting of Foreign Flagged MODUs. All of these examinations are performed under coastal state authority.

Examination Scope

U.S.-flagged MODUs receive a certificate of inspection after undergoing a satisfactory Coast Guard inspection, which is different in scope than an examination. A U.S.-flagged MODU undergoes an in-depth inspection based on U.S. rules and regulations; a foreign-flagged MODU receives an examination for a certificate of compliance to ensure it complies with appropriate international standards and applicable U.S. regulations.

A foreign-flagged MODU has three options under 33 CFR 143.207 for how it can receive a certificate of compliance. The first option requires MODUs to comply with the design and equipment standards of the U.S. regulations found in 46 CFR Part 108. USCG marine inspectors will examine foreign-flagged MODUs to ensure compliance to the same extent as would be performed on a U.S.-flagged MODU.

The second option requires a MODU to comply with the standards of the documenting nation, if the standards for safety and operational requirements provide a level equivalent to or exceeding U.S. regulations. If there is any indication the MODU is not being maintained to the flag state's standards, or there are apparent discrepancies between the flag state's standards and 46 CFR Part 108, these issues will be resolved prior to issuing a certificate.

The final option requires compliance with the IMO MODU Code. The MODU must possess a valid IMO MODU Code certificate issued by or on behalf of the flag state. Other required documents will also be examined to determine their validity.[5]

Owner and Operator Responsibilities

The owner or builder of a foreign-flagged MODU should apply for an examination to obtain a certificate of compliance at least six months prior to engaging in U.S. OCS activities by submitting a written request or email to the officer in charge of marine inspection of the marine inspection zone in which the unit intends to operate.

Foreign-flagged MODUs are charged a user fee for Coast Guard examinations in accordance with 46 CFR 2.10-130 and may not be examined until these fees are paid.

One OCS, One Standard

The Coast Guard is working to amend its coastal state regulations, 33 CFR Subchapter N, to effectively mitigate the risk OCS activities pose to people, property, and the environment. By amending its coastal state regulations the Coast Guard will ensure all MODUs, floating facilities, and vessels, regardless of flag, that operate on the U.S. OCS are required to satisfy the same standards. The new regulations will incorporate industry consensus and international standards, which will set the framework to keep pace with the rapidly evolving technology employed on the OCS.

About the authors:
LCDR Nikki Samuel is the program manager for offshore compliance in the Office of Commercial Vessel Activities. Her experience includes several marine safety assignments and staff positions at Coast Guard headquarters.

LCDR Jennifer Hnatow has served in the U.S. Coast Guard for 12 years. LCDR Hnatow has served in many capacities, most recently on the headquarters staff with the Commercial Vessel Compliance Offshore Branch.

Endnotes:

1. International Chamber of Shipping available at www.shipping-facts.com/.
2. CGBI Cubes data.
3. More detailed information on Coast Guard examinations conducted under the port state control authority can be found in Change 2 to Navigation and Inspection Circular 06-03, *Coast Guard Port State Control Targeting and Examination Policy for Vessel Security and Safety.*
4. The scope of coastal state examinations is further clarified in regulations (33 CFR 140.101(e)).
5. Further details as to the scope of COC exams can be found in CH-1 to NVIC 3-88, *Issuance of Letters of Compliance to Foreign Documented Mobile Offshore Drilling Units Operating on the Continental Shelf of the United States.*

The Deepwater Port Act of 1974

Requirements and new trends.

by Mr. Curtis Borland
Attorney/Advisor
U.S. Coast Guard
Deepwater Ports Standards Division

Congress enacted the Deepwater Port Act of 1974 during a time when America was increasingly dependent on imported oil, to establish economical means to transport it to the U.S. The act sought to enhance environmental protection by reducing the number of ships operating in U.S. coastal waters, thereby reducing the chances for vessel incidents that could initiate oil spills.

Key act components include:

- regulating deepwater port location, ownership, construction, and operation;
- minimizing any environmental impact from such ports;
- protecting U.S. interests and those of adjacent coastal states regarding deepwater port location, construction, and operation.

Depiction of a liquified natural gas cargo carrier. Copyrighted image.

A deepwater port is a structure located beyond a state's seaward boundary, used for oil or natural gas transportation.

The Coast Guard and Maritime Transportation Act of 2012 amended the Deepwater Port Act to allow for U.S. oil or natural gas export.[1]

There are currently three deepwater ports in operation:

- the Louisiana Offshore Oil Port,
- the Northeast Gateway,
- the Neptune.

The Louisiana Offshore Oil Port is the oldest deepwater port in the U.S. and transports crude oil, via pipeline, from its offshore marine terminal to onshore storage and distribution sites. The Northeast Gateway and the Neptune operate off Massachusetts and import natural gas. Moreover, a liquefied natural gas distributor has received a license to construct and operate a port off Florida's west coast, and it is expected that there will be further commercial interest in developing export facilities that can liquefy and transfer natural gas for sale on the international market.

A liquefied natural gas regasification vessel prepares for transfer operations at a natural gas deepwater port. Image courtesy of Excelerate Energy.

Coast Guard and MARAD Authorities

The Maritime Administration (MARAD) and the Coast Guard jointly administer the act. MARAD, as the licensing authority, authorizes deepwater port siting, construction, operation, and decommissioning. The Coast Guard is the co-lead federal agency that processes deepwater port applications and leads deepwater port environmental impact reviews in accordance with the National Environmental Policy Act. The Coast Guard also reviews a deepwater port's operations manual, which describes port operation and includes measures to mitigate and monitor any possible adverse environmental impact.

The Coast Guard and MARAD, via delegations from the Secretary of Transportation, are co-lead federal agencies for processing applications to site, construct, and operate deepwater ports.[2] In general, the Coast Guard is responsible for facility inspections; matters related to navigational safety, engineering, and safety standards; and approving the facility operations manual. MARAD is responsible for determining potential licensees' financial capability, confirming citizenship prerequisites, and issuing or denying the license.

Liquefied Natural Gas Exports

By allowing exports from deepwater ports, Congress recognizes that the U.S. domestic natural gas market has seen remarkable changes in a very short period.

For example, due to stricter air emissions rules, many large coal-fired electric power plants have undertaken natural gas conversion, resulting in fewer particulate matter and nitrogen/sulfur oxides emissions. Also, new hydraulic fracturing technologies have allowed access to heretofore untapped natural gas resources in the continental U.S., which has led to greater natural gas availability at unprecedented low cost.

Due to this change in market dynamics, oil and natural gas industry companies have substantially increased applications for export permits that allow shipment of domestically produced natural gas to overseas markets. It is expected that it is only a matter of time before proposals are received from deepwater port operators to convert existing ports or build new capacity to capitalize on this export trend.

In some parts of the country, the transit of liquefied natural gas cargo carriers to waterfront facilities can be highly controversial. However, constructing offshore natural gas liquefaction, storage, and offloading export facilities supports the purposes of the act by keeping large liquefied natural gas cargo carriers offshore. This would likely result in enhanced protection of the marine and coastal environment, reduce congestion in busy port access routes, and allow adjacent coastal states to better regulate growth, determine land use, and protect their coastal environments, while gaining the economic benefit from the port's construction and operation.

Finally, the Maritime Administration and Coast Guard's deepwater port regulation is a program that industry understands. It provides an appropriate regulatory scheme upon which proposed export facilities could be licensed and operated.

Processing Applications

The Deepwater Port Act prescribes a rigorous timeline for application processing. In general, the act directs that within 356 days from receipt, the Coast Guard and MARAD must complete a comprehensive environmental impact analysis of the proposed deepwater port's construction and operation, and assess the applicant's current and long-term financial capacity to construct, operate, and eventually decommission the port.

This federal review includes preparing an environmental impact statement, holding two or more public hearings in each designated adjacent coastal state, and conducting in-depth coordination with all federal and state departments and agencies that issue licenses, approvals, or authorizations over some aspect of the project.

State's Rights

The Deepwater Port Act is unusual in that it allows the governor of an adjacent coastal state to exercise *de facto* "veto" power over a federally licensed project that falls outside of the state's territorial waters, if the deepwater port is located within 15 miles of the state or if the state is to have a pipeline to the port.

To accommodate this provision, the MARAD administrator is required to publish a notice of application in the *Federal Register* that includes a summary of the plans and identifies the states that satisfy the criteria to be automatically designated as "adjacent coastal states."

No more than 10 days after publishing the notice of application, the administrator must transmit a complete copy of the application to the governor of each adjacent coastal state. Further, the act prohibits the administrator from issuing a license without approval from each governor. In practical terms, this means that a governor may register disapproval and effectively exercise veto power over the proposed deepwater port.

About the author:
Mr. Curtis Borland is the legal advisor to the Deepwater Ports Standards Division, where his practice focuses on environmental compliance and offshore energy development. He served as a judge advocate on active duty in the Coast Guard, and his tours included the 8th District legal office and the Office of Environmental Law at Coast Guard headquarters.

Endnotes:

1. Upon passage of the Deepwater Port Act, the Coast Guard published in 1975 the deepwater port regulations, found at 33 Code of Federal Regulations (C.F.R.), parts 148, 149, and 150. Originally, these regulations only applied to deepwater ports, which were constructed to import oil; however, in 2002, the Maritime Transportation Security Act amended the Deepwater Port Act (DWPA) to include the transportation of natural gas. The Coast Guard subsequently revised its deepwater port regulations by interim rule in 2004 and final rule in 2006, to accommodate both natural gas and oil deepwater ports. Part 148 addresses application processing and licensing requirements; part 149 concerns engineering, design, and technical requirements; and part 150 focuses on deepwater port operations.
2. The DWPA provides authority to the Secretary of Transportation (SECDOT) to issue, amend, transfer, or reinstate a license for ownership, construction, or operation of a deepwater port. SECDOT delegated, in 49 C.F.R. §1.46(s), to the Commandant of the Coast Guard authority to process (in coordination with MARAD) applications for licenses under the Deepwater Port Act. Sections 888 and 1512(d) of the Homeland Security Act of 2002 effectuated transfer of authority for Coast Guard authorities and functions from the SECDOT to the Secretary of DHS.

The National Offshore Safety Advisory Committee

by Mr. Scott E. Hartley
United States Coast Guard
Vessel and Facility Operating Standards Division

The National Offshore Safety Advisory Committee (NOSAC) originated in 1988 to open lines of communication between the Coast Guard and the offshore oil and gas industry. The committee serves as a public forum to discuss safety, security, and environmental concerns regarding the U.S. Outer Continental Shelf (OCS) and provides information to the Coast Guard for policy development and regulatory oversight.

NOSAC Membership

Membership is organized as outlined below.

Two members representing companies, organizations, enterprises or similar entities engaged in each of the following activities:

- **petroleum production,**
- **offshore drilling,**
- **offshore operations,**
- **offshore support.**

One member representing companies, organizations, enterprises, or similar entities engaged in each of the following activities:

- **offshore facility construction;**
- **offshore diving services;**
- **offshore safety and training providers;**
- **offshore subsea engineering, construction, or remotely operated vehicle support;**
- **offshore environmental protection, compliance, or response services;**
- **offshore oil exploration and production on the Outer Continental Shelf of Alaska.**

One member of the public.

An Evolving Membership

The committee consists of 15 members with knowledge, experience, and expertise regarding the technology, equipment, and techniques used to recover offshore mineral resources. As members represent particular offshore oil and gas industry segments, these segments change from time to time to reflect technological advances and industry adjustments

For example, an Alaska OCS segment has replaced the deepwater ports segment due to the increased activity in the Arctic region and the unique challenges faced with exploration and production. The subsea engineering segment replaced the pipe laying segment, as current production is moving further offshore into deeper water.

The secretary of the Department of Homeland Security appoints members to serve a term of three years, and membership terms are staggered, with approximately one-third expiring each year. Vacancies are advertised in the *Federal Register,* with interested individuals asked to submit an application and resume representing a particular segment. In addition, the Coast Guard Commandant may request the Bureau of Safety and Environmental Enforcement, the Environmental Protection Agency, the Maritime Administration, the Department of Energy, and the Occupational Safety and Health Administration to each designate a representative to participate as an observer.

Meetings

The committee holds two meetings annually, one in April in New Orleans, La., and the other in November in Houston, Texas. This maximizes participation, because the offshore industry is concentrated along the Gulf Coast. Notice of each meeting and an agenda are published in the *Federal Register,* one month prior to the meeting.

Copyrighted image.

Issues

Coast Guard programs that develop policy and regulations affecting the offshore industry provide NOSAC task statements for review and comment. On occasion, committee members who have a particular interest or see a developing trend may also provide a task statement. Experts from industry review each task statement and issue a final report containing recommendations. Recent recommendations include:

- evacuation and medical treatment for injured offshore workers and divers from remote offshore locations,
- certification and standards for large offshore supply vessels,
- ballast water discharge standards,
- modular quarters,
- operating standards and practices for dynamic positioning systems.

NOSAC is also actively working on task statements related to:

- accommodation service vessel standards,
- standards for additional lifesaving and fire fighting requirements aboard mobile offshore drilling units and other manned offshore facilities,
- hazardous area electrical equipment certification on foreign-flagged mobile offshore drilling units,
- life boat sea service limitations,
- Coast Guard marine casualty reporting form revisions.

A tug tows a mobile drilling unit southwest of Kodiak, Alaska. U.S. Coast Guard photo by Petty Officer Sara Francis.

Looking Ahead

The offshore industry has changed dramatically in the past 25 years. Oil exploration has moved further offshore and into deeper water, where more extreme pressures and temperatures require new technologies. Mobile offshore drilling units have become more complex, with sophisticated computer operating systems; support vessels have increased in size and complexity to meet demand; dynamic positioning has replaced traditional mooring systems in deeper water; and vessels operate in close proximity to one another, utilizing global positioning satellites and vessel-to-vessel references. Additionally, Arctic exploration presents a new frontier, and operating in its harsh environment adds further challenges.

However, with these advancements come increased risks. The tragic loss of 11 people in the explosion, fire, and sinking of the *Deepwater Horizon* is a constant reminder of these risks. The Coast Guard looks to the expertise on NOSAC to recommend safety standards and identify best practices to incorporate into Coast Guard OCS policy and regulatory development to protect the environment and ensure offshore worker safety.

About the author:
Mr. Scott Hartley works in the Outer Continental Shelf Branch of the Commercial Vessel and Facility Operating Standards Division at Coast Guard headquarters. He also serves as the NOSAC assistant designated federal official.

Offshore Commercial Diving

Industry and government collaborate to promote safety.

by Mr. Dennis Fahr
Marine Transportation Specialist
U.S. Coast Guard Office of Operating and Environmental Standards

Mr. Phil Newsum
Executive Director
Association of Diving Contractors International

Commercial diving has been around for centuries. Divers once descended to the depths with inverted clay pots around their heads or used hollow reeds for their air supply. Today, men and women don special equipment and employ advanced technology to descend to even greater depths, stay there longer, and accomplish their work.

U.S. Commercial Diving History

Commercial diving, as we know it today, began in the 1950s on the U.S. outer continental shelf (OCS) in the Gulf of Mexico. Deep commercial diving first took place in the 1960s off the coast of California, where rapid drilling development in the offshore environment called for commercial divers to accomplish underwater tasks.

A diver works off of a platform in the Gulf of Mexico. Photos courtesy of Oceaneering International Inc. unless noted otherwise.

When a major oil spill off the coast of Santa Barbara in 1969[1] curtailed oil production and exploration in the area, commercial diving shifted to the Gulf of Mexico, where it quickly became the premier location for offshore commercial diving. The Gulf of Mexico now has the highest volume of offshore structures worldwide, and the most experienced oilfield divers ply their trade there.

As oilfields continue to move further offshore and into deeper water, they present new challenges for commercial diving. For example, commercial diving often involves operations at depths of several hundred to more than 1,000 feet. Divers operating at these depths face extreme pressures and temperatures. They require trained support teams, properly maintained equipment, and must strictly adhere to safety procedures to avoid incidents.

Commercial Diving Regulatory Oversight

Federal commercial diving regulation falls under the auspices of the U.S. Coast Guard and the Occupational Safety and Health Administration (OSHA). Commercial divers working from the dock of a shipyard or marina or from an uninspected vessel are required to meet OSHA commercial diving regulations. Some states also have separate OSHA-approved commercial diving plans covering certain private-sector maritime operations such as shore-based shipyard employment and marine terminals.

The Coast Guard regulates commercial diving operations on the U.S. OCS and adjacent waters and from any vessel required to have a Coast Guard certificate of inspection.

While Coast Guard commercial dive regulations were originally promulgated in 1978, they have been revised to reflect modern commercial diving challenges.

A diver welds underwater on a platform in the Gulf of Mexico. Photo courtesy of Neptune Marine Services.

