OFFSHORE DRILLING SAFETY AND RESPONSE TECHNOLOGIES

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

WEDNESDAY, APRIL 6, 2011

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Wednesday, April 6, 2011

OFFSHORE DRILLING SAFETY AND RESPONSE TECHNIQUES

WEDNESDAY, APRIL 6, 2011

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 2:47 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Andy Harris [Chairman of the Subcommittee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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Subcommittee on Energy and Environment

Offshore Drilling Safety and Response Technologies

Wednesday, April 6, 2011

2:00 p.m. – 4:00 p.m.

2318 Rayburn House office Building

Witnesses

Dr. Victor Der
Acting Assistant Secretary for Fossil Energy, Department of Energy

Mr. David Miller
Director, Standards, American Petroleum Institute

Mr. Owen Kratz,
President and CEO, Helix Energy Solutions Group

Dr. Molly Macauley
Research Director and Senior Fellow, Resources for the Future

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
Subcommittee on Energy and Environment

HEARING CHARTER

Offshore Drilling Safety and Response Technologies

Wednesday, April 6, 2011
2:00 p.m. to 4:00 p.m.
2318 Rayburn House Office Building

PURPOSE

On Wednesday, April 6, 2011 at 2:00 p.m. the House Science, Space, and Technology Subcommittee on Energy and Environment will hold a hearing to examine industry and Federal efforts to identify and address safety and response technology challenges since last year's *Deepwater Horizon* oil spill, and how Federal programs in these areas can best be structured and prioritized.

WITNESSES

- **Dr. Victor Der,** Acting Assistant Secretary for Fossil Energy, Department of Energy
- **Mr. David Miller**, Director, Standards, American Petroleum Institute
- **Mr. Owen Kratz**, President and CEO, Helix Energy Solutions Group
- **Dr. Molly Macauley,** Research Director and Senior Fellow, Resources for the Future

Overview

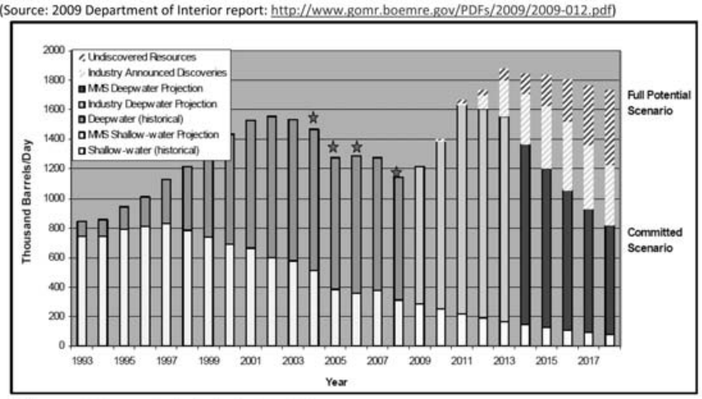
- According to DOE's Energy Information Administration (EIA), petroleum comprises 35 percent of total U.S. energy consumption, and supplies 94 percent of transportation sector needs.[1] In 2009, a little more than half of U.S. oil demand was met through imports; the rest was produced domestically at a rate of just over 5 million barrels per day. Since peaking in 1970, domestic production of oil steadily decreased for almost 40 years, until increasing 7 percent in 2009 due to a 35 percent increase in Federal waters off of the Gulf of Mexico.[2]

[1] http://www.eia.doe.gov/aer/pecss_diagram.html
[2] http://www.eia.doe.gov/kids/energy.cfm?page=oil_home#tab2

- In 2009, drilling operations in the Gulf of Mexico accounted for 1.6 million barrels per day (bpd), representing about 29 percent of total U.S. crude oil production and 11 percent of natural gas production.[3]

- Initially pursued in the early 1980s, oil and gas production from deepwater fields began to increase rapidly in the 1990s as shallow-water production declined and higher oil prices made expensive offshore projects viable (Figure 1).

Figure 1. Comparison of Shallow-water and Deepwater oil production trends in Gulf of Mexico. (Source: 2009 Department of Interior report: http://www.gomr.boemre.gov/PDFs/2009/2009-012.pdf)



★ Indicates years with known anomalous data due to hurricane affected shut-in

- According to the Department of Interior, by 2009, 80 percent of offshore oil production and 45 percent of natural gas production took place in "deepwater" (water depth of 1,000 feet or greater), and industry had drilled nearly 4,000 wells to those depths, as well as about 700 wells in "ultra-deep" water depths of 5,000 feet or greater.[4]

- Prior to the 2010 oil spill, the Federal government had foreseen most U.S. oil near-term production increases coming from deepwater fields in the Gulf. On May 27th, 2010, President Obama announced a six-month moratorium on all offshore deepwater drilling. The moratorium was lifted on October 12, 2010. As of March 30, 2011, eight permits have been issued.

[3] http://www.eia.doe.gov/special/gulf_of_mexico/index.cfm

[4] http://www.doi.gov/deepwaterhorizon/loader.cfm?csModule=security/getfile&PageID=33598

- At the time of the Deepwater Horizon accident there were 55 active rigs drilling in the Gulf of Mexico.[5] As of March 28, 2011, this figure had declined to 28 rigs. EIA is expecting production from the Federal Gulf of Mexico to fall by 240,000 barrels per day (bbl/d) in 2011 and by a further 200,000 bbl/d in 2012.[6]

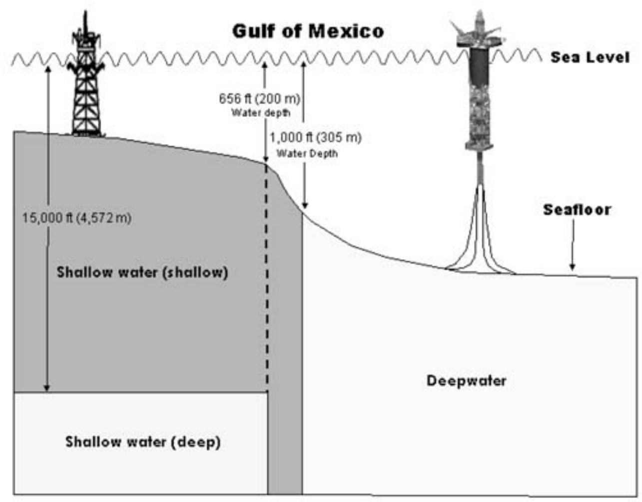
Overview of Deepwater Drilling Technology and Operations

A Congressional Research Service analysis of the Deepwater Horizon spill described deepwater drilling technology as follows (excerpt truncated)[7]:

> In comparison with near-shore oil and gas activities, deepwater and ultra-deepwater exploration and production require technologies that can withstand high pressures and low temperatures at the seafloor, and require the operator to control the process remotely from a surface vessel thousands of feet above the actual well.
>
> Drilling technologies built to withstand the harsher conditions in deep water and ultra-deep water are complicated, difficult to repair, and expensive. In addition, long lengths of pipe, or marine "riser," extending from the seafloor to the drill rig, are needed, requiring a large and complex surface platform to conduct operations through the longer pipe. One of the most common types of drilling platforms for deep water and ultra-deep water is a semisubmersible rig, which has an upper and lower hull. During the drilling operation, the lower hull is filled with water, partially submerging the rig but leaving the upper hull floating above the drill site. Transocean's *Deepwater Horizon* rig was a semisubmersible platform, kept in place above the drill site by a dynamic positioning system (i.e., not permanently anchored to the seafloor) and connected to the well by the marine riser (Figure 2).
>
> During drilling operations, the drill bit and drill pipe (or drill string) extend through the riser from the drill platform and through a subsea drilling template—essentially a large metal box embedded in the seafloor—into the marine sediments and rocks down to the hydrocarbon-bearing zone. A special fluid called drilling mud (a mixture of water, clay, barite, and other materials) is circulated down to the drill bit and back up to the drilling platform. The drilling mud, which has higher viscosity and density than water, serves several purposes: it lubricates the drill bit, helps convey rock cuttings from the drill bit back to the surface, and exerts a column of weight down the hole to control pressure against a possible blowout. A blowout can occur if the subterranean pressure encountered down the hole exceeds the pressure exerted by the weight of the drill assembly and drilling mud. The *Deepwater Horizon* rig experienced a blowout on April 20, 2010, and the role of the drilling fluid is under investigation.
>
> As a last line of defense against a blowout, a blowout preventer (BOP) is installed at the seafloor and connected to the marine riser. The BOP is essentially a system of valves designed to be closed in the event of anomalous wellbore pressure (such pressure is sometimes referred to as a "kick"). At the depth and pressures encountered by the *Deepwater Horizon* well, BOEMRE/MMS regulations require at least four such valves, or rams, which must be remote-controlled and hydraulically operated during offshore operations. During the *Deepwater Horizon* blowout, all of the rams on the BOP failed to close properly.

[5] http://investor.shareholder.com/bhi/rig_counts/rc_index.cfm
[6] http://www.eia.doe.gov/emeu/steo/pub/contents.html
[7] http://www.crs.gov/pages/Reports.aspx?PRODCODE=R41262&Source=search

Figure 2. Basic diagram illustrating differences between shallow water anchored and deepwater semi-submersible drilling rigs.
(Source: 2009 Department of Interior report: http://www.gomr.boemre.gov/PDFs/2009/2009-012.pdf)



Causes of the Deepwater Horizon Accident

Numerous investigations into the direct and indirect causes of the Deepwater Horizon accident have been undertaken and are ongoing. The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE)/U.S. Coast Guard (USCG) Joint Investigation Team (JIT), is conducting a comprehensive forensic examination into the causes of the spill. It is expected to release a report on the BOP within the next month, and a full investigation report in July.[8]

In January 2011, the President's *National Commission on the Deepwater Horizon Oil Spill and Offshore Drilling* released a detailed report exploring the facts and circumstances associated with the root causes of the spill. The report concluded that the disaster was caused by a confluence of factors, specifically finding that "The well blew out because a number of separate risk factors, oversights, and outright mistakes combined to overwhelm the safeguards meant to prevent just such an event from happening…[b]ut most of the mistakes and oversights at Macondo can be traced back to a single overarching failure--a failure of management."

[8] http://www.deepwaterinvestigation.com/go/site/3043/

Most recently, a report by the Norwegian firm Det Norske Veritas—commissioned by the Departments of Interior and Homeland Security—concluded that the ultimate cause of the spill was a piece of drill pipe that became trapped in the platform's blowout preventer.[9] Specifically, the report says the blind shear rams -- designed to cut through the well pipe and seal it -- failed to close completely and seal the well because of the trapped drill pipe.

Federal Activities to Advance Safe Drilling and Response Technologies

Department of Energy

For several decades, the Department of Energy's Fossil Energy Research and Development program has been tasked with supporting R&D to enable technological breakthroughs that lead to increased domestic energy production and deliver affordable, abundant energy to power the American economy. The technology areas pursued under this program include applied research and technology development to advance safe and responsible oil and gas exploration and production.

Within DOE's FER&D program, the Natural Gas Technologies Program and Petroleum and Oil Technologies Program are tasked with increasing access to domestic energy. Funding for the programs steadily declined in recent years and the Petroleum and Oil Technologies Program was zeroed out in FY 2010 (see table below).

Program	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY12 Request
Natural Gas Technologies	45.9	41.8	43.6	31.8	11.7	19.3	19.4	17.4	0
Petroleum – Oil Technologies	41	34.1	33	30.8	2.6	4.8	4.9	0	0

In addition to these discretionary programs, Section 999 of the Energy Policy Act of 2005 (EPACT) also authorized $50 million in annual mandatory spending (collected from oil and gas royalty revenues) for ultra-deepwater and unconventional natural gas R&D.

The goal of this program is to "maximize the value of natural gas and other petroleum resources of the United States by increasing resource supplies, reducing the cost and enhancing the efficiency of exploration and production, improving safety, and minimizing environmental impacts."[10]

Most of the program's funding (75%) is managed by a private consortium known as the Research Partnership to Secure Energy for America (RPSEA), is divided into three parts: ultra-deepwater architecture and technology (UDW); unconventional onshore natural gas and other resources; and technology challenges of small producers. The mission of the "ultra-deep" portion of this effort is to "identify and develop economically viable acceptable risk

[9] http://www.boemre.gov/ooc/press/2011/press0322c.htm
[10] http://www.fossil.energy.gov/programs/oilgas/ultra_and_unconventional/index.html

technologies, architectures, and methods for exploration, drilling, and production of hydrocarbons in formations under ultra-deepwater, or in the Outer Continental Shelf (OCS) in formations that are deeper than 15,000 feet."

The remaining 25 percent of program funding is managed by the National Energy Technology Laboratory (NETL), which conducts "in-house" R&D on drilling technology. For example, NETL has developed a prototype Ultradeep Drilling Simulator (UDS). The simulator permits researchers to replicate conditions found in wells with total vertical depths of 30,000 (almost three times the current depth of ultra-deepwater drilling), enabling study of how to best increase domestic energy production in an environmentally safe manner.[11]

Oil Pollution Act of 1990

Enacted in the wake of the Exxon Valdez spill, title VII of the Oil Pollution Act of 1990 authorized an interagency oil pollution program to conduct research, technology development, and demonstration for the prevention, response, and mitigation of oil pollution resulting from discharges.

The statute creates an Interagency Coordinating Committee (ICC) of 14 agencies and chaired by the Coast Guard. The ICC is tasked with developing a research and development plan to guide the program and identify gaps in current knowledge, research priorities and the resources needed to attain those priorities. The program is broken into three main research areas: innovative technology development, technology evaluation, and effects research.

The statute also authorizes demonstration projects, continues operation of the Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT) Research Center, requires the ICC to coordinate with States and universities to develop Regional Research programs, and provides authority to coordinate and cooperate with other nations to conduct oil pollution research, development, and demonstration activities, including controlled field tests of oil discharges. Title VII had a total authorization level of $28 million. Of that amount, $6 million was for the regional research programs.

Regulatory Changes

In response to the Deepwater Horizon incident, the Department of Interior has issued numerous regulatory changes. These rules were described in recent testimony by Bureau of Ocean Energy Management and Enforcement (BOEMRE) Director Michael Bromwich as follows[12]:

> We promulgated two new rules last fall that raise standards for the oil and gas industry's operations on the OCS. One of these rules strengthens requirements for safety equipment and drilling procedures; the other improves workplace safety by addressing the performance of personnel and systems on drilling rigs and production platforms.

[11] http://www.netl.doe.gov/publications/others/accomp_rpt/accomp09.pdf

[12] http://appropriations.house.gov/_files/031711BOEMREHouseAppropsTestimony.pdf

The Drilling Safety Rule, was an emergency rulemaking that put in place heightened new standards for well design, casing and cementing, pressure testing, and well control equipment, including blowout preventers. For the first time, operators are now required to obtain independent third-party inspection and certification of each stage of the proposed drilling process. In addition, an engineer must certify that blowout preventers meet new standards for testing and maintenance and are capable of severing the drill pipe under anticipated well pressures.

The second rule we implemented is the Workplace Safety Rule, operators now are required to develop a comprehensive safety and environmental management program that identifies the potential hazards and risk-reduction strategies for all phases of drilling and production activities, from well design and construction, to operation and maintenance, and finally to the decommissioning of platforms. Although many companies had developed such SEMS systems on a voluntary basis in the past, many had not.

In addition to the new rules, we have issued important guidance, in the form of Notices to Lessees (NTLs), which provides operators additional direction with respect to compliance with BOEMRE's existing regulations.

For example, NTL-06 (the Environmental NTL) requires that operators submit well-specific blowout scenarios and worst case discharge calculations – and that operators also provide the assumptions and calculations behind these scenarios. My staff and I are working closely with operators to ensure that they have the information necessary to perform their worst case discharge calculations accurately and in accordance with the guidance set forth in NTL-06.

Following the lifting of the suspension of deepwater drilling operations, we issued NTL-10, which provides operators with guidance related to regulatory compliance and subsea containment. First, each operator is directed to submit a corporate statement that it will conduct proposed drilling operations in compliance with all BOEMRE regulations, including the new Drilling Safety Rule.

Chairman HARRIS. The Subcommittee on Energy and Environment will come to order. Good afternoon. Welcome to today's hearing entitled, "Offshore Drilling Safety and Response Technologies." In front of you are packets containing the written testimony, biographies, and truth in testimony disclosures for today's witness panel.

Before we get started, though, this being the first meeting of the Energy and Environment Subcommittee for the 112th Congress, I would like to ask the Subcommittee's indulgence to introduce myself, welcome back returning Members, and introduce any new Members on our side of the dais. Afterwards I will recognize Mr. Miller to do the same.

It is an honor and pleasure for me to Chair the Energy and Environment Subcommittee for this Congress, and it is a position I don't take lightly. I want all Members of the Subcommittee to know that I will endeavor to serve all the Members fairly and impartially, and that I will work to serve the best interests of Congress and all Americans to ensure that the agencies and programs under our jurisdiction are worthy of the public support.

Although they are not here now, I would like to formally welcome back our returning Members Rohrabacher, Bartlett, Lucas, Biggert, Akin, Neugebauer, and Broun, and I would also like to welcome, when he arrives, our newest member, Chuck Fleischmann of Tennessee.

At this point I will recognize Mr. Miller for any—if you want to introduce or just mention your Members.

Mr. MILLER OF NORTH CAROLINA. I can do it in my opening statement.

Chairman HARRIS. Okay. Thank you. I will recognize myself for five minutes for an opening statement.

The title of today's hearing is, "Offshore Drilling Safety and Response Technologies." The context under which we review the issue is framed by complex and interrelated environmental, economic, and even geopolitical policy concerns. Looming large, of course, is the Deep Water Horizon oil spill of which we are still assessing its root causes and environmental impacts even as we approach the one-year anniversary of the disaster.

Meanwhile, American families are being hit hard at the gas pump due to multiple market factors; headlined, though, by tight supplies, rising global demand for oil, growing political instability in North Africa and the Middle East, and decreasing American production. The current national average price for a gallon of gas is over $3.60, the highest ever for this time of the year. This, of course, effectively amounts to a tax increase on our consumers and families and a drag on our economic recovery.

Accordingly, I believe we must attack the energy problem from every angle we can and expanding domestic oil and natural gas supply and production absolutely must be part of this equation. Offshore drilling holds incredible promise to help deliver on this goal. The Federal Government currently estimates the U.S. Outer Continental Shelf holds 85 billion barrels of technically-recoverable oil at this point, over half of which is in the Gulf of Mexico and 400 trillion cubic feet of natural gas.

We must pursue exploration and production of these valuable resources, but we all realize on both sides of the aisle that we must do it safely and be prepared with effective well containment and response if and when an accident should occur.

To this end, through this hearing we aim to examine the status of safety-related drilling and response technologies and standards with an emphasis on progress made since last year's accident. We also want to hear how best we should structure and prioritize federal programs in these areas, particularly those of the Department of Energy but also interagency response efforts authorized by the Oil Pollution Act of 1990.

Look. We all know it is impossible to completely and positively eliminate risks associated with complex endeavors such as deep water drilling, but we must continuously work to reduce risks and to manage them in a way that allows our economy and American consumers to benefit from our vast supply of domestic offshore oil and gas resources.

I yield back the balance of my time and now recognize Ranking Member Miller for his opening statement.

[The prepared statement of Mr. Harris follows:]

PREPARED STATEMENT OF CHAIRMAN ANDY HARRIS

The title of today's hearing is Offshore Drilling Safety and Response Technologies. The context under which we review this issue is framed by complex and interrelated environmental, economic, and even geopolitical policy concerns. Looming large of course is the Deepwater Horizon oil spill, of which we are still assessing its root causes and environmental impacts as we approach the one year anniversary of the disaster. Meanwhile, American families are being hit hard at the gas pump due to multiple market factors headlined by tight supplies, rising global demand for oil, growing political instability in North Africa and the Middle East, and decreasing American production.

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We all know it is impossible to completely eliminate risks associated with complex endeavors such as deepwater drilling, but we must continually work to reduce risks and to manage them in a way that allows our economy and American consumers to benefit from our vast supply of domestic offshore oil and gas resources.

