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Offshore Drilling: Safety and Response Technologies

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Prepared for the House Committee on Science, Space, and Technology Subcommittee on Energy and the Environment

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RESOURCES FOR THE FUTURE

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The President's Oil Spill Commission has identified a series of failures leading to last year's *Deepwater Horizon* (*DH*) spill in the Gulf of Mexico.[1] The spill's damage came not just from the blowout and tragic fire, however, but was matched by the subsequent inability to contain the spill once it began. These efforts, from junk shots to top kills, took nearly three months before finally stopping the flow of oil.

In my testimony today, I have been asked by the Subcommittee to offer my views on the problem of containment, including incentives to advance the state-of-the-art in containment to keep pace with advances in deepwater and ultradeepwater drilling. I draw from research carried out with several colleagues and undertaken for the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (Oil Spill Commission).[2] This research is available at the Commission's website and on the website of my organization, Resources for the Future, at www.rff.org/deepwaterdrilling.

I offer my views as an economist who has studied the use of new technology for environmental management and the economics of technological innovation and the environment. I have also had the opportunity to testify before the Committee on space technology, for which the problem of innovation and risk are also relevant and offer some parallels. I am a senior fellow and research director at Resources for the Future (RFF), an organization established at the request of a presidential commission in 1952. RFF is a nonprofit and nonpartisan think tank that conducts

[1] National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling: Report to the President* (Washington, DC: US Government Printing Office), January 2011.
[2] My work is coauthored with several colleagues. See Robert Anderson, Mark A. Cohen, Molly K. Macauley, Nathan Richardson, and Adam Stern, "Organizational Design for Spill Containment in Deepwater Drilling Operations in the Gulf of Mexico," Resources for the Future Discussion Paper DP 10-63, January 2011, at www.rff.org/deepwaterdrilling; and Mark A. Cohen, Molly K. Macauley, and Nathan Richardson, "Containing Future Major Oil Spills," *Resources*, Winter/Spring 2011, No. 177, pgs. 44–47, at http://www.rff.org/Publications/Resources/Pages/The-Next-Battle-Containing-Future-Major-Oil-Spills-177.aspx.

independent research, primarily using economics, on environmental, energy, and other natural resource issues. The work that my colleagues and I carried out for the Oil Spill Commission was conducted independently of the Commission to inform its deliberations. I emphasize that the views I present today are mine alone. Neither the work from which I draw nor my comments today represent the views of the Commission or RFF. RFF takes no institutional position on legislative, regulatory, judicial, or other public policy matters.

I summarize my main points as follows:

- Adequate investment in containment R&D is essential for limiting damages from future offshore accidents like the *Deepwater Horizon* spill.
- Industry and government both recognize this need and are taking commendable steps to address it.
- Over the long term, however, there is reason to be concerned that existing incentives faced by industry are inadequate to ensure a robust and sustained investment in containment R&D.
- There is a strong argument for a government role in supporting containment R&D, much like the role that government has had in supporting R&D in other industries. This need not be a financial drain on an already fiscally stressed government or an onerous burden on industry.

The Challenge of Drilling and Containment in Deepwater

The *DH* spill occurred at an underwater depth of about 5000 feet—a depth at the breakpoint between "deep" and "ultradeep" water. The spill revealed the complexities of drilling in deepwater and at the large depths of the well itself to reach hydrocarbon reservoirs beneath the ocean floor (the *DH* was drilling some 13,000 feet under the ocean floor). At these depths, particularly in the Gulf of Mexico, pressure is high, temperatures are extreme, and the geology is complex. Although industry has been drilling in deepwater for some 25 years, each well is said to have its own "personality" reflecting a complicated mix of unique conditions.[3] Prior to the accident, the Minerals Management Service of the Department of Interior had tracked the industry's efforts to develop exploration and drilling operations in the Department's periodic reports on deepwater operations in the Gulf of Mexico.[4] An independent analysis carried out by my colleagues since the spill has found a statistical relationship between deepwater drilling depth and the probability of company-reported incidents, suggesting that drilling at increased depths

[3] National Commission, p. 52.
[4] U.S. Department of Interior, *Deepwater Gulf of Mexico 2009: Interim Report of 2008 Highlights,* OCS Report 2009-016, May 2009.

seems to result in greater technical challenges and therefore, may require novel approaches to industry operation and government regulation.[5]

The spill further revealed the challenge of containment. Containment is defined to include the deployment of technology, people, and other resources to stop additional hydrocarbon release and get a well back under control when a release occurs. (Containment differs from prevention and response; preventive actions—such as a well-functioning blowout preventer—keep releases from occurring at all, and response actions deal with hydrocarbons that have escaped containment, such as use of booms, burning, skimming, and dispersants.) The series of failures before the well was finally capped and the spill contained revealed an inability to deal effectively with containment of a well in deepwater. Adequate containment capability had not appeared to keep pace with the impressive technological accomplishments that have enabled drilling in ever-deeper water.

