Working Document of the NPC Study:
Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources
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Paper #8-2

SUMMARY OF CURRENT OIL SPILL RESPONSE RESEARCH ACTIVITY (INDUSTRY AND GOVERNMENT)

Prepared for the

Technology & Operations Subgroup

On March 27, 2015, the National Petroleum Council (NPC) in approving its report, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Technology & Operations Subgroup. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 46 such working documents used in the study analyses. Appendix D of the final NPC report provides a complete list of the 46 Topic Papers. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

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Topic Paper

(Prepared for the National Petroleum Council Study on Research to Facilitate Prudent Arctic Development)

8-2	Summary of Current Oil Spill Response Research Activity (Industry and Government)
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SUMMARY

A large amount of scientific research and testing has been conducted in the past 50-years to improve equipment and methodologies available to respond to an oil spill in Arctic and cold water conditions. To develop the present capability, experts from industry, government agencies, and academic and independent research organizations have completed hundreds of scientific and analytical studies and conducted numerous laboratory and basin experiments as well as permitted field experiments. This sustained and frequently collaborative effort is not commonly known and recognized by those outside the field of oil spill response. This topic paper provides a summary of the current research on oil spill response technology development and research on the fate and effects of oil spills in Arctic waters.

RECOMMENDATION: DOE, partner agencies, and Industry should cooperate in supporting the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) as the Federal coordinating body for oil spill research. ICCOPR is designated under Oil Pollution Act of 1990 (OPA 90) as the primary means to leverage the efforts of Federal agencies engaged in research affecting offshore oil spill response. Interagency partners should collaborate with Industry to evaluate selected oil spill response equipment and tactics under realistic conditions and utilize this information to inform planning tools and requirements, and regulatory changes. ICCOPR should play a strong role in conducting and/or supporting oil spill response research and technology development, both nationally and internationally. This pertains to all aspects of oil spill planning, preparedness and response related to offshore exploration, production, and development, and includes technology R&D related to mechanical recovery equipment and systems, in-situ burning, dispersants, cold weather and ice response, remote sensing technologies, etc. ICCOPR should incorporate the knowledge from state and local agencies, academia, and industry into oil spill response R&D projects.

RECOMMENDATION: A comprehensive, collaborative, long-term Arctic oil spill research and development program needs to be established. It should include assessment of oil spill response technologies, remote sensing, environmental effects and logistics, improvements to forecasting models and associated data needs, and controlled field releases under realistic conditions for research purposes. Industry, academic, government, non-governmental, grassroots, and international efforts should be integrated into the program, with a focus on peer review and

transparency. Priorities for oil spill research should be set based on existing information and future needs, leverage existing programs, and be addressed through a comprehensive, coordinated effort that links industry, government, academia, international and local experts, and non-governmental organizations. The Interagency Coordinating Committee on Oil Pollution Research, which is tasked to coordinate oil spill research and development among agencies and other partners, should lead the effort.

RECOMMENDATION: DOE partner agencies, and Industry should facilitate dissemination of existing state-of-the-art information related to arctic OSR and environmental Impacts to stakeholders to ensure incorporation of best available information into regulatory and decision-making process as well as future research projects.

RECOMMENDATION: DOE should work with all the ICCOPR (Interagency Coordinating Committee on Oil Pollution Research) member agencies to help coordinate and expedite the issuance of timely permits (1 year or less) to conduct Arctic field oil release experiments which are issued by EPA. In compliance with statutory and permitting requirements, encourage and facilitate controlled experimental releases of oil that benefit offshore spill response R&D and testing of all available response techniques. An interagency permit approval process that will enable researchers to plan and execute deliberate releases in U.S. waters is also needed. This includes coordination with regional response teams (RRTs) in the proposed areas of release. Agencies should also include international cooperation in this area, as the U.S. has participated and been invited to participate in controlled experimental releases in other countries such as Norway.

RECOMMENDATION: DOE should support BSEE in maintaining Ohmsett as a large tank testing facility and with funding and technical support for Arctic research projects.