Mr. MILLER OF NORTH CAROLINA. Thank you, Chairman Harris, and on this side we also have very conscientious Members, none of whom are here. We have seasoned Members as well as Members with expertise in the subject matter of the Subcommittee. In addition to me, Eddie Bernice Johnson, the Full Committee Ranking Member, we have Ms. Woolsey, Ms. Lofgren, and Mr. McNerney, all Californians with—and well-known champions of– a clean energy future. Mr. Lujan represents Los Alamos National Lab, and brings his expertise on federal research and technology development to this Subcommittee, and Mr. Tonko draws upon his experience as the CEO of the New York State Energy Research and Development Authority.

Like you, Mr. Harris, we will take the jurisdiction of this Committee very seriously and will always look for ways to push our federal research agencies to be much more effective and efficient drivers of innovation and economic growth. Our job is to know the agency's capability, know what the public needs, and create a credible and strong record on government performance in meeting those needs. Where the agencies succeed, we will support them, and where they fall short, we will take corrective measures and ultimately we may support redirecting resources.

Today, however, we are here to discuss the progress that industry has made in meeting the public's needs for safety and responsible oil and gas drilling. Just as we hold our agencies accountable, we must also hold industries accountable and expect them to acknowledge the tremendous risks, the tremendous danger inherent in the services they provide, and the work they do.

Before the explosion that killed 11 men, sank the Deep Water Horizon drilling rig, and generated the ensuing oil spill that lasted for nearly three months, offshore drilling was not at the center of public attention. As is often the case with energy matters outside of the public policy world, the availability of oil was largely taken for granted, and the environmental risks were not widely known to the general public.

All that changed on April 20 when we got a violent and lasting reminder of how dangerous our need for oil has become. As the world's largest oil consumer but with less than eight percent of technically recoverable global resources and far less than that of economically-recoverable global reserves, our reliance on oil has driven domestic production to ever-deeper waters in search of more productive fields.

Chairman Hall has taught us over the years both as a Republican and as a Democrat that this is no small feat of engineering. Those companies have pushed the boundaries of technological innovation in finding and extracting oil under nearly impossible conditions.

But by almost all accounts in the race to deeper waters, the industry's investment in advancing environmental safety has not kept up with those increasingly dangerous conditions. To anyone that disputes that I ask you to tell me how an explosion killed 11 men and sank one of the most technologically-advanced drilling rigs in the world. Why did it take three months of failed attempts by a NASA team of government and industry experts to stop the oil gushing from the disabled blowout preventer thousands of feet beneath the surface, creating one of the largest and most expensive environmental disasters in U.S. history? It was because nobody was prepared.

President Obama has acknowledged that. He suspended new deep water drilling permits in the Gulf until new safety measures could be drawn up, and industry could give some assurance that they would be prepared if that should happen again. It would have been reckless not to do so.

I imagine that we will hear today a good deal of misplaced blame. We will hear from some Members, perhaps from a Member, that the President is to blame for not being more diligent in overseeing the industry's drilling practices, that the President did not do enough to help the oil industry and gas industry develop new technologies, that the President was not quick enough or prepared enough to respond to the unthinkable disaster unfolding, and that the President's timeout on the deep water drilling has been a catastrophe for the industry.

But from those Members we perhaps will not hear as much about the industry's culpability. We won't hear how the owner of Deepwater Horizon, Transocean, gave executive bonuses last year for their exemplary safety record. We won't hear how the most profitable industry in the history of the world did not see fit to invest resources in assuring that disasters like the Deepwater Horizon do not happen or that it could be cleaned up if it did. Most important, we won't hear today the truth about oil and gas production under President Obama.

We won't hear that production actually continued in the Gulf during the temporary drilling suspension, that 39 shallow water permits were granted since October, that eight new deep water permits have been granted in just the last month and a half. We won't hear that in 2010, outer continental shelf oil production increased by 30 percent, that domestic oil production is at its highest level in ten years and natural gas is at its highest ever.

I do look forward to the witnesses' testimony today. I acknowledge that the industry has made advances in safety in the last year, but it is not enough. We owe it to the public to hold this industry's feet to the fire and assure that there is relentless innovation in worker safety and environmental protection in the oil and gas industry.

Thank you, Chairman Harris.

[The prepared statement of Mr. Miller of North Carolina follows:]

PREPARED STATEMENT OF RANKING MEMBER BRAD MILLER

Thank you, Chairman Harris.

On this side of the aisle the Energy & Environment Subcommittee is also stocked with seasoned professionals. In addition to me and the full Committee Ranking Member, Eddie Bernice Johnson, we have Ms. Woolsey, Ms. Lofgren and Mr. McNerney, all Californians and well-known champions of a clean energy future. Mr. Lujan, representing Los Alamos National Lab, brings his expertise on federal research and technology development to the Subcommittee. Finally, Mr. Tonko draws upon his experience as the CEO of the New York State Energy Research and Development Authority.

Like you, Mr. Harris, I can assure the public that we take the jurisdiction of this Committee very seriously, and will always look for ways to push our federal research agencies to be more effective and efficient drivers of innovation and economic growth. Our job is to know the agencies' capabilities, know what the public needs, and build a credible and strong record on government's performance in meeting those needs. Where the agencies succeed, we will support them. Where they fall short, we will take corrective measures and ultimately may decide to redirect resources.

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As the world's largest oil consumer, but with less than 8% of technically- recoverable global reserves, our reliance on oil has driven domestic production to ever deeper waters in search of more productive fields. As Chairman Hall has taught us over the years, this is no small feat of engineering. These companies have pushed the boundaries of technological innovation in finding and extracting oil under nearly impossible conditions.

By almost all accounts, in the race to deeper waters the industry's investment in advancing worker and environmental safety has not kept up with these increasingly dangerous conditions.

To anyone that disputes that, I ask you to tell me how an explosion killed eleven men and sank one of the most technologically advanced drilling rigs in the world? Why did it take three months of failed attempts by a massive team of government and industry experts to stop the oil gushing from the disabled blowout preventer thousands of feet below the surface, creating one of the largest and most expensive environmental disasters in U.S. history? It is because nobody was prepared.

Acknowledging this, President Obama suspended new deepwater drilling permits in the Gulf until new safety measures could be drawn up and industry could give some assurance that they would be prepared when this happens again. It would have been reckless not to do so.

I imagine that what we will hear today is misplaced blame. We may hear from some Members that the President is to blame for not being more diligent in overseeing the industry's drilling safety practices; that the President did not do enough to help the oil and gas industry develop new technologies; that the President was not quick or prepared enough to respond to the unthinkable disaster unfolding at the Macondo well; and that the President's time-out on deepwater drilling in the Gulf has been a catastrophe for the industry.

We won't hear much from these Members about industry culpability. We won't hear how the owner of the Deepwater Horizon, Transocean, gave executives bonuses for their "exemplary" safety record last year. We won't hear how the most profitable industry in the history of the world did not see fit to invest resources in assuring that disasters like the Deepwater Horizon do not happen, or that it could be cleaned up if it did.

Most important, in this hearing we won't hear the truth about oil and gas production under President Obama. We won't hear that production actually continued in the Gulf during the temporary drilling suspension, that 39 shallow water permits were granted since October, or that eight new deepwater permits have been granted in the last month and a half. We won't hear that in 2010, Outer Continental Shelf oil production increased by 30%, that domestic oil production is at its highest levels in ten years, and natural gas is at its highest ever.

I look forward to the witness' testimony today. I acknowledge the industry's advances in safety in the last year. But it is not enough. We owe it to the public to hold this industry's feet to the fire, and ensure that there is relentless innovation in worker safety and environmental protection in the oil and gas industry.

Thank you, Chairman Harris.

Chairman HARRIS. Thank you very much, Mr. Miller. I know we are joined by the gentlelady from California, and if you would like to submit additional opening statements, your statement would be added to the record at this point, and if other Members arrive, I will make the same offer.

Ms. WOOLSEY. That is fine, Mr. Chairman.

Chairman HARRIS. Thank you. At this time I would like to introduce our witness panel. Dr. Victor Der is Acting Assistant Secretary for Fossil Energy. Dr. Der also serves as Principal Deputy Assistant Secretary for Fossil Energy where he provides strategic direction and guidance for the program's daily activities as well as its long-term goals and objectives. Prior to that position he was Deputy Assistant Secretary for Clean Coal. He holds a Ph.D. in mechanical engineering and has worked at DOE for 37 years.

Mr. David Miller is the Director of the Standards Program for American Petroleum Institute. He is also Chairman of the American National Standards Institute International Policy Committee, and a member of the Offshore Technology Conference Board of Directors. He was elected a fellow of the American Society of Civil Engineers in 2006.

Mr. Owen Kratz is President and Chief Executive Officer of Helix Energy Solutions Group, Incorporated. He joined Cal Dive International, now known as Helix, in 1984, and held various offshore positions before serving in a number of management positions before becoming CEO in April of 1997.

And last, Dr. Molly Macauley is Research Director and Senior Fellow at Resources for the Future. Dr. Macauley's research emphasizes new technology and its application to natural and environmental resources. She serves on several national-level committees and panels, including the National Research Council's Space Studies Board, the NASA Earth Science Applications Advisory Committee, and NOAA's Climate Working Group. She has a Ph.D. in economics from Johns Hopkins University. I know that place. And also served there as an adjunct professor of economics.

Now as our witnesses should know, spoken testimony is limited to five minutes each, after which the Members of the Committee will have five minutes each to ask questions. Right up front I apologize that we are starting late. You know, we held a series of votes. I am going to apologize to you because your time is valuable.

Now I would like to recognize our first witness, Dr. Victor Der, the Acting Assistant Secretary for Fossil Energy at the Department of Energy. Doctor.

STATEMENTS OF DR. VICTOR DER, ACTING ASSISTANT SECRETARY FOR FOSSIL ENERGY, DEPARTMENT OF ENERGY

Dr. DER. Good afternoon, Chairman Harris, Ranking Member Miller, and Members of the Committee. As Acting Assistant Secretary for Fossil Energy I appreciate the opportunity to present the Department of Energy's perspective on improving offshore drilling safety and response technologies. Before I delve into my statement I want to take a moment to recognize and remember the 11 men that died almost a year ago while working on the Deep Water Horizon. As we approach the one-year anniversary of that tragedy in the Gulf, we know that there are important challenges we must meet in order to ensure that we never again see such a calamity on the human, ecological, and economic scales.

Turning back to my statement, natural gas and crude oil provide more than 60 percent of our Nation's primary energy needs. Last week the President outlined a blueprint for a clean energy future, and to reduce our dependency on oil we must develop and deploy new options like advanced biofuels, vehicle electrification, and improve vehicle efficiency.

In the meantime, petroleum and natural gas will continue to play an important role in our economy for at least the next several decades. As both the Chairman and the President have said, we have domestic oil and gas resources here that we can use, and we will. In fact, last year American oil production reached its highest level since 2003.

But in the wake of last year's spill the President has made it clear that we must tap into these resources safely and responsibly. As this Committee knows, the Department of the Interior is the agency with the regulatory authority over the oil and gas industries' offshore drilling activities. The Department of Energy can work with other federal agencies and industry partners to ensure that new technologies improve the ability to drill in ever-deeper waters with greater margins of safety, reduce the risk of spills, and provide improved mitigation should a spill occur.

To help meet rising demand, producers are looking to identify and tap new oil and natural gas sources, including many in areas that are increasingly difficult to locate and produce such as deepwater locations. Offshore oil now accounts for about one third of our domestic fuel production, and 80 percent of this production comes from the Gulf of Mexico deepwater sites. Deepwater's contribution to domestic oil and natural gas supplies is expected to increase in the years ahead. That contribution must be accompanied by ongoing technology solutions to production safety and environmental challenges which will need to be developed and deployed.

As the Nation's largest funder of R&D in the physical sciences, DOE has long had a role in oil and gas technology development.

Again, as I noted above, DOE has no regulatory role over the oil and gas industry, which is primarily the purview of the Bureau of Ocean Energy Management, Regulation, and Enforcement at the Department of the Interior, as well as the National Oceanic Atmospheric Administration and the Coast Guard.

The DOE's responsibilities regarding deepwater research are outlined in Section 999 of the Energy Policy Act of 2005, which established the Ultra Deepwater and Unconventional Natural Gas and Other Petroleum Research Program. Until last year, DOE's activities under the deepwater portion of Section 999 were focused primarily on exploration and production-related technologies, which we believe is more appropriately funded by industry. DOE has since refocused the work under Section 999 on safety and environmental protection associated with production.

Consistent with budget requests since fiscal year 2007, the President's fiscal year 2012 budget proposes repeal of the Ultra Deepwater and Natural Gas and Other Petroleum Research Fund established as part of the Section 999A program. In the absence of this program, this important work can be carried out through investments from the private sector in coordination with the Ocean Energy Safety Advisory Committee.

In the wake of the Deepwater Horizon accident, industry developed new technologies to contain underwater blowouts. However, additional work remains to ensure that deepwater resource development is safe and environmentally sound. The Administration believes that it is appropriate for industry to assume the funding of these activities, and DOE stands ready to provide technical expertise and assistance through both the Office of Fossil Energy and our participation on the Advisory Committee in order to integrate enhanced safety and environmental capabilities into deep water production technologies.

In conclusion, Mr. Chairman, deepwater oil and gas will be crucial to meeting the demand as we continue to transition to a more sustainable energy feature. At the same time, last year's tragic oil spill serves as a stark reminder of the risks associated with deepwater drilling. As improved extraction technologies are developed and implemented, so, too must be approaches for addressing potential risks, safety issues, and environmental impacts.

With that, Mr. Chairman, I respectfully request that my written statement be included in the official record of these proceedings, and I will be happy to answer any questions that you and the other Members of the Committee may have. Thank you.

[The prepared statement of Dr. Der follows:]

PREPARED STATEMENT BY DR. VICTOR K. DER, ACTING ASSISTANT SECRETARY FOR FOSSIL ENERGY, U.S. DEPARTMENT OF ENERGY

Chairman Harris, Ranking Member Miller, and Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss the Department of Energy's (DOE) perspective on research and development (R&D) to improve oil and gas drilling in ever-deeper waters with greater margins of safety, reduced risk of spills, and better mitigation approaches should there be a spill.

As you know, the Office of Fossil Energy (FE) leads DOE's efforts to ensure that we use our hydrocarbon resources—coal, oil, and natural gas—for clean, affordable, and reliable energy. A key part of fulfilling this mission is a commitment to cutting-edge R&D across fossil energy technologies. In discharging this responsibility, we have conducted significant R&D over the years to advance technology development related to oil and natural gas supply and production, unconventional fossil energy, and deepwater resources.

In terms of going forward in the deepwater area, we must do everything possible to ensure that we never again face an environmental disaster of the magnitude as last year's Gulf of Mexico oil well spill, which not only tragically claimed 11 lives, but also caused extensive economic and ecological damage.

We at the Department of Energy (DOE) recognize that improving deepwater oil and gas technology is a challenge; but one that also provides a major opportunity. The Federal Government's responsibility is to rigorously regulate the oil and gas industry's deepwater activities, appropriately quantify risks in offshore development, and maximize the capability and resources to prevent and mitigate damages of future offshore events should they occur. As this Committee knows, the Department of the Interior is the agency with regulatory authority over the oil and gas industry's offshore drilling activities.

Today, I will offer some DOE perspectives on the continuing importance of deepwater resources, the challenges that lie ahead, the role of DOE and our Federal and industry partners in moving forward, and current R&D activities.

Moving Toward a Sustainable Future

The Obama Administration has made a strong commitment to move our Nation toward a clean energy future, which includes reducing reliance on oil and other fossil fuels, while developing new sources and technologies related to renewable energy. As we make this transition, however, oil and natural gas will continue to play a key role in our economy for many years, particularly in the transportation sector. Currently, oil and natural gas provide more than 60 percent of our Nation's energy needs, and over 95 percent of the fuel that Americans use for transportation.

According to the U.S. Energy Information Administration (EIA), the United States uses slightly more than 19 million barrels of liquid fuels every day, about 22 percent of the world's total; this total is projected to increase to nearly 22 million barrels by 2035 (*Annual Energy Outlook 2011 Early Release*). In 2010, U.S. domestic crude production rose by 150,000 barrels per day to 5.51 million barrels per day (MB/D) (STEO, March 8, 2011), the highest level since 2003. Looking longer range, EIA projects that U.S. domestic crude oil production will continue to increase to 5.7 million barrels by 2035. Production increases are anticipated to come from onshore enhanced oil recovery projects, shale oil plays, and deepwater drilling in the Gulf of Mexico. They also project that U.S. dependence on imported liquid fuels to continue declining over the projection period. This trend is in keeping with President Obama's comments at a March 11, 2011, news conference that, "First, we need to continue to boost domestic production of oil and gas." However, as the President has said, we cannot drill our way out of this problem, which is why the Administration has outlined a blueprint that includes measures to reduce our consumption.

Globally, EIA projects the world's use of oil and other liquid fuels to grow from 86.3 million barrels per day in 2007 to 110.8 million barrels per day in 2035. Global natural gas consumption is forecasted to increase from 108 trillion cubic feet per year to 156 trillion cubic feet per year over the same period.

In this environment of increasing demand, the world's producers are continuously endeavoring to identify and produce new sources of oil and natural gas to replace the volumes which are being consumed by the world's economies. While significant reserves remain, many of these are in geologic formations that are increasingly difficult to locate and produce, including deepwater locations.

Increasing Role of Deepwater Production

In recent years, the oil and gas industry has been discovering and producing in increasingly deeperwater. In the Gulf of Mexico there have been 13 major discoveries in deepwater areas over the past five years alone. Offshore oil now accounts for about one-third of our domestic field production, and some 80 percent of this comes from Gulf of Mexico deepwater locations. [1]

Internationally, 60 percent of the largest non-U.S. discoveries have been offshore, and 73 percent of offshore discoveries have been in deepwater (400 meters or deeper). Since 2007, over 70 percent by3 volume of major discoveries have occurred in deepwater, with the outliers being onshore discoveries in Iran and Iraq. [2]

The deepwater contribution to domestic oil and natural gas supplies is expected to increase in theyears ahead. A key underlying assumption, however, is that ongoing technology solutions to production safety and environmental challenges will be developed and deployed. The industry, both domestically and globally, is exploring in deeper water, which means we mustrecognize two key points:

1) We can no longer rely on inexpensive supplies of oil that can be produced from shallow waterregions and;

2) The technology used to extract these deepwater resources must be much safer and more reliable than they have been in the past. This is consistent with the Administration's determination that, prior to drilling activity, deepwater operating practices must be consistent with new heightened safety measures, including development of worst case disaster projections and demonstration of capabilities to respond to an oil spill.

DOE's Role and Perspective

The Department of Energy has long had a role in technology development for the oil and natural gas sectors. Over decades, the Department has amassed a depth of knowledge and expertise in such areas as fluid flow, imaging, fire science, and subsea systems. The focus of DOE's past R&D efforts was on reducing the cost of technologies that increase production—an area of research more appropriately funded by industry. However, a smaller portion of DOE's research addressed improvements to environmental and safety technologies.

While the Department has historically conducted fundamental and applied research to develop and improve deepwater environmental and safety technologies, it has no regulatory role over the industry. With regard to permitting and regulatory issues generally, offshore oil and gas drilling is wholly within the purview of the Department of the Interior (DOI), although activities conducted on the Outer Continental Shelf also require permits from other agencies, such as the National Oceanic and Atmospheric Administration and the Unites States Coast Guard.

The Administration has taken steps to improve its capabilities to conduct environmental and safety related research to support our regulatory responsibility. Specifically, the DOI led Ocean Energy Safety Advisory Committee (OESAC), which includes representatives from government, industry, and academia, is tasked with identifying, prioritizing and recommending research and development projects in the areas of drilling and workplace safety, containment, and oil spill response; recommending an allocation of available resources to these projects as appropriate; and providing a venue for representatives from industry, government, non-governmental organizations, national laboratories, and the academic community to exchange information and ideas, share best practices, and develop cross-organizational expertise.

The Energy Policy Act of 2005 (EPACT) established a mandatory program, the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research

[1] Source: Energy Information Administration:http://www.eia.doe.gov/oil—gas/natural—gas/data—publications/crude—oil—natural—gas—reserves/cr.html.

