OIL & GAS TECHNOLOGIES IN ARCTIC REGION

Joy Gohil
Department of Mechanical engineering (B.E.),
Silver Oak College of Engineering & Technology,
Gujarat Technological University
Ahmedabad, Gujarat State, INDIA

Abstract- This report examines the gap that exists between the growing threat of a major oil spill in the Arctic and the capacity that exists to respond to it. Its key conclusion is twofold:

1. Mounting an effective response to a major oil spill in the Arctic is presently not possible due to enormous environmental challenges, a lack of capacity and the severe limitations of current response methods in ice-covered waters. 2. Due to the Arctic's remoteness and extreme weather, there is also a high percentage of time when no response, however ineffective, could even be attempted.

This is what is now known, in published literature, as "the response gap." While response gaps exist for many areas where oil and gas extraction takes place, nowhere is the gap as large as it is in the Arctic.

From a rich profusion of phytoplankton at the bottom of the food chain to polar bears at the top of it, the Arctic is home to a vast assembly of species that could be gravely impacted by an oil spill. Oil trapped in fall ice would be released in spring melt, posing a long-term threat to wildlife. More important, the Arctic is the world's thermostat, helping to keep global temperatures in check. At a time when our climate is changing, the importance of protecting the stability of the Arctic ecosystem cannot be overstated. We cannot afford the risk of a Deepwater Horizon disaster occurring in the Arctic. Until such time as we understand the Arctic response gap, and have the means and measures in place to close it, drilling for oil in the Arctic is a risk that is far too high to take.

Keywords- Oil & Gas, Offshore, Technologies, Drilling, Arctic, Mechanical, Advance Engineering, Petroleum, Production.

INTRODUCTION:

Lessons from the Gulf The BP Deepwater Horizon oil spill raises urgent and troubling questions about the ability both to prevent a major offshore oil spill and to respond effectively when one occurs. It will take years before the full extent of the ecological and economic damage done to the Gulf of Mexico is fully understood. But of the conclusions that can already be drawn from the worst accidental oil spill in history, the most obvious is this: An enormous gap exists between the growing risks of drilling for oil in new frontiers and the capacity to manage those risks when disaster strikes. As the world's supply of easily accessible oil and gas reserves begins to run dry, even as demand for energy grows, major energy companies have invested heavily in the development of new technologies to tap reserves previously considered physically inaccessible or economically impractical to recover. Unfortunately, this effort by companies to extend the reach of their drill bits into deeper waters, and into ever more remote regions of the planet, has not been matched by a similar level of investment in the technology needed to contain and clean up oil spills occurring under these more challenging conditions. Indeed, while there have been some promising (but still largely unproven) advances in the development of new response technologies, the basic tool kit for cleaning up an oil spill—booms, skimmers and chemical dispersants—hasn't changed significantly in 20 years.1 This imbalance between the technology to drill in more risk-prone environments and the means to deal with the consequences when something goes wrong has been largely dismissed by the oil industry, which contends that improved safeguards make the likelihood of catastrophic spills a receding possibility. It is true that major oil spills from tankers traveling through U.S. waters have dropped dramatically since Congress, in the wake of the Exxon Valdez disaster, tightened legal requirements on shipping with passage of the 1990 Oil Pollution Act. But over the same time period, the number of spills from offshore rigs and pipelines in U.S. waters actually increased more than fivefold, from an average of four spills a year in the 1990s to an average of 22 spills annually over the past five years. From 2000 through 2009, BP had the highest number of spills (23), while Shell was a close second with 21.2 The bottom line is that where there is offshore drilling, there is the risk—in time, even the inevitability—of an oil spill. There is no technology that is truly fail-safe—especially when mechanical failure is compounded by human error, lack of proper oversight or the temptation to cut operational corners for profit's sake. Prior to April 20, 2010, the Deepwater Horizon rig was touted as one of the most technologically advanced drilling platforms in the world. Yet, from the alarms that didn't go off to the blowout preventer that malfunctioned, one by one, all its fail-safe devices failed. In the wake of the Deepwater disaster, the debate over offshore drilling has intensified. While we strongly believe in the need to transition away from fossil fuels altogether to deal with the over-arching threat of climate change, World Wildlife Fund's position on offshore drilling is that it should not proceed in ecologically sensitive areas until the capability to respond rapidly and effectively to a spill is demonstrably in place. North to Alaska Nowhere is the potential for catastrophic damage to the environment greater, and nowhere is the gap between the risk of a major spill and our ability to contain it wider, than it is in the Arctic (see Figure 1), the focus of this report. Oil spills can be devastating to marine environments even when conditions are conducive to a rapid spill response. In the Gulf of Mexico, those conditions were as close to being ideal as one could expect: temperate weather and easy access to ports, communications facilities, and other infrastructure critical to both mounting and sustaining a large-scale response. None of this exists in the Arctic. In the Beaufort and Chukchi seas, where Shell is pressing to begin exploratory drilling next year, conditions are characterized by moving packs of sea ice, extreme storms, heavy seas, subzero temperatures and around-the clock darkness for much of the year. There are no industrial ports, no nearby airports, no roads or available housing for the crews and support staff needed to respond to a major spill. The nearest Coast Guard station is more than 1,000 miles away. These limitations are discussed in more detail in Section V of this report. But the bottom line is that a major offshore oil spill in the Arctic would be a catastrophe—both because of the damage it would do to a delicately balanced ecosystem and because there is very little that could be done to contain it. These concerns assume new urgency in view of the growing impact of climate change, which is affecting the Arctic more rapidly and more radically than any other part of the planet. Permafrost is thawing and the polar ice cap is shrinking three times faster than experts were predicting just a few years ago. At this pace, the Arctic Ocean is likely to be ice free in summer within 20 years. What is an unmitigated environmental disaster to conservationists, however, is a potential bonanza to the oil industry: an opportunity to finally tap one of the largest remaining reserves of oil and gas in the world. Alaska's Arctic is for them the final frontier and they have invested heavily in its development. Shell alone has invested roughly $3 billion to purchase leases and prepare for exploratory drilling in the Beaufort and Chukchi seas next year.3 this report examines the capacity to respond to a spill in the Alaskan Arctic in light of the oil industry's ambitions to expand drilling there. The first section considers the growing risk of a major Arctic spill and some of its ecosystem impacts. The next section surveys the main methods available to clean up offshore oil spills and the challenges of applying them in the Arctic. In the next two sections, we define the concept of a "response gap," discuss its implications for drilling in the Arctic, and take a closer look at the logistical and infrastructural challenges that spill responders would face. Section VI takes a critical look at response capacity and contingency planning for an Arctic spill in light of the response gap. Finally, we offer a set of general recommendations to help narrow that gap through stricter safeguards and improved response capacity. Before we delve into the details, however, there is a simple question that merits posing: Why should we care about the Arctic when most of us don't live there?

