Interagency Coordinating Committee on Oil Pollution 2010-2011 Research Report

2012 Biennial Report to Congress

June 04, 2012

Homeland Security

United States Coast Guard

Message from the U.S. Coast Guard Chief, Office of Incident Management and Preparedness

The *Oil Pollution Act of 1990* requires the Chairman of the Interagency Coordinating Committee on Oil Pollution Research to submit biennial reports on the Interagency Committee's activities. The United States Coast Guard chairs the Interagency Committee, and has done so since its inception. The Interagency Committee first reported to Congress in 1994 and this report responds to the latest Congressional requirements.

The Interagency Committee has been increasingly active over the past two years and there is much on which to report. The BP *Deepwater Horizon* oil spill was, in many ways, unprecedented in scope and scale, and the lessons learned from the response will be taken into consideration by the Interagency Committee as we continue to serve as an information exchange and actively promote new research and development activities. Some use the BP *Deepwater Horizon* oil spill response to suggest that oil spill technology has not changed since *Exxon Valdez*, however, a closer examination of the use of remote sensing, dispersants, in situ burning, and other technologies during the response suggests otherwise. Years of sustained effort were behind the successful techniques and science-based decision protocols that enabled the use of these tools during the response. The Committee has been actively gathering input and analyzing the avalanche of data that is being generated as a result of the BP *Deepwater Horizon* oil spill. The Interagency Committee is committed to expanding our knowledge and tools to meet future oil spill response challenges.

This report is provided for:

The Honorable John D. Rockefeller, IV
Chairman, Committee on Commerce, Science & Transportation

The Honorable Kay Bailey Hutchison
Ranking Member, Committee on Commerce, Science & Transportation

The Honorable John L. Mica
Chairman, Transportation and Infrastructure Committee

The Nick J. Rahall, II
Ranking Member, Transportation and Infrastructure Committee

I am happy to answer any further questions that you may have, or your staff may contact the Coast Guard Senate Liaison at (202) 224-2913 or House Liaison at (202) 225-4775.

Sincerely,

J. R. Caplis
Captain, U.S. Coast Guard
Chairman, Interagency Coordinating Committee
on Oil Pollution Research

Executive Summary

Title VII of the *Oil Pollution Act of 1990* (P.L. 101-380) (OPA 90) established the initial 13 members of the Interagency Coordinating Committee on Oil Pollution Research (referred to as the "Interagency Committee") to "coordinate a comprehensive program of oil pollution research, technology development, and demonstration among the federal agencies, in cooperation and coordination with industry, universities, research institutions, state governments, and other nations, as appropriate" and to "foster cost-effective research mechanisms, including the joint funding of research." This report discusses Interagency Committee activities carried out in Fiscal Years 2010 and 2011, as well as activities proposed for Fiscal Years 2012 and 2013.

Interagency Committee member organizations continue to oversee numerous research projects related to prevention of and response to oil spills. Appendices A and B of this report describe these various projects that have been communicated to the Interagency Committee. The Interagency Committee has been actively tracking other research initiatives during this reporting period, including: the Environmental Protection Agency's Draft Oil Spill Research Strategy, National Oceanic and Atmospheric Administration's Investigation on the Future of Dispersant Use, and the Coast Guard's Standardization of Review Process for New Oil Spill Cleanup Ideas. The Interagency Committee also maintains a routine awareness of practical research being conducted at Ohmsett, the National Oil Spill Response Research and Renewable Energy Test Facility, which is managed by the Bureau of Safety and Environmental Enforcement. The Interagency Committee has also established its own website for communicating these new research initiatives as well as promoting other activities from government, industry, and academia.

Interagency Committee members have participated in numerous workshops and conferences including the October 2010 National Science and Technology Council's Joint Sub-Committee on Ocean Science and Technology (NSTC JSOST) *Deepwater Horizon* Oil Spill Principal Investigator (PI) Conference, the October / November 2010 *Deepwater Horizon* Response Symposiums hosted by the Coast Guard RDC, the 2011 International Oil Spill Conference (IOSC), and the March 2011 NOAA/CRRC workshop 'Coordinating R&D on Oil Spill Response in the Wake of *Deepwater Horizon*'. The Interagency Committee also sponsored a series of public workshops throughout the country seeking input on research and development priorities necessary for the future. These conferences and workshops facilitate information sharing and help foster a spirit of cooperation and coordination among government, industry, and academic participants. The Interagency Committee also has been reaching out to academic institutions that have been active in oil spill response research programs to facilitate understanding regarding activities being undertaken in government, private sector, and academic circles.

The Interagency Committee has substantial plans for future initiatives, including: revising and releasing an updated Oil Pollution Research and Technology Plan; identifying and promoting Arctic research; continuing outreach to non-federal stakeholders; enhancing the Interagency Committee's new website to include a research and development library; and reviewing BP *Deepwater Horizon* oil spill after-action reports to identify and prioritize new research needs.

Interagency Coordinating Committee on Oil Pollution 2010-2011 Research Report

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I. List of Acronyms

ADIOS	Automated Data Inquiring for Oil Spills
API	American Petroleum Institute
USARC	U.S. Arctic Research Commission
BFT	Baffled Flask Test
BHT	Butylated hydroxytoluene
BSEE	Bureau of Safety and Environmental Enforcement
BT	Benefit Transfer
CCoast Guard	Canadian Coast Guard
CEDRE	Center of Documentation, Research and Experimentation on Accidental Water Pollution
CEWAF	Chemical Enhanced Water Accommodated Fractions
CFR	Code of Federal Regulations
COOGER	Center for Offshore Oil and Gas Environmental Research
CROSERF	Chemical Response to Oil Spills Ecological Research Forum
CRRC	Coastal Response Research Center
DE	Dispersant Effectiveness
DHIC	Digital Holographic Imagery Camera
DMAC	Data Management and Access Committee
DOE	U.S. Department of Energy
DOR	Dispersant-to-Oil Ratio
DOT	U.S. Department of Transportation
DTC	DTC International, Inc.
DTS	Dry Tree Semisubmersible
EDP	Emergency Disconnect Package
EDRC	Effective Daily Recovery Capacity
ELA	Experimental Lakes Area
EMDS	Ecosystem Management Decision Support
EPA	U.S. Environmental Protection Agency
ERD	Environmental Research Division
EVOS	Exxon Valdez oil spill
GLRI	EPA's Great Lakes Restoration Initiative
GOM	Gulf of Mexico
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HF	High Frequency
IATAP	Interagency Alternative Technology Assessment Program
IRS	Intervention Riser System
ISB	In situ burning
ISO	International Organization for Standardization
LISST	Laser In-Situ Scattering Transmissometry
MARAD	Maritime Administration
MMS	Minerals Management Service
MWI	Mass Weathering Index
NCCPS	National Contingency Plan Product Schedule

NCP	National Contingency Plan
NMV	Nonmarket Valuation
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRC	U.S. National Research Council
NRDA	Natural Resource Damage Assessment
NRMRL	National Risk Management Research Laboratory
NSTC JSOST	National Science and Technology Council's Joint Sub-Committee on Ocean Science and Technology
OCS	Outer Continental Shelf
OMA	Oil Mineral Aggregate
OPeNDAP	Open-source Project for a Network Data Access Protocol
ORD	EPA's Office of Research and Development
ORR	Office of Response and Restoration
OSIG	Oil Spill Impact Guide
OSRO	Oil Spill Removal Organizations
PAHs	Polycyclic aromatic hydrocarbons
PE	Polyethylene
PERF	Petroleum Environmental Research Forum
PHMSA	Pipeline and Hazardous Materials Safety Administration
PWS	Prince William Sound
RDC	U.S. Coast Guard Research and Development Center
RIS	Riserless Intervention System
ROC	Response Option Calculator
ROV	Remotely Operated Vehicle
SAB	EPA's Science Advisory Board
SCAT	Shoreline Cleanup and Assessment Technique
SLC	S. Louisiana Crude Oil
SPME	Solid-phase Micro-extraction
SSTT	Subsea Test Tree
STAR	Spill Training and Response
SWAs	Surface Washing Agents
SWIS	Subsea Well Intervention System
TKN	Total Kjeldahl Nitrogen
WAF	Water-accommodated fractions
WCP	Well Control Package

II. Legislative Requirement

This document responds to the language set forth in Section 7001(e) of the *Oil Pollution Act of 1990* (P.L. 101-380) (OPA 90), which states:

> **SEC. 7001. OIL POLLUTION RESEARCH AND DEVELOPMENT PROGRAM.**
>
> (e) BIENNIAL REPORTS- The Chairman of the Interagency Committee shall submit to Congress every 2 years on October 30 a report on the activities carried out under this section in the preceding 2 fiscal years, and on activities proposed to be carried out under this section in the current 2 fiscal year period.

III. Background and Legacy Obligations

Purpose of the Interagency Committee

Section 7001(a) of OPA 90 established the Interagency Coordinating Committee on Oil Pollution Research (Interagency Committee). The purpose of the Interagency Committee is twofold: (1) to prepare a comprehensive, coordinated federal oil pollution research and technology (R&T) plan; and (2) to promote cooperation with industry, universities, research institutions, state governments, and other nations through information sharing, coordinated planning, and joint funding of projects.

Membership

The 14 Interagency Committee members, representing independent agencies, departments, and department components, include:

Department of Commerce represented by:

- National Oceanic and Atmospheric Administration (NOAA)
- National Institute of Standards and Technology (NIST)

Department of Energy (DOE)

Department of Interior represented by:

- Bureau of Safety and Environmental Enforcement (BSEE)
- Bureau of Ocean Energy Management (BEOM)
- United States Fish and Wildlife Service (USFWS)

Department of Transportation (DOT) represented by:

- Maritime Administration (MARAD)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)

Department of Defense (DoD) represented by:

- United States Army Corps of Engineers (USACE)
- United States Navy (USN)

Environmental Protection Agency (EPA)

National Aeronautics and Space Administration (NASA)

Department of Homeland Security (DHS) represented by:

- United States Coast Guard (USCG)
- Federal Emergency Management Agency - United States Fire Administration

Oil Pollution Research and Technology Plan Update

Section 7001(b) of the Oil Pollution Act of 1990 required the Interagency Committee to prepare an Oil Pollution Research and Technology (R&T) Plan. The Interagency Committee prepared the original R&T Plan to define the roles of each federal agency involved in oil spill research and development and subject areas that needed attention. The R&T Plan was submitted to Congress in April 1992 and was later reviewed by the National Research Council's Committee on Oil Spill Research and Development under the auspices of the Marine Board. Using input from the Marine Board, the Interagency Committee started a revision of the R&T Plan in May 1993 to include topics related to spill prevention, human factors, and the field testing/demonstration of developed response technologies. The revised version, released in April 1997, identified 21 research areas divided into three levels of priority and currently serves as a strategic planning document for the Interagency Committee to communicate and coordinate research needs.

In late 2009, the Interagency Committee initiated a review of its R&T Plan to determine if the original 21 research areas are still valid and to identify any new gaps that have developed since 1997. As part of the review, the Interagency Committee held three Public Meetings to solicit input on the direction of future oil pollution research needs. The Public Meetings were advertised in the Federal Register and scheduled on the West, East, and Gulf Coasts to obtain different regional interests and perspectives. The Interagency Committee is using the input from these meetings and a variety of other sources including key BP *Deepwater Horizon* spill after-action and lessons learned reports, and numerous government, academic, and industry communications to complete the R&T Plan's update. The Interagency Committee plans to complete the update by early 2013.

Oil Pollution Research and Development Program

Guided by Section 7001(c) of OPA 90, the Interagency Committee monitors, supports, and publicizes a variety of oil pollution research and development initiatives with industry, universities, research institutions, state governments, and other entities. Several ventures were completed in the first decade of the Interagency Committee's existence, while others continue to progress through the current reporting period. The status of several key initiatives listed in Section 7001(c) are discussed below:

1) *Oil pollution effects and response technology research* – The cornerstone of the Interagency Committee's role and activities is the research monitored, conducted and coordinated by its members. Chapter IV and Appendices (A) and (B) in this report describe research focus areas and specific projects and publications overseen by member organizations on the Interagency Committee during Fiscal Years (FY) 2010 through 2013.

2) *Demonstration Projects* - Section 7001(c)(6) directed that Port Oil Pollution Minimization Demonstration Projects be conducted in New York, New Orleans, and Los Angeles/Long Beach. The Great Lakes Oil Pollution Research and Development Act of 1990 amended OPA 90 to include a fourth demonstration in ports of the Great Lakes.

Demonstration Projects were held in New Orleans (December 1994) and New York (October 1995). After the first two projects were completed, the Coast Guard determined that they were cost prohibitive and the Interagency Committee agreed that the objectives for the demonstration projects requirement could be met through other means.[1] Since 1995, the objectives have been addressed through interagency participation in and support for regularly scheduled domestic and international oil spill conferences including: the International Oil Spill Conference (triennial), Interspill (triennial), Spillcon (triennial), and the Clean Pacific and Clean Gulf Conferences (biennial and annual). These domestic and international conferences present both technical programs and equipment tradeshows that present the latest issues, products, and technologies available for oil spill and hazardous materials response, spill prevention, marine salvage, cleanup and remediation, professional services, and regulatory compliance.

3) *Simulated Environmental Testing*- BSEE operates and maintains Ohmsett - the National Oil Spill Response Research & Renewable Energy Test Facility. Located an hour south of New York City, in Leonardo, New Jersey, Ohmsett provides independent and objective performance testing of full-scale oil spill response equipment and marine renewable energy systems (wave energy conversion devices), and improves technologies through research and development. It is the largest outdoor saltwater wave/tow tank facility in North America and is the only facility where full-scale oil spill response equipment testing, research, and training can be conducted in a marine environment using real oil under controlled environmental conditions (waves and oil types).

   Ohmsett is used for two primary and essential functions related to national oil spill response planning:

   - *Full-scale equipment testing* - It is estimated that 95 percent of the quantitative performance data on mechanical equipment used by the Coast Guard, EPA, USN and private industry (both domestic and international) is obtained through Ohmsett.

   - *Responder training* - Ohmsett is one of the few facilities in the world where oil spill responders can be trained under various controlled environmental conditions using real oil. Training provided at Ohmsett ensures new responders are educated about oil pollution operations in advance of an incident.

   Of particular note during this reporting period, Ohmsett hosted the Wendy Schmidt Oil Cleanup X CHALLENGE - a $1.4 Million competition designed to inspire a new generation of innovative solutions that will speed the pace of cleaning up surface oil resulting from spillage from offshore drilling rigs, platforms, tankers, and other sources. This one-year competition concluded in Fall 2011 with a cash prize being awarded to the teams that demonstrated the ability to recover spilled oil on the sea surface at the highest Oil Recovery Rate of over 2,500 Gallons Per Minute with an Oil Recovery Efficiency of more than 70 percent.

[1] Interagency Committee Biennial Report to Congress for FY 2001 & 2002

4) *Regional Research Grant Program* - Section 7001(c)(8) authorized a Regional Research Program. The objective of the Regional Research Program is to "coordinate a program of competitive grants to universities or other research institutions, or groups of universities or research institutions, for the purposes of conducting a coordinated research program related to the regional aspects of oil pollution, such as prevention, removal, mitigation, and the effects of discharged oil on regional environments." Funding for the program was authorized for each of the fiscal years from 1991 through 1995. The last reports prepared by the universities and institutions selected under this program were published in 1997.[2]

[2] U.S. Coast Guard 1995 Oil Pollution Research Grant Publications: Parts 1 &2. Final Report. John A. Volpe National Transportation Systems Center, Cambridge, Massachusetts. August 1997. See http://www.bsee.gov/Research-and-Training/Technology-Assessment-and-Research.aspx more information regarding BSEE's Technology Assessment & Research Program.

IV. Interagency Committee Activities during Reporting Period

New Website

The Interagency Committee achieved an important goal identified in the last biennial report with the launch of its new website at www.iccopr.uscg.gov. The website is an invaluable tool for communicating Interagency Committee activities to the public and other research partners. The website supports the Interagency Committee's outreach and coordination responsibilities by providing continued awareness about the broad array of oil pollution research projects, stakeholders, and databases available. The website also serves as a traffic hub that connects public visitor or Interagency Committee members to supporting documents or other research-related websites.

Interagency Committee Meetings

The Interagency Committee formally met nine times during FYs 2010 and 2011. These gatherings included quarterly meetings of the membership, Public Meetings supporting the update of the R&T Plan, and an engagement with the U.S. Arctic Research Commission (USARC). The members interacted in a number of conferences and workshops related to oil pollution research:

- November 16, 2009 – New Orleans, Louisiana: Meeting held in conjunction with the 2009 Clean Gulf Conference
- March 4, 2010 – Anchorage, Alaska: Meeting held with USARC
- May 19, 2010 - Seattle, Washington: Public Meeting about R&T Plan
- September 16, 2010 – Washington, DC: Public Meeting about R&T Plan
- November 17, 2010 - New Orleans, Louisiana: Public Meeting about R&T Plan
- December 8, 2010 – Washington, DC: Quarterly Meeting
- March 9, 2011 – Washington, DC: Quarterly Meeting
- June 15, 2011 – Washington, DC: Quarterly Meeting
- July 20, 2011 – Washington, DC: Quarterly Meeting

The agendas for these meetings and full transcripts for the Public Meetings are available on the Interagency Committee's website. At these different venues, the Interagency Committee was able to share information on recent research projects, identify new research issues, listen to presentations from other government agencies, industry, and academia, and develop strategies for future initiatives. The meeting with USARC provided an opportunity for both committees to discuss oil spill challenges in the arctic and identify current research gaps related to cold-weather responses.

