Offshore Information for Area Contingency Planning

Arctic and Western Alaska

Offshore Response Strategies and Best Management Practices (BMPs)

Technical Document #4

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1 Introduction

In 2019, the Bureau of Safety and Environmental Enforcement (BSEE) sponsored a project in cooperation with the United States Coast Guard (USCG) to improve the content of the coastal zone area contingency plans (ACPs) with respect to the information necessary to effectively plan for and respond to large oil spills from offshore oil and gas facilities. This collaboration between BSEE, the Bureau of Ocean Energy Management (BOEM), USCG Sector Anchorage, Alaska Department of Environmental Conservation (ADEC), resource trustees, state agencies, oil spill removal organizations (OSROs), and the Arctic and Western Alaska Area Committee resulted in a series of technical documents that provide offshore information on:

- Oil and Gas Infrastructure (Arctic and Western Alaska Technical Document #1)
- Worst Case Discharge Scenarios (Arctic and Western Alaska Technical Document #2 and Appendices 2A-C)
- Offshore Response Concept of Operations (Arctic and Western Alaska Technical Document #3)
- **Offshore Response Strategies and BMPs (Arctic and Western Alaska Technical Document #4)**
- Sensitive Species Profiles (Arctic and Western Alaska Technical Document #5)
- Offshore Environmental Sensitivity Index (ESI) Atlas (Arctic and Western Alaska Technical Document #6)

These documents were developed specifically for incorporation by reference into the ACP and are hosted on the BSEE Oil Spill Preparedness Division's (OSPD) website. In addition to the above technical documents, an inventory of offshore spill response equipment and a set of offshore Environmental Sensitivity Indices (ESI) maps were created and embedded in NOAA's Environmental Response Management Application (ERMA). Collectively, these materials provide a foundation of risk assessment, resources at risk, and conceptual response information to inform coastal zone ACP planning and responses to a significant offshore facility oil spill incident.

This technical document contains response strategies and best management practices (BMPs) to complement the Offshore Response Concept of Operations (CONOPS) described in the Arctic and Western Alaska Technical Document #3. Neither the CONOPS, nor these offshore response strategies and BMPs, should be seen as requiring the use of any specific offshore spill response strategy during an incident or as prioritizing response strategies. The use of any response strategy in an actual spill is subject to the authorization requirements of that strategy. During an actual incident, each strategy's geographic laydown and prioritization should be continuously reassessed and adjusted based on the conditions offshore. Responders must always consider how one strategy will impact others. In selecting the best strategies to use at any one point in the response, the Unified Command (UC) must consider the properties of the oil and the size, spread and location of the oil slick.

The response strategies discussed in this technical document align government and industry offshore best practices and follow the general structure for response outlined in the Offshore Response CONOPS (Technical Document #3).

2 Acronym List

- ACP – Area Contingency Plan
- ACS – Alaska Clean Seas
- ADEC – Alaska Department of Environmental Conservation
- ADF&G – Alaska Department of Fish and Game
- AIS – Automatic Identification System
- ARRT – Alaska Regional Response Team
- API – American Petroleum Institute
- AUV – Autonomous Underwater Vehicle
- AWA – Arctic and Western Alaska
- BMP – Best Management Practices
- BOEM – Bureau of Ocean Energy Management
- BOP – Blowout Preventer
- BSEE – Bureau of Safety and Environmental Enforcement
- CONOPS – Concept of Operations
- CRREL – Cold Regions Research and Engineering Laboratory
- DMP – Dispersant Management Plan
- DWH – Deepwater Horizon
- EPA – Environmental Protection Agency
- ERMA – Environmental Response Management Application
- ESI – Environmental Sensitivity Index
- FAA – Federal Aviation Administration
- FLIR – Forward-Looking Infrared
- FORD – Fresh Oil Removal Division
- FOSC – Federal On-Scene Coordinator
- GPR – Ground-Penetrating Radar
- IMH – Incident Management Handbook
- ISB – In-Situ Burning
- ISPR – Incident Specific Preparedness Review
- IWI – Intentional Well Ignition
- MMS – Mineral Management Service
- NESDIS - National Environmental Satellite, Data, and Information Service
- NCP – National Oil and Hazardous Substances Contingency Plan
- NISAR – National Aeronautics and Space Administration-Indian Space Research Organization Synthetic Aperture Radar
- NMFS – National Marine Fisheries Service
- NOAA – National Oceanic and Atmospheric Administration
- NRDA – Natural Resource Damage Assessment
- NSF – National Strike Force
- OCS – Outer Continental Shelf
- OCSLA – Outer Continental Shelf Lands Act

- OHMSETT – Oil and Hazardous Materials Simulated Environmental Test Tank
- OPA – Oil Pollution Act
- OSPD – Oil Spill Preparedness Division
- OSRB – Oil Spill Response Barge
- OSRO – Oil Spill Removal Organization
- OSRV – Oil Spill Response Vessel
- PPRP – Prevention, Preparedness, and Response Program
- RCP – Regional Contingency Plan
- RRT – Regional Response Team
- SAR – Synthetic Aperture Radar
- SCA – Surface Collecting Agent
- SCED – Source Control Exclusion Division
- SIMA – Spill Impact Mitigation Assessment
- SIMOPS – Simultaneous Operations
- SMART – Special Monitoring of Applied Response Technologies
- SOSC – State On-Scene Coordinator
- SPRD – Shoreline Protection and Response Division
- SSC – Scientific Support Coordinator
- TFR – Temporary Flight Restriction
- UAS – Unmanned Aerial Systems
- UC – Unified Command
- USCG – US Coast Guard
- USFWS – US Fish and Wildlife Service
- VOC – Volatile Organic Compounds
- VOSS – Vessel of Opportunity Skimming System
- WORD – Weathered Oil Removal Division
- WMP – Waste Management Plan

3 Initial Response Actions

Aerial surveillance should be conducted immediately to provide an initial assessment of the incident. This surveillance is necessary to better understand the source and volume of the oil discharge, as well as site-specific conditions in which the response needs to be conducted (see Section 3). These conditions, such as open water, broken ice, or high winds, influences the selection of tactics and coordination of the response. If the origin of the oil discharge is known, plans for controlling and securing the source should be developed and put into action as soon as possible (see Section 4). Response resources with rapid response times should also be dispatched immediately if oil spill reporting or surveillance observations indicate that recoverable or dispersible amounts of oil have been discharged into the water.

Where appropriate in Cook Inlet and in the deeper waters of the North Slope, the potential deployment of dispersant aircraft, which have quick arrival times and high oil encounter rates, should be guided by, and strictly follow Authorization of Use agreements in the Alaska Regional Contingency Plan (RCP), an assessment of operational conditions and the properties of the discharged oil, and a comparative analysis of environmental tradeoffs.

This assessment can be coordinated quickly with resource trustees by the NOAA Scientific Support Coordinator (SSC) when requested by the USCG FOSC. Oil spill fate and trajectory modeling, based on initial and subsequent spill reporting observations and weather forecasts, should be completed shortly thereafter for large offshore discharges to understand the spatial and temporal windows of opportunity that exist and guide deployment of response strategies.

The Unified Command will meet to discuss these initial findings and will initiate an incident-specific Concept of Operations (CONOPS) for the ongoing deployment of different response strategies. Figure 1 and Figure 2 show the geographic constructs for the CONOPS developed as the baseline for responses to offshore spills in Beaufort Sea and Cook Inlet, respectively (for more detail, see Arctic and Western Alaska Technical Document #3).

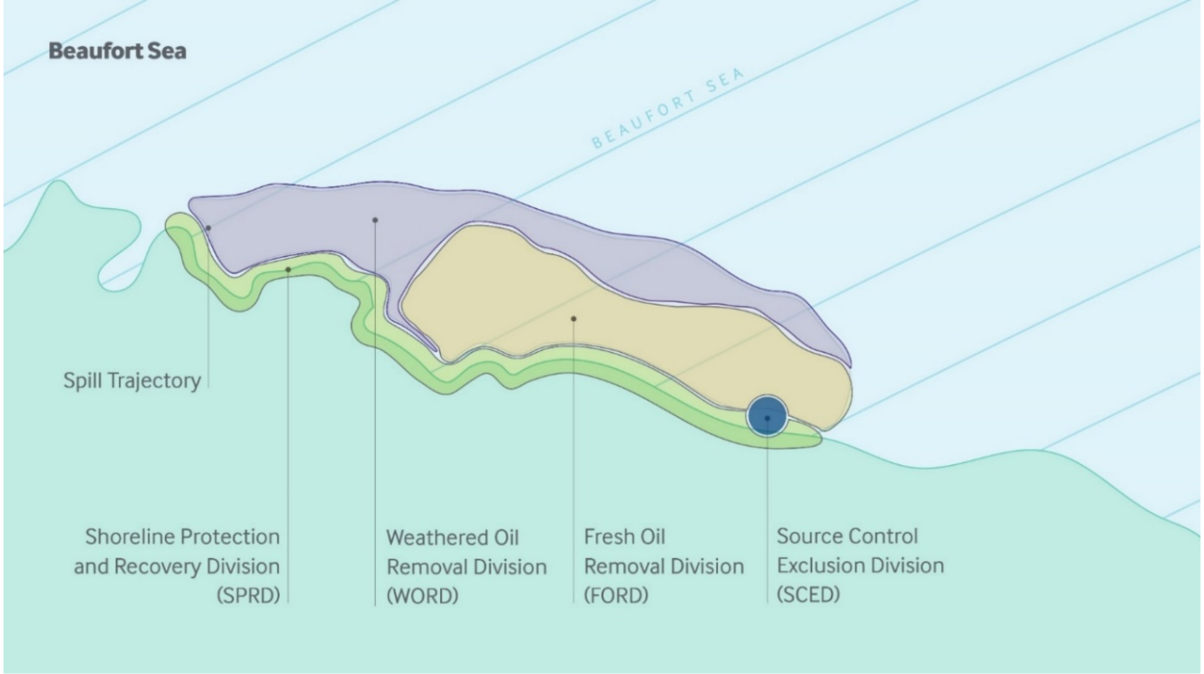

Figure 1. Possible Geographic Construct for Beaufort Sea.

Figure 2. Possible Geographic Construct for Cook Inlet.

4 Oil Spill Surveillance and Monitoring

The use of aerial surveillance is the accepted practice for detecting, assessing, and monitoring oil spills, and is critical for gaining situational awareness over the scope of an incident. Reporting in near or real-time from visual observers in aircraft has always been essential to assessing an incident, locating actionable oil slicks, and positioning tactical resources to conduct operations, including the application of dispersants, skimmers, or ISB. Either active (e.g., radar or lidar) or passive (e.g., visual, thermal, multispectral, or hyperspectral) remote sensing technologies are tools currently used from low altitudes (drones), high and low altitudes (manned aircraft), or satellites. These remote sensing tools are now developed to the point where they can also be used in the real- or near-real timeframes for these critical tasks.

The rapid development of Unmanned Aerial Systems (UAS), also commonly known as drones, over recent years, has made this technology a crucial tool for any oil spill responding organization. The great variety and advanced technology for drones deployed from responding vessels resulted in the application of UAS for detecting and characterizing oil spills more efficiently. UAS and aircraft-mounted sensor packages should be implemented for detection, assessment, mapping, and tactical support of response operations for offshore oil spills at real- or near-real timescales.

