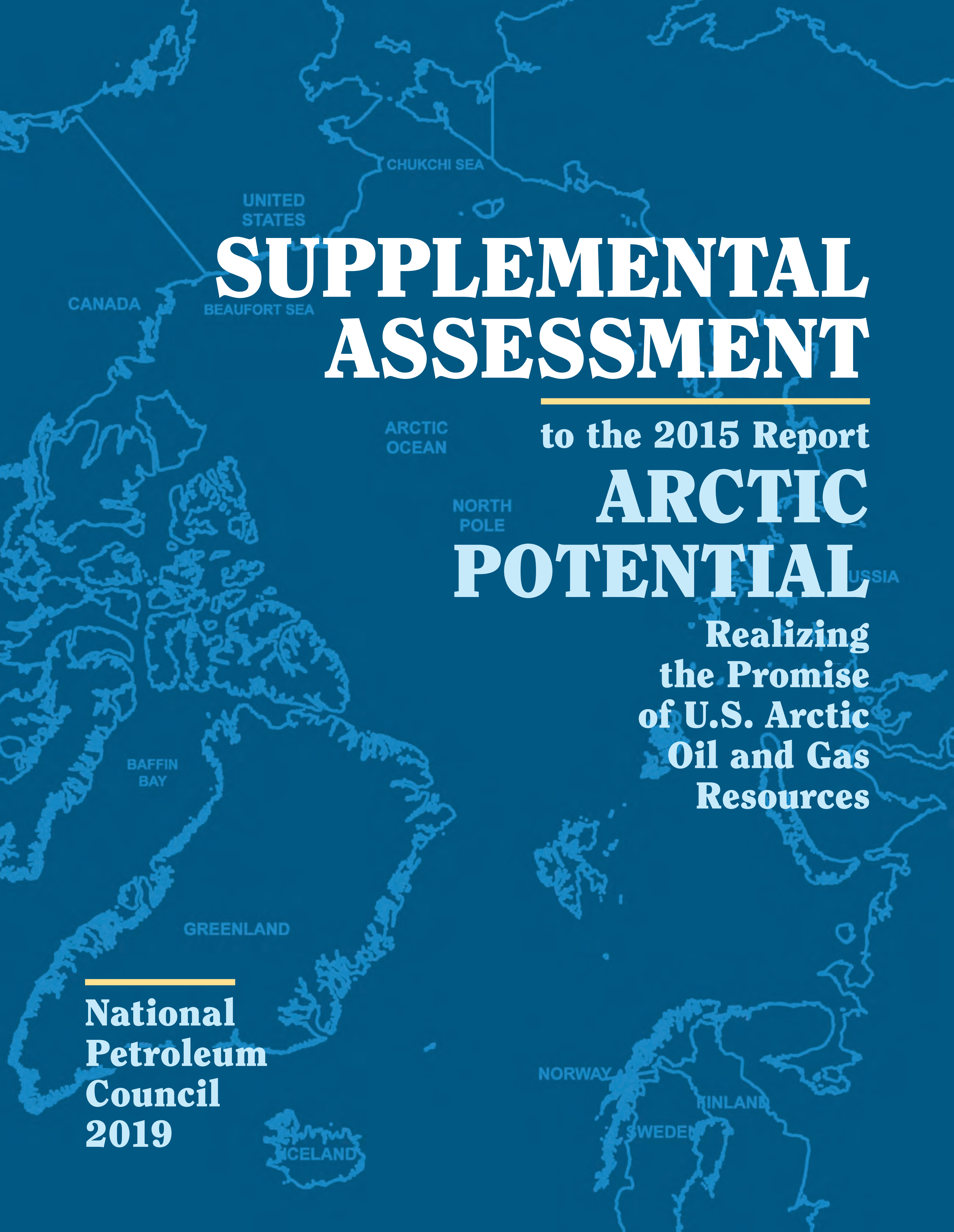

SUPPLEMENTAL ASSESSMENT

to the 2015 Report

ARCTIC POTENTIAL

Realizing the Promise of U.S. Arctic Oil and Gas Resources

National Petroleum Council
2019

National Petroleum Council

An Oil and Natural Gas Advisory Committee to the Secretary of Energy

1625 K Street, N.W.
Washington, D.C. 20006-1656

Phone: (202) 393-6100
Fax: (202) 331-8539

April 26, 2019

The Honorable Rick Perry
Secretary of Energy
Washington, D.C. 20585

Dear Mr. Secretary:

In response to your August 29, 2018 request made in coordination with the Department of the Interior, the National Petroleum Council conducted a Supplemental Assessment to its 2015 report, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources.* To build upon the deep foundation, broad participation, and consensus view of the 2015 report, the Council conducted a technical workshop to gather new information, at the Baker Institute at Rice University, attended by industry, government, and other stakeholders.

The 2015 study concluded that the technology was available to prudently explore for and develop oil and gas in the U.S. Arctic while protecting people and the environment. The 2015 study also found that the physical, ecological, and human environment was well understood after decades of research, and that sufficient information was available to pursue exploration. Despite proven technical and operational capability, the 2015 study noted that pursuing oil and gas in the U.S. Arctic was hindered by challenging economics, a regulatory framework taken from southern regions where work could be conducted year-round, and a lack of public confidence that it could be conducted safely and responsibly. The 2015 report recommended technology validation and demonstrations to promote improved understanding and public confidence, and that the results of these demonstrations be used to revise the regulatory framework to make it more consistent with other Arctic nations.

Since 2015, there has been continued growth in U.S. unconventional oil and natural gas production, substantial international advancements in Arctic technology and operational experience, and increasing global concerns of a changing climate. These developments have raised questions about the merits, economic viability, and relevance of the U.S. Arctic potential. The 2015 study concluded that the United States had significant undiscovered offshore oil potential, similar to Russia, and larger than Canada or Norway. Absent additional exploration activity, the economic viability of this U.S. Arctic potential is not known. Given the long timelines associated with exploration and development in the U.S. Arctic, pursuing additional exploration now would enable improved understanding of Arctic potential for possible future development to meet the world's energy needs. Since 2015, other nations have pursued their Arctic potential. Globally, 47 Arctic exploration wells have been drilled and 5 billion barrels of discoveries announced. Only two of these wells were drilled in the United States.

This Supplemental Assessment determined that the findings and recommendations of the 2015 report remain valid today. This assessment affirms the shared responsibility of industry and government to secure and maintain public confidence. The Council underscores the importance of the industry to continue to operate responsibly, bringing appropriate technology and operating practices to bear and continuously improving technologies and operations, and of the government and regulators' independent responsibility to oversee and verify operators' plans. In this regard, the Council has developed two additional findings.

New Finding 1: Improvements to Current Arctic Outer Continental Shelf (OCS) Regulations and Their Implementation Could Enhance Safety, Environmental Stewardship, and Public Confidence. Requiring prescriptive regulatory solutions leads to compliance rather than disciplined risk management, reduces the operator's accountability for risk management, and decreases the incentive for technology improvement. Multiple layers of requirements, and multiple agencies with conflicting mandates, without coordination across agencies, have an adverse effect on safety and environmental stewardship.

New Finding 2: Lease Availability, Lease Terms, and Regulatory Requirements Reduce the Competitiveness of the Alaska OCS, Compared with Other Opportunities Worldwide. Exploration, development, and production of oil and gas resources cannot proceed without leasing. The last lease sale in the Beaufort Sea was in 2007 and in the Chukchi Sea was in 2008. The current 10-year primary lease term for Alaska OCS acreage is inadequate for efficient and effective exploration and development, which takes 20 years or more. The restrictions on drilling season length, unrelated to actual weather, ice conditions, and capability of drilling equipment, limit productive drilling time and add significant costs. The number of U.S. regulatory agencies and lack of interagency coordination results in a lengthy and uncertain regulatory process.

Key Recommendations:

- Arctic OCS drilling regulations and their implementation should be performance-based, emphasizing prevention of loss of well control and oil spills, and use of the effective technologies to improve safety, environmental performance, and economic viability.
  - Prescriptive requirements that hinder effective risk management and add significant cost should be removed, including restrictions on drilling season length, requirement for the capability to drill a same season relief well, standby rig, and other requirements as detailed in this report.
  - The use of subsea isolation devices and capping stacks, demonstrated since the 2015 report, should be accepted in place of the requirement for same season relief well capability.
- Conflicting regulatory requirements should be harmonized, and timely, integrated review and decision-making across multiple agencies for permits should be required.
- A coordinating body for federal regulations, permitting, and environmental reviews should be established.
- The 10-year primary lease term should be lengthened based on the limited Arctic working season and extended timelines for operating in ice environments.
- The Department of the Interior should use its existing authority to allow for larger Arctic OCS lease tracts.
- Arctic OCS lease sales should be included in all Five-Year Leasing Programs and held at regular intervals.
- Preapproval to use dispersants and in-situ burning should be granted to facilitate rapid oil spill response.
- Regulatory authorities should grant permits for controlled experimental spill response drills in U.S. waters.
- Government authorities should participate in Joint Industry Projects and continue to participate in oil spill response exercises, in order to promote knowledge transfer and improve public confidence.

Implementation of these recommendations will improve safety, environmental stewardship, and the competitiveness of Arctic resources. The attached report, *Supplemental Assessment to the 2015 Report, Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources,* provides more detail. The Council looks forward to sharing this with you, the Department of the Interior, your other colleagues, and broader government and public audiences.

Respectfully submitted,

Greg L. Armstrong
Chair

Attachment

SUPPLEMENTAL ASSESSMENT

to the 2015 Report

ARCTIC POTENTIAL

Realizing the Promise of U.S. Arctic Oil and Gas Resources

Steering Committee
Darren W. Woods, Chair

National Petroleum Council 2019

NATIONAL PETROLEUM COUNCIL

Greg L. Armstrong, *Chair*
J. Larry Nichols, *Vice Chair*
Marshall W. Nichols, *Executive Director*

U.S. DEPARTMENT OF ENERGY

Rick Perry, *Secretary*

The National Petroleum Council is a federal advisory committee to the Secretary of Energy.

The sole purpose of the National Petroleum Council is to advise, inform, and make recommendations to the Secretary of Energy on any matter requested by the Secretary relating to oil and natural gas or to the oil and gas industries.

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Preface

NATIONAL PETROLEUM COUNCIL

The National Petroleum Council (NPC) is an organization whose sole purpose is to provide advice to the federal government. At President Harry Truman's request, this federally chartered and privately funded advisory group was established by the Secretary of the Interior in 1946 to represent the oil and natural gas industry's views to the federal government: advising, informing, and recommending policy options. During World War II, under President Franklin Roosevelt, the federal government and the Petroleum Industry War Council worked closely together to mobilize the oil supplies that fueled the Allied victory. President Truman's goal was to continue that successful cooperation in the uncertain postwar years. Today, the NPC is chartered by the Secretary of Energy under the Federal Advisory Committee Act of 1972, and the views represented are considerably broader than those of the oil and natural gas industry.

Council members, about 200 in number, are appointed by the Energy Secretary to assure well-balanced representation from all segments of the oil and natural gas industry, from all sections of the country, and from large and small companies. Members are also appointed from outside the oil and natural gas industry, representing related interests such as states, Native Americans, and academic, financial, research, and public-interest organizations and institutions. The Council provides a forum for informed dialogue on issues involving energy, security, the economy, and the environment of an ever-changing world.

STUDY BACKGROUND

On March 27, 2015, the report, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, was approved by the National Petroleum Council and presented to the Secretary of Energy as a response to his request for the Council's advice on this topic. The 2015 report, which focused on the U.S. Arctic Outer Continental Shelf (OCS), was the result of a one-year study conducted by the NPC Committee on Arctic Research.[1]

After the release of the 2015 NPC report, the prior Administration took several actions which dampened opportunities to realize the promise of Arctic oil and gas resources. These actions included release of prescriptive regulations for exploratory drilling in the U.S. Arctic in August 2016 (the Arctic Rule), and designating the bulk of Arctic offshore waters as indefinitely off limits to future oil and gas leasing in December 2016. The current Administration has taken a different approach. In 2018, in accordance with Executive Order 13795, entitled "Implementing an America-First Offshore Energy Strategy," the Department of the Interior initiated a review of regulations that currently impact Arctic offshore oil and gas exploration and development. In light of the National Petroleum Council's comprehensive 2015 report, the Administration expressed interest in the Council's updated views on U.S. policies relating to offshore Arctic oil and gas exploration and development. Efforts are also underway to develop a new 2019-2022 Five-Year Leasing Program.

STUDY REQUEST AND OBJECTIVES

By letter dated August 29, 2018, Secretary of Energy Rick Perry, in cooperation with the Department of

1 National Petroleum Council, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, 2015. www.npcarcticpotentialreport.org.

the Interior (DOI), formally requested the National Petroleum Council to undertake a supplemental assessment considering recent exploration experience and technological advancements or other new insights related to Arctic offshore oil and gas development that could inform government decision making. In particular, the NPC was asked to provide its views on whether the nation's regulatory environment could be enhanced to improve reliability, safety, efficiency, and environmental stewardship. Key areas to be addressed included:

- Regulatory burdens associated with U.S. OCS development
- Arctic lease terms
- Arctic oil spill response, including recent research conducted in Norway
- Infrastructure associated with offshore Arctic development, including onshore linkages.

DOI officials expressed a desire to receive the Council's assessment as soon as practicable.

The objective of this Supplemental Assessment is to provide the DOE and DOI with the Council's perspective on regulatory enhancements and other actions that support prudent development in the Arctic. The scope of this Supplemental Assessment focuses on the four key areas in the Secretary's request with an emphasis on what is new in terms of advances in technology and experience since 2015.

Appendix A contains a copy of the Secretary's request letter and a description of the NPC.

STUDY GROUP ORGANIZATION

To respond to the Secretary's requests, the Council reconvened a subset of key groups from the 2015 study, including the Steering Committee, the Coordinating Subcommittee, and the Writing Team.

This Supplemental Assessment was chaired by Darren W. Woods, Chairman and Chief Executive Officer, Exxon Mobil Corporation. Mark W. Menezes, Under Secretary of Energy, and Joseph R. Balash, Assistant Secretary for Lands and Minerals Management, Department of the Interior, served as Government Cochairs.

As in the 2015 study, members of the Supplemental Assessment study group and the technical workshop participants were drawn from NPC members' organizations as well as from other industries, state and federal agencies, nongovernmental organizations (NGOs), other public interest groups, consultancies, and academia. Nearly 70 people served on the reconvened study groups or participated in the technical workshop. While all have relevant expertise for the study, only about 50% work for oil and natural gas companies. Appendix B contains rosters of these study groups as well as participants in the study's workshop, and Figure 1 depicts the diversity of participation in the study process. These efforts were an integral part of the study, with the goal of informing and soliciting input from an informed range of interested parties.

Participants in this Supplemental Assessment contributed in a variety of ways, ranging from work in all study areas, to involvement on a specific topic, to reviewing proposed materials, or to participating in the aforementioned technical workshop. Involvement in these activities should not be construed as endorsement or agreement with all the statements, findings, and recommendations in this report. Additionally, while U.S. government participants provided significant assistance in the identification and compilation of data and other information, they did not take positions on the study's recommendations. As a federally appointed and chartered advisory committee, the NPC is solely responsible for the final advice provided to the Secretary of Energy. However, the Council believes that the broad and diverse participation has informed and enhanced its study and advice. The Council is very appreciative of the commitment and contributions from all who participated in the process.

STUDY PROCESS AND TIMETABLE

The primary source of information was a technical workshop with 45 participants hosted by the Baker Institute at Rice University on October 31 and November 1, 2018. The workshop consisted of four panels corresponding to the key study interest areas:

- Exploration drilling experience, and technology demonstrated, including well control advances
- Oil spill prevention and response
- Infrastructure developments
- Regulatory and lease terms.

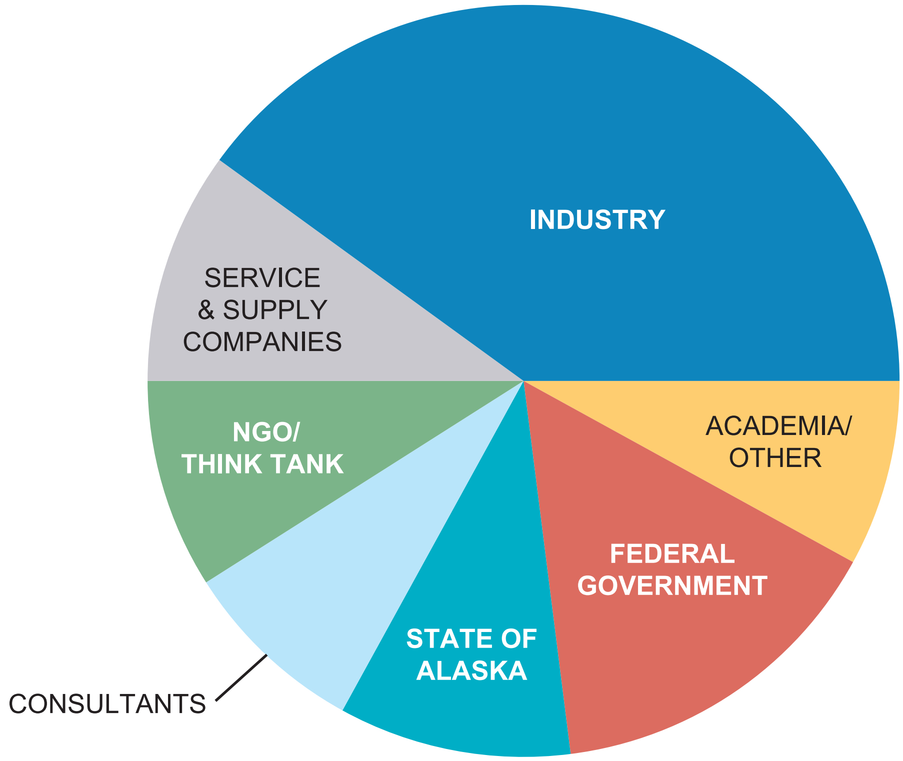


Figure 1. *Supplemental Assessment – Study Participation Diversity*

Workshop participants provided data, insights, and experiences since 2015 relating to the key study areas delineated in the Secretary's study request. The Coordinating Subcommittee considered the workshop output, developed further insights, and updated the 2015 NPC report's findings and recommendations. The learnings from the workshop are reflected in this Supplemental Assessment.

In preparation for the December 4, 2018 meeting of the National Petroleum Council, the Writing Team, Coordinating Subcommittee, and Steering Committee developed an interim report that was presented to Council membership for its review and comment. In January and February 2019, the Writing Team prepared a proposed final Supplemental Assessment for successive review and modification by the Coordinating Subcommittee and Steering Committee prior to submittal to the Council membership for final approval.

As in the 2015 study, this Supplemental Assessment was conducted in full compliance with all regulations and laws, including antitrust laws and provisions and the Federal Advisory Committee Act. This study did not include evaluations of commodity prices despite the important role these play in encouraging research and technology investments and the exploration and development of frontier resources.

Supplemental Assessment

INTRODUCTION

The U.S. Arctic is home to distinct indigenous peoples and provides habitat for large numbers of birds, mammals, and fishes. Some areas of the Arctic, such as Prudhoe Bay and the central North Slope of Alaska, have seen decades of economic activity. Today, there is increasing interest in the Arctic for tourism, and summer ice reductions provide increasing opportunity for marine traffic. The United States is believed to have large offshore Arctic oil potential, similar to Russia and larger than Canada and Norway. Facilitating additional exploration and development[1] in the U.S. Arctic could enhance national, economic, and energy security, and could benefit the Arctic people and the United States as a whole. At the same time, there is concern about the culture of the Arctic people and the environment in the face of changing climate, economic expansion, and increased human activity.

Internationally, other countries are moving forward with increased Arctic economic expansion. In Russia, new exploration oil and gas wells are being drilled in the Kara and Pechora Seas. Lacking the necessary long-term financing and technology to bolster its energy potential in the Russian Arctic following the 2014 imposition of Western sanctions, Russia turned to China as an alternative funding and technology source at the same time that China sought to diversify its shipping routes and energy sources. The convergence of their Arctic economic interests has accelerated Russian and Chinese cooperation in the Arctic, symbolized by the $27 billion Yamal LNG Project, of which 29.9 percent is owned by Chinese firms. Yamal is the centerpiece of China's Arctic infrastructure projects and represents an "anchor" project designed to establish an initial commercial presence that will eventually support related investments.

While China does not have Arctic territory, it is investing heavily in Arctic research and infrastructure, and to expand its access to natural resources. As part of its economic activity across the Arctic, Chinese firms continue to seek out additional economic opportunities including mineral resources in Greenland, energy resources in Iceland, a port on Sweden's west coast, rail lines linking south-eastern Finland with central China, mines in northern Canada, and liquified natural gas (LNG) in Alaska. Chinese President Xi Jinping's visit to Alaska in April 2017 resulted in a bilateral agreement to move forward with an Alaskan LNG project, worth an estimated $43 billion.

The United States has pursued a national strategy for the Arctic region that recognizes the importance of integrating national security, foreign policy, and energy policy, stating that "we seek an Arctic region that is stable and free of conflict, where nations act responsibly in a spirit of trust and cooperation, and where economic and energy resources are developed in a sustainable manner that respects the fragile environment and the interests and cultures of indigenous peoples."[2] However, except for plans to award a contract for the design of a new heavy icebreaker, the United States government has not substantially altered its Arctic presence over the past decade.

1 "Development" as an industry term refers to the design and installation of permanent facilities to produce oil/gas. Development follows discovery of a commercially viable resource by exploration activity.

2 The White House, "Introduction Page 4," *National Strategy for the Arctic Region*, May 2013. https://obamawhitehouse.archives.gov/sites/default/files/docs/nat_arctic_strategy.pdf.

Meanwhile, transits through the Bering Strait have more than doubled over the past decade, and further increases in maritime traffic are expected, particularly LNG carriers from the Yamal Peninsula to Asian energy markets. Militarily, Russia has increased its presence in the Arctic by moving to reopen former Soviet-era military installations, placing new radar facilities and airfields in its northern territory, and establishing new sea ports along its northern coastline.[3,4] Countries that invest in knowledge, technologies, and experience in the Arctic will have an advantage as the region grows in geopolitical importance. U.S. capability to develop and defend its Arctic interests will be affected by these developments.

Since the National Petroleum Council issued its 2015 report *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources,* there has been substantial growth in U.S. oil and natural gas production, and substantial international activity with advancements in Arctic technology and operational experience. At the same time, global alignment on the need to address human induced climate change has increased. Satellite data show that over the past 30 years, Alaska Arctic sea ice measured at the end of the summer melt season has declined by 30%.[5] In their 2018 Arctic Report Card, the U.S. National Oceanic and Atmospheric Administration stated that "as a result of atmosphere and ocean warming, the Arctic is no longer returning to the extensively frozen region of recent past decades. In 2018, Arctic sea ice remained younger, thinner, and covered less area than in the past."[6]

3 Clay Dillow, "Russia and China Vie to Beat the US in the Trillion-Dollar Race to Control the Arctic," CNBC, February 6, 2018. https://www.cnbc.com/2018/02/06/russia-and-china-battle-us-in-race-to-control-arctic.html.

4 U.S. Senate Committee on Energy & Natural Resources, "Roundtable to Discuss the United States' Overall Role in the Arctic from a Domestic and International Perspective," January 24, 2019. https://www.energy.senate.gov/public/index.cfm/2019/1/roundtable-to-discuss-the-united-states-overall-role-in-the-arctic-from-a-domestic-and-international-perspective.

5 National Snow & Ice Data Center, All About Arctic Climatology and Meteorology, "Climate Change in the Arctic," website accessed February 2019. https://nsidc.org/cryosphere/arctic-meteorology/climate_change.html.

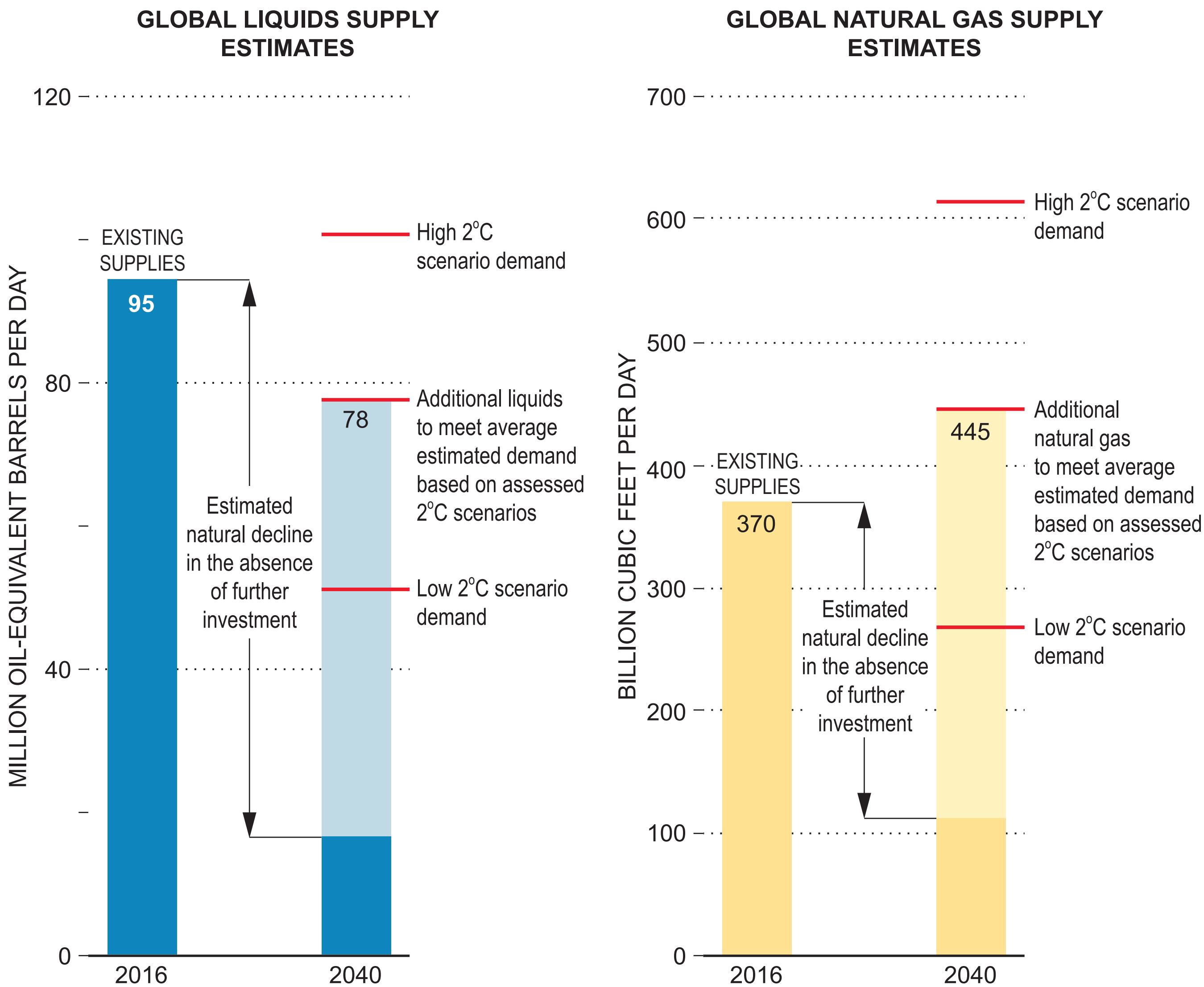
6 National Oceanic and Atmospheric Administration, "Arctic Report Card Tracks Region's Environmental Changes: Annual Update Improves Understanding of Changing Climate, Wildlife Impacts," December 11, 2018. https://www.noaa.gov/media-release/arctic-report-card-tracks-region-s-environmental-changes.

In light of global concerns with a changing climate and advances in lower carbon energy alternatives, one might ask if any future oil and gas exploration and development is needed at all, including the U.S. Arctic. The answer is yes. While electrification and a gradual shift to lower-carbon energy sources are expected to be a significant trend, oil and natural gas will continue to play a leading role in the world's energy mix. According to the International Energy Agency (IEA), global oil demand was about 95 million barrels per day (MMB/D), and global natural gas demand was about 363 billion cubic feet per day (BCF/D) in 2017. In 2040, the IEA's Sustainable Development Scenario[7] projects about 25% decrease in global oil demand, to about 70 MMB/D, and about 12% increase in natural gas demand, to about 405 BCF/D. These projections are based on increased efficiency and de-carbonization efforts, including shifts in policy, consumer preferences, and technology. However, in the IEA's scenario, significant hydrocarbon demand will remain, especially for aviation, heavy-duty transport and petrochemicals, where substitutes are challenged. In addition, without investments, the existing supply of oil and gas will decline, about 7% per year on average. New investment is needed to offset this decline, and the U.S. Arctic potential, with an economically viable discovery, could offset additional decline and help meet the world's future energy needs.

Figure 2 further illustrates the magnitude of this decline, compared with the demand for oil and natural gas in a 2°C world, as assessed by third parties.[8] The average of these scenarios suggest global liquids demand is projected to decline from 95 MMB/D in 2016 to about 78 MMB/D in 2040, as illustrated in the left-hand chart. Using the lowest liquids demand growth rate among the assessed 2°C scenarios, liquids demand would still be 53 MMB/D in 2040, as seen in the left-hand chart. However, absent future investment, world liquids production to meet demand would be expected to decline from 95 MMB/D to about 17 MMB/D in 2040. This natural field decline greatly exceeds the projected decline in global oil demand even under the lowest 2°C demand scenarios

7 International Energy Agency, *World Energy Outlook 2018*, IEA, Paris, 2018.

8 ExxonMobil, *2019 Energy & Carbon Summary*, ExxonMobil Corporation, Irving, Texas, 2019. Assessed 2°C scenarios based on EMF27 full technology/450 ppm cases targeting a 2°C pathway.



Note: Excludes biofuels. Source: IEA, EM analyses.

Source: IEA, EM analyses; IHS Markit, EM analyses.

Note: ExxonMobil (EM) Energy and Carbon Summary. Assessed 2°C scenarios based on EMF27 full technology/450 ppm cases targeting a 2°C pathway, see EM 2019 Energy & Carbon Summary.

Figure 2. *New Oil and Gas Supplies Required to Meet Demand in 2°C Scenarios*

assessed. Natural gas natural field decline rates are generally similar to liquids (about 5% per year on average), as shown in the right-hand chart.

This Supplemental Assessment reviewed the findings in the 2015 report and operational, technology, and regulatory advances since then. As a result of this review, this Supplemental Assessment includes two new findings and additional recommendations. The new findings are:

1. Improvements to current Arctic OCS regulations and their implementation could enhance safety, environmental stewardship, and public confidence.
2. Lease availability, lease terms, and regulatory requirements reduce the competitiveness of the Alaska OCS, compared with other opportunities worldwide.

A key finding of the 2015 report was that the technology to explore for and develop U.S. offshore Arctic oil and gas was available, but additional research was recommended to validate technology that had been used in other areas of the world. Since the 2015 report, there has been significant, safe, successful Arctic offshore drilling activity, and continued progress in technology for well control and oil spill response in Arctic conditions. This Supplemental Assessment concludes that, based upon technology advancements and demonstrations that have occurred since the 2015 report, changes should be made to regulations controlling U.S. Arctic exploration and drilling to enable the use of these and future technology advances. The recommended changes would improve safety, environmental stewardship, and economic viability of the U.S. Arctic potential.

This Supplemental Assessment includes these primary sections:

- A brief summary of the 2015 report findings, with particular emphasis on those relevant to this Supplemental Assessment and what has changed
- Additional findings of this Supplemental Assessment
- Recommendations of this Supplemental Assessment.

Additionally, two appendices are included to provide more detail on the 2015 report. Appendix C contains additional detailed discussion of the seven key findings of the 2015 report, and what has changed. Appendix D reprints the recommendations from the 2015 report.

SUMMARY OF THE 2015 REPORT FINDINGS AND WHAT HAS CHANGED

This section lists the key findings and recommendations from the 2015 report, and briefly discusses recent advancements in areas most relevant to this Supplemental Assessment. The 2015 findings remain valid and, in many cases, have been strengthened by technology advancements and operational experience since the 2015 report. A more detailed summary for all of these findings is included in Appendix C of this Supplemental Assessment, and the Executive Summary and full 2015 report are available on the NPC's website.[9]

9 National Petroleum Council, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, 2015. www.npcarcticpotentialreport.org.

The key findings in the 2015 report were:

1. Arctic oil and gas resources are large and can contribute significantly to meeting future U.S. and global energy needs.
2. The Arctic environment poses some different challenges relative to other oil and gas production areas, but is generally well understood.
3. The oil and gas industry has a long history of successful operations in Arctic conditions enabled by continuing technology and operational advances.
4. Most of the U.S. Arctic offshore conventional oil and gas potential can be developed using existing field-proven technology.
5. The economic viability of U.S. Arctic development is challenged by operating conditions and the need for updated regulations that reflect Arctic conditions.
6. Realizing the promise of Arctic oil and gas requires securing public confidence.
7. There have been substantial recent technology and regulatory advancements to reduce the potential for and consequences of a spill.

Discussion of 2015 Report Findings 1, 2, and 5 – Resource Potential, the Environment, and Economic Viability

In 2015, the NPC found that the U.S. Arctic oil and gas potential is large and could contribute to meeting the U.S. and global energy needs. In Finding 5, the NPC found that the economic viability of U.S. Arctic development is challenged. In Finding 2, the NPC found that the Arctic environment is generally well understood with sufficient data available to support exploration. However, the climate is changing, and additional data would be useful to support Arctic development. In light of concerns with climate change, continued growth in the U.S. Lower 48 states' unconventional oil and gas production, and challenging economics, one might ask if the potential benefits of U.S. Arctic exploration and development are worth the risk. This question is best addressed separately for exploration and development.

The 2015 report found that sufficient information was available on the ecological and human environment to support exploration. Exploration generally occurs in the open-water season in the summer months, using proven technology with no long-term environmental impacts and positive benefits to the community. As most of the assessed U.S. Arctic potential is yet undiscovered and the timeline for exploration, discovery, appraisal, and development could be more than 20 years, pursuing additional exploration now would position the U.S. to realize the benefits of its Arctic potential if discoveries are made that warrant further development. As described in the previous section, new hydrocarbon exploration and development will be needed to offset decline in existing fields and meet the world's demand for energy. Since 2015, other nations have pursued Arctic exploration drilling and production projects, at a more rapid pace and to a greater extent than in the United States.

Following an economically viable discovery, further study on the environmental and human impacts of progressing with development will be required. Such study would need to consider the specific project location and design, its physical, ecological and human environment, and any proposed mitigation plans to minimize potential negative impacts and maximize positive impact. These studies are typically incorporated into the project specific environmental and socioeconomic impact assessment and mitigation plan, which are required as part of securing regulatory approval to proceed with development. Public consultation and input, including incorporating traditional knowledge, is required and is a key part of this process.