Planetary Keystone the Arctic and the subarctic regions surrounding it are important for many reasons. One is their enormous biological diversity: a kaleidoscopic array of land and seascapes supporting millions of migrating birds and charismatic species such as polar bears, walruses, narwhals and sea otters. Economics is another: Alaskan fisheries are among the richest in the world. Their $2.2 billion in annual catch fills the frozen food sections and seafood counters of supermarkets across the nation. However, there is another reason why the Arctic is not just important, but among the most important places on the face of the Earth. A keystone species is generally defined as one whose removal from an ecosystem triggers a cascade of changes affecting other species in that ecosystem. The same can be said of the Arctic in relation to the rest of the world. With feedback mechanisms that affect ocean currents and influence climate patterns, the Arctic functions like a global thermostat. Heat balance, ocean circulation patterns and the carbon cycle are all related to its regulatory and carbon storage functions. Disrupt these functions and we effect far-reaching changes in the conditions under which life has existed on Earth for thousands of years. In the context of climate change, the Arctic is a keystone ecosystem for the entire planet. Unfortunately, some of these disruptions are happening already as climate change melts sea ice and thaws the Arctic tundra. The Arctic's sea ice cover reflects sunlight and therefore heat. As the ice melts, that heat is absorbed by the salt water, whose temperature, salinity and density all begin to change in ways that impact global ocean circulation patterns. On land, beneath the Arctic tundra, are immense pools of frozen methane—a greenhouse gas far more potent than carbon dioxide. As the tundra thaws, the risk of this methane escaping increases.4 Were this to happen, the consequences would be dire and global in scope. As we continue not just to spill but to burn the fossil fuels that cause climate change, we are nudging the Arctic toward a meltdown that will make sea levels and temperatures rise even faster, with potentially catastrophic consequences for all life on Earth—no matter where one lives it. For the sake of the planet, losing the Arctic is not an option. Mitigating the impact of climate change their ultimately depends upon our getting serious about replacing fossil fuels with non-carbon-based renewable energies. Until we demonstrate the will and good sense to do that, however, the Arctic needs to be protected from other environmental threats that, compounded by the stress of climate change, undermine its resiliency and hasten its demise. Chief among those threats is offshore drilling—especially in the absence of any credible and tested means of responding effectively to a major spill. Future technological advances may give us those means, but this report argues that we do not have them yet and that we should not drill in the Arctic until we do.

Figure 1. Map of Arctic and sub-Arctic regions

ARCTIC OIL SPILL RISKS AND IMPACTS:

Until the Deepwater Horizon disaster, the 1989 Exxon Valdez oil spill in Alaska's Prince William Sound stood as the worst in U.S. history—one whose ecological impacts are still being felt today, more than 20 years later. There have been other spills, both on and off Alaskan shores, since then—including one in the Aleutians in 2004 and another in Prudhoe Bay in 2006. But until now, a major spill has not occurred in the Arctic. This is not due to an exemplary safety record, but to the fact that most of the Arctic has been inaccessible to offshore oil and gas exploration because of its remoteness and extreme environment. However, as rising global temperatures start to melt the sea ice that has been the Arctic's first line of defense against an encroaching world, all this is changing. Within 20 years—perhaps sooner, according to some researchers—the Arctic Ocean will be ice free in the summer.5 the long-sought Northwest Passage will soon be open to transoceanic shipping throughout much or even most of the year. New oceanic routes made possible by changing sea ice conditions mean more shipping, with increased probabilities of accidents and oil spills.6 Existing routes will become more congested with vessel traffic carrying oil both as cargo and fuel. New sea routes will be exposed to the risk of pollution and spills for the first time. The world's major oil companies also are gearing up for what, if it is not carefully managed, could be the next Gold Rush—a race to mine Arctic waters for what the U.S.