To further aid marine safety efforts, the Coast Guard formalized a memorandum of understanding with the Association of Diving Contractors International (ADCI) in June 2011 to promote commercial diving safety and protect the marine environment through uniform commercial diving industry safety standards and best practices, via non-regulatory means, where possible. The Coast Guard also signed a mutual training agreement with ADCI to share information regarding the diving industry and the regulatory process.

Although there is no formal Coast Guard training program dealing with commercial diving, Coast Guard inspectors and investigators benefit from this industry training and are better prepared to effectively administer the regulations they are charged with enforcing and to effectively carry out investigations dealing with commercial diving incidents.

Current Commercial Diving Safety Issues

A number of initiatives and discussions have resulted from meetings with the Association of Diving Contractors International:

- ADCI is developing an industry standard with major companies working in the OCS to implement crew endurance management systems for the commercial diving industry.
- Collaborative efforts with other dive-centric groups such as the International Association of Oil and Gas Producers and the International Marine Contractors Association are underway to promote consistent diving safety regulations worldwide.
- The ADCI casualty analysis committee ensures that diving incident data from various reporting sources is accurate, consistent, and transmitted to divers for their benefit.
- The ADCI safety committee is working on solutions to reduce commercial diving casualties, including launching an anonymous website to log and track near misses for root cause analysis.
- The Coast Guard and ADCI participate in the Gulf of Mexico Diver Safety Work Group to share information regarding diving incidents, corrective measures, and best practices.

The Future

Commercial diving has a rich history and will undoubtedly become more complex as technological advances create new capabilities and present new challenges. New technology is enabling oilfield drilling to move into ever deeper water even as older, near-shore oilfields in shallower water are becoming economically viable again and are being revitalized. Remotely operated vehicles

A diving platform vessel retrieves a remote operating vehicle.

The Association of Diving Contractors International

In 1968, a group of dive companies formed the Association of Diving Contractors International (ADCI), a nonprofit organization to cultivate and promote commercial diving, establish uniform safe standards for commercial divers, and encourage industry-wide observance of these standards. Today, ADCI membership includes elements from the business, educational, and medical communities.

Safety Standards

ADCI developed its international consensus standards for commercial diving and underwater operations to provide industry best practices for commercial divers, tenders, supervisors, and deck support personnel.

The standards apply to all types of underwater work involving commercial diving, whether inland or offshore, and are intended to complement applicable government rules and regulations as well as supplement industrial codes of safe practice for diving and underwater operations.

Self Regulation

ADCI holds its members accountable to self regulation through its membership review committee. If incidents occur due to operational or equipment deficiencies, the committee determines the appropriate course of corrective action. Penalties can range from temporary suspension to membership termination, based upon the outcome of government agencies' investigations. In all instances, the ADCI will conduct a formal audit to determine if the member in question is operating in compliance with the consensus standards and all applicable government regulations.

A commercial diver working from a dive vessel in the Gulf of Mexico.

facilitate work at depths exceeding human capability and minimize diver risk.

The Coast Guard will continue to play an important role in inshore and offshore commercial diving safety. Leveraging its industry partnerships, the service will strive to share best industry practices through information bulletins and lessons learned from incident investigations. The Coast Guard will also seek to promote a consistent standard for commercial diving safety by working with other federal agencies that have dive safety regulatory responsibility.

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About the authors:

Mr. Dennis Fahr is a marine transportation specialist, focusing on outer continental shelf regulations. He served in U.S. Coast Guard active duty and reserves for more than 27 years and is a U.S. Navy-trained diver. He was the Coast Guard Dive Program manager from 2007 to 2010.

Mr. Phil Newsum is the Association of Diving Contractors International's executive director. He worked as a mixed gas diver and supervisor, commercial diving instructor at Divers Institute of Technology in Seattle, and serves on numerous committees and subcommittees in the underwater industry. Mr. Newsum served in the U.S. Marine Corps from 1981 to 1989.

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Steady Now

Enhancing dynamic positioning safety.

by LT Jeff Bybee
U.S. Coast Guard
Office of Design and Engineering Standards

CDR Josh Reynolds
U.S. Coast Guard
Office of Design and Engineering Standards

CDR Scott Kelly
U.S. Coast Guard
Sector Baltimore

Dynamic positioning (DP) systems are widely used in the offshore oil and gas industry for industrial missions from drilling, pipe laying, heavy lifting, or diving operations to more routine duties like cargo, personnel, or fuel transfers. All of these missions are expanding, becoming more complex, and going further offshore for longer periods of time, making station-keeping reliability more critical.

Following the *Deepwater Horizon* incident, the Coast Guard re-examined its outer continental shelf (OCS) regulations in light of technological advancements and major incidents since the regulations were published.[1] While the Coast Guard concluded that the safety systems it regulates (such as lifesaving) had a beneficial effect, despite the extreme nature of the incident, it also determined there were several critical areas where technology, including dynamic positioning, had surged ahead of its regulations.[2]

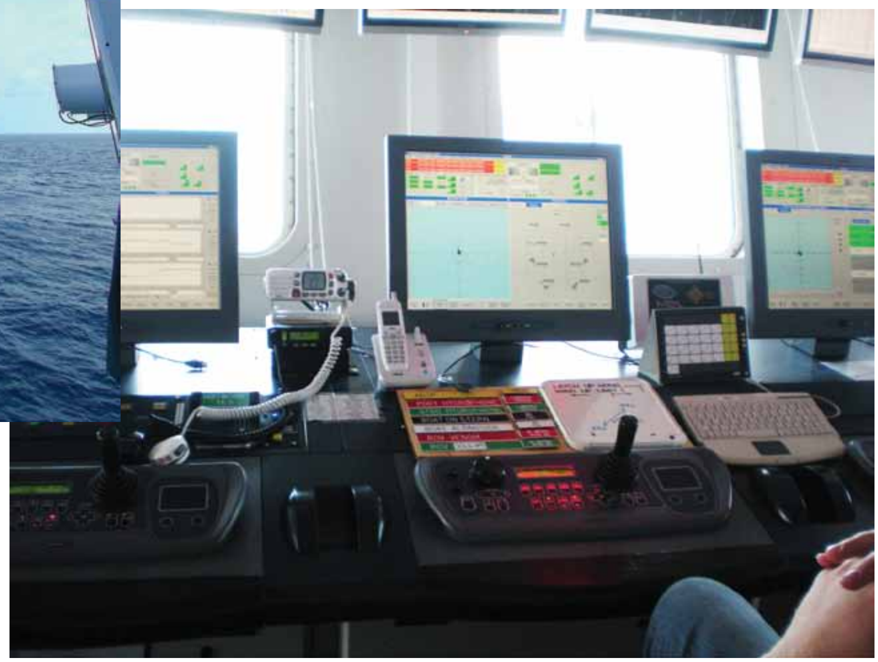
Dynamic Positioning Safety Concerns

Dynamic positioning systems use computers and position-referencing systems to automate control for vital power and propulsion systems and to maintain vessel position. Safe dynamic positioning operations are a process safety concern, as severe consequences may result if a mobile offshore drilling unit (MODU) or other vessel suffers a loss of position (LOP) during critical activities. For example, a loss of position on a MODU during well test/completion operations could result in a subsea spill, which is difficult to contain. An offshore support vessel's loss of position could cause the vessel to strike the gas export riser of a floating or fixed production facility, which may result in an explosion or an environmental event. Loss of position for a dive support vessel poses significant risk to divers.

To facilitate safe DP operations, the Coast Guard published *Federal Register* notices in 2012 that recommended voluntary adherence to Marine Technology Society DP guidance, which emphasizes hazard control

Offshore operation. Copyrighted image.

Crane operation. Copyrighted image.



Dynamic positioning operator station. USCG photo by CDR Joshua Reynolds.

arrangements, effective communications, and critical system maintenance. The notices also noted the Coast Guard's intent to address minimum dynamic positioning requirements.

Intent to Initiate a Rule

Current guidance is found in the 1994 International Maritime Organization's *Guidelines for Vessels with Dynamic Positioning Systems,* which establishes baseline DP reliability requirements but leaves important design and operational items to the discretion of the flag state. Should the Coast Guard publish a dynamic positioning rule as a coastal state, it may supplement this guidance to provide uniform requirements in areas presently left to flag state discretion. Additionally, the Coast Guard could consider publishing a DP rule under authority in Title 46, United States Code, as a flag state.

Transparency and Communication

The Coast Guard participates on the Marine Technology Society DP Guidance Subcommittee and at annual dynamic positioning conferences. These venues provide the Coast Guard with insightful feedback from leading dynamic positioning industry experts, regarding which areas are most critical to safety and what technological developments are most significant. After publishing the notices, the Coast Guard also initiated several teleconferences with designated leaseholders, drilling contractors, offshore supply vessel companies, and dynamic positioning assurance providers to solicit feedback and note areas for consideration in any dynamic positioning rule the Coast Guard might propose.[3]

Potential DP rule Considerations

The Coast Guard will consider whether to include performance-based requirements in a dynamic positioning rule, as MODU requirements have traditionally been detailed and prescriptive. While prescriptive requirements can improve safety for more basic systems, they tend to reflect only technology available at the time they were published and offer limited flexibility when technology advances.

Appropriate performance-based requirements could help solve known DP system problems such as the significant performance disparity between dynamic positioning systems of the same equipment class.[4] For example, a DP equipment class two vessel may choose to operate with closed bus ties to limit emissions, save fuel, and avoid wear and tear on equipment. However, this operational decision may compromise redundancy and lead to a LOP or other dynamic positioning incident due to hidden failures or inadequate design. The Coast Guard might also consider proposing a risk-based approach. For example, Coast Guard regulations for U.S. passenger vessels impose a higher safety standard as the vessel's tonnage or passenger count increases.

Aerial view of drillship and offshore supply vessel. USCG photo by CDR Joshua Reynolds.

In the context of conducting outer continental shelf activities using dynamic positioning, the Coast Guard might associate different risk levels with different vessel types and/or OCS activities. A risk-based approach along these lines might call for higher level DP reliability during activities where a loss of position may result in the most severe consequences. For example, the Coast Guard might consider that an offshore supply vessel using dynamic positioning to conduct a cargo transfer poses a lower level of risk than a MODU using DP to conduct well test or completion operations.

The failure modes and effects analysis (FMEA) is a key document that establishes dynamic positioning system design limits, and the Coast Guard might consider minimum requirements for the quality of this document in a potential DP rule. Because of the complex technical nature of DP systems and the number of FMEA documents produced for dynamically positioned MODUs and other vessels operating on the U.S. OCS, the Coast Guard could consider requirements that allow third-party FMEA review that meets a minimum level of DP assurance competency. Finally, marine personnel competency is an essential part of safe dynamic positioning operations, and the Coast Guard may consider minimum dynamic positioning competency requirements in a potential DP rule.

Nonregulatory DP Safety Efforts

The Coast Guard has initiated several non-regulatory efforts in addition to the *Federal Register* notices, to enhance dynamic positioning safety and inform a potential DP rule. It has conducted external outreach to drilling companies and has added dynamic positioning to its inspector training curriculum. It has also committed to sending officers to obtain master's degrees in appropriate technical disciplines and supplement this education with appropriate dynamic positioning industry training. These officers will staff technical billets that will develop DP policy, any future regulations and standards, and/or perform DP system technical oversight under a potential DP rule.

The Coast Guard also recently published a policy to facilitate voluntary dynamic positioning incident reporting and is working with advisory committees, standards organizations, and industry leaders to develop a comprehensive and effective DP oversight system. Based on its published guidance and outreach, the foundation of this system will likely be a DP rule published under Outer Continental Shelf Lands Act authority.

About the authors:
LT Bybee is a 2005 Maine Maritime Academy graduate and a 2012 University of Michigan graduate with an M.S. in naval architecture and marine engineering. He has served as a marine inspector and in the Coast Guard's Office of Vessel Activities.

CDR Reynolds is a 1993 Coast Guard Academy graduate and a 1999 Georgia Institute of Technology graduate with an M.S. in electrical engineering. He has served as a marine inspector and at the Coast Guard Marine Safety Center.

CDR Kelly is a 1993 Coast Guard Academy graduate and a 2003 Worchester Polytechnic Institute graduate with an M.S. in fire protection engineering. He has served as a marine inspector and at the Coast Guard Marine Safety Center.

Endnotes:

1. 33 CFR Subchapter N was published in 47 FR 9376 on March 4, 1982.
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3. These teleconferences took place in January 2013. The minutes are publicly available at www.uscg.mil/hq/cg5/cg521/.
4. See IMO MSC/Circ.645 Section 2.2 for a discussion of DP equipment classes.

Floating Offshore Installations

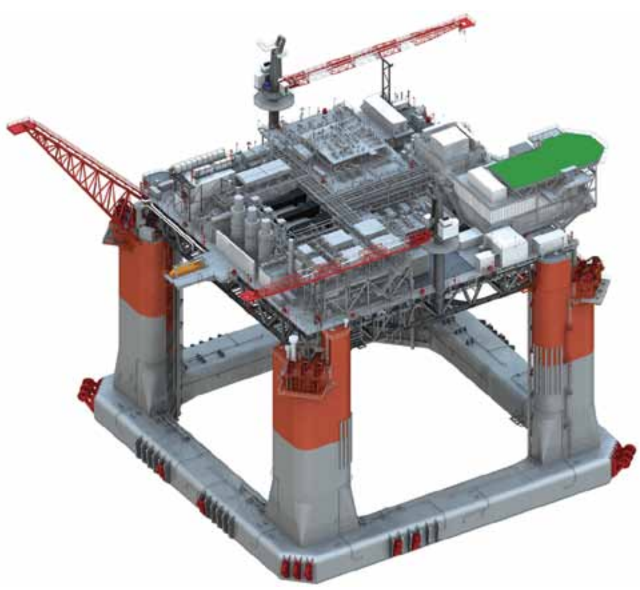
Challenges in new construction project oversight.

by CWO Joel Smith
Marine Inspector
U.S. Coast Guard Sector Corpus Christi

U.S. Coast Guard Sector Corpus Christi is located at one of the nation's largest petrochemical ports and where floating offshore installation (FOI) fabrication and integration takes place. From tension leg platforms to semi-submersible FOIs, we get to see it all down here in the South Texas coastal region.

Coast Guard Oversight and Inspections

One of the unique differences between Coast Guard oversight of a newly constructed vessel and the Coast Guard inspection process that takes place after an existing vessel is placed in service is the level of detail that is spent in getting to know the intricate design of a platform's structure. When all is said and done, the platform structure of a vessel is the backbone of the whole rig, and if it isn't built correctly, then no amount of future regulatory oversight will be able to adequately address major design flaws.



Pictured is a model view of the first semi-submersible FOI classed by DNV in the Gulf of Mexico. Photo courtesy of Mr. Craig Mullett, offshore construction manager.

The majority of the construction projects in Texas are strictly the "topsides" or modules that are subsequently integrated to the vessels' hulls. While some are built stateside, most of the FOI hulls arrive in various stages of completion from overseas, brought in on heavy lift ships.

Although most Coast Guard inspectors and class surveyors certainly have the expertise in the commissioning activities on a platform, they typically lack the knowledge and engineering background that it takes to inspect the platform structure. Locating secondary and tertiary materials, identifying end conditions of the beams, knowing the different types of weld profiles, and such can quickly become complicated. When dealing with a new construction project, one must also account for the hundreds of piping and instrumentation diagrams needed to connect the piping of the production/marine systems together. For example, one recent project included more than 100,000 linear feet of piping systems.

Standards

To aid this process, the primary structural code in the marine industry—the one used most frequently in floating offshore installation construction—is the American Welding Society's (AWS) D1.1 Structural Welding Code. This is actually a more stringent code when compared to the structural standards in American Bureau of Shipping's (ABS) Rules for Building and Classing Offshore Mobile Drilling Units, which is the regulatory requirement for the basis of Coast Guard structural standards, as adopted in 46 Code of Federal Regulations (CFR) Part 108.113.

When you consider the design basis and application of the ABS rules versus the AWS Structural Welding Code, it becomes readily apparent why AWS D1.1 is the more stringent of the two. After all, AWS D1.1 is primarily designed for buildings, which are permanent structures that need to have structural stability throughout their service lives. In contrast, ABS or another accepted classification society's rules are primarily designed for ships that are dry-docked at specified intervals for inspection, service, and repairs. Outer continental shelf platforms do not have this luxury once they are moored; there is no bringing them back to a dry-docking facility. Hence, using the more stringent structural code is practical, especially when you consider the design life of an FOI, some of which have an expected service life of 50 years.

A power module is lifted onto a tension leg platform hull. U.S. Coast Guard photo by CWO Joel Smith, Sector Corpus Christi.

Another frequently used design standard that is applied in new construction projects in South Texas is the American Petroleum Institutes' Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, most commonly referred to as API RP 2A. This contains engineering design principles and good practices that have evolved during offshore oil resource development and is another vital tool that a Coast Guard marine inspector relies on during the topside structure construction process.