Background

A large amount of scientific research and testing has been conducted in the past 50-years to improve equipment and methodologies available to respond to an oil spill in Arctic and cold water conditions. Recent examples include the SINTEF Oil in Ice Joint Industry Project (JIP) in 2006-2009 that also reviewed the results of previous research projects (http://www.sintef.no/Projectweb/JIP-Oil-In-Ice/Publications) and research sponsored by Bureau of Safety and Environmental Enforcement (BSEE) (http://www.bsee.gov/Research-and-Training/Oil-Spill-Response-Research/Categories/Arctic-Oil-Spill-Response-Research/). An inventory of some of the past research projects is also available from the US Arctic Research Commission (http://www.arctic.gov/publications/white%20papers/oil_spills_tableA.pdf). Significant advances were made in being able to detect, contain, and cleanup oil spills in Arctic environments (API 2012). To develop the present capability, experts from industry, government agencies, and academic and independent research organizations have completed hundreds of scientific and analytical studies and conducted numerous laboratory and basin experiments as well as permitted field experiments in the United States, Canada and Scandinavia (Norcor, 1975; Dickins and Buist, 1981; Sergy and Blackall, 1987, Singsaas et al., 1994; Rytkönen and Sassi,

2001; Sørstrøm et al., 2010, and Potter 2012). This sustained and frequently collaborative effort is not commonly known and recognized by those outside the field of oil spill response.

Ongoing Industry-sponsored R&D Projects

The Arctic Oil Spill Response Technology Joint Industry Programme (JIP) was initiated in 2012 and is currently ongoing. It represents a collaboration of ten international oil and gas companies (BP, Chevron, ConocoPhillips, Eni, ExxonMobil, Gazprom-neft, North Caspian Operating Company, Shell, Statoil, and Total) that have come together to further enhance industry knowledge and capabilities in the area of Arctic spill response as well as to increase understanding of potential impacts of oil on the Arctic marine environment. The program is managed by the International Association of Oil and Gas Producers (OGP) and coordinated by an executive steering committee comprised of representatives from the funding companies. The JIP has several specific projects each focusing on a different key area of oil spill response:

Project 1 - Fate of Dispersed Oil under Ice: The project will provide important information for dispersants use in ice-covered marine environments and develop a tool to support contingency planning.

Project 2 - Dispersant Testing under Realistic Conditions: The project will define the operational criteria for use of dispersant and mineral fines in Arctic marine waters with respect to oil type, oil viscosity, ice cover (type and concentration), air temperatures, and mixing energy (natural, water jet and propeller wash). Another objective is to identify the regulatory requirements and permitting process for dispersant and mineral fines use for each Arctic nation/region.

Project 3 - Environmental Impacts from Arctic Oil Spills and Oil Spill Response Technologies: The project will improve the knowledge base for using "Net Environmental Benefit Analysis" (NEBA) for response decision making and ultimately facilitate stakeholder acceptance of the role of environmental impact assessment in oil spill response plans and operations.

Project 4 - Oil Spill Trajectory Modeling in Ice: The project will advance the oil spill modeling for oil spills in ice-affected waters by evaluating ice trajectory modeling approaches and integrating the results into established industry oil spill trajectory models.

Project 5 - Oil Spill Detection and Mapping in Low Visibility and Ice: The project will expand remote sensing and monitoring capabilities in darkness and low visibility, in pack ice, and under ice. This project is split into two elements: surface remote sensing (i.e. satellite-borne, airborne, ship-borne and on-ice detection technologies) and subsea remote sensing (i.e. mobile-ROV or AUV based and fixed detection technologies).

Project 6 - Mechanical Recovery of Oil in Ice: The project will evaluate novel ideas for improving efficiency of mechanical recovery equipment in arctic conditions.

Project 7 - In Situ Burning of Oil in Ice-Affected Waters. State of Knowledge: The project will prepare educational materials to raise the awareness of industry, regulators and external stakeholders of the significant body of knowledge that currently exists on all aspects of

in-situ burning (ISB). The materials are also intended to inform specialists and stakeholders interested in operational, environmental and technological details of the ISB response technique.

Project 8 - Aerial Ignition Systems for In Situ Burning: The project will develop improved ignition systems to facilitate the use of in situ burning in offshore Arctic environments, including ice when the presence of sea ice restricts use of vessels as a platform for this response option.

Project 9 - Chemical Herders and In Situ Burning: The project will advance the knowledge of chemical herder fate, effects, and performance to expand the operational utility of in situ burning in open water and in ice-affected waters.

Project 10 – Field Research: Results from previous research projects show that many of the advances in our state of knowledge about Arctic response technology were gained through controlled field experiments with oil. This project will pursue opportunities for large scale field releases for validation of response technologies and strategies.

This JIP has brought together the world's foremost experts on oil spill response research, development, and operations from across industry, academia, and independent research centers to undertake the technical work and scientific studies. All research projects are being conducted using modern protocols and proven scientific technologies, utilizing the best and most appropriate available researchers, consultants, and laboratories. Research integrity is ensured through technical peer review and public dissemination of results. Information is available free of charge via the dedicated JIP website www.arcticresponsetechnology.org.