Discussion of 2015 Report Findings 3 and 4 – The Technology to Explore for and Develop the U.S. Arctic is Field-Proven

In Finding 3, the NPC noted the long history of successful oil and gas operations in Arctic conditions, enabled by technology advances. Globally since 2014, 47 offshore Arctic exploratory wells have been drilled safely and successfully, in a variety of ice conditions. Two of these wells were in the United States, and 45 were drilled in Norway, Canada, and Russia. Forty-six of the 47 wells were drilled using conventional floating drilling rigs adapted for Arctic conditions. One well was drilled from an ice island. These successful drilling experiences included extensive well design and execution planning exercises, and employed continuously improving ice defense planning and management systems.

In addition to this offshore exploration activity, since the 2015 report, the North Slope of Alaska has seen activity both onshore and in state waters, including:

- June 2016 – Armstrong Oil and Gas and Repsol announce the "Nanushuk Discovery"
- April 2016 – Point Thomson Field brought online by ExxonMobil
- October 2016 – Caelus discovery at Smith Bay
- January 2017 – ConocoPhillips Alaska, Inc. announces its "Willow Discovery"

More detail on these activities, globally and in the state of Alaska, and the enabling technology that supported them, is described in Appendix C.

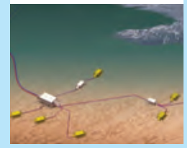
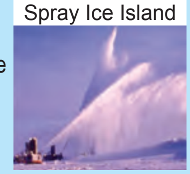
In Finding 4, the NPC highlighted the key surface factors – water depth, ice conditions, and the length of the open-water season. These surface factors make the Arctic unique, compared with other oil and gas jurisdictions, and have an impact on the technology used to explore and develop oil and gas potential, as illustrated in Figure 3, repeated here from the 2015 report.[10] As illustrated in red, most of the U.S. Arctic offshore resources are in shallow water, less than 100 meters of water depth, and have an open-water season of two months or more. Exploration in these conditions can and has been executed during the summer and shoulder[11] seasons with existing floating drilling rig technology, and production can and has been accomplished using conventional structures resting on the seafloor.

The 2015 report did not describe in detail the subsurface conditions (below the seafloor) for the U.S. Arctic continental shelf – geology, pressure, resource depth, and drilling depth. Compared with

10 Note that the Russian Arctic and deepwater areas depicted on this graphic are currently subject to both U.S. and European Union Sanctions. Development of such areas in the future would remain subject to compliance under relevant sanctions in place at the time of development.

11 On either side of the open-water season, there are periods of summer ice breakup/melting and fall-to-early-winter freeze-up where some ice can be present at a drilling location. These periods are referred to as the "shoulder" seasons, because ice coverage is reduced and the ice is either receding or newly forming.

Increasing Complexity to Explore & Develop

Physical Ice Environment and Water Depth		Technology to Explore & Develop
Description	**Examples**	
Typically ice free, any water depth • Minor first-year ice intrusions, icebergs possible	• South Barents Sea • Newfoundland	**Exploration & development proven** (Various drilling rigs, floating solutions, GBS, subsea tieback) Snøhvit Subsea  Hibernia GBS 
Any ice conditions, nearshore & shallow water • <~15m water	• Globally, near shore (including U.S. Beaufort and Chukchi Seas)	**Exploration & development proven** (Ice & gravel islands, concrete & steel structures, extended reach drilling from onshore) Spray Ice Island  Northstar 
Open water >~2 months, any water depth • Mainly first-year ice, potential for combination of multi-year ice, icebergs, and ice islands • Water depth determines development concept (greater or less than ~100m is key)	• Sea of Okhotsk • Pechora Sea • Labrador Sea • U.S. Chukchi & Beaufort Seas • South Kara Sea	**Exploration proven; development proven mainly in <~100m water** Ice management required <~100m development by GBS >~100m development by floating drilling & subsea tieback Canmar Drillship  Sakhalin-2 GBS 
Open water <~2 months, any water depth • Likely to encounter multi-year ice and/or icebergs, and in some locations ice islands • Water depth determines development concept (greater or less than ~100m is key)	• Deepwater Beaufort Sea • Deepwater Northern Russian Arctic Seas	**Exploration & development possible with technology improvements** Increased ice management capability and possible new technology
Limited to no open water • Frequent multi-year ice with embedded icebergs, and ice islands	• Northeast Greenland • Deepwater Northern Russian Arctic Seas	**Technology extensions or new technology required** Floating, robust ice managed solutions GBS/Subsea technology extensions or new technologies Difficult to mobilize equipment without open water season

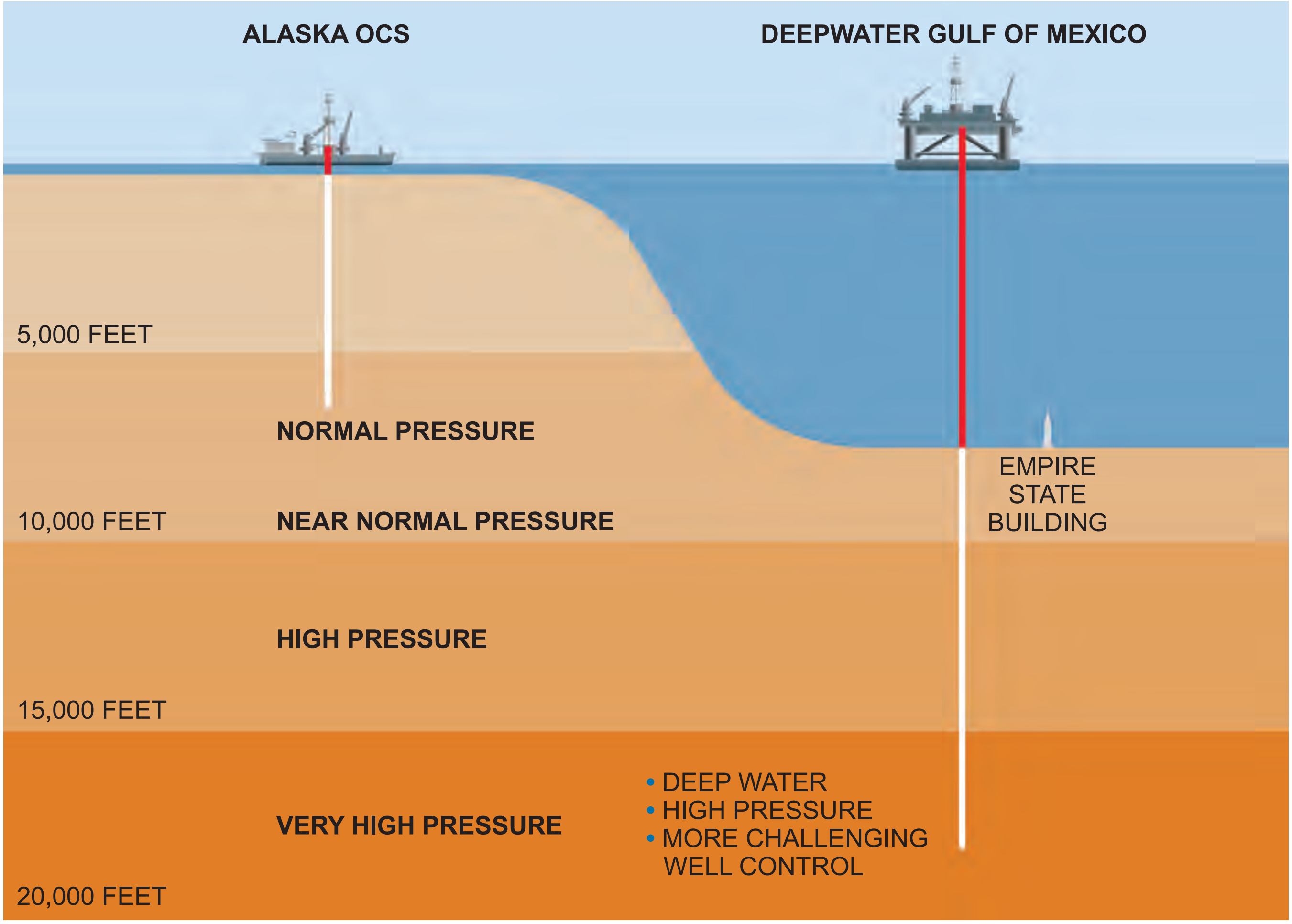
Photos: Snøhvit Subsea - Statoil (Even Edland); Hibernia GBS - ExxonMobil; Spray Ice Island - BP – Amoco; Northstar - BP p.l.c.; Canmar Drillship - R. Pilkington; Sakhalin-2 GBS - Sakhalin Energy.

Figure 3. *Exploration and Development in Various Arctic Surface Conditions*

other areas such as the deepwater Gulf of Mexico, the subsurface environment in the formations currently of interest in the U.S. Arctic is much simpler, and wells can be drilled more quickly, with fewer casing strings and simpler drilling mud designs, using existing, proven technology that has been used for decades. Figure 4 compares the U.S. Arctic subsurface conditions with the U.S. Gulf of Mexico. Confirmed by recent exploration data, targeted Arctic potential reservoirs are shallow and normally pressured, meaning that subsurface pressures can be held back by drilling mud only slightly heavier than the weight of salt water. During development, the risk of a well control event is extremely low (lower than during exploration), as the geologic and pressure conditions ahead of the bit have been already determined by exploration and appraisal drilling.

Discussion of 2015 Report Finding 5 – Economics are Challenged by Infrastructure and the Regulatory Framework

In Finding 5, the NPC noted that the economic viability of the U.S. Arctic was challenged by its remoteness, lack of infrastructure, and a need for updated regulations to reflect Arctic conditions. Regarding infrastructure, since the 2015 report, there have been operational and facility changes to allow continued operation of the Trans-Alaska Pipeline System (TAPS) pipeline at lower flow rates as Alaskan North Slope oil production has declined from its 1988 peak. Additionally, the National Oceanic and Atmospheric Administration (NOAA) recently completed a comprehensive bathymetric study in the U.S. Arctic, to



Source: Shell.

Figure 4. *Comparison of the Subsurface Environment of the U.S. Arctic with the U.S. Deepwater Gulf of Mexico, for Offshore Exploration Drilling*

improve navigation capability. Currently, the U.S. Army Corps of Engineers is examining the feasibility of constructing improvements at the Port of Nome, to increase its capability to serve as a regional hub for supply of goods. More detail on this and other infrastructure changes since 2015, globally and in the United States, are included in Appendix C.

Regarding the need for updated regulations, in 2015, the NPC identified concerns with the Arctic lease terms and lease length, which were originally developed for the offshore areas in the U.S. Lower 48 where operations can be conducted year-round. The NPC compared the U.S. lease length and framework with other Arctic nations, as illustrated in Table 1.[12] The NPC also identified the large number of agencies involved in the U.S. offshore, and the need for improved coordination to improve certainty. Both of these issues directly relate to economic competitiveness.

Since 2015, there has been no progress in addressing lease terms, and in 2016, the Bureau of Safety and Environmental Enforcement (BSEE) and the Bureau of Ocean Energy Management (BOEM) issued the Arctic Rule,[13] based largely on Shell's actual operating practices at Burger in 2015. In the NPC's view, the Arctic Rule is overly prescriptive and presumes that one set of assumptions, design, and equipment would universally apply in any given location and at

12 Note that Russian Arctic and deepwater resources are currently subject to both U.S. and European Union Sanctions. Development of such areas in the future would remain subject to compliance under relevant sanctions in place at the time of development.

13 A Rule by the Bureau of Safety and Environmental Enforcement and the Bureau of Ocean Energy Management, effective September 13, 2016, "Oil and Gas and Sulfur Operations on the Outer Continental Shelf – Requirements for Exploratory Drilling on the Arctic Outer Continental Shelf," 81 FR 46477, commonly called the "Arctic Rule."

Country	Lease/License System	Typical Well Count to Retain Lease/License*	Lease/License Duration
Canada	Exploration Based	1 to 2	9 years
Greenland	Exploration Based	1 to 2	Up to 16 years
Norway	Exploration Based	1 to 2	Up to 30 years
Russia	Exploration Based	1 to 2	10 years
United States	Development Based	6 to 7†	10 years

* The number of wells shown is estimated based on 1 to 2 wells needed to establish an exploration discovery.

† The number of wells shown includes exploration and appraisal wells. Based on practices used in the Lower 48, securing a lease extension beyond the primary term requires a firm commitment to develop requiring multiple appraisal wells, engineering studies, and funding. One appraisal well per 200 million barrels of recoverable volume, and a field size of 1 billion recoverable barrels was assumed.

Table 1. *Lease/License Comparison by Country*

any given time. These specific requirements have a negative impact on the industry's ability to effectively manage risks. Some requirements, such as restrictions on drilling season length, the requirement for same season relief well capability and a standby rig, and other specific logistical requirements, have been estimated by the American Petroleum Institute (API) to cost the industry more than 10-20 billion dollars without a reduction in risk.[14] Following its 2015 Arctic drilling activity, Shell paused its U.S. Arctic program, due to well results, high logistic and technical costs, and a challenging and unpredictable U.S. federal regulatory environment.

The current administration began work to redefine the U.S. Arctic leasing program and undertake regulatory reform efforts, as noted in the text box on key federal government initiatives relating to Executive Order 13795, and progress is being made. Regarding coordination, a memorandum of understanding between BOEM and the state of Alaska, signed in 2015, was also an important step forward, but has since expired. As highlighted in the 2015 report, state of Alaska institutions including state government and borough agencies have an important role in realizing the promise of U.S. Arctic oil and gas resources.

Given the importance in addressing the regulatory framework as a necessary step in promoting safe and environmentally responsible exploration, this Supplemental Assessment has developed two new findings related to the impacts of the current regulatory framework on safety and environmental stewardship (New Finding 1), and addressing economic burdens (New Finding 2). These are discussed in detail in the next section of this Supplemental Assessment, "Additional Findings Since the 2015 Report."

Discussion of 2015 Report Finding 6 – Public Confidence Needed to Proceed

In 2015, the NPC emphasized the need to secure and maintain public confidence that Arctic offshore oil and gas resources will be explored and developed responsibly. Further, the 2015 report noted that industry and government have a shared responsibility to gain and maintain the public trust:

- Industry must operate responsibly, bringing appropriate technology and operating practices to bear and continuously improving technologies and operations.
- Government must maintain and continuously improve effective policies and regulations that support development while ensuring protection of people and the environment.
- Both industry and government must engage with local communities.

Since the 2015 report, the industry has safely drilled 47 Arctic exploration wells. By focusing on prevention and risk management, no loss of well control events have occurred. In fact, since the 2015 report, globally, offshore, no relief well has been drilled nor has any capping stack or subsea isolation device been activated to stop an out-of-control well, because they have not been needed.

14 "Hearing to receive testimony on the Well Control Rule and other regulations related to offshore oil and gas production," U.S. Senate Committee on Energy and Natural Resources, Testimony, Erik Milito, Group Director, Upstream and Industry Operations, American Petroleum Institute, December 1, 2015.

Key Federal Government Initiatives to Advance Regulatory Reform and Expedite Environmental Reviews and Authorizations

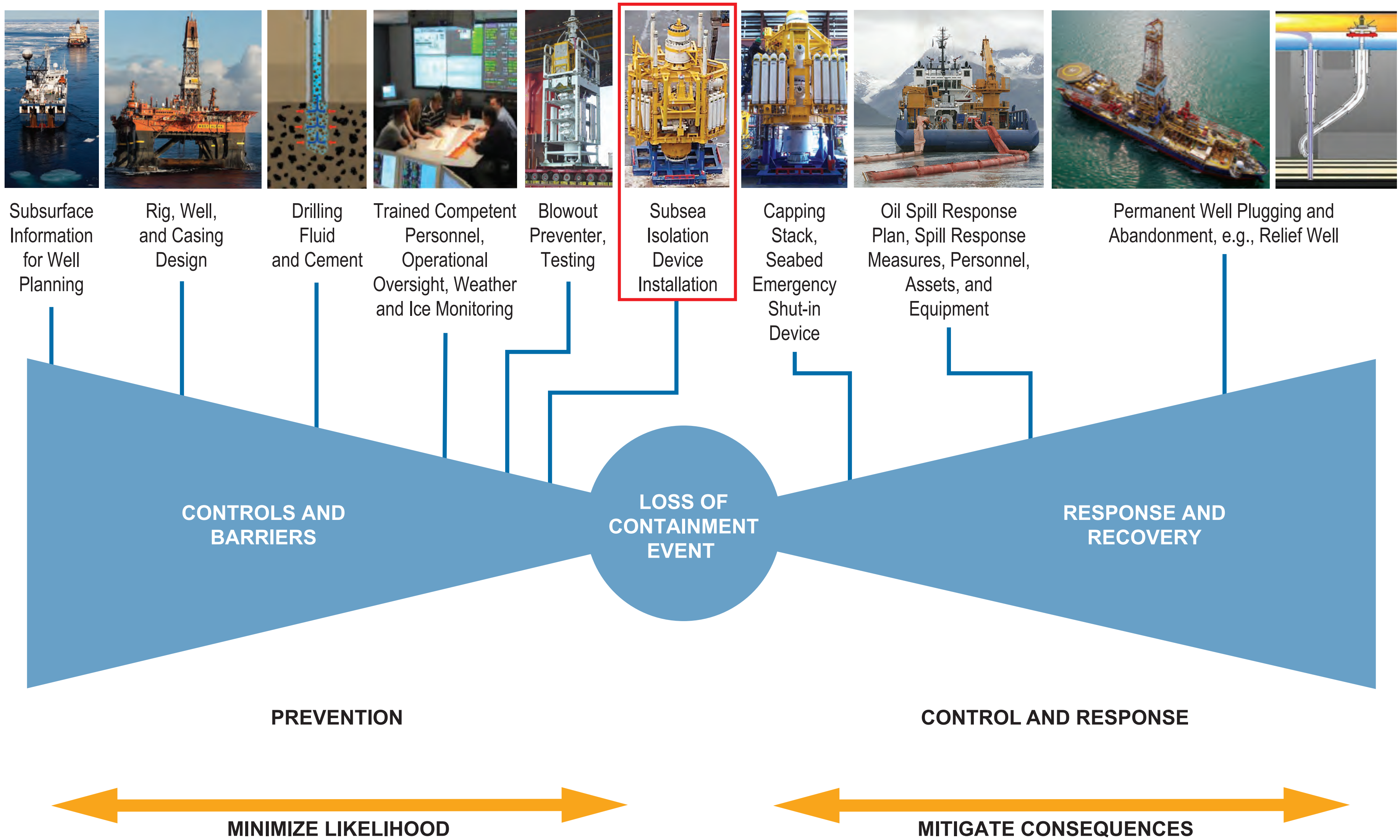
Executive Order 13795, Implementing an America-First Offshore Energy Strategy (April 2017)

- Establishes a U.S. policy to encourage energy exploration and production, including on the Outer Continental Shelf (OCS), for the benefit of the American people, while ensuring that any such activity is safe and environmentally responsible.
- **OCS Leasing.** Requires the Secretary of the Interior, in consultation with the Secretary of Defense, to give full consideration to revising the schedule of proposed oil and gas lease sales to include, but not be limited to, annual lease sales, to the extent permitted by law, in OCS Planning Areas including the Chukchi Sea, Beaufort Sea and the Cook Inlet.
  - The revised schedule of proposed lease sales may not hinder lease sales currently scheduled as part of the already published 2017-2022 OCS Oil and Gas Leasing Proposed Final Program (November 2016).
  - Requires the Secretary of the Interior, in coordination with the Secretary of Commerce, to develop and implement a streamlined permitting approach for privately funded seismic data research and collection aimed at expeditiously determining the offshore energy resource potential of the U.S.
- **Responsible Planning for Energy Development.** Requires the Secretary of Commerce, unless expressly required otherwise, to refrain from designating or expanding any National Marine Sanctuary under the National Marine Sanctuaries Act unless the sanctuary designation or expansion proposal includes a timely, full accounting from the U.S. Department of the Interior of any energy or mineral resource potential within the designated area – including offshore energy from wind, oil, natural gas, methane hydrates.
- **Regulatory Reform.** Requires the Secretary of Commerce, in consultation with the Secretary of Defense, the Secretary of the Interior, and the Secretary of Homeland Security, to conduct a review of all designations and expansions of National Marine Sanctuaries and Marine National Monuments within the 10-year period prior to the date of this order.
- Includes provisions directing the review of existing and proposed BSEE and BOEM rules on well control, offshore air quality, and Arctic drilling, and the expedited consideration of authorizations pertaining to seismic surveys and marine mammals.
- In May 2017, the Department of the Interior issued Secretarial Order 3350 to implement Executive Order 13795.

Community engagement by the industry has continued, in the 2015 Chukchi Sea exploration program, and since then at Liberty, Prudhoe Bay, TAPS, and others. All have provided jobs, training, and economic benefits and have promoted improved engagement and partnership with the community. In a few examples, the industry and the government partnered with the stakeholders to engage in activities to promote public trust. For example, the Russian regulatory agencies and community representatives witnessed the function testing and trial deployment test of the Kara Sea subsea isolation device in Norwegian waters, prior to regulatory approval of that technology for use in the 2014 Kara Sea drilling program.

Discussion of 2015 Report Finding 7 – Continued Technology Advancements to Prevent and Respond to Oil Spills

In Finding 7 of the 2015 report, the NPC noted the substantial improvements made to technology and regulations in the area of oil spill prevention and response since the 2010 Deepwater Horizon incident in the U.S. Gulf of Mexico (Macondo). The greatest reduction of environmental risk comes from preventing any loss of well control. Therefore, industry's first focus is on spill prevention. However, the risk of a spill can never be completely eliminated, so effective oil spill response capability is also critical. The "bow-tie"



Sources, left to right: Subsurface Information for Well Planning – ION Geophysical; Rig, Well, and Casing Design – ExxonMobil; Drilling Fluid and Cement – Shell; Trained Competent Personnel – Shell; Blowout Preventer – Cameron; Subsea Isolation Device Installation – ExxonMobil; Capping Stack – Trendsetter Engineering Inc.; Oil Spill Response Plan – Shell; Permanent Well Plugging and Abandonment, e.g., Relief Well – Shell, ExxonMobil.

Figure 5. *Well Control and Spill Response/Recovery*

diagram in Figure 5, adapted from the 2015 report, illustrates the spectrum of measures the industry employs to protect the environment from oil spills due to loss-of-well-control incidents. On the left-hand side of the bow-tie are preventative measures aimed at reducing the risk of an incident. On the right-hand side are response and recovery measures.

The 2015 report also described the differences in key technologies deployed by the industry – blowout preventers (BOPs), subsea isolation devices (SSIDs), and capping stacks, as illustrated in the text box below. The 2015 report discussed advances in capping stacks and SSIDs and recommended additional testing to improve confidence in them.

Advanced Technologies for Prevention of Blowouts and Major Spills

Photo: Cameron.

Blowout Preventer

Photo: Trendsetter Engineering Inc.

Subsea Isolation Device

Photo: Shell.

Capping Stack

Blowout Preventers (BOPs). Blowout preventers are standard equipment for drilling wells. Blowout preventers typically have multiple rams designed to seal around or cut through any drill pipe and casing strings in the well to prevent or stop flow from a well if other preventative measures fail. Blowout preventers are part of the drilling rig's equipment and are removed when the well is completed and the rig departs. Bureau of Safety and Environmental Enforcement regulations and notice-to-lessees require frequent testing and maintenance of BOPs.

Subsea Isolation Devices (SSIDs). Subsea isolation devices are essentially self-actuated, remotely operable blowout preventers installed on the wellhead below the drilling rig's blowout preventer. SSIDs have their own independent control system and do not rely on the drilling rig. The SSID's control system and shearing/sealing rams include enhanced levels of redundancy and capability, and provide additional protection in the event that the drilling risers are damaged, such as in the case in Macondo. These devices can be located below the seafloor in an excavated trench, if needed, to provide protection from deep ice keels in the event they need to remain in place over the ice season.

Capping Stacks. Subsea well capping operations were widely publicized during the Macondo incident in 2010; however, the well capping technique has been used by industry to shut in surface well blowouts for many decades. Capping stacks are designed to mechanically connect to a BOP or wellhead and shut-in and/or contain and divert the flow from the well until control can be regained. Since Macondo, capping stacks have become a standard part of the subsea drilling operations and specially designed and maintained units are strategically located near many offshore drilling areas such as Alaska and the Gulf of Mexico.

Since 2015, there have been significant technology improvements to BOPs. Sealing and pressure containment capability and the redundancy and reliability of control systems have increased substantially. The shearing, sealing, and pressure containment capabilities of BOPs have been extensively tested. Capping stacks have also been extensively tested, witnessed by regulators, and staged at multiple locations. For the Kara Sea program, an SSID was built, tested, and installed on the well below the BOP. The Kara Sea SSID is shown in Figure 6. The SSID served similarly to a second BOP, but was intended to be left on the wellhead rather than removed with the drilling rig if the rig was moved off the well late in the season. The SSID and casing were designed for full well shut-in pressure and the SSID is capable of being actuated remotely. To mitigate the risk of a late season well control event continuing over the winter season, the casing design and SSID together enabled safe full-well shut-in, eliminating the requirement for a standby rig to provide the capability to drill a same season relief well. Based on these advancements since 2015, in this Supplemental Assessment, the NPC has added SSIDs to the "prevention" side of the bow-tie as highlighted in red in Figure 5.

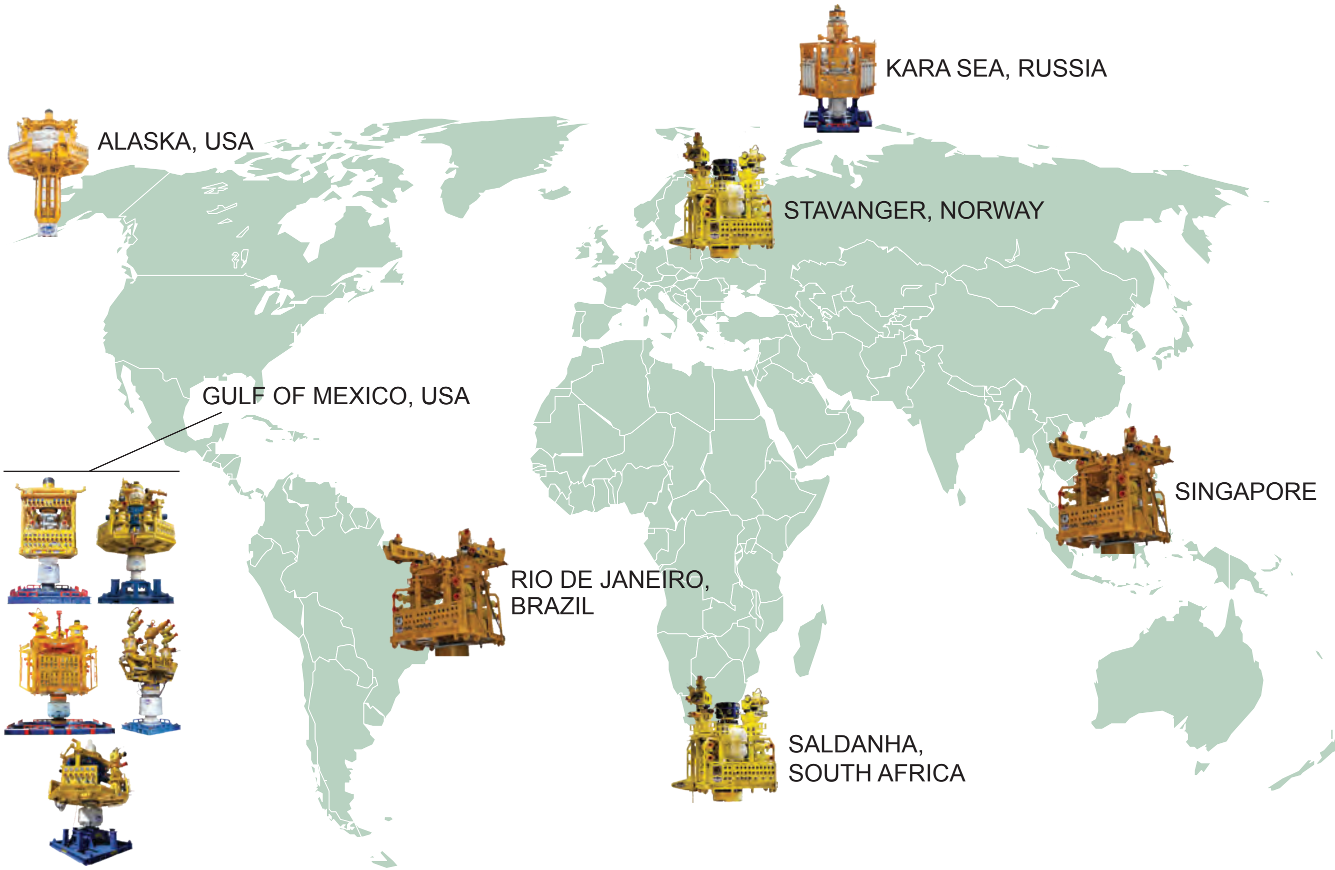
Photo: Shell.

***Figure 6.** Subsea Isolation Device used for Drilling in the Kara Sea*

Moving to the "response" side of the bow-tie diagram, there have also been significant improvements to the containment capability and the deployment of capping stacks, similar to SSID improvements. Capping stack capabilities have increased, from 250 up to 350 degrees Fahrenheit temperature and from 10,000 psi to 20,000 psi pressure, with capacity to process up to 100,000 barrels of liquid per day and up to 200 million cubic feet of gas per day. Currently, there are two companies that provide well capping and containment for the Gulf of Mexico – Marine Well Containment Company (MWCC) and HWCG (previously the Helix Well Containment Group). Worldwide, Oil Spill Response Limited (OSRL) maintains four capping stacks and other well containment equipment such as the Offset Installation Equipment for shallow water capping deployment, at locations in Norway, Brazil, Singapore, and South Africa. Offshore wells drilled in Alaska post-Macondo have been required by regulation to have a capping stack on standby near the drilling rig. Current global staging of well control devices is shown in Figure 7.

Regarding mitigation, the Arctic Oil Spill Response Technology Joint Industry Programme (ART JIP), which was underway at the time of the 2015 report, concluded in 2017, confirming and advancing oil spill response techniques and technologies in Arctic conditions. The ART JIP was initiated in 2012 as a collaboration of nine international oil and gas companies: BP, Chevron, ConocoPhillips, Eni, ExxonMobil, North Caspian Operating Company, Shell, Statoil (now Equinor), and Total. Over the course of the five-year program, the JIP carried out a series of advanced research and development projects related to dispersants, environmental effects, trajectory modelling, remote sensing, mechanical recovery, and in-situ burning in the Arctic. Final findings and conclusions are described in reports available on the program website.[15] Most notably, the ART JIP concluded that dispersants and in-situ burning can be equally or more effective in Arctic conditions than in warmer climates. The key outcomes of the Arctic Response Technology JIP are summarized in a nearby text box.

15 Arctic Response Technology, Oil Spill Preparedness, "About the Arctic Response Technology JIP," 2018. http://www.arcticresponsetechnology.org.



Source: Trendsetter Engineering, Inc.

Figure 7. *Global Deployment of Well Control Devices*

In addition to research and technology advances, many offshore oil spill response exercises have been conducted in Norway since 2015. The Norwegian Clean Seas Association for Operating Companies (NOFO) and The Norwegian Coastal Administration have arranged Oil on Water (OOW) exercises for the past 40 years. NOFO exercises with oil were conducted west of Stavanger in the North Sea in 2016 and 2018. Several trials were performed on various aspects of oil spill response relevant to the Arctic, and a key finding was that the Desmi Speed-Sweep System was able to be towed through water at double the speed of a traditional boom without significant loss of oil. Another key finding was that herding agents successfully thickened free-floating oil slicks, allowing more efficient burning than untreated free-floating slicks.

In 2015 and 2017, NOFO worked with the Barents Sea Exploration Collaboration to execute large-scale exercises in Arctic conditions. The tests were not performed with oil, but provided operability experience with oil spill emergency response in freezing weather and with marginal ice conditions. In 2015, tests in the sea outside Svalbard addressed the operability of conventional mechanical oil spill response systems[16] in cold conditions including ice. The capabilities of different remote sensing systems[17] were also tested. All the tested equipment was successfully deployed, and operated as expected with somewhat lower efficiency due to the presence of ice and the cold temperature. In 2017, NOFO performed a large-scale exercise in the Barents Sea north east of Bjørnøya. The equipment tested included the Desmi Ro-Boom 3200, the MOS Sweeper and the BV dispersant spray system. All functioned in moderate ice conditions, but further winterization would enhance performance in cold and ice.

16 Norlense 1200 booms and Framo Transrec recovery devices including a high wax skimmer.

17 Aptomar Securus, Rutter Oil Detection Radar, and Vsat and IRIDIUM communication systems.

Key Outcomes of the Arctic Response Technology JIP

- State of knowledge reports on key oil-in-ice response topics such as in-situ burning, dispersants, remote sensing, and environmental effects synthesize critical information gained over more than 40 years.
- The environmental effects database and literature navigator facilitates the use of Net Environmental Benefit Analysis (NEBA) by reducing the effort to identify and access the known, relevant information. This will lead to a better understanding of the potential environmental effects of selecting different response strategies.
- In-Situ Burning: Provides comprehensive support that technology exists to conduct controlled in-situ burning of oil spilled in a wide variety of ice conditions. Demonstrated the use of herding and burning as a new combined response strategy for both ice-covered and open water. A combined herder-ignition system was subsequently prototyped for commercial deployment.
- Dispersants: Reinforces previous research that dispersants can work in the Arctic and will, under certain conditions, be more effective in the presence of ice than in open water.
- Remote Sensing: Provides a new understanding of relative sensor capabilities, strengths, and weaknesses under a range of oil and ice conditions, using a range of different sensors above and below the ice.
- Environmental Effects: Extends the available science base on oil spill impacts in an Arctic environment to support NEBA. Provides a searchable database that references over 1,000 papers.
- Trajectory Modeling: Improves the predictive capability of existing trajectory models that will provide more accurate predictions of oiled ice movements in a range of ice conditions.
- The JIP results inform the public on many important topics involved in any discussion of Arctic oil spill response. This transfer of information is supported by public availability of reports and online access to all of the material produced by the JIP including state-of the-art technology reviews, technical reports, peer-reviewed papers, videos, and graphics.
- The rigorous scientific process followed by the JIP should provide greater levels of confidence in Arctic oil spill response capabilities.

The industry continues to pursue new technology to prevent and respond to a potential oil spill. Some of this technology and research is performed for all climates when that technology can be adapted to both temperate and cold regions. Two promising new technologies, Polymer Plugs and Seawater Injection, are currently being investigated to either prevent or mitigate a well blowout. For more information, see Appendix C.