Since the Coast Guard-issued certificate of inspection will eventually cover the vessel in its entirety, the new construction process is the most critical aspect in a vessel's life. As these projects are finished and are towed out to the Gulf of Mexico to begin their service as production facilities, it is the common goal for the project teams and the Coast Guard to ensure that these vessels meet their designed service lives.

Class Society Involvement

One particular construction project in the Corpus Christi area will be the first semi-submersible FOI in the Gulf of Mexico for which the U.S. Coast Guard has agreed to accept Det Norske Veritas (DNV) plan review and inspection. The Coast Guard's acceptance of DNV's work is predicated on the basis that DNV's plan review and inspection functions will be in accordance with applicable international convention requirements and U.S. laws and regulations.

The Coast Guard will make all decisions concerning equivalency to regulations and resolutions for apparent conflicts in Coast Guard regulations, federal statutes, and international treaties will occur at the headquarters level. As the classification society, DNV will be responsible for design approval; material, component, and equipment certification; and all surveys, tests, and trials during fabrication and commissioning.

The hull, a semi-submersible, column-stabilized unit, is being fabricated in South Korea, while the topsides will be built and integrated with the hull at the Kiewit fabrication yard in Ingleside, Texas. This floating offshore installation will most likely be unflagged and will be permanently moored in the Gulf of Mexico.

Regulatory Considerations

Setting up the proper regulatory foundation to support this first-in-kind build adds to its complexity. One of the principal documents used to outline the regulatory umbrella under which this project will be constructed is the design basis agreement. This regulatory design basis is used as an agreement between DNV and the Coast Guard on a common set of design principles, to define applicable regulatory and class requirements, and to clarify the regulatory interface between the U.S. Coast Guard and the Bureau of Safety and Environmental Enforcement. The design basis agreement will use appropriate DNV class rules in accordance with the DNV notations, with some additional U.S. (coastal state) requirements to ensure Coast Guard standards are met.

About the author:
CWO Joel Smith has served in the Coast Guard for 20 years. His background is in marine engineering and he is currently USCG Sector Corpus Christi's resident marine inspector at the offshore fabrications yards in Ingleside, Texas.

Greening the Fleet

The maritime industry considers liquefied natural gas as a marine fuel.

by LT Bryson Jacobs
Fire Protection Engineer
U.S. Coast Guard Marine Safety Center

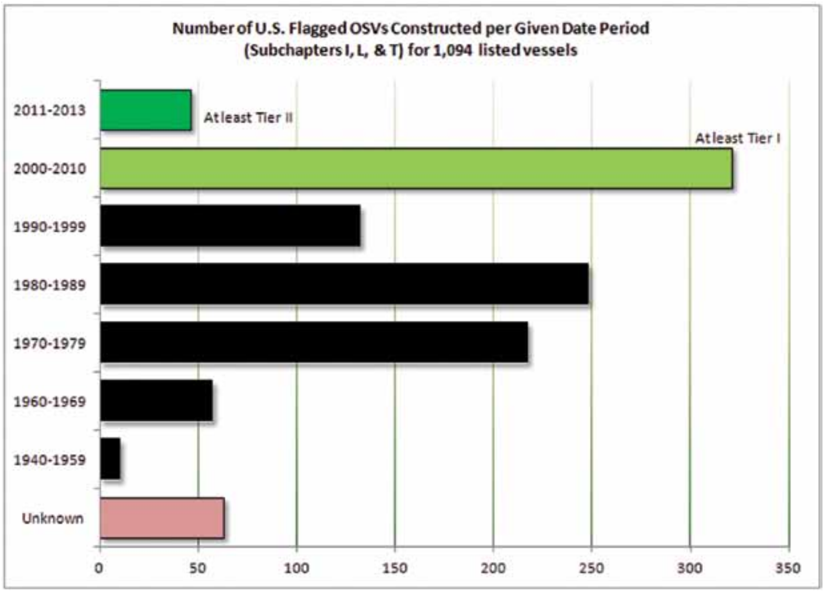
With stricter vessel air emissions requirements coming into force in the Gulf of Mexico, the search for cost-effective compliance is intensifying, and many offshore support fleet owners and operators are considering liquefied natural gas (LNG) as a marine fuel. The Coast Guard has responded to these developments by working closely with companies and evaluating design proposals in which LNG is planned for ship propulsion. Furthermore, the Coast Guard has published domestic policy based on the guidelines of the International Maritime Organization to provide a flexible and comprehensive design and review framework for the commercial industry. Additional policy guidance regarding LNG-specific bunkering facilities, tank barges, security, and training will soon be publicized. The Coast Guard, class societies, and the marine industry are cooperating closely to ensure that the safety issues inherent in the design and operation of a highly flammable and cryogenic shipboard technology are properly addressed.


An OSV supplies well stimulation chemicals to a platform approximately 160 nautical miles east of Corpus Christi, Texas. U.S. Coast Guard photos and graphics by LT Bryson Jacobs unless noted otherwise.

One appropriate LNG fuel candidate is the offshore supply vessel or OSV. This vessel is the Swiss Army knife of the Gulf, because it is designed to perform the missions of multiple specialized ships using a single, versatile platform. A given multipurpose OSV may be engaged in bulk liquid cargo transfer one day, anchor handling for a rig the next, and then proceed to transport workers to shore, before loading drilling mud and supplies to be taken back offshore. These activities and the multitude of others that OSVs must complete are usually energy-intensive, requiring high engine output and commensurate fuel consumption.

Emission Limits

Most domestic outer continental shelf resource exploitation takes place within the designated North American Emission Control Area (ECA), which extends 200 miles from land. Furthermore, of all U.S.-flagged OSVs listed in the Coast Guard's vessel database, the majority were constructed within the past 13 years.[1] This means that at least half of the fleet is subject to the newer Tier I or Tier II nitrogen oxide (NOx) emissions limits. With strict Tier III standards only a couple of years away for all ves-



Just over half of the U.S.-flagged OSV fleet completed construction since 2000. With permissible sulfur content of fuel burned in the ECA dropping to 0.1 percent m/m in 2015, many companies are seeking various methods to ensure their vessels comply.

sels operating within the ECA, however, it is no wonder that a great deal of resources have been allocated to air pollution abatement.

Sulfur oxide (SOx) is another targeted pollutant; after 2015, the permissible discharge of this poisonous gas in the ECA will drop tenfold, from a maximum fuel-mass concentration of 1 percent to just 0.10 percent. This is where the chief advantage of LNG is readily apparent. Virtually no SOx emissions are produced with liquefied natural gas combustion. On top of that, particulate matter production is eliminated and NOx and carbon dioxide are reduced by up to 85 percent and 25 percent, respectively.[2]

Other Alternatives

Other pollution abatement options are also available to the marine industry such as treating or "scrubbing" the exhaust gas from engines running on conventional fuels. This technique requires extensive vessel exhaust system modification, extra space allocation for abatement equipment, and a constant supply of treatment chemicals. Another alternative is to use only ultralow sulfur fuel oil when operating in the ECA. This requires little, if any, modification to a ship's power plant, but also introduces issues concerning the availability and cost of fuel, which can obviously erode a vessel's profitability.

These uncertainties also apply to LNG, as more space is required for equivalent power production and as it is difficult to predict LNG's near-term availability and future cost.[3] Currently, however, supply and cost prospects are attractive. Many vessel operators envision LNG as the most viable alternative available; some are investing heavily in its use.

LNG Challenges

It must be noted that using liquefied natural gas as a transportation fuel is not an entirely new concept; large LNG carriers have used boil-off gas in propulsion boilers for decades, and Norway has authorized its shipboard integration since 2000.[4] Without tight pollution restrictions on widely available conventional fuels, the cost associated with new installations or conversions, underdevelopment of infrastructure, and higher degree of design complexity initially made LNG unattractive for use as a marine fuel. The new requirements are shifting this paradigm, however.

Gas-fueled vessels must be designed with a thorough understanding of liquefied natural gas characteristics. Unlike conventional liquid fuels, LNG is comprised predominantly of methane, which cannot exist as a liquid when stored at the temperatures typically encountered in the marine environment. Its critical point, the temperature above which no additional amount of pressure can cause condensation, occurs at a temperature (-181°F) about midway between absolute zero and room temperature and a pressure of 731 lbs per square inch. When it is stored at atmospheric pressure at sea level, LNG needs to be kept at -260°F. This, coupled with the fact that any heat input results in the immediate generation of highly flammable methane gas, makes the engineering challenges of this marine system readily apparent. Safe designs need to be entirely resistant to cryogenic temperatures, highly insulated from thermal insult, and must have means of keeping the fuel gas away from unintended ignition sources.

Additionally, these designs must operate within a dynamic environment where they will be subjected to constant corrosion, erratic multidirectional acceleration, and limited weight and space allowances. Needless to say, design and approval of such systems requires flexibility, innovation, and keen attention to detail on the part of the designer and the regulator. Ultimately, the designer must demonstrate that the finished product provides a level of safety at least equivalent to that provided by standards applicable to conventionally fueled vessels.

Design Standards

Currently, the most straightforward approach for shipbuilders pursuing LNG as a fuel is to make use of the USCG Office of Design and Engineering Standards Policy Letter Number 01-12 *Equivalency Determination – Design Criteria for Natural Gas Fuel Systems,* which incorporates the International Maritime Organization (IMO) *Interim Guidelines on the Safety for Natural Gas-Fuelled Engine Installations in Ships,* as a baseline standard with some modifications.

For example, according to the IMO guidelines, two types of system configurations address fuel distribution within machinery spaces: gas safe and emergency shutdown. Only the "gas safe" avenue for piping system configuration is accepted under the Coast Guard policy letter. In this design, the fuel distribution system must be completely encapsulated by a secondary barrier, creating a buffer zone between the fuel and possible ignition sources. This involves using gas-tight enclosures around valves and double-walled piping in machinery spaces all the way to the engine cylinder intakes.

In addition to safe LNG and gas transfer within the ship, the actual storage of the cryogenic liquid presents unique engineering challenges. The IMO International Gas Carrier Code defines three types of tanks from which designers may choose. Tanks of types A and B carry LNG at or near atmospheric pressure. All design proposals for use of liquefied natural gas as fuel presented to the Coast Guard to date employ tanks of type C, which contain LNG at elevated pressure and relatively "warmer" temperatures (a balmy -229°F). Further, the policy letter stipulates they are to be designed in accordance with either the American Society of Mechanical Engineers Boiler and Pressure Vessel Code or Title 46 Code of Federal Regulations Part 154, in lieu of specific IGC Code requirements.

LNG in Action

Advanced insulating techniques, usually involving an evacuated outer tank shell, keep an inner pressurized fuel tank from heating up too quickly, which may be recognized as a design similar to that of some high-performance consumer thermoses. The pressurized design of this tank permits liquefied natural gas to be idly stored for a longer period without risk of over-pressurization. Usually, the residual pressure within the tank forces the liquid out and through heat exchangers that convert the liquid to gas at a prescribed pressure.

From there, the gas may be pressurized further with pumps or simply routed to the engines via a gas valve unit. Gas detectors and automatic isolation valves must be installed in key locations to segregate piping sections and alert operators of hazardous leaks. In the event of a gas leak, an integrated inerting system would flood the buffer spaces with an inert gas, such as nitrogen, thereby pushing the remaining methane out through vent pipes terminating high above the weather deck and away from the vessel.

If the engines are dual-fuel (capable of consuming either conventional liquid fuel only or a liquid-gas mixture), a seamless transition occurs from a 95 percent gas-to-5 percent liquid mixture to a liquid-only combustion cycle. The small amount of liquid fuel used in normal operating mode is chiefly used for pilot ignition and to aid in the emergency transition process. These engines are especially attractive to owners and operators who are concerned about future cost fluctuations for LNG and ultralow sulfur diesel, as either may be used as the primary fuel without modifications to shipboard equipment.


The importance of the OSV is readily clear to those who visit the Louisiana coast, where workboats of all sizes, design types, and capabilities abound.

Looking Ahead

The policy letter and interim guidelines by which the above configurations were designed are just that—guidelines. Proponents of alternative designs are invited to present the operating principles and features that demonstrate a degree of safety at least equivalent to a design in accordance with the accepted standards. If the arrangement is found to be satisfactory, the Coast Guard will issue a unique

Conceptual graphic of the first U.S. OSV to use liquefied natural gas as fuel. Graphic courtesy of Harvey Gulf.

design basis agreement specifying the accepted alternative engineering design and operating standards to which the vessel may be certificated.

With safe design standards in place, the Coast Guard has focused more attention on developing related policies to address bunkering procedures, crew proficiency standards, facility operations, and security. These policies will provide a comprehensive set of interim standards for LNG fuel system use until formal federal regulations can be developed.

While ensuring marine safety and environmental stewardship are primary Coast Guard missions, facilitating commerce is also very important. Working together, the Coast Guard and the maritime industry can safely incorporate novel features, including LNG fuel systems, into effective designs for the offshore supply vessel, the vital workhorse of the Gulf of Mexico.

About the author:
LT Bryson Jacobs earned a B.S. in civil engineering from the U.S. Coast Guard Academy and an M.S. in fire protection engineering from the University of Maryland. His operational tours include service aboard the cutter Healy, *as a student engineer and as a staff engineer at the Marine Safety Center.*

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Offshore Supply Vessels Going Green

A progress report.

by LT Chris Nichols
Marine Inspector
U.S. Coast Guard Activities Europe

LT Jennifer Doherty
U.S. Coast Guard
Marine Safety Engineering Program

Mr. Michael Carroll
Harvey Gulf International Marine LLC

As liquefied natural gas (LNG) gains popularity as an alternative fuel to meet today's tougher global marine emission standards, one company is working to employ the technology onboard U.S.-flagged offshore supply vessels as part of its "Going Green" initiative.

The vessel design incorporates American Bureau of Shipping (ABS) ENVIRO+ and Green Passport standards[1] and features dual-fuel engines that meet EPA Tier II/Tier III emission standards that are estimated to reduce nitrogen oxide emissions by 85 percent, reduce CO_2 emissions, and eliminate sulphur oxide emissions.[2]

In addition to the environmental benefits, LNG-fuel technology also brings economic advantages. As government regulations continue to demand cleaner emissions, low sulphur fuel oil is becoming scarce, and the price continues to rise. LNG offers an economically advantageous fuel alternative.[3]

An ABS surveyor inspects a gas valve unit. U.S. Coast Guard photo by LT Chris Nichols.

Regulatory Oversight

Offshore supply vessels are being constructed within the framework of the U.S. Coast Guard's Alternative Compliance Program, which delegates primary certification authority to the ABS with Coast Guard oversight. However, due to the novelty of LNG-fueled vessels within the U.S. fleet, the Coast Guard has retained plan approval authority and primary inspection oversight over the vessel's LNG components and systems.[4]

Since the Coast Guard does not have formally adopted regulations for LNG-fueled vessels, this project poses some unique regulatory challenges. Additionally, we anticipate that these vessels will become more mainstream in the U.S. market, so the USCG Office of Design and Engineering Standards developed draft design criteria for natural gas fuel systems based on interim International Maritime Organization guidelines.

Finally, the project comprises a wide geographical footprint, as components are being built in multiple locations in the U.S. and Europe. To overcome all these challenges, the Coast Guard has assembled a team from multiple units to oversee the project.

The Team

- *Sector Mobile*—lead officer in charge, marine inspection
- *Marine Safety Center*—plan review
- *Activities Europe*—oversee LNG bunkering, storage, and supply system and gas valve unit construction
- *Marine Safety Detachment St. Paul*—oversee LNG tank construction
- *USCG Liquefied Gas Carrier National Center of Expertise*—develop USCG marine inspector training
- *USCG Office of Port and Facility Activities*—develop manning, training, and licensing standards and LNG bunkering requirements
- *USCG Office of Vessel and Facility Operating Standards Division*—incorporate licensing standards into Standards of Training, Certification, and Watchkeeping
- *USCG Office of Commercial Vessel Compliance*—consolidate policy input and oversee USCG offices

Progress Update

As of June 2013, Sector Mobile estimated the hull for the first vessel in the series to be 90 percent complete, and LNG components are beginning to arrive for installation. The project is widely supported within the oil industry, and this enthusiasm has led to contracts for five additional vessels.

About the authors:

LT Chris Nichols graduated from the U.S. Coast Guard Academy and has served for seven years as a marine inspector in Anchorage, Alaska; Philadelphia, Pa.; and Europe.

LT Jennifer Doherty is studying naval architecture and marine engineering through the Coast Guard's Marine Safety Engineering Program. Prior to this assignment, she served as a marine inspector in Sector New Orleans.

Mr. Michael Carroll is a senior vice president for new construction with Harvey Gulf International Marine LLC.