Geological Survey describes as possibly the "largest unexplored prospective area for petroleum remaining on Earth."7 Indeed, the rush has already started. In 2008, its last year in office, the Bush Administration opened a vast area of the Chukchi Sea to leasing for the first time in more than a decade. Oil companies bid nearly

$3.4 billion—a record amount—on 488 blocks within the nearly 30 million acres opened for drilling, in spite of the fact that little is yet known about the impacts drilling would have on the marine environment.8 Marine spills can result from any phase of oil extraction, storage or transportation: from well blowouts during subsea exploration or production, acute or slow releases from subsea pipelines, releases from on-land storage tanks or pipelines that travel to water, or accidents involving oil transportation vessels or vessels carrying large quantities of fuel oil. Dynamic ice cover, low temperatures, reduced visibility or complete darkness, high winds, and extreme storms add to the probability of an accident or error in the harsh Arctic environment.9 The sea ice may be melting, but the Arctic is, and will remain, among the harshest, coldest and most remote places on Earth. Just as the risks of a spill could be greater in the Arctic, so could the impacts. Oil persists longer in Arctic conditions, both because it evaporates more slowly and because it can get trapped in or under ice, which makes it less accessible to bacterial degradation. Population recovery after exposure to an oil spill also may be slow because many Arctic species have relatively long life spans and slower generational turnover.10 Recently published research suggests that the long-term consequences of oil spills to temperate and subarctic coastal environments may persist well beyond initial projections.11 Similar impacts also could prevail along Arctic shorelines. Arctic wildlife particularly sensitive to oil drilling and/or pollution include seabirds, polar bears, bearded and ribbon seals, walruses, and beluga and bowhead whales. Polar bears rely on both their body fat and dense fur for insulation and will vigorously groom themselves in an attempt to clean their fur if it becomes contaminated by oil, studies have shown. Aspiration or ingestion of the oil can cause renal failure and dysfunction of red blood cell production and lead to death. The bears are also highly sensitive to disturbances during denning, with most of their dens located on sea ice plates. Walruses in the Chukchi and Beaufort seas spend about a third of their time hauled out on ice sheets and, like polar bears, are extremely sensitive to habitat disturbances like those that would be caused by response activities. Beluga and bowhead whales follow wind and ocean currents as they travel through the Chukchi and Beaufort seas along migration routes that, because they are likely to be coincident with the trajectory of an oil spill, can increase their exposure to toxic contamination. Whales also are highly sensitive to noise, such as that which would be produced by seismic exploration activities. Since oil trapped under ice in the fall or winter can be released with the spring melt, an Arctic oil spill can affect wildlife not only at the time of the spill itself, but seasons later.

RESPONSE METHODS AND TECHNOLOGIES:

The Arctic environment poses unique challenges to traditional oil spill response technologies, all of which were developed for use in far more temperate climates. While efforts are ongoing to develop methods more suitable for Arctic conditions, only a few have been tested in real-life conditions and most are not yet available for commercial use. Traditional oil spill response methods are generally divided into three main categories: mechanical recovery, in which oil is contained in an area using boom or natural containment and removed using skimmers and pumps; nonmechanical recovery, in which chemical countermeasures, burning or bioremediation are used to degrade or disperse an oil slick; and manual recovery, in which oil is removed using simple hand tools such as pails, shovels or nets. Most existing oil exploration, production, storage and transportation operations in Arctic waters rely on a combination of mechanical recovery and two major nonmechanical techniques—in situ burning and dispersant application—to clean up or treat spilled oil.

Typical on-water mechanical recovery system:

Mechanical recovery contains the spilled oil using booms and collects it with a skimming device for storage and disposal. Booms are deployed from vessels or anchored to fixed structures or land. A number of different kinds of skimmers exist; they use suction, oil-absorbing materials or weirs to remove oil from the water's surface. Once the oil has been recovered, it must be transferred using pumps and hoses to temporary storage prior to proper disposal.

Typical on-water in-situ burning system:

In situ burning of spilled oil involves a controlled burn of floating oil contained to the appropriate thickness. The oil is ignited by releasing a burning, gelled fuel from a helicopter or by releasing an ignition device from a vessel or other access point. If the oil is successfully ignited, some or all of it will burn off the surface of the water or ice, although there will always be some residual nonvolatile compounds that remain. This residue may float, sink or be neutrally buoyant, depending upon the type of oil spilled and the conditions of the burn. Successful ignition and burning require adequate slick thickness for ignition, minimal wind and waves, and oil that has not emulsified (incorporated water) too much. If a burn is inefficient, a mixture of unburned oil, burn residue and soot will form.13 As in mechanical recovery, oil containment for ignition can be accomplished with either natural barriers or manmade booms that are both fire resistant and able to withstand sea ice. Downwind emissions must be below threshold levels for sensitive populations.14 Chemical herders, currently under development, may thicken a slick to allow for ignition.