ADDITIONAL FINDINGS SINCE THE 2015 REPORT

Based on operational experience, technology advancement and deployment, and regulatory changes since the 2015 report, this Supplemental Assessment includes two additional Findings.

New Finding 1 – Improvements to Current Arctic OCS Regulations and Their Implementation Could Enhance Safety, Environmental Stewardship, and Public Confidence

Conducting exploration drilling safely, while protecting personnel, wildlife, the environment, and minimizing the impact on Arctic residents, is the primary objective of every operator and every regulator. These objectives influence the operators' and regulators' activities in all phases of well design and planning, contingency preparation for unforeseen events, and execution of actual drilling operations in the field. Throughout these phases, the operator, regulator, and other stakeholders align on appropriate risk management, priorities, and tradeoffs.

Requiring Specific Solutions Leads to Compliance Rather Than Disciplined Risk Management, Decreases the Operator's Accountability for Effective Risk Management, and Decreases the Incentive for Technology Improvement

When drilling in any environment, some prescriptive requirements are appropriate. Examples include the requirements for design and performance testing of blowout preventers, which have driven consistency and safety improvements across the industry. However, when compliance gets in the way of appropriate risk management, reevaluation is required. Overly prescriptive requirements at their worst can lead operators to ask "what do I need to do to get my permit approved?" and the regulators to ask "what do the regulations say?" These questions are concerning, because of the focus on the requirements rather than how to mitigate risks to acceptable levels. Prescriptive regulations can also discourage innovation and technology development. Performance-based requirements, in contrast, emphasize company accountability in planning and executing operations safely, using appropriate technology, based on the unique characteristics of the project under consideration. Some unique aspects of the Arctic that warrant specific attention are designs and execution plans to address the risks associated with cold temperatures, ice, logistics, the short operating season, and the environment.

As an example of a prescriptive requirement that leads to ineffective risk management, the requirement for the capability to drill a same season relief well to mitigate the risk of a late season well control event continuing over the winter season is outdated. It may have been an appropriate requirement in the 1980s, but now that SSIDs and capping stacks are designed, tested, and proven at full well shut-in temperatures and pressures, they are a superior solution. An SSID or a capping stack could stop the flow of oil and allow intervention through the original borehole long before a relief well could be completed. If a relief well were to be used, the entire time a relief well is being drilled, oil could be spilling to the environment. SSIDs and capping stacks are therefore superior solutions, yet the 2016 Arctic Rule mandates capability for a same season relief well.

In contrast, Norway's experience with predominantly performance-based regulations is outlined in the text box on the Norwegian Experience. Norway's performance-based system stands in marked contrast to the early years of Norway's petroleum industry, when the regulatory regime was based on specific requirements, checks, inspections and detailed orders, similar to U.S. requirements today. Over time, regulators saw that the initial system had major weaknesses, both in terms of reducing accountability of the operator for safe design and execution, and restricting innovation and technology development and adoption.

Norway's regulatory system includes both performance-based regulations and guidelines. Regulations describe performance standards that operators must meet, and guidelines describe potential methods that the operators may use to meet the performance standard. Guidelines are provided to avoid misunderstandings about what it takes to fulfill the regulations, and often refer to recognized Norwegian and international industry standards. Operators are expected to comply with regulations and may propose solutions better than the guidelines if such solutions exist. Amendments are frequently made to Norway's health, safety, and environment regulations, by way of annual updates for new innovative solutions and to ensure that they are tailored to the challenges currently facing the industry. These regular updates have the benefit that the system improves on lessons learned through execution. In Norway, the industry and the regulator work together to promote safety and improve public confidence.

Multiple Layers of "Protection" and Overly Prescriptive Requirements Can Increase Overall Risk

In the unlikely event of a well control incident, the primary focus of operators and regulators should be firstly on personnel safety, and secondly on source control. Vessels and equipment that are positioned in theater "just in case" they are needed to minimize environmental impact, can actually impede personnel safety and source control objectives, because they distract operations personnel, add congestion, and can impede surface access to the well location.

Figure 8 compares the vessel fleets used by Russia, the United States, and Norway in Arctic exploration drilling campaigns conducted since the 2015

Performance-Based Oil and Gas Regulation – Norwegian Experience

The Norwegian Continental Shelf extends from the UK North Sea border up to the Barents Sea around Svalbard. The Barents Sea South has been open for petroleum activity since the 1980s. The most important instruments governing petroleum activities on the Norwegian Continental Shelf are Integrated Management Plans and Norwegian regulations for petroleum activities.

Integrated Managements Plans are developed for: (1) North Sea and Skagerrak, (2) Norwegian Sea, and (3) Barents Sea and Lofoten Region. The plans set out open areas for licensing, the socio-economic assessment basis for licensing, and contain some area-based constraints for petroleum activities in particularly valuable and vulnerable areas or time periods.

Norwegian regulations do not differentiate between areas on the Norwegian Continental Shelf. For regulation of specific petroleum activities, such as single exploration wells in the Barents Sea, the requirements are risk based.

The Petroleum Act provides the general legal basis and health/safety/environmental (HSE) framework for petroleum activities on the Norwegian Continental Shelf. The key regulatory provisions for HSE in the petroleum sector are found in five sets of regulations. The **framework regulations** specify basic safety requirements for organizing and executing petroleum activities. Additional provisions appear in the **management, activities, facilities,** and **technical and operational** regulations. The framework regulations are established by royal decree, while the Petroleum Safety Authority is responsible for creating the other four sets and for coordinating the work of other agencies in their enforcement. Regulations are enforced jointly by the Petroleum Safety Authority Nor-way, the Norwegian Environment Agency, and the health authorities, within their respective areas of authority.

Norway's petroleum regulations are largely *based on performance requirements, which specify the level of safety that must be met but not how this is to be done.* This gives companies freedom to decide how to achieve the required level of safety based on the specific environmental and meteorological conditions in the exact area and the exact period of time for which the activity is planned. This avoids the potential for technical advances to outstrip the regulatory framework and a need for constant regulatory revisions to keep pace with new solutions. At the same time, the *performance requirements emphasize company responsibility in planning and executing operations in order to meet the safety targets.*

Guidelines are provided to avoid misunderstandings about what it takes to fulfill the regulations, and often refer to recognized Norwegian and international industry standards.* A regulatory requirement is considered to be fulfilled when a recommended solution of this kind has been adopted. However, guidelines are not mandatory; it is possible to choose an alternative approach providing the company can show requirements are met as well or better than the guideline.

Authorities

The Ministry of Petroleum and Energy (MPE): Authority to ensure good resource management through opening of new areas for petroleum activities, award of new production licenses, approval for development and operating plans for fields, pipelines and other facilities, decommissioning.

Norwegian Petroleum Directorate (NPD): The technical branch of the Ministry of Petroleum and Energy.

Petroleum Safety Authority Norway (PSA): Authority for safety, occupational health, and prevention of accidents that can lead to spills. Responsible for cross-agency coordination and reports to the Ministry of Labour and Social Affairs.

Norwegian Environment Agency (NEA): Authority for the external environment, regulation of operational discharges to sea, air and subsoil, emergency preparedness requirements. Reports to Ministry of Climate and Environment.

Norwegian Coastal Administration (NCA): Authority for supervising operators' spill cleanup activities. Can issue permits for chemicals dispersants during the operation. Responsible for governmental preparedness against acute pollution, and has nationwide administrative authority in the case of incidents. Reports to Ministry of Transport and Communications.

* Petroleum Safety Authority Norway, "Safety and Responsibility: Understanding the Norwegian Regime," Stavanger, Norway, December 15, 2017.

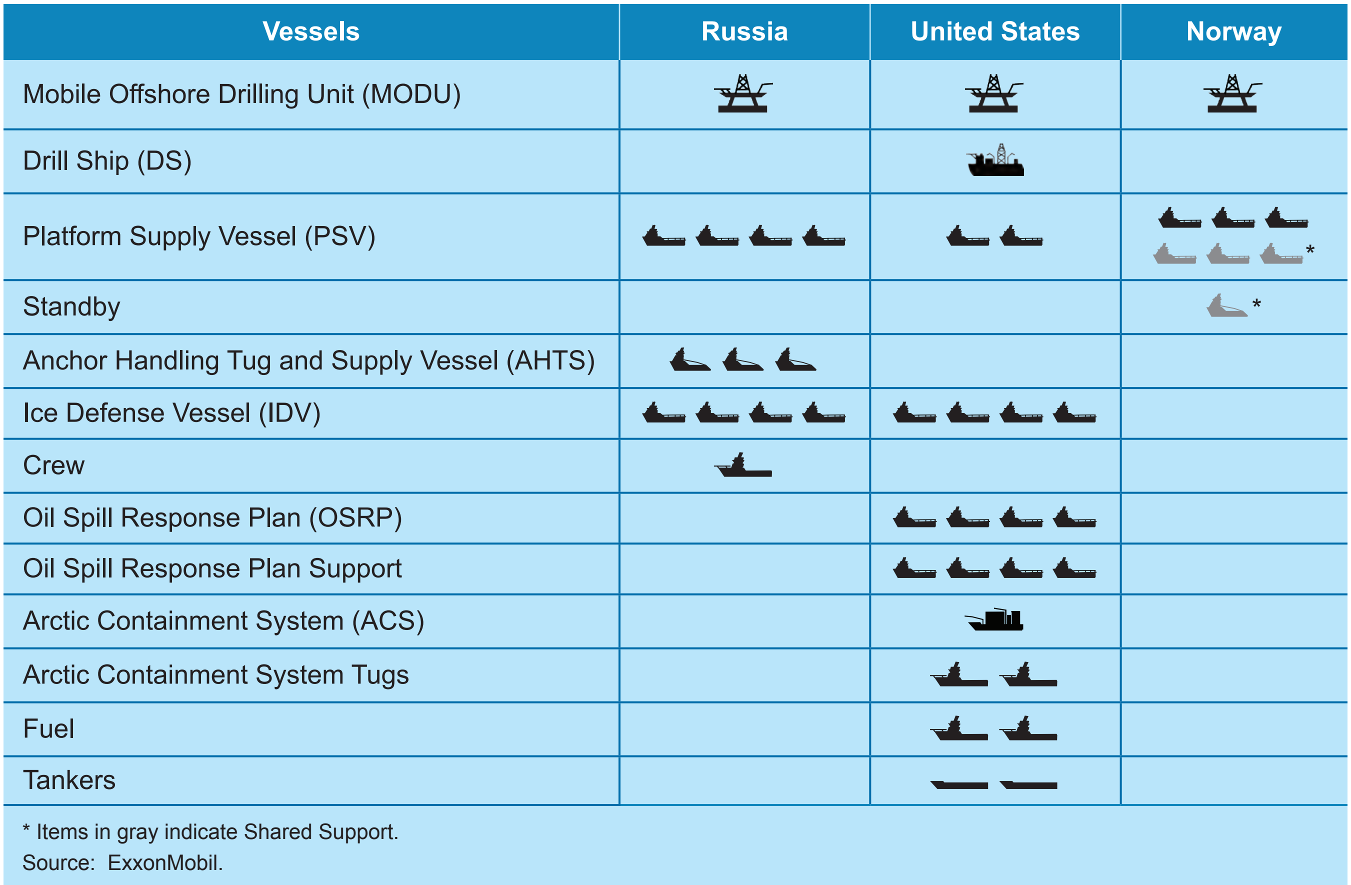


Figure 8. *Arctic Drilling Fleet Requirements in Recent Arctic Exploration Drilling Campaigns*

report. The larger number of vessels for the U.S. poses additional risk and can complicate incident response. It is instructive to compare the number of vessels for the U.S. with Norway, given the similar distances from staging areas and associated vessel requirements for crew change, medical facilities, etc. As noted in Figure 8, compared with Norway, the U.S. required double the number of rigs and over double the number of support vessels.

Additional vessel requirements in the U.S. are driven by current regulatory requirements, including relief well standby, spill containment standby, and compliance with zero-discharge requirements. A zero-discharge requirement is particularly burdensome, and is a good example of "protection" that can increase overall risk. Collecting snow that falls on a drilling rig and support vessels, melting it, transferring it to transport vessels for carriage through the Bering Strait for disposal greatly increases activity, vessel traffic, and miles traveled, which increases overall risk for questionable environmental benefit.

Multiple Agencies with Conflicting Mandates and Overlapping Requirements, Absent a Coordinating Agency to Manage Tradeoffs, Hinder Effective Risk Management

Table 2 summarizes substantive permit requirements and associated regulating agencies for recent Arctic exploration drilling in the United States, Norway, and Russia. As noted in the table, there are a large number of agencies in the U.S. and Russia. Using performance-based standards as described earlier, Norway stands out as having fewer agencies for similar activities. All three countries use designated agencies with specialized skills for effective and differentiated oversight in specific areas such as safety, air emissions, and wildlife. Comparing the U.S. with both Norway and Russia, the U.S. is notable in that there is little coordination across the agencies. For the U.S., the large number of agencies, and lack of mechanism or expectation to coordinate across those agencies results in an unpredictable and ineffective regulatory framework, the inability

Country	Key Permits / Applications	Agencies
United States	• Exploration Plan • Integrated Operations Plan • Oil Spill Response Plan • Application for Permit to Drill • Letter of Authorization for Level B Take of Polar Bears and Walrus • Bear and Walrus Management Plan • Incidental Harassment Authorization for Level B Take of Whales and Seals • National Pollutant Discharge Elimination System (NPDES) Permit • U.S. Coast Guard Vessel Inspections • National Construction Permit • North Slope Borough Shoreline Permits	• Bureau of Ocean Energy Management • Bureau of Safety and Environmental Enforcement • U.S. Fish and Wildlife Service • National Oceanic and Atmospheric Administration • National Marine Fisheries Service • Environmental Protection Agency • U.S. Coast Guard • U.S. Army Corps of Engineers • North Slope Borough Municipality • North Slope Borough Assembly • North Slope Borough Planning Department • North Slope Borough Wildlife Department • Other Alaska state agencies
Norway	• Application for Consent *(PSA)* • Application for registration number(s) *(NPD)* • Permit for drilling exploration well *(NPD)* • Application for discharge permit *(NEA)*	• Petroleum Safety Authority (PSA) • Norwegian Petroleum Directorate (NPD) • Norwegian Environment Agency (NEA) • Norwegian Radiation Protection Authority • Norwegian Coastal Administration
Russia	• State Environmental Expert Review • State Expert Review • Construction Permit • MChS (Ministry of Emergency Situations) Oil Spill Response Drill approval • FSB (Federal Security Service) Access for non-Russian nationals • Boarder Guard / Customs Checkpoint • Shorebase Security Plan (ISPS, International Ship and Port facility Security code) • Hazardous Material Handling Certification • Industrial Safety Expert Review of Rig • Regulator *(RTN)* License to Operate Rig • Regulator *(RTN)* acceptance of Enhanced Subsea Shut-in Device • Northern Sea Route Authority permit • Transport of Hazardous Material License *(RTN)*	• Federal Environmental, Industrial, and Nuclear Supervision Service *(RTN, Rostechnadzor)* • Main Department of State Expertise *(Glavgosexpertiza of Russia)* • Emergency Control Ministry • State Marine Pollution Control and Salvage Administration

Table 2. *Regulatory Requirements and Associated Agencies for Offshore Drilling for Three Arctic Nations*

to effectively balance priorities, and potentially poor risk management.

As a specific example of poor risk management due to conflicting requirements and lack of alignment on priorities, consider the permit restrictions issued in the 2015 Arctic exploration program on breaking up ice (due to potential wildlife impacts), but in some cases, ice can threaten vessels and the safety of personnel. Similarly, concerns about wildlife have restricted approval to fly helicopters even in favorable weather, which could inhibit crew changes and response to a safety or environmental incident. During the 2012 Chukchi Sea exploration program, the U.S. Environmental Protection Agency (EPA) set excessive air emission restrictions. Congress, recognizing EPA's inability to issue workable OCS air emission permits and to create consistency in the offshore, transferred authority of air quality from the EPA to BOEM. Finally, BSEE's authority for spill containment exercises and their frequency impacted the operator's focus on safe operation for no incremental benefit. BSEE's authority to direct an operator to deploy spill containment equipment may also overlap the U.S. Coast Guard's authority as the Federal On-Scene Coordinator.

Even within a single agency, there are examples of conflicting regulations. In 2016, BSEE finalized new drilling rules for all OCS areas, including the Arctic OCS. These new rules focus on BOP and Well Control Rules (commonly called the WCR). This WCR was proposed for revision in 2018 and revisions are currently under review; however, similar action has not been initiated regarding the Arctic Rule. The proposed revisions to the WCR alter the current regulations in content and structure, and overlap in numerous areas with the Arctic Rule.

An Effective Collaboration Between the Regulatory Agencies and the Industry can Help Secure and Maintain Public Confidence that Exploration can be Safely Pursued, with Care for the Environment

In addition to coordination across regulatory agencies, collaboration between the industry, technical societies, and regulatory agencies can improve safety and risk management. Norway's regulatory regime, which includes regulations (required performance standards) and guidelines, was previously described. The Norwegian Petroleum Safety Authority has a role to work with the industry and the technical societies to incorporate innovations into the regulations and guidelines. The Norwegian Regulatory Forum provides a key arena for this work. Primary responsibility for developing industry standards rests with the petroleum sector itself. The robustness of these standards depends on operators collaborating to come up with the best solutions. The Norway Petroleum Safety Authority has observers on a number of standards committees, and incorporates their learnings and new standards into the regulations and guidelines as appropriate. In this manner, the Norwegian regulators and the industry partner to improve safety and environmental performance, promote innovation, and maintain public confidence.

In the United States, the Department of the Interior, through BSEE, similarly incorporates API standards into the regulations, and since the 2010 Macondo incident, has incorporated many standards into its regulatory program for both the U.S. Lower 48 and the Arctic. These include, for example, deepwater operations, Safety and Environmental Management Systems, cementing, cranes, and safety valves. The key difference between the U.S. practice and Norway described above is the minimal involvement of BSEE and other agencies in the work of the standards committees. This results in a sequential process that can be quite lengthy, often taking 2 years or more:

- Industry standards groups meet to develop and improve standards.
- BSEE/BOEM separately perform a detailed review to determine if they agree in full or in part with the standard, and updates their regulatory requirements based on the latest experience.
- The updated documents are referenced as part of the proposed rules in the Federal Register for review by the public as a Notice of Proposed Rulemaking (NPRM), and BSEE/BOEM consult with the standards organizations, as required under the National Technology Transfer and Advancement Act (Pub. L.104-113).
- Comments received are reviewed and accepted or rejected by BSEE/BOEM.
- The final rule is posted on the Federal Register.

Prior to the 2010 Macondo incident, the Minerals Management Service (now BSEE and BOEM) and other agencies commonly participated as independent observers in API committees. While the NPC recognizes and supports the need for regulating agencies to remain independent, the NPC believes that independence can still be maintained while key agencies observe and attend the workings of the standards committees. This would facilitate technology and knowledge transfer between the industry and the regulating agency. For the regulating agencies, this collaboration results in better understanding of risk management options available to the operator and the latest operational experience and technology improvements, which better enables the agencies to discharge their role. The industry standards committees also gain understanding of the issues that are important to the regulators. This approach, similar to Norway, would result in a more efficient and more current regulatory framework.

New Finding 2 – Lease Availability, Lease Terms, and Regulatory Requirements Reduce the Competitiveness of the Alaska OCS, Compared with Other Opportunities Worldwide

Finding 5 of the 2015 report, summarized briefly earlier and more comprehensively in Appendix C, discusses the importance of lease terms and regulatory conditions to the competitiveness of U.S. Arctic opportunities. Since the 2015 report, there have been no lease sales in the U.S. Arctic OCS. The recommendations from the 2015 report, to conduct additional study comparing U.S. lease terms with operational requirements and practices from other jurisdictions and to use the results of this study to update U.S. lease terms, have not been implemented. The Arctic Rule, governing exploration drilling in the Arctic OCS, was released in 2016. It was meant to establish requirements for safe and responsible operations, largely based on the 2015 offshore Alaska drilling experience. It is the view of the NPC that the Arctic Rule is overly prescriptive and unduly burdens oil and gas activity, without clear benefits for safety or environmental stewardship.

Lease Availability – Beaufort and Chukchi Lease Sales

Continued exploration for and production of oil and gas resources cannot proceed without leasing the resource areas. The Beaufort Sea and Chukchi Sea Planning Areas have not had lease sales since 2007 and 2008, respectively. In 2012, the Five-Year Lease Sale Program included a Beaufort Sea Lease Sale, scheduled for 2017, and in the Chukchi Sea, scheduled for 2016. Both of these were cancelled in October 2015. The Department of the Interior (DOI) did not include the Chukchi Sea and Beaufort Sea Planning Areas in the Five-Year National OCS Leasing Program published in 2017 covering planned lease sales until 2022. As a result of these cancellations and withdrawals, the Beaufort Sea and Chukchi Sea Planning Areas have not had lease sales in over a decade. During that same time, the state of Alaska has held frequent and successful lease sales in state waters in the nearshore Beaufort Sea, leading to the drilling activity and discoveries noted in the discussion of 2015 Report Findings 3 and 4 above.

In light of energy security considerations and to position the U.S. as a global leader in the safe and competitive development of offshore energy resources, DOI was directed to redefine and expand the 2017 Five-Year National OCS Leasing Program. BOEM has initiated a multi-year process to establish a 2019 Five-Year National OCS Leasing Program. A draft of this program, which includes six lease sales in the Beaufort and Chukchi Seas as shown in Figure 9, was issued in January 2018. It includes areas previously set aside for whaling, including the 25 Mile Chukchi Sea Buffer (for all animals), the Barrow Whaling Area, and Kaktovik Whaling Area. These areas have been excluded since 1997, stemming from commitments by DOI to Alaska natives to protect subsistence activities. Alaska native organizations are collaborating with the Department of the Interior, to consider how to effectively balance subsistence activities with the potential socioeconomic and community benefits associated with exploration for oil and gas.

The draft 2019 Five-Year National OCS Leasing Program that was released in January 2019 is undergoing environmental review and public comment. DOI anticipates publishing the final 2019 leasing program later this year. The original 2017 Five-Year National OCS Program will continue to be implemented until the new Program is approved.

Lease Terms – Lease Length

Finding 5 of the 2015 report discussed the need for leases longer than 10 years for the U.S. Arctic. The need for longer leases remains a critical issue today.

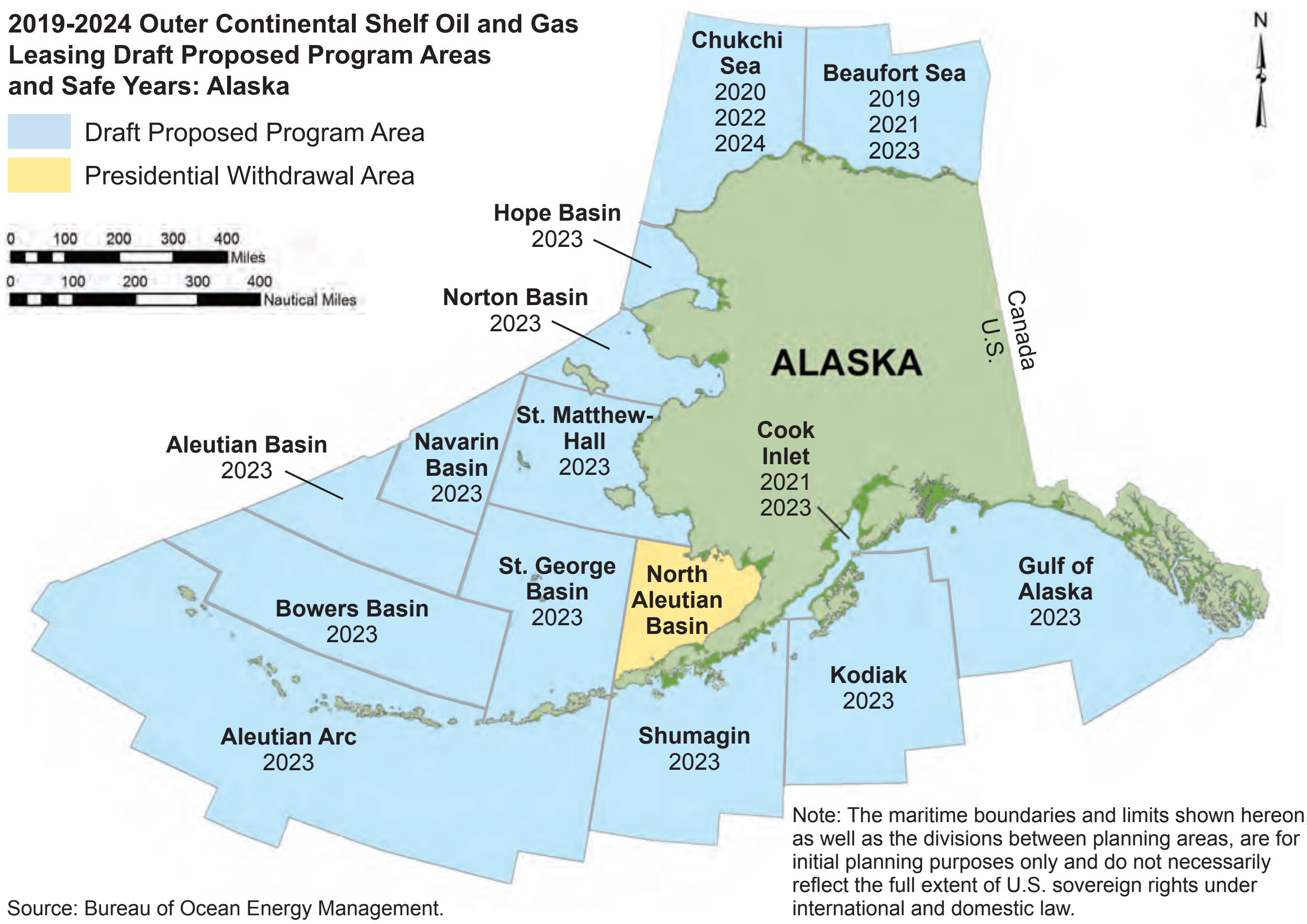


Figure 9. *Draft Proposal on OCS Lease Sales for 2019-2024*

The Outer Continental Shelf Lands Act limits the primary term of any OCS lease to a maximum of 10 calendar years. This limit comes from other offshore areas in the U.S., where operators have access to the leases all year-round. In contrast, exploratory access in the U.S. Arctic offshore is limited to 3-4 months per year by ice. As a result, the exploratory phase of an Arctic project would take three to four times longer in calendar years to account for those periods when operators cannot conduct exploration due to the presence of ice. A 10-year lease in the U.S. Arctic equates to about 3 to 4 years of working time, compared with the equivalent 10 years working time in the Gulf of Mexico.

Figure 10, reprinted from the 2015 report, compares the length of exploration and development phases for various areas, in the U.S. and globally, and the current 10-year lease limit is highlighted with the red line. Contrast the 14-year exploratory phase for a generic Alaskan OCS project with 3-4 years for the U.S. Gulf of Mexico Atlantis and Mars projects. As further evidence that the lease length is insufficient, Arctic operators routinely require extensions for exploration programs and development projects. Extensions have been requested to address judicial challenges and permitting delays, and often cite the narrow drilling season as a challenge to Arctic OCS exploration. Clearly, a 10-year lease term is inadequate for Alaskan OCS exploration and development.

Other Arctic countries address longer timelines required for exploring in Arctic frontier areas in two primary ways: (1) longer lease lengths and (2) focusing initial lease requirements on exploration requirements. Canada offers an exploration license with a 9-year term that can be extended if an operator is diligently pursuing drilling. In Canada, if a discovery is made, the area of the exploration lease can be converted to a "significant discovery license" which can be held by the operator to enable the time to advance additional appraisal drilling and investments

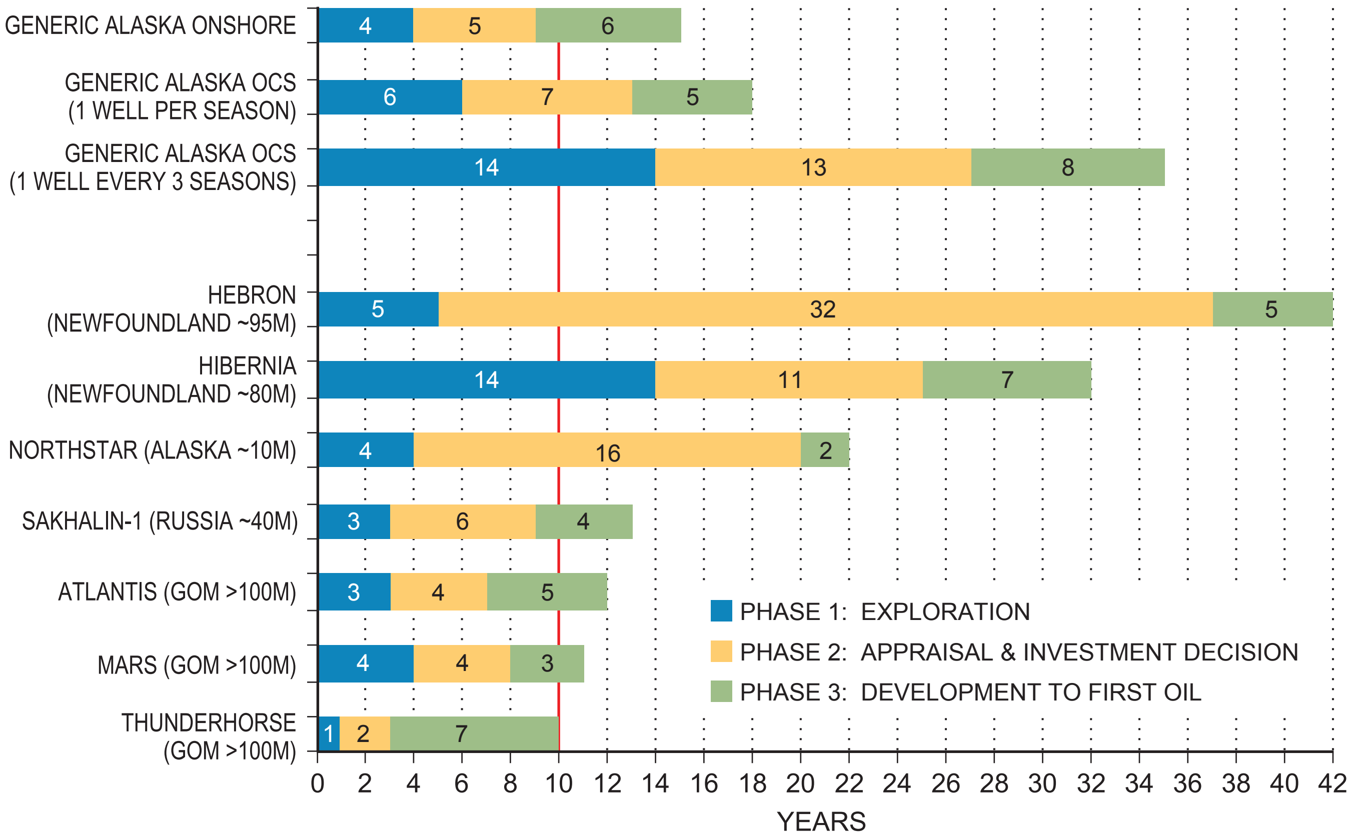


Figure 10. Comparison of Typical Arctic and Actual non-Arctic Project Timelines

in infrastructure prior to committing to development. Norway similarly provides for an initial exploration license of 4 to 6 years that can be extended up to 10 years with commitment to a work program that is advancing subsurface understanding and that may ultimately lead to a future commitment to develop. Table 1 in the previous discussion of 2015 Report Finding 5 compares various countries' lease terms.

The U.S. OCS lease system, in contrast, covers the exploration, development, and operating phases. U.S. leases have a primary and secondary term. During the primary term, only the payment of rentals is required to maintain a lease; there is no drilling commitment or work program requirement. At the end of the primary term, the lessee must be drilling a well, hold a suspension of production, suspension of operations, or be producing oil and/or natural gas to hold their lease. As long as an OCS lease is producing in paying quantities it can be maintained.

The advantage of the Canadian and Norwegian leasing approach is that operators are able to prudently explore and appraise their leases with certainty that if they discover something, they will have the opportunity to develop it.

Lease Length – Extension Issued for Leases Transferred to AEX

ASRC Exploration, LLC (AEX) assumed ownership of 21 Beaufort Sea leases in January 2017; the majority of these leases were due to expire in July 2017. AEX ownership of the leases is the first time an Alaska native corporation has directly owned federal offshore leases. AEX is a subsidiary of Arctic Slope Regional Corporation, the Alaska native corporation for the Arctic North Slope. Its shareholders are the Iñupiat people who live and subsist throughout the Arctic North Slope.

In April 2018, DOI granted ASRC Exploration, LLC a five-year suspension of operation extension (SOO) for 21 OCS leases which were due to expire in July of 2017. This was the first time in recent history an extension longer than one year has been granted, and the first time a SOO was granted to conduct additional environmental analysis. While this SOO could be considered an improvement in dealing with a specific short lease term issue, to improve the competitiveness of U.S. Arctic OCS resources, the granting of lease extensions should be a common lease administrative practice and not an infrequent anomaly.

Lease Terms – Lease Size

The Outer Continental Shelf Lands Act[18] limits lease tract sizes to no more than 5,760 acres (9 square miles), unless the Secretary finds that a larger area is necessary to comprise a reasonable economic production unit. An offshore federal tract is usually configured in the form of a square with equal sides, and a 5,760-acre tract has sides of three miles each. Because the tract system is not designed around the subsurface geology, it is very common for prospective accumulations of oil and/or natural gas resources to underlie more than one tract, and some targets are significantly larger than 5,760 acres. In other jurisdictions with limited subsurface data and infrastructure, lease sizes are typically larger to provide sufficient incentive to overcome comparatively higher geologic risks, higher drilling costs, and more challenging economics. As an example, in the Gulf of Mexico, the Mexican government offered leases up to 450,000 acres in size.

The Secretary of Interior has the authority to offer larger lease tracts as "necessary to comprise a reasonable economic production unit." The Secretary could exercise this authority to increase the lease size in the U.S. Arctic, compared to the offshore blocks in the U.S. Lower 48.

Regulatory Development: Arctic Rule Issued in 2016

The "Oil and Gas and Sulfur Operations on the Outer Continental Shelf Requirements for Exploratory Drilling on the Arctic Outer Continental Shelf 81 FR 46477," commonly called the Arctic Rule, was issued jointly by the BOEM and BSEE in July 2016. While the NPC's 2015 report identified that Arctic-specific drilling regulations were needed, the 2016 Arctic Rule as issued did not consider the NPC's recommendations in the 2015 report. During promulgation of the Arctic Rule, stakeholders across sectors raised concern that the rule would be too prescriptive and not environmentally justifiable, thus unduly burdening Arctic OCS exploration and development without clear environmental benefit. Since promulgation of the Arctic Rule, there has been no exploration activity in the Arctic OCS. Drilling activity has continued in other jurisdictions, including in Alaska state waters, despite changing crude oil prices.