[2] Source: Chakhmakhchev & Rushworth, IHS, May 2010

Program, funded with $50 million each year of diverted Federal oil and gas lease revenues that would otherwise be deposited in the Treasury to offset government-wide expenses. In the past, the Department used the deepwater portion allocated under Section 999A of EPACT 2005 for reservoir characterization, drilling and completion, seafloor facilities, and other exploration and production related technologies.

As has been requested since Fiscal Year (FY) 2007, the President's FY 2012 Budget proposes repeal of the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund which was established as part of the Section 999A program. We also are requesting no discretionary funding for R&D to increase hydrocarbon production in the belief that these activities are more appropriately funded by industry. Absent congressional action to repeal this program, DOE is refocusing the work done under Section 999A of EPACT on safety and environmental protection with the funding we continue to receive. While the administration does not support Section 999A funding, it considers OESAC to be an important mechanism to guide research to improve the safety and environmental responsibility of offshore oil and gas operations.

Industry has had success in innovating new technologies to find, develop, and commercialize oil and gas in deepwater locations. And, in the wake of the Deepwater Horizon accident and ensuing Gulf of Mexico oil spill, industry developed new technologies for the containment of underwater blowouts. Additional work remains to be done to ensure that this development is conducted with sufficient protections for workers and the environment, and to ensure that the communities that rely on our ocean resources continue to thrive. The Administration believes that it is appropriate for industry to integrate enhanced safety and environmental capabilities into the advances in production technologies for deepwater areas.

Summary

The tragic oil spill in the Gulf of Mexico last year is a stark reminder of the risks associated with operating in the deepwater. Even as we continue the transition to a more sustainable energy future, deepwater oil and natural gas will be used to meet a significant portion of our energy needs in the near future. As technologies for improving the production and economic aspects of this extraction process are developed, so too must be approaches for identifying, quantifying, and solving potential risks, safety issues, and environmental impacts.

Mr. Chairman, and Members of the Committee, thank you again for the invitation to testify today. I look forward to answering any questions that you may have.

Chairman HARRIS. Thank you very much, Dr. Der, and now I recognize our second witness, Dr. David Miller, the Director, Standards, at the American Petroleum Institute.

Mr. Miller.

STATEMENT OF MR. DAVID MILLER, DIRECTOR, STANDARDS, AMERICAN PETROLEUM INSTITUTE

Mr. MILLER. Good afternoon, Chairman Harris, Ranking Member Miller, and Members of the Subcommittee. Thank you for the opportunity to address offshore drilling safety and response technology. My name is David Miller. I am the Standards Director for the American Petroleum Institute or API.

API has more than 470 member companies that represent all sectors of America's oil and natural gas industry. Our industry supports 9.2 million American jobs, including 170,000 in the Gulf of Mexico related to the offshore development business and provides most of the energy America needs.

First, even though it has almost been a year since the tragic accident in the Gulf, it is important that we remember the families who lost loved ones, the workers who were injured, and all of our neighbors in the Gulf who were affected by it. Their losses were profound, and they remind us every single day that the work we do to improve safety in our operations is extremely important.

Our industry's top priority is to provide energy in a safe, technologically-sound, and environmentally-responsible manner. We, therefore, take seriously our responsibility to work in cooperation with government to develop practices and equipment that improve operational and regulatory processes across the board.

As further proof of our commitment, API has been the leader for nearly nine decades in developing voluntary industry standards that promote reliability and safety through proven engineering practices. API's standard program is accredited by the American National Standards Institute, ANSI, the authority on U.S. standards and the same organization that accredits programs at several national laboratories. API standards are developed through a collaborative effort with industry experts, as well as the best and brightest technical experts from government, academia, and other stakeholders.

API's Standards Program undergoes regular third-party program audits. API maintains more than 600 standards that cover all aspects of the industry, including 270 focused on exploration and production. The committees that develop and maintain these standards represent API's largest program with 4,800 volunteers working on 380 committees and task groups.

API's standards are frequently referenced in federal regulations because they are recognized to be industry best practices. Overall, nearly 100 API standards are referenced in more than 270 citations by government agencies, including the U.S. EPA, the Department of Transportation, OSHA, and in addition 80 standards referenced by BOEMRE, and as part of our commitment to program transparency, last year API made the decision to provide all of our safety and incorporated by reference standards available for free online.

We are using the incident investigation findings to continue to improve the technologies and practices to achieve safe and environmentally-sound operations. As part of this process we are working to develop new API standards and revisions of existing API standards when necessary to raise the bar of performance to a higher level.

We have already published a new standard on isolating potential flow zones during well construction, which has been incorporated by BOEMRE into its offshore regulations. We plan to complete work later this year on two new API standards; one on deep water well design and one on well construction interface. We are working also to update the API standards on blowout preventer design, manufacture, and operations.

In addition, API's Board of Directors just last month approved the formation of a Center for Offshore Safety with the mission to promote the highest level of safety for offshore operations through an effective program that addresses management practices, communication, and teamwork. This program's foundation will be API's recommended practice on safety and environmental management programs, the API standard most recently cited by BOEMRE.

Regarding permitting delays, the recently-lifted moratorium and subsequent safety regulations led to some confusion and concern in the industry. For example, the Interim Final Drilling Safety Rule published in October of last year contained text that summarily changed all 14,000 “should” statements to “must” requirements in the 80 referenced API standards.

And while DOI did provide a clarification, it wasn’t until just last week. In the meantime, industry felt it had no choice but to consider how it could possibly be in compliance with the requirements that were often contradictory and potentially unsafe. This uncertainty has added unnecessary delay in developing exploration and production plans and applications for permits to drill as industry was forced to consider the requirement to request up to 14,000 departures simply to be in compliance with the standards that its and the government’s technical experts had developed.

In fact, API provides extensive comments to DOI as part of its White House mandated regulatory review. One of my items of significant importance is compliance with the Outer Continental Shelf Land’s Act amendments of 1978, in which Congress declared that the Outer Continental Shelf is a vital national resource reserve held by the Federal Government for the public, which made available for expeditious and orderly development subject to environmental safeguards in a manner which is consistent with the maintenance of competition and other national needs.

By statute, the leasee is entitled to a timely and fair consideration of submitted plan and permit requests, and exploration plans and applications permits for drill must be acted upon within 30 days of submittal. DOI should work to meet the statutory requirement.

Permitting delays in the moratorium have already led to the loss of 300,000 barrels a day in oil production since May of 2010, according to EIA short-term energy outlook, and the job loss is no less disturbing. Dr. Joseph Mason, of Louisiana State University, who recently testified before the House Subcommittee on Energy and Power, noted in a follow-up interview that, “We are already, however, pushing above the Administration’s estimate of 20,000 jobs nationally for the deep water de facto and de jure moratoria.”

We look forward to providing constructive input as this Committee, the Congress, and the Administration consider changes to existing policy. Industry is ready to work, return to work, Mr. Chairman and Ranking Member, and seeks clarity and certainty in the permitting process.

This concludes my statement. I welcome any questions from you and your colleagues. Thank you.

[The prepared statement of Mr. Miller follows:]

PREPARED STATEMENT OF MR. DAVID MILLER, STANDARDS DIRECTOR, AMERICAN PETROLEUM INSTITUTE

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As further proof of our commitment, API has been the leader for nearly nine decades in developing voluntary industry standards that promote reliability and safety through proven engineering practices. API's Standards Program is accredited by the American National Standards Institute (ANSI), the authority on

U.S. standards, and the same organization that accredits programs at several national laboratories. API's standards are developed through a collaborative effort with industry experts, as well as the best and brightest technical experts from government, academia and other stakeholders. API undergoes regular third-party program audits to ensure compliance with ANSI's Essential Requirements for standards development.

API maintains more than 600 standards—recommended practices, specifications, codes, technical publications, reports and studies—that cover all aspects of the industry, including 270 focused on exploration and production activities. The standards are normally reviewed every five years to ensure they remain current, but some are reviewed more frequently, based on need. The committees that develop and maintain these standards represent API's largest program, with 4,800 volunteers working on 380 committees and task groups. API corporate membership is not a requirement to serve API's technical standards committees.

API's standards are frequently referenced in federal regulations because they are recognized to be industry best practices. BOEMRE, for example, currently references 80 API standards in its offshore regulations and has recently proposed an additional 12 API standards be incorporated into their regulations. Overall, nearly 100 API standards are referenced in more than 270 citations by government agencies, including the USEPA, the Department of Transportation and OSHA, in addition to BOEMRE. And, as part of our commitment to program transparency, last year API made the decision to provide all of our safety and incorporated-by-reference standards available for free on-line. One-hundred sixty API standards are now posted on API's website and have been viewed by close to 5,000 individuals since last fall.

We are using incident investigation findings to continue to improve the technologies and practices to achieve safe and environmentally sound operations. As part of this process, we are working to develop new API standards and revisions of existing API standards, where necessary. to raise the bar of performance to a higher level. We have already published a new standard on isolating potential flow zones during well construction, which has been incorporated by BOEMRE into its offshore regulations. We plan to complete work later this year on two new API standards—one on deepwater well design and one on well construction interface, which will provide a systematic way for the offshore operator and the drilling contractor to ensure that their respective safety programs are fully aligned. We are also working to update the API standards on blow-out preventer design, manufacture and operations.

In addition, API's Board of Directors just last month approved the formation of the industry Center for Offshore Safety, with the mission to promote the highest level of safety for offshore operations through an effective program that addresses management practices, communication, and teamwork. This program's foundation will be API's recommended practice on safety and environmental management programs, the API standard most recently cited by BOEMRE.

Regarding permitting delays, the recently lifted moratorium and subsequent safety regulations led to some confusion and concern in the industry. For example, the interim final drilling safety rule, published in October of last year, contained text that summarily changed all 14,000 "should" statements to "must" requirements in the 80 referenced API standards. This action vitiated the standards development process by ignoring the recommendations of the some 4,800 technical experts who labored over the years to develop performance-based standards that allow for a variety of options to ensure the most appropriate engineering choice is made. And while DOI did provide a clarification, it wasn't until just last week. In the meantime, industry felt it had no choice but to consider how it could possibly be in compliance with requirements that were often contradictory and potentially unsafe. This uncertainty has added unnecessary delay in developing exploration plans and application for permits to drill as industry was forced to consider the requirement to request up to 14,000 departures simply to be in compliance with the standards that its and the government technical experts had developed.

In fact, API provided extensive comments to DOI as part of its White House-mandated regulatory review. One item of significant import is compliance with the Outer Continental Shelf Lands Act Amendments of 1978, in which Congress declared that "the outer Continental Shelf is a vital national resource reserve held by the Federal Government for the public, which should be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs." By statute, the lessee is entitled to timely and fair consideration of submitted plan and permit requests, and exploration plans and application for permits to drill must be acted upon within 30 calendar days of submittal. DOI should work to meet this statuary requirement.

Permitting delays and the moratorium have already led to a loss of 300,000 barrels a day in oil production since May 2010, according to the EIA's Short Term Energy Outlook, and the jobs loss is no less disturbing. Dr. Joseph Mason of Louisiana State University, who recently testified before the House Subcommittee on Energy and Power noted in a follow-up interview that:

"We are already, however, pushing above the administration's estimate of 20,000 jobs nationally for the deepwater de facto and de jure moratoria."

We look forward to providing constructive input as this Committee, the Congress and the administration consider changes to existing policy. The industry is ready to return to work, Mr. Chairman and Ranking Member, and seeks clarity and certainty in the permitting process.

This concludes my statement, Mr. Chairman. I welcome questions from you and your colleagues. Thank you.

Chairman HARRIS. Thank you very much, Mr. Miller.

I would now like to recognize our next witness, Mr. Owen Kratz, the President and CEO of Helix Energy Solutions Group.

STATEMENT OF MR. OWEN KRATZ, PRESIDENT AND CEO, HELIX ENERGY SOLUTIONS GROUP

Mr. KRATZ. Mr. Chairman, Members of the Subcommittee, thank you for the invitation to testify today. As the head of a team called upon to respond to the Macondo incident, I believe Helix Energy Solutions' experience can be of assistance to the Subcommittee as it evaluates response policy going forward.

Three Helix vessels, the Q4000, the Express, and the Helix Producer I, were instrumental in successfully bringing the Deep Water blowout under control. At the Macondo site Helix staff logged a total of 135 days aboard the Q4000 alone. The lessons we learned will inform our approach to containment efforts well into the future.

In December, 2010, Helix brought numerous independent operators together to form the Helix Well Containment Group. Our purpose was to develop a comprehensive, rapid, and effective response to a deepwater well control incident in the Gulf of Mexico. Currently, 23 leading energy companies belong to the consortium, working in close collaboration with DOE and RE we designed a comprehensive, 1,000-page well containment plan that meets the agency's requirements in NTL–10.

The plan addresses multiple scenarios inclusive of specific well information and deployment procedures, many of which were refined during the Macondo response effort. Technical experts and critical equipment from each of the 23 member companies will be made available to any member during an event, providing a fully-compliant level of capability as required by NTL–10.

The system is specifically designed for expansion and inclusion of developing new technologies. The Helix Fast Response System is ready to respond today. In fact, five drilling permits have recently been granted based on our containment system.

What does it mean to be prepared for an endeavor as complex and time sensitive as an undersea well control incident? The Helix

Fast Response System's Interim Containment System includes a 10,000 pounds per square inch capping stack, a riser system, the Q4000 intervention vessel, and all necessary equipment to complete the intervention system.

This system is capable of completely capping and closing in a well that has the necessary mechanical integrity to do so or allowing flow back and flaring of up to 55,000 barrels of oil a day or 70,000 barrels of liquids per day and 95 million cubic feet of natural gas per day in water depths up to 6,500 feet. This system as described there stands ready today.

The next stage of readiness, which we refer to as the complete containment system, is designed to handle more comprehensive responses by including a 15,000 pound per square inch capping stack and a riser system capable of operating in 8,000 feet of water. By April 11 our system will be capable of completely capping and closing in a well that has the necessary mechanical integrity to do so or allow flow back by a combination of producing and flaring. By April 15 the 15,000 pound per square inch capping stack will be available.

Finally, as we look into the future, we are evaluating an even further expanded system, having capability to 10,000 feet of water that will allow capture and flow back of up to 105,000 barrels of oil per day and 300 million cubic feet of natural gas per day. Approval of this expansion will take place only if the members of our consortium decide a system with this capacity is necessary. If they do this, then the vessel or the system could be ready by 2012.

One of the most innovative parts of the U.S. energy industry comes from a robust and healthy offshore independent oil and gas sector. The diversity of upstream players has produced countless innovations, and they are not always the largest companies. Yet one of the most—one of the major impediments faced in convincing the producers to dedicate the means to provide a solution in a more timely manner is the uncertainty surrounding the government's policy as to what specifically will be accepted as a sufficient containment solution.

Helix is grateful to the BOEMRE for the relationship that we have developed. Government can greatly aid the process by continuing, if not hastening, to resolve uncertainties inherent in early drafting of the regulations and to address concerns of the industry as to what may be deemed deficient in the process of drilling that may arise in the future such as liability caps, lease expirations, and spill response.

Additionally, the government could play a productive role by assisting and minimizing the cost of capital through reinvigorating programs designed to advance maritime industrial development. The Loan Guarantee Program administered by MARAD, for example, can help. It has a proven track record. In fact, the Q4000 was built in Texas using the MARAD financing.

Thank you for the opportunity to testify today. The industry has always developed innovative technologies and processes, even in the fact of the toughest challenges. Now, with the experience of Macondo behind us, we have learned how to fashion an even more appropriate, effective containment system. Thank you.

[The prepared statement of Mr. Kratz follows:]

PREPARED STATEMENT OF MR. OWEN KRATZ, PRESIDENT AND CHIEF EXECUTIVE OFFICER, HELIX ENERGY SOLUTIONSGROUP, INC.

Chairman Harris, Ranking Member Miller, and Members of the Subcommittee, thank you for the invitation to testify before you today on the topic of *Offshore Drilling Safety and Response Technologies*. The question of the appropriate technological response to what this nation learned at the Macondo site in the Gulf of Mexico is central to responsible policy. As the head of a team called upon to lead the response to that situation, I believe Helix Energy Solutions' experience can be of assistance to the Subcommittee as it evaluates response policy going forward.

Helix provides life-of-field services and development solutions to offshore energy producers worldwide, and is a leader in the provision of containment solutions for undersea well control incidents. Since the events that began unfolding at the Macondo well nearly one year ago today, there has been a great deal of interest among all Americans—and rightfully so—about how our industry can most effectively prepare itself to respond to an undersea blow-out and oil spill as we go about the business of harvesting our nation's critical offshore natural resources. We are pleased to have the opportunity to share our considerable experience on the subject at hand today.

The provision of effective oil well containment capability plays an essential role in facilitating responsible energy development in the deep waters of the U.S. Gulf. Helix stands ready to assist industry in providing the benefit of its expertise and resources immediately. Helix has participated in hundreds of deepwater well intervention efforts around the world for more than 15 years.

Most relevant to today's discussion, Helix vessels were enlisted to play a key on-site role in the Macondo Incident Control and Spill Containment effort following the April 2010 blowout. Three Helix vessels—the Q4000, the Express and the Helix Producer I—were instrumental in successfully bringing the deepwater blowout under control. A forth Helix vessel, the Normand Fortress, also played a vital role in the effort.

At the Macondo response site, Helix staff logged 285,000 man-hours aboard the Q4000 alone during the blowout response—a total of 135 days altogether. Helix staff provided the conduit for thousands of barrels of fluid during the static kill and cementing operation. Up to 80 barrels of kill fluid were pumped every minute through four vessels daisy-chained to the Q4000 during the top kill operation. Helix also provided flowback and burning of up to 10,000 barrels of oil and 15 mmcfd for approximately 30 days as well as deploying the original cofferdam. And it was the Q4000 that eventually lifted the *Deepwater Horizon's* BOP from the seafloor onto its deck—a BOP weighing 1 million pounds. The lessons we learned during those intense days will inform our approach to containment efforts well into the future.

Building on our unique undersea containment experience, Helix joined together with numerous independent operators in December 2010 to form the Helix Well Containment Group, an industry cooperative founded under the umbrella of Clean Gulf Associates, a not-for-profit oil spill response organization serving oil and gas exploration and production companies in the Gulf of Mexico. Currently, 23 leading energy companies have joined the consortium, and over 30 subcontractors have signed on to be available to the Helix Well Containment Group to provide the core services necessary to fully complement a deepwater response.

The mission of the Helix Well Containment Group (HWCG) was to develop a comprehensive and rapid deepwater containment response system, with a designated purpose to manifest an effective response to a deepwater well control incident in the Gulf of Mexico. CGA and HWCG members have contracted with Helix Energy Solutions for vessels, equipment and services necessary to contain a deepwater spill. Helix is pleased to be of assistance, and we provide emergency containment services to the industry without regard to profit. Our goal as an offshore service company that employs more than 1,600 people worldwide is putting the Gulf back to work. And when the Gulf goes back to work—realizing the full potential of this incredibly productive energy basin—companies engaged in well intervention, drilling, field servicing and other related tasks all are gainfully employed to the benefit of the economy and energy security.

Working in close collaboration with the Bureau of Ocean Energy Management, Regulation and Enforcement—including in-person meetings with Director Bromwich and Secretary of the Interior Salazar—the HWCG technical Committee designed a well-containment plan that meets the agency's requirement in its notice to lessees, NTL 2010–N10. We developed decision trees, procedures and schedules, and identified services and equipment necessary for an effective response based upon lessons learned from the Macondo incident. Our well containment plan evolved into a comprehensive document addressing multiple scenarios inclusive of specific well information and deployment procedures.

What emerged from this work is a Well Containment Plan that encompasses over 1100 pages of comprehensive procedures, processes, and technical detail of equipment to be employed during a subsea containment response. Many of these processes and procedures were refined by Helix during the Deepwater Horizon response.