For many, the most disturbing result was not that a spill could happen, but that it could not be promptly contained. While the spill—with the benefit of hindsight—has many lessons, one of the sharpest is the need for improvement in ability to contain spills that may occur in increasingly deepwater drilling operations. It is worth considering for a moment the losses to people that would have been avoided if effective containment technology had been in place prior to the spill.

Recognition of this need has led to quick reactions. A few months after the spill was capped, a group of major drilling firms announced plans to invest an initial $1 billion in creating the Marine Well Containment Company (MWCC), a consortium to design, build, and operate a system capable of containing future deepwater spills in the Gulf of Mexico. Another company, Helix Energy Solutions, played a major role in the *DH* containment efforts and is now providing new deepwater containment services for some kinds of spills.

Regulators took notice as well, updating permit requirements to include demonstration of ability to contain spills. Companies that have been issued permits since the spill have met the new requirements by incorporating the new containment services of Helix or MWCC. The Secretary of Interior has proposed a new public-private safety institute. The Secretary and the Director of the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) have established the Ocean Energy Safety Advisory Committee, a permanent advisory group of leading scientific, engineering, and technical experts on offshore drilling safety, well containment, and spill response. [6]

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[5] See Lucija Muelenbachs, Mark A. Cohen, and Todd Gerarden, "Preliminary Assessment of Offshore Platforms in the Gulf of Mexico," Resources for the Future Discussion Paper 10-66 (Washington, DC: Resources for the Future), January 2011. We note that company-reported incidents do not necessarily mean the release of hydrocarbons, and in deepwater, where more than 14,000 wells have been drilled, there had been only minor spills until the *DH* accident (Anderson and coauthors 2011).

[6] See http://www.doi.gov/news/pressreleases/Salazar-Proposes-Ocean-Energy-Safety-Institute.cfm (accessed April 1 2011) and http://www.doi.gov/news/pressreleases/Salazar-Names-Members-of-Ocean-Energy-Safety-Advisory-Committee-to-Guide-Oil-and-Gas-Regulatory-Program-Reform.cfm# (accessed April 1 2011).

Are these steps likely to be enough to ensure future readiness and effectiveness in containing the next deepwater spill? Research undertaken with my colleagues indicates that while developments so far are positive, much more needs to be done, both in terms of government policy and industry commitments.

Incentives to Invest in Containment and in Containment Research and Development

It is well recognized that limited liability and sometimes-ineffective regulatory oversight can lead people naturally to underinvest in safety, environmental protection, and other activities that protect parties other than themselves. To be sure, no one wants to hurt companies, shareholders, and customers by causing harm to workers, incurring business disruption, losing expensive equipment, or losing revenue. The question here, and for government, is something more: whether firms have adequate incentives to minimize additional harm to third parties (people, other businesses, ecosystems, public health). Liability caps and ineffective regulatory oversight limit incentives to protect these third parties. Striking the right balance in public policy to protect third parties is essential but not easy.

Government intervention such as this results in a situation where government co-produces risk together with industry. In other words, by limiting liability, government (and taxpayers) assume part of the financial risk not covered by the firm and its shareholders. Similarly, by regulating safety and other operating conditions, government assigns some risk to workers and other parties, and some to industry. Measures to enhance incentives, such as raising or eliminating liability caps, will push firms to make greater containment investments and reduce the burden borne by taxpayers. My colleagues and others have suggested alternatives to eliminating the liability caps altogether, recognizing the disproportionate burden this could impose on smaller firms and a possible chilling effect on insurers.[7] For example, alternatives include a separate, risk-based liability cap for each well determined by the estimated worst-case discharge for each well; requiring firms to demonstrate financial responsibility up to the level of the cap; phasing in requirements for third-party insurance to fully cover financial responsibility; and introducing risk-based drilling fees (much like risk-based insurance premiums).