The impact of these prescribed requirements on safety and risk management was discussed in detail in the above section on New Finding 1. This section focuses on the economic burdens associated with the Arctic Rule. BSEE and BOEM estimated the cost of the Arctic Rule to the industry of about $2 billion over 10 years.[19] The API and others have challenged this assessment, stating that the cost to the industry for the Arctic Rule is approximately $10–20 billion.[20] The BSEE and BOEM assessment differs substantially from API's assessed cost of the same season relief well requirement and also did not consider the impacts of shortening the effective drilling season (driven primarily by a same season relief well requirement) and imposing specific design, logistics, and operating requirements.

The prescriptive requirements in the Arctic Rule are largely based on the actual practices employed during the 2015 Arctic exploration drilling experience. For example, the Arctic Rule contemplates the use of floating drilling rigs, and many of the requirements are not appropriate for extended reach drilling from a permanent drill site, such as used by Caelus in its 2016 Tulimaniq discovery in Alaskan state waters, and by ENI and its partners in their Nikaitchuq prospect, currently drilling. As another example, all operators are required to have and to be able to deploy onsite within 7 days a cap and flow system and an Arctic Containment System, or containment dome. The containment system would not be useful for operators that utilize a jack-up rig in their exploration programs and may not be deployable in many shallow ocean conditions common in the Beaufort and Chukchi Seas.

18 43 U.S. Code § 1337, "Leases, easements, and rights-of-way on the Outer Continental Shelf."

19 Bureau of Safety and Environmental Enforcement, "Fact Sheet - Arctic Drilling Rule," Press Release July 7, 2016. https://www.bsee.gov/guidance-and-regulations/regulations/arctic-rule.

20 "Hearing to receive testimony on the Well Control Rule and other regulations related to offshore oil and gas production," U.S. Senate Committee on Energy and Natural Resources, Testimony, Erik Milito, Group Director, Upstream and Industry Operations, American Petroleum Institute, December 1, 2015.

The prescribed one-size-fits-all approach to Arctic exploration within the Arctic Rule eliminates the flexibility both by the operator and the agencies to design, operate, and govern Arctic OCS exploration programs taking into consideration subsurface geological targets, emerging technology, advancements in spill prevention and control, and changing environmental conditions. The specific requirements in the rule that have the largest impact on competitiveness are:

- *Limitations on the Drilling Season.* The exploration drilling season in the Arctic OCS is naturally abbreviated by the presence of seasonal ice for the majority of the year. Operators already have a narrow window in which to conduct operations, compared to southern regions where work occurs year-round, as discussed above. Further exacerbating this problem, the drilling season has been limited by specific dates written into the Arctic Rule and other regulations. For example, operators are unable to pass through the Bering Strait until after July 1st, according to the U.S. Fish & Wildlife "Incidental Take Regulations" for Pacific walrus. In addition, the National Marine Fisheries Service in 2015, implemented the same restrictive dates in the "Incidental Harassment Authorizations" for whales and ice seals. The current drilling season length is specified in the regulations by date, and is unrelated to actual site conditions. It unnecessarily shortens an already short season and increases the cost substantially, by requiring work in multiple seasons that could be done in a single season. It also discourages use of proven technology to safely extend the drilling season.

- *Same Season Relief Well (SSRW) Capability, and 45 day "Hydrocarbon Blackout."* The useful drilling period is further shortened by the Arctic Rule's requirement that an operator have the capability to drill a relief well within the same drilling season, and the "hydrocarbon blackout," which restricts drilling into the hydrocarbon bearing zone 45 days prior to November 1, the historical seasonal ice encroachment. As discussed in 2015 Report Finding 7 above, technologies have advanced to offer superior protection with shorter implementation times than a relief well, such as subsea isolation devices and capping stacks. However, the language in the Arctic Rule requires an operator have the capability to "permanently plug and abandon" a well in the same season. The ability to plug and abandon a well can only be achieved by a drilling rig, thus the agency restricts application of superior technology by defining the equipment an operator would use if required: a drilling rig.

  The ability to drill a relief well to plug a compromised well in the following season would not be precluded by allowing the use of alternative well control technologies that can safely shut in and make the well safe over the winter season. Communities and regulators must be confident that any new technology allowed will perform as desired. Industry and government must work together to build this confidence.

- *Stand Alone Relief Rig Requirement.* Related to the requirement to provide the capability to drill a same season relief well, the Arctic Rule also requires an operator to have a stand-alone rig available and dedicated to drilling such a relief well. In order to justify the cost of a stand-alone relief rig, as discussed previously, the Regulatory Impact Analysis accompanying the Arctic Rule assumed multiple operators per season and resource sharing amongst operators. This scenario does not accurately depict the level of activity seen in the U.S. Arctic today or at any time in the past.

- *Prescribed Source Control and Containment Equipment (SCCE).* The Arctic Rule prescribes that an operator have access to a capping stack, cap and flow system, and containment dome, and be able to deploy this suite of SCCE within certain time frames and at the direction of the BSEE Regional Supervisor. A containment dome may not be deployable in many Arctic conditions, most notably in shallow water, yet is required under the Arctic Rule, adding cost and complexity.

- *Drilling Options other than Floating Rigs, and Development Drilling.* The current OCS regulations are written assuming the use of floating drilling rigs for exploration. However, in 2016, Caelus made a discovery in Alaska's Smith Bay using extended reach drilling from an ice island in state waters, and in 2018 ENI accessed federal acreage from an island in state waters. While the Arctic Rule does not preclude use of directional drilling techniques, many prescriptive requirements are only applicable to floating drilling. In addition, development drilling would typically be conducted from a permanent drill site, and many of the requirements would not be appropriate.

- *Conflicting and Duplicative Requirements:*
  - *Integrated Operations Plan.* The requirement for an operator to submit an Integrated Operations Plan (IOP) was in response to recommendations within DOI's March 2013 report "Review of Shell's 2012 Alaska Offshore Oil and Gas Exploration Season." The DOI-required IOP includes much of the same information required in the Exploration Plan submittal, such as: a schedule of the exploratory drilling program, a description of mobilization and demobilization operations, the general maintenance schedule for operations, and a description of the operator's weather and ice forecasting capabilities. In practice, the IOP requirement is largely duplicative with the operator's Exploration Plan and puts the onus on the operator to stimulate intra-agency collaboration. The IOP requirement may also circumvent BOEM's mandate under federal law to complete review of Exploration Plans within 30 days.
  - *Discharge Restrictions.* The Arctic Rule grants discretion for the BSEE Regional Supervisor to require the capture of water-based drilling mud during operations in the Arctic OCS. However, drilling mud discharge falls under the jurisdiction of the EPA through the NPDES program. The requirement to capture water-based mud during operations is very costly, creates numerous logistical challenges, and generates substantial additional vessel activity in the drilling area.

Successful production of Alaskan OCS oil and gas resources will be dependent upon finding an economically commercial resource opportunity. The ability to explore is the first critical step. Successful exploration will require competitive lease terms and regulatory requirements that effectively balance economic viability with environmental stewardship.

Regulatory Coordination

In the 2015 report, the NPC called on the government to provide leadership and to improve policy and regulatory coordination to facilitate the prudent development of U.S. Arctic oil and gas resources. In the United States, the regulatory framework that governs oil and gas activity remains highly complex, although there are recent efforts by the current administration to improve it (see the earlier text box on key federal government initiatives, describing Executive Order 13795 "Implementing an America-First Offshore Energy Strategy").

The impact of the U.S. regulatory framework on risk management was discussed in detail above. Considering competitiveness, the number of agencies in the U.S. and the lack of coordination among them results in a long and uncertain regulatory process. The 2012 Chukchi Sea drilling program required 6 years to secure regulatory approval (2006-2012), compared with a 2-year regulatory process for the Russian Kara Sea (2012-2014). These wells both represent the first well in a remote region, in a similar surface and subsurface environment. The second Chukchi Sea drilling program (2013-2015) received regulatory approval in 2 years, similar to the Kara Sea program.

RECOMMENDATIONS

The view of the 2015 report was that the technology and operating knowledge existed to prudently explore for and develop the U.S. Arctic while protecting people and the environment, based on technology demonstrated in other Arctic jurisdictions. This Supplemental Assessment affirms that view and concludes that the recommendations of the 2015 report remain relevant. The 2015 report recommendations are included in Appendix D for reference.

The 2015 report recommended further assessment and demonstration to gain acceptance by regulators and other stakeholders of key technologies and operating practices that would improve personnel safety, environmental stewardship, economic viability, and overall competitiveness of the U.S. Arctic. Since 2015, these available technologies have been further demonstrated and deployed in other jurisdictions, as discussed in Appendix C (see subsection on 2015 Report Finding 7). These demonstrations now provide the basis for this Supplemental Assessment to recommend regulatory changes to improve U.S. Arctic competitiveness, safety, and environmental stewardship.

The NPC makes the following overarching recommendations, which are each discussed in detail below:

1. Update and implement performance-based Arctic regulations governing drilling and oil spill prevention and response, to enable improved safety, environmental stewardship, and competitiveness.

2. Improve coordination across regulatory agencies, and collaboration between the industry and regulating agencies, to improve the ability to promote prudent exploration and development, and to secure and maintain public confidence.
3. Improve lease term competitiveness, by addressing exploration lease length, lease terms, and lease size.
4. Improve infrastructure planning across multiple stakeholders, to capture potential synergies and improve cost competitiveness of future U.S. Arctic oil and gas exploration and development.

Implement Performance-Based Drilling Regulations

Arctic OCS drilling and production regulations and their implementation should be performance-based, emphasizing prevention of loss of well control events and spills, and use of the most effective technologies to reduce environmental risk and enhance personnel safety, equipment reliability, and operational efficiency.

Specific examples of the current prescriptive requirements contained in the 2016 Arctic Rule should be removed, as described in New Findings 1 and 2 above:

- Where authority has been granted to the BSEE Regional Supervisor to direct or interfere with actual operations, it should be removed and replaced with clarification of the operator's accountability for risk management and operational decision-making.
- Drilling season length should be determined by actual ice conditions, ice management strategy, and the capability of the drilling rig and associated equipment to operate safely, versus prescribed calendar dates.
- The requirement for the capability to drill a same season relief well should be replaced with specifying the desired outcome, i.e., to stop the flow of a well, and allow operators to propose equivalent technology and demonstrate its capabilities.
- The requirement for a stand-alone, standby relief rig should be removed.
- BSEE should establish performance-based standards that consider the usefulness and reliability of source control and containment equipment for a variety of surface drilling considerations – including floating drilling, jack-up drilling, and directional drilling from on-shore or island locations. SCCE specifications and requirements should be fit-for-purpose and tailored to safely and successfully address the risk identified.
- The surface casing blackout date should be removed, and replaced with a requirement that operators demonstrate the ability to safely manage the risk of a late season loss of well control event.
- The Arctic Rule should be updated to remove specific requirements that are appropriate for floating drilling rigs but not appropriate for wells directionally drilled from a permanent surface location, such as a capping stack and same season relief well.
- Preapproval should be provided by the Alaska Regional Response Team[21] to facilitate the ability to rapidly deploy dispersants and in-situ burning for oil spill response.

Improve Coordination across Regulatory Agencies, and Collaboration with the Industry, to Better Balance Safety, Environmental Stewardship, and Economic Competitiveness, and Improve Public Confidence

To promote efficiency and minimize interagency government inconsistencies, a coordinating body for federal oil and gas regulations, permitting, and environmental reviews should be established. This coordinating body should be granted the authority to prioritize objectives, eliminate duplication of effort (e.g., multiple National Environmental Policy Act compliance documents for the same project), resolve interagency disputes, address conflicting regulatory requirements, improve timeliness in resolving issues, and troubleshoot across multiple agencies. Successful examples include the State of Alaska Office of Project Management and Permitting, the Canadian Energy Regulator, and the California Power Plant Licensing Program as described in a nearby text box.

The Department of the Interior, U.S. Coast Guard, Department of Commerce, state of Alaska, and North Slope organizations should cooperatively explore

21 See Alaska Regional Response Team Website, *https://www.alaskarrt.org/*.

options to enhance coordination and collaboration to support the prudent development of U.S. Arctic oil and gas resources. Such efforts may include a new memorandum of understanding, a coordination framework, or other solutions tailored to address the unique opportunities and challenges of U.S. Arctic oil and gas operations.

Conflicting regulatory requirements should be harmonized.

- The Integrated Operations Plan requirement in the 2016 Arctic Rule should be removed or harmonized with the Exploration Plan requirement.
- The conflicting requirements between the 2015 Well Control Rule and the 2016 Arctic Rule should be resolved and clarified.
- The requirements for managing drilling mud and cuttings in the 2016 Arctic Rule should be removed, as it is duplicative with the authority granted to the EPA under the Clean Water Act. Discharge requirements should be evaluated on a case-by-case basis, by the agency with clear authority and as part of permit reviews, considering prudent exploration and a balance of factors – safety, environmental stewardship, and cost implications.

California Power Plant Licensing Program

The California Energy Commission was established in 1974 by the Warren-Alquist Act. The Commission has exclusive authority to certify, i.e., grant a license, for the construction and operation of thermal electric power plants with a generating capacity of 50 MW or greater, and all related facilities in the state. Recognizing the need for energy facilities to be licensed in an expeditious and environmentally acceptable manner, the Commission aims for its program to be rigorous, fair, and consistent, while eliminating duplication and regulatory uncertainty.

The licensing process provides:

- Assurance that only power plants actually needed will be built
- Review by independent staff with technical expertise in public health and safety, environmental sciences, engineering, and reliability
- Simultaneous review and full participation by all state and local agencies, as well as coordination with federal agencies
- One regulatory permit
- A decision within a specific time frame (usually one year)
- Ample opportunity for participation by public and interest groups.

The California Energy Commission's regulations require staff to independently review the proposed project, assess whether all of the potential environmental impacts have been properly identified, and whether the applicant's proposed mitigation or other, more effective, mitigation measures are necessary, feasible, and available. Additionally, staff are required to assess the completeness and adequacy of the measures proposed. Staff also develop a compliance plan (coordinated with other agencies) to ensure that applicable laws, ordinances, regulations and standards are met and adhered to.

A certificate issued by the Commission is in lieu of other state and local permits. The Energy Commission serves as the lead agency under the California Environmental Quality Act (CEQA) and the Energy Commission's certification program provides the environmental analysis that satisfies all CEQA requirements. No additional environmental impact report is required.

The project development process and California Energy Commission staff's final staff report (FSR), as well as the certification, are docketed. The FSR may also incorporate salient comments received from agencies, the public, and parties to the siting case, and comments made at public meetings and during proceedings. Final action is taken by the Energy Commission after following semi-adjudicatory processes similar to those of the California Public Utility Commission. Once approved, the license grants the authority to construct the power plant as defined by project engineering studies and with requirements defined at the time of certification. Any substantive change in design requires a modification through the same licensing process.

Timely, integrated review and decision-making across multiple agencies for permits should be required, such as:

- Where no time restriction exists today, the regulations should be amended to require federal agencies complete their permit reviews and decision-making responsibilities within specific periods.
- The time and scope of Requests for Information should be limited, and the time between receipt and response mandated.

Collaboration between the regulating authorities and the industry, in particular technical and standards committees, should be increased to improve timeliness and effectiveness of regulations, such as:

- Government agencies should participate as observers in the process of developing new and updating existing standards, to facilitate knowledge transfer and timely incorporation of new technology and practices, such as the Norwegian Petroleum Safety Authority, described earlier.
- The agencies should consider adopting updated documents much faster into the regulations or revisiting the procedure that would allow these documents to be cited as "the latest edition" rather than having to state the exact edition of the document.

Regulatory authorities should participate as independent observers in Joint Industry Projects, and continue to participate in oil spill response exercises, including those in other jurisdictions, to promote public confidence.

Regulatory authorities should grant permits for controlled experimental oil spill exercises in U.S. waters.

Prior to issuing specific permits, the industry and regulator should separately and together engage with the communities and the general public, to promote improved understanding and public confidence that activities can be conducted safely and with care for the environment.

Improve Lease Term Competitiveness

The 10-year primary lease term should be lengthened based on the Arctic working season and extended timelines for operating in an ice environment.

The exploration phase should be separated from the development phase and additional time allowed to evaluate a discovery.

For OCS leases, "suspensions of operations" (extensions to the lease term) should be granted for non-working time: weather, permitting or approval delays, wildlife management, litigation, and other periods when the lessee is prohibited from operating on their lease/unit.

- For existing OCS leases, a regulatory policy should be established to reliably grant these extensions under existing least terms.
- For new OCS leases, suspensions of primary lease terms to address Arctic operations and permit conditions should be stipulated in the lease itself when issued.
- These extensions should be durable through administration changes.

The Department of the Interior should use its existing authority to allow for Arctic OCS leasing of "economically productive units" greater in size than the current 5,760-acre lease tract limitation. Larger tract sizes could be offered at future OCS Arctic lease sales using one of the existing bidding systems found under Section 8 (a)(1) of the OCS Lands Act.

Arctic OCS lease sales should be included in all Five-Year Leasing Programs and held at regular intervals, to promote certainty for effective exploration and development planning.

Improve Infrastructure

Local, state, and federal agencies should coordinate infrastructure planning across industries by developing and maintaining integrated scenarios and plans.

- Agencies should conduct activities to gather information and identify mutual needs such as airfields, ports, roads, and communications, and opportunities for investment synergies.
- Local stakeholders and the oil and gas industry should be included.

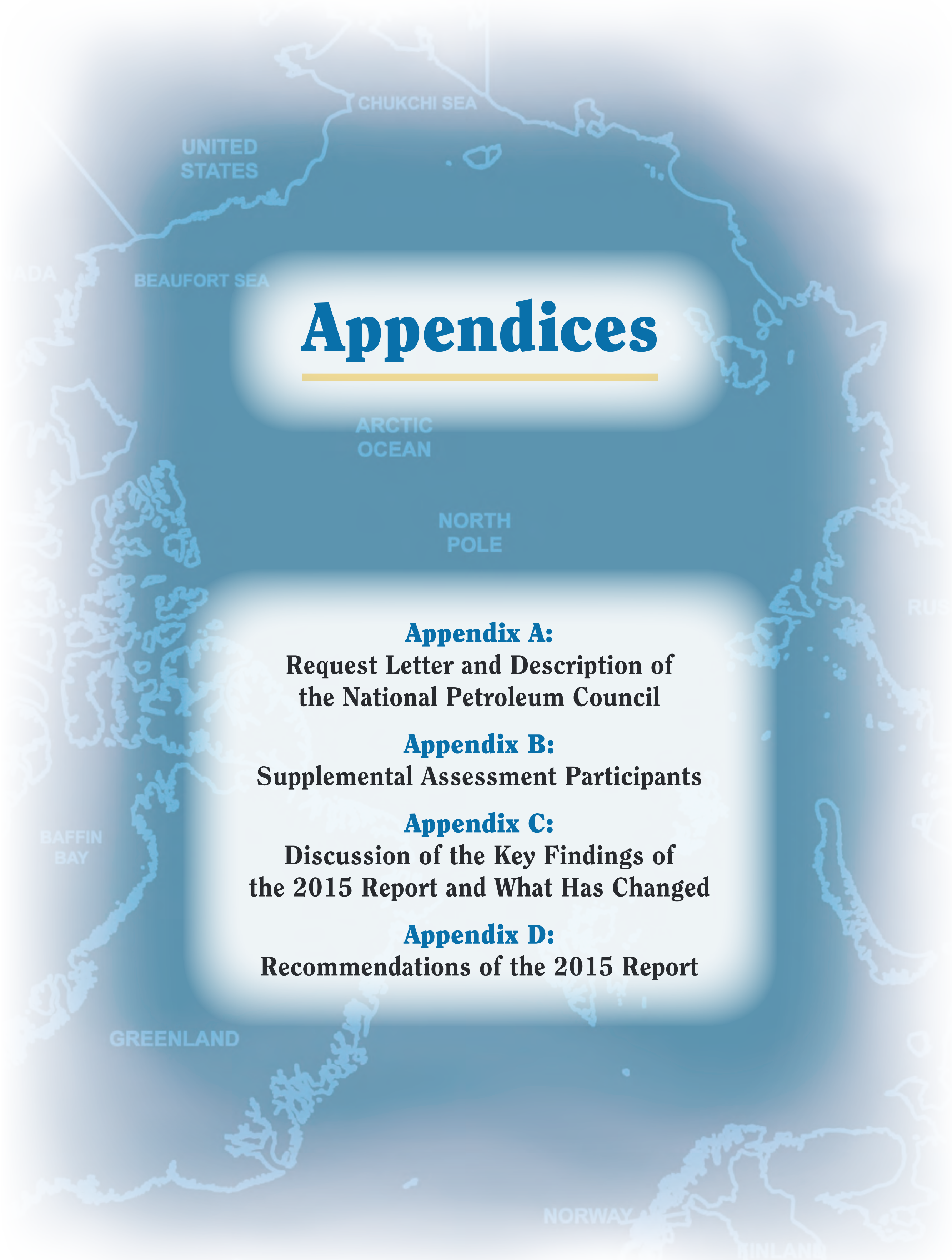
- The process should be initiated by the Department of the Interior coordinating a workshop with the relevant parties.

The U.S. Army Corps of Engineers should conduct an Alaska deep draft marine port study for north and northwest Alaska.

The U.S. Coast Guard icebreaker fleet and presence should be expanded.

All stakeholders should work with FAA to support use of unmanned aircraft in the Arctic for all phases of oil and natural gas development.

Enactment of these recommendations will improve the safety and environmental stewardship of Alaska operations, increase the competitiveness of Alaska resources, and increase the energy security of the United States.



Appendices

Appendix A:
Request Letter and Description of the National Petroleum Council

Appendix B:
Supplemental Assessment Participants

Appendix C:
Discussion of the Key Findings of the 2015 Report and What Has Changed

Appendix D:
Recommendations of the 2015 Report

The Secretary of Energy
Washington, DC 20585

August 29, 2018

Mr. Greg L. Armstrong
Chair
National Petroleum Council
1625 K Street, NW
Washington, DC 20006

Dear Mr. Armstrong:

In accordance with Executive Order 13795, entitled *Implementing an America-First Offshore Energy Strategy*, the Department of the Interior (DOI) has initiated review of several regulations that currently impact Arctic offshore oil and gas development scenarios. In light of the National Petroleum Council (NPC) comprehensive 2015 report, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, and possible new insights on Arctic oil and gas resources, technology and operations, the Administration would like the NPC's updated views on Arctic oil and gas development.

Accordingly, I request NPC undertake a supplemental assessment considering recent exploration experience and technological advancements or other new insights related to Arctic offshore oil and gas development that could inform government decision making. In particular, NPC should provide its views on whether our Nation's regulatory environment could be enhanced to improve reliability, safety, efficiency, and environmental stewardship.

Key areas to be addressed include:

- Regulatory burdens associated with U.S. Arctic Outer Continental Shelf development;
- Arctic lease terms;
- Arctic oil spill response technologies, including recent research conducted in Norway; and,
- Infrastructure associated with offshore Arctic development, including onshore linkages.

For the purposes of this review, I am designating Under Secretary of Energy Mark Menezes to represent me. He will provide the necessary coordination between the Department of Energy (DOE), DOI, and other government agencies with the National Petroleum Council. Mr. Steven Winberg, DOE's Assistant Secretary for Fossil Energy, will work with Under Secretary Menezes to provide needed government participation.

DOI Secretary Ryan Zinke has designated Mr. Joseph Balash, Assistant Secretary for Land and Minerals Management, and Ms. Katharine MacGregor, Principal Deputy, to assist in coordination with the Department of the Interior.

Sincerely,

Rick Perry

Rick Perry

DESCRIPTION OF THE NATIONAL PETROLEUM COUNCIL

In May 1946, the President stated in a letter to the Secretary of the Interior that he had been impressed by the contribution made through government/industry cooperation to the success of the World War II petroleum program. He felt that it would be beneficial if this close relationship were to be continued and suggested that the Secretary of the Interior establish an industry organization to advise the Secretary on oil and natural gas matters. Pursuant to this request, Interior Secretary J. A. Krug established the National Petroleum Council (NPC) on June 18, 1946. In October 1977, the Department of Energy was established and the Council was transferred to the new department.

The purpose of the NPC is solely to advise, inform, and make recommendations to the Secretary of Energy on any matter requested by the Secretary, relating to oil and natural gas or the oil and gas industries. Matters that the Secretary would like to have considered by the Council are submitted in the form of a letter outlining the nature and scope of the study. The Council reserves the right to decide whether it will consider any matter referred to it.

Reports previously issued by the NPC in response to requests of the Secretary include:

- *Emergency Preparedness Implementation Addendum* (2016)
- *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources* (2015)
- *Enhancing Emergency Preparedness for Natural Disasters* (2014)
- *Advancing Technology for America's Transportation Future* (2012)
- *Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources* (2011)
- *One Year Later: An Update on Facing the Hard Truths about Energy* (2008)
- *Facing the Hard Truths about Energy: A Comprehensive View to 2030 of Global Oil and Natural Gas* (2007)
- *Observations on Petroleum Product Supply* (2004)
- *Balancing Natural Gas Policy – Fueling the Demands of a Growing Economy* (2003)
- *Securing Oil and Natural Gas Infrastructures in the New Economy* (2001)
- *U.S. Petroleum Refining – Assuring the Adequacy and Affordability of Cleaner Fuels* (2000)
- *Meeting the Challenges of the Nation's Growing Natural Gas Demand* (1999)
- *U.S. Petroleum Product Supply – Inventory Dynamics* (1998)
- *Issues for Interagency Consideration – A Supplement to the NPC Report: Future Issues* (1996)
- *Future Issues – A View of U.S. Oil & Natural Gas to 2020* (1995)
- *Research, Development, and Demonstration Needs of the Oil and Gas Industry* (1995).

The NPC does not concern itself with trade practices, nor does it engage in any of the usual trade association activities. The Council is subject to the provisions of the Federal Advisory Committee Act of 1972.

Members of the National Petroleum Council are appointed by the Secretary of Energy and represent all segments of the oil and gas industries and related interests. The NPC is headed by a Chair and a Vice Chair, who are elected by the Council. The Council is supported entirely by voluntary contributions from its members.

Additional information on the Council's origins, operations, and reports can be found at www.npc.org.

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2018/2019

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Greg A. Arnold	Chairman and Chief Executive Officer	The Arnold Companies
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Jeffrey A. Bruner	President	Iroquois Pipeline Operating Company
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Robert B. Catell	Chairman Advanced Energy Research and Technology Center	Stony Brook University
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Trammell S. Crow	Founder	EarthX
Bruce Culpepper	Former President	Shell Oil Company
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David E. Dismukes	Executive Director Center for Energy Studies College of the Coast & Environment	Louisiana State University
Timothy L. Dove	Former President	Pioneer Natural Resources Company
Laurence M. Downes	Chairman of the Board and Chief Executive Officer	New Jersey Resources Corporation
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Randy A. Foutch	Chairman and Chief Executive Officer	Laredo Petroleum, Inc.
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David L. Goldwyn	President and Founder	Goldwyn Global Strategies, LLC
Joseph W. Gorder	Chairman, President and Chief Executive Officer	Valero Energy Corporation
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James T. Hackett	Partner	Riverstone Holdings LLC
Michael E. Haefner	President and Chief Executive Officer	Atmos Energy Corporation
Karen Alderman Harbert	Former President and Chief Executive Officer Global Energy Institute	U.S. Chamber of Commerce
John A. Harju	Vice President for Strategic Partnerships Energy & Environmental Research Center	University of North Dakota
Marilu Hastings	Vice President, Sustainability Program	Cynthia and George Mitchell Foundation
John B. Hess	Chief Executive Officer	Hess Corporation
Jack D. Hightower	Chairman, President and Chief Executive Officer	HighPeak Energy
Stephen L. Hightower	President and Chief Executive Officer	Hightowers Petroleum Co.
Jeffery D. Hildebrand	Executive Chairman and Founder	Hilcorp Energy Company
Steven B. Hinchman	President and Chief Executive Officer	Scala Energy LLC
John D. Hofmeister	Founder and Chief Executive Officer	Citizens for Affordable Energy, Inc.
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Hillard G. Huntington	Executive Director Energy Modeling Forum	Stanford University

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John Krenicki, Jr.	Senior Operating Partner	Clayton, Dubilier & Rice, LLC
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David L. Lamp	Chief Executive Officer and President	CVR Energy, Inc.
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Andrew N. Liveris	Former Chairman and Chief Executive Officer	The Dow Chemical Company
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D. Nathan Meehan	2016 President	Society of Petroleum Engineers
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Julie J. Robertson	Chairman of the Board, President and Chief Executive Officer	Noble Corporation plc
Matthew C. Rogers	Senior Partner	McKinsey & Company, Inc.
Matthew K. Schatzman	President and Chief Executive Officer	NextDecade Corporation
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Berry H. Tew, Jr.	State Geologist of Alabama Oil and Gas Supervisor Geological Survey of Alabama	State of Alabama
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Lee M. Tillman	President and Chief Executive Officer	Marathon Oil Corporation
Scott W. Tinker	Director, Bureau of Economic Geology and State Geologist of Texas Jackson School of Geosciences	The University of Texas
William Paschall Tosch	Global Co-Head Oil & Gas Investment Banking	J.P. Morgan Securities LLC

H. A. True, III	Partner	True Oil LLC
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Frank A. Verrastro	Senior Vice President and Trustee Fellow Energy and National Security Program	Center for Strategic & International Studies
Bruce H. Vincent	Chief Executive Officer	Vincent & Company
Patricia K. Vincent-Collawn	Chairman, President and Chief Executive Officer	PNM Resources, Inc.
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John W. Wallace	Chairman and Chief Executive Officer	DeGolyer and MacNaughton
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J. Robinson West	Managing Director Center for Energy Impact	The Boston Consulting Group
Craig E. White	President and Chief Executive Officer	Philadelphia Gas Works
William H. White	Chairman	Lazard Freres & Co. LLC
Elizabeth J. Wilson	Director, Arthur L. Irving Institute for Energy and Society Professor of Environmental Studies	Dartmouth College
Mary Jane Wilson	President and Chief Executive Officer	WZI Inc.
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George M. Yates	President and Chief Executive Officer	HEYCO Energy Group, Inc.
Daniel H. Yergin	Vice Chairman	IHS Markit

Appendix B

Supplemental Assessment Participants

STUDY PARTICIPATION

Study group participants contributed in a variety of ways, ranging from work in all study areas, to involvement on a specific topic, or to reviewing proposed materials. Involvement in these activities should not be construed as endorsement or agreement with all the statements, findings, and recommendations in this report. Additionally, while U.S. government participants provided significant assistance in the identification and compilation of data and other information, they did not take positions on the study's policy recommendations.

As a federally appointed and chartered advisory committee, the National Petroleum Council is solely responsible for the final advice provided to the Secretary of Energy. However, the Council believes that the broad and diverse study group participation has informed and enhanced its study and advice. The Council is very appreciative of the commitment and contributions from all who participated in the process.

This appendix lists the individuals who served on this study's Steering Committee, Coordinating Subcommittee, and Writing Team, and participated in the study's technical workshop, as a recognition of their contributions. Their time, energy, and commitment significantly enhanced the study and their contributions are greatly appreciated.

LIST OF STUDY GROUPS

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J. Larry Nichols	Vice Chair	National Petroleum Council

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SECRETARY

Marshall W. Nichols	Executive Director	National Petroleum Council

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David T. Seaton	Chairman of the Board and Chief Executive Officer	Fluor Corporation
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Gretchen H. Watkins†	President	Shell Oil Company
Michael K. Wirth	Chairman of the Board and Chief Executive Officer	Chevron Corporation

* Replaced Andrew T. Mack in November 2018; Appointment to the NPC is pending.

† Replaced Bruce Culpepper in December 2018; Appointment to the NPC is pending.

COORDINATING SUBCOMMITTEE

CHAIR

Carol J. Lloyd	Senior Strategy Advisor	Exxon Mobil Corporation

ASSISTANT CHAIR

Douglas S. Hoyt	Upstream Advisor	ExxonMobil Production Company

DOE GOVERNMENT COCHAIR

Steven E. Winberg	Assistant Secretary for Fossil Energy	U.S. Department of Energy

DOI GOVERNMENT COCHAIR

Katharine S. MacGregor	Deputy Chief of Staff Office of the Secretary	U.S. Department of the Interior

ALTERNATE GOVERNMENT COCHAIR

Shawn Bennett	Deputy Assistant Secretary, Office of Oil and Natural Gas, Office of Fossil Energy	U.S. Department of Energy

SECRETARY

John H. Guy, IV	Deputy Executive Director	National Petroleum Council

ALTERNATE SECRETARY

James A. Slutz	Director Study Operations	National Petroleum Council

MEMBERS

Heather A. Conley	Senior Vice President for Europe, Eurasia, and the Arctic	Center for Strategic & International Studies
J. Keith Couvillion	Land Consultant	Chevron Corporation
John M. Dabbar	Vice President, Federal and State Government Affairs	ConocoPhillips Company
Daniel D. Domeracki	Vice President Government, Industry Relations and Corporate Stewardship	Schlumberger Limited
Charles K. Ebinger	Nonresident Senior Fellow Global Energy Center	Atlantic Council
Thomas R. Eizember	Consultant	Eizember Consulting LLC
Corri Ann Feige*	Commissioner, Department of Natural Resources	State of Alaska
Richard K. Glenn	Executive Vice President Government and External Affairs	Arctic Slope Regional Corporation
David L. Goldwyn	President and Founder	Goldwyn Global Strategies LLC
Jon Harrison	Senior Advisor, Oceans and International Environmental and Scientific Affairs	U.S. Department of State

* Replaced Andrew T. Mack in November 2018

Bradley C. Hoffman	General Manager Exploration	Chevron Corporation
Teresa Imm	Executive Vice President Regional & Resource Development	Arctic Slope Regional Corporation
Nancy L. Johnson	Senior Advisor, Environmental Science and Policy Analysis	U.S. Department of Energy
Sara W. Longan*	Deputy Commissioner, Department of Natural Resources	State of Alaska
Jan W. Mares	Senior Policy Advisor	Resources for the Future
Drue Pearce	Deputy Administrator, Pipeline and Hazardous Materials Safety Administration	U.S. Department of Transportation
David Sackett	Vice President, Project Director	Fluor Corporation
Cam Toohey	Director, State and Government Relations Americas	Shell Oil Company
Peter K. Velez	President	Peter Velez Engineering LLC
Foster L. Wade	Manager Public and Regulatory Affairs	Equinor US

* Served until December 2018 as Executive Director, North Slope Science Initiative, Bureau of Land Management, U.S. Department of the Interior.