Aerial support of oil containment, recovery, burning, or dispersant operations can greatly increase the oil encounter rates of these tactics and improve their effective deployment and operations in the field. Similarly, improvements in the processing and workflow of remote sensing data have changed the way responders can use satellite data. Satellite observations are fast becoming a frequently used, real or near-real time tool for detecting and monitoring oil spills, such as NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) reporting done during Hurricane Ida in the Gulf of Mexico. In addition, it is important to point out that high-resolution Synthetic Aperture Radar (SAR) satellite imagery is available in Arctic regions from Canadian, European, and Asian satellites. The new generation of U.S. SAR satellites will further expand this toolset of imagery. The new U.S. National Aeronautics and Space Administration-Indian Space Research Organization Synthetic Aperture Radar (NISAR) satellite is scheduled to be launched in 2024.

One practical way to discern remote sensing technologies is by separating the platforms based on sensors that are used and the altitudes at which they operate. Starting from sea level, handheld or tethered devices and sensors can be used from a responding vessel or crews on the ice in winter. These sensors include cameras, thermal imagers (Forward Looking Infrared – FLIR), ground penetrating radar, X-band radars, spectrophotometers, fluorometers, etc. These sensors, which are used to conduct direct in-situ measurements and observations, can also be mounted on various aerial-based platforms that provide a much larger area of coverage (e.g., drones, aircraft, satellites, etc.). Figure 3 shows the commonly used sensors for oil spill detection, along with their characteristic platform and altitudes. It remains a challenge for remote sensing/tracking to determine oil thickness to better utilize response tools, e.g., mechanical, ISB, and dispersants.

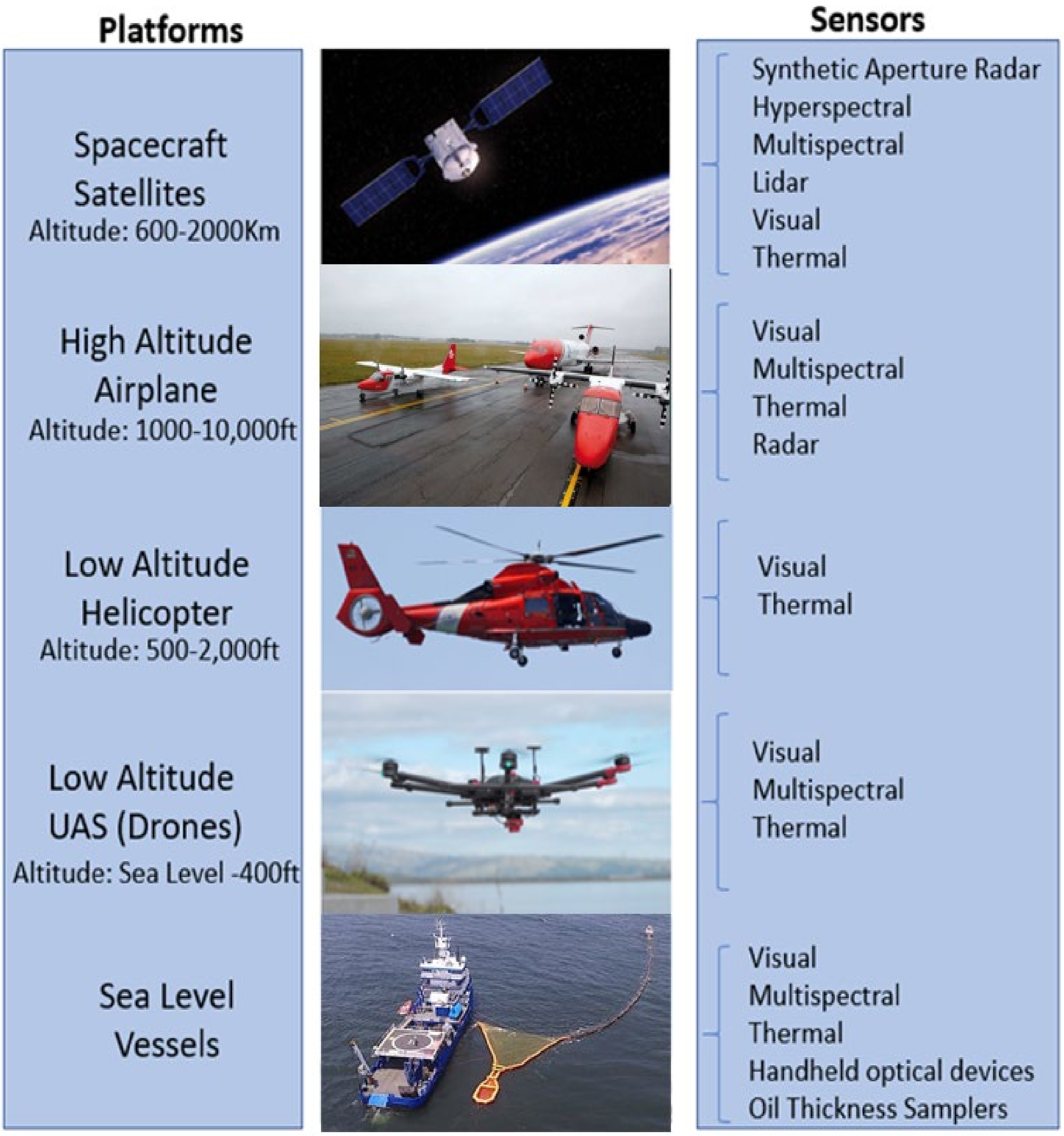

Figure 3. Representative platforms and sensors used for oil spill remote sensing monitoring. Platforms are classified by altitude and coverage.

Oil spill detection and mapping in ice introduces additional challenges. Owens and Dickins (2015) summarize some of the key points associated with oil in ice remote sensing.

- Detecting and tracking oil in ice and snow is challenging. Existing trajectory models are limited in their capability to model oil fate and behavior in the presence of a range of sea ice conditions. Trajectory uncertainties will be larger than usual in remote polar regions because of limited meteorological and oceanographic data inputs. Updated forecasts of oil trajectories may also be less reliable because of reduced frequency overflight reconnaissance (drones or aircraft) due to poor flying weather with limited visibility, periods of darkness, and long distances from airfields limiting time on site.
- A mix of conventional airborne sensors already used in open water spill response is likely to prove effective with spills in very open drift ice (1-4/10). Response in very open drift ice is similar to open water with some ice present.
- The use of remote sensing to detect spills contained in more closely packed ice (>6/10) is still uncertain, requiring all-weather, high-resolution capabilities that have yet to be fully tested in a field situation.
- The damping effect of significant ice cover on sea state complicates the use of marine or satellite radar systems, both of which depend on differences in surface roughness (oil versus no oil) as a means of detection. The calming effect of ice on wind waves reduces the ability to discriminate between oiled and non-oiled areas between the ice floes with radar satellite imagery.
- Detection of oil underneath and within ice remains a challenge. Recent promising developments in the past decade include the use of ground-penetrating radar (GPR) from above and upward looking sonar operating from AUVs beneath the ice. GPR has been proven in field tests with helicopters detecting oil buried under snow on top of the ice and from the surface, detecting trapped oil layers in cold ice. Sonar under the ice has proven effective in detecting and mapping oil layers under the ice in basin tests. See further details of current work in this area in Section 3.2.
- Future platforms will likely involve both unmanned aerial systems (UAS) and autonomous underwater vehicles (AUVs).
- An extensive multi-partner research effort in 2014/2015 compared the capabilities of different sensors in detecting different oil under a range of ice conditions, using the large ice basin at the Cold Regions Research and Environmental Laboratory (CRREL) in NH.

4.1 Remote sensing data integration

NOAA’s ERMA is an online mapping tool offering comprehensive access to localized oil spill response information. Responders can now use ERMA for the integration and dissemination of the remote sensing data gathered through various forms of aerial surveillance. The example below in Figure 4 shows a demonstration of the workflow established during a response.

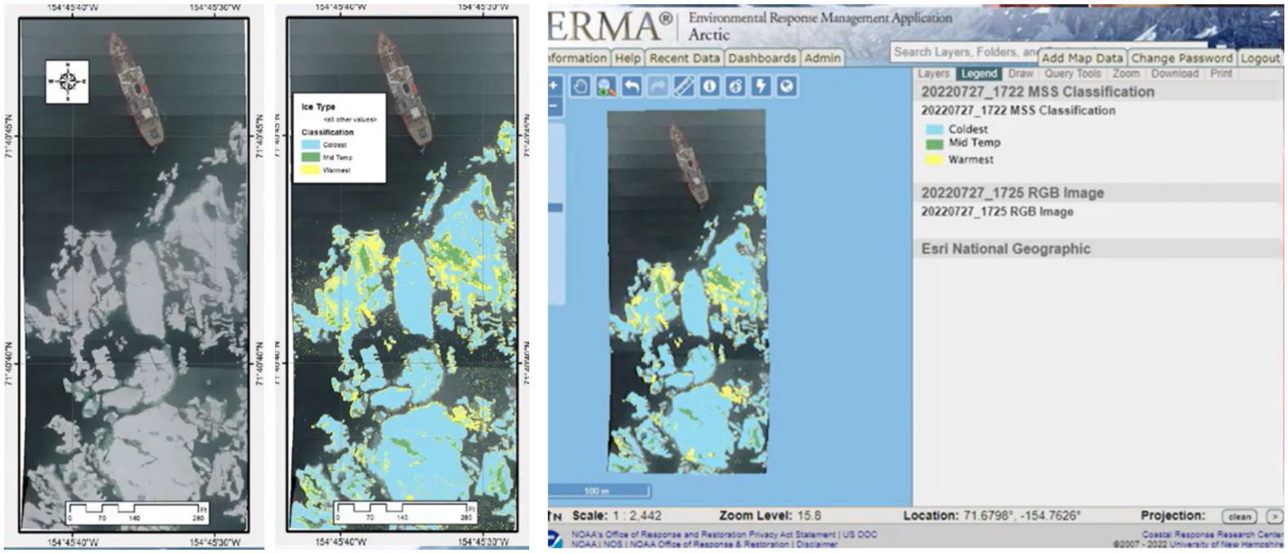

Figure 4. Workflow of data integration during an oil spill response.

First, remote sensing data is obtained (in this case a drone deployed from a U.S. Coast Guard vessel), and a map is produced. Second, a classification map is generated depicting targets or different areas captured on the imagery. Third, the maps and classifications are uploaded into ERMA and made available to responders.

4.2 Emerging remote sensing technologies

The advancement of remote sensing technologies for detection and mapping of oil spills can be seen at every level. For example, the new U.S.-Indian made NISAR satellite will count with cross-polarization 'L' and 'S' microwave frequencies. The recent use of 'L' bands SAR sensors mounted on NASA aircrafts (i.e., UAVSAR) have revealed the capacity of this frequency to discern oil slicks of various emulsifications and thicknesses levels. To date, researchers have not had the opportunity to experiment with an 'S' microwave satellite to investigate how this frequency band can be used to study floating oil. The launch of NISAR imagery is planned for 2024 which will hopefully provide responders with new capability to assess slick thickness.

The incorporation of UAS as a key part of aerial surveillance has accelerated remote sensing studies of oil spills. Just recently, the USCG acquired hundreds of drones to be used from USCG cutters everywhere in the U.S. The USCG and NOAA are conducting a joint effort to develop a UAS training programs and Standardized Operational Procedures (SOP) for capturing and report data from the USCG drones. This training program continuously evaluates new UAS technologies, and established SOPs) for the USCG pilots while using thermal and visual sensors to image oil spills. UAS-USCG instructors and pilots follow these SOPs to facilitate entering oil spill data in near real time to ERMA. Figure 5 shows some of these operations conducted by the USCG.