The bow takes shape. U.S. Coast Guard photo by LT Dave Solarzano.

Endnotes:

1. These standards focus on environmentally friendly building materials, design characteristics, management and support systems, and minimizing sea and air discharges.
2. Available at www.marinelink.com/news/construct-usflagged339823.aspx.
3. Available at www.wartsila.com/en_US/news-releases/wartsila-to-equip-first-us-flagged-lng-offshore-vessel.
4. The Coast Guard Marine Safety Center is reviewing the LNG components and systems.

In the Loop

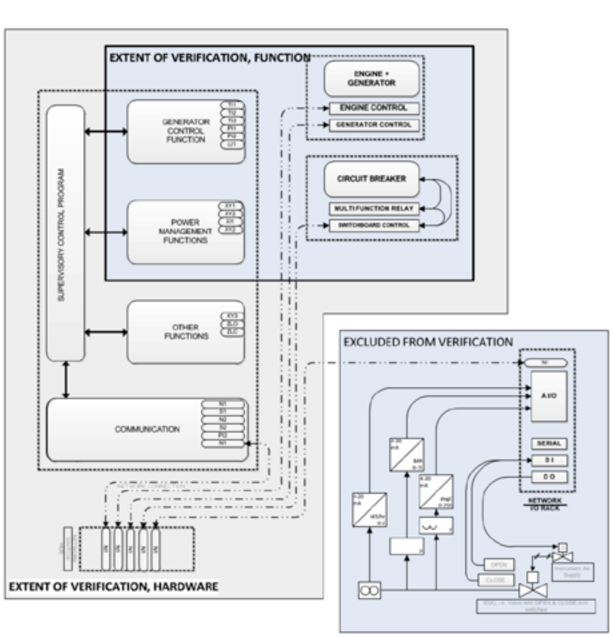
System verification evolution.

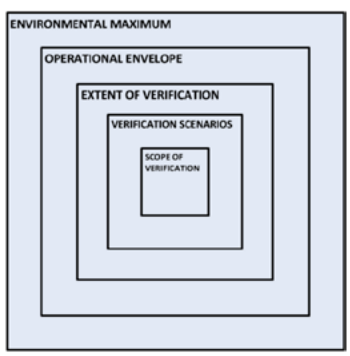
by Mr. Milton Korn
Managing Senior Principal Engineer
American Bureau of Shipping

Even a cursory glance at marine casualty lists shows that the root cause of a disturbingly high number of vessel casualties is system failure. In July 2012, the American Bureau of Shipping published a guide for system verification including "hardware in the loop" (HIL) testing, as part of its mission to safeguard life by minimizing system failure.

Verifying System Integrity

Stakeholders use system verification to affirm their shipboard equipment and systems operation are in accordance with appropriate specifications and functional descriptions, which provide a structured method to develop, manage, and implement a test scope for verifying system performance throughout the system life cycle. Implicit in the concept is the recognition that although a system has been verified, the test scope may need to be updated as that system changes. Therefore, a simple "snapshot" of system performance at a particular instant is of limited value.





The scope of the system verification notation assigned to a vessel, offshore installation, or facility is defined by the verification process completed in accordance with the ABS-reviewed verification plan. The notation applies only to the hardware, firmware, and functions of the target system and equipment under control that are included in the verification plan. All graphics courtesy of the American Bureau of Shipping.

An additional benefit from system verification is the ability to ascertain that system functionality is as intended, but, perhaps the specification is wrong. As the system is being verified, any system operation that is not in accordance with the functional description or that is not intended is identified as a defect. To verify operation and to identify as many defects as possible, the equipment and systems are tested in accordance with a relevant and appropriate test scope contained within a verification plan.

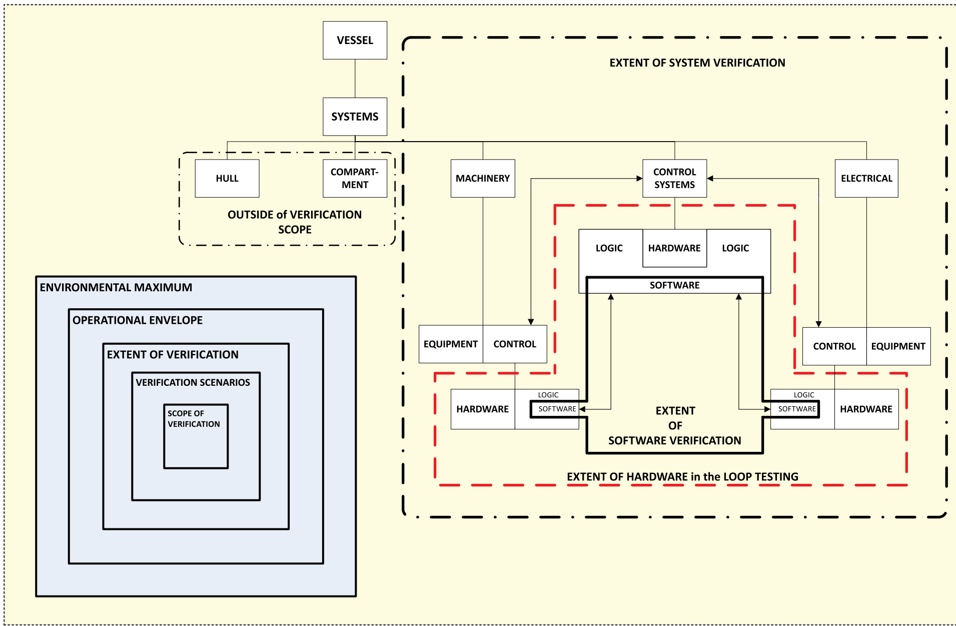
The test scope is developed from functional descriptions including systems analysis such as:

- failure mode effect and criticality analysis,
- fault tree analysis,
- safety analysis.

The Art of System Verification

System verification includes developing a test scope that provides a venue appropriate to the point in the system life cycle at which testing will occur and applying reasonable and relevant tests that fit into the constraints of time, resources, and effort. It is best to follow a structured approach to select tests that are appropriate and relevant to the verification goals and justify exclusion of other tests. For example, a verification scope that cannot be completed in the time available or in which the perceived benefit is less than the cost of development and execution, is of little value.

System verification is also complicated by the need to manage expectations and changes throughout the life cycle. Those new to system verification may have unwarranted confidence in systems that have been verified, mistakenly believing that it is possible to identify all defects. This is simply not possible, especially with a test scope constrained by time, cost, and venue. It is anticipated that equipment and systems will be tested during development and construction prior to installation, during commissioning, and periodically throughout the system life cycle as warranted by time, change, or casualty. However, aspects of equipment and system functionality and the risk of damage and personal injury can constrain the extent of feasible onboard testing. These constraints are problematic, especially after change is introduced into a deployed system.



System verification extends classification to provide a higher degree of confidence that the systems are capable of and do function in a planned and specified fashion under a variety of states.

To achieve the full value, the stakeholder commitment must be for the lifetime of the equipment and systems. Without this commitment, system performance can only be verified at a particular instant and with only a specific system hardware, logic, firmware, and software configuration. Change introduced to a previously verified system could necessitate additional testing, which must be performed in accordance with an updated test scope to identify new defects. Uncontrolled change can effectively negate system verification benefits.

Introducing Guidelines

The ABS System Verification Guide provides direction to define and develop a meaningful testing scope that identifies and remediates as many defects as possible prior to system deployment. Defect remediation prior to deployment is less costly than remediation in service when the total cost of remediation can include the consequential cost of damage to equipment, the environment, personal injury, or even death.

The system verification notation can be assigned to a specific vessel or facility for specified equipment or systems that have been verified in accordance with guide requirements. To that end, the guide recognizes three system verification methods:

- hardware in the loop,
- software in the loop,
- system state estimation.

Additionally, the guide recognizes that a combination of these techniques may be a more appropriate and practical approach.

Control Systems

Many modern control systems—especially those with a large input and output (I/O) count and/or great dispersion throughout a vessel or facility—connect processors to I/O via a communication network. Some control systems use a single communication network for all input/output and control functions, while others use multiple networks. A typical installation can have remote data-gathering cabinets distributed throughout a vessel connected to the processors via a communication network; input and output local to the data-gathering cabinets are typically hard-wired to them.

There are variants of this scenario where in some implementations, input/output is directly connected to the communication network and others, such as those used for navigation or dynamic positioning, where a second communication network can be used. The National Marine Electronic Association bus, for example, is especially configured for communication among navigational instruments such as GPS, radar, compass, and wind speed.

Modern control systems also include error-checking and annunciation capabilities, which typically allow for diagnostic and error identification at the rack and card level and can extend down to the I/O level, where individual loops can be checked for open, short, ground, and such. They can also be used to perform transducer and measuring instrument diagnosis and calibration.

Control Systems Redundancy

One aspect of modern control systems is the level of redundancy built into the system to facilitate continuous operation in the event of a single failure. Examples include dual communication networks, master/slave processor relationships, voting processor relationships, and multiple power supplies. In practical terms, this means that for systems using a single communication network, the network is duplicated, and the two networks operate in parallel. Should one network fail, it is assumed that the other will continue to operate.

Because it is difficult to "separate" redundant parts during system verification, redundancy introduces challenges and complexities, especially when verification testing is to be performed on the installed hardware of an operating control system.

Common Mode Failure

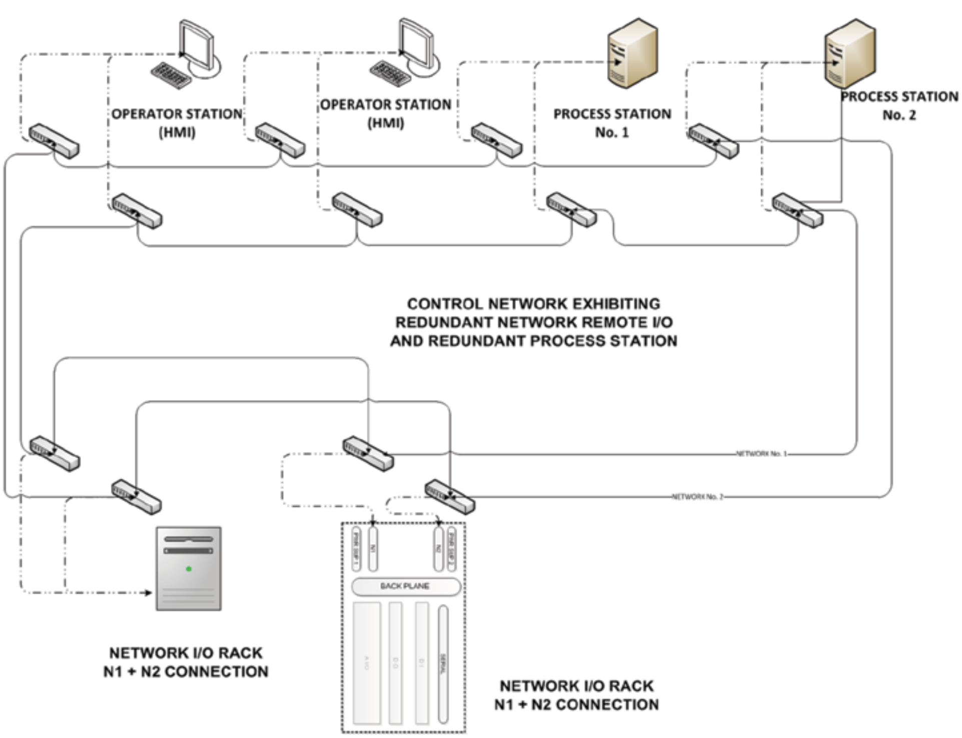
A common element that is without redundancy is the logic, including software. This commonality can prove to be an Achilles heel for the control system. If the master and slave processor are running the same software and a software defect disables the master processor, it simultaneously disables the slave processor. Similar issues exist regarding the data communication networks.

Hardware in the Loop

Hardware in the loop or HIL testing is the result of 30 years' worth of technological evolution; it allows simulations to connect to and interact with the real world. HIL testing consists of connecting equipment under test to a simulation of another collection of hardware and performing a series of tests that verify key functionalities. Before this type of testing, simulation, consisting of models and logic developed from functional descriptions, were executed on the simulator hardware. Early simulations had limited facility to connect to and interact with the world outside and rarely occurred in real time.

These early efforts were the precursors of what now is called software in the loop (SIL) testing, so with the introduction of HIL testing, the art has developed into two distinct branches:

- power hardware in the loop,
- control hardware in the loop.



If redundant or parallel processors or automatic control systems are fitted, it is recommended that the redundant automatic control systems be independent, self-monitoring, and arranged such that, should one fail, control is automatically transferred to a non-failed automatic control system.

In its purest form, hardware in the loop testing uses the actual hardware deployed aboard the vessel or facility and the actual logic, some of which is implemented in software. Verification testing is then tied to the real-time characteristics of the actual hardware, firmware, software, and interfaces—which means that there is limited ability to accelerate the control system speed to shorten the testing process. The logic is loaded into and operates on the actual hardware. HIL testing provides the opportunity to identify logic defects as well as defects that are coupled to the control system hardware and firmware.

In practice, it is nearly impossible to meet this criteria, which is the actual logic (including software) running on the actual hardware. Reasons for this include the challenge of bringing the actual hardware together; the inability to connect the actual hardware; and, for the case of onboard testing, the difficulties associated with HIL testing, interfering with onboard operations and concerns about equipment damage or personal injury.

Some stakeholders address these challenges by building laboratories where "identical" hardware has been set up for verification testing. Some labs even duplicate the interconnecting communication networks. This arrangement allows for software verification on hardware prior to deployment.

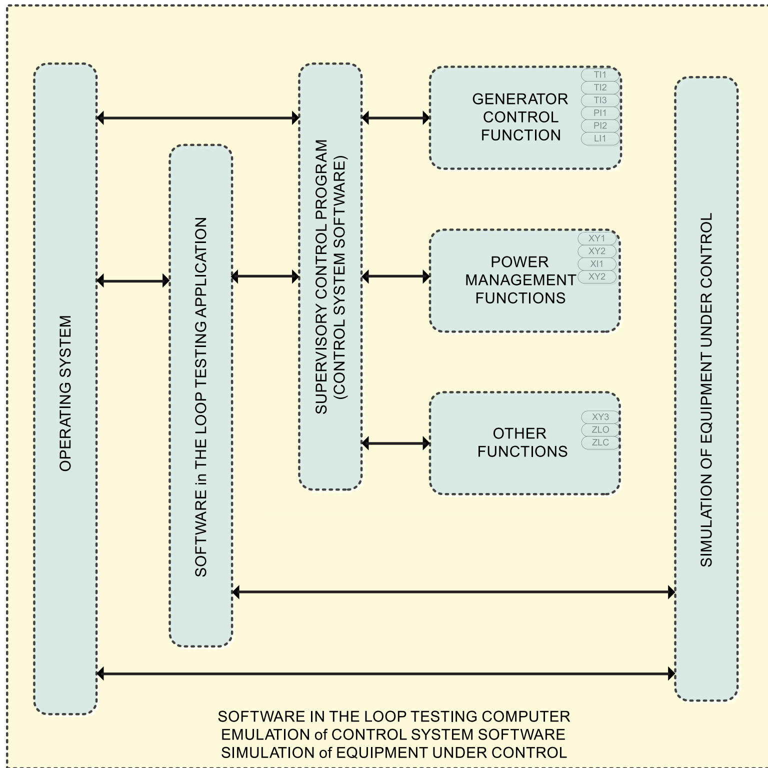
Software in the Loop

SIL testing consists of loading control system models, logic, and software onto an emulation of the control system hardware on which the logic and software are intended to operate, coupling the emulation to a simulation of the equipment under control, and executing a test scope to verify the software. Software in the loop can be performed using a single computer that acts as the emulation and simulation host, or multiple computers. In all cases, users must implement an appropriate interface between the emulation and simulation.

In the case of a single computer, the interface is often implemented in software, while in the case of multiple computers, other means would be required. Also, SIL testing can take place at much greater speeds than HIL testing, because the software is decoupled from physical time constraints or characteristics. SIL testing is a variant of simulation.

One of the major issues with SIL testing is how and where to connect the simulation to the system to be verified. For a system where the input/output is connected to data-gathering cabinets that are distributed throughout the vessel, one possibility is to distribute the simulation throughout the vessel and connect at the data-gathering cabinets. This approach is not likely in a large or distributed system due to the difficulty of distributing and synchronizing the simulation. An alternative is to connect the simulation to the communication network(s) or use the network connection of the control system. A connection such as this does not include the remote I/O data-gathering cabinets in the verification, so this exclusion has to be evaluated.

A third option is to use a dedicated communication port built into the control system. This kind of connection does not include the communication networks and adds a layer of complexity, as there needs to be some switching method implemented in hardware or software to direct the control system to look at the verification port, as opposed to the normal connection for I/O.