Building on the results of recently completed NewFields JIP (Gardiner et al 2013; McFarlin et al 2014[1]), which evaluated toxicity and biodegradation of physically and chemically dispersed Alaska North Slope oil under Arctic conditions in the Beaufort and Chukchi Seas, University of Alaska continues evaluation of oil biodegradation in Arctic marine environment. This project aims to identify microorganisms and genes that are responsible for hydrocarbon biodegradation, evaluates their background levels in environment and how it changes in response to presence of hydrocarbons (McFarlin et al 2014[2]). This new JIP is supported by Shell, ConocoPhillips, ExxonMobil, Statoil, BP as well as Alaska Clean Seas and the Oil Spill Recovery Institute.

Alaska Clean Seas (ACS) provides response services to the Alaska North Slope Crude Oil Producers and the first 167 miles of the Trans-Alaska Pipeline System. ACS maintained an active oil spill research and development program since the early 1980's (http://www.alaskacleanseas.org/). The program focuses on spill response and wildlife management in Arctic conditions. Currently funded (and co-funded) projects include a study of remote sensing techniques for locating oil under ice conducted in Germany (Wilkinson 2013), support to University of Alaska biodegradation research, coordination with NOAA National Marine Fisheries, U.S. Fish and Wildlife, the Alaska Zoo, and Alaska SeaLife Center in development of Arctic marine mammal response capabilities, and participation in the Mechanical Recovery work stream of the Arctic Oil Spill Response Technology (OGP) JIP.

ExxonMobil Upstream Research Company (EMURC) has an ongoing research and development program on Arctic and cold weather oil spill response mostly focused on remote sensing and enhanced oil spill response techniques. Ongoing projects include evaluation of the Nuclear Magnetic Resonance (NMR) for detection of oil in and under ice. NMR uses the earth's magnetic field to differentiate the subtle differences of hydrogen protons in water and oil (Palandro et al. 2013). The NMR concept has advanced past laboratory and initial field testing and is currently being evaluated for a full-scale test. Efforts to enhance Arctic OSR have focused on existing technologies and making their use more effective for the Arctic. The use of surface dispersants has long been part of the OSR toolbox. A gel dispersant has been developed for treating more viscous oils in cold marine environments (Nedwed et al. 2010). The gel-like consistency allows for greater encounter time with the viscous oil allowing the dispersant time to breakdown the oil into biodegradable droplets. A consideration for using dispersants on surface oil in the ice-covered waters is the dampening of surface waves by the ice, which may limit dispersant effectiveness due to limited surface turbulence and mixing energy. Ice breakers have been tested at the basin scale and were found to produce enough mixing energy to promote dispersant effectiveness (Nedwed et al 2007).

In 2011 American Petroleum Institute has initiated a 4 years research and development Joint Industry Program (API JIP) focused on subsea dispersant injection. Subsea injection of dispersants offers some significant benefits compared to the application of dispersants on the sea surface, for example access to the freshest and non-emulsified oil in the high turbulence environment, ability to reduce the volume of required dispersant by injecting it directly into the oil stream without the loss of the product, ability to operate day and night under a wider range of weather conditions, and availability of a large water mass to rapidly decrease the concentration of a dispersed oil plume. Subsea injection of dispersants also reduces concentration of the Volatile Organic Compounds at the water surface creating safer work environment for spill responders and well control specialists. API JIP scope includes research on application methods, effectiveness, plume modeling, monitoring techniques and potential environmental effects of oil dispersed subsea (http://www.api.org/environment-health-and-safety/clean-water/oil-spill-prevention-and-response/api-jitf-subsea-dispersant-injection-newsletter ; Nedwed 2014). While this work is not specifically Arctic-focused, many of its findings should also be applicable to Arctic regions. The use of subsea dispersants would greatly reduce the amount of oil that would become trapped under or encased in ice.

Research activities in Europe and Scandinavia

Finish and Norwegian scientists have historically conducted research on arctic and cold-weather response techniques. This work continues with the development new ice-capable oil spill recovery vessels by Aker Arctic (Wilkman 2014), development of high capacity arctic skimmers by skimmer manufacturers as well as the work of the Finish Environmental Institute

(SYKE). A team of international researchers recently evaluated sensors for detecting oil under sea ice in a test tank experiment at the HSVA, Hamburgische Schiffbau-Versuchsanstalt, a research and test facility in Hamburg, Germany (Wilkinson 2013). Some other projects conducted in Norway for sub-arctic conditions include SYMBIOSES model that can assist with Net Environmental Benefit Analysis of response options (http://www.symbioses.no/) and a JIP evaluating environmental impacts and response options in coastal environments. Norwegian Clean Seas Association for Operating Companies (http://www.nofo.no/en/) have sponsored a research focused on sub-arctic oil spill response for years. This program also includes yearly offshore exercises and tests with real oil. With increasing interest to arctic operations this program will likely add oil-in-ice projects to its portfolio.