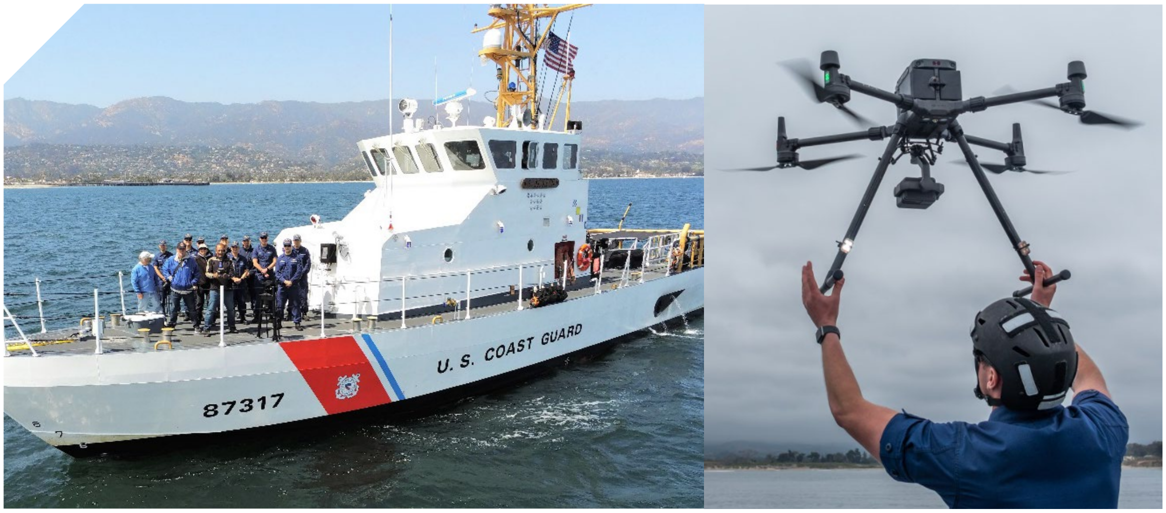

Figure 5. USCGC Blackfin off the coast of Santa Barbara California during a UAS research mission (left). UAS deployment from a USCG moving vessel as part of the USCG-NOAA training programs for SOP for oil spill response (right).

At the sea surface, new technologies are being developed to study oil submerged or under ice conditions. Funded by BSEE, this research program is scheduled for completion in Sept. 2024. The following excerpt is a program summary from BSEE's website.

"Although remote sensing technologies have been advanced for airborne and spaceborne sensors, it is still challenging to detect oil under/encapsulated in ice as well as on seafloor." The main objective of this project is to advance the current underwater technology to detect and measure thickness of oil under ice, encapsulated in ice and/or on the seafloor (BSEE Project # 1155).

5 Source Control Actions

BSEE, executing its authorities under the Outer Continental Shelf Lands Act (OCSLA) and the Oil Pollution Act (OPA), will assist the Federal On Scene Coordinator (FOSC) by overseeing and, when necessary, directing measures to abate sources of pollution from regulated offshore facilities to ensure minimal release of oil and to prevent unwarranted shutdown of unaffected production and pipeline systems. (RE: USCG Incident Management Handbook (IMH) concerning management of source control/abatement activities involving an offshore facility, also reference 30 CFR Parts 250, 254, and 550 Bureau of Ocean Energy Management 30 CFR Part 550-2016 Final Rule-Oil and Gas and Sulphur Operations on the Outer Continental Shelf— Requirements for Exploratory Drilling on the Arctic Outer Continental Shelf concerning source control resource requirements). The Arctic and Western Alaska ACP, Section 3260.3 includes guidance on Intentional Well Ignition (IWI) as a source control strategy.

One of the first priorities for any response to an oil spill is to secure the source of the discharge. For large discharges of oil from offshore facilities, such as a well blowout, this effort to secure the source can be a complex endeavour that will occur while response activities are underway. A blowout is an uncontrollable flow of fluids from inside a rock formation (a reservoir) that has been penetrated by an oil or gas well. Blowouts can occur in producing or drilling wells. They are caused by the failure of pressure control systems used while drilling, completing, producing, or working over the well. The fluids may include a mixture of oil, gas, and water. A blowout can be classified as a surface blowout when the fluids come to the surface of the earth via flowing up the well and discharge at the site where the wellhead is located. This is the most common type of blowout. Another type of blowout is known as an underground or down-hole blowout. Underground blowouts occur when fluid flows from high-pressure rock formations penetrated by the well to lower-pressure rock formations within the well. The high-pressure fluid may cause the lower-pressure formation to fracture. When this results in fluid discharging at the surface via a fracture rather than through the well itself, it is known as broaching. If the wellhead is underwater, a blowout may also be called an underwater or subsea blowout. However, an underground blowout always means that the discharge occurred beneath the surface of the earth.

There are numerous methods related to the intervention of a well blowout. The quickest option is to use the original well control equipment (blowout preventer (BOP) or a production tree) attached to the wellhead to regain control and shut-in the well. Often, this option is ineffective due to damage sustained by the well control equipment during the blowout.

The next method is to install a new, temporary well control device onto the well. This operation often involves removing part or all of the original well control equipment and can be a complex series of activities conducted in a dangerous or difficult environment.

All BSEE regulated facilities in Alaska have wellheads at the surface. In a surface blowout, a modified BOP or production tree may be attached to the wellhead after the original control device is removed, and several cuts are made to the wellhead to ensure the device can be secured. The well may be discharging large amounts of oil, water, sediments, and gas, or may be on fire. In addition, the drilling rig or platform supporting the well may be damaged and structurally unsound, and there may be significant debris that must be cleared before source control personnel can access the well.

When a surface blowout occurs in Alaska, operators will make notifications, begin initial spill containment operations, and initiate source control activities. From notification, it will typically take 48 hours to mobilize source control equipment to the site. When well control is lost resulting in an uncontrolled flow of fluids at the surface, a well control plan must be developed considering ignition of the blowout, drilling a relief well, and additional source control measures. Containment equipment includes production risers, surface production vessels, and offloading/disposal systems. Actions will be taken to kill the well. If surface control measures fail, drilling a relief well will be considered. In these situations, interim collection and containment methods are employed to reduce the environmental impacts while responders work to drill a relief well.

Depending on availability, it may take 20 days for a relief rig to arrive via barge. Based on the season, it may be necessary to contract a helicopter-lift rig from the Lower 48 to allow for a rig to be mobilized during freeze-up or breakup. Ideally, a relief well will be staged on the North Slope for this purpose. A possible timeline for drilling a relief well would be 4-8 months. Circumstances impacting this timeline include weather, the cause of the blowout, the choice of the surface location for the relief well, and the depth of the well. If this incident occurs during break up or freeze up, it could add up to 3 months to the timeline. The steps in the process for an incident on the North Slope may include:

1) Mobilize gravel equipment	1 week
2) Construct ice road	3 weeks
3) Construct gravel island	2 weeks
4) Set conductor; mobilize rig	3-4 weeks
5) BSEE inspect, spud and drill relief well	3-6 weeks
6) Kill well and plug & abandon	1-2 weeks
7) Demobilize rig	2 weeks

As mentioned above, the method, used for permanently securing a well blowout, is to drill a relief well. A relief well intercepts the wellbore of the blown-out well, and permanently abandons the well by pumping cement into it. The UC may direct two relief wells be drilled simultaneously; the second relief well is drilled as a contingency. Relief well operations are an effective but time-consuming method and may take two to five months to reach the target interval and begin kill operations.

With reference to the CONOPS, these source control operations will occur within the Source Control Exclusion Division (SCED). Figure 6 illustrates depicts an example of a potential SCED layout for the Beaufort Sea, and Figure 7 illustrates a potential SCED layout for Cook Inlet.

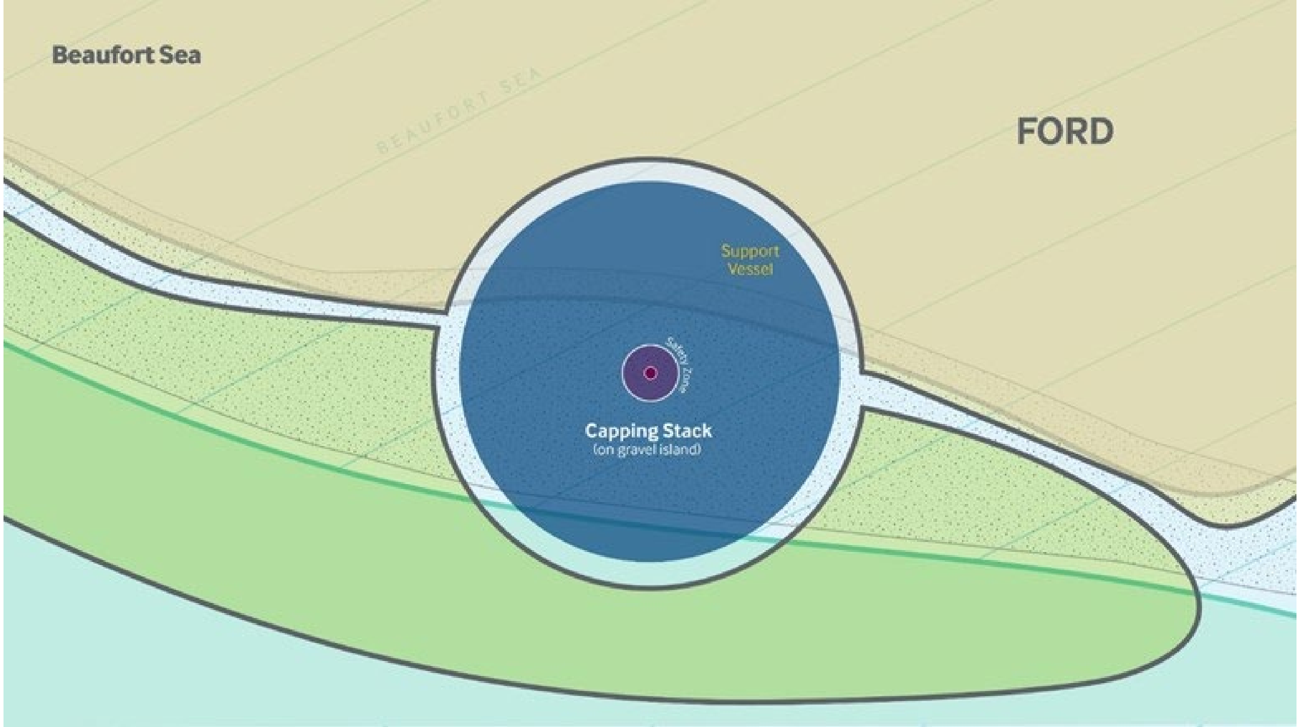

Figure 6. Possible SCED Configuration for the Beaufort Sea.