The Helix Fast Response System, the key component of the HWCG, is ready to respond to a subsea deepwater containment incident today, as shown by the four drilling permits recently granted based on our containment system. The Fast Response System is underpinned by a Mutual Aid Agreement that outlines how technical experts and critical equipment from each of the 23 member companies will be made available to any member during an event—providing a level of capability not required by NTL 2010–N10, but which the member companies feel adds an additional layer of capability to protect the safety of our workers, the environment and commerce of the Gulf of Mexico, our integrity, and our companies' investments. The system is designed for expansion and inclusion of developing new technologies.

We are pleased to report to the Committee that the HWCG today stands ready to respond to the most complex scenario referenced in the well containment plan—including an incident with the complexities of Macondo. The technology deployed in this effort is innovative, to be sure, but the real secret is the men and women of companies like Helix who are fully trained on how to use equipment in a broad range of circumstances and at a moment's notice.

What precisely does it mean to be prepared for an endeavor as complex and time-sensitive as an undersea well control incident? The Helix Fast Response System's Interim Containment System includes a 10 thousand pounds per square inch (psig) capping stack, a riser system capable of operating in 6500 feet of water, the Q4000 intervention vessel (used during the Deepwater Horizon response) and all necessary equipment to complete the intervention system. This system is capable of completely capping and closing in a well that has the necessary mechanical integrity to do so, or allowing flow back and flaring of up to 55,000 barrels of oil or 70,000 barrels of liquids per day and 95 million cubic feet of natural gas per day at water depth up to 6500 feet of water. This system stands ready now.

The next stage of readiness, which we refer to as the Complete Containment System, is designed to handle more comprehensive responses by including a 15 thousand pounds per square inch capping stack and a riser system capable of operating in 8000 feet of water. By April the 11th, our system will be capable of completely capping and closing in a well that has the necessary mechanical integrity to do so, or allowing flow back by a combination of producing and flaring of up to 55,000 barrels of oil per day and 95 million cubic feet of natural gas per day in 8000 feet of water. By April 15th, the 15 thousand pounds per square inch capping stack will be available.

For the sake of context, the initial reservoir pressure at the Macondo well face at the time of the blowout was 11,850 psig, according to the U.S. Coast Guard. The well sat in 4,992 feet of water and, according to final government estimates, may have disgorged up to 60,000 barrels of oil per day. It is important to note that a discharge rate of 60,000 barrels of oil per day does not equate to the flowback requirements. Flowback capacity required is meaningfully less than the discharge rate due to hydrostatic head and flow restrictions through the system. Actual flowback capacity requirements must be calculated for each well, but our system would have completely contained the Macondo well.

Finally, as we look into the future, the HWCG is evaluating an even further expanded system having capability to 10,000 feet of water that will allow capture and flow back of up to 105,000 barrels of oil per day and 300 million cubic feet of natural gas per day. Approval of this expansion will take place only if the Members decide a system with this capacity is necessary. If approved by the Members, this expansion could be made available by 2012.

You have asked for input on what role the Federal Government can play going forward to assist with further innovation. Frankly, one of the most innovative parts of the energy industry in the United States comes from a robust and healthy offshore independent oil and gas sector. Consistently, a diversity of players in upstream oil and gas have produced innovation after innovation (not always the largest companies), tackling technological challenges safely and effectively. When the government fails to respond appropriately to permitting concerns or creates significant doubt which undermines business confidence, it saps potential investment capital necessary to innovate. The smaller companies are more vulnerable to production delays and may leave the market. Ironically, if production in the Gulf should fall, the government is also denying itself access to revenue, making its own oversight job all the more difficult. So the bottom line is that in a world of limited resources, one of the most critical things for the government to do is "to do no harm." And that means putting the Gulf back to work as soon as possible. I understand the charge of responsibility the government has, but quite frankly, one of the major impediments faced in convincing the producers to dedicate and allocate the means to provide a solution in a more timely manner is the uncertainty surrounding the government's policy as to what specifically will be accepted as a sufficient solution.

Of course, the federal government has its own research and development resources. In the Macondo situation, the private sector worked hand in glove with the talented men and women of the U.S. Coast Guard, including its capable Research and Development division. Further, the research centers of the U.S. Navy were called upon to assess technology, particularly for surface containment applications. NOAA also has tremendous value to bring to bear. We certainly encourage those government agencies to work closely with industry organizations like the HWCG and the Marine Well Containment Corporation established by some of the major integrated oil corporations. Coordination and sharing ideas is very important to making advances.

The technology we deploy is robust, but it is not inexpensive. Another policy the government can undertake is to assist us in minimizing the cost of capital by reinvigorating programs specifically designed to advance maritime industrial development. One familiar program of this type is the loan guarantee program administered by the U.S. Maritime Administration, or MARAD. MARAD can help responsibly and within fiscal constraints, and has established a proven track record for bringing innovative vessel designs to market. As we have seen, the most innovative vessel designs will be the most useful going forward. The Q4000, built in Texas with MARAD financing, provides an excellent example. As I described earlier in my testimony, the Q4000 was instrumental in bringing the blowout under control—and MARAD support helped make the Q4000 possible.

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to testify. There is no doubt that the unique circumstances faced in the Gulf last year were one of the most difficult crises faced by our industry. But the industry has always developed innovative technologies and processes even in the face of the toughest challenges. Now, with the experience of Macondo behind us, we have learned how to fashion an even more appropriate and effective containment system. It is time to get back to work.

Thank you.

Chairman HARRIS. Thank you, Mr. Kratz.

I now recognize our final witness, Dr. Molly Macauley, Research Director and Senior Fellow, Resources for the Future. Dr. Macauley.

STATEMENT OF DR. MOLLY MACAULEY, RESEARCH DIRECTOR AND SENIOR FELLOW, RESOURCES FOR THE FUTURE

Dr. MACAULEY. Good afternoon, Chairman Harris and Ranking Member Miller, Subcommittee Members, and panelists. I am an Economist and Research Director at Resources for the Future, which is an economics research organization established by the President of the United States in 1952, and my comments today draw from work that I carried out together with colleagues at Resources for the Future, and we undertook this work for the National Commission on the BP Deep Water Horizon oil spill and offshore drilling. But my comments today are my own. They do not represent the views of the Commission nor of Resources for the Future.

As an economist I know that jobs matter not only in the Gulf but to this Nation. I appreciate the role of energy. It is our Nation's lifeblood. I am aware of the concern expressed by businesses of all stripes, government and the public, about the need to balance the benefits of energy with the risks in producing energy of all types, both fossil and renewable.

The public cares. We mourn when we lose coal miners, oil riggers, nuclear plant operators, and when the environment is harmed. I think people want government and industry to balance that risk, and in fact, the Nation mourned the loss of those on the rig. And then in addition perhaps the most disturbing result of the Deepwater Horizon spill a year ago was not that the spill could happen. Spills, small spills happen all the time, but that the spill could not be promptly contained, and containment is precisely what I have been asked to speak about today.

So I will make two points. The first about containment in the near term over the next horizon for spills similar to last years roughly in about 5,000 or so feet of water, and this speaks to the technology that my panel colleague has just described.

And then the other point I will make is something near and dear I think to this Subcommittee's reason for being, which is research and development for containment in the future, and this is particularly in the case of ultra-deep water. You know, these depths are greater than 5,000 feet, and it is a very extreme environment in which to operate pressure, temperature, geology. It is very similar in its extremities to what we do with our Nation's space program. It is an extreme environment. It is very unique in that regard, and the genus of industry is that it is drilling there. It is drilling successfully in ultra-deep water, much like we are very successful in the extreme environments of space.

According to the Energy Information Administration production in ultra-deep water is really where the action is. Production at these depths has risen sharply. In fact, according to the EIA production there has reversed the decline in overall Gulf of Mexico production that began in 2003.

So containment in the near term. As we have heard from Helix, industry has stepped up and committed over $1 billion to supply containment services for some types of spills in the Gulf of Mexico. Helix played a major role in helping to contain the Deep Water spill, and the newly formed Marine Well Containment Corporation, MWCC, is also part of this industry effort.

I understand there are some types of spills for which these services are not optimized at the present time, but the adequacy of containment readiness is being jointly determined, not only what industry is willing to supply but what government is demanding. It is a joint effort here.

I think where I lose sleep is on my second point. It is not so much containment today because there are very strong incentives for government and industry to make sure containment works. Imagine the public reaction to another large spill anytime soon.

But where I lose sleep is about the next battle. Again, these ultra-deep water depths exceed those where MWCC and Helix are prepared to service at the present time, although as Helix mentioned, if your members agree, you may be prepared to go up to 10,000 feet, and that is exactly my point.

In the event of a spill at these deeper depths, will we have to innovate on the fly again? What new science and engineering and state-of-the-art risk assessment do we need now? Who has this game plan? In short, are we innovating such that the capacity to contain keeps pace with the capacity to drill in increasingly extreme environments?

Now, the National Commission acknowledged these questions. It did not consider them at length, and if unanswered, these questions point to a potentially large gap in our public policy. And there is a reason to ask these questions. As a Nation our industry and our government tends to under-invest in R&D for a lot of reasons. It takes money to do R&D. Sometimes the results aren't fully appropriable. The reward is shared widely, and it doesn't return to the innovator, and the problem with innovation in containment is particularly difficult because government limits liability for a spill, and regulation is sometimes not as effective as we would like it to be for these blunt incentives to contain and incentives to innovate.

And if we discover new ways to contain, we want that technology widely deployed yet proprietary innovation is not always widely deployed. I note that the commission staff paper points out that a few years after the Valdez oil spill efforts to innovate in spill response had dwindled to almost nothing.

So I have three suggestions for what the Committee or other policymakers might do. First, have some discussions, not only with Helix but with MWCC and others supplying containment services, ask them what their plans are for innovation.

Second, already a panelist has referenced the new permanent federal advisory group on safety containment and response. Federal advisory groups can do a good job, but who is going to listen, who is going to act upon their suggestions?

And third, and this is more substantial, disadvantages and advantages worth talking about, but we might consider changing the liability regime to risk-based drilling fees much like risk-based insurance premiums, risk-based liability caps for each well, or phasing in requirements for insurance to cover damages to third parties.

So I think a prudent approach and the best we can do is make sure we align incentives to think about the R&D for the next battle. It still may have to occur but at least we will have done the in advance, long-lead kinds of research and development that will be necessary then.

Thanks very much for asking me to join the panel today.

[The prepared statement of Dr. Macauley follows:]

PREPARED STATEMENT OF DR. MOLLY K. MACAULEY, SENIOR FELLOW AND RESEARCH DIRECTOR, RESOURCES FOR THE FUTURE, WASHINGTON, DC

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 Drill-

[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: U.S. Government Printing Office), January 2011.

ing (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 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 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 addi-

[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.

[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.

[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).

tional 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]

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 coproduces 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

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[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).

[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.

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 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 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.

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[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 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 htpp://www.rff.org).

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 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]

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[9] See*Response/Clean-Up Technology Research & Development and the BP Deepwater Horizon 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%20Pa per.pdf (accessed April 3, 2011).

[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.

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.

Chairman HARRIS. Thank you very much, Dr. Macauley, and thanks to all the panel Members for their testimony.

Reminding Members of the Committee rules. Limit questioning for five minutes, and the Chair at this point will open the round of questions, and I will recognize myself for the first five minutes.

Dr. Der, thank you very, very much for coming and testifying before the Committee. My understanding from your testimony is that once again the President's budget reposes repeal of the ultra-deep water and unconventional natural gas and other petroleum research fund, and I have got to ask that given the fact that we are recently—it is coming to our attention that our oil reserves, our recoverable reserves both for oil and especially now for natural gas, are coming to be realized that we have these reserves, why don't you think there is a role for the government in trying to figure out how to get to them safely, not just safety but how to, you know, partnering with industry or, in fact, doing some of the research.

You know, my understanding that, for instance, the research to get to our shale natural gas, you know, is one fellow who thought, yes, this could be done when everybody else said, no, it couldn't be done, but—it took him years and years to figure it out with apparently little help from the government, even though we sit on these resources.

So, Doctor, why is it not appropriate for the government to actually help as part of this program to do some of that innovative research that could get to more of our oil and natural gas given the rising price of energy, the rising cost of gas?

Dr. DER. Thank you for the question here. I want to let you know that this innovative person who developed and commercialized the technology for hydrofracking, and horizontal drilling was, in fact, a result of the early research that the Department of Energy has engaged in. We had spent I think on the order of something like $137 million between the 1980s and 1990s to release trillions and trillions of potential in terms of natural gas in this country.

So the role of the government early on is there, but oil and gas production is a fairly mature technology, and the industry and the Administration's opinion is that industry is well capable of investing in these types of technologies to unlock and unleash these potential domestic resources that we have in our country.

Continuing forward I think that we do have a role in helping advise and assist where necessary in terms of safe and responsible drilling in areas such as the ultra-deep regime. But, again, the Administration's position is that the oil companies and gas companies and the majors are very well equipped to make these types of investments on their own with the guidance from groups such as this advisory Committee I spoke of in my opening statement.

Chairman HARRIS. Yes. Thank you. I guess the only follow up I would say is if you think that those $137 million which we invested in the past had something to do with leading to the development of the new technology to unlock some of the natural gas, it almost makes an argument for continuing for the government to do things like that because that has yielded some result.

Mr. Miller, let me ask you a question because, you know, it appears that we are going to be buying oil that is found in deep waters off Brazil, that there is a national decision that has been made to invest billions of dollars through the Export-Import bank to do deep water drilling off Brazil.

So I have got to ask you, what are the standards that they are going to have? I mean, because, you know, the API is developing all these standards. First of all, is there an international equivalent of the API? Are they ahead of us or behind us on these standards? I mean, you know, it begs the question how do we make certain that when we are supporting this drilling elsewhere in the world, how do we know that it is going to be up to the standards that we hope to have here in the United States?

Mr. MILLER. Thank you for the question. There are really a couple of ways to answer that, Chairman. The first way is that API as was mentioned when you gave my bio, is very involved in international standards development, and I am the chairman of the ANSI International Policy Committee, and one of the things we look at is how industries work with the International Organization for Standardization or ISO, which is based in Geneva and develops standards that are worldwide recognized.

And in our support of that particular set of Committees that develop international oil and natural gas standards, approximately 70 percent of the standards that they have developed under that one Committee are base API standards. So number one, we have worked with our international counterparts to make sure that these best practices are moved around the world and used around the world.

The second point I would make is that in a study that was done last year by the UK-based Oil and Gas Producers' Association, looking at 14 different producing regions around the world, they found that API standards were the most widely referenced by the regulators, with over 225 citations in addition to the citations here in the United States. So the regulatory regime is there for both the standards to have been transferred and used through the ISO process or the International Organization for Standards Processing in addition to the regulators using the API standards for their regulations as well.

Chairman HARRIS. So in Brazil if they are going to drill using those standards, then your feeling would be that since those standards roughly are going to be equivalent to the standards we have here, then perhaps we should be doing it here as well. I take it that you think they are roughly equivalent.

Mr. MILLER. Absolutely. I would think that with the strong records we have here we should be expanding our drilling operations here in the states.

Chairman HARRIS. Thank you very much.

I now recognize Mr. Miller.

Mr. MILLER OF NORTH CAROLINA. Thank you, Mr. Chairman. Just as a layman, when I hear that there is a device called a blowout preventer on a well and the well has a blowout, my conclusion is that the blowout preventer probably didn't work.

Mr. Miller, is there a flaw in that reasoning?

Mr. MILLER. To answer your question, I know that there has been a study that has just been released that has come out that is looking at some of the potential problems that occurred in the Deep Water Horizon. We have got a group of technical experts that are looking at the standards that cover blowout preventer design and operation, and in addition to other items that we were already looking at, we are looking at that case where you did have that uncontrolled kick, if you will, that according to the study, and we haven't fully had a chance to digest it yet because it is over 500 pages, where they theorized that the kick, the uncontrolled release pushed the pipe into a place where the sheer rams did not fully close.

So we are looking at those design requirements to make sure that as we update the standard we consider those results.

Mr. MILLER OF NORTH CAROLINA. Well, some scientists or some engineers who have looked at this have said that the assumption that the pipe would be centered at that depth with those pressures from every direction, that those pressures were not unusual. I mean, they are usually unusual, and some engineers have said that if it was actually centered, it would be just dumb luck. It would be like a stopped clock being correct. It does happen twice a day, but it is really just dumb luck.

What are the differences between drilling or the safety considerations, the technological challenges in safety and the environmental protection between shallow water and deep water drilling?

Mr. MILLER. Well, I am not a drilling expert, but I can talk a little bit about the equipment itself. It is governed by 12 separate regulations under BOEMRE. In each one of your BOP's you are required to have at least one annular ram, which is sort of the rubber donut that sits on top, two pipe rams, which do help you center the pipe and also can help you close in a blowout, and then finally a blind sheer ram that closes that.

One of the other things that we are looking at is that we understand, and this was just announced I think earlier in this week, that we will be seeing additional proposed regulations from BOEMRE. We understand there will be an advanced notice of proposed rulemaking on BOP design and manufacture and operations. So we will have a chance to take a look at what they are believing we need to be looking at as far as our design requirements, those particular pieces of equipment.

Mr. MILLER OF NORTH CAROLINA. Uh-huh. What role, if any,—well, you really are not claiming any expertise in drilling or drilling safety?

Mr. MILLER. No. My expertise is in standards and standards development and the technical standards that support drilling operations and equipment but not as a petroleum engineer, drilling engineer.

Mr. MILLER OF NORTH CAROLINA. Okay. Well——

Mr. KRATZ. Would you mind if I added something to that?

Mr. MILLER OF NORTH CAROLINA. Yes, sir.

Mr. KRATZ. I think it is important in any discussion, and I am not an expert on BOPs, but any discussion about BOPs I think it is important to understand that any technology has operational limits, and I am not making a comment on Macondo or not, but the BOP is actually the last barrier of defense in a series of barriers used to control a drilling operation.

So when you say the BOP failed, what has to occur for that to happen is several other systems have to fail as well, and I think what Macondo has taught is that no matter how well the system is designed, and I think the government, the BOM has it right on this, you can't rely totally on prevention, and that is where the missing link of the next step of containment comes in is for the inevitable.

Mr. MILLER OF NORTH CAROLINA. Okay. Well, I am in search for a witness who seems to have expertise on a topic I want to ask about.

Dr. Macauley, you were an economist, Ph.D., and you mentioned liability and liability caps and the affect that had on innovation in the safety area. I don't claim to be an economist, but I have studied kind of the economics of liability, the theory behind legal liability and that potential liability is kind of the economic incentive to safety practices.

What is the economic effect of setting a cap, a liability cap on safety innovation?

Dr. MACAULEY. Yeah. It is an excellent question, because it is so relevant to what we are discussing. A liability cap, caps-led industry will be liable for and who foots the bill then? The other parties, the taxpayers in this case. Liability caps serve important purposes. They are often thought to allow small companies to enter in, and you don't have to back the company in order to provide a useful public service, in this case, offshore drilling.

On the other hand, the very fact that you have a cap does say, well, who will pay, taxpayers, but we have this tradeoff. We are allowing small companies to participate, provide that competition. So setting the liability cap is really important.

To the extent it can be related to the risk, then you begin to put incentives in place to bring about the very prevention containment and effective response that we are talking about, though.

Mr. MILLER OF NORTH CAROLINA. I am sorry. Will the liability—will the safety efforts match the potential liability if there is a liability cap?

Dr. MACAULEY. I think that industry has an incentive to pay attention to the liability cap to protect its shareholders. Industry also has a reputation to uphold, though, so it may well be that industry acts beyond the cap because reputation really matters, what the public thinks is very critically important as we know in the case of nuclear power plant safety.

So the role of the liability cap is a complex one.

Mr. MILLER OF NORTH CAROLINA. Mr. Chairman, I see my time has expired. There are three documents, studies of this disaster that I would like to enter into the record. The first is the study—and in each case I have excepted out the portions that seem to be pertinent. If the Chair wants to add additional chapters, that is fine, but these seem to be the ones pertinent.

The first is a report by the Det Norske Veritas on their forensics examination of Deep Water Horizon's blowout preventer that they undertook for the Department of Interior. DNV concluded that the buckled drill pipe inside the blowout preventer obstructed the blind sheer rams that the witnesses just described in their ability to sheer the pipe fully and seal the well. And in addition to the introduction, Chapter 4 would be sufficient to deal with those conclusions.