Typical on-water dispersant response system:

Dispersants are a group of chemicals sprayed or applied to oil slicks to accelerate the dispersion of oil into the water column. They do not remove oil from the water, but are meant to limit the amount of oil forming a slick on the water surface or shoreline by driving it into a dissolved phase. Dispersants are applied using spray nozzles, pumps and hoses, and can be applied from a vessel or aircraft. Dispersant operations are usually monitored from aircraft to make sure the application is on target. Dispersants have a limited time frame for effective application and require prompt, accurate application, with oil type, emulsification, salinity, weather conditions and sea state all aligned.

Oil and Ice each of the main response methods has its limitations, even in the temperate conditions for which it was designed. Mechanical recovery, for instance, at best captures only 20% of the oil spilled. Of the estimated 4.9 million barrels of oil that gushed into the Gulf of Mexico during the Deepwater Horizon blowout, less than 17% was recovered. Under some conditions, ice can facilitate the recovery of spilled oil, both by dampening wave action and by serving as a natural containment barrier, pooling oil in pockets of water where it can be burned or recovered. Under most conditions, however, ice severely limits the effectiveness of all three response methods and the extreme difficulty of even detecting oil trapped under ice presents an enormous and, so far, unsurmounted challenge (see Table 1).

Mechanical recovery is generally acknowledged to be ineffective in waters with more than 30% ice coverage. Booms can be moved or torn by ice, skimmers can freeze or get clogged, and oil's increased viscosity at low temperatures makes it more difficult to recover and pump. Large ocean booms work best in currents of less than 0.75 knots and in seas of under five feet. In swifter currents or higher seas, oil becomes entrained beneath the boom or splashes over it.16 "Winds, currents and wave action seriously reduce the ability of booms to contain and of skimmers to recover oil," notes a background paper by the International Tanker Owners Pollution Federation. "In practice, the most efficient recovery of oil is achieved only under calm conditions."17 In the Beaufort and Chukchi seas, wave heights in excess of seven feet and wind speeds of 15 to 20 knots occur throughout much of the year—posing a challenge to all recovery methods and rendering both mechanical recovery and the use of dispersants particularly ineffective. In situ burning is a more viable response option in some Arctic conditions, where the spilled oil has not emulsified and the slick is thick enough to burn. But conditions prevailing in most of the Arctic for most of the time are likely to impede its use. Slush ice can reduce burn effectiveness or prevent ignition, and high winds or heavy seas can make it both more difficult and extremely unsafe. One study estimates that in situ burning has an efficiency rate of only 3.4 to 6.4% in fall freeze-up conditions on open Arctic waters.18 Research is currently under way to develop a class of chemicals known as herding agents—chemicals sprayed onto oil to thicken it and thereby facilitate burning or mechanical recovery. However, concerns remain about the toxicity of some of these chemicals, and to date there are no commercially produced, EPA-approved herding agents available for use in Arctic waters. Dispersants are so ineffective in cold water that most experts discount them as a useful option in the Arctic. To work properly, they must be applied accurately, which is hard to do in conditions characterized by high winds and/or poor visibility. The use of dispersants, moreover, raises questions about their potentially toxic impact on marine life, especially small, sensitive organisms at or near the base of the Arctic food chain. While experiments are under way to create more effective cold water dispersants, none are yet available for use. The need to improve the recovery rate in ice-covered waters is cited repeatedly in technical literature. Promising advances using Ground Penetrating Radar (GPR) to detect oil spilled under ice have been reported in laboratory tests and controlled field trials. But GPR still can only detect thick slicks (one inch or more) and then only in a relatively narrow range of cases—in ice up to three feet thick when deployed from the air and in ice up to seven feet thick when deployed on the ground. GPR cannot detect thin slicks, oil trapped under new or young ice, oil in ice with ridges, or oil in ice thicker than seven feet. Detection of slicks with ground-based GPR units is also slow and very labor intensive. While research into new technologies continues, improvements in current response methods are expected to be incremental at best. The current inability to detect and map oil trapped in, under, on or among ice remains the overarching challenge, one that affects "all aspects of response to spills in ice.

Conditions: Sea Ice [1] Potential impacts on spill response General constraints: Ice can impede access to the spill area, making it difficult to track and encounter oil. Remote sensing techniques are being improved and refined to detect oil under and among sea ice, but they are not yet mature. Ice can impede or limit vessel operations, especially for smaller work boats. Boats without ice-capable hulls should not operate in heavy ice conditions. Slush ice may clog seawater intakes or accumulate in vessel sea chests.

Mechanical Recovery: Containment boom can be moved, lifted or torn by ice. Skimmer encounter rate may be reduced by ice chunks, and skimmers and pumps may clog. Limited maneuverability may prevent or delay accurate skimmer or boom deployment. Attempts to deflect the ice from recovery areas may also deflect the oil. Ice must be separated from recovered oil. Ice may provide natural containment. Reinforced vessel hulls or ice scouts may be required. Ice movement can be unpredictable or invisible. Vessel operators must be experienced in the ice conditions of the area.