To be sure, part of the reason for past underpreparedness to contain large spills like the *Deepwater Horizon* was a widespread belief that such spills were either extremely unlikely or impossible. Yet that belief failed to take into account that deepwater drilling is more complex and riskier, and that risk assessments did not adequately account for these complications.[8] Policy

[7] Mark A. Cohen, Madeline Gottlieb, Josh Linn, and Nathan Richardson, "Deepwater Drilling: Law, Policy, and Economics of Firm Organization and Safety," Resources for the Future Discussion Paper 10-65, January 2011.
[8] Much like the accident of the space shuttle *Columbia*, occurring 21 years after the first operational shuttle flight, or the failure of the long-operating nuclear power plant in Japan, the *DH* spill shows the consequences of a sequence of individual failures in large-scale technology systems even when none of the individual failures alone is by itself catastrophic.Cooke and coauthors recommend use of an approach, known as accident sequence precursor analysis, for assessing risks in deepwater drilling; this approach models situations when failure can happen as a result of a

changes to take account of these complexities and to increase financial liability will strengthen incentives to invest in containment.

Incentives for research and development in containment are another concern, one that is separate but related to the problem of incentives to invest in containment alone. Even if changes in liability led firms to perfectly internalize damages in the event of a spill, industry may underinvest in containment R&D. Yet innovation in containment is necessary to keep up with innovation in deepwater and ultradeepwater drilling.

Underinvestment in R&D is one of the most-studied but, as yet, incompletely answered questions in technology policy. Incentives to innovate depend on several conditions being met: obviously, first the ability of firms to fund R&D, then the ability to appropriate the returns to invention, and at the same time, protect intellectual property embodied in the invention. These conditions can sometimes be hard to meet, hence the tendency of firms to underinvest in R&D. Moreover, another problem arises in the special case of innovation that, if widely deployed, would serve the public, not just the individual firm carrying out the innovation. Containment to protect third parties has this potential problem. Incentives are weakened when damages to third parties are not fully borne by the firms (circumstances related to the liability and regulatory problem discussed above). The proprietary nature of innovation, the need to deploy it widely to serve broader public interests, and the limits on damages internalized by firms all tend to reduce incentives to invest in containment R&D. This result calls into question whether we will be able in the future, without making the up-front investment in R&D now, to deploy state-of-the-art containment technology in increasingly deeper water in the coming years.

On this point, the extent of innovation likely to be taken by industry as a whole, or by MWCC and Helix, is not clear. The services offered by MWCC and Helix are impressive. They appear to focus, however, on preparing for a repeat of the *Deepwater Horizon* spill. MWCC's proposed system would not, for example, be able to contain a spill like the 1979 *Ixtoc I* event, in which the sinking rig came to rest on the wellhead. It also does not appear to address un- or underappreciated failure scenarios such as multiple simultaneous blowouts at different wells or a leaking well casing. It is also unclear the extent to which MWCC, Helix, or other containment suppliers will undertake R&D today, in order to provide containment tomorrow at future, deeper water depths.

Based on the experience that BP has documented for responding to the *DH* spill, it is worth noting that, going forward, innovation in containment requires not only innovation in engineering and new hardware. Innovation in all of the processes, logistics, and people that serve to deploy the hardware and make decisions in real-time and under the duress of an emergency is also necessary. These systems, processes, procedures, and organization of people who will be

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sequence of individual failures (see Roger Cooke, Heather Ross, and Adam Stern, “Precursor Analysis for Offshore Oil and Gas Drilling,” Resources for the Future Discussion Paper 10-61, January 2011, at http://www.rff.org).

called upon to deploy and manage containment activities are a necessary part of containment readiness. To illustrate this point, Box 1 shows the wide range of innovations, in addition to equipment, listed by BP as required in responding to the *DH* spill.

Box 1. Innovations Listed by BP as Required in Responding to the *Deepwater Horizon* Spill
(from *BP Deepwater Horizon Containment and Response: Harnessing Capabilities and Lessons Learned*, 1 September 2010, p. 69).