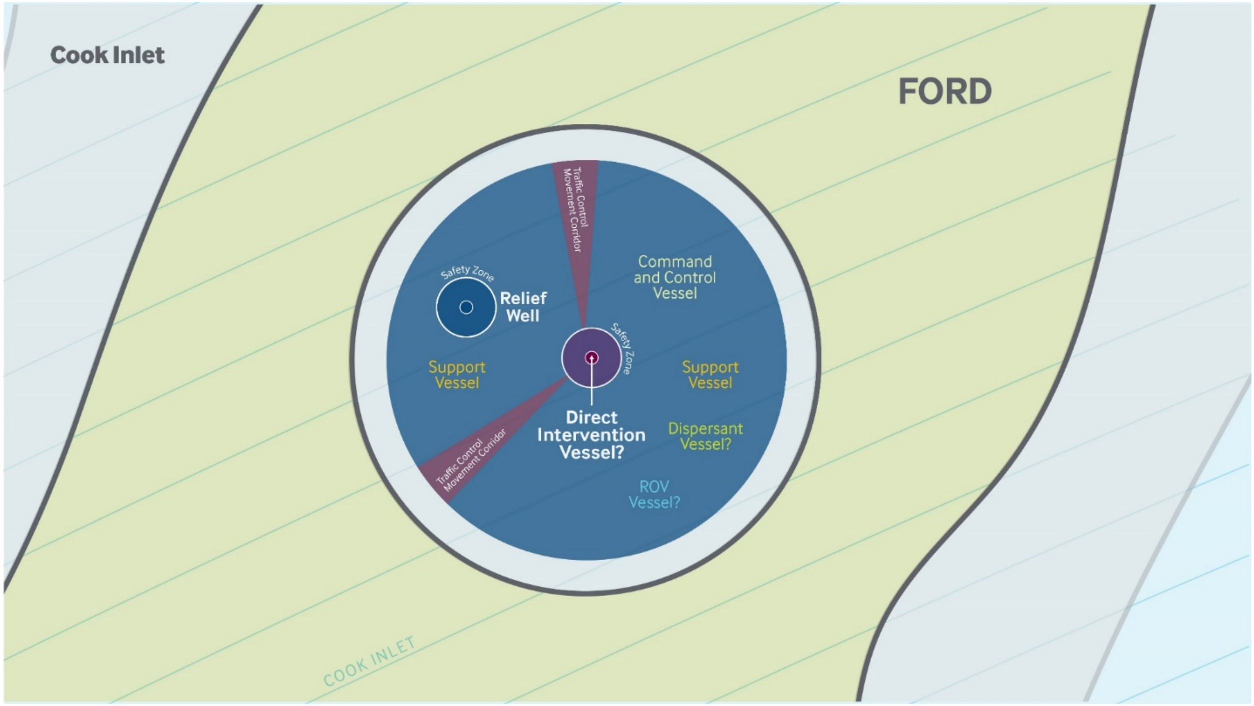

Figure 7. Possible SCED Configuration for Cook Inlet.

6 Offshore Response Countermeasures and Strategies

Four main categories of offshore response strategies are described in this Technical Document. These various countermeasure strategies complement the CONOPS framework for an offshore response from an OCS facility. The response strategy categories are:

- Source Control
- Mechanical Recovery
- Dispersants (Aerial/Surface Dispersant Application only)
- ISB

In addition, implementation plans for these countermeasures and strategies must incorporate the following:

- Vessel and Aircraft Tracking
- Effectiveness and Environmental Monitoring
- Wildlife Monitoring
- BMPs

Although source control and mechanical recovery operations are the primary response strategies for any large offshore oil spill, a Unified Command (UC) will likely consider additional response strategies to mitigate the significant volumes of oil that could be discharged. Therefore, the UC should develop a Simultaneous Operations (SIMOPS) Plan to implement multiple strategies as soon as feasible. The SIMOPS will ensure the maximum effectiveness of the use of each response tool while minimizing the conflicts between each response methodology , e.g., safe concurrent operations within the same area.

The Deepwater Horizon (DWH) Incident Specific Preparedness Review (ISPR) noted the following, "...efforts to contain, control, and remove the oil at the well and offshore areas provided the first line of defense for protecting environmentally sensitive areas. While they did not prevent oiling and impact to shorelines and sensitive areas, the use of the full range of response tools, including mechanical removal, dispersants, and in-situ burning, diminished immediate impacts."

The selection of response strategies using multiple countermeasures is dependent upon many incident-specific factors involving resource availability, efficacy, and assessing potential environmental outcomes of each. From an environmental impact mitigation perspective, this has traditionally been accomplished through the use of comparative risk assessment models, with the most recently proposed model being described as a Spill Impact Mitigation Assessment (SIMA). SIMA is an updated approach to Net Environmental Benefit Analysis (NEBA) that also incorporates socio-economic and cultural considerations. Ideally, these assessment models are used in the planning phase to identify and assemble the information that will inform the use of response options for representative planning scenarios. During a spill response, the UC can conduct an expedited or qualitative SIMA to rapidly select the response option(s) that are expected to yield the greatest overall environmental benefit. SIMA should neither pre-empt a response decision nor be the starting point for every decision. The goal of the SIMA methodology is to obtain agreement among the various parties over which response options will be most effective and result in the least overall impact on the environment.

When selecting response strategies for deployment, it is also important to understand how incident specific conditions offshore will affect the efficacy of employing the various countermeasures for any given operational window of time. Figure 8 compares the efficiencies of response countermeasures under different wind speeds and wave heights. Note that recovery system efficiency is different from recovery throughput or effectiveness under real life conditions. Efficiency estimates simply provide a guide to what percentage of the oil encountered can be expected to be either recovered or removed by a particular strategy. Calculating effectiveness in any given situation is much more complex and will depend on many often rapidly changing variables such as: system speed of advance, swath width, oil thickness and degree of oil weathering, etc. Figure 9 compares the "windows of operability" for different response options as a function of oil thickness and is included in NOAA's Guide for Spill Response Planning in Marine Environments (2013 Rev).

In Alaska, the seasonal impacts to any response will be significant with the presence or absence of ice, the complicating impacts of cold, and the short to non-existent daylight for long periods in the winter. In 2016, Nuka conducted an oil spill response gap analysis for three areas in the U.S. Arctic in the Beaufort and Chukchi Seas. This analysis quantified the frequency that oil spill response may not be feasible due to weather or environmental conditions. Conditions including wind, sea state, temperature, ice coverage, and visibility were considered in the analysis. Response options included mechanical recovery, in situ burn, and use of dispersants. Limits of air reconnaissance were also considered due to its importance in oil tracking.[1]

Although Lower Cook Inlet will likely be ice-free year-round, the make-up of a response effort on the North Slope will be dictated primarily by ice conditions from early October to July. Response strategy decisions will depend largely on whether or not ice is present and, if so, in what forms: thin new ice, stable winter fast ice, deteriorating fast ice in spring or mobile pack ice (often referred to as "broken ice") at break-up.

The remainder of this document is divided into two sections to capture the applicability of different response strategies in open water (Chapter 6) and in ice conditions, including the transition season of freeze-up and break-up (Chapter 7). The section covering Monitoring (Chapter 8) is generally applicable to year-round response in open water and with ice present, so it applies to both Chapter 6 and Chapter 7.

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[1] https://www.bsee.gov/research-record/osrr-1022-estimating-oil-spill-response-gap-us-arctic-ocean

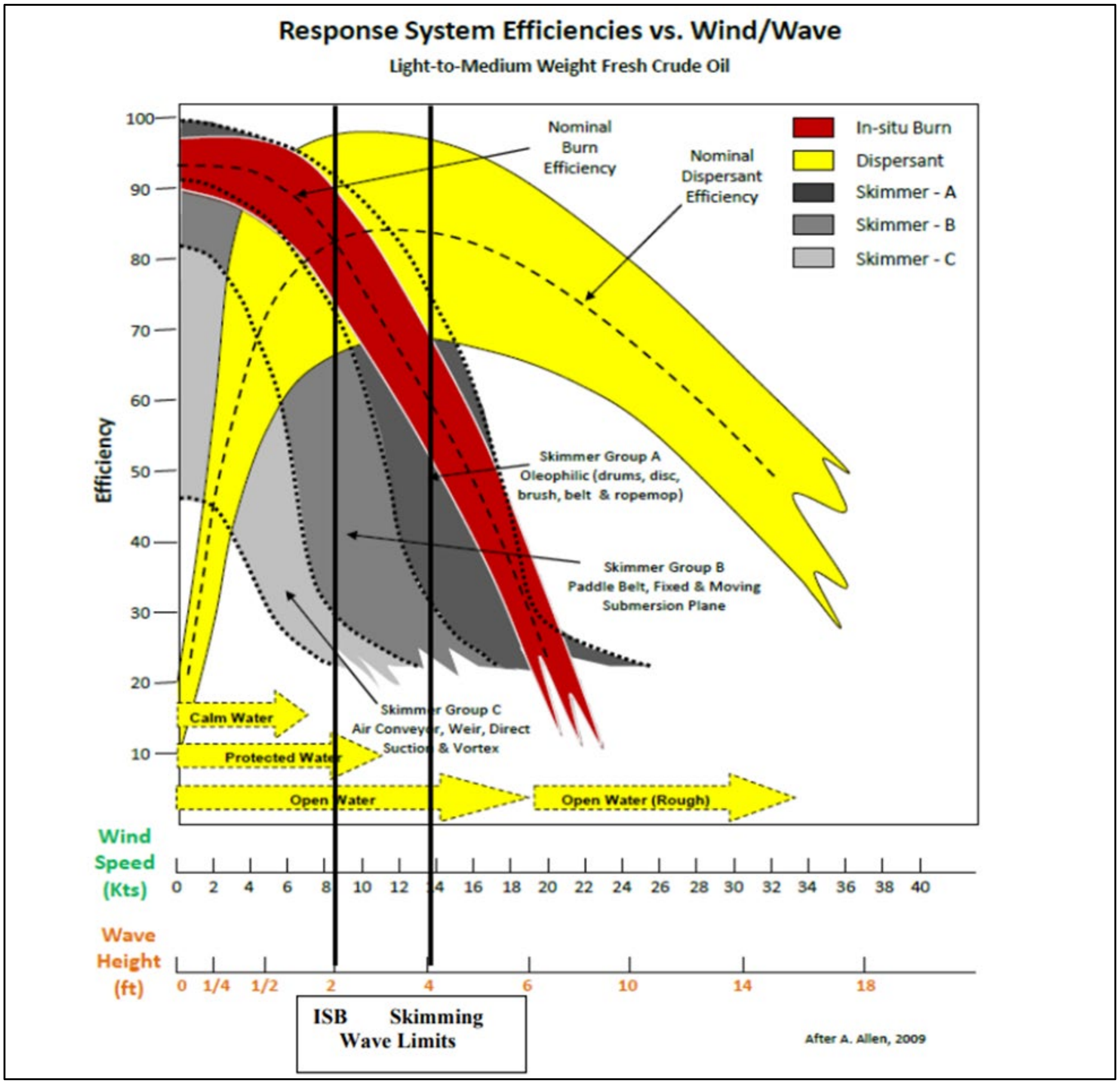


Figure 8. Response System Efficiencies of Response Countermeasures under Different Wind Speeds and Wave Heights. Source Al Allen, Spiltec, 2009.