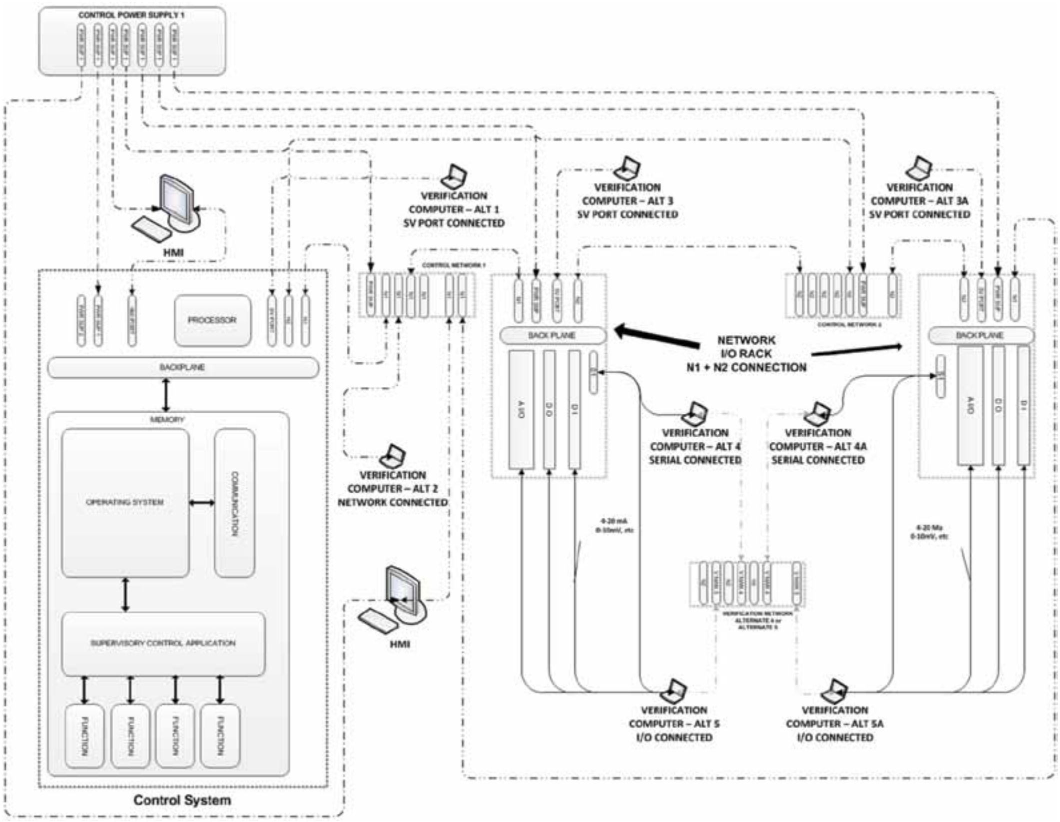
Software in the loop can be performed using a single computer acting as the host for the emulation and simulation.

An additional complexity for these last two scenarios is that often diagnostic and error-checking functions are built into the control system and are operating in the background in some combination of hardware and software. With the control system operating, the I/O loops are not connected, so the diagnostic and error-checking functions can generate a large number of errors or alarms that must be managed throughout the verification testing procedure.

Applications, Challenges, and Results

In preparation to develop a test scope, it is important to know what is proposed to be verified. Is it only logic, including software, or does it also include the coupling of the logic to the hardware? If the only interest is in software verification, SIL testing alone could be appropriate. If there is interest in knowing how hardware and firmware influence system performance, SIL testing alone may not be adequate, and HIL testing could be the vehicle for verifying logic on hardware. The significance of differences between the verification hardware and installed hardware are not fully understood or quantifiable.

Onboard control system and software testing (either as part of the initial deployment/ commissioning or as part of the management of a proposed change) is especially challenging if the equipment installed onboard the vessel or facility is in operation. A major challenge is to



Guidance to identify and remediate as many defects as possible prior to system deployment.

decouple the control system from the operating equipment to perform verification testing, while maintaining effective equipment operation and supervision.

An instance of a control system failure illustrates the potential system verification application. For example, imagine that, upon the conclusion of a port stay, a vessel was making preparations to get underway. It was not able to transfer propulsion remote control to the bridge, because two mechanical contacts from adjacent mechanical indicator pushbuttons were simultaneously closed. One button was for port wing control, the other for central console control. This occurrence of mutually exclusive events prevented the use of propulsion remote control. There was no physical manifestation that the vessel technical team could see, and the control system did not have the ability to identify the error.

A test scope prepared in accordance with system verification guide requirements would have considered the occurrence of mutually exclusive events and included verification tests for this potential situation. Logic that would not recognize this occurrence would have been identified, and the logic could have been updated to address this error.

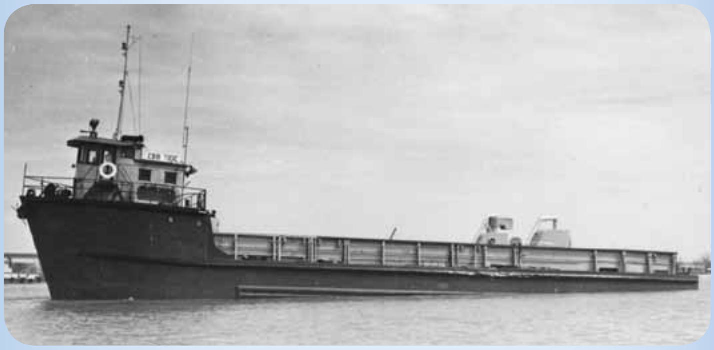
Enhancing System Reliability

The nature of system development, installation, and deployment makes it highly unlikely that a single verification technique will be appropriate at each stage of the system life cycle. System verification lets the user identify and remediate defects prior to system deployment and manage change throughout the system life cycle using a variety of techniques that, when implemented in a coordinated fashion with an appropriate test scope, offer the opportunity to enhance system reliability in a timely and cost-effective manner.

About the author:
Mr. Milton Korn is a managing senior principal engineer at ABS. He is also an assistant professor of electrical engineering at the United States Merchant Marine Academy, in Kings Point, N.Y. He holds a chief engineer's license with Standards of Training, Certification, and Watchkeeping endorsement and is a registered professional engineer in New York and New Jersey.

The Past, Present, and Future of the Offshore Supply Vessel

by Mr. Richard Wells
Vice President
Offshore Marine Service Association



The 120-foot long *Ebb Tide* was built in Louisiana in 1955 and operated under the U.S. flag for many years. Photo courtesy of Tidewater Inc.

In 1947, the oil and gas industry marked a milestone by drilling the first true offshore well in open waters about 45 miles offshore of Louisiana.[1] With this innovation grew the need for vessels in the Gulf of Mexico to support the offshore oil and mineral exploration and production industry.

Until 1955, most seagoing cargo vessels located houses amidships or aft. However, everything changed with the creation of the first purpose-built offshore supply vessel, the *Ebb Tide,* a 120-foot-long vessel conceived by Alden "Doc" Laborde.[2] The vessel had its wheelhouse located far forward, which created a large open cargo deck in the aft.

This arrangement, along with a duplicate set of vessel controls behind the wheelhouse, allows the master a clear view of the stern and cargo deck, which makes offshore cargo transfers safer and quicker.

What is an Offshore Supply Vessel?

Offshore supply vessels (OSVs) carry goods, supplies, people, or equipment to support offshore mineral or energy resource exploration, exploitation, or production.

In practical terms, OSVs cannot carry any "passengers," however they can transport offshore workers to their work sites. They can also carry equipment and supplies the offshore energy industry requires.

Early OSVs operated as uninspected vessels, under existing U.S. Coast Guard inspection regulations. However, offshore supply vessel designs and regulations slowly evolved over the course of five decades, and vessels that were first inspected under 46 Code of Federal Regulations (CFR), subchapter's T or I, are now inspected under Subchapter L (46 CFR 125-134).

What Does an OSV Do?

An offshore supply vessel is intentionally built and operated as a multifunction vessel with multiple main engines, generators, rudders, and propellers to allow continued operation—even in the event of a minor engineering casualty or a precautionary shutdown of the engineering plant.

When an outer continental shelf (OCS) block lease holder needs drill pipe, the OSV deck is loaded with drill pipe. When drilling mud is needed, the independent cargo tanks below deck are loaded with the very dense, custom blended, proprietary drilling fluids. At the end of the life of a platform, explosives are transported offshore to assist in the removal of the mothballed facility and to bring some of the smaller pieces ashore for scrapping.

The 177-foot long, 3,915 GT liftboat *Robert* is a very large example of this special OSV class. Photo courtesy of Montco Offshore Inc.

During the operation of an offshore facility, an offshore supply vessel delivers all of the consumables such as potable water, diesel fuel, groceries, and spare parts to a mobile offshore drilling unit (MODU), rig, floating offshore installation, or fixed platform (also called offshore facilities).

As a follow-on to the initial offshore supply vessel design, a very specialized type of OSV was developed called a liftboat. Rather than transporting routine cargo, these vessels primarily provide services to offshore facilities or transport heavy or large pieces of equipment. These self-elevating vessels force their legs into the seafloor until the liftboat is lifted out of the water. The liftboat can then serve as a stable platform for:

- initial platform construction;
- well maintenance, such as wireline work and pipeline clearing;
- structure maintenance, such as blasting and painting;
- end-of-life decommissioning and platform removals.

Liftboats also began service as uninspected vessels, but moved to inspected vessels status by 1998.

Current Design Trends

The trend in OSV design incorporates greater capacity and capabilities, while keeping the multifunction character intact. This multifunction character is evident in some current offshore supply vessels that are dual certificated to function as both an OSV (under subchapter L) or as a "cargo and miscellaneous vessel" (under subchapter I), when doing salvage work or other operations not related to offshore energy production. In the height of flexibility, one industry company recently converted two tank ships into multipurpose supply vessels certificated under subchapters D and O (tank ship) and subchapters I and L. Offshore supply vessels also serve as oil spill recovery vessels or as vessels of opportunity to apply oil dispersant chemicals or skim oil from the ocean.

Current offshore drilling projects are moving farther from shore and into deeper water. This requires larger quantities of drilling mud, fuel, and drill pipe. This has resulted in OSV hulls approaching 300 feet, with larger and more numerous cargo tanks.

Most operators view an offshore supply vessel hull as a temporary platform to build needed capability upon and then later change to meet new market demands, similar to a truck chassis that interchanges a box van with a cargo tank as needed. A notable example is the specialized OSV that conducts well stimulation or "fracturing" services for offshore facilities, which involves pumping chemical mixtures such as acids or aromatic hydrocarbons into a well to increase flow rates. As such, this type of offshore supply vessel lacks the large open cargo deck and instead will have multiple smaller-capacity integral and portable product tanks with multiple pumps and transfer piping systems. Some offshore supply vessels are also modified to perform seismic survey work to assist locating commercially viable oil deposits. But even these more specialized OSVs have been converted to conventional multifunction offshore supply vessels when market demand changes.

In a further design development, some OSV operators have investigated using LNG as fuel to reduce air emissions like carbon dioxide, nitrogen oxides, and sulfur dioxide. However, the logistical challenges of refueling at dockside, higher construction costs, and uncertain

The 380-foot long multipurpose supply vessel *HOS Centerline* has its house in the aft part of the hull. Photo courtesy of Hornbeck Offshore Services.

international LNG fuel system design and safety requirements resulted in only one OSV operator actually signing a contract to build dual-fuel (LNG and diesel) U.S.-flagged OSVs as of May 2013. LNG-powered offshore supply vessels will likely see a slow, cautious implementation, absent changed customer or regulatory requirements and concerns about "methane slip," or introduction of unburned methane into the atmosphere.

The 277-foot long well stimulation vessel *Blue Dolphin*. Note the absence of the aft open deck that typifies a conventional OSV. Photo courtesy of Edison Chouest Offshore.

Other OSV design changes include moving away from main engines driving a conventional shaft and propeller toward diesel-electric power plants powering azimuth thrusters. While this gives the designer more layout flexibility and increases under-deck cargo capacity, some OSV operators are concerned about the durability and repair costs for azimuth thrusters and are staying with traditional propulsion systems.

Dynamic positioning (DP) systems that automate holding position alongside an offshore facility are now common on offshore supply vessels, and many OSV charterers demand DP-equipped vessels to service floating facilities. The OSV industry has responded by retrofitting older OSVs with DP systems and upgrading originally installed DP systems to increase redundancy. The United States government has proposed to the International Maritime Organization (IMO) that the international DP standard (MSC 645) be revised in the wake of the Macondo incident, so there may well be more changes in DP standards.

Additionally, some recent offshore supply vessels include larger and more capable cranes that allow the vessel to launch a remotely operated vehicle or an autonomous underwater vehicle, or to perform subsea construction, installation, inspection, maintenance, and repair projects.

International OSV Trends

Without a doubt, the OSV fleet goes wherever the MODUs and drill ships are operating. Following the Gulf of Mexico drilling moratorium beginning in May 2010, many MODUs left the Gulf of Mexico, and part of the support vessel fleet left also for the areas actively drilling, such as Brazil and the Pacific/Asian OCS.

The Pacific/Asian OCS in particular is expected to be a rapidly growing area for OSV operations due to continued and expanding energy exploration and production, coupled with growing petroleum consumption in that region. While the Arctic waters are believed to hold significant quantities of oil, OSV operations in that challenging environment are likely to be very slow and cautious.

International vessel operators and oil companies are building support vessels to facilitate activities outside the Gulf of Mexico. Based on the reported orders for new OSVs, there is some risk of overbuilding the offshore supply vessel fleet, much like the current container ship glut. This supply overhang might develop as the build cycle for OSVs is shorter than that for the MODUs and other offshore operations that the vessels are being constructed to support.

Another risk to the offshore supply vessel fleet is the current IMO effort to revise the international OSV codes and guidelines along with the project to draft a code for LNG-fueled vessels. What is the danger? IMO is more focused on and familiar with deep sea ships, such as tank ships and container ships. As such, there is a risk that inappropriate requirements from tank ship rules will be placed into the revised OSV documents.

Another international trend: Certain sovereign nations require oil companies exploring for hydrocarbons in their economic zone waters to comply with cabotage requirements and to use vessels flagged in that country. The United States has had cabotage laws (popularly called the Jones Act, named after Congressman Walter Jones) since 1920. The Jones Act reserves transport of merchandise or passengers by water between U.S. ports or places to U.S.-flagged ships, constructed in the United States, owned and crewed by U.S. citizens.

Additionally, under the Jones Act, a U.S. flagged vessel that changes nationality can return to the U.S. flag, but it cannot ever again perform work in the Jones Act trade. This trend forces an OSV owner to make difficult business decisions.

Lt. Sonha Gomez, a U.S. Coast Guard marine inspector, inspects a life float onboard an offshore supply vessel. U.S. Coast Guard photo by Petty Officer Ryan Tippets.

What Does the Future Hold?

While there are many elements that may affect the future of the U.S.-flagged offshore supply vessel fleet, it seems likely in the near term that:

- New, larger, more capable vessels will continue to be built for domestic and international work and could result in a spike in the supply of OSVs compared to the demand.
- There will be an increase in multipurpose and multi-certificated OSVs in the U.S.-flagged fleet.
- More offshore supply vessels will have DP systems fitted at construction or retrofitted and will install higher redundancy systems rated DP-2 and DP-3.
- There may be a push at IMO to apply the Energy Efficiency Design Index (EEDI) requirements to offshore supply vessels. These rules are currently applied only to large tank ships and cargo ships. They do not currently apply to OSVs and towing vessels, but it is likely that an attempt will be made to expand application to all vessels.
- Offshore supply vessel charterers will demand more energy efficient operational performance, even without any IMO EEDI requirements.
- New offshore supply vessels will have larger, quieter accommodation spaces to satisfy regulators, customers, and crew members.
- Some OSVs, particularly liftboats, will increase the number of persons that can be accommodated aboard, once the USCG and/or IMO finalize accommodation service vessel requirements.
- Given the growth of the OSV fleet and shrinking inspector staff levels, the alternate compliance program and/or streamlined inspection program alternatives to traditional USCG inspections will grow and expand. Alternatively, the difficulties in scheduling inspections and getting timely OSV certificates of inspection will increase for the industry and the USCG.
- The final rules for USCG inspection and certification of large offshore supply vessels (more than 6,000 tons) will be published.
- Serving as an OSV crew member will remain a well-paying career that provides significant time at home and is not a typical 9 to 5 job.