Member Research and Development Initiatives

Member organizations of the Interagency Committee managed a number of new and ongoing research projects during this reporting period: 25 publications are listed in Appendix (A), and 83 research projects are summarized in Appendix (B). The research projects are categorized according to the 21 areas identified in the R&T Plan. While the appendices detail research projects funded and managed by Interagency Committee members, the Interagency Committee also monitors a variety of oil spill research projects conducted by other non-Committee entities.

In addition to the specific research projects and publications described in the appendices, some of the member organizations have prepared broad research strategies and initiatives that are being coordinated with the Interagency Committee.

1) *EPA's Draft Oil Spill Research Strategy* - The EPA's Oil Spill Research Program conducts research under the Oil Pollution Act of 1990. The response efforts to the BP *Deepwater Horizon* oil spill highlighted the need for additional research to prevent spills, evaluate new spill response technologies, investigate the human health and ecological implications of deepwater oil spills, assess the use of dispersants, and estimate the acute and chronic health risks for spill response workers and the public from oil spills and spill mitigation. To respond to these research issues, the EPA developed the *Draft Oil Spill Research Strategy* for FYs 2012 through 2015 to present a research approach on potential human and environmental risks from oil spills and the application of dispersants, surface washing agents, bioremediation agents, and other mitigation measures.

   The goal of the research outlined in the *Strategy* is to provide environmental managers with the tools, models, and methods needed to mitigate the effects of oil spills in terrestrial and aquatic systems in coastal, inland, and marine environments. The EPA's Office of Research and Development (ORD) requested its Science Advisory Board (SAB) to review and provide advice on the proposed research initiatives, as described in the *Strategy*. The SAB Staff Office formed an *ad hoc* panel, the Oil Spill Research Strategy Review Panel, to conduct the review. The charge to the SAB included questions about the proposed science questions, research activities, and research outcomes outlined in the *Strategy*.[3] EPA continues to share its progress on this initiative with the Interagency Committee and its potential interplay with the update of the R&T Plan.

2) *NOAA's Investigation on the Future of Dispersant Use* - The Coastal Response Research Center (CRRC) is a partnership between NOAA's Office of Response and Restoration (ORR) and the University of New Hampshire (UNH) and its Environmental Research Group. The Center was created in 2004 by a Memorandum of Agreement between NOAA and UNH when NOAA ORR wanted to partner with a research-oriented university to create a center to address its research needs in spill response, recovery and

[3] The SAB review and additional information about EPA's *Draft Oil Spill Research Strategy* can be found through http://yosemite.epa.gov/sab/SABPRODUCT.NSF/.

restoration. Through the partnership, NOAA and CRRC have accomplished a number of oil pollution research coordination objectives – the latest being the identification of future dispersant research needs. NOAA and EPA are coordinating the dispersant research to avoid any duplication of effort and to build off of each other's finding.

The Future of Dispersant Use: CRRC is partnering with ORR to lead an evaluation of the observations and science conducted during the BP *Deepwater Horizon* oil spill to build a foundation for planning and decision-making in future spills. Conducted in coordination with the Interagency Committee, the project will: produce a synthesis of available data on the application of BP *Deepwater Horizon* dispersants; provide a technical basis for NOAA and Regional Response Team members to provide clear recommendations for future spills; strengthen partnerships with the academic research community**;** move toward an external consensus among agencies and stakeholders for future spills**;** outline standard procedures for measuring dispersant components in water and seafood; and develop a better technical basis and guidance for trade-off decision-making during spills. The project will be completed in 2012.

As part of this initiative, the Center organized and facilitated a workshop on September 20-22, 2011 in Mobile, Alabama. Listed below are the seven key topics identified by CRRC, NOAA, and an organizing committee containing representatives from the Interagency Committee.

- Dispersant efficacy and effectiveness,
- Degradation of dispersants and dispersed oil,
- Physical transport and chemical behavior of dispersed oil,
- Biological effects of dispersants and dispersed oil on surface and deep ocean species,
- Dispersants and seafood safety,
- Dispersants and human health,
- Dispersants and risk communication.

Various experts, identified by NOAA, the CRRC, Coast Guard, and EPA, wrote white papers on each of the above topics, which served as starting points for the discussions. Each topic was supported by a breakout group that included experts with a range of perspectives. The groups were presented with questions regarding their paper. The outcomes of this workshop will be a final report, including the revised white papers and a list of R&D needs for each breakout group.

3) *Standardizing a Review Process for New Oil Spill Cleanup Ideas* - In May 2010, the Coast Guard Research and Development Center (RDC) responded to a request by the National Incident Commander for the BP *Deepwater Horizon* Response to serve as the government's lead organization for the Interagency Alternative Technology Assessment Program (IATAP). IATAP provided a fair and systematic means for the government to receive, acknowledge, assess, and respond to ideas from industry, academia, government, and public entities that addressed five major technology areas in the BP *Deepwater Horizon* cleanup efforts.

These technology areas included:

- Alternative Oil Spill Response Technologies,
- Traditional Oil Spill Response Technologies,
- Oil Wellhead Control and Submerged Oil Response,
- Oil Sensing Improvements to Response and Detection,
- Oil Spill Damage Assessment and Restoration.

Coordinating with representatives from the Army, Navy, EPA, NOAA, BSEE, and MARAD, IATAP completed the analysis of more than 4,000 technology submissions during BP *Deepwater Horizon* and identified over 195 technologies that showed potential benefit for the response effort.

The IATAP process was not the only review process available. BP maintained separate submission and review procedures and NOAA has maintained an evaluation tool for several years known as Alternative Response Technology Evaluation System (ARTES). Consequently, these various tools and processes need to be reviewed and possibly reconciled for future activities. The Interagency Committee has been briefed on these various processes by the Coast Guard RDC and will engage industry and government agencies to develop a way ahead for the implementation and management of future industry and government technology review processes.

4) *DOE's Ultra-Deepwater Oil Spill Prevention Research* - DOE's research is focused on maximizing the value of domestic oil and gas resources, environmental protection, and safety. However, in response to specific recommendations by the National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling, DOE's ultra-deepwater research was refocused on understanding the risk associated with exploration and production activities conducted in ultra-deepwater in order to prevent oil spills.

   The goal of the research is to ensure that the Federal Government's understanding of the risks associated with offshore operations keeps pace with the technologies that industry has developed for dealing with the increasingly challenging conditions found in ultra-deepwater. Research topics include an assessment and mitigation of the risk in offshore production activities related to controls, safeguards, and environmental impact mitigation procedures in place during drilling and production operations for the purpose of preventing oil spills.

   The ultra-deepwater research program includes cost-shared research pursuant to an annual plan approved by the Secretary of Energy and research conducted by the National Laboratories. Annual funding for ultra-deepwater research comes from royalties and rents collected by the Department of the Interior from oil and gas exploration and production activities conducted on federal lands and waters. Each year, over $18 million is invested in ultra-deepwater research. This was increased to over $23 million for FY 2011.

The FY 2011 portfolio is fully dedicated to risk assessment and mitigation for the purpose of preventing oil spills during drilling and production activities conducted in ultra-deepwater. DOE has drafted the 2012 Annual Plan which is available on their website.[4]

Member Participation in Workshops and Conferences

Each year a variety of workshops and conferences are held that address various facets of the petroleum industry and oil pollution research. The Interagency Committee monitors these forums to stay abreast of the latest topics and issues that support ongoing and future research initiatives. The Interagency Committee's member organizations participate or directly sponsor many of these workshops and conferences. To increase the communication and networking benefits across the oil pollution research community, the Interagency Committee has devoted a specific area of its website to tracking and publicizing these conferences and workshops, including their associated website links and basic support documents.

In this reporting period, some conferences and workshops were particularly important to the Interagency Committee's purpose and objectives. The key forums are highlighted below:

1) *Deepwater Horizon Oil Spill Principal Investigator (PI) Conference* – On October 5-6, 2010 in St. Petersburg, Florida, the National Science and Technology Council's Joint Sub-Committee on Ocean Science and Technology (NSTC JSOST) sponsored a conference hosted by the University of South Florida. The conference brought together scientific investigators from academia, private research institutes, and agencies who were actively conducting BP *Deepwater Horizon* oil spill related research, monitoring, and sampling as well as representatives from the NSTC JSOST agencies. This was an opportunity to foster new collaborations, compare initial results, interact with federal agencies, and discuss recommendations for longer term research activities. The input gathered from researchers at the conference was used to help NSTC JSOST federal agencies identify information needs and plan short and long term research directions. The Interagency Committee is also using this input to further its coordination efforts and update the R&T Plan. Members attended the one-year follow-up conference on October 25-26, 2011 in St. Petersburg.

2) *Deepwater Horizon Response Symposiums* - As part of the ongoing effort to identify technology gaps for deepwater open ocean oil spills, the Coast Guard RDC, in support of the Interagency Committee, hosted two symposiums on oil spill response and recovery. These symposiums were organized to provide federal agency responders, scientists, and contractors involved in BP *Deepwater Horizon*, a forum to discuss current oil spill priorities, and the needs and challenges in executing the spill clean-up. The first gathering was the "*Deepwater Horizon* Response – Surface Oil Symposium" held on

[4] DOE 2012 Draft Annual Planproject fact sheets can be found at http://www.netl.doe.gov/technologies/oil-gas/EPAct2005/Index.html

October 14, 2010 in New Orleans, where participants addressed topics related to offshore/inshore containment; skimmers, in-situ burning; shoreline operations; command and control; oil separation and offloading. The second symposium was the "*Deepwater Horizon* Response – Submerged and Sunken Oil Symposium" held on November 9-10, 2010, in Groton, Connecticut, where the participants addressed submerged/sunken oil characterization, subsea dispersants, and detection and modeling issues. Final written reports from both symposiums were given to the Interagency Committee for further use in its R&T Plan update and additional communications.

3) *2011 International Oil Spill Conference (IOSC)* – The triennial 2011 International Oil Spill Conference (IOSC), the world's largest conference of its kind, was held in Portland, Oregon, on May 23-27 at the Oregon Convention Center (Figure 3). Since 1973, the Coast Guard and EPA have formally sponsored the IOSC alongside the American Petroleum Institute (API). NOAA and BSSE joined later and the current IOSC permanent sponsorship team consists of seven domestic and international organizations, four of whom are members of the Interagency Committee. The goals of the IOSC are: "To promote an international exchange of information and ideas dealing with spill prevention, planning, response and restoration processes, protocols and technology" and "To promote international sharing of best practice as it relates to management of the varied impacts of oil spills and their aftermath."

   The 2011 IOSC was the most successful to date, with over 2,100 participants from 35 different countries. The backbone of the conference is its technical program consisting of peer-reviewed paper and poster presentations, and unique film submissions – all managed by subject matter expert volunteers from academia, industry, and the government. Over 220 papers, posters, and films were presented this year, covering diverse topics such as oil spill modeling, dispersant use policies and applications, arctic issues, and cutting-edge response technologies. All accepted papers and posters are published in the conference's *Proceedings* – thereby adding to over 40 years of published oil spill research literature generated by the Conference.[5] Research-oriented conferences and workshops like the IOSC are key venues for promoting effective collaboration and communication between industry, academia, and the government. Member organizations of the Interagency Committee have been long-time supporters of the IOSC and similar conferences.

   The IOSC is part of the "triennial conference series," which is also comprised of its European and Australian counterparts known as Interspill and Spillcon, respectively. All three conferences are major venues for hosting the latest oil pollution research communications and technology displays. In 2005, the conference organizers agreed to work on a three year cycle to avoid overlap and reduce the travel/financial burden of government and industry participants. The next conference is Interspill, scheduled for March 13-15, 2013, in London, England.

[5] The technical program and past archive of papers can be accessed at: www.iosc.org.

4) *Coordinating R&D on Oil Spill Response in the Wake of Deepwater Horizon* - In 2003, CRRC and NOAA held a workshop titled "Research and Development Priorities: Oil Spill Workshop" to assess the current state of knowledge and identify priority research needs. CRRC used these findings to focus research efforts over the following five years, and through partnerships and subcontracts was able to address some of the research needs identified in the 2003 workshop.

   To gain a better understanding of the evolving needs of spill response, CRRC hosted a second Research and Development (R&D) priorities meeting in March 2009. The scope of this workshop was expanded to include spill response during disasters, response technologies, acquisition, synthesis and management of information, human dimensions, ecological monitoring and recovery during spills, biofuels, ecological effects of oil spills, and environmental forensics. As with the 2003 meeting, the goal of the 2009 meeting was to identify top research priorities within the response and restoration community to better focus future research efforts to address these needs.

   On March 22-24, 2011, NOAA and the CRRC convened a workshop in Baton Rouge, Louisiana titled "Coordinating R&D on Oil Spill Response in the Wake of *Deepwater Horizon*". This workshop brought together researchers & responders (70 total participants) to coordinate research activities in the wake of multiple industry and government funding of diverse research projects. To optimize the benefits of the limited funding available for research on spill response and restoration, the workshop was organized to better understand the different research activities happening and help publicize known research gaps.

   The 2011 workshop brought together oil spill practitioners and researchers from the public and private sectors and academia to discuss R&D needs and projects. The goals of the workshop were to: (1) update the R&D needs for spill response, and (2) create a dialogue between researchers and practitioners to ensure the usefulness and application of the findings for future oil spill response.

   The workshop included focus groups on:
   - Dispersant effectiveness and effects,
   - Oil spill modeling,
   - Detection of oil,
   - Seafood safety monitoring,
   - Human dimensions and spill response,
   - Acquisition synthesis and data management.

   This meeting did not cover any NRDA activities, response issues specific to the Arctic, or research focusing on the impacts of the BP *Deepwater Horizon* spill on the Gulf of Mexico. The workshop involved plenary and breakout sessions. CRRC worked with funding entities to identify researchers they have funded on these spill response topics and with the oil spill response community to identify practitioners and responders.

5) On November 2-3, 2011, the Bureau of Safety and Environmental Enforcement (BSEE) sponsored a workshop on the *Effects of Water Depth on Deepwater E&P Equipment and Operations on the OCS.* Nearly 140 subject matter experts from the oil and gas industry and federal regulatory agencies, attended this two-day workshop in Galveston, TX to discuss technical issues. This workshop was the direct result of a recommendation made by the Outer Continental Shelf Safety Oversight Board (OSOB) in their September 1, 2010 report to the Secretary of the Interior, Ken Salazar. It was the first major public meeting of the newly formed BSEE organization since its inception on October 1, 2011 and served to bring a broad and diverse group of subject matter experts from both the offshore drilling industry and its regulatory bodies together to collaborate on the technical challenges facing the offshore deepwater drilling environment and the need for revised and/or new regulations and industry standards to improve drilling, well control, and oil spill response operations. The objective of the workshop was to: (1) identify the critical issues and effects of water depth on equipment and operations and (2) determine the adequacy of current regulations.

   The proceedings and findings from the workshop were captured in a final report and made available for review and downloading from BSEE's Technology Assessment and Research Program webpage at http://www.bsee.gov/Research-and-Training/Technology-Assessment-and-Research/tarworkshops/EWD/index.aspx.

V. Future Activities

During this reporting period, several high-profile oil pollution events occurred around the world. Major spills like the 2009 Montara oil spill in the Timor Sea near Western Australia, the 2010 BP *Deepwater Horizon* oil spill in the Gulf of Mexico, and the 2010 Enbridge Pipeline spill in the northern United States, all underscore the need for continued research to improve oil spill prevention and response capabilities. The Interagency Committee will have a great deal of information to sort through and evaluate over the coming years from the numerous after-action and lessons learned reports and studies generated from these events. Addressing this data and new emerging issues will guide many of the Interagency Committee's future activities. Future initiatives include:

1) *Oil Pollution Research and Technology Plan Update* –The highest priority of the Interagency Committee is to complete the update of its R&T Plan. The R&T Plan serves as a strategic planning document for the Interagency Committee. The Interagency Committee continues to collect and review a number of documents and informational sources to update the plan. While it evaluates these sources, the Interagency Committee is organizing the funding and technical resources needed to complete the update for a final publication scheduled for Calendar Year 2013.

2) *BP Deepwater Horizon Research* – Similar to the after-effects of the Exxon Valdez oil spill, the devastating 2010 oil spill in the Gulf of Mexico is producing a staggering array of research initiatives, issues, and discussions that will occupy public and private sectors for years to come. The Interagency Committee is closely monitoring the after-action reports being released about the accident to help identify and prioritize new research needs. The Interagency Committee will continue to monitor, identify, and help communicate interconnections between the numerous research projects being funded by industry, academia, and the government.

3) *Website for Research and Development*. With the establishment of its basic website, the Interagency Committee is exploring the feasibility of a greater information technology challenge – the development of an online comprehensive oil pollution research library and informational database. This online resource would potentially hold an archive of the literally thousands of published studies related to oil pollution research. The site would also host active data-sharing services related to ongoing research initiatives. The Interagency Committee will be working with the National Response Team Science and Technology Sub Committee (NRT S&T) to evolve this concept.

4) *Arctic Research Gaps and Needs* - In the past decade, a number of research projects in the public and private sectors have focused on arctic and cold-weather response issues and impacts associated with oil spills. With the potential for increased shipping and exploration activities in this region, arctic research needs continue to grow. Member organizations of the Interagency Committee are addressing their own issues and responsibilities associated with activities in the arctic. Consequently, the collective information and perspectives of the member organizations will help shape the Interagency Committee's understanding and communications related to cold weather

research. The Interagency Committee will continue to gather information from other venues, such as numerous subject workshops and meetings coordinated by NOAA and CRRC. The National Academy of Sciences briefed the Interagency Committee during its July 20, 2011, quarterly meeting on a proposed 18-month Arctic Oil Spill Study that has garnered financial support from several Interagency Committee member organizations. The Interagency Committee will closely look to see how all of this information should be used to inform the R&T Plan and its other initiatives.