WRITING TEAM

LEAD

Thomas R. Eizember	Consultant	Eizember Consulting LLC

MEMBERS

Shawn Bennett	Deputy Assistant Secretary, Office of Oil and Natural Gas, Office of Fossil Energy	U.S. Department of Energy
Susan Childs	Upstream Americas Regulatory Policy and Advocacy Manager	Shell Exploration and Production Company
J. Keith Couvillion	Land Consultant	Chevron Corporation
Daniel D. Domeracki	Vice President Government, Industry Relations and Corporate Stewardship	Schlumberger Limited
Richard K. Glenn	Executive Vice President Government and External Affairs	Arctic Slope Regional Corporation
John H. Guy, IV	Deputy Executive Director	National Petroleum Council
Douglas S. Hoyt	Upstream Advisor	ExxonMobil Production Company
Teresa Imm	Executive Vice President Regional & Resource Development	Arctic Slope Regional Corporation
Catherine Jahre-Nilsen	Senior Advisor, Equinor Arctic	Equinor ASA
Nancy L. Johnson	Senior Advisor, Environmental Science and Policy Analysis	U.S. Department of Energy
Carol J. Lloyd	Senior Strategy Advisor	Exxon Mobil Corporation
Sara W. Longan*	Deputy Commissioner, Department of Natural Resources	State of Alaska
Katharine S. MacGregor	Deputy Chief of Staff, Office of the Secretary	U.S. Department of the Interior
James A. Slutz	Director of Study Operations	National Petroleum Council
Peter K. Velez	President	Peter Velez Engineering LLC

ASSISTANTS

Bargo Adibhatla	Energy Advisor, Strategic Planning	Exxon Mobil Corporation
Tyler Janowski	Regulatory Coordinator	Arctic Slope Regional Corporation
Matthew Waters	Drilling Manager – Regulatory Affairs and Issues Management Team	ExxonMobil Development Company

* Served until December 2018 as Executive Director, North Slope Science Initiative, Bureau of Land Management, U.S. Department of the Interior.

TECHNICAL WORKSHOP PARTICIPANTS

Don Armijo*	Chief Executive Officer and Chief Operating Officer	Marine Well Containment Company, LLC
Bargo Adibhatla	Energy Advisor, Strategic Planning	Exxon Mobil Corporation
Adm. (ret.) Thomas J. Barrett	President	Alyeska Pipeline Service Company
Randal Buckendorf	Managing Counsel	BP Alaska
Susan Childs	Upstream Americas Regulatory Policy and Advocacy Manager	Shell Exploration and Production Company
J. Keith Couvillion	Land Consultant	Chevron Corporation
John J. Crowther†	Director of State and Federal Relations	State of Alaska
Daniel D. Domeracki	Vice President Government, Industry Relations and Corporate Stewardship	Schlumberger Limited
Thomas R. Eizember	Consultant	Eizember Consulting LLC
Karl D. Fennessey	Manager, Corporate Public Policy	ConocoPhillips Company
Jason Gahr	Drilling Manager, ExxonMobil Permian Development Team (formerly Drilling Operations Manager, Kara Sea Program)	XTO Energy, a division of ExxonMobil
Richard K. Glenn	Executive Vice President Government and External Affairs	Arctic Slope Regional Corporation
Matthew D. Givens	Business Development Manager Pressure Control Systems	Cameron, a Schlumberger Company
Whitney Grande	Vice President Safety, Environment & Quality	Eni US Operating Co., Inc.
John H. Guy, IV	Deputy Executive Director	National Petroleum Council
Dennis Henderson	Vice President, Land	Repsol USA
Bradley C. Hoffman	General Manager Exploration	Chevron Corporation
Doug Hoyt	Upstream Advisor	Exxon Mobil Production Company
Teresa Imm	Executive Vice President Regional & Resource Development	Arctic Slope Regional Corporation
Catherine Jahre-Nilsen	Senior Advisor, Equinor Arctic	Equinor ASA
Nancy L. Johnson	Senior Advisor, Environmental Science and Policy Analysis	U.S. Department of Energy
Carol J. Lloyd	Senior Strategy Advisor	Exxon Mobil Corporation
Roy Long	Technology Manager, Offshore Oil and Gas, Office of Science & Technology	U.S. Department of Energy/ NETL
Sara W. Longan‡	Deputy Commissioner, Department of Natural Resources	State of Alaska

* Participated in DOE AND DOI briefings but not in the October 31-November 1 Workshop.

† Served in this position until January 2019.

‡ Served until December 2018 as Executive Director, North Slope Science Initiative, Bureau of Land Management, U.S. Department of the Interior.

TECHNICAL WORKSHOP PARTICIPANTS

Mario Lugo	Chairman and Chief Executive Officer	Trendsetter Engineering, Inc.
Katharine S. MacGregor	Deputy Chief of Staff, Office of the Secretary	U.S. Department of the Interior
Barton W. Marcois	Consultant	National Petroleum Council
William Lee Majors	Planning and Development Manager	Alaska Clean Seas
Jan W. Mares	Senior Policy Advisor	Resources For The Future
Kenneth B. Medlock III	James A. Baker III and Susan G. Baker Fellow in Energy and Resource Economics, and Senior Director, Center for Energy Studies, James A. Baker III Institute for Public Policy	Rice University
Elena Melchert	Director, Upstream Research Division, Office of Oil and Natural Gas, Office of Fossil Energy	U.S. Department of Energy
Timothy J. Nedwed	Oil Spill Response Senior Technical Professional Advisor	ExxonMobil Upstream Research Company
Marshall W. Nichols	Executive Director	National Petroleum Council
Barbara T. Parker	Energy Management Science and Advocacy Manager	Shell Exploration and Production Company
Drue Pearce	Deputy Administrator, Pipeline and Hazardous Materials Safety Administration	U.S. Department of Transportation
Cole W. Ramsey	Policy Advisor	American Petroleum Institute
Rayssa Sanchez	Engineer	ExxonMobil Development Company
Peter E. Slaiby	Managing Director	Quartz Upstream
James A. Slutz	Director Study Operations	National Petroleum Council
Cam Toohey	Director, State and Government Relations, Americas	Shell Oil Company
Peter K. Velez	President	Peter Velez Engineering LLC
Foster L. Wade	Manager Public and Regulatory Affairs	Equinor US
Eric Washburn	President and Chief Executive Officer	Windward Strategies
Matthew Waters	Drilling Manager – Regulatory Affairs and Issues Management Team	ExxonMobil Development Company
Eric Whatley	Drilling Superintendent, Deepwater (former Drilling Superintendent, Shell's Beaufort 2012 drilling campaign, and Chukchi 2015 drilling campaign)	Shell Exploration and Production Company
Mitchell Winkler	Arctic Oil and Gas Consultant	Houston, Texas

Appendix C

Discussion of the Key Findings of the 2015 Report and What Has Changed

This Supplemental Assessment concludes that all of the key findings of the 2015 report remain valid and, in many cases, have been strengthened by technology advancements and operational experience since the 2015 report. This Appendix C briefly summarizes the key findings of the 2015 report and highlights changes and advancements since then. The 2015 Executive Summary and full 2015 report are available on the NPC's website.[1]

KEY FINDINGS OF THE 2015 REPORT

1. Arctic oil and gas resources are large and can contribute significantly to meeting future U.S. and global energy needs.
2. The Arctic environment poses some different challenges relative to other oil and gas production areas, but is generally well understood.
3. The oil and gas industry has a long history of successful operations in Arctic conditions enabled by continuing technology and operational advances.
4. Most of the U.S. Arctic offshore conventional oil and gas potential can be developed using existing field-proven technology.
5. The economic viability of U.S. Arctic development is challenged by operating conditions and the need for updated regulations that reflect Arctic conditions.
6. Realizing the promise of Arctic oil and gas requires securing public confidence.
7. There have been substantial recent technology and regulatory advancements to reduce the potential for and consequences of a spill.

2015 Report Finding 1 – Arctic Oil and Gas Resources are Large and Can Contribute Significantly to Meeting Future U.S. and Global Energy Needs

The Arctic can be defined as areas north of the Arctic Circle, as shown in Figure C-1, reprinted from the 2015 report. The United States, Canada, Russia, Kingdom of Denmark (Greenland), and Norway all have coastlines within this region.[2] Oil and gas activities in the Arctic have resulted in production of over 30 billion barrels of liquids and 650 trillion cubic feet of natural gas.[3]

The 2015 report identified an estimated reserve base of 38 billion barrels of hydrocarbon liquids and 920 trillion cubic feet of natural gas, plus an additional 525 BBOE[4] of conventional resource potential, as shown in Figure C-2, reprinted from the 2015 report. Much of the resource potential is in Russia, but the U.S. and Russia have nearly equivalent amounts of oil potential.

Globally, offshore Arctic exploration has continued since 2015, with 47 additional exploration wells drilled safely and successfully to their objective. Much of this exploration drilling was in Norway's

1 National Petroleum Council, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, 2015, www.npcarcticpotentialreport.org.

2 The main island of Iceland is not in the Arctic Circle, but a small island off its north coast straddles the Arctic Circle.

3 IHS Markit, EDIN database and technical reports by the Plays and Basins service.

4 Billion barrels of oil or oil-equivalent for gas; 6,000 cubic feet of gas is equivalent to one barrel of oil.

Figure C-1. *Arctic Circle Circumpolar Map*

South Barents concession area with 28 wells drilled. Exploration activity in the South Barents is aided by the area being predominantly ice free all year, long lease terms, and favorable tax incentives. Off Canada's Eastern coast, 16 exploration wells have been drilled, generally ice-free but contending with occasional icebergs. In the U.S. Arctic, only two wells have been drilled, one using a floating drilling rig during the open-water season and the other from an ice pad using a land rig. In the Russian Kara Sea, one well was drilled during the open-water season with a floating drilling rig.

Since the 2015 report, no comprehensive reassessment of U.S. or global resource potential has been completed. The exploration drilling noted above has led to announced discoveries of nearly 5.3 BBOE.[5] As shown in Figure C-3, the majority of this incremental discovered resource is located in U.S. waters. The largest single announced discovery since 2015 is also in the United States. The Tulimaniq discovery, in Alaskan state waters by Caelus Energy in 2016, has been assessed to contain about 2.7 BBOE.

5 From the IHS Markit EDIN database as of October 2018.

2015 Report Finding 2 – The Arctic Environment Poses Some Different Challenges Relative to Other Oil and Gas Production Areas, But is Generally Well Understood

The Arctic is a vast, remote, and integrated system, with a challenging and variable climate. The Arctic physical environment is unique, compared with other oil and gas jurisdictions, due to the presence of ice. The Arctic biological environment is host to a rich fabric of aquatic and land species, each dependent on the environmental niches in which they thrive. There is a significant population of indigenous peoples who live there and draw sustenance from the land and sea. The Arctic physical, biological, and human environment has been studied for many decades by indigenous peoples, the industry, government, and academia, and based on this research, it is generally well understood. The 2015 report found that sufficient data were available to support exploration. However, as acknowledged in the 2015 report, the climate is changing, and additional information on the expected impacts of climate change would

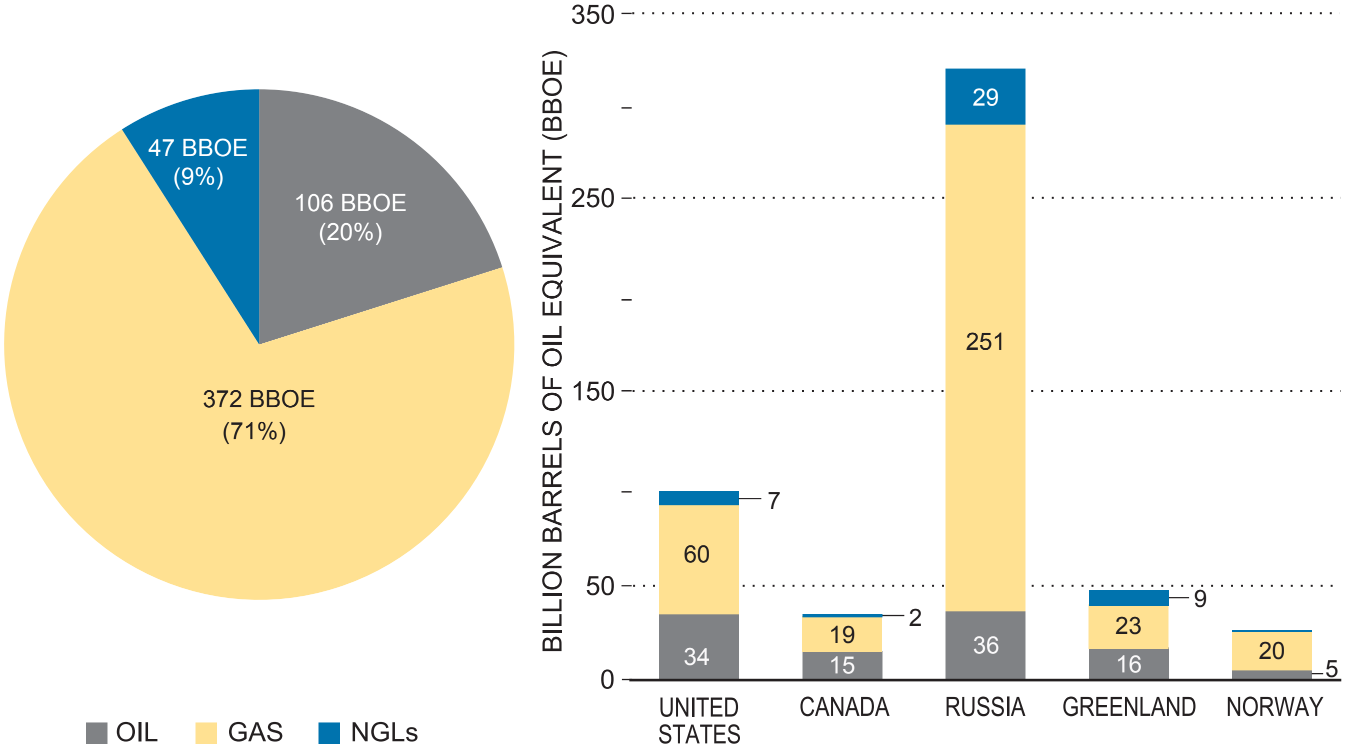
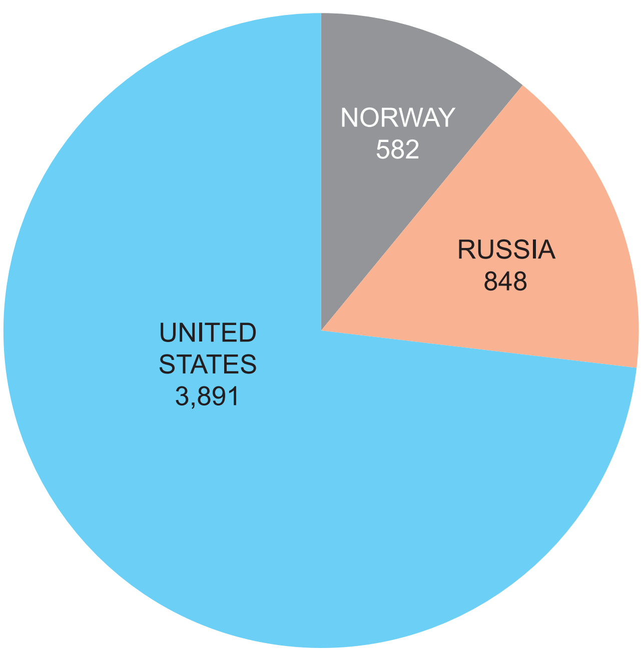


Figure C-2. *Global Arctic Resource Potential by Petroleum Type (Oil, Natural Gas, and NGLs) with Distribution by Country*



Source: IHS Markit, October 2018.

Figure C-3. *Total Recoverable Discovered Oil and Gas Resource from 2014*

be helpful to facilitate long-term development and secure public confidence.

The Arctic Physical Environment

Many aspects of the Arctic pose challenges similar to other oil and gas production areas, and experience and technologies from these other areas can be applied to Arctic development. There are three key physical characteristics of offshore Arctic environments that play a large role in determining the technologies that are applicable and the degree of complexity of operations. The dominant physical characteristic is ice type and abundance, but water depth and length of the open-water season also play key roles in differentiating one Arctic location from another in terms of applicable technologies and the economic prospects for development.

Ice Type and Abundance

In areas of the global Arctic that experience seasonal ice, Figure C-4 from the 2015 report depicts the gradation of ice conditions typically encountered from the shoreline to about 100 meters water

Source: Chevron.


Photo: NASA. Photo: ExxonMobil. Photo: ION Geophysical.

Figure C-4. *Typical Arctic Ice Regimes*

depth. Landfast ice can extend from the shoreline out to a depth of about 15 to 20 meters. Landfast ice freezes fast to the shoreline and is relatively stable throughout the winter until the summer break-up occurs. With thicknesses approaching 2 meters, it can provide a stable platform for drilling exploration wells, transporting materials and equipment, or supporting equipment to lay pipelines to shore for shallow water projects in the winter season. Beyond the edge of the landfast ice zone is floating pack ice of varying concentrations, which, depending on the season, might range from sparse coverage near the edge to complete coverage further into the pack.

Mobile pack ice consists of sea ice of varying age and thickness. Depending on location, there can also be inclusions of icebergs or drifting fragments of thick, multi-year shelf ice known as ice islands. The new ice that forms over the open water each winter is called first-year ice. It typically reaches a thickness of 1.5 to 2 meters over the winter season. Wind forces compress and break the ice sheet, forming thickened ridges and rubble fields. When these thickened areas refreeze, they can become the dominant features that impede icebreaker transit and can exert large forces on stationary platforms. Second-year ice is thickened ice that results from refreezing of surviving first-year ice from the previous season. Similarly, multi-year ice is built up from multiple freeze cycles of previous years of second-, third-, etc.-year ice. Multi-year ice can range in thickness from approximately 3 meters to more than 6 meters.

Icebergs are large pieces of fresh-water ice that break off from glaciers and drift with sea currents. Icebergs are nearly nonexistent in the U.S. Arctic due to the lack of large glaciers terminating in the nearby ocean. While relatively rare, the U.S. Arctic does contain ice island features, which are thick tabular masses of ice that break off from Canadian ice shelves and drift with the pack.

Water Depth

Water depth within the world's prospective Arctic oil and gas basins varies from zero to more than a thousand meters. Most of the U.S. Arctic offshore oil and gas potential lies in water depths of less than 100 meters. The Russian Arctic shelf is also broad and shallow, with a large fraction of the area lying in water depths less than 100 meters. Water depths offshore Arctic Canada and Greenland, on the other hand, fall off to more than 100 meters closer to shore.

Water depth predominantly impacts the type of drilling and production platforms that can be used and whether offshore wellheads and pipelines require burial to protect them from being damaged by moving icebergs that extend to the seafloor. Developments in ice-prone water depths less than about 100 meters are amenable to well-established technology of structures resting on the seafloor ("bottom-founded"). Beyond about 100 meters, a technology transition from bottom-founded to floating platforms may be required because the overturning forces of the floating ice become too large for practically sized bottom-founded structures. Unlike for temperate waters, where floating drilling facilities are routinely used in thousands of meters of water, suitable technology to allow year-round floating drilling in Arctic pack ice will require additional development before commercial use.

Open-Water Season

In addition to ice conditions and water depth, the length of the open-water season – the time without ice coverage – has a significant impact on the types of technologies that can be used for exploration and development. The length of the open-water season can vary considerably from year to year. Over most of the U.S. Chukchi Sea lease area, the average open-water season is about 3 to 4 months long. Mid-season incursions of pack ice from the north can occur, potentially interrupting operations. In the correspondingly shallow shelf areas of the U.S. Beaufort Sea, the open-water season is typically 1 to 1.5 months shorter than in the Chukchi Sea, and can also be interrupted by pack ice intrusions. Access into the Beaufort Sea at the start of the open-water season can be impeded by high ice concentrations at Point Barrow, restricting the usable operating window in some years.

If the open-water season is 3 months or more, it can be possible to complete the drilling of an exploration well in a single season using conventional technology that would be used in any open-water setting. Shorter open-water seasons or deeper reservoirs can require multiple seasons to complete a single well, resulting in much higher costs for exploratory drilling. Installing production facilities becomes more challenging with increasing costs as the open-water season decreases. For example, 3 months can provide sufficient time for installation of platforms and pipelines, while shorter open-water periods can necessitate special measures such as ice management or multiple season work for platform installation and pipeline construction.

On either side of the open-water season, there are periods of summer ice break-up/melting and fall-to-early-winter freeze-up where some ice can be present at a drilling location. These periods are often referred to as the "shoulder" seasons, because ice coverage is reduced and the ice is either receding or newly forming. Past Arctic exploration drilling programs have successfully extended operations into the shoulder seasons by using ice management to break or guide away approaching ice that might otherwise interfere with the rig's ability to stay in place over the well ("station-keeping"). The ability to operate safely in the shoulder season depends on the capability of the drilling rig and ice management vessels to safely contend with ice. In previous Canadian Beaufort Sea drilling programs using the Kulluk drilling rig, the summer shoulder season could begin as early as late June or early July, and the winter shoulder season could extend into November or even early December. Beyond about mid-December, the ice cover becomes essentially continuous and thickness exceeds 0.7 meter. Extending the drilling season beyond mid-December would require robust station-keeping and ice management capability.

The Arctic Ecological Environment

A number of companies and government and international bodies have conducted assessments of the ecological science available to inform decisions in the Arctic. These assessments conclude that there is a substantial amount of information available for Arctic ecological resource management and oil/gas resource development while protecting the environment.

Humans have observed and studied the seasonal patterns of the physical environment and the biological inhabitants of the Arctic for thousands of years. Current ecological understanding of the Alaskan Arctic, aided by Alaska Native traditional knowledge, has been driven by basic scientific inquiry supported through academia, government institutions, nongovernmental organizations, and by various commercial endeavors, particularly oil and gas exploration and development. Alaska Native traditional knowledge is a practical knowledge base founded upon personal experience and observation of the environment. Traditional knowledge among the Iñupiat population has been handed down for millennia; early western knowledge was derived from the scientific curiosity of members of exploration teams looking for new global travel routes and potentially useful natural resources.

The species present in the U.S. Arctic continental shelf are well known, and the ecosystem processes that determine habitat characteristics and species distribution are increasingly well understood. For many key species, the populations, habitats, and migration patterns are also very well understood. For example, abundance and habitat use of birds in terrestrial areas of the North Slope are well documented. Aerial surveys in the Beaufort Sea have documented widespread use of the nearshore and offshore waters along most of the coastline and into the northern Chukchi Sea during the open-water period. Marine mammal populations of the Alaskan Arctic are some of the most intensively studied populations in the world, primarily because the importance of these species to Alaska Native cultures and subsistence activities and interest in oil and gas resources. As a result, a great deal is known about the life history, distribution, and behavior of marine mammals in the Alaskan Chukchi and Beaufort Seas.

In the 2015 report, the NPC noted that some additional information would improve the ability of trustee agencies (resource managers including U.S. Fish and Wildlife Service and U.S. National Marine Fisheries Service) to establish more effective management policies and to issue permits that protect ecological resources while accommodating exploration and development activities. For example, population estimates could be improved for a number of species, including the Arctic cod and other forage fish, Pacific walrus, four species of ice seals, polar bears in the Chukchi Sea, and beluga whale stocks. Without detailed population estimates and growth/decline trends, agencies are not well equipped to establish policies based on sound population biology and to respond to litigation challenges.

The Arctic Human Environment

The term "human environment" as used in this study means the physical, social, economic, and cultural aspects of local communities and how these aspects can be positively or negatively affected by oil and gas and other activities. Indigenous subsistence cultures of the North, such as the Inuit (Iñupiat), Yup'ik, and Chukchi, possess individual and community identities that are closely connected to hunting, distribution, and consumption of subsistence foods. The harvest of the bowhead whale by many coastal communities is a well-established example. Caribou, birds, fish, and plants are also valuable subsistence resources. Local stakeholders have concerns related to their ability to continue to utilize their environment sustainably.

The oil and gas industry has partnered with the local communities for many years to maximize the positive benefits and minimize or eliminate the negative impacts of oil and gas exploration and development. Positive economic impacts are significant, and in many cases, have enhanced subsistence practices by providing jobs and income, with a flexible work schedule to promote subsistence hunting and fishing. These are intertwined because money is necessary to purchase equipment, supplies, and fuel for harvesting subsistence resources. Oil and gas development in the Arctic is a major source of economic activity that supports the local economy.

The oil and gas industry has coordinated its activities with the whaling associations in North Slope villages to minimize disruption of subsistence activities. The Conflict Avoidance Agreement is one tool for communication and negotiation on topics such as subsistence hunt window, timing of operations, participation in communication centers, and other topics such as discharges. This negotiation and communication process is a conduit for bringing both traditional knowledge and western science together for the common purposes of protecting subsistence use while accommodating industry activities. While it is generally agreed by North Slope residents that oil and gas activity has improved their quality of life in many respects, the potential social effects of additional economic activity in the region are a common concern. These concerns include how increased economic activity could impact subsistence lifestyles, change the cultural and demographic makeup of villages, and increase reliance on outside resources. There is concern that a significant oil release could substantially affect subsistence lifestyles. A focus on safety and prevention of a major spill in the Arctic is the top priority for the oil and gas industry.

2015 Report Finding 3 – The Oil and Gas Industry Has a Long History of Successful Operations in Arctic Conditions Enabled by Continuing Technology and Operational Advances

Globally, the oil and gas industry has a long history of environmental stewardship and successful operations in the Arctic, including exploration, development, production, and transport, enabled by continuous technology advances and learnings from experience. Approximately 490 exploration wells have been drilled in Arctic waters, including 36 in the Alaskan OCS. Figure C-5 highlights some of the key technology and operational "firsts" in offshore Arctic conditions. Oil and gas activities in the global Arctic, onshore and offshore combined, have produced more than 25 billion barrels of liquids and 550 trillion cubic feet of natural gas.

Exploration drilling in Arctic conditions began just below the Arctic Circle at Norman Wells in the Canadian Northwest Territories in 1920, with production beginning in 1932. In 1985, the development was expanded to include six artificial islands designed to withstand seasonal water level changes and loads from ice floes. This field continues to produce today, with a long record of operations integrity while contending with challenges such as seasonal flooding, ice jams, ice scouring, and permafrost.

Most of the oil already produced from Alaska has come from the onshore North Slope Prudhoe Bay field, discovered in 1968 and on production in 1977. Specialized drilling and well designs were used to enable drilling through permafrost, and operating production facilities were designed for extreme climatic conditions. Oil from Prudhoe Bay is transported through the 800-mile Trans-Alaska Pipeline System, which incorporates multiple advancements including an innovative passive refrigeration system to avoid melting the permafrost and a zigzag configuration to allow for expansion and for movement in case of earthquakes. As onshore activity progressed, technology advancements such as horizontal and extended reach drilling allowed development with fewer and smaller drilling pads, reducing the environmental footprint.

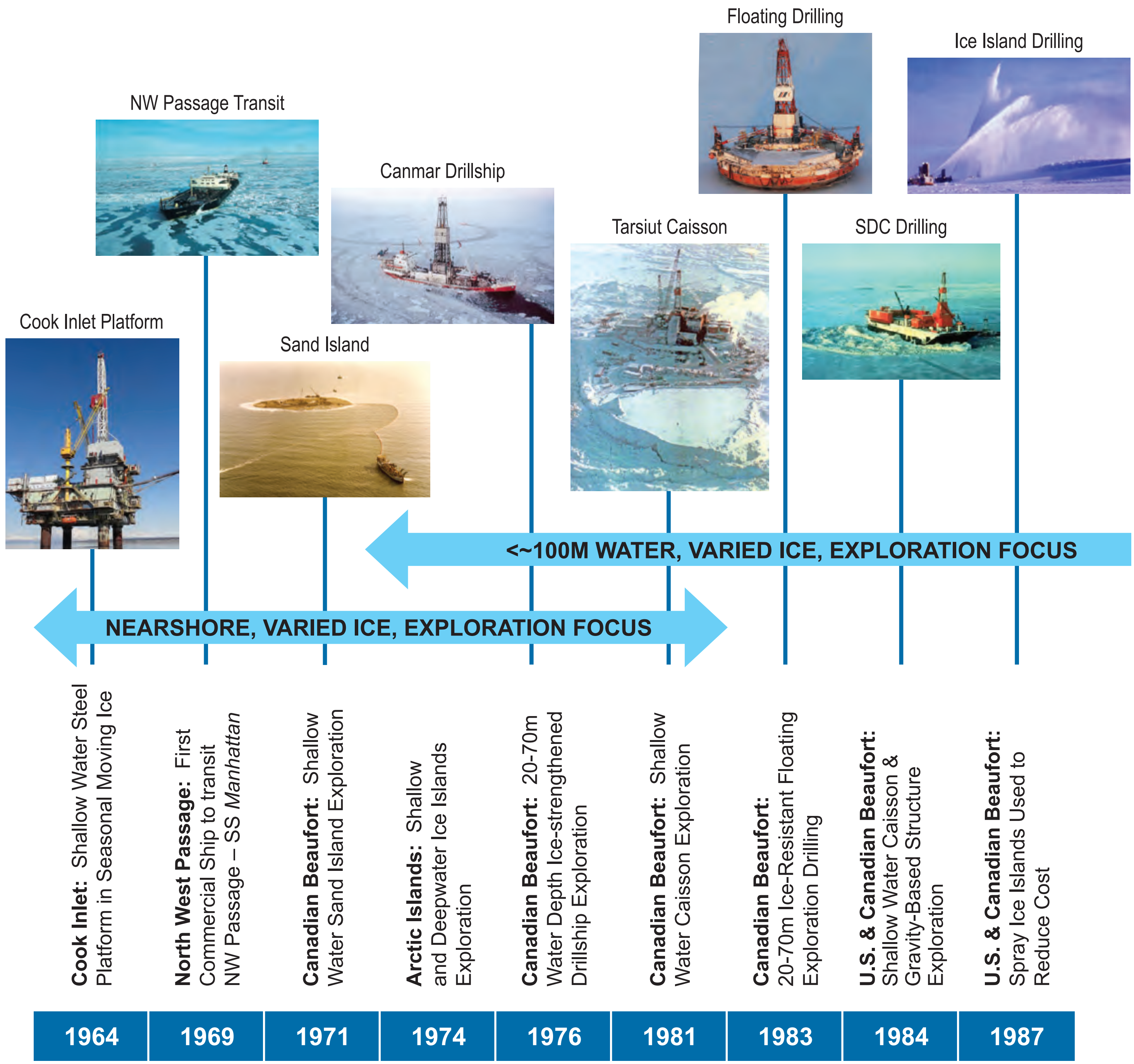
Since the 2015 report, 47 exploration wells have been drilled safely and successfully in the global Arctic offshore. Twenty-eight of these wells, including the world's most northerly well, Korpfjell, were drilled in Norway's South Barents concession area. The Goliath oil field started production in 2017 and the Aasta Hansteen gas field started production with the world's largest spar platform and the world's first offshore pipeline to cross the Arctic circle. In addition, the Johan Castberg oil field was sanctioned for development, Wisting and Alta Gohta are progressing concepts, and there have been significant new discoveries. The Norwegian state, institutions, and companies continue to focus on technologies and knowledge for the Arctic, with many large collaborative projects, to understand the ecosystem and develop beneficial technologies. In 2017, Equinor undertook a major research project using fully instrumented moored vessels in ice in the Bay of Bothnia, in order to calibrate existing best available tools to model ice loading.

One exploratory well was drilled by ExxonMobil in the Russian Kara Sea, during the open-water season using a floating drilling rig. That Kara Sea drilling experience is highlighted in a nearby text box. Enabling and demonstrated technologies are described, including an advanced ice detection and monitoring system, and a specialized subsea isolation device used in lieu of a standby capping stack or a same season relief well.

In the U.S. Arctic, two wells have been drilled. One was Shell's well in the Chukchi Sea, which used a floating drilling rig during the open-water season. The Chukchi Sea well experience is highlighted in a nearby text box. The other was drilled by Caelus in Smith Bay of the Beaufort Sea from a grounded ice pad using a land-based rig and extended reach drilling. In addition to these two wells, a third well in the Alaskan OCS is currently being drilled. ENI and its partners are targeting the Nikaitchuq prospect, located in shallow water just outside the state boundary. The well is being directionally drilled from a surface location located on the Spy Island permanent surface drilling site in Alaskan state waters.

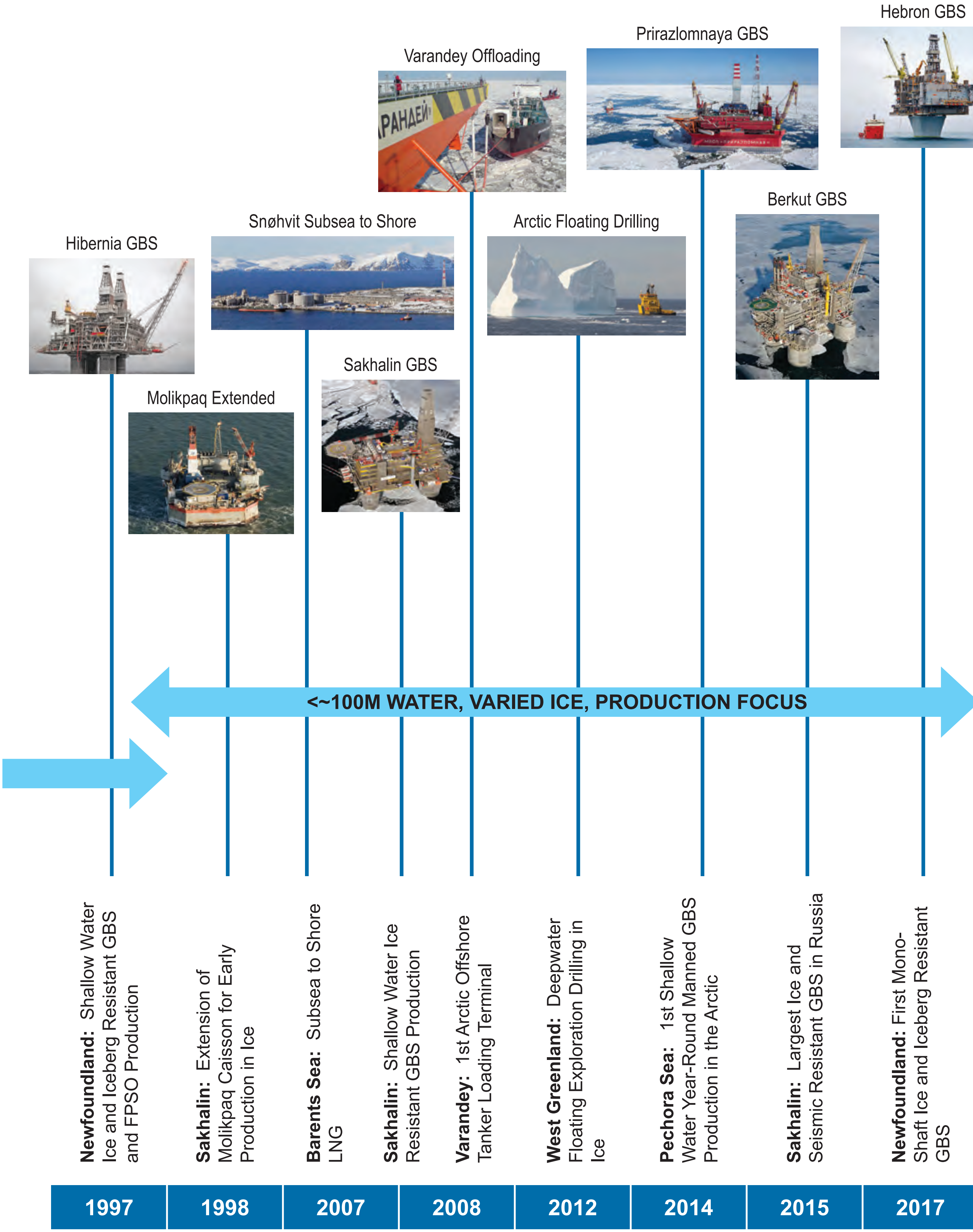
In addition to this offshore exploration activity, since the 2015 report, the North Slope of Alaska has seen activity both onshore and in state waters, including:

- June 2016 – Armstrong Oil and Gas and Repsol announce the "Nanushuk Discovery"



Photos, left to right: Cook Inlet platform - Hilcorp; NW Passage Transit - ExxonMobil; Sand Island - John Waring; Canmar Drillship - R. Pilkington; Tarsiut Caisson - G. Timco; Floating Drilling - Shell; SDC Drilling - G. Timco & I. Morin; Ice Island Drilling - BP – Amoco.