And then two other documents from the Department of Interior. One is investigation, MMS report 2001–009, and report 2004, page 21, conclusion six, and page 5. Those appear to indicate that BOP failure similar to that depicted in the DNV report had occurred in the past decade on two other occasions.

And Mr. Chairman, I would now move these three documents be inserted into the record.

Chairman HARRIS. I thank you very much. I thank the Ranking Member for sharing that with staff and without objection, so ordered.

[The information follows:]

DET NORSKE VERITAS

Final Report
for
UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF OCEAN ENERGY MANAGEMENT,
REGULATION, AND ENFORCEMENT
WASHINGTON, DC 20240

FORENSIC EXAMINATION OF DEEPWATER HORIZON BLOWOUT PREVENTER

CONTRACT AWARD NO. M10PX00335

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Forensic Examination of Deepwater Horizon Blowout Preventer

For:

United States Department of the Interior
Bureau of Ocean Energy Management, Regulation, and Enforcement
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List of Abbreviations and Acronyms

AMF	Automated Mode Function
API	American Petroleum Institute
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
BOP	Blowout Preventer
BP	BP Exploration & Production Inc.
BSR	Blind Shear Ram
CAD	Computer Aided Design
CSR	Casing Shear Ram
DHS	Department of Homeland Security
DNV	Det Norske Veritas
DOI	Department of the Interior
EDS	Emergency Disconnect Sequence
EPA	Environmental Protection Agency
ERT	Evidence Response Team
FAT	Factory Acceptance Test
FBI	Federal Bureau of Investigation
FEA	Finite Element Analysis
HP	High Pressure
HPU	Hydraulic Pressure Unit
ID	Inside Diameter
JIT	Joint Investigation Team
LA	Lower Annular
LMRP	Lower Marine Riser Package
MIC	Microbiologically Influenced Corrosion
MMS	Minerals Management Service
MODU	Mobile Offshore Drilling Unit
MOEX	Mitsui Oil and Exploration Company
MUX	Multiplex cables
NACE	National Association of Corrosion Engineers
NASA	National Aeronautics and Space Administration
NPT	National Pipe Thread
OD	Outside Diameter
PBOF	Pressure Balance of Oil Filled
PETU	Portable Electronic Test Unit
PSIG	Pounds Per Square Inch Gauge
RCB	Rigid Conduit Box cable
ROV	Remotely Operated Vehicle
SCAT	Systematic Causal Analysis Technique
SEM	Subsea Electronic Modules
SMYS	Specified Minimum Yield Strength

STM	Subsea Transducer Module
TWG	Technical Working Group
UA	Upper Annular
USCG	United States Coast Guard
UTS	Ultimate Tensile Strength
VBR	Variable Bore Ram
YS	Yield Stress

1 EXECUTIVE SUMMARY

A Joint Investigation Team (JIT) of the Departments of the Interior (DOI) and Homeland Security (DHS) was charged with investigating the explosion, loss of life, and blowout associated with the Deepwater Horizon drilling rig failure. As a part of this overall investigation, Det Norske Veritas (DNV) was retained to undertake a forensic examination, investigation, testing and scientific evaluation of the blowout preventer stack (BOP), its components and associated equipment used by the Deepwater Horizon drilling operation.

The objectives of the proposed investigations and tests were to determine the performance of the BOP system during the well control event, any failures that may have occurred, the sequence of events leading to failure(s) of the BOP and the effects, if any, of a series of modifications to the BOP Stack that BP and Transocean officials implemented.

The set of activities undertaken by DNV included:

- Establishing a base of operations at the NASA Michoud facilities for receiving and testing the BOP stack and associated equipment
- Building a temporary enclosure to house the BOP Stack to facilitate the forensic examinations
- Recovery of and assessment of drill pipe, rams, fluids and other material from the BOP Stack and recovered drilling riser
- Function testing of the hydraulic circuits, mechanical components and control systems of the BOP Stack
- Visual examination of evidence and additional analysis using laser profilometry
- Mechanical and metallurgical testing of pieces of drill pipe
- Coordination of activities with other stakeholders through the JIT and the Technical Working Group (TWG)
- Review of documents and Remotely Operated Vehicle (ROV) videos
- Mathematical modeling of the mechanical damage and deformation of drill pipe
- Developing possible failure scenarios

1.1 The Equipment

The Deepwater Horizon was a semi-submersible, dynamically positioned, mobile offshore drilling unit (MODU) that could operate in waters up to 8,000 feet deep and drill down to a maximum depth of 30,000 feet. The rig was built in South Korea by Hyundai Heavy Industries. The rig was owned by Transocean, operated under the Republic Of The Marshall Islands flag, and was under lease to BP from March 2008 to September 2013.

The BOP Stack, built by Cameron, was in use on the Deepwater Horizon since the commissioning of the rig in 2001. The BOP Stack consisted of the following systems, sub-systems and components:

- A Lower Marine Riser Package (LMRP) containing two annular preventers and two Control Pods
- The lower section of the BOP Stack contains five sets of rams. These rams are referred to as the Blind Shear rams (BSR), the Casing Shear rams (CSR), Upper Variable Bore rams (VBR), Middle VBRs and Lower VBRs. The LMRP sits on top of the lower section of the BOP.
- Two electronic Control Pods are located or fitted to the LMRP. These control pods receive signals from the control panels that are located on the rig itself, and then activate various solenoids in turn functioning various hydraulic circuits and mechanical components on the BOP Stack.

At the time of the accident, the rig was drilling an exploratory well at a water depth of approximately 5,000 feet in the Macondo Prospect. The well is located in Mississippi Canyon Block 252 in the Gulf of Mexico.

1.2 The Accident

On the evening of April 20, 2010, control of the well was lost, allowing hydrocarbons to enter the drilling riser and reach the Deepwater Horizon, resulting in explosions and subsequent fires. The fires continued to burn for approximately 36 hours. The rig sank on April 22, 2010. From shortly before the explosions until May 20, 2010, when all ROV intervention ceased, several efforts were made to seal the well. The well was permanently plugged with cement and "killed" on September 19, 2010.

In the event of a loss of well control, various components of the BOP Stack are functioned in an attempt to seal the well and contain the situation. The most important of these components are the blind shear rams. These can be activated in several different ways:

- Activation from either of two control panels located on the Deepwater Horizon rig itself
- Through the Emergency Disconnect Sequence which is also activated from either of the two control panels on the rig itself
- By the Automated Mode Function (AMF)/Deadman circuits located in the Subsea Electronic Modules within either of two subsea control pods mounted on the LMRP
- By the Autoshear function located on the BOP Stack
- By ROV intervention through a panel on the BOP Stack

1.3 Forensic Tests

On September 4, 2010, the BOP Stack was raised from the sea floor. The BOP Stack was transferred by barge to the NASA-Michoud facility in New Orleans, LA.

On October 3, the BOP Stack and LMRP were lifted from the barge and placed on test pans that were constructed on the West Dock of the Michoud facility. Per contract requirements, DNV developed and submitted a draft test plan to the JIT for review, comment and approval. The JIT forwarded this plan to several Parties-In-Interest to the forensic examinations for their review and comment. These comments were, in turn, submitted to DNV for consideration and possible inclusion. Part of the forensic testing protocol was to establish a Technical Working Group consisting of technical representatives from BP, Transocean, Cameron, Department of Justice, Chemical Safety Board and the Multi-District Litigation. A final Forensic Testing Plan was approved on October 22, 2010. Forensic testing began on November 15, 2010 and was completed on March 4, 2011.

The Blind Shear, Casing Shear and three sets of Variable Bore Rams were removed from the lower section of the BOP, cleaned and examined visually and using laser profilometry. The wellbore was examined using high definition video cameras and the section of the wellbore at the Blind Shear Rams was also examined by laser profilometry. The wellbore and the upper and lower annulars in the LMRP were examined using a high definition video camera. Fluid samples were collected from the wellbore and various hydraulic circuits.

A total of eight segments of drill pipe were recovered, examined and tested. Two drill pipe segments were recovered from the BOP at Michoud. Three additional segments were recovered from the drilling riser at Michoud. Three other segments of drill pipe previously recovered were also examined. The segments were matched together using a combination of visual examination of the shear or fracture surfaces, laser profilometry, mechanical and metallurgical testing. A timeline sequence of the various failures in the drill pipe was developed. The results of the mechanical and metallurgical testing for the drill pipe were in accordance with industry standards.

Function testing included:

- ST Locks
- Choke and Kill valves
- The hydraulic operators and circuits of the five ram sets on the lower BOP
- The high pressure accumulators on the lower BOP
- The hydraulic circuits of the AMF/Deadman and Autoshear
- The electronic circuits of the AMF/Deadman and Autoshear

The hydraulic circuits of all the above functioned as intended when tested or operated. The tests of the electronic circuits of the AMF/Deadman demonstrated that the voltage of the 27V battery in the Blue Pod was insufficient to activate the High Pressure Blind Shear Ram pilot solenoid mounted on the Blue Pod. The tests of the Yellow Pod High Pressure Blind Shear Ram pilot solenoid circuits were inconsistent.

1.4 What is Considered to Have Happened

Prior to the loss of well control on the evening of April 20, 2010, the Upper Annular (UA) was closed as part of a series of two negative or leak-off tests. Approximately 30 minutes after the conclusion of the second leak-off (negative pressure) test, fluids from the well began spilling onto the rig floor. At 21:47 the standpipe manifold pressure rapidly increased from 1200 psig to 5730 psig. The first explosion was noted as having occurred at 21:49. At 21:56 the Emergency Disconnect Sequence (EDS) was noted to have been activated from the bridge. This was the final recorded well control attempt from the surface before the rig was abandoned at 22:28.

The Upper VBRs were found in the closed position as-received at the Michoud facility. There was no documented means of ROV intervention to close the Upper VBRs. ROV gamma ray scans on May 10, 2010, confirmed that the ST Lock on the port side Upper VBR was closed. Scans of the starboard side ST Lock on the Upper VBRs were inconclusive. Measurements of the ST Lock positions performed at the Michoud facility confirmed that both ST Locks on the Upper VBRs were closed. Evidence supports that the Upper VBRs were closed prior to the EDS activation at 21:56 on April 20, 2010.

A drill pipe tool joint was located between the Upper Annular and the Upper VBRs. With both the Upper Annular and the Upper VBRs closed on the drill pipe, forces from the flow of the well pushed the tool joint into the Upper Annular element. This created a fixed point arresting further upward movement of the drill pipe. The drill pipe was then fixed but able to pivot at the Upper Annular, and horizontally constrained but able to move vertically at the Upper VBRs. Forces from the flow of the well induced a buckling condition on the portion of drill pipe between the Upper Annular and Upper VBRs. The drill pipe deflected until it contacted the wellbore just above the BSRs. This condition would have most likely occurred from the moment the well began flowing and would have remained until either the end conditions changed (change in Upper Annular or Upper VBR state) or the deflected drill pipe was physically altered (sheared). The portion of the drill pipe located between the shearing blade surfaces of the BSRs was off center and held in this position by buckling forces.

As the BSRs were closed, the drill pipe was positioned such that the outside corner of the upper BSR blade contacted the drill pipe slightly off center of the drill pipe cross section. A portion of the pipe cross section was outside of the intended BSR shearing surfaces and would not have sheared as intended. As the BSRs closed, a portion of the drill pipe cross section became trapped between the ram block faces, preventing the blocks from fully closing and sealing. Since the deflection of the drill pipe occurred from the moment the well began flowing, trapping of the drill pipe would have occurred regardless of which means initiated the closure of the BSRs.

Of the means available to close the BSRs, evidence indicates that the activation of the BSRs occurred when the hydraulic plunger to the Autoshear valve was successfully cut on the morning of April 22, 2010. However, on the evidence available, closing of the BSRs through activation of the AMF/Deadman circuits cannot be ruled out.

In the partially closed position, flow would have continued through the drill pipe trapped between the ram block faces and subsequently through the gaps between the ram blocks. When the drill pipe was sheared on April 29, 2010, using the CSRs, the well flow pattern changed to a new exit point. At this point, the flow expanded through the open drill pipe at the CSRs and up the entire wellbore to the BSRs and through the gaps along the entire length of the block faces and around the side packers.

1.5 Primary Cause and Contributing Causes

The failure cause analysis was organized and conducted around a single top event. For the purposes of this investigation, the top event was defined as the failure of the BSRs to close and seal the well.

The primary cause of failure was identified as the BSRs failing to fully close and seal due to a portion of drill pipe trapped between the blocks.

Contributing causes to the primary cause included:

- The BSRs were not able to move the entire pipe cross section into the shearing surfaces of the blades.
- Drill pipe in process of shearing was deformed outside the shearing blade surfaces.
- The drill pipe elastically buckled within the wellbore due to forces induced on the drill pipe during loss of well control.
- The position of the tool joint at or below the closed Upper Annular prevented upward movement of the drill pipe.
- The Upper VBRs were closed and sealed on the drill pipe.
- The flow of well fluids was uncontrolled from downhole of the Upper VBRs.

1.6 Recommendations for Industry

The primary cause of failure was identified as the BSRs failing to close completely and seal the well due to a portion of drill pipe becoming trapped between the ram blocks. The position of the drill pipe between the Upper Annular and the upper VBRs led to buckling and bowing of the drill pipe within the wellbore. Once buckling occurred the BSRs would not have been able to completely close and seal the well. The buckling most likely occurred on loss of well control.

The recommendations are based on conclusions from the primary and contributing causes or on observations that arose during the course of DNV's investigations.

1.6.1 Study of Elastic Buckling

The elastic buckling of the drill pipe was a direct factor that prevented the BSRs from closing and sealing the well.

It is recommended the industry examine and study the potential conditions that could arise in the event of the loss of well control and the effects those conditions would have on the state of any tubulars that might be present in the wellbore. These studies should examine the following:

- The effects of the flow of the well fluids on BOP components and various tubulars that might be present,
- The effects that could arise from the tubulars being fixed or constrained within the components of a Blowout Preventer,
- The ability of the Blowout Preventer components to complete their intended design or function under these conditions.

The findings of these studies should be considered and addressed in the design of future Blowout Preventers and the need for modifying current Blowout Preventers.

1.6.2 Study of the Shear Blade Surfaces of Shear Rams

The inability of the BSRs to shear the off-center drill pipe contributed to the BSRs being unable to close and seal the well.

It is recommended the industry examine and study the ability of the shear rams to complete their intended function of completely cutting tubulars regardless of their position within the wellbore, and sealing the well. The findings of these studies should be considered and addressed in the design of future Blowout Preventers and the need for modifying current Blowout Preventers to address these findings.

1.6.3 Study of Well Control Procedures or Practices

The timing and sequence of closing of the UA and upper VBRs contributed to the drill pipe segment buckling and bowing between the two moving the drill pipe off center.

It is recommended the industry examine and study the potential effects or results that undertaking certain well control activities (e.g. closing of the annulars, or closing of the VBRs) could have on the BOP Stack. Examination and study should identify conditions, which could adversely affect the ability to regain control of the well (e.g. elastic buckling of tubulars). Industry practices, procedures and training should be reviewed and revised, as necessary, to address the prevention of these conditions.

1.6.4 Status of the Back-Up Control Systems

The BOP functionality testing indicated some back-up control system components did not perform as intended.

It is recommended the industry review and revise as necessary the practices, procedures and/or requirements for periodic testing and verification of the back-up control systems of a Blowout Preventer to assure they will function throughout the entire period of time the unit is required on a well.

1.6.5 Common Mode Failure of Back-Up Control Systems

The BOP functionality testing indicated not all back-up control systems had built in redundancy.

It is recommended the industry review and revise as necessary the practices, procedures and/or requirements for evaluating the vulnerability of the back-up control systems of a Blowout Preventer to assure they are not subject to an event or sequence of events that lead to common mode failure.

1.6.6 Study the Indication of Functions in an Emergency

The ROV intervention efforts reviewed indicated the ROVs were not capable of directly and rapidly determining the status of various ROV components.

It is recommended the industry examine and revise the current requirements for providing a means to verify the operation, state or position of various components of Blowout Preventers in the event of an emergency. The industry should require that it is possible to confirm positively the state or position of certain components such as the rams, annulars and choke and kill valves either with the use of Remotely Operated Vehicles or by other means.

1.6.7 Study of the Effectiveness of Remotely Operated Vehicle Interventions

The ROV intervention efforts reviewed indicated initial ROV efforts were not capable of performing key intervention functions at a level equivalent to the primary control systems.

It is recommended the industry examine and study the conditions and equipment necessary for Remotely Operated Vehicles to perform various functions (e.g. the BSRs) at a performance level equivalent to the primary control systems. Make adequate provision to mobilize such equipment in the event of a well control emergency.

1.6.8 Stipulating Requirements for Back-Up Control System Performance

A review of industry standards indicated they do not stipulate performance requirements for back-up systems (e.g. closing response times) as they do for primary control systems.

It is recommended the industry review and revise the requirements for back-up control system performance to be equivalent to the requirements stipulated for primary control systems.

1.7 Recommendations for Further Testing

DNV's forensic examinations and testing were organized and conducted around the top event of the failure of the Blind Shear Rams to close and seal the well.

The recovery and examination of the eight segments of drill pipe and the five sets of rams shifted the focus from the question of whether the blind shear rams were activated to that of identifying the factors that would have caused or contributed to the blind shear rams failing to seal the well. As described in this report, DNV is of the view that the primary cause for the blind shear rams failing to close arose from conditions that led to the drill pipe being forced to one side of the wellbore at a position immediately above the Blind Shear Rams. DNV has investigated the conditions that could lead to such a buckling scenario developing. However, even here DNV recognizes there are additional studies and tests that could be undertaken to examine this scenario further.

In addition, DNV has identified a number of areas or issues associated with the overall performance of the BOP Stack that should be examined, investigated or tested further. As a result, DNV puts forward the following recommendations.

1.7.1 Additional Studies of Conditions Leading to Elastic Buckling

- Supplement the Finite Element Analysis buckling model with a Computational Fluid Dynamic simulation of the flow through the drill pipe.
- Run the Finite Element Analysis drill pipe-cutting model to include the buckling stresses that would have existed in the drill pipe.
- Field test the blind shear rams shearing a section of off-centered (buckled) 5-1/2 inch drill pipe.
- Field test the ability of a closed annular to restrain the upward movement of a 5-1/2 inch drill pipe tool joint at the forces calculated for buckling.
- Field test the conditions required to push a 5-1/2 inch tool-joint through a closed annular element.

1.7.2 Additional Tests or Studies of the Performance of the Blowout Preventer Stack

- It is suggested that the static pressure tests undertaken at Michoud on the high-pressure shear hydraulic circuits of the lower section of the BOP be supplemented with additional tests of the circuits of the Casing Shear Rams and the Variable Bore Rams.
- The tests at Michoud performed on the high-pressure blind shear close solenoid removed from the Yellow Pod in May 2010 gave inconsistent results. It is suggested this solenoid be further tested and possibly disassembled to discern the reason for its performance and whether it was likely to have functioned at the time of the incident.
- On pressuring the high-pressure shear ram circuit, the high-pressure casing shear regulator leaked. It is suggested the high-pressure casing shear regulator be further tested and disassembled to try and discern its state at the time of the incident.
- It is suggested that the behavior of the elastomeric elements of the rams and annulars be tested to assess their performance when exposed to well fluids at the temperatures that existed at the time of the blowout.
- The tests of the Subsea Electronic Modules (SEMs) undertaken at Michoud should be supplemented by removing the SEMs from the Control Pods, venting and then opening the SEMs to understand better their possible state at the time of the incident. The following tests or activities are suggested:
    - Collect and analyze samples of the SEMs gas/atmosphere prior to or as part of venting the SEMs
    - Remove the batteries and record part numbers, serial numbers, date of manufacture and any other pertinent manufacturing data
    - In place of the batteries connect a voltage generator and conduct a series of tests on the AMF/Deadman circuits at various voltages and record the results
- The lower and upper annulars are well control components of the BOP stack. As a result the following tests or examinations of the lower and upper annulars are suggested:
    - Laser scanning of the upper annular in-situ and "as-is" condition
    - Remove and examine the upper and lower annular elements
    - Static pressure tests of the annular operating systems
    - Function testing of the open and close operating systems of both annulars
- The evidence from eyewitnesses was that the Emergency Disconnect Sequence was activated approximately seven minutes after the first explosion. It is suggested the hydraulic circuits and functioning of the LMRP HC collet connector and the choke and kill collet connectors be tested as a means to try and assess their state at the time of the incident.
- It is suggested the wellbore pressure-temperature sensor at the base of the lower section of the BOP be removed and its accuracy checked or tested.
- It is suggested the industry perform field tests on the ability of the BSRs to shear and seal a section of 5-1/2 inch drill pipe under internal flow conditions that existed at the time of the incident.