5) *Continued Outreach to Non-Federal Stakeholders* – To further its awareness and mutual communications on research needs, the Interagency Committee will continue to reach out to state research programs, industry, academia, and non-government organizations. In the late summer of 2011, the Interagency Committee extended an invitation to meet with the current active R&D programs from Texas and Alaska. A similar invitation was extended to Louisiana, which previously maintained a robust research and development program.

VI. Appendices

(A) FY 2010-2011 Interagency Committee Member Publications

(B) FY 2010-2013 Interagency Committee Member Projects

FY2010-2011 Interagency Committee Member Publications

Ballestero, H., Z. Magdol. 2011. Biodegradation of Polycyclic Aromatic Hydrocarbons in Simulated Arctic Sea Ice Brine Channels and Protistan Predation. In: *Proceedings of the 2011 International Oil Spill Conference*, Portland, OR, May 23-26, 2011.

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FY2010-2013 Interagency Committee Member Projects*

Table of Contents

*The Interagency Committee monitors a variety of oil spill research projects conducted by other non-Committee entities and for purposes of brevity, only those research projects funded and managed by Interagency Committee members (includes those principally having access to the Oil Spill Liability Trust Fund) are listed in the appendices. The research projects are categorized according to the 21 gap areas identified in the 1997 R&T Plan.

Alternative On-Water Countermeasures

Literature Review on Chemical Treating Agents in Fresh and Brackish Water
Gap: Alternative On-Water Countermeasures
Contracting Agency: BSEE
Project Completed: 2010
The purpose of this research was to document what is currently known about the use of dispersants and chemical herders in fresh and brackish waters to assist decision makers when they are confronted with these conditions. An extensive review of worldwide scientific and technical journals was undertaken to identify relevant literature on the use of chemical treating agents for oil spill response in fresh and brackish water.

Numerous laboratory-scale, meso-scale, and field studies, dating back to the late seventies, have been conducted to study the effect of water salinity on the effectiveness of oil spill chemical dispersants. The consistent significant finding of all of these tests is that dispersant designed for use in marine environments (30 to 35 ppt salinity) are considerably less effective when the salinity falls below about 20 ppt or above 40 ppt.

Dispersants have been formulated for use in fresh water, and these have also been tested for effectiveness over a range of water salinities, although not as extensively as the marine dispersants. The effectiveness of freshwater dispersants have been shown to generally be much better than the marine products in freshwater but often achieve their best results in waters between 10 and 20 ppt salinity.

In theory, water salinity should have only a small influence on the effectiveness of herding agents. Tests using herders in fresh, brackish, and salt water consistently have confirmed that salinity has a minimal effect on their performance

Development of a Laboratory Protocol Testing the Effectiveness of Commercial Solidifiers in Cleaning Up Oil Spills on Water
Gap: Alternative on-water countermeasures
Contracting Agency: U.S. EPA/ NRMRL
Estimated Completion: 2012
The objectives of this laboratory study are: (1) to develop a protocol for testing the effectiveness of solidifying an oil slick on water using commercial solidifiers; (2) to evaluate the recovery of oil from solidified product; (3) to determine the mechanism of solidification; and (4) to quantify the effects of environmental conditions (temperature, salinity, mixing energy, degree of oil weathering, etc.) on the solidification process. These objectives will lead to a better scientific understanding of the solidification process so that interpretation of results of testing is facilitated.

Employing Chemical Herders to Improve Oil Spill Response Operations
Gap: Alternative On-Water Countermeasures
Contracting Agency: BSEE
Project Completed: 2010
Research on using chemical herding agents to thicken oil slicks in pack ice conditions for *in situ* burning has proved successful. Herding agents applied to the water surface around the edge of spills of fluid oil in broken ice conditions cause the oil slicks to contract and thicken to ignitable thicknesses. As a result of that success, a two-year program of R&D was undertaken to determine if there was a potential to use herding agents to improve other areas of marine oil spill response. Laboratory and Ohmsett experiments on the use of herders to enhance mechanical recovery in drift ice showed that: (1) the use of herders in drift ice conditions could potentially improve the Oil Recovery Rate and Oil Recovery Efficiency performance of weir skimmers by factors of 2 to 10; however, the oil thicknesses produced by the herder were too low to permit optimal performance of the weir skimmer; and (2) no significant improvement was measured in the performance of a disc skimmer in herded slicks compared to unherded slicks.

Results from preliminary salt marsh tests indicated that: (1) the herder did not clear the oil completely from the marsh plants in any of the static tests; (2) in some tests the herder caused the oil slicks to contract in size sufficiently to significantly reduce the oiled area of the marsh; however, even in these cases, there remained a ring of oil at the waterline around the originally oiled stalks of the marsh plants; and (3) in all cases, after herder had been added, the slicks were thick enough to support ignition.

In the case of the experiments on using herders to improve operational efficiency of dispersants: (1) the use of herders on an oil slick did not detract from the effectiveness of chemical dispersant application; and (2) using herders to contract slicks on open water can improve the operational efficiency of dispersants applied by vessels.

Development of a Surface Washing Agent Protocol
Gap: Alternative on-water countermeasures
Contracting Agency: U.S. EPA/ NRMRL
Estimated Completion: 2013
The goal of this work is to develop a standardized and reproducible testing protocol to evaluate the shoreline cleaning efficiency of surface washing agents (SWAs). Oil removal efficiencies for SWA treatments are being compared to the washing efficiency of water without SWA. Since a good SWA should not disperse oil into water, the dispersibility of each SWA is being evaluated separately using the BFT. To date, the protocol experiments have already been completed for a medium crude oil (Prudhoe Bay Crude or PBC), a light crude oil (S. Louisiana Crude or SLC), and a heavy refined oil, IFO180. The Headquarters program office, the Office of Emergency Management (OEM) asked if the protocol could be extended to larger media (like concrete tiles) for more realistic application and testing of products. The research is continuing by conducting experiments on granite tiles using the three types of oils already studied on sand. If this innovation improves the results, it will be used as the final protocol. If it does not, then the previous version will be adopted.

Anaerobic Biodegradability and Toxicity of Non-Petroleum Oils
Gap: Alternative On-Water Countermeasures
Contracting Agency: U.S. EPA/NRMRL
Project Completed: 2010
Because the most damaging effects of vegetable oil spills occur while the oil is floating on the water surface, rapid response is critical to minimizing the harmful effects of vegetable oil spills. Conventional oil-spill response techniques, such as booming and skimming operations, are used for vegetable oil spills, but these procedures are labor intensive, expensive, and may require substantial time to mobilize a response. Previous research investigated the feasibility of an alternative spill response that is expected to be faster, less expensive, and easier to implement than traditional technologies. The proposed spill response alternative involves sedimentation of floating vegetable oil by addition of a dense mineral, such as clay, that will interact with the oil to form negatively buoyant oil-mineral aggregates (OMAs) that will settle out of the water column. The oil that is transported to the sediment compartment by this process is expected to be degraded to harmless products, especially methane and carbon dioxide, by indigenous anaerobic microorganisms.

Basic Fate and Transport

Investigation of Physical and Chemical Causes of Heavy Oil Submergence
Gap: Basic Fate and Transport
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Estimated Completion: 2011
This proposal is derived from the CRRC research needs assessment: Submerged Oil – State of the Practice and Research Needs. Our objectives are: (1) to examine the causes and effects of density changes in heavy petroleum oils that cause just-buoyant oils to become overwashed and sink at sea and in fresh water; and (2) to examine the physical and chemical causes for refloatation of heavy oils. The proposed work includes both simulation of spills at the bench-scale and examination of real samples of submerged oil from spills of opportunity. The factors affecting oil submergence to be considered include: temperature, solid-phase uptake, water uptake (and emulsification), evaporation and photo-oxidation. This work will lead to a better understanding of the micro-changes in oils and their environments that lead to submergence of oils. This is expected to benefit both the spill modeling and spill response communities.

Characteristics, Behavior and Response Effectiveness of Spilled Dielectric Insulating Oil in the Marine Environment
Gap: Basic Fate and Transport
Contracting Agency: BSEE
Project Completed: 2011
The goal of this project was to provide a comprehensive analysis of the possible fate and effects of spilled dielectric insulating oil that will include a detailed literature review and scientific information on the characteristics, weathering behavior, and window of opportunity for using short-term response options for removal of spilled dielectric fluids in the marine environment. The goals of this project were achieved through a series of laboratory and field-scale studies conducted at research facilities. Results from this study will aid planning and management personnel when designing coastal use permits for future offshore wind generation systems.

Oil-in-Ice: Transport, Fate, and Potential Exposure
Gap: Basic Fate and Transport
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2011
Oil spilled in the arctic marine environment can be rapidly frozen into the ice sheet. The oil will in this way be to some extent preserved, in the sense that evaporation, dissolution, and degradation are expected to be reduced. This implies that the oil will retain much of its potential toxicity upon release from the ice, either via transport in brines channels and/or eventual breakup and melting of the ice sheet. Being able to estimate the pathways, release rates, and chemical characteristics of the remaining oil will provide the basis for eventual environmental risk and impact assessments. The purpose of this project is to provide a basis and methodology for estimating routes and magnitudes of potential environmental exposures and concentrations of oil components migrating through the ice regime as the oil is subjected to a freezing-thawing cycle.

A transport/exposure laboratory study is suggested to determine how ice growth conditions affect the transport and fate of entrapped oil in ice. Quantitative data on the partitioning of oil (dissolved, particulate oil) components (bioavailable fractions) into brine inclusions and channels, and rates of vertical transport, will be collected. Since biodegradation of petroleum hydrocarbons at subzero temperatures has not yet been shown, it will be essential to determine if crude oil biodegradation takes place in marine sea ice within a defined span of time and to what extent. If so, the contribution of biodegradation to the depletion of hydrocarbons in comparison to other depletion processes will be quantified.

The study directly addresses the need for exposure and injury assessment tools for oil spills in cold climates. The use of passive samplers is a fast and cheap method to detect polycyclic aromatic hydrocarbons (PAHs), the most toxic group of all the compounds present in oil. In this proposal, the research team suggests advancing the use of two different passive samplers as a tool to detect PAHs from oil spills in ice cores. The two types of passives samplers being considered are polyethylene (PE), and solid-phase micro-extraction (SPME) fibers. They will be used to detect the transport and fate of oil-derived PAHs in ice cores.

In a combination of laboratory and field studies, performance reference compounds will be included in the polyethylene matrix to enable their use as kinetic samplers and shorten deployment time in the field. In flow-through exposures using Narragansett Bay water, deployment will be undertaken to verify the use of the passive samplers to reflect dissolved concentrations as either equilibrium or kinetic samplers. Finally, in simulated oil spills in ice cores in the laboratory, dissolved concentrations of oil components will be detected using the passive samplers. The developed passive samplers will enable the oil spill community to deploy passive samplers to measure baseline conditions before a spill, as kinetic samplers during a spill and during the recovery phase of the natural ecosystem.

The findings from the laboratory experiments will be used in the development of an oil-in-ice sub-model. In contrast to most other recent and on-going work at the macro-scale, this project will start at the micro- and meso-scale (roughly mm to cm and cm to m or greater, respectively), to build up an understanding and a dynamic model from basic principles, to the maximum extent possible. Other experimental and model development work at this scale will contribute to the technical basis for the proposed model development.

The development of the numerical model associated with this project will integrate knowledge, understanding, and data derived from other tasks within this project and from earlier work by other investigators, into an internally consistent and relatively comprehensive numerical framework. The goal is to produce a dynamic module focused on micro- and macro- physical scales, built up as much as possible from first principles, to serve as a building block in an eventual large scale model of ice dynamics. The available level of funding is insufficient to complete the modeling work, in addition to all the necessary laboratory work. The research team therefore proposes to produce a prototype model at the end of the first year, and seek additional funding to complete the model calibration, testing and documentation during the second year.

Biodegradability of Lingering Crude Oil 19 Years after the Exxon Valdez Oil Spill
Gap: Basic Fate and Transport
Contracting Agency: U.S. EPA/ NRMRL
Project Completed: 2010
In 2001 and 2003, geospatial surveys of lingering oil were conducted in Prince William Sound (PWS) resulting in a prediction of significant acreage being contaminated with substantial subsurface oil from the 1989 Exxon Valdez oil spill (EVOS). In 2007, other researchers developed a mass weathering index (MWI) based on the degree of weathering of PAHs normalized to conserved biomarkers: if the degree of weathering of oil is 70% or more, further attempts at bioremediation would be unjustified. The objective of this study was to measure the biodegradability of the 19-year lingering oil in laboratory microcosms. Samples of beach substrate were collected from representative sites in PWS contaminated with oil residues of varying weathering states according to the MWI model. Enough sacrificial microcosms were set up to accommodate two treatments for each site (natural attenuation and biostimulation). Results indicated that lingering oil is biodegradable. Nutrient addition stimulated biodegradation compared to natural attenuation in all treatments regardless of the degree of weathering. The most weathered oil according to the MWI was the most biodegradable. Substantial biodegradation occurred in the natural attenuation microcosms due to the high sediment Total Kjeldahl Nitrogen (TKN), which served as a nitrogen source for biodegradation. Most of the observed biodegradation was due to the presence of dissolved oxygen. Nitrogen was a limiting factor but oxygen was the predominant one.

Biodegradability and Toxicity of Biodiesel Blends
Gap: Basic Fate and Transport
Contracting Agency: U.S. EPA/ NRMRL
Estimated Completion: 2012
While there are great benefits to using biodiesel as a fuel, its environmental fate and effects need to be evaluated and the risks associated with their use understood. There is a dearth of information on the states and conditions biodiesel and its blends have in the environment, their fate, and their effects on aquatic organisms. The current understanding of the fate and effects of biodiesel and its various blends is inadequate to evaluate environmental risks from its use. Unlike petroleum diesel, biodiesel fuels are made from many sources, including soy oil, rapeseed/canola oil, reclaimed restaurant grease, fish oil, and rendered animal fats, each having different chemical compositions. This wide variability of biodiesel formulations may result in very different toxicological and environmental fates depending on the feedstock. The objective of this work is to determine the biodegradability and biodegradation kinetics of different biodiesel blends (B0, B20, B40, B60, B80, and B100, corresponding to 100% petroleum diesel and 20-100% soybean oil fatty acid methyl esters). The second objective is to quantify the toxicity of the water accommodated fraction of the biodiesel blends as measured by the Microtox assay, which uses the bioluminescent bacterium *Vibrio fischeri* as the test species. Much of this research has been completed, and three manuscripts are being prepared for submittal to journals. The research will continue into the next two fiscal years to study biodiesels from other vegetable oil and fry oil feedstocks.

Experimental Wave Tank Studies of Oil Spill Response Using Dispersants
Gap: Basic Fate and Transport
Contracting Agency: U.S. EPA/ NRMRL
Estimated Completion: 2014
This project, which is planned to be conducted with the Department of Fisheries and Oceans Canada (DFO), addresses the performance evaluation of dispersants applied to oil spills on the water surface and subsurface injection in subsea blowouts during oil spill response. Dispersant effectiveness (DE) will be evaluated by conducting experimental studies using a modified flow-through wave tank that is capable of generating advective current flow. The EPA/DFO wave tank will be modified to incorporate a pressurized underwater oil and gas release system. DE will be evaluated by measuring dispersed oil concentrations, ultraviolet fluorescence, and droplet-size distributions. Analysis of dispersed oil droplet size distributions will be performed using submersible Laser In-Situ Scattering and Transmissometry (LISST-100X) instruments and a digital holographic imagery camera (DHIC) particle counter. Wave tank studies will be conducted to evaluate DE as a function of oil type, dispersant type, dispersant-to-oil ratio (DOR), and oil and gas flow rates. The influences of other operational conditions, such as high oil temperature, the presence of natural gas and/or suspended particulate materials on oil dispersion efficiency will also be tested. The experimental results, particularly those obtained for in-situ droplet size distribution data, will have significant application in the oil spill trajectory and ocean circulation models required by responders to predict the fate and transport of subsurface plume and surface oil slicks.

A second aspect of this project is development of numerical models of dispersant use. One of the most important parameters required for oil spill models to provide better prediction of oil transport is oil droplet size distribution. Literature reviews indicate that this is still poorly understood, particularly for the case of a deep water blowout where dispersants are applied. This project addresses this issue by conducting research to: (1) model the particle size distribution of physically dispersed oil in deep water blowouts; (2) study the effects of dispersants on droplet size distribution; (3) evaluate effects of high oil temperature, low water temperature, and the co-presence of natural gas on dispersed droplet size distribution; (4) determine the minimum droplet size needed for re-coalescence of oil droplets; and (5) develop a new numerical formula for droplet size distribution and integrate it into a deep water blowout model.

The Roles of Gas Hydrates During the Release and Transport of Well Fluids into Deep Ocean
Gap: Basic Fate and Transport
Contracting Agency: BSEE
Estimated Completion: 2013
The objective of this project is to use existing, novel equipment for obtaining fundamental, crosscutting chemical, physical, and hydrodynamic information on fluids that could be released and transported from deep, subsea hydrocarbon reservoirs and inadvertently released into a deepwater environment. Specifically, the research will use the resulting fundamental information in numerical, thermodynamic, and plume models to comprehensively describe potential roles and impacts of gas hydrates in such a scenario. The goal is to have a comprehensive understanding of:

- The formation and stability of simple and complex hydrates under deepwater conditions.
- The stability of hydrates and their interaction with hydrocarbon fluids at or near the point of release into deep water and at longer times as they are transported away from the point of release into the seawater column.
- The impact of dispersants and anti-agglomerates on the fate and interaction of hydrates near the point of release and during transport in the seawater column.