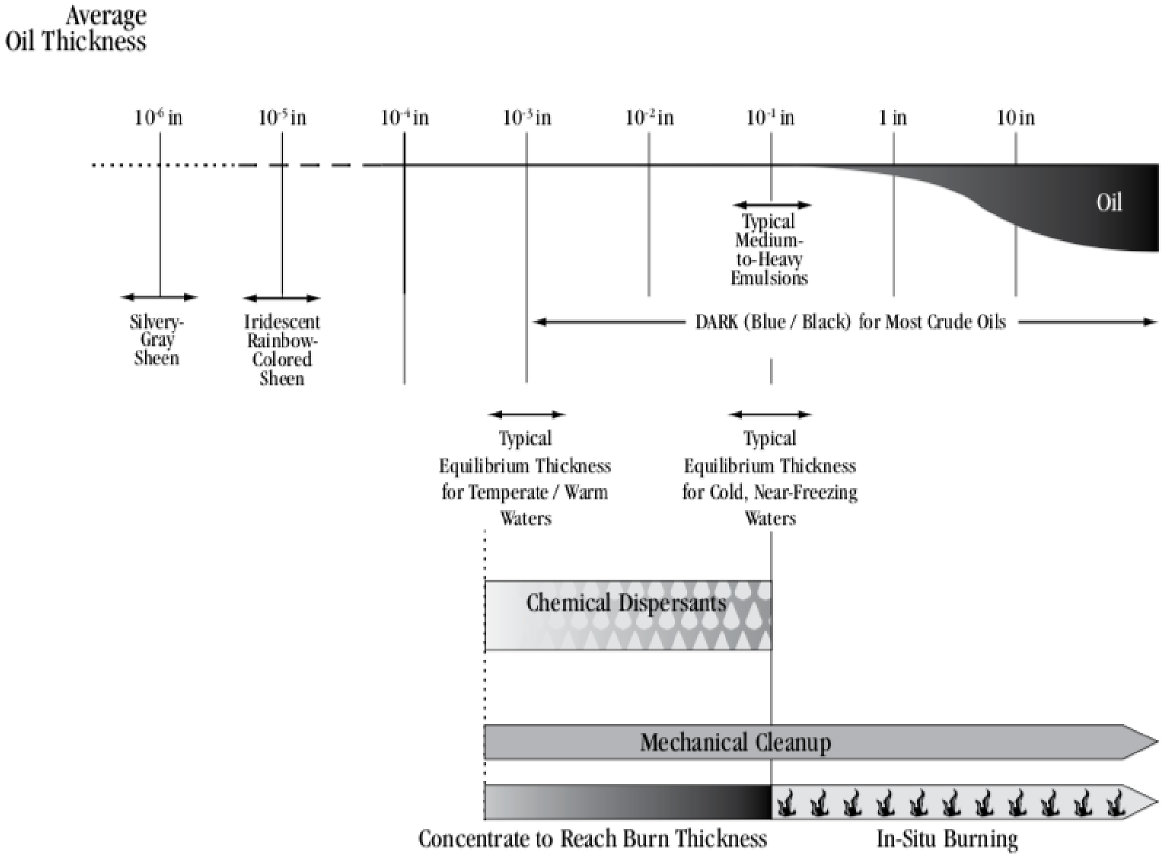


Figure 9. Window of Operability for Different Response Options vs. Oil Thickness (Allen, 1996 used in NOAA's Guide for Spill Response Planning in Marine Environments (2013 Rev).

7 Open Water Response

7.1 Mechanical Recovery

Mechanical recovery will always be the primary response strategy for oil removal in accordance with the National Contingency Plan, especially for an offshore incident on the OCS. However, ice infested waters in the Alaska environment will complicate the use of this strategy. The mechanical recovery of oil offshore involves the use of advancing skimmers (Chapter 7). Skimming systems with containment arms, a collection or sump area with a skimming device designed to separate the oil from the water through such means as weirs or oleophilic surfaces, pumps, and offloading recovered product when the skimmers fill up to primary temporary storage either offshore or onshore. Typical advancing mechanical recovery systems can operate on average around 0.75 knots relative to the oil slick and currents. However, the use of technology such as Current Busters in the booming system may allow skimming speeds to increase thereby potentially increasing recovery volumes. The use of FLIR and X-Band radar technologies can enhance mechanical recovery in low light conditions. The use of oleophilic skimmers versus other types may also increase the recovery volumes within a range of environmental conditions, e.g., sea state, as shown in Figure 8.

Table 1 presents the advantages and disadvantages of mechanical recovery operations.

Table 1. Oil Removal Strategy – Mechanical Recovery.

Oil Removal Strategy	Advantages	Disadvantages
Mechanical Oil Recovery	• Physically removes the oil from the environment. • Can be deployed immediately and does not require Authorization of Use procedures. • Mechanical recovery systems are part of existing Alaska OSRO inventories. • Potential for reinjection and reprocessing on the North Slope.	• Presence of ice limits on water mechanical recovery ~~use~~ to less than three months of the year in the Beaufort Sea. See Chapter 7. • Spreading of oil into patches and windrows too thin to remove oil limit recovery. • Inability to locate thick patches of oil in a timely manner due to darkness, sun glare, fog, etc., limits recovery. • Slow transit speeds, significant distances, and short open water period may

		make it impossible for additional resources to arrive in time. • Skimming operations are subject to operational limitations due to sea state, ice, and visibility (for spotter aircraft). • Oil emulsification and viscosity increases reduce effectiveness of recovery. • Limited storage capacity on each skimmer which prevents continuous skimming until offloaded. • Requires significant temporary storage and overland transport of oily water and solid waste for disposal. • Low encounter rates with slow speeds of advance and limited swath widths lead to low recovery throughputs. • Labor and equipment intensive. • Typically recovers less than 10% of the oil available for recovery offshore on the surface (often less than 5%). • Ineffective on thin slicks. • Skimming operations are dependent on sea state and may be infeasible with the presence of even small concentrations of ice (Chapter 7) • Requires temporary storage of large volumes of recovered fluids and waste disposal

7.1.1 General Considerations

The laydown of mechanical recovery resources will be based on the oil properties of the slick in the vicinity of the discharge and as it moves along its trajectory. The offshore response Concept of Operations (CONOPS) for the Arctic and Western Alaska (see Arctic and Western Alaska Technical Document #3) is organized into two separate divisions based on the principal that oil weathers and spreads out over time as it is transported away from the source. Figure 10 and Figure 11 illustrate these divisions, namely the Fresh Oil Removal Division (FORD) and the Weathered Oil Removal Division (WORD).

In the FORD, spilled oil should still be concentrated in thicker, more continuous slicks that are relatively fresh in terms of weathering (and associated viscosities). High-volume mechanical recovery assets should be assigned to the Primary Mechanical Recovery Zone in the FORD. These assets should have high oil recovery rates, large onboard storage capacities and be supported by additional secondary temporary storage. Large Oil Spill Response Vessels (OSRVs), Oil Spill Response Barges (OSRBs), and Vessels of Opportunity Skimming Systems (VOSSs) will provide significant operational value in this division, with the understanding that VOSSs units may have very limited onboard temporary storage and may have to frequently interrupt skimming operations in order to transfer recovered materials to a larger temporary storage unit. It should be noted that these high recovery rate assets are not available in the Beaufort Sea and would need to be in the area during the limited open water window.

Figure 10. Possible configuration for the FORD in the Beaufort Sea.

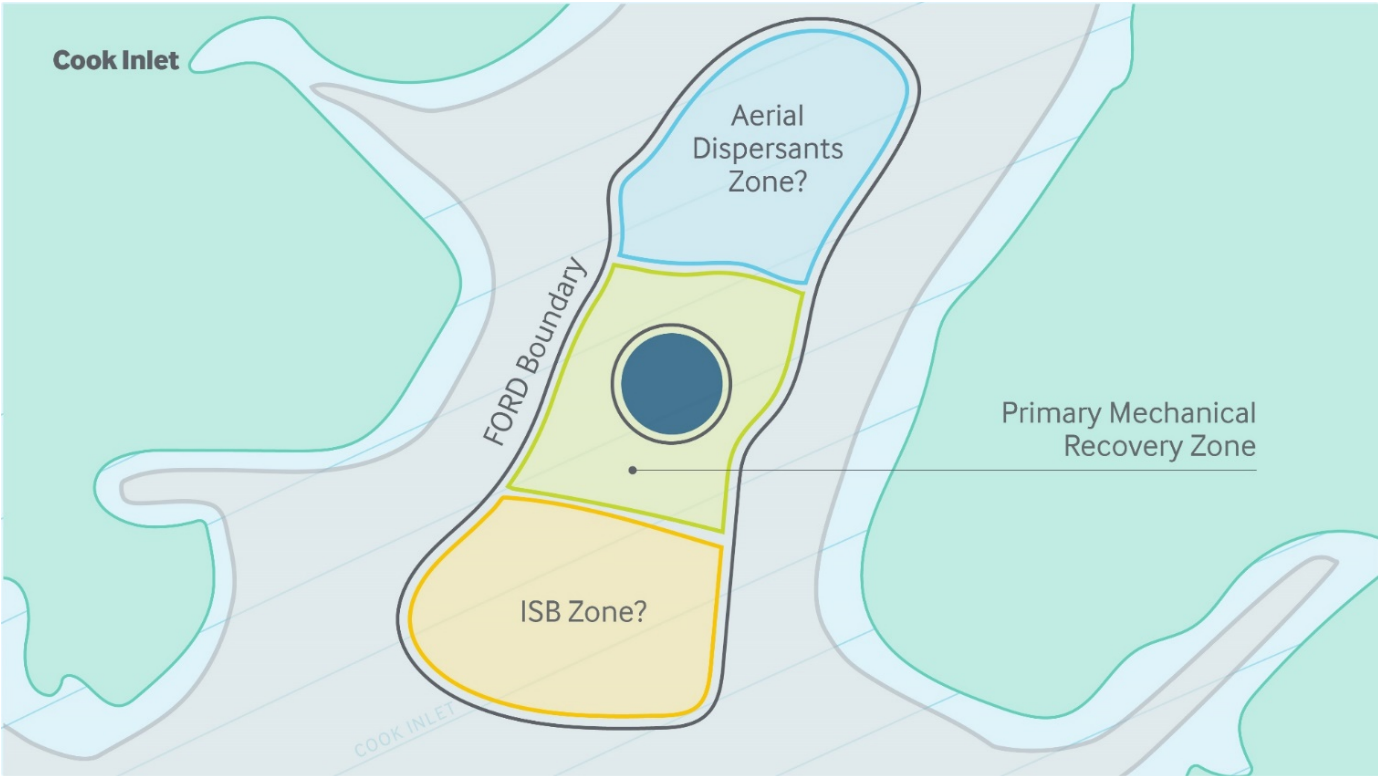


Figure 11. Possible configuration for the FORD in Cook Inlet.

By closely monitoring the fate of the weathered oil, the Operations Section will also set the boundary for the WORD and the Secondary Mechanical Recovery Zone which is the offshore portion of WORD (see Figure 12 for the Beaufort Sea and Figure 13 for Cook Inlet). Different mechanical recovery tactics and equipment will be required for offshore recovery of the weathered oil. The oil will typically be more viscous, potentially more emulsified, and slicks will separate into discontinuous and distributed patches and streamers that are more difficult to collect and recover. Tactics that increase a mechanical recovery system's swath width, such as towing boom in a "U" configuration with an open apex should be considered (Figure 14). Surveillance support will be critical for effective containment and recovery operations under these conditions. While any mechanical recovery task force will benefit from ongoing aerial surveillance support and nearby secondary temporary storage resources, these supporting components are critical for successful operations in the WORD Secondary Mechanical Recovery Zone

As oil slicks move closer to shore, the Nearshore Mechanical Recovery Zone will be a continuation of operations from the Secondary Mechanical Recovery Zone. However, responders will need to closely evaluate the water depths in this zone and select both mechanical recovery and temporary storage assets with shallow drafts. Nearshore response resources will usually not include large temporary storage capacities or crew accommodations for overnight operations when compared with vessels designed to operate in the offshore/open ocean environments. The smaller storage capacities and limits on operational hours will require different strategies for logistical support and tactical employment.