Figure C-5. *Key Developments in Offshore Arctic Conditions*



Photos, left to right: Hibernia GBS - ExxonMobil; Molikpaq Extended - Sakhalin Energy; Snøhvit Subsea to Shore - Statoil (Harald Pettersen); Sakhalin GBS - Sakhalin Energy; Varandey Offloading - MacGregor Pusnes AS; Arctic Floating Drilling - Viking; Prirazlomnaya GBS - Gazprom; Berkut GBS - ExxonMobil; Hebron GBS - ExxonMobil.

Figure C-5. *Key Developments in Offshore Arctic Conditions (continued)*

ExxonMobil Experience in the Russian Kara Sea

In August through October 2014, ExxonMobil drilled an exploratory well in the Kara Sea of the Russian Arctic. Well planning operations began in late 2011 and continued over the next three years. The objective was to develop a robust well design that could be drilled in a single season. To manage the risks in offshore Arctic drilling, the team had to develop robust plans, make equipment upgrades, and work closely with regulators.

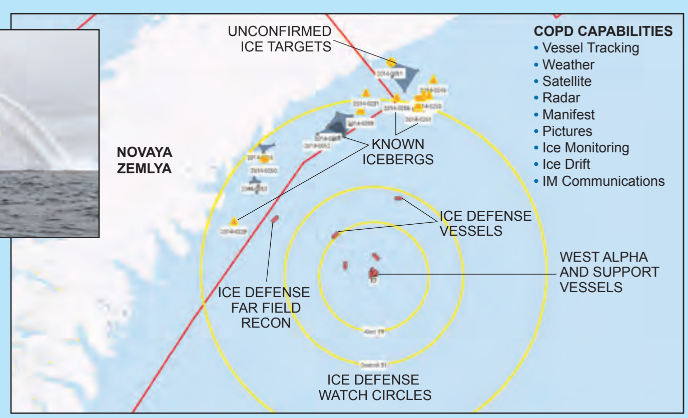
ExxonMobil selected a moored, Arctic-rated, semi-submersible rig for the work, the West Alpha. While the rig was already rated for the Arctic environment, it underwent a five-year classification inspection and Russian certification including targeted upgrades for personnel safety and ice defense. The upgrades included improved HVAC systems, a contained emergency egress system (MEES), and the ice defense common operating picture display (COPD). To facilitate efficient operation, the company used a five-vessel pre-mobilization fleet to pre-lay the rig anchors and other seafloor equipment in July 2014, before the open-water season. This activity required partnership with local authorities and extended the drilling days within a single season.

Two enabling technologies were deployed with close coordination with the regulator. First, the team developed an Ice Defense Strategy that tied a clear view of potential ice threats to risk-based decision-making. This strategy was simulated, tested, and upgraded using decades of real ice data and a simulated well-drilling exercise during the 2013 season. To provide this clear view, ExxonMobil brought together a combination of satellite, radar, and visual technologies into a COPD from the day the rig entered the area until departure. The COPD brought all this collective data to a single view that was discussed daily between the rig, ice defense fleet, and the field operations team in office. All satellite-imaged ice bodies were visually confirmed with a recon vessel. The display tracked the ice as it moved through a series of watch circles that determined pre-planned responses which were pre-approved by the regulator. Should it have been required, the team was prepared to intervene and tow ice bodies to protect rig operations and the environment. The Ice Defense Strategy and COPD enabled the drilling season to expand, or contract, based on actual ice conditions.

The second key technology that was deployed was a subsea isolation device (SSID). This system was developed to provide a pre-installed shut-in measure below the existing blowout preventer. The device is based on existing capping stack technology utilizing dual blind shear rams with an upgraded, redundant control system and side inlets for intervention below a closed cap. The SSID is ready to activate throughout the drilling process to provide a fast response to a worst-case well-control event or ice emergency, avoiding difficulties with deploying capping stacks in shallow water and minimizing the environmental impact of a spill. The system was designed with the well location in mind to preserve isolation in an emergency through the winter season and allow re-entry the following season. The SSID was successfully demonstrated for the regulator, and it was approved in lieu of a standby capping stack or same season relief well requirements.

West Alpha

Iceberg Water Cannon Training



Common Operating Picture Display (COPD)

Photos and graphic: ExxonMobil.

Shell Experience in the Chukchi Sea

During the 2015 Alaska Arctic open-water season, and for the first time in more than 20 years, Shell Offshore Inc. (Shell) executed an exploration drilling operation in the Chukchi Sea. Shell safely drilled into oil-bearing zones 134 miles Northwest of Barrow, Alaska, on the Burger Prospect in a single season. This was accomplished with no significant downtime events, no major Health, Safety, Security, and Environment (HSSE) incidents, and no environmentally significant issues. Shell's team safely managed two drill rigs (the Noble Discoverer and the Polar Pioneer) and three ice management/anchor handling vessels, with a well-integrated relationship among all supporting contractors. Furthermore, the Alaska Venture (including key teams such as Exploration, Logistics, Operations, Oil Spill Response crews) managed operations for 24 marine vessels and additional aviation support including 6 helicopters and 5 fixed winged. There were approximately 1.2 million hours of work performed without a lost-time injury, including 4,000 lifting and hoisting operations for load-out and offloading and the start-up of novel technologies.

Throughout this same period, Shell continued to collect important (1) ecological data to address stakeholder concerns and support permit applications and (2) physical data important for operations. This program brought industry, communities, universities, and local, state, and federal agencies together to recognize the importance of continuing to increase our understanding of the environmental health of the Chukchi and Beaufort Seas. Shell's Chukchi Sea environmental program began in 2006 and is recognized among many as one of the premier data collections in the U.S. Arctic environment to date.

Technically, the various operations/drilling teams at times faced challenges from the remoteness of the Chukchi exploration site along with well-understood harsh conditions. The environmental challenges were managed successfully but were exacerbated by a complex and evolving regulatory framework including regulator-imposed limited drilling season length, severe restrictions associated with distance between drill ships, and limiting ice reconnaissance that could have resulted in an unintended safety issue. There were many unsupported restrictive regulatory requirements implemented by agencies following the Deepwater Horizon incident in 2010 which ultimately became the basis for the 2015 Arctic Rule that was issued in July 2016. In addition, there were multi-year litigation actions, significant resistance from Alaska-based, national, and international non-governmental organizations (eNGOs), and a complex local community dynamic. One of the major positive stakeholder key developments was the formation of the Arctic Iñupiat Offshore LLC, which Shell believes resulted in a paradigm shift in how North Slope communities, Native corporations, and the North Slope Borough Municipality and Department of Wildlife Management viewed offshore drilling. This was accomplished in part by the establishment of a science collaboration between the North Slope Borough and Shell, which created a common basis for evaluating environmental issues and analysis.

Following the 2015 Chukchi drilling season, Shell withdrew from the Alaska Arctic due to well results, high logistic and technical costs, and the challenging and unpredictable U.S. federal regulatory environment.

Photo: Shell.

Noble Discoverer

Photo: Shell.

Polar Pioneer

- April 2016 – Point Thomson Field brought online by ExxonMobil
- October 2016 – Caelus discovery at Smith Bay
- January 2017 – ConocoPhillips Alaska, Inc. announces its "Willow Discovery"

Nanushuk Discovery. Based on the results of two exploration wells drilled during the 2015-2016 season, Repsol and Armstrong Oil and Gas announced a significant discovery of the Nanushuk field in June 2016. The companies lauded Nanushuk as one of the most significant U.S. onshore oil discoveries in three decades, with estimates of reserves ranging between 497 million barrels and 3.758 billion barrels of oil. The Nanushuk discovery could produce up to 120,000 barrels of oil per day.

Point Thomson Field. The Point Thomson reservoir holds an estimated 8 trillion cubic feet of natural gas and 200 million barrels of natural gas condensate; Point Thomson gas represents about 25% of the known gas resources on the North Slope. ExxonMobil brought Point Thomson online in April 2016. Point Thomson production is about 11 thousand barrels per day of natural gas condensate, a high value liquid similar to kerosene. Gas is reinjected to save for future use and to maintain the pressure of the reservoir, while condensate is transported via pipeline to the Trans-Alaska Pipeline System.

Smith Bay Discovery. In October 2016, Caelus Energy Alaska announced that it made a significant discovery of light oil on its state leases in Smith Bay, located offshore of the National Petroleum Reserve Alaska. Caelus estimated a 6 to 10 billion barrel discovery based on the results of its exploration program, with future plans for an appraisal program. Caelus estimates the Smith Bay Discovery could produce up to 200,000 barrels of oil per day.

Willow Discovery. ConocoPhillips's "Willow Discovery" was announced in 2017 with an estimated 300 million barrels of recoverable oil. Since its initial announcement, ConocoPhillips has updated its estimates to 450-700 million barrels of oil equivalent based on the results of its 2016-2018 exploration and appraisal campaign. First oil is anticipated by 2024-2025, which will tie in approximately 100,000 barrels of oil per day to the Trans-Alaskan Pipeline System.

Station-Keeping in Ice

Ability to predict ice actions and effects on stationary floating structures is critical for safe and cost-efficient operations. Ice basin tests and numerical simulations have traditionally been used to calibrate models due to the relatively limited public availability of full-scale data.

In early 2017, Statoil (now Equinor) performed station-keeping trials (SKT) in drifting ice in the Bay of Bothnia with two anchor-handling tug supply vessels, Magne Viking and Tor Viking. The primary objective of the SKT project was to gather full-scale data on a stationary floating structure in ice, but it also tested observation and detection systems. The project undertook multiple station-keeping, mooring, and disconnection tests, in a variety of temperature, visibility, wind, and ice conditions. Over 20 terabytes of data were collected for validation of models and are being used to increase confidence in modelling tools for design and operation in ice-covered waters. A satellite image of the test area is shown in Figure C-6. These data are available to the academic research community.

The project demonstrated that it is possible to stay single point moored in ice, even in intact ice up to a certain threshold and to keep on-position in well-managed ice. The results showed that numerical models perform reasonably well and identified potential for further improvements which are being addressed through the FOLLOWS JIP.[6] Additional ice-basin model tests were performed after the full-scale testing and further support the integrated understanding of the models and tests.

2015 Report Finding 4 – Most of the U.S. Arctic Offshore Conventional Oil and Gas Potential Can Be Developed Using Existing Field-Proven Technology

The technical ability to explore and develop in the offshore Arctic is governed by a number of key factors – the conditions above the seafloor (surface conditions), including water depth, ice conditions, and

6 In March 2018, DNV GL and Statoil initialized a joint industry project (FOLLOWS JIP) to develop a methodology and numerical models and tools for estimating the actions on and response of moored floating structures caused by sea ice.

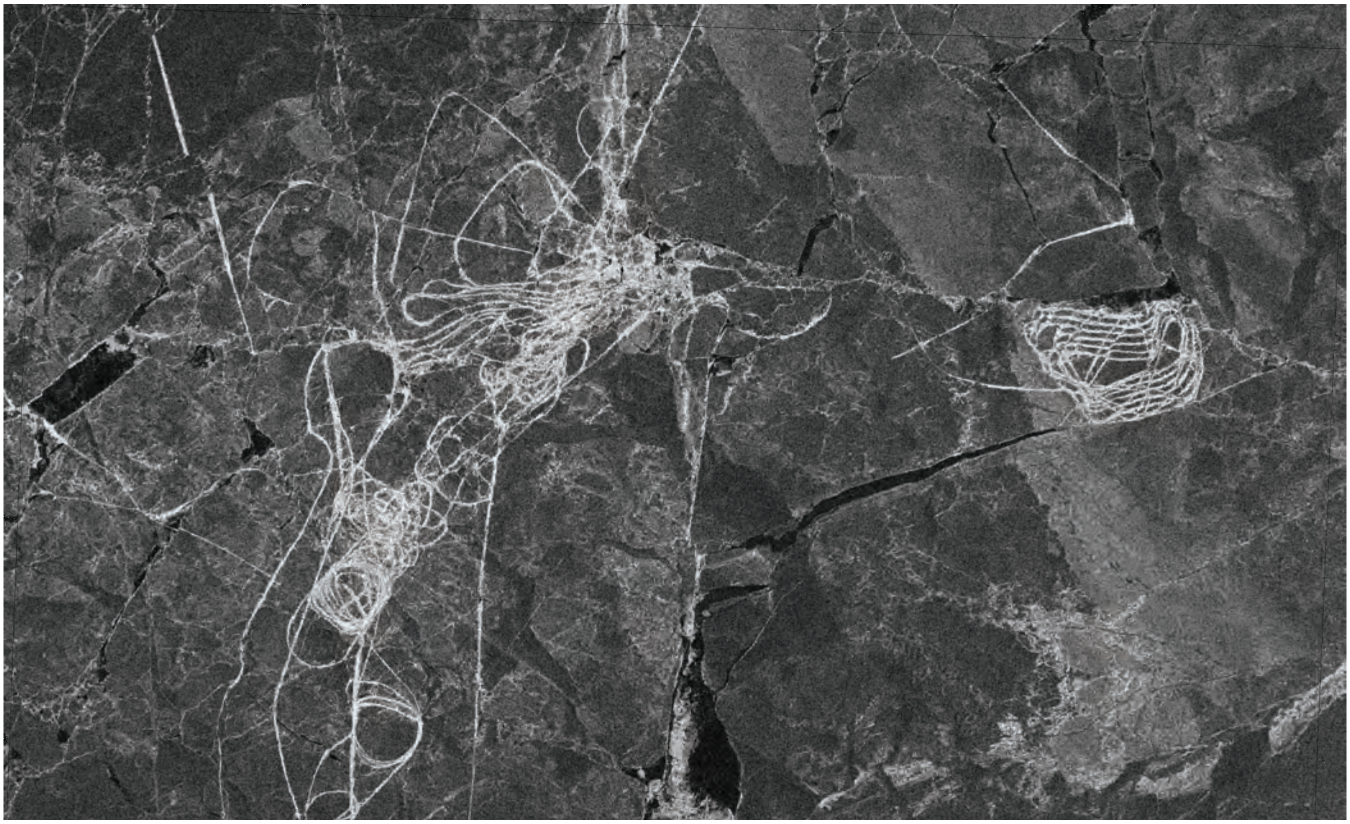


Figure C-6. *Cosmo Sky-Med Satellite Image Overlooking Test Area. Visible Tracks from Ice Management*

the length of the open-water season, and conditions below the seafloor (subsurface conditions) – geology, pressure, and resource depth.

The presence of ice and limited open-water season make the Arctic unique, compared with other jurisdictions. Drilling rigs that rest on the seafloor have a maximum usable depth of about 100 meters in ice; deeper water requires floating rigs. Exploration can be carried out in waters with a short ice-free season using floating drilling rigs in waters deeper than about 20 meters, but production would require year-round operation to be economic, which means using fixed facilities that rest on the seafloor and are resistant to ice forces in ice-prone areas.

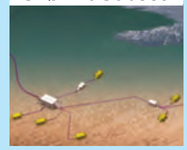
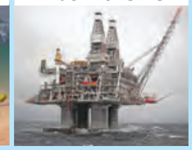
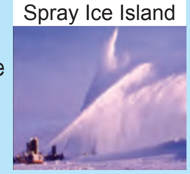
The length of the open-water season impacts the ability to carry out seismic acquisition and to conduct exploration and appraisal drilling with floating rigs. Nearshore, where landfast ice can be used to drill in the winter, the length of the landfast ice season is the primary variable that controls the ability to explore and appraise opportunities in that region. Figure C-7 shows how the combination of these factors impacts the ability to explore and develop in various Arctic and some sub-Arctic basins.

Most of U.S. Arctic offshore resources are in less than 100 meters of water and have an open-water season of two months or more – conditions described in the second and third rows highlighted in red in Figure C-7.[7] As a result, exploration can and has been be executed during the summer and shoulder seasons with existing floating drilling rig technology, and production can and has been achieved using conventional bottom-founded drilling and production facilities.

Regarding subsurface conditions (below the sea floor), Figure C-8 compares the U.S. Arctic with the U.S. Gulf of Mexico. From data from exploration wells drilled in the 1980s to 2015, the Arctic potential reservoirs currently being targeted are shallow and normally pressured, meaning that subsurface pressures

7 Note that the Russian Arctic and deepwater areas depicted on this graphic are currently subject to both U.S. and European Union Sanctions. Development of such areas in the future would remain subject to compliance under relevant sanctions in place at the time of development.

Increasing Complexity To Explore & Develop

Physical Ice Environment and Water Depth		Technology to Explore & Develop
Description	**Examples**	
Typically ice free, any water depth • Minor first-year ice intrusions, icebergs possible	• South Barents Sea • Newfoundland	**Exploration & development proven** (Various drilling rigs, floating solutions, GBS, subsea tieback) Snøhvit Subsea  Hibernia GBS 
Any ice conditions, nearshore & shallow water • <~15m water	• Globally, near shore (including U.S. Beaufort and Chukchi Seas)	**Exploration & development proven** (Ice & gravel islands, concrete & steel structures, extended reach drilling from onshore) Spray Ice Island  Northstar 
Open water >~2 months, any water depth • Mainly first-year ice, potential for combination of multi-year ice, icebergs, and ice islands • Water depth determines development concept (greater or less than ~100m is key)	• Sea of Okhotsk • Pechora Sea • Labrador Sea • U.S. Chukchi & Beaufort Seas • South Kara Sea	**Exploration proven; development proven mainly in <~100m water** Ice management required <~100m development by GBS >~100m development by floating drilling & subsea tieback Canmar Drillship  Sakhalin-2 GBS 
Open water <~2 months, any water depth • Likely to encounter multi-year ice and/or icebergs, and in some locations ice islands • Water depth determines development concept (greater or less than ~100m is key)	• Deepwater Beaufort Sea • Deepwater Northern Russian Arctic Seas	**Exploration & development possible with technology improvements** Increased ice management capability and possible new technology
Limited to no open water • Frequent multi-year ice with embedded icebergs, and ice islands	• Northeast Greenland • Deepwater Northern Russian Arctic Seas	**Technology extensions or new technology required** Floating, robust ice managed solutions GBS/Subsea technology extensions or new technologies Difficult to mobilize equipment without open water season

Photos: Snøhvit Subsea - Statoil (Even Edland); Hibernia GBS - ExxonMobil; Spray Ice Island - BP – Amoco; Northstar - BP p.l.c.; Canmar Drillship - R. Pilkington; Sakhalin-2 GBS - Sakhalin Energy.

Figure C-7. *Exploration and Development in Various Arctic Surface Conditions*

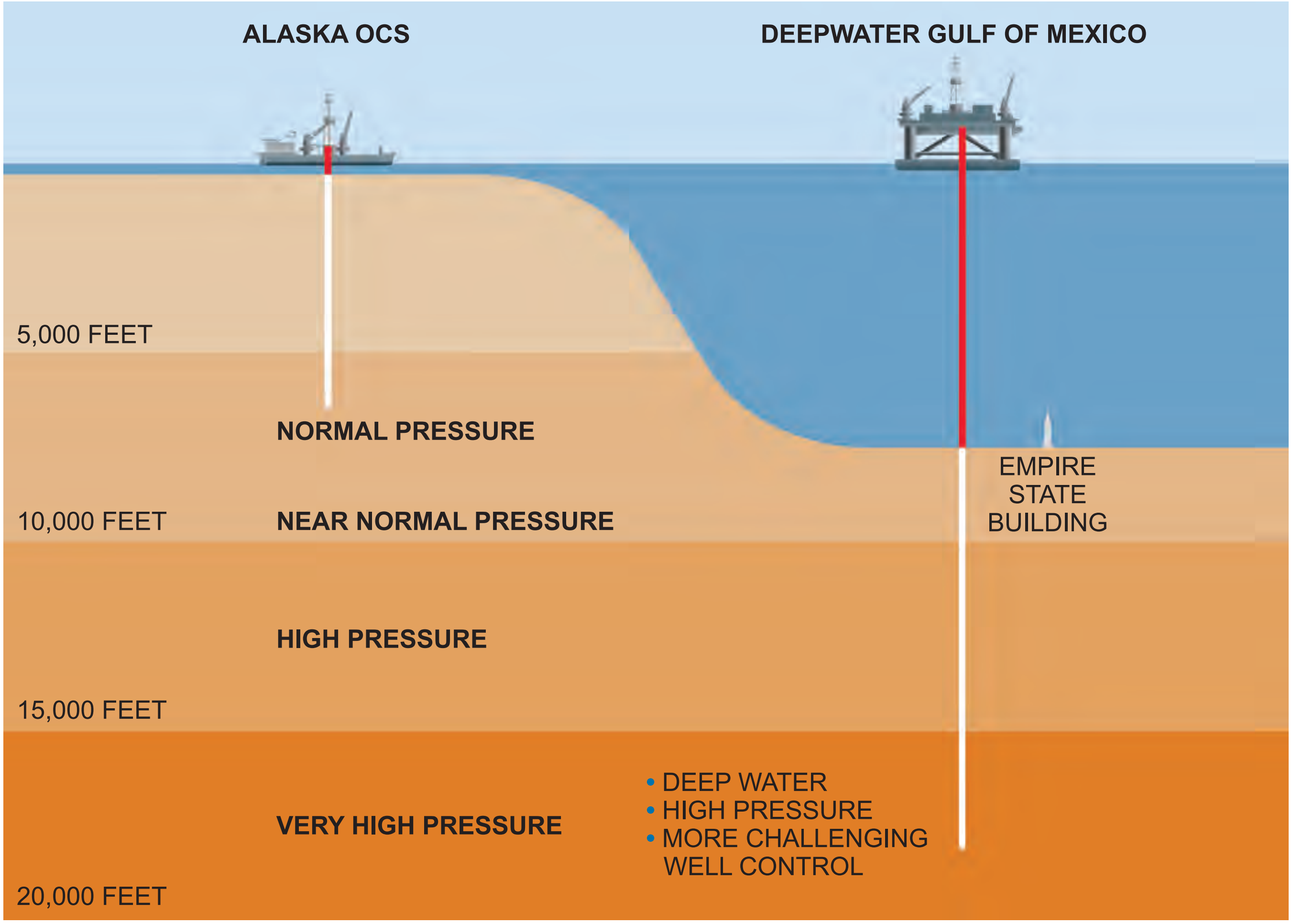
can be held back by drilling mud only slightly heavier than the weight of salt water. Compared with other jurisdictions, the subsurface environment in the U.S. Arctic is much simpler, and wells can be drilled more quickly, with fewer casing strings and simpler drilling mud designs, using existing proven technology that has been available for decades.

2015 Report Finding 5 – The Economic Viability of U.S. Arctic Development is Challenged by Operating Conditions and the Need for Updated Regulations that Reflect Arctic Conditions

Technical feasibility is not the only consideration for successful development of oil and gas resources. Ultimately, an opportunity must be both technically and economically feasible to warrant pursuit. To progress, a resource opportunity of sufficient size and quality of recoverable oil and gas must first be found. Thus, the ability to explore is the first critical step in a successful development process. Arctic exploration and development are more costly than in other areas due to remoteness, lack of infrastructure, challenging climate, and short operating seasons. Finding large, high-quality resources will be key to economically viable Arctic developments. Additional factors that influence the economic feasibility of an opportunity include infrastructure and a regulatory framework adapted to reflect Arctic conditions, discussed in this Finding.

Regulations Adapted to Arctic Conditions

The 2015 report identified concerns with the regulatory effects on drilling season length in the Arctic and



Source: Shell.

Figure C-8. *Comparison of the Subsurface Environment of the U.S. Arctic Potential with the U.S. Deepwater Gulf of Mexico, for Offshore Exploration Drilling*

the applicability of lease terms and length originally established for offshore areas in the U.S. Lower 48, where operations can be conducted year-round. Current regulatory implications for drilling season length and requirements for lease terms and length have substantial negative implications for oil and gas exploration in the Alaska OCS.

Since 2015, there has been no progress in addressing lease terms, and in 2016, the Bureau of Safety and Environmental Enforcement (BSEE) and the Bureau of Ocean Energy Mangement (BOEM) issued the Arctic Rule,[8] based largely on Shell's actual operating practices at Burger in 2015. In the study participants' view, the Arctic Rule is overly prescriptive, and presumes that one set of assumptions, design, and equipment would universally apply in any given location and at any given time. These specific requirements have a negative impact on the industry's ability to effectively manage risks. Some requirements, such as restrictions on drilling season length, the requirement for same season relief well and a standby rig, and other specific logistical requirements, have been estimated by the American Petroleum Institute (API) to cost the industry more than 10-20 billion dollars without a measurable reduction in risk.[9] Following its 2015 Arctic drilling activity, Shell paused its U.S. Arctic program due to well results, high logistic and technical costs, and a challenging and unpredictable U.S. federal regulatory environment.

8 The "Oil and Gas and Sulfur Operations on the Outer Continental Shelf Requirements for Exploratory Drilling on the Arctic Outer Continental Shelf 81 FR 46477," commonly called the "Arctic Rule."

9 Hearing to receive testimony on the Well Control Rule and other regulations related to offshore oil and gas production, U.S. Senate Committee on Energy and Natural Resources, Testimony, Erik Milito, Group Director, Upstream and Industry Operations, American Petroleum Institute, December 1, 2015.

Exploration Drilling Season Length

The limited time available each year for exploratory seismic data gathering and drilling is a major factor affecting the economic feasibility of offshore U.S. Arctic activity. Beyond nearshore landfast ice and water shallow enough for constructing artificial islands, offshore exploratory drilling will generally need to be conducted using some form of mobile offshore drilling unit. Currently, regulations and permit conditions only allow exploratory drilling activity during the open-water season, irrespective of existing technology that can allow for safe operation in ice.

The U.S. Arctic open-water season is typically only 3 to 4 months long. The useful drilling period is further shortened by restrictions in recent permits requiring the ability to drill a same season relief well[10] before the onset of ice. It can take approximately one month to drill a relief well in the Arctic.

For example, in the western area of the U.S. Chukchi Sea, the accessible season for drilling is July 1 to November 1, a total of 124 days. Allowing 7 days to mobilize the drilling rig and supporting vessels to the site, and reserving 38 days at the end of the season for drilling a relief well in the unlikely event that one should be necessary, there would only be 79 days actually available in a calendar year for exploratory drilling, as shown in Figure C-9. The useful drilling season can be even further shortened by voluntary agreements or regulations requiring an operator to cease operations to accommodate subsistence harvesting and marine mammals. This drilling season length makes completing an exploratory in a single season challenging. Multiple expensive mobilizations over several years would likely be necessary to complete exploration of a prospect, substantially reducing the feasibility of offshore Arctic development.

There have been significant technology and operational advancements since the 2015 report that could be applied to substantially extend the useful drilling season while maintaining operational safety and enhancing environmental protection. These technologies fall into two broad categories: (1) advanced well control and (2) ability to operate in shoulder seasons.

Advanced Well Control

As discussed in Key Finding 7 on oil spill prevention and response, technologies have been developed that can offer superior protection with shorter implementation time than a relief well. These technologies include subsea isolation devices and capping stacks.

Ability to Operate in Shoulder Seasons

Some drilling rigs and the associated support vessels, including those for oil spill response and emergency evacuation, are already capable of operating in water where ice is present and accompanied by ice

10 A relief well is a separate well that is drilled, in the unlikely event of a loss-of-well-control incident or blowout, to intercept and permanently stop the flow from a blown-out well. Relief wells are discussed in more detail in Finding 7.

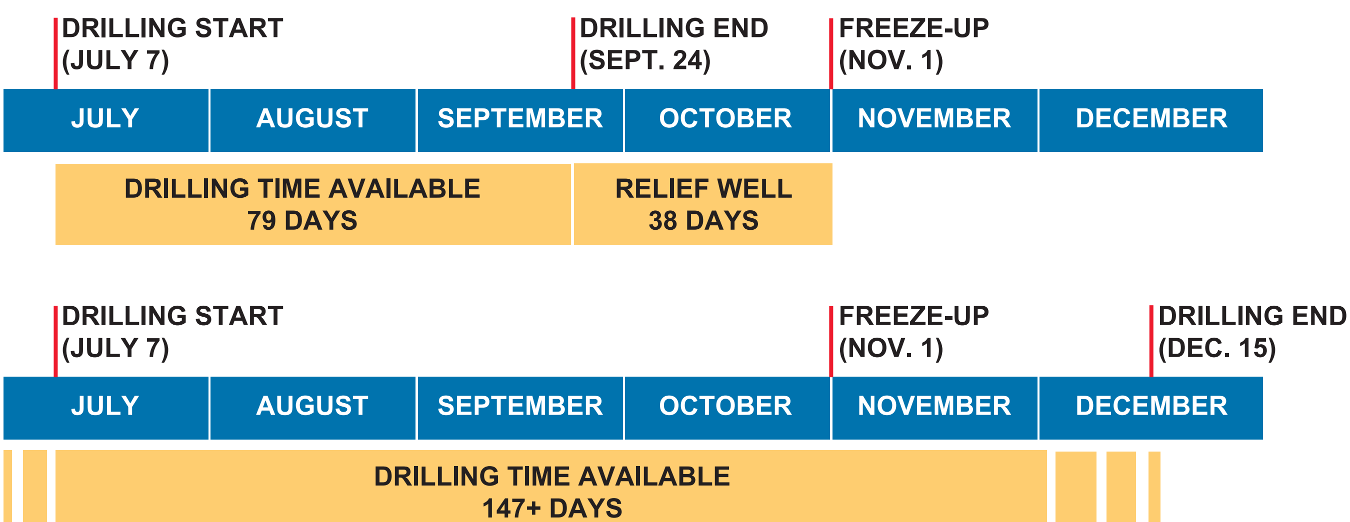


Figure C-9. *Drilling Season Length Example Comparing Current Practice to an Extended Season* monitoring and ice-management vessels, and others can be strengthened to do so. The ability to work safely and effectively in ice-covered waters has been demonstrated through Arctic exploration experience in the 1980s, as noted in the 2015 report.

Applying both advanced well control devices and ice-capable drilling systems to the previous Chukchi Sea example could significantly lengthen the drilling season. Substituting a subsea isolation device that could be activated immediately in place of a relief well requirement would add 38 additional days to the useful drilling season. Allowing operations to extend into early ice season conditions within the demonstrated capability of an ice-capable drilling system would add an additional 30 to 45 days to the end of the useful drilling season, extending it from an end date of November 1 to December 15, as shown in Figure C-9. The combined result would nearly double the available drilling season each year, enabling the drilling of at least one exploration well to its target depth in a single season and improving the economics of developing offshore Arctic prospects without compromising safety or environmental protection.

Additionally, operators are unable to pass beyond the Bering Strait until after July 1. Rather than specifying a precise date, regulators should allow operators to begin activities based on weather, ice, and wildlife conditions, supported by an ice-capable fleet and ice monitoring and management programs. This could allow operations to begin prior to July 1, further extending the drilling season.

Lease Length and Terms

The Outer Continental Shelf Lands Act (OCSLA) limits the primary term of any OCS lease to a maximum of 10 years. If oil or gas is discovered but cannot be shown to be commercially viable within this time, the lease must be relinquished, leaving the operator with no return on their exploration investment. Lessees in the U.S. Lower 48 have access to their leases 12 months of the year. In the Arctic, access is limited to 3 to 4 months a year. There are no specific allowances made in the lease terms for time lost on a lease due to ice, operating season length, permitting delays, legal challenges, etc.

Arctic resources are expected to be larger, but less dense and spread over broader areas than in the Gulf of Mexico, and thus the Arctic is expected to require more exploratory wells to gain sufficient definition of the resource to proceed to development. Also, the resource uncertainty in frontier areas such as the Alaska OCS means that subsurface knowledge gained from each well has a great impact on future drilling decisions, compelling serial rather than concurrent exploration drilling. Given the limitations on the length of the useful annual exploration season, the greater time required for Arctic exploration programs, and the high costs of drilling in remote, icy Arctic conditions, the current 10-year lease term is inadequate to support developing Alaska's OCS potential.

Other Arctic countries address the need for longer lease terms for Arctic frontier areas by requiring an exploration discovery only. The U.S. lease system is development-based; to retain a lease, the operator must have gained sufficient information to be able to move into the commercial development phase (with additional regulatory approval) by the end of the 10-year lease term. As described in the previous section, the short drilling season can make this difficult as a number of appraisal wells are required to assure commerciality. Other countries have regulations that provide extra time to determine technical or commercial viability. Canada offers an exploration license with a 9-year term that can be extended if an operator is diligently pursuing drilling. If a discovery is made, the operator receives a Significant Discovery License that allows the operator to hold the lease indefinitely until the discovered field can be economically developed. Norway provides for an initial exploration license of 4 to 6 years that can be extended up to 10 years with commitment to a work program. If oil or gas is found, the operator can apply for an extension of up to 30 years. Table C-1 summarizes these differences.[11]

In addition to extending the lease time available for exploration, holding more frequent and predictable lease sales would also improve the ability to plan and execute exploration programs, particularly important in an area with a short working season. The inherent uncertainty in prospective frontier areas such as the Alaska OCS means that the subsurface knowledge gained from seismic surveys and from each drilled

11 Note that Russian Arctic and deepwater resources are currently subject to both U.S. and European Union Sanctions. Development of such areas in the future would remain subject to compliance under relevant sanctions in place at the time of development

Country	Lease/License System	Typical Well Count to Retain Lease/License*	Lease/License Duration
Canada	Exploration Based	1 to 2	9 years
Greenland	Exploration Based	1 to 2	Up to 16 years
Norway	Exploration Based	1 to 2	Up to 30 years
Russia	Exploration Based	1 to 2	10 years
United States	Development Based	6 to 7†	10 years

* The number of wells shown is estimated based on 1 to 2 wells needed to establish an exploration discovery.