Decision Support Systems for Contingency Planning and Response

Oil Spill Training and Response (STAR) Calculator Program
Gap: Decision Support Systems for Contingency Planning and Response
Contracting Agency: BSEE, Shell International Exploration & Production Inc., and API
Project Completed: 2010
The purpose of this project was to improve the industry's ability to respond to oil spills. Specifically, the project developed a software-based tool that can be used to guide in the selection and assessment of response countermeasures during spill events and exercises. The objectives of this project were to standardize the existing software packages; to enhance their utility, user-interface and output; and, to integrate all three response options (mechanical, burning & dispersants) using improved algorithms for their efficient use under a variety of spill scenarios. The project will standardize and unify the three NOAA Spill Tools and combine them with weathering algorithms to better estimate oil recovery/treatment during exercises and actual oil spill events. The resulting Response Option Calculator (ROC) is in the public domain; all of the algorithms used are documented and are freely available with the software. ROC is currently available on the Genwest website at http://www.genwest.com/roc. NOAA's Office of Response and Restoration will also be hosting ROC on their website.

Guidance for Dispersant Decision Making: Potential for Impacts on Aquatic Biota
Gap: Decision Support Systems for Contingency Planning and Response
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2010
The proposed research addresses the major priority area identified in the Coastal Response Research Center (CRRC) RFP "Biologically/Ecologically-Driven Spill Response", specifically identifying the timing and nature of trade-off decision points in the context of response activities and expected level of resource injury. This project will provide responders with a quick guide allowing them to determine the likely water volume adversely affected by naturally- or chemically-dispersed oil and dissolved hydrocarbons, as well as the surface area impacted by floating oil, with which they can evaluate tradeoffs of dispersant use and plan monitoring activities, including for natural resource damage assessment.

It is well understood that direct measurement of water column effects from naturally and chemically dispersed oil is extremely difficult, if not impossible, because of the inherent patchiness of concentrations and water column organisms and the ephemeral nature of the subsurface plumes. The spatial and temporal scales of patches with potentially toxic

concentrations are typically on the order of meters to kilometers and hours to days. Thus, modeling is the most productive method for estimating water column acute toxic effects from dispersed oil. Modeling also provides estimates of areas swept by floating oil and shoreline oiled, within which wildlife and shoreline habitat injuries would occur.

The Oil Spill Impact Guide (OSIG) will be based on a matrix of 240 model runs using ASA's SIMAP physical fates, exposure and oil toxicity models, where key variables determining impact are varied: oil type, weathering state, oil volume, environmental (e.g., wind speed, temperature) conditions, dispersant use, and toxicity to aquatic biota. The key model results from these runs will be the volume of water where acute toxic effects would occur and the area of water surface oiled (which would impact wildlife, as well as socioeconomic uses). Model results from the matrix will be summarized in both tabular and chart format so that users of the guide can look up the order of magnitude of likely impact and interpolate between results for intermediate conditions to those run in the matrix of scenarios. Simple regression equations will be provided to facilitate such interpolations for intermediate volumes of oil spilled and dispersed. The guide will be in three forms: as a report describing the approach, assumptions and results of the modeling and guidance development; a field guide in paper/PDF format; and a calculator in spreadsheet format that will facilitate interpolations.

The research and lessons learned from this effort will contribute to national efforts aimed at developing decision-making tools and supporting information related to spill response, and specifically with respect to dispersant use. The results of the research will be presented and explained to the spill response community during or adjunct to a spill response related meeting or conference. The presentation will be part of a focused halfday workshop on dispersant decision-making, where discussion of the results and implications will be solicited. The seminar will include presentation of the Oil Spill Impact Field Guide and calculator. The Oil Spill Impact Guide will be freely available on the web.

Social disruption from oil spills and spill response: Characterizing effects, vulnerabilities, and the adequacy of existing data to inform decision-making

Gap: Decision Support Systems for Contingency Planning and Response
Contracting Agency: UNH/NOAA: CRRC
Project Completed: 2010

Oil spill response planners never disregard the human dimensions of oil spills. In fact, the National Contingency Plan requires that items of economic and environmental importance that are threatened by a spill be covered in the plan. However, the strength of ecological concerns and the wealth of information on ecological sensitivity tend to be primary drivers in contingency planning. The socioeconomic lags behind the ecological in terms of readily available information and tools to assess sensitivity. Social endpoints that are acutely threatened are protected in an emergency response, but the systematic assessment of social and economic effects is not widely done in area-based contingency planning processes. This research project investigates what is involved in bringing a systematic assessment of socioeconomic vulnerability considerations into area-based oil spill contingency planning. While this project has one eye on the ultimate goal of producing practical decision-support or social impact assessment tools, it presupposes that several types of information need to be collected, evaluated, and synthesized

before such tools can be constructed. Specifically: (1) human dimensions endpoints threatened by oil spills need to be systematically identified; (2) the relationships between these endpoints, effects, and planning and management actions should be evaluated; and (3) the sufficiency of existing data and data-analysis tools to characterize and anticipate these causal relations must be assessed. Initial inquiries with emergency responders and contingency planners into these questions have validated their importance.

Drawing on existing data wherever possible, the authors propose to review qualitative data to reveal the types of human dimension endpoints that matter in oil spills. In Phase 1, the study will document how the importance of endpoints can be understood and, eventually, measured using the conceptual framework of vulnerability. To this end, researchers will meet with experienced personnel as part of three case studies to identify endpoints of concern and use the conceptual framework of vulnerability to identify key factors influencing losses. The information gathered will be structured in a way that facilitates planning interventions. In Phase 2, the study will investigate to what extent existing data are capable of depicting the human dimensions considerations identified in Phase 1 and propose recommendations for how a planning process that has been strongly led by ecological considerations can be broadened to also include the most important human dimensions. These recommendations will also summarize how oil spill planning can proceed using a perspective that highlights the coupled human and natural systems.

Transport of Biofuels in Inland Waters
Gap: Decision Support Systems for Contingency Planning and Response
Contracting Agency: U.S. EPA / NRMRL
Project Completed: 2011
Because of increased production and transportation of ethanol, a number of spills have occurred to the land surface or to inland waterways. Fuel ethanol itself is composed of mainly ethanol, but also some byproducts (usually called fusel oil). Denaturant is added, which is usually gasoline or gasoline range hydrocarbons. When this liquid comes in contact with water, the ethanol and gasoline can separate and form two separate phases. The properties and composition of fuel ethanol, denatured fuel ethanol, and consumer ethanol fuels have been studied and an EPA report prepared for use by consultants, state agencies, and federal response officials. This information forms part of the knowledge basis for modeling transport of these liquids in inland waterways. The purpose of modeling is for response planning. Given effects of releases of these fuels in water (e.g., phase separation, volatilization of gasoline, aerobic biodegradation of ethanol, depletion of oxygen leading to fish kills), the modeling is intended to provide a tool for estimating the ability of booms to recover gasoline and bubblers to re-oxygenate impacted waterways.

Effective Daily Recovery Capacity (EDRC) Project
Gap: Decision Support Systems for Contingency Planning and Response
Contracting Agency: BSEE & USCG
Estimated Completion: 2012
EDRC is the calculated capacity of oil recovery devices as determined by using a formula defined in 33 CFR (Code of Federal Regulations) 154, Appendix C and 33 CFR 155, Appendix

B that accounts for limiting factors such as daylight, weather, sea state, and emulsified oil in the recovered material. The regulatory EDRC calculation provides a mathematical calculation for estimating the capabilities of a skimmer based on the de-rating of its pump's nameplate capacity. Enforced by the United States Coast Guard and the BSEE, EDRC was the first effort to quantify oil spill recovery equipment following the Exxon Valdez oil spill in Prince William Sound. The BP *Deepwater Horizon* oil spill response has highlighted that the EDRC for an oil skimmer may not be an effective or accurate planning standard and predictor of oil response equipment recovery capacity. EDRC is a regulation that greatly influences vessel and facility response planning standards nationwide and established the basis for the initial capitalization of Oil Spill Removal Organizations (OSROs) in the U.S. The primary EDRC regulation is located in 33 CFR 154, Appendix C and CFR 155, Appendix B; and 30 CFR 254.44, which are administered by the USCG and BSEE, respectively. EDRC is also included by reference in 40 CFR 112 of the EPA.

There are three primary objectives of this project: (1) prepare an objective and independent assessment to scientifically validate the most appropriate methodologies for estimating the effective daily recovery capacity (EDRC) of oil skimming systems; (2) provide recommendations for EDRC improvements to inform oil spill planning and preparedness; and (3) make recommendations for new EDRC methodologies and guidelines for response systems deployed in nearshore and offshore operating environments. Analysis of the project may suggest revising the regulatory ERDC calculation. If so, the Coast Guard and the BSEE would solicit comments from the public on any proposed rulemaking as part of the evaluation process.

IATAP Lessons Learned Analysis
Gap: Decision Support Systems for Contingency Planning and Response
Contracting Agency: USCG Research and Development Center (RDC)
Estimated Completion: 2012
The outcome of the Interagency Alternative Technology Assessment Program (IATAP) Analysis Project will document the key lessons learned from the IATAP and provide recommendations for formalizing a scalable program for future use. This is the initial step in establishing a framework for a fair, repeatable, and systematic, government-managed process to solicit, screen, and evaluate public, other government agencies, and academia-suggested technologies in support of any incident of national significance. The ultimate objective is to ensure that the Federal Government has the best available tools at its disposal during the course of any type of response effort.

Initial research and information gathering has begun with several interviews of individuals who served in different levels of the incident framework. Interviews are to determine roles, objectives, perceptions, and recommendations to establish an institutionalized, government-managed framework for future events. Conducting a functional/comparative analysis of similar processes used by Incident Command Post and Interagency Solutions Group, a unit within National Incident Command to evaluate suggested technologies.

Dispersants

Heavy Oil Dispersion Research
Gap: Dispersants
Contracting Agency: BSEE
Project Completed: 2010
The objective of the work was to study the mechanism by which oil viscosity limits the effectiveness of dispersants. Specifically, two viscosity issues were studied. One is the ability of the dispersant to penetrate into viscous oil upon initial application prior to being washed away by surface water. The other is the internal visco-elasticity of the oil-dispersant mix (in conjunction with the dispersant dosage that has successfully mixed into the oil) that may prevent the oil from being broken into droplets when wave energy is applied. The success achieved at the high dose for the most viscous oil indicates that the viscosity limit for dispersion is a function of both the amount of dispersant mixed into the oil and the oil-dispersant mix viscosity. Based on the small- and large-scale test results of this study oil-dispersant mixes with final viscosities of about 10,000cP appear to need a dispersant to oil ratio of 1:10 or better to achieve significant dispersion. Both the reduction in viscosity due to the addition of the more fluid dispersant and the presence of more surfactant improve the final dispersant effectiveness. This study demonstrated in both the small- and large-scale pre-mixed tests that the oil-dispersant mix viscosity and final dispersant to oil ratio both are important.

Chemical Dispersant Research at Ohmsett: Phase 2
Gap: Dispersants
Contracting Agency: BSEE
Project Completed: 2011
This research project contained three distinct tasks.
"Evaluation of Dispersant Effectiveness in Low-Dose, Repeat Applications"
The objective of the work was to investigate the effectiveness of chemical dispersants applied to crude oils in low-dosages and with repeated application. The behavior of the surface oil was observed after each application of dispersant to determine if the dispersant was effective on the oil remaining or returning to the surface over the life of the test. The initial low-dose dispersant application resulted in a partial dispersion of the oil in all tests and also resulted in a drastic spreading of the oil over a broad area of the tank. "Café-au lait"- colored dispersions of the remaining thick surface oil patches were also observed on each subsequent low-dose application. Based on these observations it appears that each single, low dose application of dispersant will be effective in dispersing some of the surface oil.

"Validation of Small-Scale Laboratory Test Dispersant Effectiveness Ranking" The objective of the work was to compare the results of large-scale dispersant effectiveness tests conducted at the Ohmsett facility to those from a number of small-scale laboratory tests. A comparison of the Ohmsett test results with those from the three small-scale tests methods is summarized in the main body of the final report. Of the three small-scale test methods the EXDET test results most closely matched the Ohmsett efficiencies but under-estimated dispersant effectiveness (by between 6 and 33%) when compared to the large-scale Ohmsett results for the majority of the oils tested.

Dispersant Effectiveness as a Function of Energy Dissipation Rate and Particle Size Distribution

Gap: Dispersants
Contracting Agency: U.S. EPA / NRMRL
Project Completed: 2011

The overall goal of this research is to conduct scientific studies addressing the following objectives: (1) to quantify the natural rates of dispersion for multiple crude oils over a range of sea states (wave energies); (2) to quantify the effectiveness of multiple representative oil dispersant formulations on different types of reference crude oils; (3) to define the sea states (wave energies) over which current commercial dispersant formulations are most effective by quantifying the degree of dispersion expected under varying wave energies; and (4) to conduct toxicological analyses of exposed organisms to determine if dispersed oil provides a toxic exposure to the test species. All of these studies will be done under both batch and continuous flow conditions to accommodate sea currents that further dilute the dispersed oil over time. To achieve the stated objectives, pilot-scale wave studies will be conducted in a fabricated wave tank that will simulate different wave conditions, including periodic breaking waves amid regular, non-breaking waves. The wave tank measures 32 m long, 0.6 m wide, and 2.0 m deep. The tank is equipped with a flap-type wavemaker that generates waves with periods varying from about 0.5 to 3 seconds.

Assessment of Dispersant Effectiveness using Ultrasound to Measure Oil Droplet Particle Size Distributions

Gap: Dispersants
Contracting Agency: BSEE
Estimated Completion: 2012

The goal of this project is to develop novel ultrasonic scattering methods to measure the droplet size of dispersed oil in order to provide technologies that monitor the efficacy of dispersants subsea. Ultrasonic measurements will be developed to determine the crude oil droplet size of dispersed oil to monitor/determine the efficacy of dispersants as a function of oil type, dispersant type, dispersant-to-oil ratio, water temperature, oil temperatures, and the presence of sediment on the effectiveness of dispersants. The project will be accomplished in a series of tasks beginning with lab measurements and culminating with testing at Ohmsett. Droplet sizing algorithm will be developed to best characterize the efficacy of the dispersants based on the measurements and theories. The long term goal is to transfer the algorithms and measurement protocols developed in the lab and optimized in wave tanks and on spills of opportunity to commercial sonar and marine acoustic instruments like the Acoustic Doppler Current Profiler and the Acoustic Doppler Velocimeter.

Laboratory-Scale Investigation of a Method for Enhancing the Effectiveness of Oil Dispersants in Destabilizing Water in Oil Emulsions
Gap: Dispersants
Contracting Agency: BSEE
Estimated Completion: 2012
The research will investigate the feasibility of enhancing the de-emulsifying properties of commercially-available oil dispersants by modifying the composition and fraction of polar constituents in the oil phase of water-in-oil emulsions and increasing the pH of the emulsion aqueous phase. Candidate polar additives will be selected based on human and ecological toxicity, solubility, reactivity in dispersant solutions, and effectiveness in increasing the de-emulsification properties of commercially-available dispersants. Additional consideration will be given to additives based on the ability to modify dispersant solution pH. A series of emulsion destabilization experiments will be conducted. These experiments will involve mixing known volumes of homogenized raw crude oil and (1) standard seawater; (2) standard seawater plus dispersant; and (3) standard seawater plus polar compound-modified dispersant.

Combining Mineral Fines with Chemical Dispersants to Disperse Oil in Low Temperature and Low Mixing Energy Environments
Gap: Dispersants
Contracting Agency: BSEE
Estimated Completion: 2012
The objective of this research is to assess the feasibility of a cold water and Arctic marine oil spill countermeasure strategy based on the stimulation of Oil Mineral Aggregate (OMA) formation in the presence of a chemical dispersant. Evaluations will be conducted on both laboratory and wave tank systems under controlled conditions to evaluate the potential effectiveness of treatment of oil spills from shipboard and rig operations. Mathematical models will be developed from the data to assess the environmental risks of the proposed operational strategy and the effectiveness as a means to provide guidance for field operations.
The program aims to study the applicability of combining a dispersant and common fine mineral application to treat oil slicks in low energy regimes that are typical in cold water and the Arctic. The hypothesis is that this combined treatment process would enhance the stability of the oil dispersion and reduce its toxicity. The fine minerals considered in this study are readily available at oil field sites since they are common components used in the formulation of drilling mud mixtures. The final aim of this study is to develop new practical strategies for the use of dispersant in low mixing energy and sensitive environments, including the Arctic.

Validation of the Two Models Developed to Predict the Window of Opportunity for Dispersant Use in the Gulf of Mexico
Gap: Dispersants
Contracting Agency: BSEE
Estimated Completion: 2012
In a previous BSEE-funded research project entitled "Identification of Window of Opportunity for Chemical Dispersants on Gulf of Mexico Crude Oils," two correlation models were developed to predict the window of opportunity (or time-window) for successful chemical

dispersant use in the Gulf of Mexico (GOM). The models consist of correlation relationships established using best-fit correlation between readily available fresh oil properties and the window of opportunity for successful chemical dispersant use estimated using data from GOM crude oils and spill volumes of 1,000 and 10,000 barrels. The study demonstrated that combination of Sulfur, Saturate, and Wax contents of the fresh oils correlated best with the time-window for dispersant use.

This project aims to validate and improve the two correlation models using a well known oil spill model OILMAP by adding crude oils from outside the GOM for which physical and chemical properties are available, introducing 10 new crude oils from the GOM for which physical and chemical properties will be measured in this study, considering existing data from large tank tests and field trials/spills, and using data from new small tank tests. The project also aims to evaluate the sensitivity of the models to water temperature, wind speed, and the oil viscosity with the aim to include effects of these parameters into the models. This project is a direct continuation of TAR Project 595 - Identification of Window of Opportunity for Chemical Dispersants on Gulf of Mexico Crude Oils.