2 INTRODUCTION

On April 27, 2010, the Departments of Interior and Homeland Security signed an order that made provision for the Departments to convene a Joint Investigation of the April 21-22 2010, explosion and sinking of the Deepwater Horizon Mobile Offshore Drilling Unit[1].

On August 10, 2010 the Bureau of Ocean Energy, Management, Regulation and Enforcement (BOEMRE) of the Department of Interior issued a competitive Request for Proposal to undertake a series of forensic investigations and tests on the Deepwater Horizon Blowout Preventer. The objectives of the proposed investigations and tests were to determine the performance of the BOP system during the well control event, any failures that may have occurred, the sequence of events leading to failure(s) of the BOP and the effects, if any, of a series of modifications to the BOP stack that BP and Transocean officials implemented. As part of the foregoing task, the examination was to determine:

- If leaks on the BOP were critical to the non-performance during the blowout and during the ROV intervention attempts
- If any modification(s) made to the control logic and stack inhibited the performance
- If any other relevant factors, including but not limited to manufacturing defects, deferral of necessary repairs affecting functionality, and maintenance history contributed to the BOP's failure to operate as intended

DNV submitted a proposal to undertake the forensic examinations, investigations and tests in accordance with the RFP and was awarded a contract on September 1, 2010.

The set of activities undertaken by DNV included:

- Establishing a base of operations at the NASA-Michoud facilities for receiving and testing the BOP stack and associated equipment,
- Building a temporary enclosure to house the BOP stack to facilitate the forensic examinations,
- Recovery of and assessment of drill pipe, rams, fluids and other material from the BOP stack and recovered drilling riser,
- Function testing of the hydraulic circuits, mechanical components and control systems of the BOP stack,
- Visual examination of evidence and additional analysis using laser profilometry,
- Mechanical and metallurgical testing of pieces of drill pipe,

[1] Statement of Principles and Convening Order regarding an investigation into the Marine Casualty, Explosion, Fire, Pollution and Sinking of Mobile Offshore Drilling Unit Deepwater Horizon, With Loss of Life in the Gulf of Mexico 21-22 April 2010

- Coordination of activities with other stakeholders through the JIT and the technical working group,
- Review of documents and ROV videos,
- Mathematical modeling of the mechanical damage and deformation of drill pipe, and
- Developing possible failure scenarios

On September 4, 2010, the Deepwater Horizon Blowout Preventer was removed from the wellhead and raised from the sea floor by the multi-purpose intervention vessel Q-4000. A hazards search of the BOP Stack was conducted. Initial stabilization activities were also performed on board the Q-4000. The Lower Marine Riser Package (LMRP) was separated from the lower BOP section prior to transferring the two units from the Q-4000 to a transport barge. The two units were then towed to the NASA-Michoud facility in New Orleans, LA.

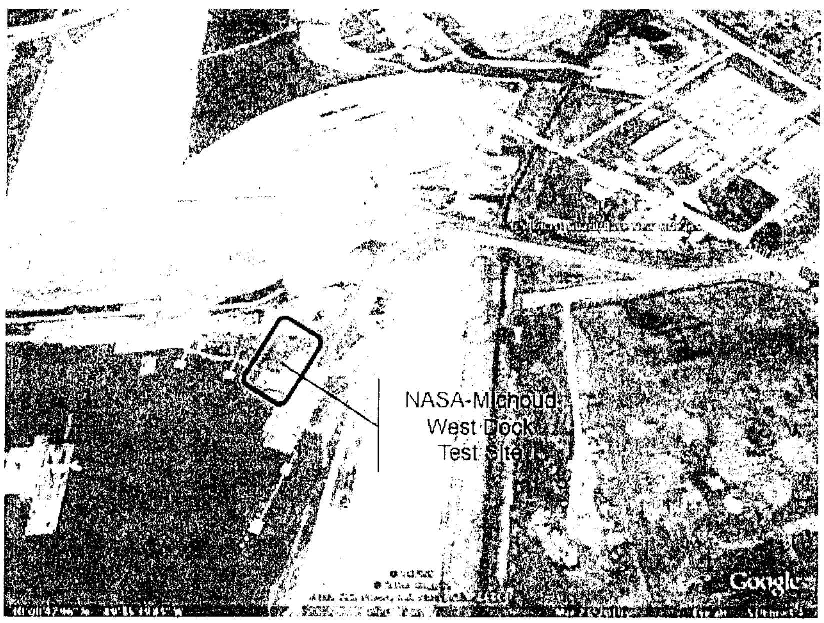

Figure 1 NASA-Michoud West Dock Test Site

The NASA-Michoud facility constructed two test pans or pads on their West Dock as part of their preparations to receive the two units. On October 3, the BOP and LMRP were lifted from the transport barge and placed on the test pans.

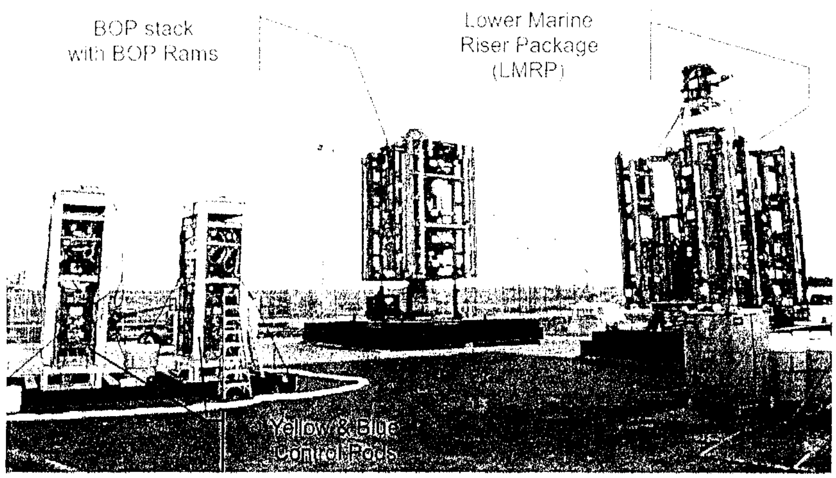

Figure 2 NASA-Michoud Test Facility Test Pads

Per contract requirements, DNV developed and submitted a draft test plan to the JIT for review, comment and approval. The JIT forwarded this plan to several Parties-In-Interest to the forensic examinations for their review and comment. These comments were returned to DNV for consideration and possible inclusion. Part of the forensic testing protocol was to establish a Technical Working Group (TWG) consisting of representatives from BP, Transocean, Cameron, Department of Justice, Chemical Safety Board and the Multi-District Litigation. A final test plan was approved by the JIT on October 27, 2010.

Forensic testing began on November 15, 2010. On December 23, 2010, the forensic investigations and testing on the West Dock stopped for enclosure construction. A temporary enclosure was constructed over and around the LMRP and BOP on the West Dock. Construction started on December 27 and continued on through January 28, 2011. During the enclosure construction period the drill pipe segments and rams were moved to Building 411 for cleaning and examination. Testing on the West Dock resumed on January 28 and continued through to March 4, 2011, when the last series of tests were completed.

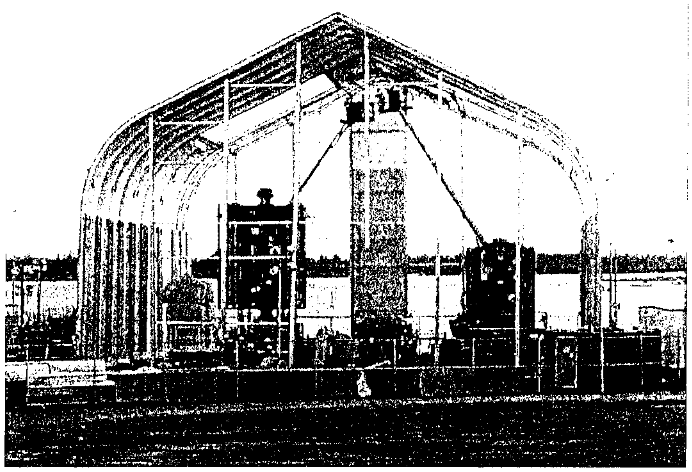

Figure 3 Early Stages of Temporary Enclosure Construction

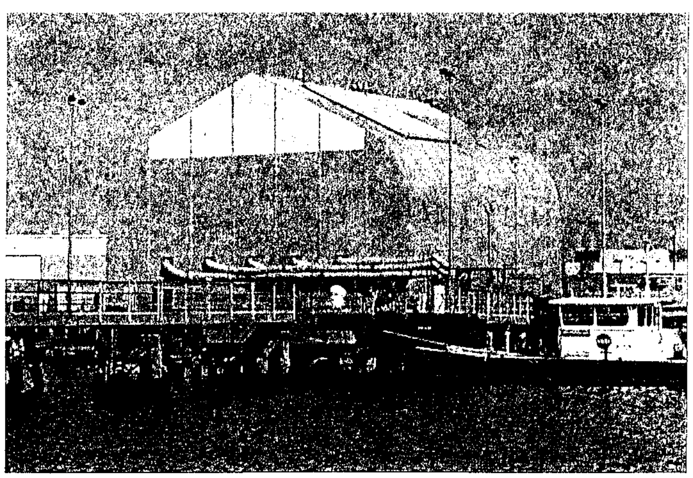

Figure 4 Temporary Enclosure

3 BACKGROUND

The rights to drill or explore the Macondo Prospect or well within the Mississippi Canyon are jointly owned by BP Exploration & Production (BP), Anadarko Petroleum and Mitsui Oil and Exploration Co (MOEX). The Mississippi Canyon is located approximately 40 miles off the coast of Louisiana.

The engineering and design of the well started in 2009. Drilling of the well began in October 2009 using the Mobile Offshore Drilling Unit "Marianas" which is owned by Transocean and was under contract to BP. Drilling was halted in November 2009 due to the passing of Hurricane Ida. Damage to the Marianas required it to be returned to dock for repairs and it subsequently went off contract. The Transocean Deepwater Horizon Mobile Offshore Drilling Unit was selected to continue drilling of the well.

The Deepwater Horizon started drilling in February and continued through to April 2010. On April 9, the well was drilled to its final depth of 18,360 feet.

During the afternoon and early evening hours of April 20, the crew performed two negative pressure or leak-off tests on the well. The second of these two tests was recorded as being completed at 21.10 hours. Approximately 30 minutes after having finished this test, the crew observed water and mud

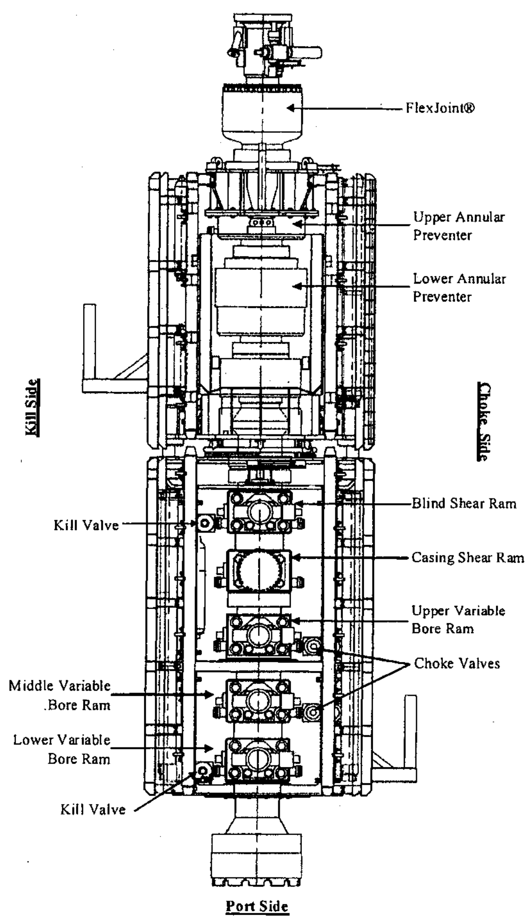

Figure 5 Deepwater Horizon BOP Port Side

on the floor of the drill rig. At 21:49 an explosion occurred on the rig followed immediately by fire. The Emergency Disconnect Sequence of the Blowout Preventer was reportedly activated just before 21:56. The rig was abandoned at 22:28.

Prior to, during and following the initial stages of the accident, numerous attempts were made to control the well by activating or functioning various components of the Deepwater Horizon's subsea Blowout Preventer (BOP). The Blowout Preventer is comprised of two primary packages or systems, the Lower Marine Riser Package and the lower section of the Blowout Preventer.

The lower section of the Blowout Preventer attaches to the subsea wellhead. The Lower Marine Riser Package attaches to the top of the lower section of the Blowout Preventer. When these two units are 'stacked' or attached they are generally referred to as the BOP 'Stack'. When stacked the two units are approximately 57 feet in overall height with a combined weight of approximately 400 tons.

The lower section of the Blowout Preventer consists of three sets of Variable Bore pipe Rams (VBRs), a set of Casing Shear Rams (CSRs), and a set of Blind Shear Rams (BSRs). The VBRs are designed to close and seal around drill pipe. The Casing Shear Rams are designed to sever casing (large diameter pipe). The Blind Shear Rams are designed to sever drill pipe that might be in the wellbore and seal the

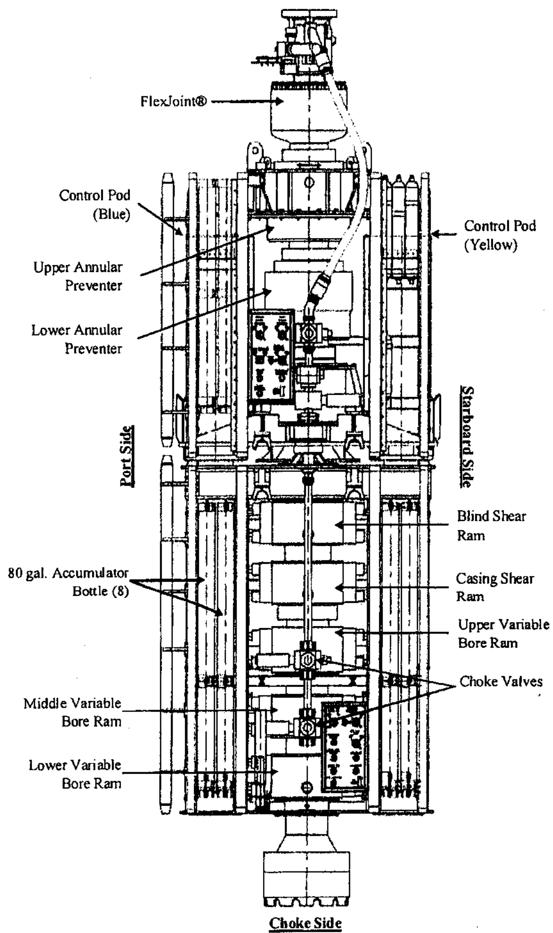

Figure 6: Deepwater Horizon BOP Choke Side

wellbore in the event of the loss of well control. The BSRs are the only set of rams designed to cut drill pipe and seal the well in the event of a blowout. The lower section of the BOP also contains 8 x 80 gallon accumulators. These accumulators contain a bladder separating the accumulator into two sections or chambers. One chamber is filled with nitrogen gas; the other chamber with a hydraulic fluid. The chamber with nitrogen is pressured to a level that is established and dependent on the depth of water in which the BOP will be located (i.e., the 'pre-charge'). The second chamber is filled with hydraulic fluid which is then pressured to a level also dependent on the water depth in which the BOP will be located. It is this hydraulic fluid which is used to function the blind shear rams in the event of an emergency.

The LMRP contains two annular preventers, the Upper Annular (UA) and the Lower Annular (LA). The annular preventers consist of a set of hydraulically activated fingers and an elastomeric element that can be closed which will compress and seal around the drill pipe. The LMRP is also fitted with two control pods, one designated "blue" and the other "yellow". Each pod contains a Subsea Electronic Module (SEM), a hyperbaric cylinder or chamber in which the electronic control circuits for both the LMRP and BOP components are housed. Each control pod is connected to the control systems or panels on the drilling rig itself by Multiplex (MUX) cables. These cables transmit power from the rig to the Control Pods as well as send and receive communication signals between the control panels on the rig and SEMs in the Control Pods. In addition to the MUX cables, a hydraulic line from the rig to the LMRP charges the subsea accumulators to function the hydraulic circuits of various stack components.

A Flex Joint mounted to the top of the LMRP connects the LMRP to the subsea Riser.

In situations where events could lead to the loss of well control or well control is lost, the various rams and annulars can be functioned to regain control of the well. Of these functions, as noted earlier, the blind shear rams are the only component designed to shear drill pipe that might be in the wellbore (the situation that existed at the time of the accident) and then seal the well.

The Blind Shear Rams can be activated in several different ways.

- Activation from either of two control panels located on the Deepwater Horizon rig itself
- Through the Emergency Disconnect Sequence which is also activated from either of the two control panels on the rig itself
- By the AMF/Deadman circuits located in the Subsea Electronic Modules within either of two subsea control pods mounted on the LMRP
- By the Autoshear function located on the BOP stack
- By ROV intervention through a panel on the BOP stack

Normal or standard closing of the BSRs occurs at a pressure of 3,000 psig. The blind shear rams can also be closed through a high-pressure circuit of 4,000 psig. The two control panels on the rig have systems or buttons that provide for closing the rams in 'normal' or high-pressure mode. The Emergency Disconnect Sequence, Autoshear and AMF/Deadman all activate the high-pressure circuits to the BSRs. ROV intervention bypasses the accumulators on the lower BOP and uses pumps and systems ancillary to the BOP accumulators to function the BSRs. The pressure and flows to close the BSRs using an ROV are determined by the capability of the ROV and its ancillary systems, not those of the lower BOP. When activated, the time for the BSRs to close is approximately 25 seconds (other than by ROV).

As noted earlier, at 21:56/57 or approximately six minutes after the first explosion, the EDS was reported to have been pushed. This was the only recorded activation of a system on the rig, which would have functioned the high-pressure blind shear ram circuit. Despite having initiated the EDS, the LMRP did not unlatch from the lower BOP (one of several EDS functions). Unlatching of the LMRP would have provided the ability to disconnect the LMRP and riser from the source of well fluids and the move the MODU from over the well. In addition, the well continued to flow through the BOP stack feeding the fires on the rig indicating the BSRs had not closed and sealed. At 18.00 on April 21, the first of several ROV interventions to control the well was initiated. A number of these interventions were focused on satisfying the conditions required to initiate the AMF/Deadman or the Autoshear sequences to close the blind shear rams. Despite these attempts, flow through the BOP stack continued. This indicated the blind shear rams had either not functioned, or if they had functioned, they did not close fully and seal the well.

On July 16, the flow from the well was stopped after a method termed a 'top kill' was completed. On September 19, Admiral Thad Allen, USCG, announced the well was effectively dead after a relief well was completed and cement was pumped into the Macondo 252 well to seal it.