In-situ burning: Certain ice conditions (i.e. slush ice) may reduce burn effectiveness or impede ignition. Fire boom deployment may become difficult or impossible. Residue recovery requires vessel support. Ice may provide natural containment, and burning in ice leads may be possible

Dispersants: Oil under ice is inaccessible to dispersant application. Ice can dampen required mixing energy. Dispersants generally less effective at lower salinities. In most regions, dispersants are not considered an operational technology for use in sea ice.

[1] "Sea ice is a prominent feature of the arctic marine environment. The generic term "sea ice" encompasses a wide range of ice conditions. Sea ice may be present year-round, or it may follow an annual freeze-melt cycle. Ice conditions may be described in terms of the formation of the ice or the percentage coverage. The World Meteorological Organisation's ice classification system and terminology are used in this report (WMO, 2005)."

Conditions: Wind

General constraints: High winds can make it difficult to deploy effectively the crew, vessels, equipment required for a response. High winds can make air operations difficult or unsafe.

Mechanical Recovery: High winds can move boom and vessels off station or tear boom off the anchor point.

In-situ burning: In-situ burning is not generally safe or feasible in high winds.

Dispersants: Accurate application of dispersants is difficult in high wind conditions.

Conditions: Temperature

General constraints: Prolonged periods of subfreezing temperatures can impact personnel safety, or require more frequent shift rotations. Extreme cold temperatures may be unsafe for human operators. Cold may cause brittle failure in some metals. Cold air may freeze sea spray, creating slick surfaces. Icing conditions may make vessels unstable.

Mechanical Recovery: Skimmers freeze up. Freezing sea spray can accumulate on boom and cause it to tear, fail or over wash. Increased oil viscosity makes it difficult to recover and pump.

In-situ burning: Extreme cold temperatures may make ignition more difficult or ineffective, and may cause burn to slow or cease.

Dispersants: Cold temperatures and increased oil viscosity may reduce dispersant effectiveness.

Conditions: Limited visibility (including months of darkness in far northern areas)

General constraints: Any condition that reduces visibility may preclude or limit oil spill response operations, particularly any involving aircraft or vessel operations. Limited visibility may make it difficult or impossible to track the spill location and movement. Fog banks make vessel or aircraft operations extremely.

Mechanical Recovery: Accurate deployment of vessels and equipment requires sufficient visibility to deploy and operate equipment. Work lights may be used during darkness, if safety allows.

In-situ burning: In-situ burning is not recommended during darkness (USCG, 2003). Aerial ignition and/or aerial monitoring require visual flight conditions.

Dispersants: Aerial application and/or aerial monitoring requires visual flight conditions. Vessel application requires visual confirmation of slick location.

Conditions: Sea state

General constraints: Booms and skimmers do not function well at high sea states. Equipment must be suitable (rated) for typical sea states. Fast currents, changing tides and short period waves can make it difficult to keep boom and vessels on station. It is dangerous to manoeuvre booms and skimmers in rough seas. A common rule-of-thumb limitation for boom is a 2-3m significant wave height.

In-situ burning: High sea states make containment and ignition difficult and potentially unsafe.

Dispersants: High sea states typically enhance the effectiveness of chemical dispersants to disperse the oil.

THE RESPONSE GAP:

"We are not prepared for a major oil spill in the Arctic environment. The Coast Guard has no offshore response capability in northern or western Alaska and we only dimly understand the science of recovering oil in broken ice."—RADM Arthur Brooks, former commander, 17th District, U.S. Coast Guard.21 The disparity between the risk of a major oil spill and the ability to respond to it has given rise in recent years to the concept of a response gap. Simply put: A response gap exists whenever activities that could result in a spill are conducted during times when extreme weather or other environmental conditions exceed the limits of available spill response systems. [illegible]

usually expressed in percentages representing the amount of time when an effective response cannot be mounted in the event of an oil spill. They are, by nature, estimates derived from the capacity of available response equipment and historical data on operating conditions in the potential area of a spill. Critical to this equation are the operating limits of available spill response systems and their effectiveness under the conditions in which they will be deployed. Particularly important here is the cumulative stress placed upon the limits of response tools and technologies by the interplay of conditions encountered in real-life situations. Tools that have been tested to perform in ice-infested waters, or in poor visibility or extreme cold, may not work as expected when confronted by all those conditions simultaneously. Much of the data essential to performing accurate response gap analyses has not yet been collected in the Arctic, but should be before offshore drilling is allowed to proceed there. Missing, for instance, is multi-year data about currents, sea states and wind, Also missing from our understanding of the Arctic is baseline scientific information about the region's ecology and distribution of flora and fauna.

While this data is not directly related to the concept of a response gap, it is critical to our understanding of the potential consequences of an oil spill and therefore the risk of drilling, especially during times when a response gap exists. As the U.S. Arctic Research Commission, the federal body charged with developing policies and goals for scientific research in the Arctic, noted in a May 2010 white paper: "Fundamental baseline scientific information is lacking for living resources in much of the region, and basic biological aspects, such as the ecology of the area, and the spatial habitat of flora and fauna that might be at risk from spills, are poorly known."23 Although major "improvements are needed in both the ability to clean up oil spilled under ice and the detection of thin oil slicks trapped under ice in Arctic and subarctic regions, little progress has been made over the past two decades" in part because "federal oil spill research efforts for Arctic conditions are fragmented, uncoordinated, underfunded and in dire, immediate need of improvement," the white paper concluded.