Baffled Flask Dispersant Effectiveness Testing
Gap: Dispersants
Contracting Agency: BSEE
Project Completed: 2011
BSEE entered into an Interagency Agreement with EPA to conduct laboratory dispersant effectiveness tests (DE) using the Baffled Flask Test (BFT) on 20 crude and fuel oils using the dispersant Corexit 9500. Laboratory-scale DE tests were conducted using the same dispersant and oil combinations, and results were compared to determine if the bench-scale test results can be used to provide reasonable estimates of field performance.
The correlation among the three different methods of measuring DE appears to be low.

Validation of Small-Scale Laboratory Test Dispersant Effectiveness Ranking
Gap: Dispersants
Contracting Agency: U.S. EPA / NRMRL
Estimated Completion: 2012
Limited field data are available comparing bench scale test results to field success. BSEE funded and conducted a research project at Ohmsett to provide large-scale test tank dispersant effectiveness (DE) data (estimates) on twenty crude and fuel oils using Corexit 9500 dispersant. Laboratory-scale DE tests were conducted using the Baffled Flask Test with the same dispersant and oil combinations as used at Ohmsett to determine if the bench-scale test results can be used to provide reasonable estimates of field performance. EPA conducted the BFT tests on all 20 crude and fuel oils using Corexit 9500 dispersant at a fixed temperature of 15 °C. The results of the BFT tests were compared with results from other laboratory-scale experiments (SFT, EXDET, IFP) to determine if correlations can be made or extrapolated to establish if the bench-scale test results can be used to provide reasonable estimates of field performance.

Use of the Baffled Flask Test to Determine the Dispersant Effectiveness of the Eight NCP Product Schedule Dispersants on S. Louisiana Crude Oil at Two Temperatures
Gap: Dispersants
Contracting Agency: U.S. EPA / NRMRL
Project Completed: 2011
The recent BP *Deepwater Horizon* spill in the Gulf of Mexico sparked renewed interest by EPA's Office of Research and Development (ORD) to test all the dispersants on the National Contingency Plan Product Schedule (NCCPS) for their ability to disperse S. Louisiana crude oil (SLC). NRMRL ran the Baffled Flask Test (BFT) on the eight listed and available dispersants to supplement toxicity testing conducted by our sister lab in Gulf Breeze, FL. Because water temperatures in the deep sea are in the vicinity of 5 °C, while temperatures within 5 m from the surface average around 25 °C, this project studied dispersant effectiveness at both temperatures. The BFT was conducted on only one oil, SLC. No hypothesis testing was needed in this project. All statistics were generated automatically as part of the SOP. The objective was to record dispersant effectiveness at the two different temperatures for all eight dispersants. The eight dispersants tested included Corexit 9500, Dispersit SPC 1000, JD 2000, Nokomis 3-AA, Nokomis 3-F4, Saf-Ron Gold, Sea Brat #4, and ZI-400. The dispersants were provided to NRMRL by its sister lab at RTP, NC. Three of the eight dispersants gave satisfactory results while the others did not.

Biodegradability of Dispersants and Dispersed Oil at Two Temperatures
Gap: Dispersants
Contracting Agency: U.S. EPA / NRMRL
Estimated Completion: 2012
The recent BP *Deepwater Horizon* blowout has raised questions not only about the biodegradability of oil in deep waters and surface waters of the Gulf of Mexico but also raised concerns about the rate of biodegradation of the dispersants per se and the dispersed oil. The objective of this study is to determine the rate of biodegradation of S. Louisiana crude oil (SLC) spilled in the Gulf of Mexico (GOM) in the recent BP *Deepwater Horizon* blowout with and without the presence of two dispersants currently on the National Contingency Plan Product Schedule (NCPPS). Since the temperatures of the GOM at depth and at the surface are substantially different, a further objective is to determine biodegradation rates at 5 °C, corresponding to average temperature at depths > 1000 m, and at 25 °C, corresponding to average temperature in the top 5 m. The experiment with Corexit 9500 has been completed, and the one with JD2000 is on-going as of Aug 2011.

Operational Chemical Dispersant Research at Ohmsett
Gap: Dispersants
Contracting Agency: BSEE
Estimated Completion: 2013
The overall objective of the proposed research is to advance the state of the art and knowledge in chemical dispersant use in marine spill applications. Three separate projects will be conducted primarily at the Ohmsett test facility in Leonardo, New Jersey. Project (1): Validation of Time Window for Dispersant Use Model. A two-week testing program will be conducted at Ohmsett

to validate the models that have been developed for predicting the time window for successful use of dispersants. Project (2): Comparison of Small Scale Dispersant Testing Methods to Ohmsett Results: The Effects of Dispersant Type and Oil Properties. A one-week dispersant effectiveness testing program at Ohmsett and a series of laboratory-scale dispersant effectiveness tests in Ottawa will be conducted to compare results of the two methods using different oil types and dispersants. Project (3): Effectiveness of Typical Aircraft Spray Dosages on Outer Continental Shelf Crude Oils. A one-week testing program at Ohmsett will be conducted to study the effectiveness of dispersant applied at typical aircraft application dosages (5 gallon/acre) on light to medium Outer Continental Shelf oils including the MS 252 crude oil spilled during the BP Horizon incident under near-at sea conditions.

Wave Tank and Field Study of Dispersion Effectiveness in Arctic Conditions
Gap: Dispersants
Contracting Agency: U.S. EPA / NRMRL
Estimated Completion: 2014
This is a study of dispersion effectiveness in a wave tank at Arctic temperatures. Little is known about how effective dispersants are in icy waters. Oil spill responders and clean-up teams in the Arctic face the challenges of ice, cold temperatures, isolated locations, and limited daylight hours. Equipment for recovery of spilled oil is mostly designed for use in open-water conditions with no ice. As wave tank data are developed, information will be fed into numerical models for predicting the fate of dispersed oil plumes and to understand recent field measurements in the Gulf of Mexico. The modeling effort will be followed by a field study in the Arctic to calibrate the model with real field data. A field study will take place in 2013 (locations currently being considered: Barrow Strait, Wellington Channel, Lancaster Sound) with the collaboration of the Canadian Coast Guard (CCG), the U.S. government, BSEE, and other partners to prepare territorial partners, local communities, and non-governmental organizations to be ready and better prepared in the case of an emergency spill.

In situ Burning

Research on Improving Methods for Recovering Residues from In Situ Burning of Marine Oil Spills
Gap: In situ Burning
Contracting Agency: BSEE
Project Completed: 2011
The objective of the proposed research program was to develop methods for: (1) recovering potentially non-buoyant In-Situ Burning (ISB) residues through innovative surface and sub-surface collection means; and (2) recovering buoyant residues, including those attached to sorbent agents that were intentionally added to the residue to prevent subsequent residue sinking. The goal of the program is to refine and develop ideas for preventing ISB residues from sinking and for collecting both buoyant and non-buoyant ISB residues, based on earlier studies. After an 18-month effort, BSEE was unable to obtain permission and permits to conduct the crude oil burns at Ohmsett and the project was cancelled.

Oil Spill Surveillance

Delivery and Quality Assurance of Short-Term Trajectory Forecasts from HF Radar Observations
Gap: Oil Spill Surveillance
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2009
The project is proposing to develop, assess, and document the use of real-time ocean surface current maps from high frequency (HF) radar installations. Specifically, the research team will evaluate the use of these data in support of oil spill response activities. An extensive test of these capabilities was conducted in connection with the NOAA Safe Seas 2006 oil spill exercise offshore San Francisco in August, 2006. The research team intends to conduct a systematic post-exercise evaluation and to document lessons learned. The research team also intends to quantitatively assess the performance of the short-term (24-hour) surface current prediction methodology that was developed for the Safe Seas 2006 exercise by comparing observed and predicted currents under a wide range of environmental conditions. To aid that assessment, the research team will conduct a multi-day, multi-deployment field experiment using an array of GPS-tracked surface drifters. Finally, the research team intends to document our results in the form of a package of recommendations and procedures for the integration of HF radar-derived products into real-time spill response protocols.

Open Water Multispectral Aerial Sensor Oil Spill Thickness Mapping In Arctic and High Sediment Load Conditions
Gap: Oil Spill Surveillance
Contracting Agency: BSEE
Estimated Completion: 2012
The existing aerial thickness mapping system was developed and operationally tested under temperate sea and atmospheric conditions with reasonable water clarity. The technology must be tested and validated under oceanographic and environmental conditions that were not experienced during initial development. One important example is Arctic conditions at high latitudes. With the rapid advancement of digital camera imaging technology, a new, much more compact, less expensive and simpler to operate hardware could be utilized in the future systems. There is a need for the testing of simplified, self contained multispectral system configurations. The project comprises five research/development and test/demonstration phases that also represent the project's major milestones. Some tests are dependent on specific seasons such as wintertime experiments at Ohmsett and summer (ice free) testing on Alaska's North Slope.

Detecting Oil On and Under Sea Ice Using Ground Penetrating Radar: Development of a New Airborne System
Gap: Oil Spill Surveillance
Contracting Agency: BSEE
Estimated Completion: 2012
The goal is to significantly expand the practical operating window for oil detection with Ground Penetrating Radar (GPR) to cover a wider range of sea ice and climate conditions. This research project will carry the GPR development program to the next level, to reduce the operating

limitations of existing systems in the oil/ice remote sensing role, the objective is to build and test (over fresh water ice) two new GPRs that will incorporate a number of major technological improvements over currently available systems. This project focuses on hardware development that will produce two prototype, higher-powered radar systems that can be tested in Arctic field environments using commonly available light helicopters (AS350 or equivalent). The goal is to significantly expand the practical operating window for oil detection on and under sea ice with GPR to cover a wider range of sea ice and climate conditions.

Funding partners in this project include Alaska Clean Seas, BSEE, ConocoPhillips, ExxonMobil Upstream Research, Shell International E&P, and StatoilHydro.

Response to Oil in Ice
Gap: Oil Spill Surveillance
Contracting Agency: USCG Research and Development Center (RDC)
Estimated Completion: 2014
There is not a detailed and accepted group of methodologies to minimize the damage to the environment caused by spilled oil in extreme cold either in the Arctic Region or the Northern states in the US. The objective is to develop equipment and techniques that can be used successfully to detect, track, and recover oil in ice filled waters in all conditions.

An assessment of the scope of the issues in the Great Lakes and the Arctic and the state-of-the art of spill response in both regions was accomplished. Workshops were held in Anchorage and in Cleveland to canvas experts from both areas for potential operational gaps that could be identified and solved using exercises. Use of existing icebreakers and logistic support capabilities in the Great Lakes could provide valuable opportunities to test Arctic research results. A demonstration of some equipment occurred in the Great Lakes in April 2011. A follow on test in ice is scheduled for winter in 2012.

Detection and Mitigation of Oil Within the Water Column
Gap: Oil Spill Surveillance
Contracting Agency: USCG Research and Development Center (RDC)
Estimated Completion: 2016
The current spill technology is not capable of accurately detecting and mitigating subsurface oil within the water column down to 10,000 feet. Some potential solutions were utilized during the BP *Deepwater Horizon* Spill; but both deep and shallow water solutions are needed. The minimum requirements for the proposed technology are to operate in all environmental conditions; and locate and mark subsurface oil to allow the decision-makers to formulate the most feasible approach to mitigate or remove the oil. The final product should have sufficient resolution for detecting small droplets of oil. The proposed technology should also have the ability to be efficiently used near shore and in rivers.

On-Water Containment and Recovery

Testing of Speed Sweep Boom for High Speed Open Water Oil Recovery Application
Gap: On-Water Containment and Recovery
Contracting Agency: U.S. NAVY
Project Completed: 2010
The overall goal of this research is to conduct tests of a prototype boom system for Vessel of Opportunity Skimming applications off shore. The research team addressed the following objectives: (1) to quantify capture efficiency at speeds from 1 to 4 knots; (2) to compare the effectiveness of the boom to existing commercial and foreign products at various speeds; and (3) assess the modalities of oil entrainment and over wash to attempt to improve future designs. All tests were done in the Ohmsett facility the week of 10 May 2010. The prototype successfully contained oil at a higher speed than all known US manufactured systems but entrained at speeds significantly slower than a system currently manufactured overseas (NOFI, Norway). As well, span lines forward (not present in current systems) caused concerns about debris fouling.

Recovery of Heavy Oil
Gap: On-Water Containment and Recovery
Contracting Agency: USCG Research and Development Center (RDC)
Estimated Completion: 2013
Existing USCG and commercial systems are inadequate for heavy, viscous oil recovery. This includes both emulsified oils floating on the surface and oils heavier than water that sink to the bottom. The underwater environment poses major problems including poor visibility, difficulty tracking oil spill movement, colder temperatures, problems with containment methods and technologies, and the electric or mechanical recovery equipment's interaction with water.

The objective is to analyze existing technology and develop products to increase the USCG and industry's efficiency and effectiveness when responding to heavy, viscous oil spills sitting on the bottom.

Proof-of-concept detection technologies including sonar, laser fluorosensor, real-time mass spectrometry and in-situ fluorometry were tested at Ohmsett February, 2008. Additional testing of prototype sonar and laser fluorometer systems was completed in January 2009. In November 2009, three developmental contracts were awarded to design a complete recovery system. Testing of the prototypes is scheduled for November 2011, followed by potential field tests in FY12.

Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention

New Safety Barrier Testing Methods (08121-2101)
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: DOE, Southwest Research Institute, RPSEA
Project Completed: 2012
Safety barriers, such as valves and blow-out preventers, are vital components to continued oil and gas operations. These safety barriers are particularly vital for ultra-deepwater applications for which the failure to hold, operate, and maintain pressure could have catastrophic impacts to worker safety, the environment, and the economics of well operators. The utilization of these barriers requires that assessment of their performance be periodically assessed. The current approaches to performance evaluation, including leak detection, are costly and can result in unacceptable losses of production.

Southwest Research Institute is conducting a program to move the oil and gas industry, particularly in the ultra-deepwater community, towards more efficient and effective means of evaluating safety barriers. This program is a two-prong effort aimed at both background information collection as well as proof-of-concept validation. The initial tasks would include soliciting regulatory input, reviewing existing literature, and executing a technology-selection task. The second half of the project will be aimed at lab-scale and field testing of selected technologies.

High Resolution 3D Laser Imaging for Inspection, Maintenance, Repair, and Operations (09121-3300-06)
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: DOE, 3D at Depth LLC., UTEC Survey Inc., CDL Inc.
Estimated Completion: 2013
The primary objective of this project is to radically improve the accuracy and efficiency of the inspection, maintenance, and repair of ultra deepwater assets. 3D at Depth LLC, the prime contractor for this project, has developed an underwater medium range laser imaging solution to a Technology Readiness Level (TRL) 2 capability. This project includes a consortium of companies that includes 3D at Depth, CDL Inc., and UTEC Survey. The project will raise the TRL of 3D at Depth's underwater 3D laser scanner (the LaserFish) from 2 to 5/6. The objective of the consortium is to eventually utilize the technology to dramatically improve the processes and methodologies used in underwater survey and metrology just as laser scanning has done for terrestrial inspection, maintenance, repair, and construction projects.

The key deliverables will include the published results of the lake and integrated ROV demonstrations of the working full-scale prototype. Additional optional tasks can be funded to perform an open water demo on an actual project of opportunity (TRL 6).

The speed and precision of the technology developed by this proposed project will for the first time allow operators to acquire accurate as-built 3 Dimensional models of deepwater assets. This major breakthrough in underwater data collection: reduces operating costs for underwater inspection, maintenance, and repair; reduces environmental risk through more accurate inspection and faster response, significantly improves construction practices and quality / reliability; greatly reduces risks to high value assets; allows infrastructure owners/operators to rapidly respond to problems; and provides rapid access to sharable accurate as-built data before, during and after construction.

Autonomous Inspection of Subsea Facilities (09121-3300-05)
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: DOE, Lockheed Martin, Florida Atlantic University, Seanic Ocean Systems
Estimated Completion: 2013
Autonomous Underwater Vehicles (AUVs) are becoming more capable and reliable. Implementation of AUV-based inspection, repair and maintenance in ultra-deepwater fields will provide game-changing improvements in cost, performance, safety and reliability that will enable cost effective production of these smaller deepwater fields. Industry advances in autonomy used on Unmanned Ground and Air vehicles may be transitioned to existing AUVs enabling the capability to perform autonomous inspections and light intervention. Incremental demonstration of such AUV capabilities will be required to convince Field Operators that the reliability, safety, and capabilities of these systems are acceptable for deepwater operations.

Lockheed Martin will develop, integrate and test technology for autonomously conducting a pre/post hurricane inspection of a facility. This will include integrating existing capabilities for: (1) autonomous real-time imaging and reconstruction (3D model) of an underwater facility; (2) detection and highlighting of changes to the facility ; and (3) aiding the AUV's navigation along its path based on feature detection and recognition. The project will include an offshore demonstration providing increased operator confidence of AUV capabilities for use in a deepwater field environment. Lockheed Martin MS2 will be the overall project lead incorporating autonomous technology from within the corporation augmented by expertise from Florida Atlantic University and Seanic Ocean Systems.

Fatigue Performance of High Strength Riser Materials Subjected to Sour Environments (07121-DW1403)
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: DOE, Southwest Research Institute, BP, Inc.
Project Completed: 2012
The goal of this project is to assess the fatigue performance of new high strength materials required for ultra-deepwater high pressure, high temperature risers, under representative conditions. These materials include high strength steel and titanium linepipe, high strength forgings, and nickel-base alloys.

Increasing water depth results in production from reservoirs with increased pressures and in some cases reservoirs can exhibit high temperature and/or "sour" (hydrogen sulfide or H_2S) environments. These conditions limit the use of conventional materials, particularly for production risers, which must be capable of withstanding extremes of pressure and temperature. Several suppliers of tubular materials have developed higher strength products that would enable the design of light-weight risers needed for deepwater application. However, information is lacking on the fatigue performance of these new materials under environments representative of those anticipated in ultra-deepwater development areas. The objective of this project is to generate corrosion fatigue data on these new materials to fill this information and data gap.