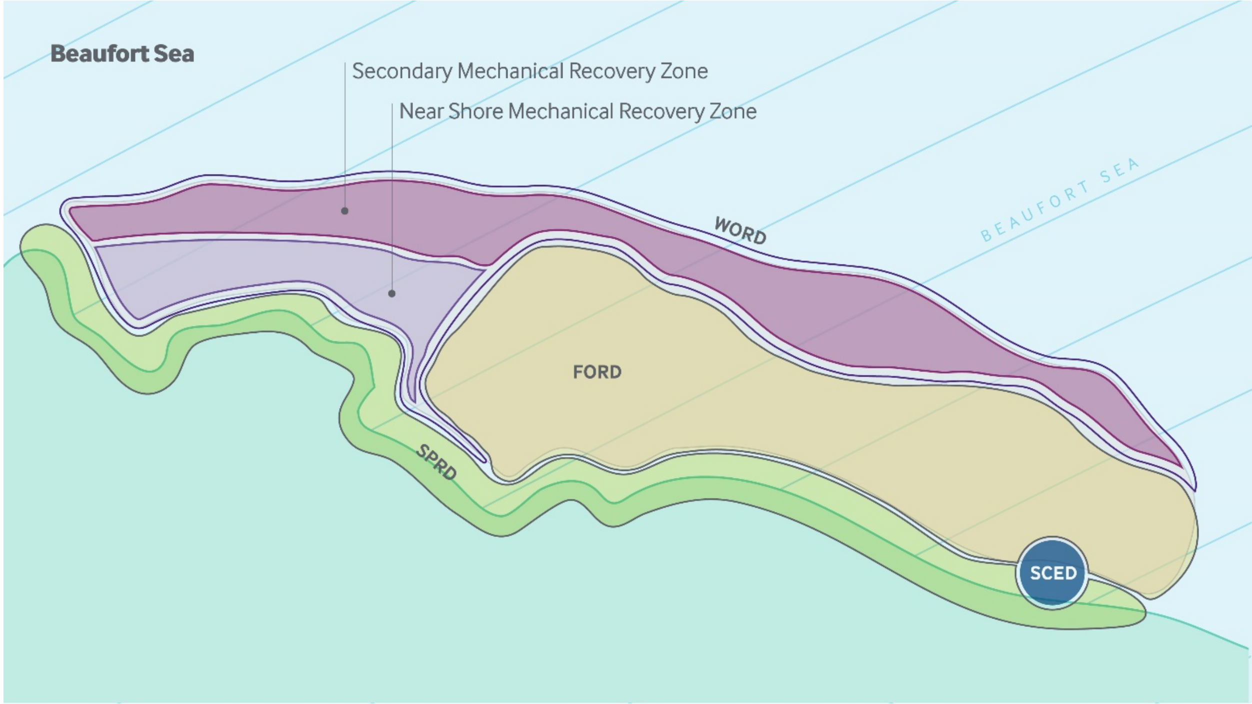


Figure 12. Possible configuration for the WORD in the Beaufort Sea.

Figure 13. Possible configuration for the WORD in Cook Inlet.

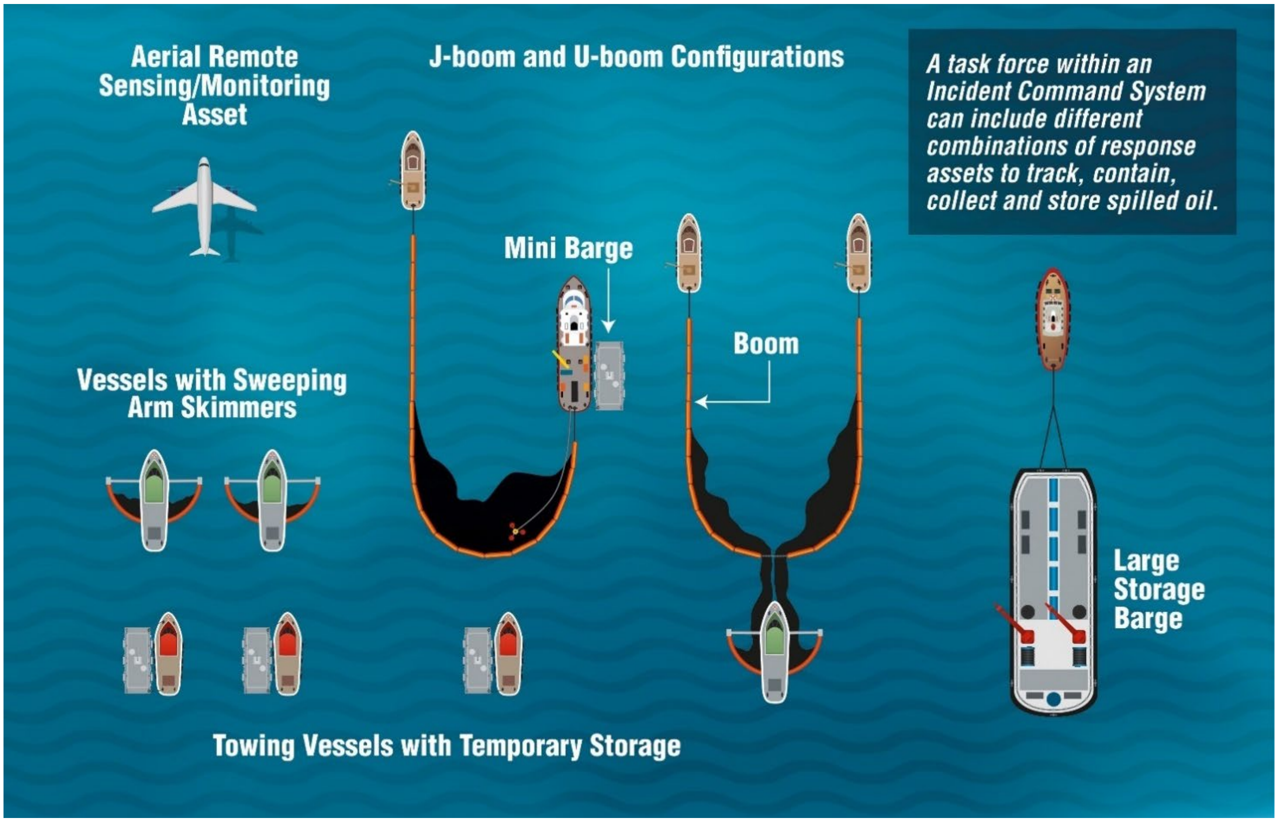


Figure 14. Mechanical recovery task force components.

7.1.2 Mechanical Recovery Systems & Efficiency Factors

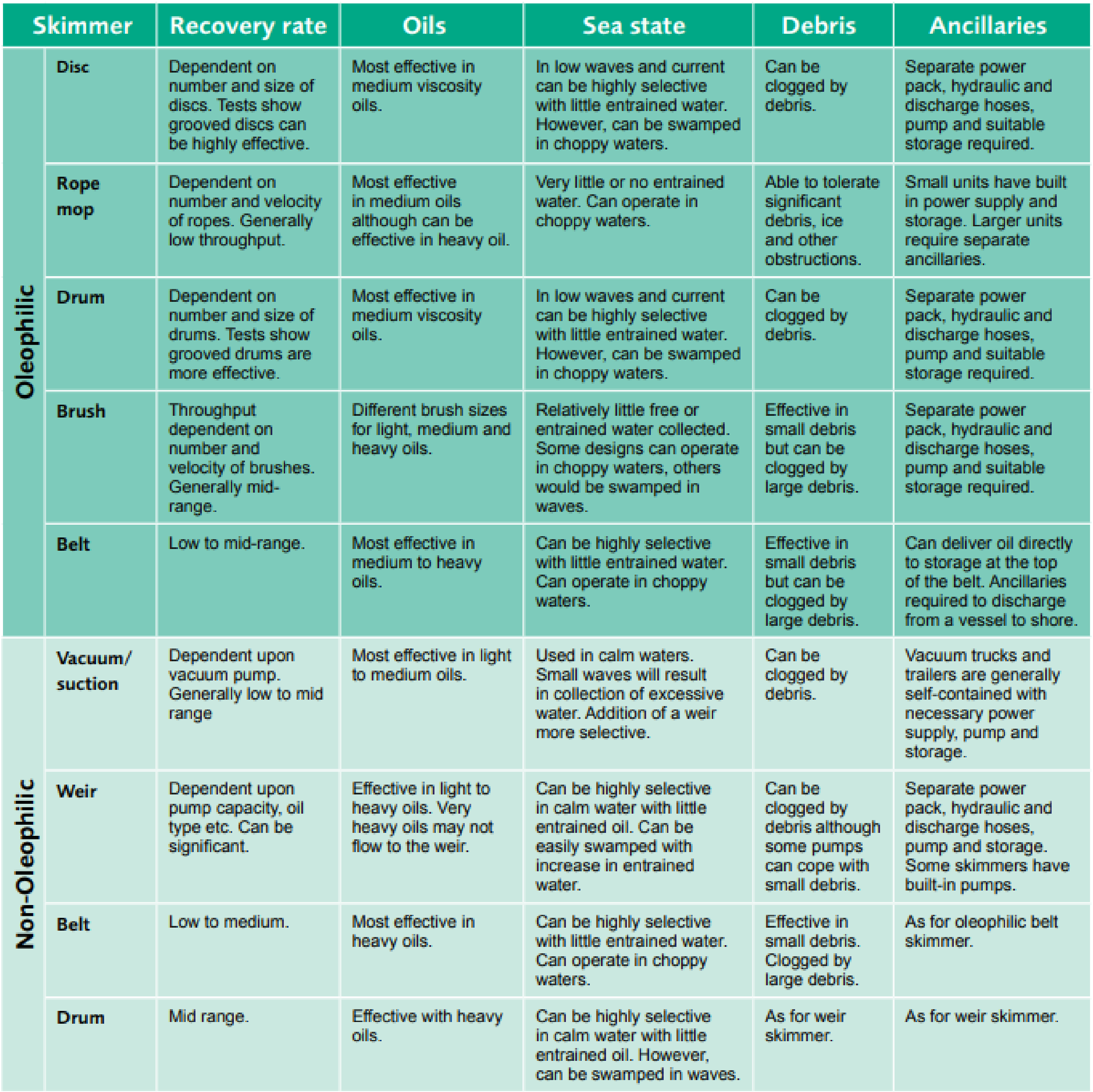
Since the performance of different skimmer types can vary considerably, spill responders must evaluate the specific skimmer type and efficiencies as they relate to the existing sea conditions and the properties of the discharged oil. They must attempt to match and operate the most appropriate recovery systems for the situation. This consideration is especially important as the oil characteristics change and slicks transit from the FORD into the WORD. Some skimmer types/systems can be modified with pump changes to accommodate varying oil viscosities as oil weathers to maintain effective operations. However, responders should evaluate whether oleophilic or weir skimmer systems will work best as the oil properties change.

Table 2 displays the different types of skimmers and the oil types and environmental conditions for which they are best suited. As the oil weathers, the effectiveness of a particular type of skimmer may change, requiring an alternate design for continued recovery.

Figures 15 and 16 illustrate the recovery efficiency of different skimmer types for different wind speeds, wave heights, oil types and viscosities. Emulsification can significantly impact the effectiveness of different response options on major surface oil spills. Emulsified oil typically has both increased volume and increased viscosity. However, not all oils emulsify, and the stability of the formed emulsion is not the same in all cases. Emulsification will be a significant concern for skimmers operating in the WORD.