† The number of wells shown includes exploration and appraisal wells. Based on practices used in the U.S. Lower 48, securing a lease extension beyond the primary term requires a firm commitment to develop requiring multiple appraisal wells, engineering studies, and funding. One appraisal well per 200 million barrels of recoverable volume, and a field size of 1 billion recoverable barrels was assumed.

Table C-1. *Lease/License Comparison by Country*

well significantly impacts future drilling decisions. In the Alaska OCS, exploration and appraisal activities must proceed serially because the results of the first well in each area will determine where and how the next well should be drilled.

Infrastructure

Availability of existing infrastructure to support exploration, development, and production increases the attractiveness of an opportunity. The remoteness and limited infrastructure of the Alaska Arctic pose challenges to oil and gas pursuits. Since the 2015 report, some progress has been made improving U.S. Arctic infrastructure, including advances made to support logistics and communication in the U.S. and globally.

Trans-Alaska Pipeline System

The construction of the Trans-Alaska Pipeline System (TAPS) in the 1970s was a primary enabler of north Alaskan oil production. The 800-mile TAPS carries oil from the large onshore Prudhoe Bay field in north Alaska to the southern Port of Valdez, which has year-round shipping capability. TAPS throughput peaked in 1988 at 2.1 million barrels per day, and has since declined to about 25% of the peak throughput as Prudhoe Bay production has declined. Low throughput poses challenges to maintaining pipeline operation, as the oil cools and water and wax separate from the oil at low flow rates. Declining TAPS volumes are shown in Figure C-10.

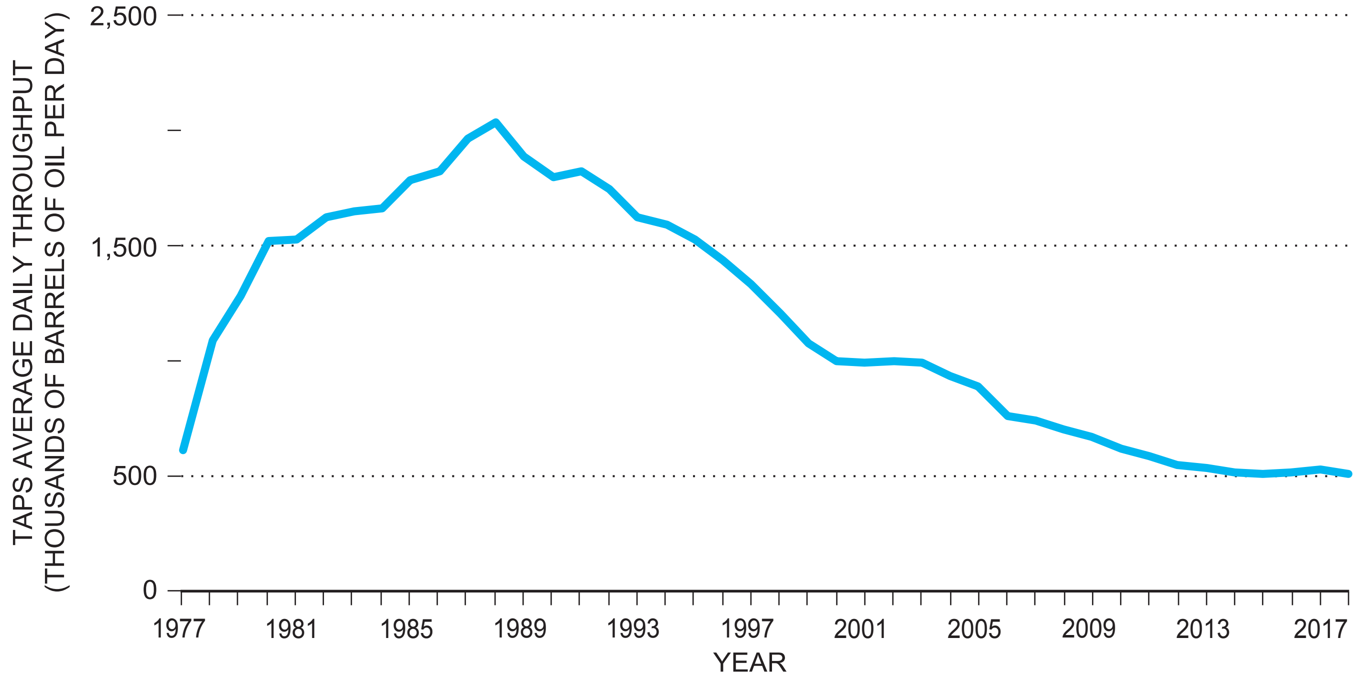
The TAPS operator, Alyeska Pipeline Service Company, has made technology and equipment improvements to significantly extend the operating life of TAPS and manage lower throughput volumes as Alaska production has declined. These improvements include freeze depressants, pigging equipment design changes, and the ability to add heat to the oil flowing along the pipeline. While these advancements have allowed TAPS to operate safely at lower flow rates, achieving higher throughput by increasing oil production in north Alaska would help ensure the continued viability of TAPS. If oil production in north Alaska continues to decline, eventually TAPS will become inoperable and there will be no way to ship the remaining oil production.

Oceanscape Studies

The National Oceanic and Atmospheric Administration (NOAA) recently completed the most comprehensive bathymetric study in the U.S. Arctic since 2002. These improved bathymetric data provide the understanding necessary for improved navigation, and were recommended by the 2015 report.

Alaska Deep Draft Port

There has long been interest in understanding the options to build and utilize an adequate deepwater port system in the U.S. Arctic. In 2011, the U.S. Army Corps of Engineers initiated the Alaska Deep-Draft Arctic Port Study, where an initial study plan identified the Nome/Port Clarence region as having the greatest potential to support vessel traffic and economic activity in the Arctic. In 2015, the Army Corps of Engineers announced a temporary suspension of the Alaska Deep-Draft Arctic Port Study. In early 2018, the Army Corps of Engineers



Source: Adapted from Alyeska Pipeline Service Company "Low Flow Impact Study" and website data, http://www.alyeska-pipe.com/TAPS/PipelineOperations/LowFlow.

Figure C-10. *Trans-Alaska Pipeline System (TAPS) Throughput*

entered into an agreement with the city of Nome to examine the feasibility of constructing navigation improvements at the Port of Nome. The new investigation will examine a wider array of benefits than the previous study, including Nome's role as a regional hub for surrounding communities that rely on fuel and goods.

Icebreakers

Icebreaker vessels provide assured year-round access to ice covered waters. Icebreakers can also serve as mobile infrastructure. There are currently four icebreakers capable of independent Arctic operation in the United States. Only two of the icebreakers are U.S. government owned, The Polar Star and the Healy. The U.S. has plans to award a contract for design of a new icebreaker, with delivery no earlier than 2023. In contrast, Russia has 44 icebreakers in service and eleven more under construction. Finland currently has ten icebreakers, and Canada and Sweden each have seven. China, which has no coastline in the Arctic, currently has three icebreakers, with another under construction. Figure C-11 shows current and planned icebreakers by country. Relative to other Arctic nations, the U.S. Coast Guard is inadequately resourced to execute its mission to sufficiently safeguard U.S. territorial waters in the Arctic.

There are many synergies between the types of infrastructure that would facilitate Arctic oil and gas exploration and development and the infrastructure needs of local communities, the state of Alaska, and the U.S. military such as the Coast Guard and Navy. Investments by any party in new or upgraded airfields, ports, roads, navigational aids, satellites, radars, and communication facilities could confer wide benefits. The U.S. Coast Guard and Navy, which play key roles in the areas of safety, search and rescue, and national defense, are subject to many of the same resupply and support requirements in the Arctic as the oil and gas industry.

2015 Report Finding 6 – Realizing the Promise of Arctic Oil and Gas Requires Securing Public Confidence

In the original 2015 report, the NPC emphasized the need to secure and maintain public confidence that Arctic offshore oil and gas resources would be explored and developed responsibly. Further, the 2015 report noted that industry and government have

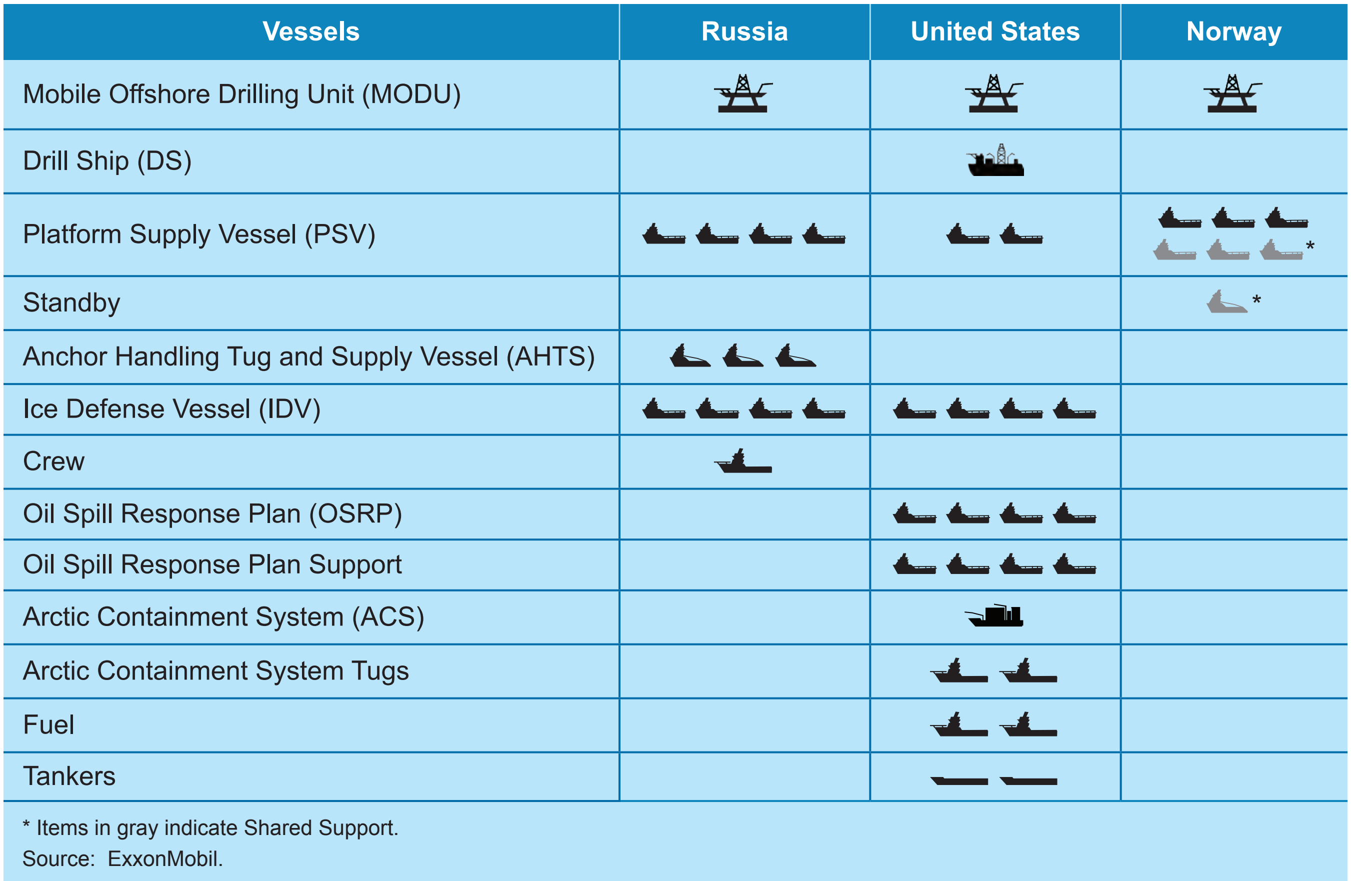


Figure C-11. *Icebreaker Fleets*

a shared responsibility to gain and maintain the public trust:

- Industry must operate responsibly, bringing appropriate technology and operating practices to bear and continuously improving technologies and operations.
- Government must maintain and continuously improve effective policies and regulations that support development while ensuring protection of people and the environment.
- Both industry and government must engage with local communities.

In addition, the fourth finding of the NPC 2011 report *Prudent Development: Realizing the Potential of North America's Abundant National Gas and Oil Resources* stated:

> Achieving the economic, environmental, and energy security benefits of North American natural gas and oil supplies requires responsible approaches to resource production and delivery. Development in different geographic areas requires different approaches and continued technological advances. But in all locales and conditions, the critical path to sustained and expanded resource development in North America includes effective regulation and a commitment of industry and regulators to continuous improvement in practices to eliminate or minimize environmental risk. These steps are necessary for public trust.

The NPC continues to support this finding. Examples of industry collaborative activities in support of prudent development are included in the nearby text box on Joint Industry Task Forces.

Since the 2015 report, the following activities demonstrate continued commitment by industry and government to the responsibilities of prudent development:

- The industry has safely drilled 47 exploration wells. By focusing on prevention and risk management, no loss of well control events have occurred.

Joint Industry Task Forces

Immediately after the Macondo incident in the Gulf of Mexico (GOM), the U.S. oil and natural gas industry (Industry) launched a comprehensive review of offshore safety to identify potential improvements in spill prevention and intervention and response capabilities. Four Joint Industry Task Forces (JITFs) were assembled to focus on critical areas of GOM offshore activity: the Joint Industry Offshore Operating Procedures Task Force, the Joint Industry Offshore Equipment Task Force, the Joint Industry Subsea Well Control and Containment Task Force, and the Joint Industry Oil Spill Preparedness and Response Task Force. Teams were composed of industry expert members of the American Petroleum Institute, International Association of Drilling Contractors, Independent Petroleum Association of America, National Ocean Industries Association, and the United States Oil and Gas Association. Sessions began in early spring of 2010 to provide recommendations to the U.S. Department of the Interior (DOI) in the areas of prevention, intervention, and oil spill response.

The JITFs worked with trade associations, DOI's Bureau of Safety and Environmental Enforcement and Bureau of Ocean Energy Management and their predecessor organizations, U.S. Coast Guard, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, National Response Team, the National Commission on the Deepwater Horizon Oil Spill and Offshore Drilling, the Chemical Safety Board, the National Academy of Engineering, members of Congress, and others as they considered the Macondo incident and potential changes in Industry regulation.

The work of the JITFs has been instrumental in creating enhanced safety in offshore oil and gas operations in each of the key areas: prevention, intervention and containment, and response. The reports are available online: *https://www.api.org/oil-and-natural-gas/environment/clean-water/oil-spill-prevention-and-response/api-joint-industry-task-force-reports.*

Since the 2015 report, offshore globally, no relief well has been drilled nor has any capping stack or SSID been activated to stop an out of control well, because they have not been needed.

- Since 2010, the American Petroleum Institute has published over 100 new and revised exploration and production standards, including standards for well design, and for blowout preventer equipment design, operation, repair, and testing, and control

American Petroleum Institute (API) Standards Supporting Oil Spill Prevention

API standards have been developed for many years and are utilized on a global basis by the industry. The standards raise the level of safety performance across the industry, and more than 100 have been incorporated into U.S. federal regulation. The industry has 224 exploration, drilling, and production standards that address offshore operations, covering everything from blowout preventers to comprehensive guidelines for offshore safety programs. Since 2010 API has published over 100 new and revised exploration and production standards, including standards for:

- Well design, cementing, and operator/contractor interaction
- Blowout prevention equipment design, operation, repair and maintenance, and associated control systems
- Subsea equipment interfaces with remotely operated vehicles and well capping equipment
- Protective equipment for oil spill response workers.

Industry has adopted and implemented these updated standards. They have been incorporated into the design of wells, manufacturing of equipment, operational procedures, and other activities related to offshore oil and gas including the Arctic exploration. Many of them have also been incorporated by reference into regulations of the Bureau of Safety and Environmental Enforcement, the Bureau of Ocean Energy Management, the U.S. Coast Guard, and others.

systems. See the text box on the previous page for additional background on API standards supporting oil spill prevention.

- Since the 2015 report, the International Association of Oil and Gas Producers (IOGP) updated their good practices for oil spill preparedness and response, described further in the text box on IPIECA and IOGP good practices.
- Community engagement by the industry has continued, including Prudhoe Bay, Liberty, and TAPS. Each provided jobs, training, and economic benefits, and promoted improved engagement and partnership with the community.
- Partnership between the industry and the regulator to reach alignment on safety protocols was essential in reaching agreement on improvements to blowout preventers and securing approval to proceed with deploying a purpose-built subsea isolation devices.

2015 Report Finding 7 – There Have Been Substantial Recent Technology and Regulatory Advancements to Reduce the Potential for and Consequences of a Spill

Prudent development of the offshore U.S. Arctic is contingent on being able to prevent major oil spills and to respond effectively should any spills occur. Over the past four decades, the oil industry has made significant advances in being able to prevent, contain, and mitigate impacts of spills in Arctic environments. At the time of the 2015 report, concerns existed regarding industry's capability to prevent spills and to promptly deal with spills in Arctic waters, especially in the presence of ice. Since the 2015 report, additional technology advancement and operational experience have increased the industry's ability to prevent spills and respond to any spills that do occur.

IPIECA and IOGP Oil Spill Preparedness and Response Good Practices

The International Petroleum Industry Environmental Conservation Association (IPIECA) is a not-for-profit association that provides a forum for encouraging continuous improvement in industry performance. IPIECA develops, shares, and promotes good practice and knowledge to help the industry improve its environmental and social performance. IPIECA is the only global association involving both the upstream and downstream oil and gas industry.

Organizations that are members of IPIECA share values and a commitment to:

- Contribute to sustainable development by providing safe and reliable energy in an environmentally and socially responsible manner
- Conduct their operations and activities in accordance with applicable law related to environmental and social issues and ethical business practices
- Improve their performance in addressing environmental and social issues
- Develop, share and promote implementation of sound practices and solutions with others in the industry, and engage with stakeholders in order to take into account their expectations, concerns, ideas and views, and work with government and non-government organizations.

In 2015, IPIECA and the International Association of Oil & Gas Producers (IOGP) updated their document "Oil Spill Preparedness and Response: An Introduction." This document provides a synopsis of the essential components of an effective oil spill preparedness, response, and restoration framework. It describes the core principles that are used by the industry to underpin the framework and which run through the IPIECA-IOGP series of Good Practice Guides on oil spill preparedness and response.

The IPIECA-IOGP Good Practice Guide Series summarizes good practices for a range of oil spill preparedness and response topics. The series aims to help align industry practices and activities, inform stakeholders, and serve as a communication tool to promote awareness and education. This material is available on the Oil Spill Response JIP website at *http://oilspillresponseproject.org*, and also on the IPIECA and IOGP websites at *www.ipieca.org and www.iogp.org*.

The greatest reduction of environmental risk comes from preventing any loss of well control. Therefore, industry's first focus is on spill prevention. However, the risk of a spill can never be completely eliminated, so effective oil spill response capability is also critical. The "bow-tie" diagram in Figure C-12 illustrates the full spectrum of measures industry employs to protect the environment from oil spills due to loss-of-well-control incidents. On the left-hand side of the bow-tie are preventative measures aimed at reducing the risk of an incident in the first place. Prevention is accomplished through a set of primary and secondary measures.

Prevention – Primary Well Control Measures

The primary well control measures maintain control of formation fluids during the drilling process. These begin with well planning and design based on knowledge of the subsurface formations and fluid pressures gained from seismic exploration. Steel casing and wellheads are designed to withstand formation pressures, and specially formulated cement seals the steel casing to the borehole. Specially designed and monitored drilling fluid offsets subsurface formation pressures. These engineering safeguards are backed up by requiring strict adherence to operations integrity management systems as part of an overall culture of safety and risk management.

Careful control of the drilling process is facilitated by teams of specially trained personnel who constantly monitor well stability. This includes the use of sensors located near the drill bit that continuously measure downhole conditions, surface measurements of the drilling fluid volume and flow rates, and geoscientists onsite who analyze the rock cuttings from the well.

Alaska OCS oil and gas resources are typically much shallower, and generally have lower formation pressures than deepwater formations in the U.S. Gulf Coast OCS. This doesn't mean that less care should be applied to Arctic OCS wells, but rather that the geological risk is lower than in the U.S. Gulf Coast OCS.

Prevention – Secondary Well Control Measures

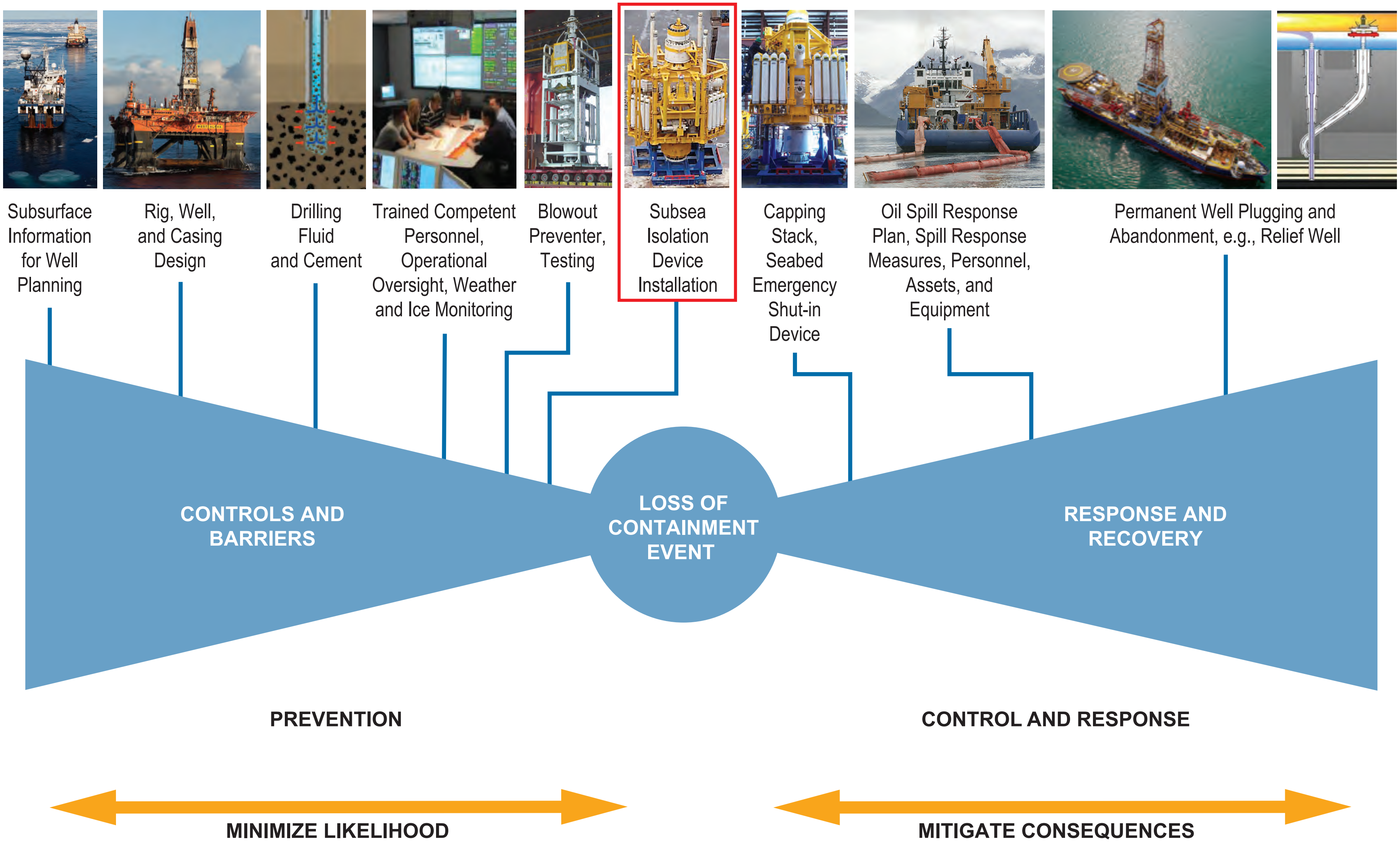
Secondary measures include procedures to detect and control deviations from normal operating conditions and shutoff devices such as blowout preventers (BOPs) and subsea isolation devices (SSIDs). An example of a deviation is an influx of formation fluids into the wellbore, also called a "kick." Kicks are detected using equipment located on the deck of the drilling rig. If formation fluid flows into the wellbore, an increase in the volume of returning drilling fluid will result. A trained drilling crew will detect this and take the necessary action, which normally involves pumping heavier mud into the wellbore and closing the BOP if necessary while control is regained. As previously described, U.S. Arctic resources are lower pressure than in the deepwater offshore U.S. Gulf Coast OCS, greatly reducing the potential for kicks or difficulties controlling formation fluids.

BOPs are devices mounted on the wellhead during drilling to seal the well if necessary. BOPs have multiple, redundant, powerful shearing and sealing rams that can be remotely activated to close around or shear through drill pipe and seal the wellbore to provide containment of fluids before they can escape in the event of a loss of well control. An SSID is essentially similar to a BOP, but the SSID is intended to be left on the wellhead rather than removed with the drilling rig if the rig must move off of the well unexpectedly, such as to avoid storms or ice incursions. The SSID can also be a primary well control component, as shown in Figure C-12, as it is pre-installed in the well below the BOP. The preferred method is to rely on the BOP for the main measure to close the well but the SSID can also function in that capacity. In Arctic waters where ice might gouge the ocean floor, the SSID can be installed in a depression in the ocean floor so that it won't be damaged by ice. BOPs and SSIDs are described more in the text box entitled "Advanced Technologies for Prevention of Blowouts and Major Spills."

At the center of the bow-tie diagram in Figure C-12 is a loss-of-well-control incident, which occurs if primary and secondary measures have been breached. The right-hand side of the diagram addresses limiting the size of and responding to a spill if containment is lost.

Response – Capping Stacks

The first control measure shown on the right-hand side of the bow-tie diagram is a capping stack. Capping stacks are designed to attach to the BOP or wellhead to allow collecting leaking oil and limiting or stopping the flow while measures are undertaken to plug the well at the wellhead. It is important to



Sources, left to right: Subsurface Information for Well Planning – ION Geophysical; Rig, Well, and Casing Design – ExxonMobil; Drilling Fluid and Cement – Shell; Trained Competent Personnel – Shell; Blowout Preventer – Cameron; Subsea Isolation Device Installation – ExxonMobil; Capping Stack – Trendsetter Engineering Inc.; Oil Spill Response Plan – Shell; Permanent Well Plugging and Abandonment, e.g., Relief Well – Shell, ExxonMobil.

Figure C-12. *Well Control and Spill Response/Recovery*

Advanced Technologies for Prevention of Blowouts and Major Spills

Photo: Cameron

Blowout Preventer

Photo: Trendsetter Engineering Inc.

Subsea Isolation Device

Source: Shell

Capping Stack

Blowout Preventers (BOPs). Blowout preventers are standard equipment for drilling wells. Blowout preventers typically have multiple rams designed to seal around or cut through any drill pipe and casing strings in the well to prevent or stop flow from a well if other preventative measures fail. Blowout preventers are part of the drilling rig's equipment and are removed when the well is completed and the rig departs. Bureau of Safety and Environmental Enforcement regulations and notice-to-lessees require frequent testing and maintenance of BOPs.

Subsea Isolation Devices (SSIDs). Subsea isolation devices are essentially self-actuated, remotely operable blowout preventers installed on the wellhead below the drilling rig's blowout preventer. SSIDs have their own independent control system and do not rely on the drilling rig. The SSID's control system and shearing/sealing rams include enhanced levels of redundancy and capability, and provide additional protection in the event that the drilling risers are damaged, such as in the case in Macondo. These devices can be located below the seafloor in an excavated trench, if needed, to provide protection from deep ice keels in the event they need to remain in place over the ice season.

Capping Stacks. Subsea well capping operations were widely publicized during the Macondo incident in 2010; however, the well capping technique has been used by industry to shut in surface well blowouts for many decades. Capping stacks are designed to mechanically connect to a BOP or wellhead and shut-in and/or contain and divert the flow from the well until control can be regained. Since Macondo, capping stacks have become a standard part of the subsea drilling operations and specially designed and maintained units are strategically located near many offshore drilling areas such as Alaska and the Gulf of Mexico.

distinguish between a BOP and a capping stack. A BOP is a safety device meant to prevent a blowout from occurring. The BOP is always present when drilling any well.

Unlike SSIDs, capping stacks are not installed while drilling operations are underway; rather they are kept at a pre-determined location near drilling locations. If installation is necessary, a capping stack provides a completely separate system for control of leaking oil or gas. The capping stack's valves can be closed to cap the well or, if necessary, the flow can be directed through flexible pipe to surface vessels for collection while other efforts to stop the flow are undertaken.

Response – Relief Well

Should efforts to stop flow and plug the well at the wellhead fail, the alternative flow-stoppage measure is to drill a relief well, which is a separate well drilled to intercept and permanently stop the flow from an out-of-control well. Use of relief wells is very rare. Since the 2015 report, globally offshore, no relief well has been drilled, nor has any capping stack or SSID been activated to stop a well control incident, because they have not been needed.

Response – Oil Spill Response

The right-hand side of the bow-tie includes a variety of oil spill response measures that can be used to remove spilled oil from the environment and minimize environmental damage. These would include mechanical recovery using booms and skimmers, in-situ burning of the oil, and use of dispersants. The potential for encountering sea ice, cold temperatures, and limited shore infrastructure are key features that differentiate Arctic spill response from others. While challenging in many respects, research has shown that cold temperature and ice can slow the spreading and weathering of spilled oil, increasing the time available for response.

Response – Research

Over the past four decades, the oil industry and government have made significant advances in being able to detect, contain, and clean up spills in Arctic environments. Many of these advances were achieved through collaborative international research programs with a mix of industry, academia, and government partners. Much of the existing knowledge base in the area of Arctic spill response draws on a long history of experiences with a number of key field experiments, backed up by laboratory and basin studies primarily conducted in Norway, Canada, the United States, and the Baltic countries.

In addition to substantial industry-sponsored research, there has been a long and effective research effort led by government organizations. For more than three decades, the Minerals Management Service (MMS) and Bureau of Safety and Environmental Enforcement (BSEE) have funded research programs for open water and in ice. The National Oceanic and Atmospheric Administration (NOAA) is involved in a variety of oil spill research projects in conjunction with academia and other agencies that include development of an Arctic version of its oil spill trajectory model GNOME (General NOAA Operational Modeling Environment). The U.S. Environmental Protection Agency has conducted tests of dispersant efficacy and toxicity at low temperatures.

Demonstration and Exercises of Oil Spill Response in Norway

For four decades, Norway has hosted an annual Oil on Water (OOW) Exercise. Designed as an opportunity to verify and maintain the continuous improvement of Norway's national spill preparedness plan, the exercise is conducted by the Norwegian Clean Seas Association for Operating Companies (NOFO) as part of their research and development objectives. The OOW is also an opportunity to verify new oil spill response technology and equipment in realistic conditions. It is a cooperative project with the Norwegian Coastal Administration in accordance with the requirements of the Norwegian Environment Agency.

Selecting and Executing the Most Effective Spill Response Strategy

The overall goal of spill response is to control the source as quickly as possible, minimize the potential damage caused by a release, and employ the most effective response tools for the incident. Promoting mutual understanding of the benefits, limitations, and trade-offs of different response tools would facilitate achieving this goal. Response options that are highly effective under certain conditions can be ineffective in others depending on spill size, location, oil type/weathering,[12] and environmental conditions.

Response strategies for spills in ice use the same general suite of countermeasures, modified and adapted for use in ice, that are used elsewhere in the world, including:

- Mechanical containment and recovery with booms and skimmers in open water and open pack ice, and skimmers extended from vessels directly into trapped oil pockets in heavier ice
- Dispersants applied from the surface, subsea, or by air

12 Weathering is the loss of lighter material from crude oil, resulting in thicker, more easily emulsified remaining oil.

- In-situ burning of thick, burnable oil by using containment against natural ice edges without booms, fire resistant booms in open water or very open drift ice, or herding agents in open water and intermediate ice concentrations
- Detection and monitoring while planning the response
- Natural attenuation through evaporation and dispersion.

In a spill in open water in warm weather, the oil usually spreads quickly to form a very thin layer on the water surface. Ice and cold temperatures can decrease or eliminate oil spreading, weathering, and shoreline stranding, providing additional response time for an Arctic oil spill response.

Containment and mechanical recovery are generally regarded as the preferred strategy for responding to small oil spills in open water, and these are mandated by regulation as the primary technique in the United States. Mechanical recovery will always be a critical tool for oil spill response – including in the Arctic – because the vast majority of historical spills have been small. Containment and recovery of oil is effective when responding to small spills and spills that are rapidly contained in relatively calm waters and close to the spill source. *However, larger and more remote spills can be better remediated, with lower environmental impact, using dispersants and in-situ burning*. They are more effective in these scenarios because they require fewer logistics and can encounter and treat oil more quickly.

Dispersants are an important response option for Arctic contingency planning. Dispersants work by breaking up oil into tiny droplets that rapidly dilute in the water column, thus speeding biodegradation to reduce the toxic effects of the oil. Dispersants have a significant advantage: the ability to be applied by aircraft or directly to a subsea release point. Aircraft application allows response operations in remote locations much faster than response or application by boat. Subsea dispersant injection has the advantage of treating oil at the release point continuously. It is not affected by weather, sea states, or darkness. A large body of research demonstrates that dispersants can be used over a wider range of conditions than other response options, and studies have shown that cold temperatures do not hinder the dispersion of many oils. Studies have also shown that dispersants rapidly biodegrade in seawater even at temperatures close to freezing. Further, research has shown that Arctic marine organisms are no more sensitive to dispersants than their temperate cousins.

In-situ burning is especially suited for use in the Arctic where ice can naturally contain and thicken oil without the need for booms. The cold temperatures also reduce the loss of the lighter portion of spilled oil, thereby increasing the window for dispersant use from less than two days for typical spills in the Gulf of Mexico to five days or more for a spill in the Arctic. Also, thick, cold oil will remain un-emulsified longer, improving the efficiency of response options. Decades of research have demonstrated the ability to use controlled in-situ burning in cold water and the Arctic. Research conducted at several scales including in the field has demonstrated that when conducted in accord with established guidelines, in-situ burning is safe and poses no risk to human populations or responders and no unacceptable risk to the environment. In-situ burning minimizes or eliminates the logistical challenges of collecting, storing, transferring, and disposing of oil.