The work carried out under this project will quantify the fatigue properties of high strength line pipe material (steel and titanium). An assessment of the fatigue properties of high strength forgings and nickel base alloys could occur in a subsequent project phase. Fatigue life (S-N) and fatigue crack growth rate behavior will be evaluated under various environmental conditions. The aim is to explore several different materials and systems and determine those which exhibit the best properties. Work on this project began on December 15, 2008. To date, three of the test materials have been procured and test specimens have been machined.

Robotic Magnetic Flux Leakage (MFL) Sensor for Monitoring and Inspection of Deepwater Risers Graduate Student Design Project (07121-DW1603D)
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: DOE, Rice University, iTRobotics
Project Completed: 2012
This project seeks to advance the development of inspection robots and nondestructive evaluation sensors for the on-site inspection of risers used in deepwater offshore platforms. The new idea in this study is to model, develop and test promising nondestructive testing technologies such as magnetic flux leakage, that can be incorporated into tether-less, mobile, remotely operated robots to detect defects and fatigue cracks inside installed risers, in real time. The project will also develop new damage detection algorithms and correlate the results of the magnetic flux leakage technique with the results of existing techniques. Development of the on-site inspection robots and nondestructive techniques for riser inspection will help prevent costly downtime or accidents from occurring, leading to the avoidance of lost production and a reduction in the risks of environmental damage.

This project includes two major elements: (1) development of a detailed analytical model of a deepwater semi-submersible platform and risers, with coupled analysis floating platform/mooring/risers, and the establishment of the dynamic response of riser for fatigue crack evaluations; and (2) experimental evaluation of a remotely operated nondestructive evaluation sensor on a small scale finite section of the riser, under the dynamic response to which the riser is subjected under normal and adverse operating conditions.

Sensors and Processing for Pipe, Riser, Structure, and Equipment Inspection to Provide Detailed Measurements, Corrosion Detection, Leak Detection, and/or Detection of Heat Plumes from Degraded Pipeline Insulation (09121-3300-08)
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: DOE, Blueview Technologies Inc.
Estimated Completion: 2012
This project will develop critical sensing capabilities that improve efficiency, reduce time and costs, reduce rework, and improve safety and environmental performance when developing, exploiting, and producing ultra-deep water resources. These goals will be accomplished by leveraging the enhanced fidelity of a DoD-fueled and commercially-matured technology and products in concert with world-class partners to rapidly develop and field water-clarity-independent sensing solutions to enable: (1) detailed physical measurements of underwater pipes and structures for inspection, metrology, and assessment of deflection, curvature, and anode condition; (2) detection and identification of external corrosion, pitting, and biologic fouling; (3) detection and quantification of gas or petroleum product leaks; and/or (4) detection and quantification of heat plumes resulting from cracked or degraded pipeline insulation.

The project leverages some of the most advanced acoustic sensing technology (Blazed Array sonar) available today, which is the product of 10 years of DoD and commercial investment. The project will be conducted in two phases. The first phase will collect initial data in shallow water and controlled tank environments to reduce risks and logistics and provide initial results to down-select to highest potential, highest value deep water capabilities for the second phase. The second phase will collect deep water data and refine algorithms/methods to accelerate the maturation of the selected deep water capabilities. This approach will first broadly pursue new, game changing capabilities in shallow water and then focus down on selected deep water capabilities to provide the highest likelihood of successfully launching key deep-water capabilities into broad deployment.

Technologies of the Future for Pipeline Monitoring and Inspection (08121-2902-02)
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: DOE, University of Tulsa, T.D. Williamson
Project Completed: 2011
The objective of this project is to provide a system for monitoring and maintaining deepwater pipelines which would predict and allow proactive measures to be taken to avoid the problems associated with pipeline fouling or plugging or other deleterious conditions in the pipeline. This will be accomplished by using miniature capsules to record and/or record/transmit measured data in real time. The measurements would be analyzed to identify anomalous conditions existing in the pipeline being monitored and corrective action(s) implemented based upon the real time measurement of the parameter of interest. The ideal capsule would be the size and shape of a pill. These capsules would be recovered on the platform and re-injected to gather additional data.

The project involves the integration of the latest technology advancements in the medical field and the petroleum industry coupled with standard state-of-the-art pipeline technology. The impact of the project would be a pipeline that is unsupervised and auto adaptive to the environment so that real time problem identification and corrective action can be implemented.

Potential pipeline problems will be mitigated to avoid costly down time and repair. A key feature of this technology is to develop full knowledge of flow assurance parameters from the reservoir to the sales point in pipelines and production risers; and from the wellhead through drilling risers to the rig when developing a field. The technology will significantly reduce environmental contamination concerns.

Deepwater Subsea Test Tree and Intervention Riser System (09121-3500-07)
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: DOE, DTC International, Inc; Stress Engineer Services, Inc.; Det Norske Veritas
Estimated Completion: 2012
DTC International, Inc. (DTC) will develop a Deepwater Subsea Test Tree (SSTT) and Intervention Riser System (IRS) that are capable of conducting Riser–Based (Thru-Drilling Riser and Open Water Riser) intervention operations on subsea completed wells with wellhead shut-in pressures up to 20,000 psi and wellhead flowing temperatures up to 350 °F in water depths up to 12,000 feet. The SSTT and IRS will be developed as part of a fully integrated Subsea Well Intervention System (SWIS) that also includes a Riserless Intervention System (RIS) that is capable of conducting both Wireline and Coiled Tubing (future upgrade) intervention operations without the need for a riser. DTC will progress the design of the SSTT and IRS to the point that that they are certified, ready to fabricate, develop cost estimates for manufacturing and qualification testing of the SSTT and IRS, and develop a business case for a SWIS "Tool Pool" that includes the SSTT and IRS in addition to the RIS.

The RIS portion of the SWIS is currently being development by DTC under RPSEA Project No. UDW2301. This project will develop the remaining two parts of the SWIS, the SSTT and IRS. Once completed, the SSTT, IRS and RIS will function as a fully integrated subsea well intervention system that shares many common components, including the Well Control Package (WCP), Emergency Disconnect Package (EDP) and Intervention Control System, and is capable of conducting both riser-based and riserless intervention operations on both Vertical and Horizontal Christmas Trees.

The SSTT and IRS proposed by DTC are expected to have the following major impacts and benefits: (1) provide a means of conducting thru-drilling riser and open water riser intervention operations on subsea wells in water depths up to 12,000 ft. water depths and at working pressures and temperatures up to 20,000 psi 350 °F; (2) together with the RIS, complete the development of a fully integrated Subsea Well Intervention System capable of conducting both riser-based and riserless intervention operations; (3) be applicable for use on 80% of the subsea wells in the deepwater and ultra-deepwater areas of the Gulf of Mexico; (4) reduce the risk of interface problems, equipment damage, loss of well control, or discharge of fluids to the environment; and (5) reduce the cost of conducting intervention operations on subsea wells by sharing components between multiple applications and forming a SWIS "Tool Pool".

Deepwater Riserless Interventions System (RIS) (08121-2301)
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: DOE, DTC International, Inc.; Superior Energy Services; NOV Texas Oil Tools; Deepwater Research Inc.; Det Norske Veritas
Estimated Completion: 2012
The objectives of this project are: (1) to develop a Deepwater Riserless Intervention System (RIS) capable of conducting typical wireline interventions in water depths up to 10,000 feet; (2) to progress the design to the point that it is certified, ready to fabricate; (3) to establish the cost of conducting a typical wireline intervention using the RIS; (4) to verify the anticipated cost savings achievable with the RIS; and (5) to develop a business case for commercialization of the RIS.

Additional objectives established by DTC are: (6) to develop the RIS as part of a fully integrated Subsea Well Intervention System (SWIS) capable of conducting both Riser-based and Riserless Interventions; (7) to increase the maximum water depth rating to 12,000 feet; (8) to increase the maximum pressure rating to 15,000 psi and for potential upgrading to 20,000 psi; (9) to increase the maximum temperature rating to 300 °F and for potential upgrading to 350 °F; (10) to eliminate all downlines from the intervention vessel except for the ROV deployment cable and to eliminate all connections between the RIS and the intervention vessel and ROV; (11) to develop standardized interfaces between the RIS and subsea trees to minimize potential interface problems and issues and to offer these standardized interfaces to the subsea industry for adoption by the operators and/or standardization societies such as ISO and API; and (12) to develop a business case for a SWIS "Tool Pool" which would include the RIS.

The RIS proposed by DTC is expected to have the following major benefits: (1) reduce the cost of conducting wireline intervention operations by as much as 50% or more; (2) significantly shorten the planning and preparation time for intervention operations; (3) reduce the need for reallocation of critical resources from other projects; (4) reduce the impact on the environment; (5) greatly reduce the risk of equipment damage, loss of well control, or discharge of fluids to the environment; (6) significantly increase the operating envelope for the RIS by eliminating all downlines and connections between the RIS and the intervention vessel and ROV; and (7) be applicable for use on 80% of the subsea wells in the deepwater and ultra-deepwater areas of the GOM by developing a RIS which is initially rated for 15,000 psi and 300 °F, but is designed for upgrading to 20,000 psi and 350 °F.

Deepwater Blowout Preventer (BOP) Reliability & Well Kicks – Phase I
Gap: Offshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: BSEE
Estimated Completion: 2012
To meet the increased demand for deepwater drilling services, several new floating drilling rigs dedicated for deepwater drilling have been put into service over the past decade, yielding a newer generation of rigs that include new technology both in terms of subsea BOPs. The major new technology is the modern control system, locking system for rams, high capacity shear rams, more compact preventers, increased number of ram preventers, and more emergency shear and disconnect systems. The performance of these new BOP systems has not yet been systematically evaluated since BSEE's last BOP reliability studies performed in 1999 and 2001. The primary objectives of this study is to establish: (1) an updated reliability overview of deepwater subsea BOPs used in the Gulf of Mexico, U. S. OCS waters during 2007 – 2009 and (2) a quantified overview of the

deepwater well kick frequencies and important parameters contributing to the deepwater kick frequency in the various areas.

Sub-objectives include (1) Insure that the deepwater drilling business keep up the focus on the importance of BOP reliability and kick prevention, (2) Establish an overview of BOP stack layout for the various rigs and further to highlight differences among the different areas, (3) Establish an overview of the various emergency control systems, (emergency disconnect, autoshear, dead man and acoustic system), (4) Present the deepwater BOP reliability time dependant trends by comparing with results from earlier studies, (5) Compare kick frequencies and parameters from the various areas and earlier studies, and (6) Highlight the impact of "new" equipment on the BOP reliability.

Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention

Non-Destructive Quantitative Residual Stress Assessment Tool
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, JENTEK Sensors Inc.
Estimated Completion: 2012
This new tool utilizes low frequency impedance measurements to quantify the residual stresses associated with each type of anomaly to assess the need for pipeline repair or removal. The low frequency impedance detection system must operate outside of the pipeline with a hand-held, probe. The time to complete a full inspection of the mechanical damage will be on the order of tens of seconds or minutes, depending upon probe design and other variables.

Future work may include establishing a database of residual stress measurements on selected steels, which could be utilized to determine the residual stress during measurements. The hand-held tool could include wireless data transmission or other communications methods to enable accurate pipeline operator analysis.

Anticipated results should include a prototype measurement system that is validated, and will offer an economical alternative to existing technologies while also offering superior performance. Progress Reports Publically available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=416

Low-Cost, Full Field Tool for In-Ditch Deformation Measurement
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Intelligent Optical Systems, Inc.
Estimated Completion: 2012
Mechanical damage (typically from third party excavations) is the most frequent cause of leaks and ruptures in pipelines. Surface corrosion is also a threat to pipeline integrity. Currently used techniques for assessing damage by means of in-line inspection and in-ditch tools are not accurate enough for reliable determination of fitness for service. In this project, Intelligent Optical Systems will determine the feasibility of implementing a novel surface-profiling tool for mechanical damage evaluation based on the real-time processing of a single digital image.

This inexpensive, full-field system images the full shape of the damaged region with high accuracy, and overcomes current limitations in the assessment process. In Phase I, Intelligent Optical Systems will demonstrate the capability to produce surface profiles with the required spatial and depth resolution. Intelligent Optical Systems will perform measurements on test samples, and compare the data with related data obtained with more complex laser-based tools. Progress Reports Publically available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=417

Development of Non-Destructive In-Service Detection of Damage Severity for Pipeline Steel Inspection

Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Generation 2 Materials Technology LLC
Estimated Completion: 2012
The project will develop a nondestructive tool to quantitatively assess residual stress in pipelines from the exterior and through coatings. Residual stress is a critical factor that determines the cracking susceptibility of pipeline steels, but existing methods for measuring mechanical damage in pipeline steels are incapable of quantifying the residual stress levels. A larger gouge or dent does not necessarily signify worse damage than a smaller gouge or dent; it is more important to focus on the actual residual stress levels induced by damage.

Knowledge of the residual stress levels provides an accurate means to assess the severity of the damage and improve the pipeline integrity, ultimately reducing the amount of unnecessary removal and repair applications. The unique use of low frequency impedance sensors will allow for through-thickness pipeline integrity assessment.

Phase I will utilize low-frequency impedance analysis to perform in-situ residual stress measurements on simulated mechanically damaged pipeline steel to compare with finite element and other stress estimation techniques. Phase II and Phase III efforts will develop a calibrated portable low frequency impedance tool for in-situ assessment of pipeline damage without removal of coatings. Progress Reports Publically available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=391

Comprehensive Study to Understand Longitudinal Electrical resistance weld (ERW) Seam Failures

Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Battelle Memorial Institute
Estimated Completion: 2013
The objective of the proposed project is to assist PHMSA in favorably closing NTSB Recommendation P-09-1 arising from the Carmichael MS pipeline rupture involving an ERW seam, which directed that PHMSA conduct a comprehensive study of ERW pipe properties and the means to assure that they do not fail in service. The proposed work is anticipated to validate that periodic use of the current ERW seam integrity assessment methods (hydrostatic testing and in-line inspection using a crack-detection tool) are the best means to prevent ERW seam ruptures.

The work will address the characteristics of ERW seams that make them susceptible to failure, and it will identify the factors the pipeline operators must consider in order to assure that their ERW pipelines are safe. Progress Reports Publically available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=390

Consolidated Research Program, Right of Way Automated Monitoring Threat Prevention
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Electricore, Inc.
Estimated Completion: 2014
Preventing unauthorized intrusions on pipeline Right of Ways (ROWs) and mechanical damage due to third party strikes by machinery is a constant challenge for the pipeline industry. Equally important for safety and environmental protection is the detection of leaks from pipeline systems. This proposal presents a consolidated research and development program to develop, test, and deploy an integrated technology package for automated monitoring, assessment, and reporting of various threats to energy transportation pipelines.

The Consolidated Program is being implemented through primary projects focus areas: (1) ROW Threat & Change Detection and Identification; and (2) Leak Detection. The main goal is to use technology to provide "near real-time" detection and reporting of the main threats, with the ultimate objective to develop and deploy advanced sensors and data processing systems on various platforms (ground patrol, manned aircraft) to patrol energy pipeline ROWs and similar-oriented linear features/infrastructure using automated processes.

The program includes developing integrated sensing suites to provide improved and cost effective aerial surveillance for detecting unauthorized activity and changed conditions and communications systems for prompt reporting of threats. This will include on-board data processing systems for identification and screening of threats, data archiving and storage, and could include advanced methods of data analysis and predictive modeling for assessing threats to pipelines. This Consolidated Program will substantially meet many of the challenges currently confronting the pipeline industry for damage prevention, threat identification, and leak detection, and will improve pipeline safety and reliability of service by advancing the state of current technologies for pipeline ROW monitoring and surveillance. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=389

Meandering Winding Magnetometer (MWM)-Array Characterization of Mechanical Damage and Corrosion
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, JENTEK Sensors Inc.
Estimated Completion: 2013
This project will advance the JENTEK MWM-Array technology to provide quantitative characterization of corrosion and mechanical damage. This includes characterization through coatings/insulation; followed by higher resolution imaging with coatings/insulation removed. For mechanical damage, quantitative characterization includes geometric variations and multidirectional residual stresses (near the surface and deeper within the pipeline).

This project will develop capability to detect cracks at damage sites. For corrosion, enhanced high resolution imaging of both external and internal corrosion will be developed for specific applications to support life management decisions. This team will build on demonstrated MWM-Array (and MR-MWM-Array) detection capabilities to deliver substantially enhanced

characterization of damage and practical means for implementation. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=354

Integrated Internal Inspection and Cleaning Tool Technology for Pipelines
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Electricore, Inc.
Estimated Completion: 2013
To develop an innovative and new multi sensor approach to monitoring the integrity of pipelines. This program has been termed 'The Integrated Internal Inspection and Cleaning Tool' or 'Semi-Smart Pig'. The program will identify and progress technology that can be added to standard internally deployed cleaning tools to detect, measure, and characterize a number of variables that provide data utilized in integrity management decisions.

This integrated tool will perform its conventional cleaning function but this 'add on' capability will provide data that can be used to measure and monitor critical parameters. The addition of 'sensor' technology to cleaning tools already frequently deployed by the industry will allow repeated measurement and parametric data to be recorded providing trends and changes in pipeline network degradation. These tools, deployable at a lower cost and higher frequency, will act as 'alarms' on a pipeline's changing conditions that affect integrity and also allow more accurate planning for the deployment of high resolution inspection tools. It's anticipated that these 'semi smart' tools will also be deployable in other pipelines where geometric configuration does not currently permit the use of In Line Inspection tools.