Locating the thickest portions of oil slicks and focusing recovery efforts on these areas is another important factor for increasing efficiency. Aerial surveillance and drones may be used for spotting these areas and directing response vessels. However, the ability of aerial surveillance to accurately determine spill thickness continues to be a challenge. Darkness and visibility issues (e.g., fog and sun glare) in Alaska will limit the ability of spotting thicker collections of oil.

Table 2. Generic characteristics of commonly encountered skimmer types. Source: ITOPF Technical Report #5.



Skimmer		Recovery rate	Oils	Sea state	Debris	Ancillaries
Oleophilic	**Disc**	Dependent on number and size of discs. Tests show grooved discs can be highly effective.	Most effective in medium viscosity oils.	In low waves and current can be highly selective with little entrained water. However, can be swamped in choppy waters.	Can be clogged by debris.	Separate power pack, hydraulic and discharge hoses, pump and suitable storage required.
	Rope mop	Dependent on number and velocity of ropes. Generally low throughput.	Most effective in medium oils although can be effective in heavy oil.	Very little or no entrained water. Can operate in choppy waters.	Able to tolerate significant debris, ice and other obstructions.	Small units have built in power supply and storage. Larger units require separate ancillaries.
	Drum	Dependent on number and size of drums. Tests show grooved drums are more effective.	Most effective in medium viscosity oils.	In low waves and current can be highly selective with little entrained water. However, can be swamped in choppy waters.	Can be clogged by debris.	Separate power pack, hydraulic and discharge hoses, pump and suitable storage required.
	Brush	Throughput dependent on number and velocity of brushes. Generally mid-range.	Different brush sizes for light, medium and heavy oils.	Relatively little free or entrained water collected. Some designs can operate in choppy waters, others would be swamped in waves.	Effective in small debris but can be clogged by large debris.	Separate power pack, hydraulic and discharge hoses, pump and suitable storage required.
	Belt	Low to mid-range.	Most effective in medium to heavy oils.	Can be highly selective with little entrained water. Can operate in choppy waters.	Effective in small debris but can be clogged by large debris.	Can deliver oil directly to storage at the top of the belt. Ancillaries required to discharge from a vessel to shore.
Non-Oleophilic	**Vacuum/ suction**	Dependent upon vacuum pump. Generally low to mid range	Most effective in light to medium oils.	Used in calm waters. Small waves will result in collection of excessive water. Addition of a weir more selective.	Can be clogged by debris.	Vacuum trucks and trailers are generally self-contained with necessary power supply, pump and storage.
	Weir	Dependent upon pump capacity, oil type etc. Can be significant.	Effective in light to heavy oils. Very heavy oils may not flow to the weir.	Can be highly selective in calm water with little entrained oil. Can be easily swamped with increase in entrained water.	Can be clogged by debris although some pumps can cope with small debris.	Separate power pack, hydraulic and discharge hoses, pump and storage. Some skimmers have built-in pumps.
	Belt	Low to medium.	Most effective in heavy oils.	Can be highly selective with little entrained water. Can operate in choppy waters.	Effective in small debris. Clogged by large debris.	As for oleophilic belt skimmer.
	Drum	Mid range.	Effective with heavy oils.	Can be highly selective in calm water with little entrained oil. However, can be swamped in waves.	As for weir skimmer.	As for weir skimmer.

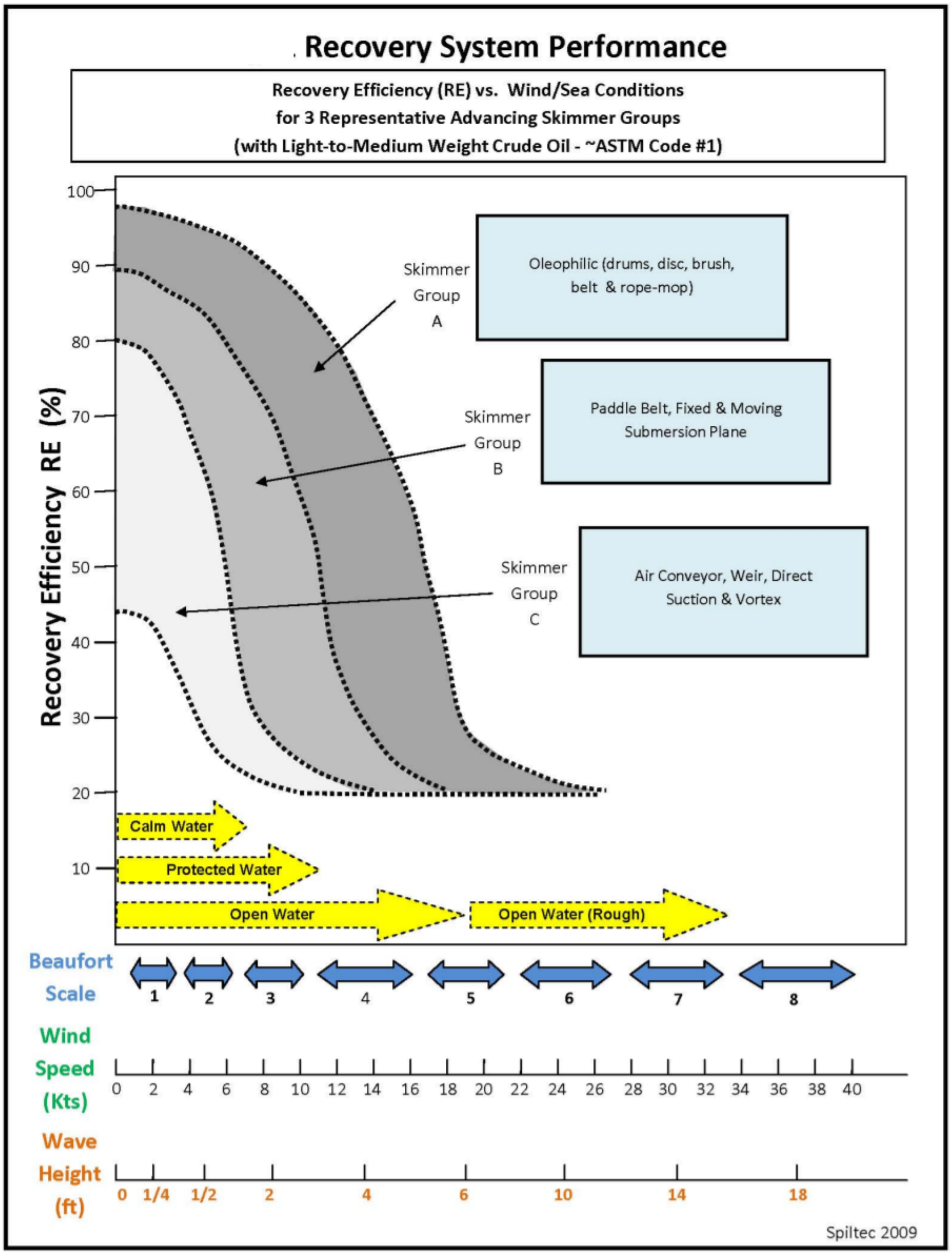


Figure 15. Recovery Efficiencies of Different Skimmer Types based on Wind Speed and Wave Height. Source Al Allen, Spiltec 2009.

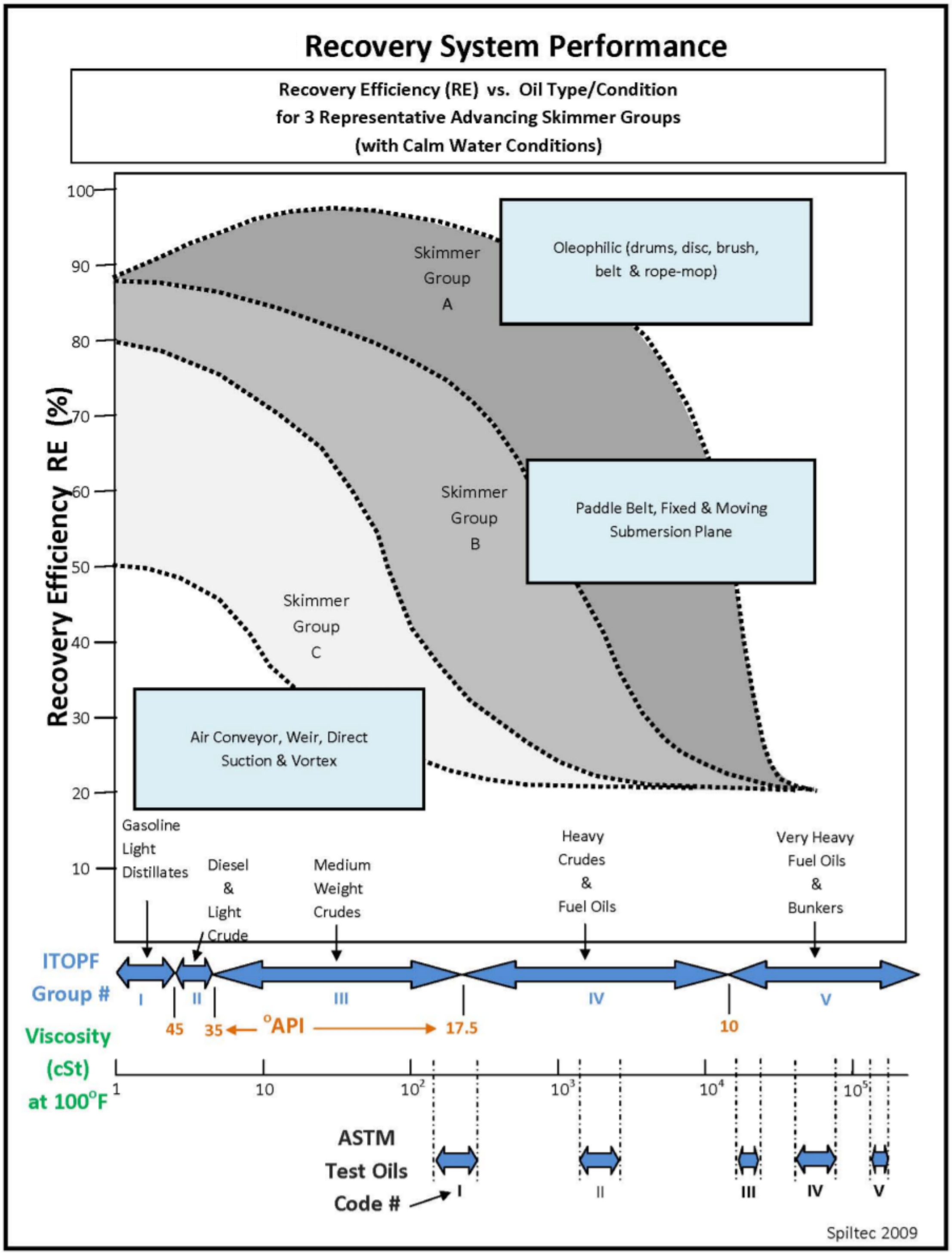


Figure 16. Recovery Efficiencies of Different Skimmer Types based on Oil Type and Viscosity. . Source Al Allen, Spiltec, 2009.

7.1.3 Enhanced Recovery Techniques

Responders can potentially improve recovery rates by using various enhanced recovery strategies. Enhanced recovery (or enhanced skimming) refers to different methods of increasing a recovery system's encounter rate. This can typically be achieved through increasing the speed of tow and recovery vessels, the containment boom swath width, or both. Systems may also incorporate an oil/water separator or utilize decanting to increase the efficiency of their temporary storage and skimming capacities. Decanting is discussed in Section 6.4. Enhanced oil collection methods use long lengths of towed containment boom and an open apex to increase the area of the ocean surface being swept (effectively increasing the swath width of a recovery system) and includes a dedicated vessel following behind to recover the oil (Figure 17). This method increases the encounter rate but requires close coordination of multiple vessels and competent response crews. The use of Current Busters may increase the recovery of an advancing skimming system. Alaska Clean Seas maintains two Current Busters in Alaska.