Equipment:	**Systems, processes, and procedures:**	**Organizational schemes:**
Open and closed containment	System integration tests	Near-source containment
Subsea hydraulic distribution and tools for remotely sensed vehicles	Diagnostic pressure measurements	Relief wells
Hydrate mitigation	Removal of damaged risers	Containment disposal
Acoustic telemetry	Closed-system construction	Branch office organization
Information technology	Redundant systems	Strategic Planning
Multipurpose vessels	4D planning	
Ranging technologies	Storyboarding	
Riser systems	Visualization tools for marine ops	
Subsea dispersant injection	Dynamic positioning	
Surveillance communications and data management	Relive well operations	
	Kill strategies	

Because incentives can be weak for investing in R&D to prepare for future containment, it may be that industry containment suppliers, while ready for spills similar to *DH*, may have less capacity to advance the state-of-the-art in containment to keep pace with ongoing innovation in drilling in the extreme operating environment of increasingly deep water. It also may be that R&D in containment is not part of the mission of these containment suppliers. If this is the case, then ascertaining who will be responsible for leading the next generation of containment research, prototyping, and testing is a fundamental question with keen policy importance. This doesn't mean that ongoing containment plans and systems won't have value, but it will likely mean that in the event of a new catastrophic spill, these plans will have to be adapted and updated on the fly—much as was necessary for the recent spill.

Recommendations

My colleagues and I suggest moving beyond this rearward focus and devoting resources toward a more comprehensive examination of future scenarios, particularly since future drilling efforts are expected to reach ever-increasing water depths. This recommendation is wholly aligned with experience in other technologies under this committee's purview, including space transportation, for instance. Much like the post-shuttle accidents, expert analysis and risk assessment, both by industry and by third parties, are needed. War gaming to test procedures and failure scenarios would inform this analysis and improve preparedness. Creation of a center of excellence specifically to carry out state-of-the-art research in deepwater and ultradeepwater containment, again with third-party involvement, would be a welcome development.

The recent history of spill response (clean-up) technology gives some reason for concern that industry efforts to prepare for the next spill may still fall short over the longer run. Regulatory requirements and industry resources for response were increased following the *Exxon Valdez* spill in 1989. The Marine Spill Response Corporation (MSRC) was created as an industry collaboration with many similarities to MWCC. But the Oil Spill Commission report found that despite claims by industry, the evidence suggests that little investment has gone into response and containment technologies. One of the staff papers published by the Commission finds that "despite industry claims that the oil industry committed significant funds to clean-up technology R&D in the years immediately following the Exxon Valdez spill…this commitment quickly waned. Industry funding for response R&D fell off after the mid-1990s. Today, oil companies invest 'little to no' money in oil spill response technology."[9] Private companies entered the business, but did not significantly expand response capability. The same series of events could occur in containment if the current focus is not translated into an ongoing commitment to innovation.

Part of this commitment must come from industry. Even if permit requirements ensure that the containment plans submitted to regulators are grounded in sound technology and practices, and capable of replicating the containment needs displayed during the *DH* spill, we lack assurance of continued investment in R&D to go beyond current capabilities—especially as we continue to drill into deeper waters. For example, a governance structure for MWCC that includes either public-interest board members or an external third-party expert panel and transparent disclosures

[9] See *Response/Clean-Up Technology Research & Development and the BP Deepwater Hoirzon Oil Spill*, Staff Working Paper No. 7, National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 11 January 2011, p. 3, at http://www.oilspillcommission.gov/sites/default/files/documents/Updated%20Response%20RD%20Working%20Paper.pdf (accessed 3 April 2011).

of expenditures might provide some assurance that R&D is adequately funded and containment technology keeps up with the latest drilling depths. Some direct or indirect government oversight and support of containment R&D may be warranted—for example, to encourage frontier academic research and its application—given the difficulty for any individual company to fully appropriate the returns to innovation. One route may be to link directly the recommendations of the new safety advisory committee with an existing energy research partnership that was established by the Energy Policy Act of 2005. [10]

Conclusions

Deepwater Horizon revealed a failure of spill containment. That failure was partly technological, but it was ultimately human. The MWCC, the Helix services, and updated permit requirements show recognition of this and are undoubtedly positive steps. But the opportunity created by momentary attention to containment should not be lost. Other measures are needed as well, including attention to incentives that are blunted by liability limits, consideration of a wide range of failure scenarios, use of third-party review, and commitment to ongoing innovation in spill containment to match the pace of innovation in drilling.

[10] This partnership is the Research Partnership to Secure Energy for America (RPSEA), a consortium of industry and academic experts. At present, the emphasis in RPSEA's mission statement, its annual draft plan for 2011, and current list of funded activities appears to be on new technology and engineering but not containment *per se* or related organizational and process design and risk assessment. Perhaps the mission and activities could be realigned to include a focus on containment R&D.