The program is designed to specifically address: Technology Development–Detection and Characterization of Anomalies from Inside the Pipe. The ultimate deliverables of this project are a lowered number of pipeline incidents and reduced costs for operators whilst increasing reliability. Progress Reports Publically available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=356

Quality Management Systems for Pipelines
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Det Norske Veritas (U.S.A.) Inc.
Estimated Completion: 2013
A significant number of service failures for pipelines can be traced back to flaws introduced prior to commissioning the pipeline. The pre-service hydrotest is able to detect and remove critical defects. Hydrotest failures indicate that quality management practices were ineffective in preventing and detecting critical defects. This project addresses the need for improved quality management practices for pipeline projects.

The objectives of the project are: (1) to develop general guidelines for a Quality Management Systems for pipeline projects (from design to commissioning) to provide greater assurance of consistent and acceptable quality; and (2) to develop enhanced Quality Management Systems guidelines that provide assurance of pipeline safety and integrity without having a pre-service

hydrotest. The latter will be of particular benefit for pipeline projects in challenging environments such as the Arctic, where there may be a desire to eliminate the hydrotest due to significant associated costs and logistical challenges. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=357

Dent Fatigue Life Assessment - Development of Tools for Assessing the Severity and Life of Dent Features

Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, BMT Fleet Technology Limited
Estimated Completion: 2012

Failures in transmission pipelines are often the result of mechanical damage. The US DOT has indicated that 20 to 40 percent of the serious pipeline incidents in any given year are related to mechanical damage. A majority of the mechanical damage is caused by third party activities, mishandling during construction, pipeline bedding material consolidation, or ground movement. Damage usually takes the form of a dent and may be associated with a gouge.

The primary objective of the project is to predict the local stress-strain state of a dented pipeline segment and to develop criteria for ranking and estimating the remaining life of dents (plain dents and dents interacting with welds) features interacting with welds, considering through life fatigue initiation and growth in pipelines fabricated from a range of steel grades commonly used in transmission and distribution pipelines. This project builds on existing work that is developing full-scale mechanical damage experimental data to facilitate the development and validation of models for undertaking fitness for assessment and developing guidance documents. The project will produce procedures for evaluating the severity of plain dents and those interacting with welds considering their geometry and operating conditions. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=358

Selection of Pipe Repair Methods

Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Operations Technology Development NFP
Estimated Completion: 2013

The research project will establish procedures and perform long-term tests to evaluate the performance of metallic and composite pipe repair methods, improve the selection and installation of the repair methods, and ultimately reduce the risks associated with faulty or ineffective repairs.

This will be achieved by: (1) establishing and modifying testing protocols to evaluate long-term properties of the repair systems; (2) working with the suppliers and service providers to test and evaluate the performance of the repair systems available in the market; (3) working with the American Society of Mechanical Engineers PCC 2 Subcommittee on Post-Construction Repair and Testing in developing and modifying the standards for testing and qualification of repair systems; and (4) providing the pipeline operators with guidelines for evaluating and selecting the

appropriate repair method based on pipe characteristics, damage criteria, and performance of the repair.

The results will allow operators to properly select repair systems based on sound engineering tests. Working with the manufacturers will accelerate the implementation of the results that the industry needs regarding the products' long-term reliability. The work will benefit industries with transmission lines as well as utility distribution lines. The benefit of the results will not only be useful for the natural gas industry but will extend to cover liquid transmission pipes. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=359

Optimization of Multi-Wire Gas metal arc welding (GMAW) Welding Procedure for Heavy-Wall Offshore Pipeline Construction

Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Center for Reliable Energy Systems
Estimated Completion: 2012

As energy demand for oil and gas increases, offshore pipelines have been moving into deeper water with longer distance. The increases in both external water pressure and the internal operation pressure require higher strength and higher toughness of pipeline materials. Among the technical challenges in deep water pipeline construction, the quality and productivity of girth welds made during pipeline-laying operation have been two of the major concerns for safety and cost-effective reasons. In particular, as modern high-strength linepipe steels such as X70 or X80 and multi-wire gas-metal arc (GMAW) welding processes have been increasingly applied by the pipeline industries, there is an urgent need to understand the dependency of weld quality and mechanical properties on the selected welding procedure and its parameters.

With focus on the high-strength steels and multi-wire GMAW processes, the objectives of the proposed work are to understand the relation between weld properties and welding conditions, especially the new welding variable(s) that are associated with the multi-wire GMAW processes; and based on this knowledge, establish the optimal welding conditions for heavy-wall offshore high-strength line pipe steels for better weld quality and higher welding productivity.

This project is being co-funded by the Bureau of Ocean Energy Management, Regulation, and Enforcement with $125K. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=360

Fuelfinder: Remote Leak Detector for Liquid Hydrocarbons

Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Physical Sciences Inc.
Estimated Completion: 2012

The project goal is to develop a commercially successful Remote Methane Leak Detector platform to a general purpose hydrocarbon leak detector – FuelfinderTM. Fuelfinder will adopt recent advances in room-temperature diode laser technology operating near 3 microns to enable

remote sensing of gasoline, petrochemicals, biodiesel, and ethanol leaks from pipelines with man-portable, mobile, and airborne platforms in a low-cost, commercially-viable product offering. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=362

Advanced Development of PipeGuard Proactive Pipeline Damage Prevention System
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, NYSEARCH
Estimated Completion: 2012
The program objective is to develop an in-ground warning system that uses advanced security technology to proactively warn against encroachment to gas/liquid transmission and gas distribution lines. The Senstar "PipeGuard™" technology addresses damage prevention monitoring issues of accuracy, reliability, cost, real-time response, ease of installation, response time and advanced data processing.

Based on 2008 DOT data, the gas industry as a whole has over 1.2 million miles of distribution main, 45% of it is steel, over 50% plastic and the remaining mileage in the category of "other" which includes cast iron and ductile iron. As networks and new construction expand the gas distribution system, over 97% of the new network is plastic pipe. One of the most serious problems faced by natural gas and liquid companies is damage caused to the infrastructure that is unknown or preventable.

It is the objective of this program to improve Pipe Guard™ software, hardware and develop new techniques to meet distribution company needs in proactively monitoring critical pipeline sections and providing 24/7 alarm activity in the event of nearby 3rd party excavating. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=364

Advanced Learning Algorithms for the Proactive Infrasonic Gas Pipeline Evaluation Network (PIGPEN) Pipeline Encroachment Warning System
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Physical Sciences Inc.
Estimated Completion: 2012
Physical Sciences Inc. (PSI), with American Innovations Ltd. (AI) and NYSEARCH, are addressing the technology gap of Early Warning Damage Prevention Monitoring Systems, specifically Advanced Development of Algorithms for Detecting Digging Threats and Avoiding Alarms. This research will implement and evaluate self-training algorithms in the Proactive Infrasonic Gas Pipeline Evaluation Network (PIGPEN) autonomous distributed seismic sensor system.

PIGPEN provides real-time warning of unauthorized right-of-way encroachment and excavation activity near a pipeline. Early warning enables a response to the potential intrusion in time to prevent pipeline damage, and thus preclude the additional cost and risk of repairs. The ideal

PIGPEN alarm system would activate an intruder notification with 100% reliability and no alarms. The project will enhance reliability by enabling PIGPEN to learn the characteristics of its local environment and optimize its intruder detection algorithms based on learned experience. Field tests are expected to demonstrate better than 97% alarm reliability with few alarms. Progress Reports Publically available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=366

Setting Safe Limits on Biodiesel Constituents for Pipeline Integrity
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Det Norske Veritas (U.S.A) Inc.
Estimated Completion: 2012
It is anticipated that biodiesel production will increase in the coming years and will come from increasingly diverse sources, such as jatropa, algae, etc. Therefore there is a need to identify the potential corrosive contaminants from these sources and set appropriate limits for pipeline transportation.

The objectives of this work are to: (1) understand the effects of minor constituents beyond the ASTM D 6751 on corrosivity of biodiesel under pipeline specific conditions; (2) develop safe limits for any deleterious constituents in biodiesel; and (3) develop a method to rapidly monitor biodiesel corrosivity in terms of any deleterious effect on pipeline integrity.

The project will be performed in collaboration with CANMET laboratories in Canada and aims to simulate realistic flow conditions in pipelines to determine the safe limits. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=352

Corrosion and Integrity Management of Biodiesel Pipelines
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Det Norske Veritas (U.S.A) Inc.
Estimated Completion: 2012
The Pipeline Biodiesel Steering Committee together with five major multi-product pipeline operators have identified several areas that need further research to assure the safe transportation of blends above B5. According to the committee, there are relatively few technical challenges associated with movement of up to B5 blends in pipelines carrying only gasoline, diesel, or heating oil. There are, however, a number of technical items that need to be scrutinized before approval of biodiesel blends above B5 in pipelines.

Two critical issues included in the document published by the Pipeline Biodiesel Steering Committee are related to the efficiency of corrosion inhibitors and the degradation resistance of non-metallic components in biodiesel blends. Therefore, the objectives of this work are twofold. Firstly, the performance of selected corrosion inhibitors commonly used in diesel transportation will be investigated to determine whether new corrosion-related issues could arise from the use of biodiesel blends above B5. The second objective will be to understand and quantify the

degradation of non-metallic and non-ferrous metallic pipeline system components in biodiesel blends above B5. Likewise, an added objective is to generate awareness and to facilitate technology and knowledge transference between pipeline operators, biodiesel producers, research laboratories, and regulatory agencies. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=319

Technical and Economic Feasibility of Preventing Stress Corrosion Cracking through Control of Oxygen

Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Det Norske Veritas (U.S.A) Inc.
Estimated Completion: 2012

Stress corrosion cracking (SCC) has been observed in carbon steel tanks and piping in contact with fuel grade ethanol in user terminals, storage tanks, and loading/unloading racks. Previous detailed laboratory studies demonstrated that, in ASTM D-4806 fuel grade ethanol, dissolved oxygen was the most important factor leading to stress corrosion cracking, followed in importance by pre-existing scale on steel, chloride, and methanol. In a Roadmapping Workshop conducted in October 2007, methods to avoid oxygen contamination in ethanol and defining safe operating limits in terms of ethanol chemistry and oxygen concentration were identified as major gaps in the safe transportation of ethanol in pipelines. In the present project, the feasibility of oxygen removal methods for fuel grade ethanol will be evaluated using the following four methodologies: (1) the performance of oxygen scavengers under flowing conditions; (2) the consumption of oxygen under natural conditions (i.e., without using scavengers); (3) a method for direct and rapid oxygen concentration determination; and (4) the feasibility of oxygen control in pipeline operations.

The information obtained from the first three methodologies will be combined to conduct the final feasibility evaluation, taking into consideration the potential oxygen contamination or downstream oxygen in-take in pipeline operations. The results from the execution of this project will provide guidance on selecting the optimal methods, from both economic and engineering perspectives, for oxygen control of different pipeline operational situations. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=320

Feasibility of Chemical Inhibition of Ethanol Stress corrosion cracking

Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Det Norske Veritas (U.S.A) Inc.
Estimated Completion: 2012

Stress corrosion cracking has been observed in carbon steel tanks and piping in contact with fuel grade ethanol in user terminals, storage tanks, and loading/unloading racks. Previous detailed laboratory studies demonstrated that, in ASTM D-4806 fuel grade ethanol, dissolved oxygen was the most important factor leading to stress corrosion cracking, followed in importance by pre-existing scale on steel, chloride, and methanol. In a Roadmapping Workshop, conducted in October 2007, the identification of natural inhibitors (i.e. those that could be present in some

ethanols that have not shown any adverse effects) and new inhibitors that are acceptable to all stakeholders, including automakers, were recognized as major gaps in the safe transportation of fuel grade ethanol in pipelines.

Using inhibitors to prevent stress corrosion cracking in fuel grade ethanol poses unique challenges in that the impact on the fuel end users and the limited solubility of some inhibitors in ethanol need to be considered. Thus, this project proposes to work with the inhibitor manufacturers, pipeline operators and possibly the end users in order to select inhibitors that can potentially prevent stress corrosion cracking and are acceptable based on technical and end user compatibility considerations. More importantly, the ability of the inhibitors to prevent stress corrosion cracking will be evaluated under flowing conditions created by jet impingement, which can simulate pipe flow conditions in the pipelines.

The results will help identify the appropriate inhibitors, the optimum dosage and guide the application of inhibitors (e.g. batch vs. continuous) in operations. A method will be developed for rapid evaluation of inhibitors in fuel grade ethanol. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=321

Compatibility of Non-Ferrous Metals with Ethanol
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Det Norske Veritas (U.S.A) Inc.
Project Completed: 2011
Pipeline transportation of fuel grade ethanol is vital to the cost effective delivery of this fuel to the end-users. While the potential for stress corrosion cracking of steel in the presence of ethanol is one of the main concerns in the transportation of fuel grade ethanol, the compatibility of non-ferrous metals found in pipeline and downstream systems also is an area of concern. Previous studies have addressed the compatibility of some non-ferrous metals with ethanol and other alcohols but a comprehensive assessment of this issue, with respect to ethanol transportation, has not been conducted. This research project aims to develop guidelines on the selection of non-ferrous metal for use in fuel grade ethanol. The major benefit of the project is the development of comprehensive guidelines that could be used to develop ethanol transportation standards. Progress Reports Publically available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=322

Stress Corrosion Cracking of Pipeline Steels in Fuel Grade Ethanol and Blends
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Georgia Tech Research Corporation
Estimated Completion: 2012
This project will evaluate and use standard test methods to investigate stress corrosion cracking of pipeline steels in fuel grade ethanol and gasoline/fuel grade ethanol blends as alternative tests for slow strain rate tests. Slow strain rate tests can be used as screening tests to understand the environmental conditions that may cause stress corrosion cracking but do not simulate the stress

conditions experienced by the operating pipelines. Tapered tensile tests will be used to determine threshold stresses needed for stress corrosion cracking initiation under constant loads as well as under fluctuating stresses. Once the threshold stresses under different environmental conditions are determined, 4-point bend tests, simulating pipeline stresses will be used to study crack initiation and propagation under different environmental conditions.

In both, tapered tensile tests and 4-point bend tests, original pipeline surfaces can be tested to see the effect of mill scale or used pipeline surface on stress corrosion cracking initiation in fuel grade ethanol environments. Crack growth rate in different environments will be determined by using double cantilever beam samples. Role of environmental constituents and impurities in the fuel grade ethanol blends on crack initiation and propagation will be determined by both alternative stress corrosion cracking tests as well as by electrochemical methods to develop phenomenological understanding. Slow strain rate tests will also be used to compare the data from different test methods and evaluate its effectiveness in predicting stress corrosion cracking behavior in the real pipeline conditions. Ethanol from different sources, including corn, sugarcane, and cellulose based fuel grade ethanol will be tested in this three year project. Progress Reports Publically available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=296

New Design and Construction Techniques for Transportation of Ethanol and Ethanol/Gasoline Blends in New Pipelines

Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Electricore, Inc.
Estimated Completion: 2012

Previous investigations on stress corrosion cracking in fuel grade ethanol have focused on two important but different issues: (1) the determination of the cause and relevant factors involved in failure in actual facilities tanks, piping and equipment in the downstream sector handling fuel grade ethanol; and (2) assessment of the potential for stress corrosion cracking in existing pipelines being converted to transport fuel grade ethanol. This research focuses on information required to design and construct new pipelines to handling the increased demand for fuel ethanol as a result of US government mandates.

In addressing this topic, the research is directed at specific items. The major emphasis of the research is: (1) safety of transporting blends containing more than 10 percent ethanol (requirements for pipelines to handle fuel grade ethanol – E95); and (2) phenomenological understanding of ethanol stress corrosion cracking (understanding and use of metallurgical, welding and surface treatments to mitigate stress corrosion cracking). Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=295

Low-Cost, Full-Field, Surface Profiling Tool for Mechanical Damage Evaluation
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Intelligent Optical Systems, Inc.
Project Completed: 2010
The successful development of this system will yield a new class of pipeline monitoring equipment capable of the rapid, accurate surface profiling of damaged and corroded regions. Given the capital invested in pipeline infrastructure, Intelligent Optical Systems anticipate strong commercial interest in this initial target market with a strong potential to apply this novel technology to a wider field of structural inspection and monitoring applications. Progress Reports Publically available at: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=291

Digital Imaging of Pipeline Mechanical Damage and Residual Stress
Gap: Onshore Facility and Pipeline Design, Inspection, Monitoring, and Spill Prevention
Contracting Agency: U.S. DOT, Pipeline and Hazardous Materials Safety Administration, JENTEK Sensors, Inc.
Project Completed: 2010
While mechanical damage to pipelines is a common occurrence, the impact of mechanical damage on pipeline remaining life is not easily determined. The mechanical damage features, such as residual stresses and stress concentrations, will determine the effect of the damage on pipeline remaining life. Empirical relationships between damage features and burst pressure have been developed and adopted into national and international standards, but they are conservative to encompass the scatter in the data.

Mechanical damage characterization and assessment have been highlighted as a critical need by PHMSA, Pipeline Research Council International, and at public forums. Yet no "low-cost, time-efficient, reliable and simple to use" solution is available. The research team will deliver such a low cost, easy to use solution in the form of both a hand held version and a portable version, based on our award winning Meandering Winding Magnetometer (MWM)-Array technology. Progress Reports Publically available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=292

Restoration Methods and Technologies

Ecology and Economics of Restoration Scaling
Gap: Restoration Methods and Technologies
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2009
The research team proposes to develop a synthesis of restoration scaling methods used in coastal response and restoration. Resource managers throughout the country, and increasingly throughout the world, rely on a wide selection of methods to determine the appropriate quantity and type of restoration to compensate for oil spills and other perturbations to ecological resources and systems. Methods for restoration scaling draw on a variety of techniques from the fields of ecology and economics. These include the development of metrics that quantify ecological services, the use of models to establish equivalence between injured and restored services, and valuation of the use of resources for recreation and other activities. By summarizing scaling applications contained in hundreds of published articles, research reports and government documents, the project will help practitioners identify scaling methods appropriate to particular resource injuries. By recasting the relevant ecological and economic techniques in a unified presentation of scaling methods, the project will assist researchers from a variety of specializations and identify new research opportunities. The final product will be a thorough and intuitive text that will make restoration scaling techniques more accessible to scientists, public officials, industry, and the public. Workshops will be conducted to disseminate results and provide an introduction to the use of the text as a resource for restoration planning and outreach.