RESPONSE GAP ANALYSIS FOR PRINCE WILLIAM SOUND:

In 2007, a response gap analysis was completed for two areas in Prince William Sound, the site of the Exxon Valdez oil spill 18 years earlier. Data on wind, sea states, temperature and visibility were gathered from buoy observations from 2000 through 2005. More than 40,000 separate observations were used to generate the data set that was integrated into the analysis. However, currents and ice—important factors to consider when performing an Arctic response gap analysis—were not considered in the Prince William Sound case, as there was no way to measure local currents (e.g., rip tides) and ice was uncommon in the two areas analyzed. The operating limits of mechanical and non-mechanical response systems were also factored into the analysis, based on a review of published literature, existing contingency plans, manufacturers' ratings and spill response exercise reports, among other sources of information. The results were then grouped into three color-coded categories: green for when an oil spill response was judged to be possible, yellow for when a response might be possible but would be hampered by environmental conditions impairing its effectiveness, and red for when no response would be possible. The analysis concluded that no response would be possible 38% of the time on a yearly average. In the winter months, the gap was much higher,

existing 65% of the time. Worth noting here is that Prince William Sound has a much higher capacity to
respond to a spill than currently exists in the Arctic. It also has exceptional prevention measures in place during all weather conditions, including a tug escort system for laden oil tankers and transit lane closures when winds or sea states exceed prescribed levels. Both of these are examples of measures that can be put in place to help reduce the risk of spills where a response gap exists.

ON THIN ICE: OIL EXPLORATION IN THE ARCTIC:

"We weren't dealing with a single monolithic slick like . . . the Exxon Valdez. This was an uncontrolled discharge, with 53,000 barrels each day spewing in different directions and . . . creating hundreds of thousands of separate oil slicks. The United States had never dealt with that situation before."—Adm. Thad Allen, National Incident Commander, Deepwater Horizon oil spill.24 For the past 20 years, U.S. policies and procedures for responding to a spill of national significance have been based on lessons learned from the Exxon Valdez disaster, where the threat involved a vessel spilling a finite quantity of oil onto the surface of the sea. These policies focused on preventing spills after oil had been extracted and was in the process of being transported. Over the past decade, however, drilling technology has evolved, moving offshore and then into progressively deeper and more remote waters. In the process, the locus of the threat also shifted, from tankers on the surface of the sea to the wellheads beneath it. The nature of the challenge had changed, but as Adm. Allen noted in an interview with the National Journal in July, the policies and procedures in place to respond to it failed to "keep pace with those changes."25 With oil continually gushing from a hole in the sea floor a mile beneath the surface of the Gulf of Mexico, responders soon realized that the challenge of containing it was "going to dwarf what was anticipated in BP's response plan," Allen added.26 In the end, an amalgam of technology from around the world—a floating production system from the North Sea and special freestanding pipes used for drilling off the shores of Angola—had to be hastily collected and reassembled in the Gulf of Mexico in a daring experiment that had never been tried before. "Our solution amounted to the North Sea meets Angola in the Gulf of Mexico," Allen said. "Lashing all that together took 85 days, because none of it had been put together that way in the past."27 Try to imagine replicating that kind of experiment in the Arctic. The oil companies are quick to point out that the challenges of capping a blowout in the Gulf of Mexico are different from what might be encountered in the Beaufort and Chukchi seas, where the waters are much shallower. But while that is true, the risk of a blowout is not related to depth, per se. Last year's blowout in the Timor Sea, which took 74 days to cap, occurred in 261 feet of water. The IXTOC I, the worst accidental spill in history until the Deepwater Horizon disaster, took place in only 160 feet of water. Both of these catastrophes occurred in depths and pressures comparable to those found in the Beaufort and Chukchi seas. In fact, data compiled by the former Minerals Management Service indicates that most blowouts occur in shallow-water wells.28 The Arctic, moreover, also poses very formidable challenges not found in the waters of the Gulf of Mexico. As documented by the National Oceanic and Atmospheric Administration and the National Weather Service, conditions in Barrow, on the northwestern coast of Alaska where the Chukchi and Beaufort seas meet, are typical of the region. Freezing temperatures are the norm 324 days out of the year, with whiteout conditions from wind-whipped snow being common. Snow can fall in any season but is heaviest in October. Dense fog with zero visibility occurs 65 days a year on average, mostly in the summer months. The polar night begins in mid-November and continues through most of January.29 Given such harsh conditions and the lack of roads, airports and other land-based infrastructure, the only way to bring in heavy equipment is by ship. But dense sea ice is the rule for more than half the year and even icebreakers—of which the Coast Guard at present has only one that is functioning—can't ensure access in winter.30 Bad enough already, these conditions are expected to get worse. Climate change may be melting the sea ice, but as it does so, scientists are predicting storm intensity will grow due to an increase in the exchange of energy between an expanding expanse of open water and the atmosphere. More open water will also allow for greater wave height.31 In the absence of hotels, restaurants, roads, grocery stores and medical facilities, where would the hundreds of personnel required to respond to a major spill be housed and fed? Even if food and other supplies could be airlifted onto the tundra, under conditions of frequently poor visibility, there are no industrial ports to unload heavy equipment. The closest Coast Guard station is on Kodiak Island—1,000 very hard miles away. Several small coastal villages in the region—inhabited predominantly by native communities that rely on the marine resources of the Chukchi and Beaufort Seas for subsistence—could provide a base for some logistical support, but expectations that they can, or even should, form the foundation of a major spill response effort are unrealistic. Shell's 2010 contingency plan for a Chukchi spill identifies the village of Wainwright as the marine hub for a response effort—when Wainwright (population: 494) doesn't even have a dock.