It is *possible* in the longer term that:

- OSVs will install more capable DP systems that allow operation in more extreme wind or current conditions.
- Offshore supply vessels will transfer LNG to offshore facilities in a trial effort to reduce air emissions.
- OSVs will reduce their ambient noise profile to meet customer and regulatory requirements.
- A modular cargo block OSV design will be tested to increase multipurpose capabilities and flexibility.
- Offshore supply vessel or liftboat designs will be modified to facilitate operation as wind farm construction and maintenance vessels.
- Offshore supply vessel designs will be modified to facilitate subsea projects.
- U.S.-flagged OSV dominance will decrease, due to international building efforts, tax and regulatory disadvantages of operating U.S.-flagged OSVs, and expanding cabotage requirements.
- And, on many wish lists, 46 CFR Subchapter L will be rewritten to acknowledge industry and technology changes, to acknowledge IMO OSV and SOLAS rule changes, and to split off liftboat regulations and definitions from those for conventional offshore supply vessels.

About the author:
Mr. Richard Wells has worked in the maritime field for more than 30 years. He currently serves as the vice president of the Offshore Marine Service Association. Prior to this, he supervised the USCG Regional Examination Center in New Orleans and was an STCW course instructor. He performed 20 years of active service with the U.S. Coast Guard, primarily as a marine safety specialist.

Endnotes:

1. See www.naturalgas.org.
2. Woodman, R. *The History of the Ship: The Comprehensive Story of Seafaring from the Earliest Times to the Present Day.*

Outer Continental Shelf Wind Farms

by Mr. George H. Detweiler Jr.
Marine Transportation Specialist
U.S. Coast Guard Marine Transportation Systems Management Directorate

The U.S. outer continental shelf (OCS) is regulated by the U.S. federal government through the Outer Continental Shelf Lands Act. The OCS refers to 1.7 billion acres of federal submerged lands, subsoil, and seabed generally beginning three nautical miles off the coastline (for most states) and extending for at least 200 nautical miles to the edge of the exclusive economic zone, or even farther if the continental shelf extends beyond 200 nautical miles.

A Brief History of Wind Energy

Wind energy, which helps generate electricity primarily through wind turbines, has been utilized for more than 2,000 years. Farmers and ranchers use windmills for pumping water or grinding grain. The newest wind turbines are technologically advanced and include a number of engineering and mechanical innovations to help maximize efficiency and increase electricity production.

Continental Shelf Development

The continental shelf is the gently sloping undersea plain between a continent and the deep ocean. It is an extension of the continent's landmass under the ocean. During glacial periods, much of the continental shelf consisted of exposed dry land. Today, during interglacial periods, the shelf is submerged under relatively shallow waters. The continental shelf waters are rarely more than 500 feet deep, compared to the open ocean, which can be miles deep.

Offshore Wind Energy Resources

A number of countries use offshore wind turbines to harness the energy of strong, consistent winds that sweep over the oceans. In the United States, 53 percent of the nation's population lives in coastal areas—where energy costs and demands are high and land-based renewable energy resources are often limited. Abundant offshore wind resources have the potential to supply immense quantities of renewable energy to major U.S. coastal cities such as New York City and Boston.

Wind speeds off the Atlantic Coast and in the Gulf of Mexico are lower than wind speeds off the Pacific Coast. However, the shallower water in the Atlantic makes development more attractive and economical for now. Hawaii has the highest estimated potential of any state,

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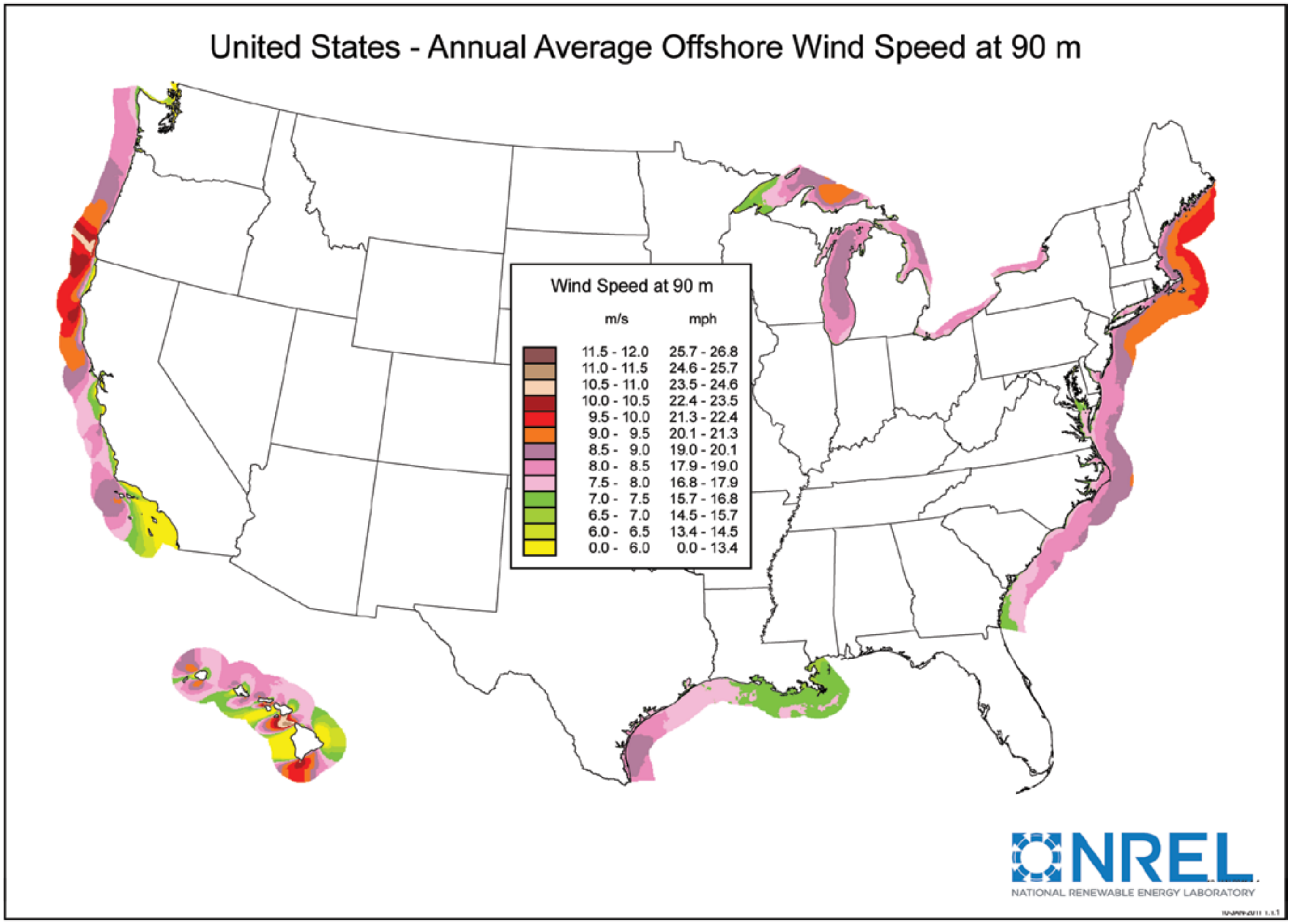

Average offshore wind speed. Map is reprinted with permission from the National Renewable Energy, the U.S. Department of Energy.

accounting for roughly 17 percent of the entire estimated U.S. offshore wind resource.

Commercial Offshore Wind Energy Generation

Many other countries have coastal areas with high wind resource potential. Worldwide there are 4.45 gigawatts (GW) of offshore wind energy installed, with another 4.72 GW under construction, and an additional 30.44 GW approved. More than 50 projects are operational in coastal waters of Denmark, the United Kingdom, Germany, Norway, the Netherlands, Japan, China, South Korea, Belgium, Sweden, Italy, and Portugal.

While the U.S. does not have any operational projects, there are thousands of megawatts in the planning stages—mostly in the Northeast and Mid-Atlantic regions. For example, the U.S. Department of the Interior's "Smart from the Start" initiative promotes wind power projects that will soon be built off the Atlantic Coast.

Smart from the Start

The "Smart from the Start" wind energy initiative for the Atlantic Outer Continental Shelf launched in November 2010. This initiative includes three key elements:

- eliminate a redundant step from the renewable energy and alternate use rule,
- identify wind energy areas to be analyzed in an environmental assessment (prepared pursuant to the National Environmental Policy Act 42 U.S.C. 4321 *et seq*) to support lease issuance and site assessment activities,
- process offshore transmission proposals.

Wind Energy Areas

The Bureau of Ocean Energy Management (BOEM) describes a wind energy area (WEA) as an area that appears to be suitable for commercial wind energy leasing. WEAs are delineated following deliberation and consultation with intergovernmental renewable energy state task forces.

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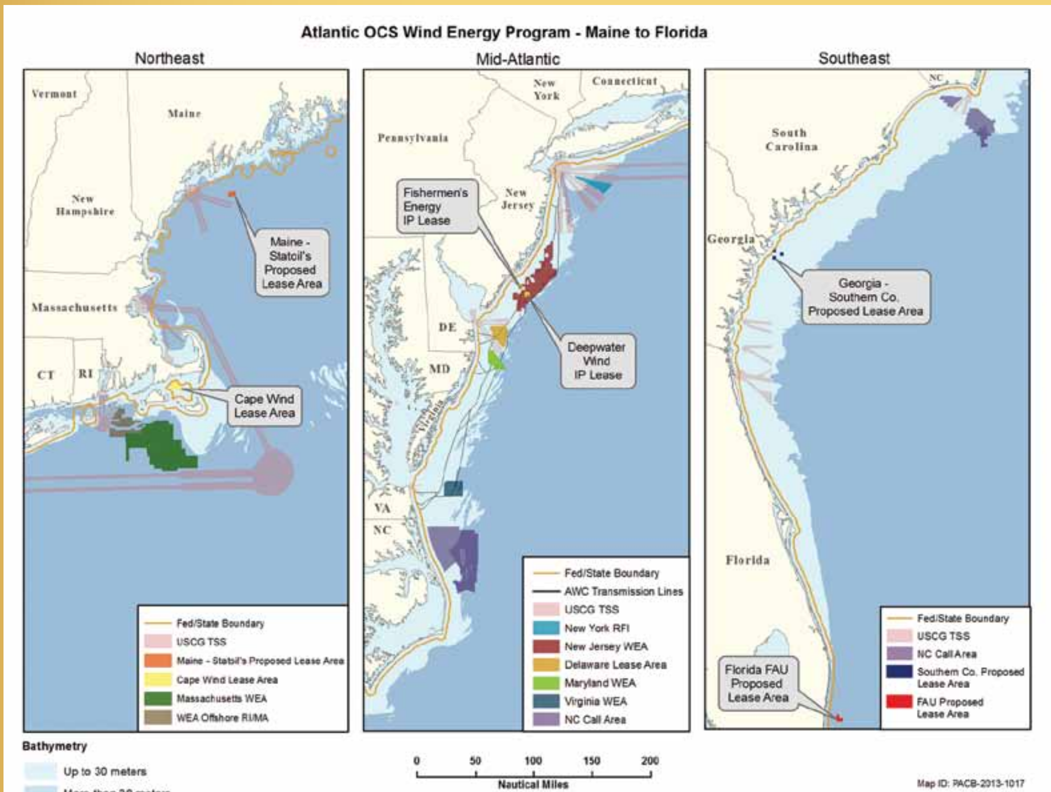
State Task Forces



Graphic courtesy of BOEM.

The Bureau of Ocean Energy Management has seen very strong interest in offshore renewable energy projects on the outer continental shelf. Because of this interest, BOEM has created state task forces with requesting states. Membership on a task force includes representatives from federal, state, local, and tribal governments. A status of activity in the different states, as of October 2013, follows.

California/Washington

As part of the West Coast Governors Alliance (WCGA) on Ocean Health—a regional ocean partnership—the states of Washington and California have agreed to collaborate with BOEM, the Department of Energy, Federal Energy Regulatory Commission, National Oceanographic and Atmospheric Administration, and other agencies to evaluate the potential benefits and impacts of renewable ocean energy projects off the West Coast.

WCGA established the Renewable Ocean Energy Action Coordination Team to develop a shared strategy with the states to ensure that when renewable ocean energy development activities are proposed along the West Coast, comprehensive planning will occur to increase renewable energy generation and minimize negative impacts to marine ecosystems and coastal communities.

Delaware

The Bureau of Ocean Energy Management has identified a formal wind energy area for Delaware of approximately 122 square nautical miles—roughly seven nautical miles from shore at the closest point. BOEM's environmental assessment of the Mid-Atlantic wind energy areas (New Jersey, Maryland, Delaware, and Virginia) concluded that no significant impact would result from issuing leases to developers for site assessment activities in the Delaware wind energy area. In November 2012 a lease was executed that allows for site assessment activities. The next step is submitting a site assessment plan.

Hawaii

The Bureau of Ocean Energy Management established the Hawaii OCS Renewable Energy Task Force to promote intergovernmental planning and coordination for commercial and research leases and right-of-way grants for power cables on the federal outer continental shelf off Hawaii. Members of the intergovernmental task force include representatives of federal, state, and local government agencies and offices that coordinate with native Hawaiians.

The first BOEM Hawaii OCS Renewable Energy Task Force meeting was held in Honolulu, Hawaii, on March 7, 2012. During this meeting BOEM and the Hawaii Department of Business, Economic Development and Tourism officials described their respective renewable energy programs and discussed future coordination and consultation opportunities. The second task force meeting, held December 2012, provided updates on renewable energy activities.

Maine

In 2011, a developer submitted an unsolicited request to BOEM for a commercial wind lease offshore of Maine. The proposed project would consist of four 3-megawatt wind turbine generators configured for a total of 12 mw in water depths greater than 100 meters, to be located approximately 12 nm off the coast of Maine. In 2012, BOEM made a determination of "no competitive interest."

Maryland

BOEM has identified a formal wind energy area for Maryland, located 10 nautical miles from Ocean City, Md., covering about 94 square nautical miles or roughly 79,000 acres. According to the Maryland Energy Administration, this site could generate as much as 1,000 megawatts of energy for the state.

BOEM's environmental assessment of the Mid-Atlantic wind energy areas concluded that no significant impact would result from issuing leases to developers for site assessment activities in the Maryland wind energy area.

In addition, the BOEM has received six expressions of interest from developers for the Maryland wind energy area and will grant leases through its auction process in 2013.

Massachusetts

The Massachusetts wind energy area is the largest area BOEM is considering for any state, covering nearly 1,000 square miles—roughly 15 nm south of Nantucket, Mass. (The second is the Rhode Island-Massachusetts WEA, a roughly 257-sq. mile area.) The Commonwealth of Massachusetts estimates that these areas have the potential to provide six gigawatts of clean energy. BOEM has had an active task force in Massachusetts since 2009.

In July 2012, BOEM released its environmental assessment for the RI-MA WEA regarding any potential impact resulting from issuing leases to developers for site assessment and characterization activities in this area. BOEM is finalizing its environmental assessment for the Massachusetts wind energy area.

New Jersey

A wind energy area for New Jersey has been identified and is approximately 418 square nm and begins approximately seven nautical miles from shore. In February 2012, BOEM concluded that no significant impact would result from issuing leases to developers for site assessment activities in the New Jersey wind energy area.

The Bureau of Ocean Energy Management has received 11 expressions of interest from developers for lease sites within the New Jersey wind energy area. The next step in the competitive leasing process is to issue a proposed sale notice.

In July 2012, another project received its final permit for a 25 mw offshore wind project in state waters—approximately three miles off the coast of Atlantic City. The New Jersey Board of Public Utilities is currently reviewing the project's potential impact on the state's ratepayers.

New York

In September 2011, a lease application was filed for a collaborative effort among New York Power Authority, Consolidated Edison of New York and the Long Island Power Authority to develop a 350 to 700 mw offshore wind energy project approximately 13 miles southwest of Rockaway Peninsula.

North Carolina

The Bureau of Ocean Energy Management is in the process of developing several wind energy areas (up to five) for North Carolina; and in December 2012, issued a call for information and nomination for three of the areas. The comment period closed in March 2013; comments are helping to identify wind energy areas.

