U.S House of Representatives
Committee on Science and Technology
Subcommittee on Energy and Environment

Deluge of Oil Highlights Research and Technology Needs for Oil Recovery and Effective Cleanup of Oil Spills
June 9, 2010

Statement of
Dr. Richard C. Haut
Senior Research Scientist
Houston Advanced Research Center

Good morning Chairman Baird, Ranking Member Hall and Members of the Subcommittee.

My name is Rich Haut. I am currently employed at the Houston Advanced Research Center, a 501(c)3, non-profit organization. (www.harc.edu) At the Center, we use the tools of science, policy and technology to provide new knowledge about the complex balance between environmental, social and economic issues. We are funded on a project-to-project basis by local, state and federal agencies, as well as industry and foundations. The Houston Advanced Research Center is a boundary organization, working with universities, industries, environmental organizations and government entities to take an unbiased, scientific approach to provide scientific based reasoning for policies and to push environmental based technologies to commercialization. Businessman George P. Mitchell, supported by four Texas universities, created the Center in 1982. Today the Center is focused on three areas: 1) clean energy, including the acceleration of alternative energy, 2) air quality research that includes emissions technologies and transportation policies and 3) the interaction between natural and human systems.

I am also on the board for the Research Partnership to Secure Energy for America (RPSEA: www.rpsea.org) where I chair the Environmental Advisory Group. The Research Partnership has over 160 universities, companies and organizations nationwide and is the research management organization coordinating 37.5 million dollars of research funding per year that was created by section 999 of the Energy Policy Act. This funding is related to deepwater oil and gas development, unconventional natural gas development and technology requirements for small producers. The Environmental Advisory Group consists of members from universities and industry as well as representatives from prominent environmental organizations.

The recent incident involving the Deepwater Horizon at Mississippi Canyon Block 252 (MC252) is a tragedy. As the investigation continues with the objective to identify the root cause of the accident, the failure of the system and the resulting impact has already identified specific areas requiring research.

The offshore drilling industry had an extraordinary safety record. No one expected the incident to happen. The incident has appropriately caused everyone to reflect, refocus and rethink about the importance of offshore production and the research needed to ensure the safe, environmentally sound production of these reserves.

The Need for Energy

The Energy Information Administration's Annual Outlook 2010[1] projects that total U.S. consumption of liquid fuels, including both fossil liquids and biofuels, grows from 19.5 million barrels per day in 2008 to 22.1 million barrels per day in 2035. U.S. dependence on imported liquids is expected to decline from the 60 percent share attained in 2005-06 to 45 percent in 2035. Domestic crude oil production increases from 5 million barrels per day in 2008 to 6.3 million barrels per day in 2027 and remains at just over 6 million barrels per day through 2035.

Production increases are relied on from the deepwater areas of the Gulf of Mexico and from onshore enhanced oil recovery (EOR) projects. Efforts to increase the share of domestically produced oil in the Nation's liquid fuel supply are generally seen to be serving a beneficial purpose from both economic and energy security perspectives, provided they are done in an environmentally safe manner. The future of the U.S. energy supply is dependent upon the reserves located in the deepwater areas of the Gulf of Mexico.

The recent incident involving the Deepwater Horizon underscores the need for research to address critical aspects of deepwater developments. An objective, science based program may be undertaken with three main objectives:

- Enhance Technologies to Minimize Incidents
- Identify, Develop and Improve Proactive and Reactive Response Procedures and Processes
- Develop Understanding of the Value of Ecosystem Services and Identify Locations of High Value in a Seasonally Dynamic Ecosystem

Enhance Technologies to Minimize Incidents

The first objective of a comprehensive research program is aimed at preventing incidents from occurring. A review of the state-of-the art of technologies that may be used to improve safety, wellbore integrity and environmental protection of deepwater operations could identify priorities, technology gaps and further research needs. The review may consist of an evaluation of existing safeguards and international offshore procedures, standards and practices as well as identifying promising technologies that can address safety and environmental concerns associated with deepwater, harsh environments.

One of the programs that I direct is the Environmentally Friendly Drilling Systems Program (www.efdsystems.org). Our research team consists of several universities and national laboratories as well as industry. Our advisory committee has members from all stakeholder groups, including prominent environmental organizations, industry and concerned citizens. We focus on identifying and developing new technologies for environmentally sensitive development of unconventional onshore energy resources. The objective is to identify, develop and transfer critical, cost effective, new technologies so that onshore reserves may be developed in a safe and environmentally friendly manner. One of the elements of the program is an environmental tradeoffs scorecard that is based on the U.S. Green Building Council's methodology and has been supported by all of our program stakeholders. Another element is the handling of produced water.