CONTINGENCY PLANNING:

In Alaska, response roles and responsibilities in the event of an oil spill are delineated in a joint state-federal preparedness plan administered by the Alaska Department of Environmental Conservation, the U.S. Coast Guard (17th District) and the Environmental Protection Agency.33 As with other regional plans, however, the actual job of capping a well and containing a spill rests largely with the oil company responsible for the spill. The companies, in turn, often rely on subcontractors for cleanup services. In the Arctic coastal waters off Alaska's North Slope, those responsibilities are contracted to Alaska Clean Seas (ACS), an oil spill response cooperative whose members include companies prospecting for oil and/or gas in the Alaskan Outer Continental Shelf and its adjacent shorelines. Within 72 hours of the Deepwater Horizon blowout on April 20, some 1,000 responders were on the scene, struggling to cap the well and contain the oil gushing into the Gulf of Mexico—an effort that would ultimately take three months and involve more than 40,000 personnel and nearly 5,000 vessels, along with scores of aircraft, mobile drilling units and remotely operated vehicles.34 According to its website, ACS's rapid response capacity includes its 78 full-time personnel and another 115 temporary workers who could be mobilized on short notice.35 With only one working ice breaker in its arsenal, the Coast Guard would also face an enormous challenge responding to a spill in the Arctic. All of the Coast Guard's assets are based well below the Arctic Circle and would have to travel vast distances to get there. Moreover, "its surface and air assets are limited by fuel capacity and the distance to fuel sources," according to a recently released report by the Government Accounting Office. As a result, cutters and aircraft are able to operate in the Arctic only "for a few days or a few hours on scene before returning for fuel," the report added.36 Given the lack of appropriate infrastructure to support a sustained spill response, the Coast Guard would require a "minimum of 18-24 hours lead time" to assemble supplies and spare parts before it could begin operations in the Arctic, the GAO said. Even assuming such obstacles could be overcome, the challenge of containing a major spill in the Arctic could very well overwhelm any conceivable response. The Arctic response gap has yet to be formally quantified, But Table 2 illustrates one aspect of its enormity through a comparison between the resources brought to bear in the Gulf of Mexico within the first 24 hours of the Deepwater disaster and those that would be available, based on known inventories and response capacities, in the Chukchi Sea during the first 24 hours of a major spill. With Shell pressing to drill in 2011, the company's oil spill and contingency plans need to be re-examined in light of the Deepwater Horizon disaster and a response gap that in the
Arctic is at least several orders of magnitude greater than it is in the Gulf of Mexico. Since much of the information that is connected with

these plans is not available to the public there is little ability to evaluate the adequacy of them. However, the following concerns can be highlighted:

1. Does the Contingency Plan consider the scale of response that would be required in the event of a catastrophic blowout releasing more than 5,500 barrels of oil per day for a maximum of 30 days? Under Alaskan state regulations, that figure is the default planning rate for a blowout from a well for which there is no previous exploratory data. But many nearby wells in the North Slope have documented production rates of more than 10,000 barrels per day.

2. What assumptions have been made about weather conditions which, as this report has demonstrated, can frequently be extremely severe, essentially prohibiting any meaningful response to a spill?

3. What provisions have been made for the drilling of a relief well, including the need for a backup drilling vessel, and what assumptions are made about the time within which a well blow out would be stopped?

4. What estimates have been made about the probability of recovering oil from a major Arctic spill and do they take into account the results of field trials in the Beaufort Sea in 2000, which showed that the maximum operating limit for barge-based mechanical recovery was less than 1 % in fall ice?

5. What are the assumptions that have been made about the ability to estimate actual spill size and its movement and dispersal within the marine environment?

6. What provisions have been made for support services to respond to a major spill for which the containment and clean up takes substantially longer than 30 days?
Last year's Timor Sea blowout took 74 days to cap;
Deepwater Horizon took 85 days. Given that responders would face harsher conditions and even bigger challenges in the Arctic, what provisions have been made to deal with issues such as transportation, housing, medical care, and containment facilities for recovered material?

7. Is there adequate description of the potential risk in the event of a spill to human social and economic activities as well as environmental resources and specific measures identified to mitigate those risks?

Deployable Assets within First 24 Hours: Gulf of Mexico vs. Chukchi Sea*:

Within 24 hours of the Deepwater Horizon disaster, BP had mobilized these on-the-scene resources:

32 spill response vessels, Skimming capacity > 171,000 bpd,
417,320 ft. of containment boom, offshore storage capacity:
122,000 barrels; 175,000 more on standby, Preplanning (identification of priority sites for protection), 48-hour spill trajectory forecast.