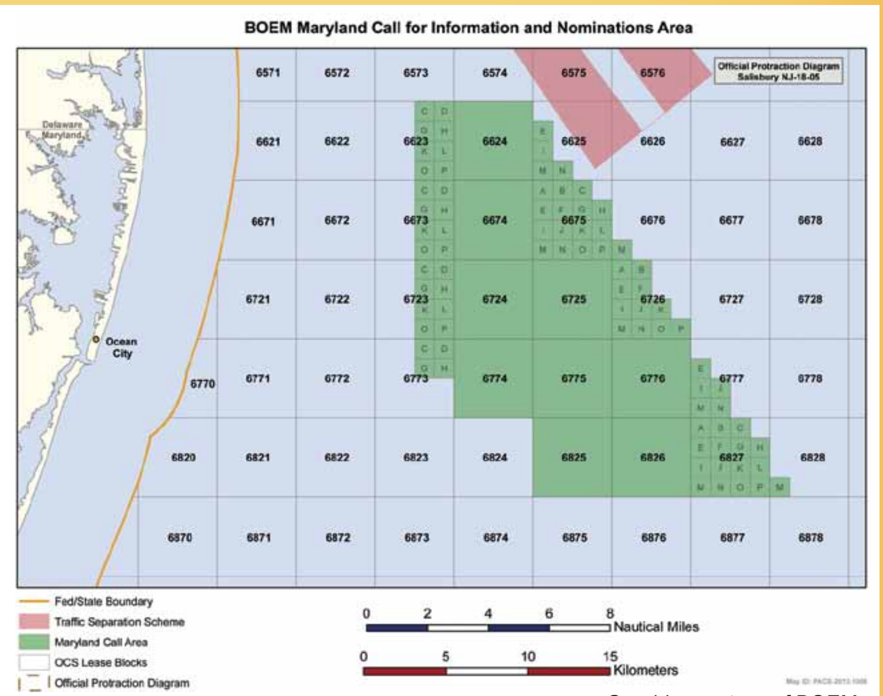
Oregon

BOEM established an intergovernmental renewable energy task force with the state of Oregon in 2011. Five meetings have been held to date, and BOEM is reviewing two unsolicited lease requests associated with proposed offshore wind and marine hydrokinetic projects.

In 2013, a developer submitted an unsolicited lease request to BOEM for a commercial wind lease for a proposed 30 MW floating deepwater wind energy project off Coos Bay, Ore. Another developer submitted an unsolicited research lease request in 2013 for a marine hydrokinetic research facility off Oregon's coast.

Rhode Island

In 2008, the Rhode Island Coastal Resources Management Council began a planning process to develop a comprehensive management and regulatory tool for siting offshore renewable energy projects in Rhode Island Sound (the Rhode Island Ocean Special Area Management Plan,



Graphic courtesy of BOEM.

Copyrighted image.

or the Ocean SAMP). A renewable energy zone was identified within the Ocean SAMP boundary, as the preferred area for offshore wind projects, and BOEM released its environmental assessment in July 2012.

A developer has proposed to build a 30 mw demonstration-scale project approximately three miles off the southeast coast of Block Island, using five 6-mw turbines. The project will include a 21-mile transmission cable that will connect the project to Block Island and the mainland electric grid. Construction is expected to begin by 2014.

South Carolina

A publicly owned utility formulated a 40-mw demonstration project for South Carolina, but, unfortunately the project is not currently moving forward due to unforeseen circumstances, but this effort is a noteworthy achievement that has paved the way for future collaboration.

Virginia

The Bureau of Ocean Energy Management has identified a formal wind energy area for Virginia, which is approximately 23 nm from Virginia Beach and covers approximately 113,000 acres or 133 sq. nautical miles. BOEM included Virginia in its finalized regional environmental assessment of the Mid-Atlantic wind energy areas and concluded that no significant impact would result from issuing leases to developers for site assessment activities in the Virginia wind energy area.

BOEM has received eight expressions of interest from developers; as a result, BOEM published a proposed sale notice in December 2012.

Reference:

U.S. Coast Guard Atlantic Coast Port Access Study, Interim Report, July 13, 2012.

Wind energy areas have been identified off the coasts of Massachusetts, Rhode Island, New Jersey, Delaware, Maryland, and Virginia. The WEAs are coincidentally located at or near the entrances of major ports, because ports are suitable for possible commercial exploitation, the depth of water is adequate for wind farm construction, and there is landside electrical energy infrastructure within acceptable distances to connect to the wind farms.

In addition to the Atlantic Coast, BOEM has received indications of interest in renewable energy projects off of Washington, Oregon, and California (both deepwater wind as well as marine hydrokinetic energy), and has received two lease requests for renewable energy projects offshore Oregon. The Bureau of Ocean Energy Management will work with the Federal Energy Regulatory Commission on hydrokinetic project management. Lastly, BOEM has received interest from Hawaii to consider wind farms in that location.

U.S. Offshore Wind Development

The U.S. is moving closer to the construction of its first offshore wind farm. Cape Wind, to be built off Cape Cod, Mass., has its lease and an approved construction and operation plan, so it may be just a matter of time before it starts construction. Other projects are close at hand as well. So the question is begged: "Is 2014 the year the United States construction on a wind farm is actually started?" This author believes the answer is a resounding "yes!"

About the author:

Mr. George H. Detweiler Jr. retired from the USCG with more than 20 years of military service. He returned to the USCG as a marine transportation specialist in the Marine Transportation Systems Management Directorate at headquarters. His major projects include port access route studies for the Atlantic Coast, protecting Right Whales through restrictions on vessel speed, creating ship routing measures, and reviewing offshore renewable energy installations proposals. Mr. Detweiler has worked on the Cape Wind project and has been a panelist at alternative energy workshops and conferences.

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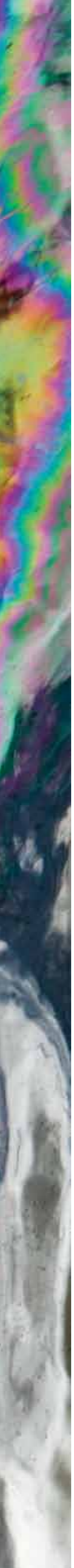

Lessons Learned

The Big Spill

A glimpse into the largest marine casualty investigation in Coast Guard history.

by CDR Michael Simbulan
Investigating Officer and Enforcement Program Manager
U.S. Coast Guard Office of Investigations and Analysis
Coast Guard liaison to the USCG-MMS Joint Investigations Team

On April 20, 2010, a series of explosions and fire onboard the Mobile Offshore Drilling Unit *Deepwater Horizon* set off a chain of events that resulted in the loss of 11 mariners, and the eventual sinking and complete loss of the vessel. This would become the largest oil spill disaster in U.S. history.

Due to the magnitude of the event, U.S. Coast Guard personnel and the public focused much of their attention on the rescue and response operations. However, a group of CG investigators and members of the Minerals Management Service (MMS) (which evolved into the Bureau of Safety and Environmental Enforcement and the Bureau of Offshore Energy Management) had a different mission in mind—to determine what went wrong and the cause of this fatal disaster.

The First Investigators On Scene

On the afternoon of April 21, 2010, MMS and Coast Guard investigators reached the scene of the incident. With the *Deepwater Horizon* still burning on the horizon, they boarded an offshore supply vessel, loaded with a majority of the survivors.

The first step in a marine investigation process is to establish a timeline of events, which involves:

- inspecting the incident scene;
- gathering and recording physical evidence;
- interviewing witnesses;
- reviewing documents, procedures, and records;
- conducting any required specialized studies.

However, when a vessel (such as the one involved in this incident) sinks, the scene of the incident is 70 miles offshore and 5,000 feet below the ocean's surface, the main witnesses are missing, and the key pieces of evidence are mammoth in size—establishing a timeline can be complicated.

Nevertheless, the first order of business was to identify all of the survivors and to determine which ones to interview. All survivors were asked to provide a written statement detailing their role aboard the vessel, their location at the time of the first explosion, and their recollections of the events. After reviewing the statements, investigators split into two teams to interview the key witnesses.

While the witnesses were interviewed offshore, investigating officers at Marine Safety Unit Morgan City arranged for post-casualty drug testing and prepared for the major investigation that would soon manifest.

Meanwhile, the Office of Investigations and Analysis at Coast Guard headquarters established a dialogue with the Department of the Interior and MMS headquarters in anticipation of convening a formal investigation into the incident. They searched for candidates who were qualified to perform a Marine Board of Investigation, and staff members were sent to New Orleans to establish a base of operations for the investigators, and to make the logistical arrangements for the public hearings to accompany the formal investigation.

The Joint Investigation Team

On April 27, 2010, the Secretary of Homeland Security and the Secretary of the Interior established a joint investigation team (JIT) that consisted of co-chairs CAPT Hung Nguyen, of the U.S. Coast Guard, and Mr. David Dykes, of the MMS, along with technical experts, legal advisors, and administrative staff from each agency. In all, hundreds of Coast Guard and MMS employees were involved.

The USCG and MMS have authority to investigate incidents on the outer continental shelf,[1] so working together was not something new. However, neither the USCG nor the MMS had ever faced an event or investigation of this magnitude, so DHS and DOI issued a convening order that spelled out the authorities and defined the rules for the investigation. Per the order, the JIT operated under the procedures for a Coast Guard Marine Board of Investigation to provide transparency of effort.

Interviewing Witnesses

The joint investigation team held seven public hearings to obtain testimony from witnesses. Interviewing took place in a public venue; furthermore, parties with a vested interest, or "parties in interest," such as the owner and operator of the vessel, the owner of the Macondo well, and the vessel's flag state, were allowed to question witnesses.

The investigation team looked at the sequence of events that led to the loss of well control, and the sinking of the vessel. They also asked questions about the immediate response and evaluation efforts.

Members of the *Deepwater Horizon* joint investigation board prepare to question a witness. U.S. Coast Guard photo by Petty Officer Prentice Danner.

In addition to interviewing all witnesses, the team collected thousands of documents and examined more than 400,000 pages of documentary evidence, which helped them understand:

- the chain of events leading up to the explosion and fire,
- offshore drilling operations in general,
- the equipment on the *Deepwater Horizon*,
- the safety systems and regimes in place.

All of the documentary evidence the JIT collected was electronically imaged. In addition, protocols were developed so that the JIT could receive information, such as videos or photos, in electronic format. Electronic document storage facilitated evidence collection, review, and cataloging as well as sharing information with other investigating bodies, such as the Oil Spill Commission and the National Academy of Engineers.

In addition, the joint investigation team established a secure server for all of the documents on the Coast Guard Data Network to provide Coast Guard JIT members with access to the evidence from any Coast Guard workstation.

Inspecting the Scene

There was a significant amount of underwater video of the Macondo well from the response efforts, but very little video footage of the vessel itself. Due to the lack of video footage that documented the wreckage of the *Deepwater Horizon*, the joint investigation team determined that an underwater survey of the wreckage as well as a map of the evidence on the seabed were needed.

After weighing various options and determining that an impartial third party was needed to conduct the dive operations, the team called upon the U.S. Navy Supervisor of Salvage (SUPSALV) for assistance. Given the water depth at the wreckage site, the SUPSALV recommended using an underwater remotely operated vehicle (ROV)[2].

The ROV sent back hundreds of hours of video footage of the vessel structure and the debris on the ocean floor. In addition to documenting the wreckage, the survey also provided SUPSALV with the information that was

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Retrieving and Examining Physical Evidence

The Evidence Yard

As the first pieces of physical evidence floated ashore in April 2010, the *Deepwater Horizon* joint investigation team recognized the need for general evidence collection procedures and an evidence processing and storage facility. With that in mind, the JIT issued several subpoenas and an accompanying directive requiring that all parties involved in the response collect and preserve all evidence from the vessel, including the drilling equipment. In addition, the JIT issued guidance to all federal agencies involved in the response to ensure that all debris from the incident scene was collected and sent to the JIT for evaluation.

Given the proximity of the Coast Guard Base Support Unit New Orleans to the JIT's base of operations in New Orleans, and the base's security, waterside access, and ample space, the BSU was the logical choice for the *Deepwater Horizon* "evidence yard."

Later on in the investigation, while the joint investigation team was planning the retrieval of the subsea evidence, the team determined that the evidence facility needed to accommodate transportation, preservation, storage, and, most importantly, the forensic analysis of the subsea evidence.

Given the size of the subsea evidence, like the blowout preventer (BOP)[1], this was not an easy requirement to accommodate. After much deliberation, the JIT determined that NASA's Marshall Assembly Facility (MAF) met all of the aforementioned criteria. And, since BSU New Orleans was a tenant of NASA MAF, the proximity of both locations simplified managing the evidence.

Subsea Evidence

The investigation team recognized early on that the physical evidence at the bottom of the ocean would be critical to the investigation—in particular, the blowout preventer from the Macondo well. However, retrieving anything from the bottom of the ocean requires special equipment and skills. Furthermore, evidence retrieval efforts could not interfere with the ongoing response efforts.

So, the investigation team embedded a liaison at the incident command post in Houston, Texas, whose purpose was to coordinate evidence collection efforts and leverage the response structure and assets. To that end, the incident commander established the investigations planning group, made up of representatives from the Coast Guard, MMS, the FBI, and the EPA.

This group developed evidence collection, preservation, and transportation procedures for all subsea evidence, and these procedures were integrated into all relevant operations plans. The group also coordinated with the JIT representatives who were offshore to witness and document evidence retrieval efforts. With multiple response vessels and ROVs on scene, choreography of the operations and the personnel was no simple task.

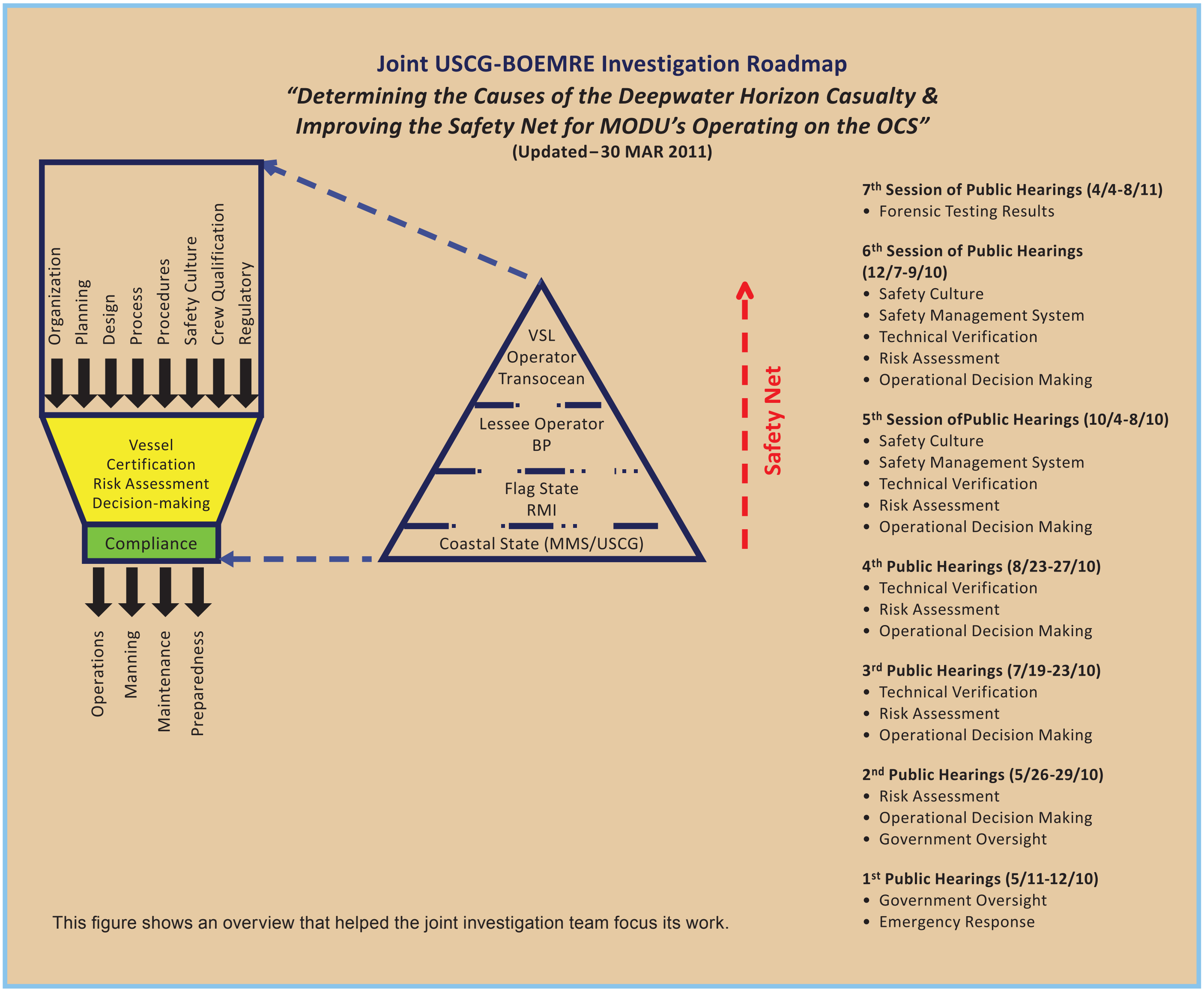
Forensic Analysis

As the condition of the blowout preventer from the Macondo well was of particular interest, and the federal government did not possess the expertise and specialized equipment to dismantle and analyze this and other key pieces of physical evidence, the MMS hired the engineering service firm Det Norske Veritas (DNV).

From October 2010 to July 2011, DNV personnel disassembled the BOP and documented the condition of every part as well as the drilling equipment trapped inside it. The FBI evidence response team worked alongside DNV and documented every item as well. When needed, fluid and material samples were sent to labs for analysis. In the end, DNV representatives used laser scanning to develop three-dimensional models of the evidence, then used animations to show how all of the pieces went together and how the blowout preventer failed.