Dispersants and in-situ burning are most effective when employed immediately. Delays in gaining approval to use dispersants and in-situ burning will reduce the overall effectiveness of response. Therefore, pre-approval of dispersants and in-situ burning should be included as part of any drilling plan. Government agencies need to review and update federal and state planning standards and regulations to reflect the latest technologies, realistic operational and environmental constraints, and practical levels of response capability.

Improvements and Advancements Since the 2015 Report

Prevention – Well Design and Planning

Since the 2015 report, advances in well design, operational execution planning capabilities, and the increased use of sophisticated computer simulations (modeling anticipated ice floes, seasonal weather variations, and drilling operations, for example) have enhanced operational efficiency and reduced the potential for environmental incidents. These modeling capabilities, conducted in advance of drilling, have enhanced well design, rig selection, drilling operations, subsea isolation equipment design, rig tow and anchoring pathway selection, vessel and ice monitoring, seasonal weather/ice forecasting, and emergency response. Comprehensive simulation modeling provides an additional means of assuring safe, environmentally sensitive Arctic operations.

Prevention – BOPs and SSIDs

Since 2015, there have been significant technology improvements to BOPs. Sealing and pressure containment capability and the redundancy and reliability of control systems have increased substantially. The shearing, sealing, and pressure containment capabilities of BOPs have been extensively tested. For the Kara Sea program, an SSID was built, tested, and installed on the well below the BOP. The Kara Sea SSID is shown in Figure C-13. The SSID served similarly to a second BOP intended to be left on the wellhead rather than removed with the drilling rig if the rig was moved off the well late in the season. The SSID and casing were designed for full well shut-in pressure and the SSID was capable of being actuated remotely. To mitigate the risk of a late season well control event continuing over the winter season, the casing design and SSID together enabled safe full well shut-in, eliminating the need for a same season relief well. Based on these advancements since 2015, this Supplemental Assessment has added SSIDs to the "prevention" side of the bow-tie as highlighted in red in Figure C-12.

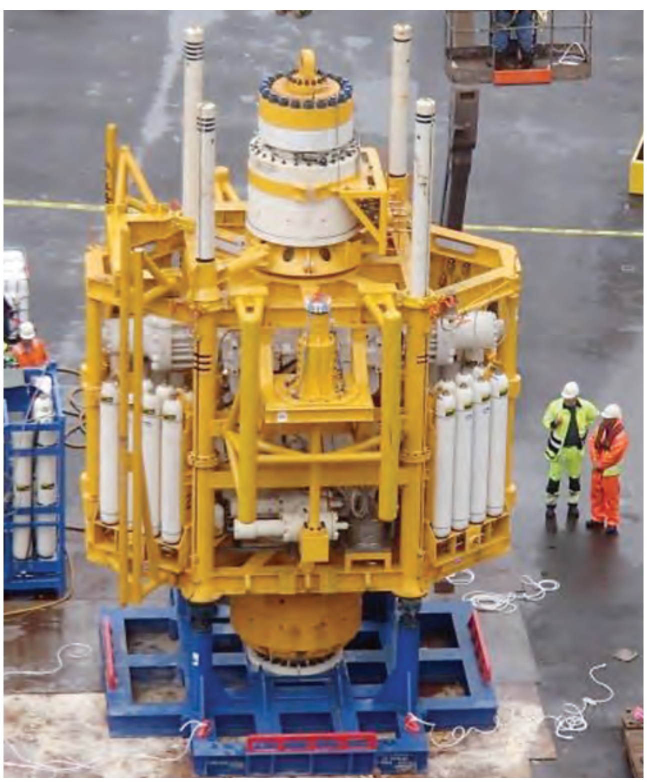


Photo: Shell.

Figure C-13. *Subsea Isolation Device Used for Drilling in the Kara Sea*

Response – Capping Stacks

Similar to SSIDs, there have been significant improvements to the containment capability and the deployment of capping stacks. Capping stack capabilities have increased up to 350 degrees Fahrenheit temperature and 20,000 psi pressure, with capacity to process up to 100,000 barrels of liquid per day and up to 200 million cubic feet of gas per day. Today, there are two companies that provide well capping and containment for the Gulf of Mexico – Marine Well Containment Company (MWCC) and HWCG (previously the Helix Well Containment Group). Worldwide, Oil Spill Response Limited (OSRL) maintains four capping stacks and other well containment equipment at locations in Norway, Brazil, Singapore, and South Africa. Offshore wells drilled in Alaska post-Macondo have been required to have a capping stack on standby near the drilling rig. Current global deployment of well control devices is shown in Figure C-14.

MWCC, HWCG, OSRL, and others have built a portfolio of capping stacks for every offshore scenario, including systems uniquely designed for shallow-water drilling operations, including Arctic locations. In addition, these companies have developed approaches to rapidly mobilize the large amount of resources, equipment, and personnel it takes to install a capping should an incident occur.

In addition to capping stack deployment, the U.S. oil and gas industry has a sophisticated and well-coordinated oil spill response network, described in more detail in the text box on the U.S. industry oil spill response network.

Response – Research

The Arctic Response Technology Joint Industry Programme (ART JIP) was a comprehensive research initiative completed in 2017. This program was initiated in 2012 as a collaboration of nine international oil and gas companies: BP, Chevron, ConocoPhillips, Eni, ExxonMobil, North Caspian

Source: Trendsetter Engineering, Inc.

Figure C-14. *Global Deployment of Well Control Devices*

Operating Company, Shell, Statoil (now Equinor), and Total. Over the course of the five-year program, the JIP developed and carried out a series of advanced research and development projects in all areas of oil spill response relevant to the Arctic. The 2015 report described preliminary findings from the program. Since then, final findings and conclusions have been made, and they are described in reports available on the program website.[13] The six key areas of oil spill response that were part of the research are: dispersants, environmental effects, trajectory modeling, remote sensing, mechanical recovery, and in-situ burning.

JIP research involved a combination of laboratory and field experiments, modeling and analysis of existing data, and development of improved operational methods for response. Projects included dispersant effectiveness testing, modelling the fate of dispersed oil in ice, assessing the environmental effects of an Arctic oil spill, advancing modelling trajectory capabilities in ice, mapping of oil in or under ice in daylight and darkness, assessing best options for mechanical recovery, and expanding the window of opportunity for in-situ burning response operations. Key outcomes of the Arctic JIP are summarized in a nearby text box.

The JIP teams worked to consolidate the vast amount of existing knowledge in all areas of oil spill response. In addition, the new scientific research conducted by the JIP researchers has added significantly to the knowledge base. The detailed reports and publications produced by the JIP research teams provide oil spill responders with information needed to more effectively respond to oil spills in Arctic environments.

As noted earlier, the Norwegian Clean Seas Association for Operating Companies (NOFO) and The Norwegian Coastal Administration have arranged

13 Arctic Response Technology: Oil Spill Preparedness, "About the Arctic Response Technology JIP," 2018. http://www.arcticresponsetechnology.org.

U.S. Industry Oil Spill Response Network

The United States has established one of the world's most sophisticated and well-coordinated spill response networks by bringing together the resources and expertise of private industry, public agencies, and academia to make sure we learn everything we can from past incidents. Since Macondo, oil spill response organizations have increased their capabilities by increasing training and keeping in inventory more equipment that is fit for specific purposes such as in-situ burning. Assessments conducted immediately after the Macondo incident also led to the creation of new guidance documents and reports, including:

- Guidance on the creation of offshore oil spill response plans
- An evaluation of the mechanical recovery systems used at sea during the Macondo incident
- A report and field guide for spills on sand beaches and shoreline sediments, including protection techniques and detection and response capabilities
- An evaluation of the process by which alternative technologies are reviewed for use during an oil spill.

Oil spill response organizations have increased their capabilities by increasing training and keeping in inventory more equipment that is fit for specific purposes such as in-situ burning. In addition, API and the oil and natural gas industry have established a robust program of oil spill response research and development, with a focus on: planning, mechanical recovery, dispersants, in-situ burning, remote sensing, shoreline protection, alternative technologies, and inland spill response. More information is available at *http://www.oilspillprevention.org*.

The industry has also invested in two international oil spill preparedness and response programs focused on improving industry operational capabilities in all parts of the world including the Arctic. These two programs are coordinated with API's activities, and together, they represent a comprehensive, global approach to continued advancements in oil spill preparedness and response.

Oil on Water (OOW) exercises. The exercises are designed to verify existing oil spill response equipment used on the Norwegian Continental Shelf and to test and improve new oil spill tactics and technologies in realistic conditions. In 2015, NOFO worked with the Barents Sea Exploration Collaboration to execute a large-scale exercise in the sea outside Svalbard. The tests were not performed with oil, but tested the operability of conventional mechanical oil spill response systems[14] in cold conditions including ice. In addition, different remote sensing systems[15] were tested. All the tested equipment was successfully deployed and operated but as expected with somewhat lower efficiency due to the presence of ice and the cold temperature.

NOFO exercises with oil were conducted in 2016 and 2018. These exercises took place west of Stavanger in the North Sea. Although several trials were performed on various aspects of OSR relevant to the Arctic, a key finding was that the Desmi Speed-Sweep System was able to be towed through water at double the speed of traditional boom without significant loss of oil. Another key finding was that herding agents successfully thickened free-floating oil slicks allowing more efficient burning than untreated free-floating slicks.

In 2017, NOFO performed a large-scale exercise near the southernmost island of the Svalbard archipelago. This test was not with oil, but provided operability experience with oil spill emergency response equipment in freezing weather and with marginal ice conditions. Two high-speed booming systems (Desmi Ro-Boom 3200 and MOS Sweeper) and a dispersant spray system (BV spray) were among the equipment tested. This equipment worked in the conditions with moderate ice influence, but reduced performance should be expected when significant ice is present. An oil spill response exercise is shown in Figure C-15.

14 Norlense 1200 booms and Framo Transrec recovery devices including a high wax skimmer.

15 Aptomar Securus, Rutter Oil Detection Radar, and Vsat- and IRIDIUM-communication systems.

Key Outcomes of the Arctic Response Technology JIP

- State of knowledge reports on key oil-in-ice response topics such as in-situ burning, dispersants, remote sensing, and environmental effects synthesize critical information gained over more than 40 years.
- The environmental effects database and literature navigator facilitates the use of Net Environmental Benefit Analysis (NEBA) by reducing the effort to identify and access the known, relevant information. This will lead to a better understanding of the potential environmental effects of selecting different response strategies.
- In-Situ Burning: Provides comprehensive support that technology exists to conduct controlled in-situ burning of oil spilled in a wide variety of ice conditions. Demonstrated the use of herding and burning as a new combined response strategy for both ice-covered and open water. A combined herder-ignition system was subsequently prototyped for commercial deployment.
- Dispersants: Reinforces previous research that dispersants can work in the Arctic and will, under certain conditions, be more effective in the presence of ice than in open water.
- Remote Sensing: Provides a new understanding of relative sensor capabilities, strengths, and weaknesses under a range of oil and ice conditions, using a range of different sensors above and below the ice.
- Environmental Effects: Extends the available science base on oil spill impacts in an Arctic environment to support NEBA. Provides a searchable database that references over 1,000 papers.
- Trajectory Modeling: Improves the predictive capability of existing trajectory models that will provide more accurate predictions of oiled ice movements in a range of ice conditions.
- The JIP results inform the public on many important topics involved in any discussion of Arctic oil spill response. This transfer of information is supported by public availability of reports and online access to all of the material produced by the JIP including state-of the-art technology reviews, technical reports, peer-reviewed papers, videos, and graphics.
- The rigorous scientific process followed by the JIP should provide greater levels of confidence in Arctic oil spill response capabilities.

Photo: Shell

Figure C-15. *An Oil Spill Response Exercise*

Prevention and Response – Additional Research

The industry continues to pursue new technology to prevent an oil spill. Much of this technology can be adapted to both temperate and cold regions. Two promising new technologies, Polymer Plugs and Seawater Injection, are currently being investigated to either prevent or mitigate a well blowout.

Polymer Plugs. Research is underway to evaluate a concept to respond to a BOP seal failure by injecting a liquid monomer and a catalyst below a BOP leak to rapidly form a polymer-plug seal. The solidification reaction can occur under extreme temperatures and pressures and withstand significant contamination from other fluids and solids.

Seawater Injection. Research is also underway to evaluate a method that pumps seawater at high rate into a BOP to form a pressure barrier to avoid the uncontrolled release of hydrocarbons from a reservoir. Pumping seawater at the correct pressure and flow rate into a BOP will produce pressure in the wellbore equal to or greater than the pressure of the oil reservoir. Once the well becomes equal/over pressured, the flow of hydrocarbons from the reservoir will stop. The technique is applicable to a surface blowout through a failed BOP; an underground blowout where hydrocarbons are passing outside a wellbore to another formation; and an underwater blowout where fluids are passing outside a wellbore to the seabed. Further, the technique could be used for deepwater and shallow-water drilling and both surface and subsurface BOPs. The seawater-injection concept does not require any specialty fluids or engineered materials.

A long history of intensive research into oil spill behavior and response in ice-covered waters provides a strong foundation for Arctic oil spill contingency planning today.

Appendix D

Recommendations of the 2015 Report

The view of this study [2015 study] is that the essential technology and knowledge currently exist to explore and develop oil and gas resources in the U.S. Arctic while protecting the environment and benefiting local populations. That said, there have been recent technology advancements that still need assessment and demonstration to gain acceptance by regulators and key stakeholders, and opportunities for further technology and knowledge can and should be developed to improve safety, environmental, and/or cost performance.

The National Petroleum Council makes the following recommendations, grouped into three broad themes:

Environmental Stewardship

1. Oil spill prevention and source control
2. Oil spill response in ice
3. Increasing knowledge of arctic ecology and human environment

Economic Viability

4. Technologies to safely extend the drilling season
5. Lease terms appropriate to arctic conditions
6. Effective policies and regulations
7. Enabling infrastructure

Government Leadership and Policy Coordination

8. Domestic leadership and policy coordination
9. U.S. chairmanship of the Arctic Council

Recommendations are discussed by subject areas. There are 32 recommendations in this executive summary, made up of 13 research, 3 regulatory, and 16 leadership/policy recommendations. In addition to these recommendations, there are an additional 60 research recommendations in the research chapters. These are summarized at the beginning of each of the technology chapters in Parts 2 and 3 of the report.

Environmental Stewardship

Continued prudent development in the Arctic requires the public's trust that companies are able to prevent oil spills and to effectively respond should a spill occur. The potential effects of oil and gas development are both a source of economic benefit as well as cause for concern about the effect of development on traditional cultures and the security of subsistence food resources. Obtaining higher confidence in ecological and human environment conditions and interactions would support improvements in science-based regulation and development.

1. Oil Spill Prevention and Source Control

The greatest reduction of risk to safety and the environment comes from preventing or limiting loss of well control. Current Department of the Interior (DOI) BSEE regulations (30 CFR 250.141) and procedures allow alternative and equivalent technology to be proposed in a drilling operations plan for the Arctic. There have been major recent advancements in well control technologies.

- Industry and regulators should work together with government agencies and other stakeholders to synthesize the current state of information and perform the analyses, investigations, and any necessary demonstrations to validate technologies for improved well control. Canada is using an approach described in the text box entitled

"Evaluating Same Season Relief Well Equivalency."

- The benefits and risks of advanced control technologies should be assessed relative to the current practice of a same season relief well. Alternatives include subsea shut-in devices independent of the standard blowout preventer. These alternatives could prevent or significantly reduce the amount of spilled oil compared to a relief well, which could take a month or more to be effective. This assessment should consider the benefits and risks of leaving the well secured using these technologies over the winter season.

  DOE should work with industry and DOI to perform this assessment, engaging the National Laboratories, the National Academies, and other stakeholders as appropriate. Assessment techniques could include those used in the nuclear, aviation, and petrochemical industries, such as precursor analysis and quantitative risk assessment, where the DOE already has expertise.

- Future regulation and permit requirements should be informed by the results of this analysis including required demonstrations and testing. DOI, DOE, and the National Laboratories should witness these demonstrations of improved well control devices and include appropriate observers from the stakeholder community.

2. Oil Spill Response in Ice

While oil spill prevention is industry's primary focus, the probability of a spill can never be reduced completely to zero. Therefore, effective oil spill response capability will be critical to Arctic development. Over the past four decades, BSEE, other domestic and international agencies, and industry have conducted significant research on oil spill response techniques in Arctic conditions.

Industry currently has the capability to respond quickly and effectively to an oil spill in Arctic conditions, in part by having oil spill response vessels and key response assets stationed at the drilling site, but many stakeholders remain concerned, underscoring the need for further collaborative work.

- Government agencies should participate in the ongoing and future oil spill response Joint Industry Programs. As an example, the ongoing ART JIP (2012-2016) includes projects to:
  - Conduct field testing, using relatively small amounts of oil, to further test the efficacy of tactics and strategies for spill response
  - Advance remote sensing technology for tracking of spilled oil
  - Improve and enhance fate and effects models and model inputs for varying sizes of oil spills
  - Advance research in support of other options to mechanical recovery, including dispersants, in-situ burning, and chemical herders.
- Regulators should continue to evaluate oil spill response technologies in Arctic conditions, considering past and ongoing research. Future regulations and oil spill response plans should consider this evaluation such that other technologies could be used as primary response options.
  - A Net Environmental Benefits Assessment (NEBA)-based decision process should be used collaboratively by government decision-makers with industry assistance to assess and approve all available oil spill response technologies to achieve the greatest reduction of adverse environmental impacts.
  - Preapproval options should be reviewed and provided to facilitate rapid response for dispersants and in-situ burning where supported by NEBA.
- Consistent with the Oil Pollution Act of 1990, the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) should play a stronger role in conducting, coordinating, prioritizing, and supporting oil spill response research and technology development, across federal and state agencies, with industry and academia, and internationally.
- Recognizing the importance of field trials and the need to coordinate timely permits across multiple agencies (federal, state, local), ICCOPR or the new Arctic Executive Steering Committee could facilitate a collaborative process to conduct Arctic field oil release experiments.
- The National Laboratories should pursue development of oil simulants to facilitate field testing

EVALUATING SAME SEASON RELIEF WELL EQUIVALENCY
THE CANADIAN EXPERIENCE

National Energy Board (NEB) Same Season Relief Well Hearing

In 2010, the Canadian National Energy Board (NEB), the government body responsible for regulating offshore drilling in the Canadian Arctic, initiated a public process to review the long-standing Same Season Relief Well Policy and provide operators an opportunity to propose alternative technology approaches that would meet or exceed the intended outcome of the Policy. Following the Macondo incident, the NEB cancelled the Same Season Relief Well Hearing process and replaced it with a more broadly scoped review of all components of drilling activities in the Canadian Arctic Offshore. This process was initiated as the NEB Arctic Offshore Drilling Review.

NEB Arctic Offshore Drilling Review (AODR)

The objective was to provide a comprehensive review of Arctic offshore drilling preparedness including:

- Drilling safely while protecting the environment
- Responding effectively when things go wrong
- Learnings from past incidents
- Filing requirements for applicants seeking an authorization to drill.

The NEB conducted the review as a fully public process. All interested parties within Canada were given an opportunity to provide input into the review design and process. The NEB released a comprehensive written request for information on the above topic areas, and all written submissions were made publicly accessible via the NEB website. After the written review period, a week-long workshop was conducted to discuss the content of the Review.

The NEB held community meetings across Yukon, Northwest Territories and Nunavut to hear residents' views. All interested parties within Canada were invited to provide written comments. Inuvik workshop attendance included more than 200 representatives from government, communities, industry, academia, ENGOs, the general public, and government representatives from Alaska and Greenland.

The NEB released two final reports following the review:

- *Review of Offshore Drilling in the Canadian Arctic: Preparing for the Future*
- *Filing Requirements for Offshore Drilling in the Canadian Arctic.*

The Filing Requirements outlined the necessary components a proponent must provide in a submission for a drilling program. The NEB reaffirmed the Same Season Relief Well Policy, but stated they would consider proposals that would meet or exceed the intended outcome of the Policy on a case-by-case basis.

NEB Advance Ruling on or Same Season Relief Well Policy

The AODR proceedings clearly demonstrated the benefit of applying the most current proven technology to planned drilling programs. Two separate industry applications were initiated requesting an advance ruling on proposed alternative methods for a same season relief well.

The National Energy Board has yet to determine the final format of the process to provide the advance rulings. The NEB is expected to continue its commitment to public involvement in the process. As of March 2015, the review process is underway.

Case Study: Evaluating Same Season Relief Well Equivalency Related Technology Development

The Chevron/Cameron Alternative Well Kill System (AWKS)

- In 2008, Chevron identified the need for and initiated an R&D project that would meet or exceed the required Same Season Relief Well Policy in the Canadian Arctic offshore.
- Technology selection criteria included consideration of a tangible technology that could be demonstrated to, and understood by, local stakeholders who were involved directly in the project team.
- Project initiated in 2008 as a technology joint venture between Chevron and Cameron, with the goal of developing a step change in best available BOP technology.
- Developed the concept of a fully independent safety package including two shear rams capable of simultaneously shearing and sealing heavier wall, larger diameter tubulars and casing than was currently possible.
- A proof of concept testing video distributed to local stakeholders and regulators with the intent of educating interested parties on the project scope and objectives.
- Consultation was conducted with local stakeholders on equipment testing criteria.
- Held numerous engagement and education sessions with local community stakeholders, including equipment demonstrations.
- Joint representation with local stakeholders at major conferences discussing both industry and community perspectives on the SSRW Equivalency issue.
- Successfully completed internal testing of AWKS in May 2014, thereby making AWKS ready for commercial deployment.

of oil spill response technologies in lieu of using crude oil.

- Industry and the federal government, including the National Laboratories, should collaborate to determine if any existing military technology or other research in the area of remote sensing, including satellite access, can be made available and commercialized for oil spill response.

3. Increasing Knowledge of Arctic Ecology and Human Environment

Research has been conducted by industry, government, and academia for decades, and much is known about the Arctic ecology and native peoples. Obtaining higher confidence in ecological and human environment conditions and interactions would support improved science-based decision-making. Key study areas include enhancing the ability to determine impacts, better defining special status species listings and critical habitats, and improving ecological resource management. This research would promote prudent development.

- Trustee agencies, such as U.S. Fish and Wildlife and U.S. National Marine Fisheries, could execute multi-year population assessment and monitoring of key Arctic species, including the Pacific walrus, ice seals, polar bears, and beluga whales.
- Under its legislative mandate to coordinate scientific data that will provide a better understanding of the ecosystems of the North Slope of Alaska, the North Slope Science Initiative (NSSI) should work with trustee agencies, industry, and other stakeholders to define, develop, and maintain

an ecological monitoring program to detect and interpret change in the Arctic ecosystem.

- DOE, other governmental entities, the National Laboratories, and industry should execute additional studies of fate and effects of oil under Arctic conditions and upon Arctic species: toxicity of oil, oil residue, and dispersants to key Arctic species, including Arctic cod and plankton, the rate and extent of biodegradation of oil in Arctic environments, and the interactions of oil with under-ice communities.

- The federal government, namely the National Marine Fisheries Service, should work collaboratively with industry and other stakeholders to develop a coordinated strategy for industry and government research on interactions between energy development and key species.

  - Specifically, the improved understanding of the response of ice-dependent species to specific industry activities (ice management, seismic, drilling, etc.) would inform operational planning and permitting as well as designations and management of critical habitats.

  - The National Marine Fisheries Service should join the Bureau of Ocean Energy Management (BOEM) in participation as an observer in the Sound and Marine Life joint industry program.

- An updated Social Impacts Assessment protocol is needed to improve consistency and ability to integrate baseline data across agencies, industry, and communities.

  - The Department of State, via the Senior Arctic Official and the Arctic Council Sustainable Development Working Group, should update the Social Impacts Assessment protocol, leveraging the state of Alaska's coordinated framework for a Health Impact Assessment, recently developed by the Alaska Department of Natural Resources and Department of Health, in partnership with federal agencies, the Alaska Native Tribal Health Consortium, and local boroughs.

  - The Council for Environmental Quality could include this updated protocol in the existing Environmental Impact Assessment protocol under the National Environmental Policy Act (NEPA).

- The NSSI's mandate is to provide scientific information on both environmental and social science to its 14 federal, state, and local government members and to the public. Recognizing the importance of improved collaboration and coordination of human environment research activities, enhancement of NSSI capacity and capability in social science should be pursued to enable the NSSI to deliver on its mandate.

- The NSSI should work with the Interagency Arctic Research Policy Committee and other stakeholders to establish appropriate protocols and gather best practices for the effective collection and integration of traditional knowledge, existing science, community engagement, and resource management.

- Industry, government, and academia should work to establish data sharing agreements and promote use of platforms such as the Alaska Ocean Observing System and the University of Alaska Fairbanks/NSSI catalog.

Economic Viability

Prudent development in the offshore Arctic requires exploration activity and success to find an oil accumulation of sufficient size and quality to justify the substantial investments required to develop in a remote location. This section includes recommendations that could enable economically viable exploration and development.

4. Technologies to Safely Extend the Drilling Season

Extending the drilling season available for exploration in the U.S. offshore Arctic is vital to economic exploration and subsequent development. In addition to the limitations on the drilling season posed by the physical Arctic conditions, concerns regarding oil spill response in ice and the requirement for a same season relief well in ice-free conditions further limit the time available to drill exploration wells.

- Industry and regulators should work together with other government agencies and stakeholders to synthesize the current and evolving state of knowledge and perform the analysis, investigations, and any necessary demonstrations to validate technologies and capabilities that could safely extend the useful drilling season length.

- These technologies include recent advancements in source control and containment and improvements in oil spill response in ice discussed earlier.
- The capabilities include the drilling rig, ice management vessels, and emergency and oil spill response capability.

5. Lease Terms Appropriate to Arctic Conditions

The short useful working season in the U.S. Arctic offshore makes it difficult to develop an opportunity within the same time frame achievable with the lease terms applied in other parts of the United States that experience year-round working seasons. This challenge reduces the competitiveness of Alaskan OCS opportunities compared to other global Arctic regions.

- The Department of Energy, working in collaboration with the Department of the Interior and with input from other stakeholders, should conduct an assessment of the timelines required to progress an offshore exploration prospect from lease through a decision to proceed to development. This assessment should be completed before the next lease sale.
  - These timelines should include the time to plan, permit, and safely execute seismic surveys, exploration drilling, and any necessary appraisal wells, as well as conduct and interpret results from these activities. The time required to complete engineering studies, including an economic feasibility assessment, to enable a development decision should also be included.
  - The assessment should consider the season length limitations imposed by the Arctic operating environment and ecological/subsistence considerations, as well as approaches used by other Arctic nations with similar geological and operating environments.
  - If warranted based on this assessment, congressional action to amend the Outer Continental Shelf Lands Act to reflect the lease term for Arctic operations could be pursued. For existing leases, the Department of the Interior could clarify suspension authority.

6. Effective Policies and Regulations

Oil and gas exploration and development in the Arctic is extensively regulated. Drilling an offshore exploration well in the Arctic currently requires permitting from at least 12 principal state and federal agencies; progressing offshore development in the Arctic would require about 60 permit types through 10 federal agencies. Regulations should be adaptive to reflect advances in technology and ecological research, and achieve an acceptable balance considering safety, environmental stewardship, economic viability, energy security, and compatibility with the interests of the local communities. Prescriptive regulation may inhibit the development of new, improved technologies by suppressing the potential opportunity that drives advancement.

- Policies and regulations should encourage innovation by providing for incorporation of technological advancements.
  - Where authority already exists to consider industry proposals that provide for equivalent or better levels of safety and environmental protection, such as that already established in 30 CFR 250.141, use of that authority should be encouraged.
  - BSEE should continue to review existing and new regulations to identify candidate areas for implementation of performance-based regulation, considering lessons from other jurisdictions.
  - Staff development in Arctic-specific operational and regulatory requirements should be pursued within regulatory agencies.
- Policies and regulations should reflect improved ecological understanding from ongoing research and monitoring. Regulators could use their authority to designate or update appropriate mitigations based on more recently developed science.
- Regulators should identify, prioritize, coordinate, and communicate permit information requirements to the operators in a timely manner.
- The Administration should champion policies that enable effective and efficient logistics and infrastructure. Examples of current requirements that unnecessarily constrain Arctic development include:
  - Limited access to federal lands for oil and gas transportation systems where no practical alternative exists

- Presupposing oil transport solutions for potential new discoveries
- The Jones Act rules on tankers and support vessels mandate largely unavailable and noncompetitively priced ships, unduly increasing the cost of operations in the U.S. Arctic.

7. Enabling Infrastructure

The Arctic is characterized by its climate, remoteness, sparse population, and long distance between population centers. This has resulted in limited infrastructure development including ports, airfields, roads, rail, communication networks, and fuel and electricity delivery systems compared with other regions. To promote prudent development, additional capacity is needed.

There are many synergies between the types of infrastructure that would facilitate Arctic oil and gas exploration and development and the infrastructure needs of local communities, the state of Alaska, and elements of the U.S. Armed Forces such as the Coast Guard and Navy. Investments by any party in new or upgraded airfields, ports, roads, navigational aids, satellites, radars, and communication facilities could confer wider benefits. The Coast Guard and Navy, which play key roles in the areas of safety, search and rescue, and national defense, are subject to many of the same resupply and support requirements in the Arctic as the oil and gas industry.

- Local, state, and federal government agencies should coordinate infrastructure planning by carrying out, where possible, joint scenario planning to identify the intersection of mutual needs such as airfields, ports, roads, and communications to identify opportunities for investment synergies. Planning needs and considerations should include those from the oil and gas industry, Navy, Coast Guard, and local stakeholders, and include options to extend the life of the TAPS pipeline.
- Recognizing the potential for increasing needs in the Arctic from all industries, the U.S. Coast Guard icebreaker fleet and presence should be expanded and extended into the shoulder season to promote transportation safety, national security, and a longer exploration season.
- Recognizing the potential for increased vessel traffic in the Bering Strait in the future, actions should be taken now to improve vessel safety:
  - The United States should support implementation of the International Maritime Organization Polar Code to ensure that vessel traffic traversing the Bering Strait is suitably designed and constructed per the requirements of the code.
  - NOAA should complete hydrographic mapping of the region.
  - The U.S. Coast Guard should improve regional navigational and communication aids and continue development of comprehensive Arctic marine traffic awareness systems.
- NOAA should maintain at least the current capability of polar observing weather satellites and evaluate the merits of a new publicly accessible synthetic aperture radar satellite.
- Recognizing the potential of unmanned aircraft to significantly improve current monitoring and sensing capabilities, all stakeholders should work with the Federal Aviation Administration (FAA) Investigative Program to support permitting the use of unmanned aircrafts in the Arctic. This technology is currently available and would improve safety and efficiency of logistics support, oil spill response, ice characterization, and environmental monitoring.

Government Leadership and Policy Coordination

The specifics of the extensive federal and state regulatory process for the Arctic ultimately reflect the policy of the federal and Alaska governments. In addition to guidance on potential research to support prudent development of Arctic oil and gas resources, Secretary of Energy Moniz also requested the NPC's input on implementation of the U.S. NSAR and considerations as the United States assumes leadership of the Arctic Council in 2015.

8. Domestic Leadership and Policy Coordination

There are 39 federal agencies participating in the Arctic Policy Group and 27 agencies and working groups listed in the IPNSAR. Most of these organizations are engaged in the conduct of Arctic-oriented research that could be applicable in some way to oil and gas exploration and development. However, despite the critical economic and national and energy security importance of oil and gas activities to a wide range of stakeholders, there is no clear advocate for Arctic oil and gas development at the federal level. Central leadership and collaboration and coordination of activities would improve the potential for prudent development. A January 2015 Executive Order formed a new Arctic Executive Steering Committee to provide overall coordination.

- The Arctic Executive Steering Committee should:
  - Reaffirm U.S. commitment to prudent Arctic oil and gas development and U.S. leadership in the region.
  - Assess alignment across federal agencies in advancing prudent Arctic oil and gas development.
  - Request DOE and Department of Commerce to partner to inform U.S. policymakers across federal departments and agencies about the economic, energy, and national security benefits of prudent Arctic oil and gas development, consistent with the DOE's mandate and the Department of Commerce's recently announced Arctic Affinity group.
  - Clarify the process by which it will collaborate with the state of Alaska, Alaska Native tribal governments, and other stakeholders.
- The Arctic Executive Steering Committee as part of its mandated gap analysis should:
  - Request regulators to compile a comprehensive and integrated inventory of regulatory requirements for offshore Arctic oil and gas exploration and development.
  - Recognizing the significant progress by the Interagency Working Group on coordination of permitting in Alaska, the Arctic Executive Steering Committee should, as part of its gap analysis:
    - Review lessons learned for application to broader coordination of opportunities and identify areas for improvement.
    - Recalibrate the existing Interagency Working Group to refine its mission and enhance its capabilities to coordinate Arctic activities and permitting.
    - Review the effectiveness of DOE participation in the working group.
- The Department of Energy should designate a senior advisor to support its representative on the Arctic Executive Steering Committee and be a focal point for Arctic policy, including:
  - Producing a department-wide Arctic strategy that clarifies its implementation of the NSAR
  - Advancing prudent Arctic oil and gas development
  - Coordinating with the U.S. Arctic Council Chairman
  - Coordinating the department's Arctic science and technology, integrated analysis, and research agenda and effecting full coordination and engagement of the National Laboratories.
- The Department of Energy should engage Alaska institutions including the state of Alaska in the planning and conduct of its Arctic initiatives and consider public-private partnerships and data sharing platforms similar to the Alaska Ocean Observing System.

9. U.S. Chairmanship of the Arctic Council

One of the government's key priorities proposed for the Arctic Council Chairmanship is to improve the economic and living conditions of the people of the North. Consistent with benefits realized from onshore Arctic development since the 1970s, prudent development of U.S. offshore Arctic potential would help accomplish this. With the United States assuming chairmanship of the Arctic Council in April 2015, there is an opportunity for the U.S. government to internationally promote its objectives as stated in the U.S. NSAR, which is to develop energy resources in a sustainable manner that respects the environment and the interests and cultures of indigenous peoples.

- As Arctic Council members implement the two internationally legally binding agreements on search and rescue (2011) and on oil pollution preparedness and response (2013), the U.S. government should encourage engagement and participation with the international energy industry in the conduct of its search and rescue table top exercise in May 2015 and the full-scale exercise in the summer of 2016.

- The U.S. government should seek to strengthen the Arctic Economic Council's formal interaction and engagement with the Arctic Council as well as to promote its business advisory role.

To assist readers with a particular interest in research, regulatory improvement, or leadership/policy opportunities, Appendix C of the 2015 report duplicates the recommendations above with color coding to reflect recommendation type.