[1] EIA, 2010, Annual Energy Outlook 2010, DOE/EIA-0383(2010): http://www.eia.doe.gov/oiaf/aeo/overview.html

The Environmentally Friendly Drilling Systems Program can serve as a model for an analogous offshore program that enables all stakeholders to identify needed research, to provide direction and to follow progress. Our Program recently started up a European chapter, partnering with a university in Austria. In September we will be having our first exchange, discussing new technologies, best practices, standards and regulatory frameworks related to onshore unconventional natural gas operations.

An offshore program could be developed using the same organizational structure as the Environmentally Friendly Drilling Systems Program. This new research program may, in addition to identifying and developing new technologies, explore the various approaches for regulating safe activity in the offshore sector.

Norway, for example, has moved over time from a prescriptive-based framework to a performance based framework. A prescriptive system is based on laws and regulations that set specific demands for structures, technical equipment and operations in order to minimize accidents and hazards. In a prescriptive system, regulations state the necessary requirements of safety and companies are monitored to ensure that they comply.

By contrast, performance-based regulation involves specifying the performance or function that is to be attained or maintained by the industry. The regulations define the safety standards that industry must meet. Authorities check that industry has the management systems that permit such compliance. Companies must select the solutions that fulfill the official requirements.

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

The research program may also address recommendations contained in the Secretary of Interior's May 27, 2010 report: "Increased Safety Measures for Energy Development on the Outer Continental Shelf," in particular, recommendations concerning well control systems and safety equipment. Other research needs related to wellbore integrity includes cement evaluation technologies, how to maintain communication and power between the surface and subsea safety systems and increasing the intervention capability of remotely operated vehicles.

Identify, Develop and Improve Proactive and Reactive Response Procedures and Processes

The second main objective of a comprehensive research program would address the research needed to minimize the time to respond to an incident as well as to minimize the environmental impact. In open-water marine spills, there are four primary response objectives:

1. Prevent the spill from moving onto shore
2. Reduce the environmental impact
3. Speed the degradation of any unrecovered oil while minimizing the harm on the ecosystems
4. Mobilize rapid well intervention/containment standby equipment

The industry has various vessels and equipment on standby used to contain spills, to skim, and to deploy dispersants. A research program may be established to identify the state-of-the-art technologies and methodologies and identify what else could be necessary in order to respond to an emergency situation. The Secretary of Interior's report, previously mentioned, also recommends a comprehensive study of methods for more rapid and effective response to deepwater blowouts.

This program may also include early warning sensors that may identify potential hazards to the environment as well as to understand the movement of marine life and wildlife that may be affected by an incident.

In addition, I previously mentioned that through our Environmentally Friendly Drilling Systems program we are evaluating equipment for produced water handling. Equipment and systems that handle onshore produced water could be possibly modified for handling oily water that is associated with offshore skimming technology. The research program may include the research and development required to progress technologies that can optimize offshore skimmers.

We know that BP has been requested to employ less toxic dispersants than the two chemicals that were being used. Louisiana State University, a member of the Research Partnership to Secure Energy for America, will be evaluating the effects of using hundreds of thousands of gallons of toxic dispersants on oil at and below the surface of the ocean. They will investigate where the dispersants are going, whether there is a good mix of water, oil and dispersant, and the effects of the dispersants on oil and then they will follow the dispersant through the recovery phase. The robust research program will investigate the impacts of dispersed oil and the dispersants.

The expertise to study the effects on the coastal wetlands may be found at Louisiana State University, along with other Gulf Coast universities. The Research Partnership to Secure Energy for America provides the structure for these researchers to exchange ideas, transfer technologies to industry and provide the unbiased science to develop sound policy.

The Houston Advanced Research Center has managed an innovative and unique air quality research program for the state of Texas. This research program is a collaboration of civic, industry, environmental, and local and State government entities. Over the last six years the program has administered over $10 million of research funds aimed at improving emissions inventories, air quality modeling and monitoring, and air regulations and policy. Among

other accomplishments, this program has enhanced meteorological and air quality model performance.

Controlled burns have been used to augment skimming activities associated with the Deepwater Horizon incident. When sea conditions allow (when seas are below 3 feet) fire booms towed behind two boats are used to pull oil away from the main spill for safe burning. A research program may be established to understand the environmental impact of controlled burns. For example, satellite data can now be used along with so-called "inverse" atmospheric models to keep track of emissions from controlled burns. The Houston Advanced Research Center has also developed new combination remote sensing and fast point sampling technology that can measure air emissions from controlled burns from ship platforms or from onshore. An important new area that can be develop is full multi-media modeling, that is modeling of air/water/soil compartments, of the local and distant impacts of controlled burns and other off-shore operations.