Endnote:

1. There are two basic types of blowout preventers (BOPs): ram and annular. They come in a variety of styles, sizes, and pressure ratings. The *Deepwater Horizon* BOP stack included seven individual BOPs.



This figure shows an overview that helped the joint investigation team focus its work.

needed to determine the feasibility of accessing the internal parts of the vessel as well as the feasibility of salvaging the wreckage in whole, or in part. However, both efforts were deemed unfeasible.

While there was hope that the survey would also help bring closure to family members of the deceased by locating the remains of crew members, the team found no evidence of them. In the end, the underwater survey provided valuable information and helped narrow down the plausible scenarios that led to the vessel's sinking.

The Results

The JIT final report of investigation consisted of two volumes and is available online. Coast Guard members wrote volume 1, which focused on the events on the vessel. MMS members wrote volume 2 and focused on the subsea events and deepwater drilling. The Commandant of the Coast Guard endorsed the report and its recommendations, which represents final agency action and defines a way forward for the Coast Guard to improve safety on the U.S. outer continental shelf.

In addition to supporting future Coast Guard safety initiatives, the joint investigative team's work also benefitted the National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling,[3] the Chemical Safety and Hazard Investigation Board, and the National Academy of Engineering investigation into the *Deepwater Horizon*/Macondo well blowout.[4]

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Fire-boat response crews battle the blazing remnants of the offshore oil rig *Deepwater Horizon.* Multiple Coast Guard helicopters, planes, and cutters responded to rescue the 126-person crew. U.S. Coast Guard photo.

The U.S. Coast Guard expended thousands of man hours and nearly $4 million on the joint investigation. Amid this unprecedented effort and expense, the JIT team members kept focus and maintained the time-tested marine investigations process.

About the author:
CDR Michael Simbulan is the enforcement program manager in the Office of Investigations and Analysis at Coast Guard headquarters. He has 17 years of marine safety experience, and has served as a marine investigator in San Juan and Honolulu. He was awarded the Coast Guard Meritorious Service Medal for his efforts in support of the joint investigation into the loss of the Deepwater Horizon. *CDR Simbulan holds a bachelor's degree in civil engineering from the U.S. Coast Guard Academy, and a master's degree in ocean engineering from Virginia Tech.*

Endnotes:

1. The USCG and MMS (now BSEE) enter this agreement under authority of 14 U.S. Code (USC) §141—Coast Guard Cooperation with other Agencies; 43 USC §1347, 1348(a)—the Outer Continental Shelf Lands Act (OCSLA), as amended; 33 USC § 2712 (a)(5)(A)—the Oil Pollution Act of 1990 (OPA); 43 USC §§1301-1315—the Submerged Lands Act (SLA), as amended; and the Energy Policy Act of 2005 (EPAct), Pub. L. 109–58.
2. A remotely operated vehicle (ROV) is designed to meet deep ocean salvage requirements down to a maximum depth of 20,000 feet of seawater. This vehicle is loaded with a host of new technologies and was built as a direct replacement for CURV-III but with a smaller overall system footprint. More information is available at www.navy.mil/navydata/fact_display.asp?cid=4300&tid=50&ct=4.
3. The final report is available at www.oilspillcommission.gov/final-report.
4. The National Academy of Engineering report is available at www.nae.edu/53926.aspx.

For more INFORMATION:

The USCG report and its supporting documents on the *Deepwater Horizon* incident are available at **https://homeport.uscg.mil/** under investigations.

Understanding Styrene

by LCDR Gregory Crettol
U.S. Coast Guard Academy
Science Department

Chemical of the Quarter

What is it?

Styrene is a synthetic, organic chemical that produces polymers, resins, and rubber compounds. It is an aromatic, colorless to yellowish oily liquid with a sweet odor, when pure, and a sharp disagreeable odor when not pure. It is only slightly soluble in water at 300 parts per million (ppm); but it is toxic to aquatic organisms.

Styrene has many uses. For example, it is an important feedstock, and manufacturers use it in many goods including automobiles, fiberglass boats, office equipment, kitchen appliances, toys, containers, and as polystyrene for food packaging. It is typically transported in bulk.

Styrene-based products display increased durability, high performance, manufacturing versatility, and low production costs. Styrene also offers improved sanitation and hygiene benefits, plus the material is readily recyclable. However, before producing final commercial products, bulk styrene monomer transport must be carefully monitored and managed.

Why should I care?

Shipping concerns

Styrene contains a small concentration of inhibitor to prevent self-polymerization. At high temperatures, styrene may undergo rapid exothermic polymerization, which could rupture bulk cargo holds or piping. A vessel transporting bulk styrene must have a certificate of inhibition on the bridge. Additionally, vessels equipped with cargo tank heating coils must blank them off prior to carrying styrene, and the Coast Guard must endorse the vessel's certificate of inspection to carry it.

Health concerns

Styrene is irritating to the skin, eyes, and respiratory system. Its vapors are heavier than air and may cause drowsiness, dizziness, and lung damage. As an aromatic hydrocarbon, the smell of styrene can be detected at a very low concentration of 0.15 ppm. If one is exposed to styrene, quickly move to fresh air and wash any affected skin and clothing thoroughly with soap and water.

Fire or explosion concerns

Styrene has a flash point of 90 °F and can readily form explosive vapor/air mixtures—even when inhibited, it is a highly reactive and volatile substance. When temperatures reach 125 °F, styrene can still polymerize exothermically and generate heat very rapidly, which can quickly auto-ignite the bulk styrene material. Therefore, great care should be taken to avoid temperatures higher than 77 °F, including any open flame or any source of static discharge. As a heavy vapor, styrene can travel long distances and reach remote ignition sources—causing flashback fire danger. In the event of fire, use foam, dry chemical powder, or carbon dioxide to smother the flames.

What is the Coast Guard doing about it?

The U.S. Coast Guard requires all tank vessels carrying styrene in bulk to be inspected in accordance with 46 CFR, Chapter I, Subchapter O—Certain Bulk Dangerous Cargos. More specifically, barges carrying styrene in bulk are regulated under 46 CFR 151; whereas, self-propelled tank vessels carrying styrene in bulk are examined under 46 CFR 153. Also, regarding cargo compatibility, styrene belongs to the USCG Compatibility Group No. 30—Olefins.

In the event of a chemical spill, immediately call the U.S. Coast Guard National Response Center at (800) 424-8802.

About the author:
LCDR Gregory Crettol graduated from the University of Connecticut in 2013 with an M.S. in chemical engineering. He was previously stationed in Yorktown, Va., as the chief of the International Maritime Officer's School. His field tours include supervisor of MSD Unalaska and senior marine safety inspector of Sector Seattle. LCDR Crettol received a direct commission in 1998, after graduating from Washington State University with a B.S. in biochemistry and a B.S. in chemical engineering.

Nautical Engineering Queries

Questions

Prepared by NMC Engineering Examination Team

1. **An incorrect spray pattern produced by a diesel engine fuel injection nozzle can be directly caused by ________.**

   A. incorrect fuel rack setting
   B. overcooling of the nozzle
   C. low firing pressure
   D. excessive lube oil temperature

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2. **In an impressed current cathodic protection system, concerning the anodes associated with the hull, what statement is true?**

   A. The anodes are connected to the hull and waste away with time.
   B. The anodes are insulated from the hull and do not waste away with time.
   C. The anodes are connected to the hull and do not waste away with time.
   D. The anodes are insulated from the hull and waste away with time.

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3. **In the event of a fire, automatic activation of a fixed CO_2 extinguishing system can result in which of the following areas?**

   A. machinery space
   B. paint locker
   C. cargo hold
   D. all the above

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4. **Coast Guard regulations (46 CFR) require a method for the relieving pressure of an over-pressurized refrigeration system. Which statement complies with these regulations?**

   A. The relief valve from the receiver must relieve to the condenser first.
   B. The relief valve setting shall be 1 ¼ times the maximum allowable working pressure.
   C. A rupture disc may be fitted in series with the relief valve.
   D. The rupture disc shall burst at a pressure not higher than 10% above the relief valve setting.

1. *Note: The quality of the spray pattern produced by a diesel engine fuel injection nozzle is primarily a function of the following: the viscosity of the fuel passing through the nozzle orifices, the pressure of the fuel behind the nozzle orifices, and the geometry of the orifices themselves.*

A.	incorrect fuel rack setting	Incorrect answer. An incorrect fuel rack setting results in a change of the overall quantity of fuel injected into the engine cylinder by the fuel injection nozzle. This has no impact on the rate of injection or the quality of the spray pattern.
B.	overcooling of the nozzle	**Correct answer.** When the injector nozzle is overcooled, the temperature of the fuel passing through the nozzle orifices is lowered, which results in an increase in fuel viscosity. The higher viscosity fuel results in improper fuel atomization, which impacts the quality of the spray pattern.
C.	low firing pressure	Incorrect answer. An incorrect spray pattern may possibly result in low firing pressure, but low firing pressure is not a direct cause of an incorrect spray pattern.
D.	excessive lube oil temperature	Incorrect answer. Excessive lube oil temperature certainly has a negative impact on the characteristics of cylinder lubrication, but this does not have a direct impact on fuel injector nozzle spray patterns.

2. *Note: An impressed current cathodic protection system is utilized to maintain continuous protection of the hull without sacrificial corrosion of the anodes.*

A.	The anodes are connected to the hull and waste away with time.	Incorrect answer. This type of protection is associated with the use of zinc anodes bonded to the hull which are sacrificial (waste away with time) and require periodic replacement to maintain protection of the hull. There is no impressed current with this method of protection.
B.	The anodes are insulated from the hull and do not waste away with time.	**Correct answer.** Anodes that are attached to but insulated from the hull are associated with an impressed current cathodic protection system. Such anodes are not sacrificial and will not waste away with time.
C.	The anodes are connected to the hull and do not waste away with time.	Incorrect answer. Anodes that are bonded to the hull are sacrificial and will waste away with time.
D.	The anodes are insulated from the hull and waste away with time.	Incorrect answer. Anodes that are attached to but insulated from the hull are used in an impressed current cathodic protection system and do not waste away with time.

3. *Note: Fixed CO_2 extinguishing systems can either be manually deployed or automatically activated depending upon the application.*

A.	machinery space	Incorrect answer. A fixed CO_2 extinguishing system used to protect a machinery space, such as an engine-room, is a total-flooding system. This system is always deployed manually and only after ascertaining that all personnel have been evacuated from the machinery space.
B.	paint locker	**Correct answer.** Smaller systems (using less than 300 lbs. of CO_2) used to protect a paint locker may be either manually deployed or automatically activated.
C.	cargo hold	Incorrect answer. The cargo hold fixed fire CO2 system is activated in much the same way a machinery space total-flooding system is activated. After sealing the hold, the system is deployed manually.
D.	all the above	Incorrect answer. Choice “B” is the only correct answer.

4. *Note: The pertinent regulations are found in Subchapter F, Marine Engineering. In searching the Subchapter F index, it is found that the regulations for refrigeration machinery are found in Subpart §58.20. In searching Subpart §58.20, it is found that the regulations pertaining to pressure relieving devices are found in §58.20-10.*

A.	The relief valve from the receiver must relieve to the condenser first.	Incorrect answer. The relief valve from the receiver may relieve to the condenser first before relieving to the low side or the atmosphere. However, the relief valve may either relieve directly to the atmosphere or to the low side before relieving to the atmosphere. See §58.20-10(b).
B.	The relief valve setting shall be 1 ¼ times the maximum allowable working pressure.	Incorrect answer. The relief valve shall be set to a pressure not greater than the maximum allowable working pressure. See §58.20-10(a).
C.	A rupture disc may be fitted in series with the relief valve.	**Correct answer.** A rupture disc may be fitted in series with the relief valve as long as the bursting pressure is no higher than the relief valve pressure relief setting and that the relief valve is of a type not affected by back pressure. See §58.20-10(b).
D.	The rupture disc shall burst at a pressure not higher than 10% above the relief valve setting.	Incorrect answer. When piped in series with a relief valve, the rupture disc shall burst at a pressure no higher than the relief valve pressure relief setting. See §58.20-10(b).

Nautical Deck Queries

Questions

Prepared by NMC Deck Examination Team

1. **INTERNATIONAL ONLY: A partly submerged object being towed by a vessel during the day, must display which of the following shapes?**

   A. a diamond shape when the length of the tow is 200 meters or less
   B. a diamond shape when the length of the tow exceeds 200 meters in length
   C. a black ball
   D. a black ball only when the length of the tow exceeds 200 meters in length

2. **Which statement about the carriage of solid hazardous materials in bulk is true?**

   A. A special permit issued by the Coast Guard is required before bulk solid materials that require special handling are loaded.
   B. Hazardous materials that require separation must not be handled at the same time.
   C. A certification issued by ABS will be accepted as evidence that the vessel complies with all applicable loading regulations.
   D. The shipping papers can be used in lieu of a Dangerous Cargo Manifest for a vessel carrying solid hazardous materials in bulk.

3. **While steaming at 18.9 knots, your vessel consumes 386 barrels of fuel oil per day. In order to reduce consumption to 251 barrels of fuel oil per day, what is the maximum speed the vessel can turn for?**

   A. 11.6 knots
   B. 12.3 knots
   C. 15.2 knots
   D. 16.4 knots

4. **How does reducing the speed of a vessel minimize the potential for vessel slamming?**

   A. It lengthens the wave period
   B. It shortens the wave period
   C. It reduces the force of impact of the vessel
   D. Vessel speed does not affect slamming

Deck Answers

1. A. a diamond shape when the length of the tow is 200 meters or less
Correct Answer. Reference: Rule 24(g) (iv) states that when an inconspicuous, partly submerged vessel or object is being towed, it shall display a diamond shape at or near the aftermost extremity.

B. a diamond shape when the length of the tow exceeds 200 meters in length
Incorrect Answer. Reference: Rule 24(g) (iv) states that if the length of the tow exceeds 200 meters and an additional diamond shape must be displayed as far forward as possible

C. a black ball
Incorrect Answer. Reference: Rule 30

D. a black ball only when the length of the tow exceeds 200 meters in length
Incorrect Answer. Reference: Rule 30

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2. A. A special permit issued by the Coast Guard is required before bulk solid materials that require special handling are loaded.
Incorrect Answer. Reference: 46 CFR 148.10 A material listed in Table 148.10 of this section may be transported as a bulk solid cargo on a vessel if it is carried according to this part. A material that is not listed in Table 148.10 of this section, but which is hazardous or a Potentially Dangerous Material (PDM), requires a Special Permit under §148.15 of this part to be transported on the navigable waters of the United States.

B. Hazardous materials that require separation must not be handled at the same time.
Correct Answer. Reference: 46 CFR 148.120 Materials that are required to be separated during stowage must not be handled at the same time.

C. A certification issued by ABS will be accepted as evidence that the vessel complies with all applicable loading regulations.
Incorrect Answer. Reference: 46 CFR 148.12 Certificates of loading from the National Cargo Bureau are accepted as evidence of compliance with bulk solid transport regulations.

D. The shipping papers can be used in lieu of a Dangerous Cargo Manifest for a vessel carrying solid hazardous materials in bulk.
Incorrect Answer. Reference: 46 CFR 148.62 The shipping paper and emergency response information required by §§148.60 and 148.61 of this part must be kept on board the vessel along with the dangerous cargo manifest required by §148.70 of this part.

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3. A. 11.6 knots — Incorrect Answer

B. 12.3 knots — Incorrect Answer

C. 15.2 knots — Incorrect Answer

D. 16.4 knots — **Correct Answer.** Reference: *Formulae for the Mariner,* Plant, Second Edition, page 41:

$$\frac{\text{New Consumption}}{\text{Old Consumption}} = \frac{\text{New Speed}^3}{\text{Old Speed}^3}$$

$$\text{New Speed}^3 = \frac{\text{Old speed}^3 \times \text{New Consumption}}{\text{Old Consumption}}$$

$$\text{New Speed}^3 = \frac{18.9\ \text{kts}^3 \times 251\ \text{Bbls}}{386\ \text{Bbls}}$$

$$\text{New Speed} = 16.37\ \text{kts}$$

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4. A. It lengthens the wave period
Correct Answer. Reference: *Ship's Dynamics for Mariners,* Clark, First Edition, page 236: The act of reducing vessel speed lengthens the encountered wave period and allows the vessel to ride over oncoming waves.

B. It shortens the wave period
Incorrect Answer. Increasing vessel speed would shorten the wave period.

C. It reduces the force of impact of the vessel
Incorrect Answer. Reducing the speed, would decrease the force of impact.

D. Vessel speed does not affect slamming
Incorrect Answer. Whether or not a vessel slams is dependent on its speed and draft relative to wave speed and height.

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