Shoreline Countermeasures and Cleanup

A System for Integrated SCAT Data Collection and Management: eSCAT, SCATdb, and Photologger
Gap: Shoreline Countermeasures and Cleanup
Contracting Agency: NOAA: Office of Response and Restoration
Estimated Completion: Ongoing
During response, oiled shorelines must be surveyed to guide cleanup operations. The Shoreline Cleanup and Assessment Technique (SCAT) is a standard method for conducting these surveys. Multiple field teams often conduct SCAT. SCAT surveys quickly produce a large and complex dataset comprised of SCAT observations, GPS positions, and photographs. In order to guide response decision-making, SCAT field data must be processed and analyzed in a timely manner. Until recently, SCAT and GPS data were collected on standardized paper worksheets, transcribed to electronic form, and then incorporated into maps and other decision-making products. Photographs were not tightly managed alongside SCAT data. Today, with the emergence of robust handheld computing technology, the deficiencies inherent in paper data collection are no longer necessary or acceptable. Paper data collection can be slow, error prone, and lacking quality control and integration with GPS technology. Digital options are available to address all these challenges. To exploit these potential advantages, the Office of Response and Restoration is developing a field data collection and management system for SCAT data and photographs which is comprised of: (1) specialized software for efficient SCAT data collection with GPS-integrated handheld devices; (2) a relational SCAT database which expedites the synthesis of field data into decision making products, promotes community standards, and supports standard paper worksheet data collection methods; and (3) an image database which allows for the processing, documenting, and sharing of large quantities of digital photographs. For this project, commonly used, readily available, and open-source computing resources were chosen so that end-users could easily test, adopt, and improve this system.

Spill Impacts and Ecosystem Recovery

Acute and Chronic Effects of Oil, Dispersant and Dispersed Oil to Symbiotic Cnidarian Species
Gap: Spill Impacts and Ecosystem Recovery
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2010
Cnidarian-algal symbioses exist as a sensitive balance between the two partners (cnidarian host and symbiont algae). Chemical contaminants can disrupt this balance resulting in symbiosis breakdown and loss of algae from the host cnidarian (e.g. coral and anemone species). This phenomenon known as bleaching can result in death of the species and is particularly important in tropical regions where corals form the trophic and structural foundation of the ecosystem. In temperate coastal communities, symbiotic anemones, such as *Anthopleura elegantissima*, are important members of the rocky intertidal community and are also at risk for chemical contaminant driven bleaching events. It has been reported that chronic, sub-lethal, possibly delayed reactions to oil exposure are more detrimental to coral reefs compared with acute exposures. Therefore, for oil spill responders to decide upon appropriate response strategies it is important that decisions are based on sound scientific data. There is little data regarding the effects (particularly chronic, sub-lethal effects) of oil, dispersants and dispersed oil on these sensitive cnidarian-algal species using realistic exposure regimes in combination with extensive chemical characterization of the exposure media and bioaccumulated fractions in these organisms. This project will address this data gap by providing quantitative chemical analysis, bioaccumulation and injury data in representative temperate and tropical symbiotic cnidarians using realistic short-term (8 hour) acute laboratory exposures followed with a recovery period for up to one month to assess delayed effects. Cnidarians will be exposed to various dilutions of wateraccommodated fractions (WAF) and chemically-enhanced WAF (CEWAF) of oil using standard (CROSERF) techniques. The possibility of enhanced toxicity via the physical coating of oil droplets on these organisms will be assessed by using filtered/non-filtered WAF and CEWAF preparations. Extensive chemical analysis on test waters (before and after exposures) and cnidarian tissues will be carried out by quantifying 53 PAHs and TPH. Injury will be determined using a multi-tiered approach employing an array of metrics from acute endpoints (e.g. mortality) to sub-organismal biomarkers from the molecular through behavioral levels. By linking measured exposure levels to a series of endpoints over different time scales, this study will support predictive models and will aid in the decision-making on dispersant use in areas with coral reefs and in temperate rocky intertidal zones.

Monetary Values and Restoration Equivalents for Lost Recreational Services on the Gulf Coast of Texas Due to Oil Spills and Other Environmental Disruptions
Gap: Spill Impacts and Ecosystem Recovery
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2009
The research proposes to develop a recreation demand model for beach use on the Gulf Coast of Texas to value damages due to oil spills and other environmental disruptions. The methodology will be a travel cost random utility model and will be estimated using an existing data set available through the National Park Service (NPS). The damages will be valued in terms of

monetary and non-monetary compensation. The non-monetary computation or "restoration equivalent" will consider measuring the necessary compensation in a variety of different terms such as added coastal park space, expanded beach clean-up programs, improved access for fishing, new beaches, and so forth. The model will be designed to allow for valuation of short term and long term disruptions. Short term disruptions are episodes that begin and end within one season, such as an oil spill that closes a beach for a couple weeks. The research will also develop algorithms using the model to select "restoration equivalents" such that compensation is closely aligned with actual damages across individuals. Finally, the research will conduct a transfer analysis using the model. The results will be transferred to the Mid-Atlantic region where another beach-use study is currently being conducted. This will allow for a test of the results. The end products (aside from the actual valuation estimates) include presentations at the International Oil Spill Conference and other selected professional meetings; articles submitted to leading journals in environmental economics; and model, data, and code for estimation provided to economists at the Damage Assessment Center at NOAA and the Damage Assessment and Restoration Branch at NPS.

The relationship between acute and population level effects of exposure to dispersed oil, and the influence of exposure conditions using multiple life history stages of an estuarine copepod, Eurytemora affinis, as model planktonic organisms.

Gap: Spill Impacts and Ecosystem Recovery
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2009

Consideration of dispersant use in response to oil spills involves the evaluation of environmental tradeoffs. Would there be a net environmental benefit if shoreline resources or surface water resources were protected at the cost of increased exposure of water column organisms? Proponents of dispersant use generally dismiss potential impacts to sensitive water column organisms if the dilution is rapid enough to limit the magnitude and duration of exposure so that only a small fraction of the population (or habitat) is exposed to concentrations likely to be "of concern," with this concentration rather loosely defined as a function of available acute toxicity data. The possibility of sublethal effects of exposure to dispersed oil which might lead to population level effects is a serious concern for many natural resource managers when this approach is used. While the logic is reasonable, the available laboratory data consists almost entirely of acute toxicity information, with only occasional studies which examine sublethal endpoints. There are no laboratory studies which attempt to determine multi-generational consequences of short-term, sublethal exposures, and so a significant degree of uncertainty remains. This study examines the effects of short-term exposure to dispersed weathered Alaskan North Slope crude oil on the life history of the estuarine copepod, *Eurytemora affinis*, in order to develop information on the relationship between acute toxicity, sublethal exposures, and population level effects. After initial experiments to define the LC50 concentration using standard CROSERF protocols, various life history stages (nauplii, immature, and mature females) will be exposed to dispersed oil at concentrations at or below the LC50 concentration, and then followed for approximately three generations in order to develop life history tables. In addition, the potential for photoenhanced toxicity, a concern for organisms in the upper water column, will also be examined.
http://rfp.crrc.unh.edu/projects/viewProject.php?PROJECT_ID=15

Effect of Mixing Regime on Oxygen Depletion and Toxicity in a Receiving Water Body Impacted by a Vegetable Oil Spill
Gap: Spill Impacts and Ecosystem Recovery
Contracting Agency: U.S. EPA / NRMRL
Estimated Completion: 2012
The overall objective of this study is to quantify the oxygen depletion and aqueous Microtox toxicity in oil-impacted water columns that are poorly, moderately, and fully mixed because depletion of oxygen in such water columns and release of toxic intermediates can lead to severe toxic impacts on the receiving water body. This evaluation is being performed on two commercial oils with and without the presence of butylated hydroxytoluene (BHT), the most commonly used antioxidant in the vegetable oil industry. The two oils are canola (with a high percentage of C18:1 fatty acids with one double bond), and flaxseed oil (with a high percentage of C18:3 fatty acids with three double bonds). This gives a good representation of the degree to which the number of double bonds in the vegetable oil affects biodegradability and hydrolysis in the presence and absence of antioxidants.

Toxicity of Dispersed Oil to Marine Organisms
Gap: Spill Impacts and Ecosystem Recovery
Contracting Agency: U.S. EPA / NRMRL
Estimated Completion: 2013
This study will further the information on how dispersion and weathering of dispersed oil affects the time-course and nature of exposure of relevant marine species to dispersed and non-dispersed oil and the oil spill relevant exposure regimes (time x concentration) that induce biological responses and toxic effects. The information generated will improve the capacity of on-site spill managers to gauge the risks associated with dispersant applications and contribute to optimal control strategies. To further the dispersant effectiveness research begun in previous years with crude oils, heavier oils will be studied for their dispersant effectiveness in the wave tank in conjunction with the toxicity measurements.

Spill Trajectory and Behavior Prediction

Development of a Numerical Algorithm to Compute the Effects of Breaking Waves on Surface Oil Spilled at Sea: Dispersion and Submergence/Over-washing as Extremes of a Theoretical Continuum
Gap: Spill Trajectory and Behavior Prediction
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2009
The objective of this project is to develop a set of algorithms for modeling natural dispersion of spilled oil at sea, with an eye towards unifying real oil-in-water dispersion (i.e. clouds of droplets being driven into the water column by breaking waves) with submergence, under a single concept. Submergence can be viewed as "dispersion of non-dispersible oil", resulting in the over-wash of near-neutrally buoyant “blobs” or "patches" or "carpets" of non-Newtonian oils such that they may be submerged for long periods of time, given sufficient surface turbulence. Such oil mats are probably subject to breakdown into tar balls, but over a time scale that is poorly known. The methodology proposed will carry the experimental work started by Delvigne and Sweeney (1988, 1993, 1994) into higher viscosity, non-Newtonian regions in the parameter space of the problem. The dimensions of the parameter space will also be increased to include emulsification, interfacial tension and rheological characteristics, in addition to viscosity and turbulent energy, as parameters in the equations.

The outcome or end product will be a publication of the algorithms developed during the study, such that the results are available to the international scientific community. It is anticipated that these algorithms will also provide an eventual basis for including chemical dispersion, sediment interactions, and actual sinking of oil in the future.
The model algorithms can be implemented in NOAA’s, as well as other, oil spill weathering and trajectory simulation models with applicability to spill response preparedness and decision-making, and implementation of optimum spill recovery strategies.

The proposed CRRC project will also receive additional data input from other completed and on-going projects funded by industry. The purpose of these other projects is generally to develop data on weathering of crude oils of interest to the respective companies. Such data are used as input to the SINTEF oil weathering model, whereas the CRRC project has the primary purpose of developing new algorithms spanning a range of oil types over a longer time frame. The projects are thus complementary. To the extent that other projects can supply sufficient data for “typical” crude oils, this project will focus on heavy oils and petroleum products.

Measurements and Modeling of Size Distributions, Settling and Dispersions (turbulent diffusion) Rates of Oil Droplets in Turbulent Flows
Gap: Spill Trajectory and Behavior Prediction
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2009
The objective of this proposal is to measure and parameterize the effects of turbulence and oil properties on the mean settling velocity, dispersion (turbulent diffusion) rate, and characteristic size distributions of oil droplets in sea water. These data are essential for modeling and

predicting the dispersion rate of oil spills treated with dispersants. The measurements will be performed in a specialized laboratory facility that enables generation of carefully controlled, isotropic, homogeneous turbulence at a wide range of fully characterized intensities and length scales, covering most turbulence levels that one may expect to find in coastal waters. Crude and processed oil droplets will be injected into the sample volume, and their three-dimensional trajectory will be measured at high resolution using high-speed digital holographic cinematography. The selected oils have varying viscosity, density and surface tension, especially due to introduction of dispersants, and the droplets vary in size from 30 μm to 2 mm. The research team will also introduce large oil droplets and/or small patches of oil and measure the size distribution of droplets resulting from exposure to turbulence-induced shear. Since effectiveness of dispersants varies with water salinity, the measurements will be performed in water with varying salt concentration. Subsequent analysis, consisting of calculating the Lagrangian autocorrelation functions of droplet velocity, will provide the turbulent dispersion rates, along with their mean settling/rise velocity as a function of droplet and turbulence properties. All the equipment, data analysis procedures and software needed for performing the proposed objectives are available, and have been developed in recent years specifically for studying the dynamics of droplets in turbulent flows. The results will be expressed in terms of dimensionless variables that can be conveniently incorporated into computational models that forecast the entrainment and dispersion of oil droplets generated as oil sleeks break. Collaboration with researchers in the Hazardous Materials Response Division of NOAA will facilitate smooth transition of the data into their models for oil and chemical dispersive processes.

GNOME2
Gap: Spill Trajectory and Behavior Prediction
Contracting Agency: NOAA/ORR/ERD
Estimated Completion: Ongoing
Rewrite of GNOME for new functionality to support chemical pollutants in the water column. The authors are seeking a single code base to support Mac, Windows, and Linux and new and better display options. This upgrade of GNOME will transition from 3D (x,y,t) to 4D (x,y,z,t). The desire is to add trajectory functionality to support spills that begin or go below the surface, either through dissolution or by having a density greater than the ambient water. ADIOS2 is expected to be integrated into the new framework so that more chemical information related to oils is available for trajectory predictions. A new source module will be required that contains chemical information for trajectory prediction modeling and a variety of spill scenarios, similar to ADIOS for oils. New visualization capabilities will be developed to allow the trajectory modelers to visualize and interact with the trajectory prediction, and for development of new trajectory products from the Unified Command.

Currently, development is focusing on functionality requirements for the design, including revisiting functionality from OSSM that was not brought forward, dispersed oil GNOME, and user experience and "wish lists." GNOME2 will be designed as a piece within a larger risk assessment framework for future tool development in order ensure cohesive development of future risk assessment tools. Following recommendations of the Ocean.us Data Management and Access Committee (DMAC), the authors expect GNOME2 to be OPeNDAP enabled.

Development of a Predictive Bayesian Data-Derived Multi-Modal Gaussian Maximum-Likelihood Model of Sunken Oil Mass
Gap: Spill Trajectory and Behavior Prediction
Contracting Agency: UNH/NOAA: Coastal Response Research Center (CRRC)
Project Completed: 2010
This proposal addressed the need for cost-effective tracking of sunken oil following a spill, to target cleanup activities, and to support cleanup termination decisions. Sunken oil is difficult to "see" because sensing techniques (VSORS, ROVS) show only a small space at a single point in time (Beegle-Krause et al. 2006). Moreover, the oil may re-suspend and sink with changes in salinity, sediment load, and temperature (Michel 2006), making fate and transport models difficult to deploy and calibrate when even the presence of sunken oil is difficult to assess. For these reasons, together with the expense of field data collection, there is a need for a statistical data-limited technique integrating field data collection with statistical fate and transport modeling. Predictive Bayesian modeling techniques have been developed and used by the PI to rigorously extrapolate desired information from limited available data in oil spill planning, hurricane, environmental, health, and safety risk analysis applications. For example, predictive Bayesian compound Poisson models have been developed for USCG to forecast changes in oil spill volumes (e.g., annual) arriving onshore around the Gulf of Mexico in response to proposed changes in oil transportation equipment and policies, given spatially-defined historical oil spill data, shipping routes and volumes, and hydrodynamic modeling results (Obie and Englehardt 1996; Douligeris et al. 1998). Significant advances in computational techniques such as Markov chain-Monte Carlo integration have increased the power of such methods. Modern genetic and other search algorithms and hardware can be brought to bear on the estimation of statistical parameters of highly-dimensional models such as may be obtained by superposition of Lagrangian (e.g., Gaussian) models. However, to our knowledge the approach has not been applied to the tracking of sunken oil or other pollutants.

The objectives of the proposed two-year project are to: (1) compile and summarize data on the occurrence of sunken oil, directed by the project team including end users and NOAA liaison; (2) develop one or more superimposed, multi-modal predictive Bayesian Gaussian maximum likelihood models of sunken oil locations across a bay that will accept spatial field data on sunken oil mass and hydrodynamic information from rapidly-deployable models of bottom and subsurface currents, to project assessments of sunken oil locations in time; and (3) verify the model versus sunken oil data, as possible, and simulated datasets. The approach is organized into three overlapping tasks: (1) "Development of conceptual model and data base," including a team kickoff meeting to identify data sources and define model capability; (2) "Model development," including the development of new genetic and other search algorithms for maximum-likelihood calibration of the model with field data; and (3) "Model verification, optimization, and dissemination," including active maintenance of a project website for information dissemination and model download and training activities as appropriate. The model(s) developed represent a new approach to oil and pollutant tracking in terms of the conceptual integration of maximum likelihood and search techniques with Lagrangian pollutant transport modeling, and the use of predictive (unconditional, marginal) Bayesian models capable

of assessing sunken oil location based on limited available information with rigorous accounting of uncertainty. It is anticipated the models developed will interface with current response, cleanup, and damage assessment models (e.g., GNOME, SIMAP) as appropriate, and be amenable to refinement and expansion to address a wider range of bathymetric conditions and potential tracking of suspended oil.
http://www.cae.miami.edu/sunken-oilmass/PDF/FinalReportUnivMiamiSOSimDevelopment.pdf