Develop Understanding of the Value of Ecosystem Services and Identify Locations of High Value in a Seasonally Dynamic Ecosystem

The third main objective of a comprehensive research program would develop an understanding of the value that various ecosystems supply. The marine and coastal areas of the Gulf of Mexico are home to highly productive and valuable ecosystems. These ecosystems provide a wide range of benefits known as ecosystem services including fishing, primary production, nutrient cycling, tourism, storm surge mitigation, climate regulation, wildlife habitat, water quality and aesthetic and cultural benefits. Ecosystem service benefits arise from the functioning of a healthy ecosystem and provide significant value to people – monetarily, environmentally, socially and culturally. A research program may be established to investigate how these benefits vary with spatial or temporal changes in the ecosystem, developing a clear understanding for the Gulf's many stakeholders. Areas that supply high-valued ecosystem services may then be identified in order to prioritize where to place appropriate monitoring and early warning devices.

With over 95,000 miles of coastline and the largest exclusive economic zone in the world, the US benefits significantly from goods and services derived from the ocean and coasts – food, minerals, energy and other natural resources and ecological benefits. Economic activity in US coastal regions and waters account for a large portion of the national economy, totaling trillions of dollars each year. Nearly half of the US population is located in coastal counties. The oceans also play a primary role in the Earth's environment and natural operations, shaping and sustaining life.

Currently, marine ecosystem health and the benefits humans receive from these ecosystem services are threatened by a range of challenges. The challenges include increased levels of exposure to toxins and pollutants from harmful algal blooms, industrial emissions and accidents, agricultural runoff, and other sources. Overfishing and certain fishing techniques remain a serious concern with significant consequences for the health of marine ecosystems. These challenges are increasing stressors and impacts on the marine environment, people and communities, and are presenting management issues that need to be confronted. Energy development, shipping, aquaculture and emerging security requirements are examples of uses that place increasing demands on the oceans' ecosystems.

A research program may be designed to develop ecosystem management tools and metrics applicable to coastal and offshore regions. The program can identify, assess, and recommend remote sensing technologies and ecosystem services models and methodologies appropriate for marine ecosystems. The basic components of the program's conceptual framework would be remote sensing technologies that can gather data on ecosystem attributes, ecosystem function models that can approximate the response of the ecosystem attribute to stimuli (such as presence of an oil spill, change in water temperature, shifts in population, or installation of new infrastructure), and the ecosystem services models that can evaluate the changes in benefits received by humans from the working environment. The program would improve the understanding of how changes in the physical, biological, ecological and chemical marine processes are connected with social and economic consequences of management decisions on the long-term health and well-being of the oceans.

Remote Sensing – Measuring the complexity of species and their natural environments may be time consuming and expensive. However, remote sensing techniques used for mapping and monitoring of terrestrial and ocean conditions via the reflective or absorptive properties at particular energy spectra may effectively monitor specific resources across large scales. It is, for example, possible to estimate the species richness of terrestrial ecosystems across regional scales using Normalized Difference Vegetation Indices (NDVIs) derived from National Oceanic and Atmospheric Administration (NOAA) satellite imagery. Indicators of ecosystem health and productivity, such as chlorophyll concentration and biomass production, can also be assessed using satellite imagery. For marine ecosystems, several datasets useful for assessing ecosystem attributes are routinely collected including Chlorophyll-a measurements, sea surface temperature, and surface reflectance. Advanced Very High Resolution Radiometer (AVHRR) and Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data are routinely used to monitor the density of phytoplankton in the surface waters of the oceans.

In addition to satellite imagery, aerial sensors can be used across smaller scales to provide finer resolution imagery, which is often used as a ground-truth when studying satellite imagery. Light Detection and Ranging (LiDAR) data is also obtained via aerial platforms and can be used to measure ecosystem complexity or suitability as habitat for a particular species.

A research program could explore the use of satellite and aerial measurement technologies for measuring and monitoring marine and coastal ecosystems, and the subsequent linking of these data into spatially-cognizant ecosystem function and service models.

Ecosystem Function and Service Modeling –The valuation of ecosystem services is done to 1) to estimate a value of ecosystems services both as they exist now and relative to other economic activities and 2) to conduct scenario analysis to better understand changes in the value of ecosystem services due to impacts on the quality or quantity of these service flows and stocks. Typically, these studies have been one-off, location-specific studies with the set of economic tools remaining fairly constant, but with advances over time in the methodology for implementing these tools.

Methodologies to value ecosystem services have and continue to be developed to improve inclusion of environmental services and resources in policy making regarding resource and development management. The value that these services have for society, businesses and

individuals remains largely unknown in any measureable sense and often in a conceptual sense. Without measurable values, it is difficult to evaluate tradeoffs resulting from different management or development options or changes from other impacts. Ecosystem service values give a clearer idea of human benefit that is consistent with improving welfare.