Shell's available assets in the Chukchi Sea within the first 24 hours would be:

13 response vessels—only eight self-propelled, 6,000 ft. of ocean containment boom, 28,000 barrels storage capacity, Environmental sensitivity maps for Alaska are outdated and lack detailed identification of high priority areas, Trajectory modeling lacks critical data to produce accurate planning and response models.

*This table was compiled by a coalition of conservation groups including Audubon, Oceana, Ocean Conservancy, Pew and WWF.

RECOMMENDATIONS:

A better understanding of the vulnerability and importance of the Arctic ecosystem and the magnitude of the response gap must be established before any further drilling is allowed to proceed in Arctic waters. Decisions about the adequacy of contingency plans, and the capacity that needs to be in place to respond to relatively lowprobability but high-impact oil spills, cannot be made responsibly in the absence of this knowledge. The response gap, by its very nature, is unlikely to ever be completely closed. However, WWF believes that the following recommendations could, if adopted, help to manage what is currently an unacceptably high level of risk and allow policymakers to make more-informed decisions about whether and when drilling should be allowed to proceed in the Arctic.

1. Undertake a science-based national research program to better understand the value and vulnerabilities of the Arctic ecosystem and the risks and challenges of drilling for oil in remote, icecovered waters. The promise of a "rigorous and coordinated national research program"39 was first made in the
Oil Pollution Act of 1990 but was never fulfilled. We know the Arctic is critically important, but we know far less about its ecosystem, or the long-term consequences of a major oil spill there, than we do about the Gulf of Mexico. Without this critical information, future decisions about drilling in the Arctic are bound to be ill-informed. As the U.S. Arctic Research Commission suggests, funding for this research effort could be derived from the interest earned on the Oil Spill Liability Trust Fund established by 26 U.S.C. 2509. Planning for, and participation in, this effort should involve all relevant stakeholders—including federal and Alaska state agencies with relevant expertise, academia, and indigenous communities with traditional knowledge of the ecosystem upon which they depend for their subsistence.

2. Require that a response gap analysis be performed for the Beaufort and Chukchi seas before any further decisions are made about leasing or drilling in the Arctic.

We cannot proceed responsibly with drilling in the Arctic without a better understanding of the risks, and we will not gain that understanding until we know more about the nature and timing of seasonal conditions that exceed the limits of available response systems. Once a response gap analysis has been performed, its results should be factored into risk assessments and response plans before they are approved. It should also be used to inform seasonal restrictions on drilling in times when the gap is known to be greatest.

3. Strengthen oversight and tighten standards for exploration and leasing activities.

The reforms undertaken by the Department of the Interior in the wake of the Deepwater Horizon disaster are to be commended, but they need to go further before drilling in the Arctic is allowed to proceed. A critical reform is the need to completely separate the leasing functions of the Bureau of Ocean Management, Regulation and Enforcement (BOEMRE) from its environmental, scientific review, approval and oversight responsibilities. To avoid a recurrence of the kind of conflicts of interest that plagued the Minerals Management Service, BOEMRE's predecessor agency, these two distinct sets of functions should be independent of one another. The pressure to collect revenue through lease sales must not influence decisions about science or safety. While BOEMRE is already moving in this direction, these reforms should be in place before any further decisions are made about drilling in the Arctic.
Regulations for worst-case discharge scenarios also need to be reviewed and strengthened. For instance, BOEMRE's requirement that

an oil company plan for a worst-case scenario lasting 30 days seems arbitrary and unrealistic, given that a worst-case spill is unlikely to be contained in so short a time.

4. Increase the capacity of the U.S. Coast Guard to respond to, and oversee, a major oil spill in Arctic waters.

The Coast Guard's current capacity to respond to an oil spill in Arctic waters is nearly nonexistent. Its two heavy-class ice breakers are both well past their 30-year service lives and both are in dry dock—one for decommissioning and the other for extensive repairs. Only the Healy, a medium-class ice breaker intended for research purposes, currently remains in service. The Coast Guard has forward operating locations, but no fully equipped bases in northern Alaska and virtually no presence along the Chukchi Sea coast. The closest base from which to mount a spill response is 1,000 miles away on Kodiak Island. Senior Coast Guard officers have been quite blunt about this lack of response capacity in the Arctic for some time. Drilling should not be allowed to proceed there until and unless that capacity has been substantially reinforced.

5. Amend the Outer Continental Shelf Lands Act (OCSLA) to incorporate stronger environmental safeguards, in line with the president's July 2010 Executive Order and the recommendations of the Interagency National Ocean Policy Task Force.

The OCSLA, the law under which leasing decisions are made, prioritizes oil and extraction over environmental values and should be amended to incorporate environmental and safety objectives. BOEMRE also should enforce compliance with the new national ocean policy, which includes requirements to restore and maintain ocean and coastal health while minimizing the adverse environmental impacts of other uses. A critical tool of this new policy will be the development of regional, coastal and marine spatial plans to create a more holistic approach to the management of our oceans and coasts. No offshore drilling should proceed in the Arctic until the marine spatial planning process has been completed and an Arctic strategic plan— identified by the task force as a priority—is in place.

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