4 OBJECTIVES AND SCOPE

For this testing and analysis, DNV was asked to determine the performance of the BOP system during the well control event, any failures that may have occurred, the sequence of events leading to failure(s) of the BOP and the effects, if any, of a series of modifications to the BOP stack that BP and Transocean officials implemented. As part of the foregoing task, the examination sought to determine the following:

- If leaks on the BOP were critical to the non-performance during the blowout and during the ROV intervention attempts
- If any modification(s) made to the control logic and stack inhibited the performance
- If any other relevant factor, including but not limited to manufacturing defects, deferral of necessary repairs affecting functionality, and maintenance history contributed to the BOP's failure to operate as intended

The scope of the investigation included the following:

- Develop and submit for JIT approval a forensic testing plan consistent with the JIT-provided examination objectives and parameters that included (1) forensic testing procedures for the BOP Stack and its components in accordance with established and accepted scientific protocols, methods, and techniques, and (2) processes and procedures DNV would implement to conform to the protection and preservation of evidence protocols also to be provided by the JIT
- Perform and manage the tests of the BOP Stack and its components
- Document and record the testing and all related and supporting steps and procedures, including the video recording of the examination in its entirety
- Conform with the protocols established by the JIT for the proper custody and documentation of chain of custody of the BOP Stack and its components
- Conform with the protocols established by the JIT for the proper protection and preservation of the evidence, which included all BOP Stack components and preservation (and, as necessary, replication) of all pertinent physical conditions associated with those components on the sea floor and otherwise, to the maximum extent possible, avoid destructive testing
- Identify and provide for all specialized third-party (subcontractor) testing and ensure that this testing was performed in accordance with all established JIT approved protocols
- Execute all necessary agreements to review and utilize proprietary information
- Review video of remotely-operated underwater vehicle (ROV) intervention operations during pertinent times
- Review government provided records obtained from the commercial parties relevant to the BOP and its components, including design specifications, schematics, purchase orders, maintenance and operating manuals, service records, and other documents

- Produce a factual report of the testing of the BOP and its components including review of the ROV intervention operations, conclusions, and professional opinions; the final report shall include as an index the administrative record of the testing procedure, including but not limited to, all emails, other electronic media, videographic and photographic documentation, and other contractor work product
- Testify in public hearings concerning the results of the testing and conclusions

5 METHODOLOGY

5.1 Evidence Collection and Control

Evidence was in the form of components removed from the BOP and LMRP during the investigation, items removed from the wellbore of the BOP and LMRP, or samples collected in the form of scrapings, particles, scale, coating samples, liquids, etc. All evidence was handled in accordance with the DNV Forensic Testing Plan.

US Coast Guard (USCG) personnel took possession of the evidence for secure storage. The FBI Evidence Response Team (ERT) recorded and documented all evidence.

The EPA National Environmental Investigations Center (NEIC) provided the primary support for all fluid samples collected during the investigation. The USCG personnel took initial custody of the fluid samples. The custody of the fluid samples was transferred from USCG control to the EPA NEIC for analysis.

5.2 Technical Working Group

The Parties In Interest Technical Working Group (TWG) was made up of technical representatives from interested parties including: Transocean, BP, Cameron, Chemical Safety and Hazard Investigation Board (CSB), Department of Justice, and two technical representatives from the Multi-District Litigation.

Meetings were held with the TWG on a daily basis to review site safety issues and the testing plan for the day. In addition, meetings were held on Wednesday afternoon to review the next week's work plan. Impromptu meetings were held with the TWG, or individual members of the TWG, to discuss issues as the DNV Investigation Team or the TWG deemed necessary.

5.3 Investigative Process

The investigative process was an iterative process that integrated the BOP and LMRP function testing, evidences collection, preservation of evidence (especially the drill pipe contained in the wellbores of the BOP and LMRP), materials examination and damage assessment, and video and photo documentation. In addition, as the testing proceeded, the findings dictated the sequence of steps required to balance further investigations and activities. Therefore, the protocols in the Forensic Testing Plan were not meant to be a step-by-step procedure, but rather provided a roadmap for meeting the objectives. Additional protocols that were outside of the scope outlined in the original testing plan were submitted to TWG for review and comment and to the JIT for approval. Detailed procedures to more fully describe a particular testing sequence were required on a routine basis. These detailed procedures were developed in cooperation between the DNV

Investigation Team and the TWG. In addition, the performance of these detailed procedures was documented through notes, photography, and videography.

5.4 Forensic Testing Plan and Protocol Development

The first activity was to develop and submit for JIT approval a Forensic Testing Plan consistent with the JIT objectives. The Forensic Testing Plan included forensic testing procedures for the BOP stack and its components in accordance with established and accepted protocols, methods, and techniques. The Forensic Testing Plan protocol and procedures conformed to the protection and preservation of evidence protocols agreed with the JIT. The protocols included professional video recording of the entire examination and complete photographic documentation.

DNV drafted a Forensic Testing Plan consistent with the examination objectives and parameters provided by the JIT, which included forensic testing procedures for the BOP stack and its components. The Forensic Testing Plan was presented in a meeting of the TWG for the purpose of review and comment.

As a result of the review and comment process, approximately 200 comments were received. The comments were reviewed by the DNV Team for technical viability, responses provided, and revisions made where appropriate to the Forensic Testing Plan. The revised Forensic Testing Plan was approved by the Joint Investigation Team on October 27, 2010. The approved Forensic Testing Plan is provided as Appendix A.

5.5 Site Preparation

As part of the preparations for receiving the Lower Marine Riser Package and the lower BOP, the NASA-Michoud facility constructed two test pans on the West Dock of the facility (see Figure 2). The test pans served two purposes, one to provide the necessary foundation for the receipt of the two units as they weigh approximately 190 tons each, the second to provide for secondary containment of any potential spills of hydraulic fluids or hydrocarbons contained within each of the units. With the removal of the rams and drill pipe segments, a second secure facility was necessary to carry out required evaluations. A building on the NASA-Michoud site (Building 411) was identified and prepared for this purpose.

Activities related to the mobilization included:

- Construction of security fencing around the test site and provision of guards for verification of permission to enter the test site
- Siting of a trailer to house an office for on-site technical staff and two additional trailers for evidence storage within the security fence
- Procurement of heavy lift equipment

- Construction of an enclosure around the BOP and LMRP stacks that was resistant to a wind loading of 105 mph
- Development and implementation of safety and environmental plans

5.6 Blowout Preventer Functionality

The forensic investigation as described in this report was both video and photo documented. This documentation was performed from multiple angles and included close-up documentation where details of specific activities or of specific component conditions dictated the need.

Video documentation was accomplished through J.A.M. Video Productions. J.A.M. used Sony A390 Digital Single Lens Reflex cameras with an aspect ratio of 3:2 and a density of 14 Megapixels per photograph. Each picture was recorded in a compressed jpg format in addition to a 'raw' uncompressed format. A variety of video cameras were used, including Sony DSR 570 cameras, with an aspect ratio of 16:9 and recording in High Aspect Definition. Other cameras of various sizes were required and used for examination and recording of information in areas such as the wellbore and ram cavities. The need for lighting was assessed and adjusted accordingly as each activity progressed.

Upon receipt of the BOP Stack at the site, a visual examination was performed. Part and serial numbers that were visible were recorded. Internal components of the BOP Stack were examined using a camera and video borescope.

The hydraulic circuits on the BOP Stack were examined and compared to the most recent working drawings, dated 2004. Modifications and ROV interventions as observed were documented on the 2004 working drawings (Appendix B).

The forensic testing of the BOP Stack was performed in accordance with the Forensic Testing Plan for the Forensic Investigation and Testing of the Blowout Preventer & Lower Marine Riser Package Ref – M10PS00234 (Appendix A) and commenced on November 15, 2010. In certain instances, decisions were made to deviate from the original test plan following discussions with the TWG and approval by the JIT where appropriate. From the period of November 15, 2010, to December 23, 2010, the following activities were undertaken:

- Determination of the final position of the annular preventers and rams
- Examination of the condition of the BOP and Lower Marine Riser Package (LMRP) wellbores, rams, and annulars
- Removal of drill pipe from the BOP and LMRP

On December 23, 2010, the forensic investigations and testing stopped for enclosure construction. A temporary enclosure was constructed over and around the LMRP and

BOP on the West Dock. Construction started on December 27 and continued on through January 28, 2011.

During the enclosure construction period the drill pipe segments and rams were moved to Building 411 for cleaning and examination. Following preliminary investigation of the drill pipe removed from the BOP, LMRP and Riser, prioritizations were discussed with the TWG members, agreed and then approved by the JIT. The purpose for prioritization was to focus the remaining function testing on certain critical functions and circuits that were involved in the attempts to control the well during the first two days following the blowout of the well and prior to the rig sinking. Testing at the West Dock test site restarted on January 28 and continued through to March 4, 2011, when the last series of tests were completed.

5.7 Materials Evaluation and Damage Assessment

Materials evaluation included (1) cleaning and examining the BOP rams, (2) cleaning and examining drill pipe segments removed from the BOP and LMRP, (3) cleaning and examining miscellaneous components extracted during the removal of the rams, and (4) sifting through viscous material(s) collected from different ram cavities and the wellbore and collecting and cleaning all solid objects found. Evidence collection included scale and debris from surfaces where appropriate. In addition, for the drill pipe recovered from the LMRP, swabs of the surface for microbiologically influenced corrosion (MIC) testing were performed.

Damage assessment was performed by several methods including (1) visual inspection and photo documentation, (2) dimensional measurements, and (3) three-dimensional laser scanning to characterize the as-received condition of the components. Laser scanning for the BSRs, CSRs, and VBRs recovered from the BOP and for all segments of drill pipe recovered from the BOP, LMRP, and Riser was performed with a FARO Laser ScanARM scanner. The ScanARM scanner is accurate up to ±0.0014 inches. Laser scanning for select areas of the wellbore was performed with a Nextengine HD Scanner. The HD Scanner is accurate up to ±0.005.

Samples were removed from each recovered drill pipe segment to examine the metallurgical and chemical properties of the pipe. Samples were removed from two of the recovered drill pipe segments to examine the mechanical properties (tensile and toughness). The samples to test the mechanical properties were taken from areas representative of the two joints of drill pipe recovered.

Miscellaneous pieces of solid materials/objects were recovered at different stages of the investigation. These materials/objects were inspected, cleaned and entered into evidence indicating the area from which they were recovered. The viscous material collected from different locations was sifted using a 1/4-inch screen. Solid materials/objects were removed, inspected, cleaned, and entered into evidence.

Structural analysis and modeling was used to simulate drill pipe behavior within the wellbore. The modeling package used was ABAQUS™.

5.8 Document Review

The document investigation was implemented by reviewing documents from various information sources. Sources included publicly available information and Government-provided records. Information was available regarding the BOP stack, BOP components, and the events leading up to, during, and following the incident. A comprehensive list of the documents reviewed is provided in Appendix C.

All received documents were initially reviewed by the document investigation team for content and relevance. Documents considered of interest or key to the BOP forensic investigation were subsequently examined in further detail.

The document investigation had three objectives:

- To create a timeline of events prior to, during, and subsequent to the Deepwater Horizon incident that occurred on April 20, 2010
- To provide on-going specific document review support to efforts toward the BOP Functionality testing, the Materials Evaluation and Damage Assessment, and the Cause Analysis
- To identify relevant documents regarding the working configuration of the BOP stack at the time of the incident

5.9 Remotely Operated Vehicle Intervention Operations Review

Remotely Operated Vehicle intervention video footage and still photographs were provided from several ROVs; the Millennium 36 and Millennium 37 from the Boa Sub C, the C-Innovation from the C-Express, and the Hercules 6 and Hercules 14 ROVs from the Skandi Neptune. Other video footage was made available and reviewed on an "as requested" basis.

The ROV video footage was reviewed with two objectives:

- To confirm the times, dates and activities referenced by other sources for the purpose of substantiating and illustrating timeline events
- To provide ongoing ROV video review support to confirm observations related to the BOP condition, the origin of leaks and modifications to the hydraulic circuitry
- To assess the impact of various ROV interventions undertaken to try and control the well

The ROV footage of primary interest was from the C-Innovation, Millennium 36, and Millennium 37. These three ROVs performed significant interventions following the incident. Dive logs were reviewed in detail and log entries of specific interest to the condition of the BOP were identified. Such log entries included monitoring of various BOP components, intervention efforts (cutting of the Autoshear pin, ROV hot stab, cutting of hoses, etc.) and identification and repair of leaks in the hydraulic systems. Specific successes/failures during the intervention efforts as well as general observations of BOP condition were noted.

The ROV intervention times and activities were cross-referenced to other supporting documentation where possible. Discrepancies identified were flagged for later confirmation. Times, dates and activities were then included in the "master" timeline that was developed as part of the document review task.

Information relevant to the BOP functionality testing task was relayed to project team members on site in New Orleans. As function testing evolved, requests were made by the project team members in New Orleans to review specific footage relating to the repair of leaks in the hydraulic system to assist in the testing program. In addition, the ROV intervention efforts were re-evaluated following retrieval and metallurgical analysis of the drill pipe, to support the overall effort of determining the sequence of key events that occurred both during and following the incident.

5.10 Failure Cause Analysis

The failure analysis approach used was based on the Systematic Causal Analysis Technique (SCAT™). The technique was developed by DNV to analyze the causes of failures and to assist in making recommendations to prevent future incidents.

The process involved development of a timeline, identification and investigation of key events, determination of both immediate and basic causes of failures, and rationalization and consolidation of causes.

The sequence of events allowed a list of possible contributing causes to be developed. BOP function testing results and information provided by the detailed timeline were then considered. Some possible contributing causes could then be eliminated. The nature of the evidence and the results of the examinations and testing allowed several conclusions to be considered.

OCS Report
MMS 2001-009

Investigation of Blowout and Fire Ship Shoal Block 354 OCS-G 15312 Well A-2 September 9, 1999

Gulf of Mexico
Off the Louisiana Coast

MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Regional Office

Investigation and Report

Authority

Uncontrolled flow of Well A-2 during coiled tubing operations occurred on Newfield Exploration, Inc.'s (NFX) Lease OCS-G 15312, Platform A, Ship Shoal Block 354, in the Gulf of Mexico, offshore the State of Louisiana, on September 9, 1999, at approximately 1545 hours. Pursuant to Section 208, Subsection 22(d), (e), and (f), of the Outer Continental Shelf (OCS) Lands Act, as amended in 1978, and the Department of the Interior Regulations 30 CFR 250, the Minerals Management Service (MMS) is required to investigate and prepare a public report of this accident. By memorandum dated September 10, 1999, the following personnel were named to the investigation panel:

Joe Gordon	New Orleans, Louisiana (Chairman)
David Dykes	New Orleans, Louisiana
Mike Saucier	Houma, Louisiana
Leslie Monahan	Houma, Louisiana

Procedure

On the afternoon of September 10, 1999, an inspector of the MMS Houma District conducted an aerial reconnaissance of the platform to assess the situation.

On the morning of September 11, 1999, an inspector of the MMS

(Page 5)

Houma District arrived at Ewing Bank Block 947, Platform A, where NFX personnel had set up their initial incident command center. Several members of NFX's incident command team briefed the inspector on the incident.

On September 12, 1999, an MMS inspector returned to the incident location to get an update on the response effort. The derrick barge *Hercules* had been brought on location to be used as a staging/support vessel, and was subsequently used as NFX's incident command center.

On September 20, 1999, Panel Members of the Accident Investigation Team were present at OSCA's Lafayette, Louisiana, office to witness the tear–down of the blowout preventer (BOP) stack and associated equipment.

On October 7, 1999, a meeting attended by representatives of NFX and MMS was held at the MMS Regional Office in New Orleans. At the meeting, the status of the investigation was discussed, as were a recap of the incident and emergency responses to the incident. MMS received copies of the eyewitness statements and requested a copy of the investigation report being prepared by a consulting firm, SAS Industries, Inc., contracted by NFX to investigate the incident. Signed

OCS Report
MMS 2004-048

Investigation of Loss of Well Control
Eugene Island Block 107, Well B-1 Workover
OCS-G 15241
8 March 2003

Gulf of Mexico
Off the Louisiana Coast

MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Regional Office

The ejection of the hanger along with tubing attached to it meant that the blind rams and pipe rams, though shut by the crew, could not control the well because tubing was across the rams and no shear rams had been installed. Evacuation of the Rig was then initiated.

Review of Design and Installation of Tubing Hanger

The cause of the ejection of the hanger and tubing was the subject of an internal Operator investigation in conjunction with an investigation by the Manufacturer of the hanger. These reviews determined through inspection of the tubing hanger spool and tubing hanger lockdown lock screws (or hold-down pins) that the hold-down pins holding the tubing hanger in place failed when the pressure reached approximately 6,100 psi (*see pictures, Attachments 7, 8 and 9, diagrams, Attachment 10 and 11*).

The hanger installed in the B-1Well was a Cameron-produced mandrel hanger that provided a metal-to-metal seal, as well as an elastomer backup seal. It was designed for use in critical service applications including high pressures up to 15,000 psi, and was rated to resist corrosive and erosive effects associated with well flow. The subject hanger spool was a 7 1/16" API 15,000 psi, top flange, Type C with a 1 1/16-inch T-40-CL hanger, holding the Well's 2 7/8-inch tubing set in tension.

When the annulus pressure in the Well suddenly rose, it was contained within the wellbore by the seal elements of the hanger, but because of the parted tubing at 1,900 ft, all of the pressure forces placed on the hanger were restrained only by the hanger hold-down lock screws (hold-down pins). As has been noted, the hanger in the B-1 Well was designed to sustain over twice the >6,000 psi pressure measured on the annulus of the B-1 Well, even with just the hold-down pins opposing the well pressure.

However, in the B-1 well, shortly after the annulus pressure in the wellbore rose above 6,000 psi, the nose of the hold-down pins retaining the hanger in place sheared off *(see pictures, attachment 8 and 9)*. The failure allowed the ejection of the hanger followed by loss of well control. According to well service reports, shortly prior to the failure, the hold-down pins of the hanger had been replaced by a representative of the hanger manufacturer, torqued and the settings were re-checked. The hold-down pins hold the tubing hanger in place and energize the sealing elements of the hanger as shown in *Attachment 11 and 12.*

Conclusions

A series of dependent events led to the loss of control of the Well. Absent one of the events or a change in order of the events, it is probable that Well control would have been maintained.

Cause of Loss of Control

1. A workover of the Well was required because extensive CO_2 pitting and corrosion caused communication between the production tubing and the annulus. The pitting and corrosion were exacerbated because the tubing string originally installed was not designed to resist CO_2 corrosion.

2. In an attempt to isolate the holes in the tubing caused by the corrosion, a number of through-tubing pack-offs were set. While these pack-offs failed to end the communication, they remained an impediment to through-tubing operations during any workover.

3. Subsequent suspected parted tubing was found after the pack-offs had been set. The parted tubing made retrieving the pack-offs impossible and the presence of the pack-offs made it impossible to use through-tubing means to isolate the under-pressured "P" sand that was the target of the workover, until the tubing could be fished to a depth that allowed conventional well- control methods.

4. The inability to isolate the communication between the annulus, tubing, and depleted "P" sand caused severe pressure differential to be created across from the "O" sand. The differential possibly reached a high of approximately 10,000 psi. Because of the pressure differential, the high pressured "O" sand then breached the isolation barriers between the reservoir and the well annulus by either compromising the cement sheath or casing integrity or both.

5. When the pressure from the "O" sand was observed at the surface, no effective method of circulating the kick existed because of the tubing string damage. Therefore, the only way to control the increasing pressure was to pump directly against the pressure, down tubing and annulus. This method was of questionable effectiveness because the severely under-pressured "P" sand would not support the hydrostatic head unless an LCM pill was able to lockup the "P" sand. However, the extensive

communication between the tubing and annulus made accurately spotting an LCM pill into the "P" sand perforations difficult. This in turn made it difficult or impossible to control the high pressure from "O" sand hydrostatically until the "P" sand could be completely isolated.

Before initiating a direct attempt to pump an LCM pill and heavier mud into the annulus to kill the high pressure, the last containment of the pressure, the tubing hanger hold-down pins failed. This failure was due to a fundamental Manufacturer design flaw. The ejection of hanger and tubing and loss of control were caused by this design flaw, the lack of suspended tubing weight, and the removal of the tree. The fact that no shear rams were installed prevented any control of the Well by use of the BOP's, once tubing was lodged across the stack.

Chairman HARRIS. With respect to the DNV report on the blowout preventer I think it is worth noting for the record there appears to remain a great deal of uncertainty surrounding what actually did happen that day and the conclusions reached in the report itself, so to that end I would like to enter into the record an article from the New Orleans Times-Picayune that summarizes some of the issues in question, in particular the accuracy of DNV's computer modeling that they use in their report of the blowout preventer. So thank you.