Identification or development of an ecosystem response function is necessary for modeling marginal changes in ecosystem services. An ecosystem response function will allow both 1) a quantitative link between ecosystem attributes and ecosystem services and 2) an ability to model scenarios or marginal changes in the ecosystem. The program will also identify or develop a computer based evaluation process that will aid replication of analysis.

Studies in ecosystem services valuations must carefully consider the trade-offs between costs and accuracy. Original research provides more reliable and credible results, but it is more expensive and time consuming. Alternatively, the lower cost Benefit Transfer approach is only as reliable as the original studies and errors in the existing reports are likely to be passed through and possibly amplified. Decision makers need results which indicate how marginal or incremental changes in ecosystem attributes or functions will impact ecosystem service valuations. Finally, the most frequent knowledge gap in the analysis of ecosystem services pertains to the ecosystem response function, which is often ignored due to the inherent complexities involved with ecosystem functioning.

Through the Environmentally Friendly Drilling Systems Program, the research team has been developing a comprehensive framework with a proven valuation model. The comprehensive framework is provided by the Economic Valuation of Ecosystem Services (EVES) framework. Valuation is provided by the Multi-scale Integrated Models of Ecosystem Services (MIMES) model. Explicit in this approach is the consideration of the linkages between ecosystem attributes and the delivery of ecosystem services. This is achieved by making use of remote sensing technologies and data sets and inclusion of ecological experts in the research process. This technology possesses a demonstrated capability to combine social, economic and environmental perspectives (i.e. a triple bottom line approach) in order to assess the status and to indentify optimal and balanced outcomes from different management options for ecosystem services.

A research program may be designed to conduct an evaluation of key ecosystem services of Gulf of Mexico deepwater, coastal regions and Gulf Coast wetlands that dynamically links ecosystem attributes with ecosystem service valuations. The objective would be to identify the areas of high value in order to ensure that appropriate and adequate monitoring and early warning devices may be placed. Valuation of ecosystem services can be used to prioritize spending on ecosystem protection.

In conclusion, our quality of life has an unquenchable thirst for energy. Offshore drilling and production helps to satisfy this thirst. Offshore resources provide national security, federal revenue and jobs for thousands of workers. As we remember the 11 workers that perished and the thousands of current offshore workers, I thank you for this opportunity to discuss the specific research needs to exploit offshore resources in an economically sound, safe and environmentally sensitive manner.

Richard C. Haut, Ph.D.
Senior Research Scientist
Houston Advanced Research Center

Dr. Richard Haut is currently a Senior Research Scientist at the Houston Advanced Research Center (HARC). He serves as the Principal Investigator (P.I.) for various projects associated with securing energy for the future. A major effort is serving as P.I. for the Environmentally Friendly Drilling (EFD) program in partnership with Texas A&M University, other universities, industries and environmental organizations with the objective of integrating advanced technologies into systems that significantly reduce the environmental tradeoffs of petroleum drilling and production. He also serves as the P.I. for various projects concerning the built environment, working with the City of Houston. Dr. Haut also serves as the P.I. for the Marine Retrofit Program sponsored by the U.S. Environmental Protection Agency.

Dr. Haut's technical background includes a Masters degree and a Ph.D. in Engineering. He has over 25 years of industry technical and management experience prior to joining HARC in June 2002, having been responsible for analyzing offerings for key technologies or niche capabilities and developing synergistic, strategic relationships in the energy industry. He also was instrumental in establishing joint ventures and other joint industry programs, including the start-up of Enventure Global Technology where he was the Chief Operating Officer. Over a two year time period, Dr. Haut was involved in the successful development of Enventure, taking it from conception to profitability during this time period. In 1999 he received Hart Publication's Meritorious Award for Engineering Innovation and in 2002 received the Natural Gas Innovator of the Year Award from the Department of Energy. In 2009, the EFD Program, under Dr. Haut's direction, was honored by the Interstate Oil and Gas Compact Commission with their Chairman's Stewardship Award for Environmental Partnership.

Dr. Haut has been invited to speak at various conferences, has authored numerous papers, has been awarded various patents and has several patents pending. He was featured in the ***Wall Street Journal***, February 11, 2008 as well as the Summer 2008 edition of ***Echoes***, the alumni magazine of Rose-Hulman Institute of Technology and has been interviewed on multiple occasions by the media. He has frequently been asked to speak about sustainable development, the built environment and the offshore/energy industry. He is a board member of the Research Partnership to Secure Energy for America (RPSEA) where he also chairs the Environmental Advisory Group. Dr. Haut chaired the Society of Petroleum Engineers' Health, Safety and Environment subcommittee for the 2009 Annual Technical Conference and continues to serve on the subcommittee throughout 2010.

Dr. Haut has made over 25 invited presentations, has over 20 publications and more than 80 patents/published patent applications along with numerous media interviews directly related to the environmental stewardship of the energy industry.