Ongoing R&D Projects sponsored by Non-profit Organizations

The Oil Spill Recovery Institute (OSRI) was established by Congress in response to the 1989 Exxon Valdez oil spill. Its mandate is to support research, education, and demonstration projects designed to respond to and understand the effects of oil spills in the arctic and sub-arctic marine environments http://www.pws-osri.org. Over the years OSRI funded numerous projects on arctic spill response and evaluation of environmental impacts. Among currently funded projects is an evaluation of an aerostat for oil spill remote sensing, provision of oil spill drifter buoys to the USCG Arctic Shield exercise, evaluation of sonar's ability to detect oil in and under ice, and support to University of Alaska biodegradation research.

Ongoing R&D Projects sponsored by Governmental Organizations

For three decades, the Bureau of Safety and Environmental Enforcement (BSEE) (formerly MMS) was the principal United States federal agency funding oil spill response research including arctic-relevant research and has maintained a comprehensive long-term program to improve oil spill response technologies. The achievements of the program have been described in the U.S. Department of the Interior Minerals Management Service publication of 2008 in details. The BSEE research program is addressing oil spill research needs on two levels. First through direct applied research and second through testing, training and basic research conducted at Ohmsett – The National Oil Spill Response Test Facility in Leonardo, New Jersey. Ohmsett represents a necessary intermediate step between small-scale bench testing and open water testing of equipment. Many of today's commercially available oil spill cleanup products and services have been tested at Ohmsett either as off-the-shelf commercially available equipment, or as equipment or technology still under development. Ohmsett is not only a vital component of the BSEE oil spill research, it is also a national asset where government agencies, private industry and academia can conduct full-scale oil spill research and development programs in a controlled environment with real oil. It is the premier hands-on training site for

spill response personnel from state and federal government agencies, private industry and foreign countries.

Description of the ongoing projects and reports from the completed projects are available at http://www.bsee.gov/Research-and-Training/Oil-Spill-Response-Research/Categories/Arctic-Oil-Spill-Response-Research/. Some of the currently funded projects on arctic OSR include testing of skimmer hoses and hose couplings under simulated arctic conditions; development of surrogate ice modules for simulated arctic environment testing; technological assessment of Alaskan arctic oil spill response temporary oil storage options; hosting an "Ice Month" - evaluation of oil recovery systems in ice conditions at Ohmsett; participation in the National Research Council study on arctic OSR (http://www.nap.edu/catalog.php?record_id=18625); research to support the prediction of effectiveness of dispersant use in the U.S. Beaufort and Chukchi Seas; dispersant effectiveness comparative testing in a simulated arctic environment; enhanced oil spill detection sensors in low-light environments; oil spill detection and mapping under arctic sea ice using autonomous underwater vehicles; and burning behavior of oil in ice channels.

The US Coast Guard Research and Development Center has conducted field deployments of response equipment in ice-covered waters in Great Lakes; and most recently in collaboration with USCG District 17 in offshore Alaska during Arctic Shield Exercises in 2012 and 2013 (Hansen 2014). The objective of these exercises in realistic field conditions (albeit without oil) was to do a capability assessment of existing response equipment and evaluate potential technologies that could enhance the efficiency oil spill response in arctic waters, specifically in broken ice that will not support personnel and equipment. During the arctic exercises several remote sensing techniques were tested including UAS, ROV and UUV, SWIFT Buoy (for measuring turbulence), and an aerostat. A standalone Common Operating Picture (ERMA) was also evaluated with support from NOAA. During Great Lakes demonstrations, booms for in-situ burning, several skimmers (drum, rope mop and brush), and water monitor herding were deployed in ice conditions.

Plans for the Arctic Shield Exercise in 2014 include additional testing of the remote sensing (Puma, aerostat, AUV, UAV, ROV). An evaluation of communications equipment to map out the coverage gaps in the current system where transmission cannot be received is being done. A cooperative effort with Marine Exchange Alaska will also be evaluating coverage of the existing Automatic Identification System (AIS).

Other projects underway include development of an on-deck temporary storage system for CG buoytenders, an ice management cage for skimmers and a personal decontamination system for cold weather for use on small vessels of opportunity (fishing vessels and tug boats).

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