[The information follows:]

Everything New Orleans

BOP investigator admits to fault in model used in forensic examination

Published: Monday, April 04, 2011, 11:33 AM Updated: Monday, April 04, 2011, 11:45 AM

By **David Hammer, The Times-Picayune**

The maker of the blowout preventer that failed to shut in BP's **blown-out Gulf oil well** last year took aim at a **forensic examination** of its equipment, raising significant concerns about the models used by the inspectors.

The Associated Press

Oil leaking from the Macondo well blowout preventer deep in Gulf waters in June.

The inspectors at Det Norske Veritas (DNV) used computer models to determine that the massive blowout preventer failed to stop the blowout because it couldn't cut drill pipe that had shifted to the side.

The implication was that the BOP never had a chance and wasn't designed to handle the intense pressures of a deepwater blowout.

But a lawyer for Cameron International, the BOP's manufacturer, blasted the project manager for the Norwegian company hired to perform the autopsy during testimony in the Deepwater Horizon Joint Investigation **hearings that reconvened** in Metairie Monday.

The lawyer, David Jones, showed that a model used by examiners at DNV depicted an impossibility: In running the computer models of how a key set of slicers and seals would have malfunctioned, it placed the drill pipe where oil was flowing in a place where it couldn't have been.

The model showed the drill pipe inside a wall of the BOP, and Neil Thompson, the project manager for DNV, was forced to admit it was an error in the model placement.

That, combined with Thompson's acknowledgement that he'd "never laid eyes on a blowout preventer" before he began this examination, called into doubt some of the most critical findings of the report.

Thompson also admitted that his team never conducted tests to determine flow pressures or figure out what forces caused the pipe to deflect inside the BOP and muck up the works.

Some BOP experts have questioned why a set of pipe that was stuck in the BOP for two days after the accident would have shot up above the machinery after the rig sank. Thompson stumbled when Jones asked him repeatedly about how Det Norske Veritas determined a valve called the "upper annular" was closed. Testimony from surviving rig workers stated a different valve was the one closed.

Joining Jones in his skepticism of the forensic report was BP lawyer Richard Godfrey. He wanted to know whether there was any physical evidence that the 5.5-inch, heavy-duty drill pipe bowed in the middle, knocking it off-center. That's a key hypothesis of the inspectors' report.

Thompson said there was no physical evidence of the elastic bowing of the pipe. He said it was recovered as a straight, 28-foot piece because it would have straightened out after it was cut, about two days after the accident. Godfrey suggested that nobody in the industry had ever seen such "elastic buckling" of a drill pipe before. But Thompson said it's a commonly understood concept of physics.

Mr. MILLER OF NORTH CAROLINA. Is that the article that really talks about the lawyers questioning of the—okay. Well, I certainly welcome the Chairman treating lawyers as expert on all topics on which they represent a client.

Chairman HARRIS. That may be unusual for this physician, but anyway, Ms. Woolsey, you are recognized.

Ms. WOOLSEY. Thank you, Mr. Chairman. Mr. Chairman, for as complicated as this topic is, I feel like my questions are really basic, but I think they are necessary.

So, Mr. Kratz, when you were talking about Helix's fast response system being ready and up and ready to go now, how long did that take to develop, and what if we had had it in place before the Deepwater Horizon oil spill? How much difference would there have been in the results, and why aren't we doing this sooner?

Mr. KRATZ. I think it is important to note that Helix is a well-intervention company, which is different from a well service company like a Schlumberger or Halliburton. They are the ones that actually do the work down inside the well. Helix's expertise is actually getting onto a well and into a well. What we do every day with our vessels is intervene into live oil wells—and then allow the service companies to do the work.

So getting into the well is not new technology. In fact, the capping stack that we have we actually fabricated two years prior to Macondo so that the technology is there. We do it every day. It is reliable. The issue really is on readiness and preparedness because it is a complicated operation, and it takes an awful lot of people to be coordinated, and that is where the consortium has spent a lot of their time on preparing these procedures, and we have actually run two tabletop drills now just to refine it, where you are actually simulating a crisis and trying to———

Ms. WOOLSEY. Let me just interrupt a minute.

Mr. KRATZ. Sure.

Ms. WOOLSEY. That is why we care about this and this testimony on this subject today. So why didn't we have all that tabletop exercise done before this all happened? I mean, were people just taking it for granted?

Mr. KRATZ. That is a good question. I think the industry's predominant view was on prevention and probably an over-reliance on prevention, and I think following the Valdez incident there was a lot of focus on spill cleanup. The part that, you know, and there was supposed to be a renewal and—but as the industry went deeper, the missing link between the inevitable spill and the cleanup was sort of overlooked. And the innovation of our equipment for application onto the blowout actually came from the fact that innovation occurs through the commercial incentive of the well intervention market. It just happens that the same technology is very easily applied to blowout containment.

Ms. WOOLSEY. Okay, and with the idea that April 11 the new system will be up and ready to go feels a little bit like, well, company is coming. I am going to be a witness. I need to—we better hustle and get this done, but whatever, whatever the incentive was. It is good that you have that new technology developed or system developed.

Mr. KRATZ. We are actually late.

Ms. WOOLSEY. Well———

Mr. KRATZ. We had promised it over a month ago, so we are behind schedule.

Ms. WOOLSEY. Okay. Well, get on with it.

Dr. Der, last year this Committee and the full House passed my legislation, the Oil Pollution R&D Program Reauthorization Act, which would have doubled the federal investment in oil spill response technologies, and unfortunately, the bill was not taken up by the Senate.

But my question to you is in your opinion would doubling—is it— I mean, currently do we have enough federal investment or would it have been better to pass this and double the investment in oil spill technologies? How much do we need, and who should contribute?

Dr. DER. Well, as I mentioned before, and I think the Secretary of energy has testified that the funding of oil and gas research relating to safety and environmental mitigation should be the responsibility of the industry since they are a very big industry, they can afford to do that kind of work. Our role in the Department of Energy would be to help guide some of that activity, but I think in the end it should be funded by industry. Our ongoing work in Section 999 has refocused the emphasis on safety and response and environmental aspects and sustainability.

Ms. WOOLSEY. So, your current budget in order to do this oversight that you—encouragement, is it enough, or would you prefer that we increase it?

Dr. DER. Primarily I would have to say that the response to oil spills is primarily the responsibility of the U.S. Coast Guard and those programs that come under its purview, but the Department of Energy does have a lot of technical expertise that could help in that regard.

Ms. WOOLSEY. That is right, and the Department of Energy is part of the team of the Coast Guard and NOAA to keep these systems and these programs current. I mean, we were way back in another century virtually when we got—came forward for this deep water protection and know how.

So okay. I just wanted to make sure you knew that we were trying to get you more.

Dr. DER. Appreciate it. Thank you.

Chairman HARRIS. Thank you, and I am going to take the opportunity to ask a few more questions and give the opportunity to any member here to continue questioning at this point.

Mr. Kratz, let me ask you a question—to recap part of your testimony, obviously from your testimony had that accident occurred after April 15 when this 15,000 pound per square inch cap would be available, your opinion would be that could have been contained?

Mr. KRATZ. Our current depth, the 10,000 pound cap could have contained the well.

Chairman HARRIS. Well, I thought the testimony was that the measured pressure was 11,800 or something. It is in your———

Mr. KRATZ. Yeah. Shut-in pressure that was within———

Chairman HARRIS. Okay. So that could even be done by the system we have now. So let me ask you. Where does that stand, that kind of pressure? Where does that stand within the range of what is—and I got to ask. Are pressures always measured? Are these estimated pressures? What are they?

Mr. KRATZ. The shutting pressure?

Chairman HARRIS. Yes.

Mr. KRATZ. That would be read off of a gauge.

Chairman HARRIS. So it is measure—all right. So what is the range of measured pressures that you have? As we gauge whether or not your systems would be adequate to reasonably, very—prevent the vast, you know, virtually 99.9 percent of these kind of problems. What is the range of pressures that are measured?

Mr. KRATZ. A majority of the systems internationally might comment on it, but are rated at 10,000 PSI. It is only more recently that the 15,000 PSI pressures have been encountered, and you are seeing a greater and greater proliferation of it, but still, 15,000 PSI is relatively rare.

Chairman HARRIS. That would be rare. And—let me ask you. Do you—does your company also do bioremediation, or is that the idea of developing something that eventually—if some oil spills, you know, some bacteria or some organism actually just consumes it?

Mr. KRATZ. No.

Chairman HARRIS. Who does that?

Mr. KRATZ. I believe that would come more under the purview of spill cleanup kind of a company, which we are not involved with.

Chairman HARRIS. Well, Dr. Der, let me ask you. Has your shop done any of this? I mean, that would come right under the purview of environmental, you know, environmental protections against spills, and you know, that is the kind of biological development that may fall in the cracks. I mean, you know, I don't think the NIH is doing it, you know. Mr. Kratz is not going to do it. Who would be doing that, and how are we developing those other—those alternative, those thinking outside the box techniques?

Dr. DER. Well, again, the response capability to spill response is the U.S. Coast Guard's, but I think the technologies that we have been working on in the laboratories may have some bearing on that. Again, our role is to help, assist and to advise through our program with the Safety Advisory Committee.

Chairman HARRIS. But is it funded through this program? Because, I mean, the recommendation was to eliminate this program, and my only response is as I think Dr. Macauley mentioned, there are some things that probably you might need, you know, government research support in order to develop some things to make these types of endeavors, these exploration and production endeavors that are safe.

Dr. DER. The program that we have currently and under the Section 999 was refocused from the efficiency and economics of production into safety and environmental aspects, and I am not 100 percent clear that we have that funding under Section 999.

Chairman HARRIS. Well, but why not? I mean—why would you want to zero out a program when there are questions that, really some basic questions that could be answered that could result in, in fact, even say for production and exploration.

Dr. DER. Well———

Chairman HARRIS. I guess I am asking—are we really sure there is not a role for some basic research to be done to make these techniques production, exploration safe and environmentally sound?

Dr. DER. I think there is, but my point is that the funding of those types of technologies should come from industry, and they can make use of the resources that we at the Department of Energy and our national labs have.

Chairman HARRIS. So that would be in contra-distinction to, for instance, how we handle medical research where you could say, look, you know, medical device companies, hospitals, they all make a lot of money, but yet—we think there is a role for some basic research in other areas of the government. So you think we should just think about this completely differently?

Mr. DER. I am not familiar with the medical field, sir.

Chairman HARRIS. Well, we spend tens of billions of dollars on research that one could make the argument that some pharmaceutical company should fund, some medical device company should fund, so, you know, someone who is going to make money on the final product should fund it.

So I just ask that you consider that it is my opinion that there may be areas like that.

And, Dr. Macauley, I was going to just ask you because you mentioned it and perhaps there may be some errors. I mean, what kinds of new science do you think might be under the purview of the Federal Government to be involved in? Basic materials? Yeah. Bioremediation. What do you think?

Dr. MACAULEY. Yeah. I think this discussion of what is the basic research is an interesting one. My colleagues and I when we were working for the—on our research project, we were searching to find a discussion of the R&D that would be needed to see how much of it is basic, how much of it is development, how much is it ready to prototype. This is why I think there is a policy gap at the moment. I am not sure we have a full understand, and if it is really, really basic research, it could be exactly what we need for, you know, the stem concerns, the science, technology, et cetera.

So I would love to see that intersection, but we weren't able to find anything, you know.

Chairman HARRIS. That is being done. Well, thank you very much.

Mr. Miller.

Mr. MILLER OF NORTH CAROLINA. Thank you, Mr. Chairman. I think when the Chairman and I agree we should pause and celebrate that as we did when he earlier agreed to the expertise of lawyers on almost any topic.

But—and I am very pleased to hear you supporting research, but we saw in H.R. 1 dramatic cuts in research funding and even in this Committee just a couple, three weeks ago cuts to the FAA's Authorization Bill for research into, flight safety.—Icing, human error, cockpit fires, and smoke— and the argument for cutting that funding was that that it was applied as opposed to basic research, and applied research should be paid for by the industry, not by the government.

It certainly appears that this industry, the oil and gas industry, is vastly more profitable than the airline industry, and I know that there is not a bell that sounds when basic research crosses over into applied research, but is correcting the flaws in a blowout preventer or containment technologies basic or applied research? Anyone? Dr. Macauley?

And do you agree with that distinction and that we shouldn't fund applied research?

Ms. MACAULEY. I never argue for government intervention unless it seems to really, really be necessary, and I comment that industry will do the innovation on its own. Sometimes industry does, something industry doesn't, and it is identifying is there a market failure in R&D to ensure the health of our offshore deep water drilling industry.

That is a gap in our understanding as policymakers at the moment, and I do hope that we can get a better handle on where those gaps are and what is the nature of the R&D, and who is doing it.

Mr. MILLER OF NORTH CAROLINA. Okay. Well, Dr. Macauley, you said that there was more than just the economic consideration of liability. There is reputation at stake. But I have seen folks who have made a whole lot of money doing really disreputable things be accepted into polite society, and their acceptance seems to have been greased by how much money they had.

Now, I know that Tony Hayward, it appeared to hurt his feelings how much criticism he got. This industry seems to be vastly profitable and not terribly bothered by the bad press that they may have gotten.

Mr. Miller, what percentage of the industry's profits went into safety research and development before this?

Mr. MILLER. Well, I don't have that information with me, but I know that we have done studies on the basic R&D that the industry does and percentages and to different areas, and I will be happy to get that information back to you. I just don't have it with me.

Mr. MILLER OF NORTH CAROLINA. Okay. Anyone else venture a guess on that?

Okay. Mr. Chairman, I yield back.

Chairman HARRIS. Thank you very much, and I would like to recognize the Chairman of the Committee, Mr. Hall, for any questions.

Chairman HALL. Mr. Chairman, since like everybody up and down the row here on both sides have other things they have been doing all day today and the problems we have, I have been looking for a doctor to give me an appointment tomorrow to take my appendix out again where I won't have to cast those bad votes tomorrow, but I haven't been able to get that.

But I won't take their time because———

Chairman HARRIS. I could do the anesthesia.

Chairman HALL. —I don't know what has been asked, but if I might, I will send some questions in, and I am sure they will answer them if you as them to properly.

Chairman HARRIS. Thank you very much, Mr. Chairman.

Chairman HALL. Thank you.

Chairman HARRIS. I am just going to follow up just one very brief question before we close the meeting.

I guess—along the lines of what I was suggesting was, for instance, I am going to ask Mr. Kratz and maybe Mr. Miller, you know, when you design, for instance, you showed us all the materials that you are going to put down under, you know, 10,000 feet of water for instance. There has to be some fairly basic research into materials that I am sure your company doesn't do. I mean, really basic research on materials that can withstand that pressure.

So along the lines, and you know, the ranking member brings up a good point. I mean, the blowout preventer appears not to have worked, but maybe it was a materials issue on what the material was, and you know, the Federal Government supports a lot of materials research.

Does the industry have the ability to do that? And, Mr. Miller, maybe you can answer. Is there something within the industry that can do that?

Mr. MILLER. Well, that is a really good question. We have been working for a little while now on a new standard on high pressure, high temperature equipment. In particular, we are looking at equipment that will be rated higher than the 15K, 15,000 that Mr. Kratz mentioned.

And one of the real challenges for us in developing that standard is the material section because what we want to develop as many of our standards are primarily performance-based standards. So we will set the criteria for generally speaking what the performance of the material must be but not make it so specific that it excludes the innovation and industry.

And so what we ask the Members of the Committees to do is to bring to us their broad outlines so that we can craft a standard along those lines to allow that innovation to continue to take place as was mentioned earlier.

But I can provide that information back to you and where we are on that standard and when we expect to publish it.

Chairman HARRIS. Thank you very much.

Mr. Miller, anything else?

Mr. MILLER OF NORTH CAROLINA. Well, Mr. Chairman, just because you asked questions I think I should.

This—well, first of all, it is pretty clear that the blowout preventer didn't work because there was a blowout that was not prevented. So I think we can say conclusively the blowout preventer didn't work, and we can argue about why, but I don't think you can argue about whether.

We have been talking about an event at 5,000 feet below—about a mile deep—below the surface and how extreme that is, how extreme the pressures are, et cetera, and now we are talking about drilling 10,000 feet.

Is that going to double how extreme, or is it more exponential? What are the pressures going to be at 10,000 feet as compared to 5,000?

Mr. KRATZ. I will start. I think the industry is, if not prepared, has been preparing for quite awhile for 10,000 feet. The Q4000, for instance, there was a lot of R&D help from tax credits on that vessel. It was the first vessel specifically designed to work in 10,000 feet of water, funded by MARAD.

Since then, you know, we are producing out at 9,000 feet, so there has been and there continues to be and especially with Brazil on the horizon, there is a lot of incentive for the industry to develop the capabilities in 10,000 feet of water. Most robotics now are designed for 10,000 feet of water. In fact, 10,000 feet of water is becoming pretty much of a standard basic design parameter for any service company or drill or doing work in the deep water.

Mr. MILLER. And one thing that I could add, Ranking Member Miller, is that as we move into some of the ultra-deep water, some of the things that we want to look at are the idea of what is known as a safety case approach. This is a recommendation that our joint industry task force made to the Department of Interior when we had those 30 days to respond right after Deep Water Horizon, and it was included in the final White House report that they would consider a safety case.

And what that is is a more risk-based approach so that you are looking at your actual individual well, and you are combining the safety approach from both the driller and the operator to make sure that you have considered all these different risks as you described when you move into different environments.

So that is another area that you could sort of innovate on how you approached safe operations and your compliance.

Mr. MILLER OF NORTH CAROLINA. Mr. Chairman, I don't have anymore questions unless you do.

Chairman HARRIS. No. Thank you very much. I want to, listen, I want to thank the witnesses for your valuable testimony, and the Members for questions.

Again, I want to apologize for us starting late, but I will have you out on time because your time is valuable.

The Members of the Subcommittee, including those who weren't here today, may have additional questions for witnesses and would ask for you to respond to those in writing. The record will remain open for two weeks for additional comments from Members.

The witnesses are excused, and this hearing is now adjourned.

[Whereupon, at 3:59 p.m., the Subcommittee was adjourned.]

Appendix I:

ADDITIONAL MATERIAL FOR THE RECORD

PREPARED STATEMENT BY REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Chairman Harris

I appreciate the opportunity to discuss this important topic.

As a Texan I am very familiar with the oil and gas industry. Oil derricks are as much an icon of our state as the cowboy hat and boots. Much of the state's history and economy is built upon the enormous profits of the industry. However, we have also seen the downside of booms and busts in oil and gas, and have diversified the state's economy to protect ourselves from fluctuations in the market.

My constituents also spend a lot of time in their cars, and feel the pains of high gas prices. But, contrary to the claims of some, this pain is not caused by President Obama's drilling policies. Instead we should acknowledge that the price of oil is, by and large, out of our control. Despite reducing our net oil imports by 10% in the last two years, we cannot count on drilling our way to energy independence and low gas prices. We simply don't have the oil. And, even if we did, we would still be vulnerable to price volatility and manipulation in the global marketplace. In the long-run, our only recourse is to wean ourselves off of oil. It is an addiction we cannot afford.

As Texas has done with its economy, the Nation should be protected from the potentially devastating effects of an unpredictable global oil market. We must diversify in the fuels we use to power our transportation sector, and we must do so in the most environmentally benign way possible. From its earliest days, oil and gas drilling has been tough and dangerous work. It is an impressive testament to human ingenuity to move a hydrocarbon molecule from thousands of feet underground to your car's engine, and all for a few dollars per gallon. But it is also dirty work, and the Deepwater Horizon disaster highlighted that pushing the technology envelope to drill in ever deeper waters also exposes workers, the public, and the environment to new risks.

Regardless of the contribution to our economy, no industry has a right to neglect public health and environmental safety. Instead, the oil and gas industry should take responsibility and devote some of its intellectual and technological capacity to developing safer drilling practices and advancing the technologies to respond to spills when they happen.

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