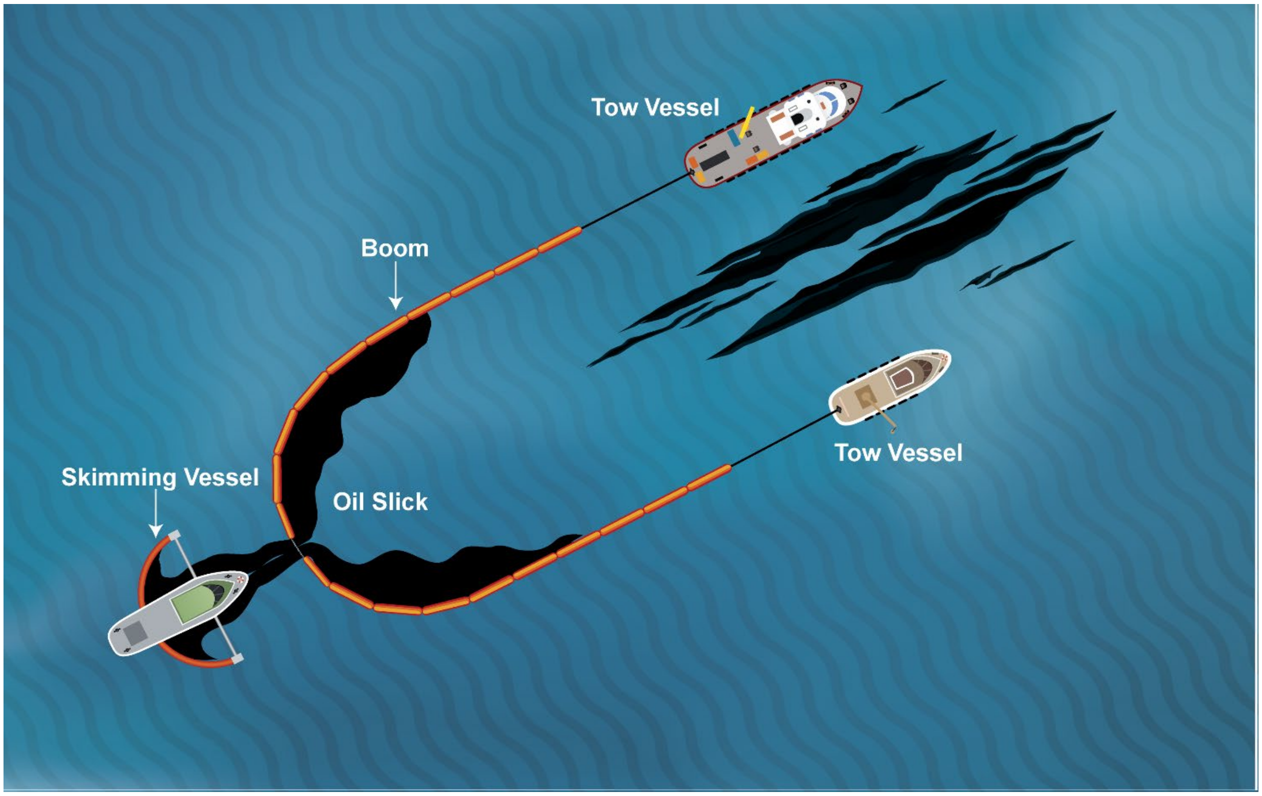


Figure 17. Enhanced Containment Configuration with an open apex U-boom.

Another important method for increasing the total amount of oil recovered by a system is to keep the recovery system skimming as long as possible by limiting the number of times a system needs to discontinue skimming and offtake/discharge the recovered oil/water to a secondary temporary storage unit. The logistics of skimming may be improved by selecting recovery vessels with decanting capabilities, larger integrated storage tanks, adding additional storage tanks to the vessel deck, and/or providing dedicated secondary storage tank barges or tankships in close proximity to the recovery operations.

7.1.4 Temporary Storage, Decanting, and Waste Management

Offshore mechanical oil recovery operations generate both solid and liquid waste. Liquid waste comprises the largest component, consisting of oily water mixtures of varying degrees. Management of these wastes involves the setting up of a logistics chain to transfer recovered waste in a safe and secure manner from the recovery vessels to a final authorized recycling or disposal facility deemed compliant by the governing federal/state agencies. The UC should develop an incident-specific Waste Management Plan (WMP) as soon as feasible that addresses both liquid and solid wastes.

When planning a waste management strategy for an offshore oil spill, the waste management stream should be structured around at least three components:

- primary temporary storage (i.e., storage immediately available as part of the recovery system, such as portable tanks loaded onto the deck or internal tanks onboard a recovery vessel, or towed storage);
- secondary temporary storage (i.e., tank barges/tank ships); and
- shoreside facilities where interim bulk storage, processing, transport, and/or final disposal takes place in conformity with all applicable federal, state, borough/county, and local laws, regulations, and procedures.

For North Slope facilities that generate oily water, ice, or snow, the primary final disposal is by shoreside disposal wells, also referred to as injection wells. For incidents in close proximity to disposal wells, these resources can reduce shoreside storage needs for situations where these wells are permitted for potential disposal.

The logistics chain needs to be rapidly established and tailored to the specifics of the incident. For the recovery of heavy oils or emulsified oils, consideration should be given to using heated temporary storage tanks, positive displacement discharge/transfer pumps, and skimmer types that are efficient/effective with higher viscosity oils.

Strategies must also comply with regulatory and classification society requirements, such as load line and inspection certificates, when determining the utilization of storage tanks onboard vessels. Not all available storage vessels will have the appropriate certifications for temporary oil storage or offshore/open ocean operations. Responsible Parties need to ensure that their pre-spill planning for temporary storage capabilities include appropriately certificated and classed vessels for the anticipated geographic spill response operating area. Waste management strategies for nearshore operations must consider the secondary temporary storage needs of shallow water recovery systems, which typically have smaller primary storage capacities and operate in limited water depths.

If the waste management logistics and/or capacities becomes overwhelmed, response operations are likely to be interrupted. For many oil recovery systems, primary temporary storage capacities will be limited, especially for many vessels of opportunity or shallow water skimmers. Such systems may rapidly reach their storage limitations and will need to curtail skimming operations if they cannot offload to readily available secondary temporary storage vessels.

For any system where large volumes of oil are encountered, an oil/water separator can be used to concentrate recovered oil and maximize the use of limited storage space. Gravity separation in settling tanks, then decanting the separated water overboard, is also an acceptable process. Vessels with oil/water separation and/or decanting capabilities will be able to extend their time on scene recovering oil. These vessels tend to be larger and well suited for offshore oil recovery but may be limited in their ability to operate in nearshore areas, especially in the shallow waters extending off the North Slope.

Decanting consists of oil/water mixtures being collected and pumped into temporary storage tanks, and the water is allowed to settle and separate from the oil. The free water is then discharged into the sea where the skimming vessel and/or secondary storage devices are conducting recovery operations. Decanting operations are not preauthorized; however, as specified in 40 CFR 122.3(d), the Federal On-Scene Coordinator can authorize the discharge as well as the conditions for that discharge. Although the USCG FOSC is authorized to allow decanting within the coastal zone, the USCG FOSC must consult with the State On-Scene Coordinator (SOSC) before authorizing decanting within state waters. In the case of an actual spill incident, decanting cannot be used unless approved by the SOSC. In accordance with the ADEC Division of Spill Prevention and Response, Prevention, Preparedness, and Response Program (PPRP) guidance, the SOSC must authorize the approval of the use of decanting and will make the decision at the time of an incident and on a case-by-case basis (ADEC Guidance No. PPRP 2018-02).

The amount of oil recovered by a system is often limited by the size of their primary temporary storage capacity and the amount of time spent offloading to secondary temporary storage vessels. Using towed storage such as dracones or bladders should not be used for offshore operations due to the potential for rough sea conditions, as well as difficulties with offloading these devices. Ultimately, recovered oil will require discharge to shoreside storage, and those shoreside facilities need to be identified early in the response.

7.2 Dispersants

Dispersants are chemical agents composed of detergent-like surfactant and solvent carriers that break up oil slicks into smaller particles that mix into the water column. These oil droplets are rapidly dispersed throughout the water column and are further broken down by natural processes, such as biodegradation, over a longer time period. Dispersants can be applied on the surface from aircraft or vessels. All of these application platforms use spray systems designed to deliver dispersants at specific dosages and droplet sizes. The use of all chemical countermeasures, including dispersants, is regulated under the National Oil and Hazardous Substances Contingency Plan (NCP), Subpart J of 40 CFR 300 and require approval under authorization of use protocols (preauthorization plans or incident-specific approval processes) outlined in Appendix I, the Alaska Regional Response Team (ARRT) Dispersant Use Plan for Alaska within the Alaska RCP. Dispersants are a complementary response countermeasure that may be considered in addition to employment of mechanical oil recovery systems.

The decision to apply dispersants must be based on an assessment of their availability, expected effectiveness, and whether their use in conjunction with mechanical recovery systems will provide the best overall outcomes for mitigating impacts to affected resources at risk. In Alaska, neither Cook Inlet nor the Beaufort Sea are covered as a Pre-Authorization Area for dispersant use. The procedures in Appendix I must be followed to authorize dispersant use. Dispersants may only be applied in areas where the water depth is greater than or equal to 10 fathoms or 60 feet and at sufficient distances from shore to ensure that sensitive nearshore and benthic habitats ae not affected by dispersants and/or dispersed oil. Table 3 presents the advantages and disadvantages of using dispersants.

Table 3. Oil Removal Strategy – Dispersants.

Oil Removal Strategy	Advantages	Disadvantages
Chemical Dispersion of Oil	• Aerial application has fast transit speeds for remote areas and high encounter rates that can treat oil over large areas quickly. • Effective in much more severe wind and sea conditions than mechanical. • More effective on thin oil slicks than other options. • Reduces oil concentrations on the water surface which may reduce the risk of fouling and inhalation of oil for wildlife (birds, marine mammals, sea turtles, sargassum communities). • Reduces the risk of oil reaching the shoreline related impacts. • Reduces the need for temporary storage offshore. • Increases availability of oil to biodegradation by oil eating microbes. • Rapidly reduces concentrations of harmful vapors at the surface, improving worker safety.	• Does not physically remove oil from the environment. • May not be effective on high viscosity fuel oils or weathered crude. • Relies on effective biodegradation to remove oil from the marine ecosystem. • Not effective under calm conditions with low wave action. • Requires authorization of use at multiple agency levels, which may delay deployment. • Requires extensive monitoring capabilities. • Requires some mixing energy for immediate effectiveness (e.g., waves or turbulence). • Not applicable in most areas of the Beaufort Sea due to shallow depths • Dependent upon oil properties and ambient metocean conditions, timeframe for effective use may be short. • Negative public perception.

Dispersing discharged oil into the water column has potential benefits and risks that, like the consideration of any response method, need to be addressed by conducting a SIMA.

7.2.1 Vessel-Mounted Dispersants

Vessel-mounted dispersant operations are conducted by utilizing dispersant spray arms deployed from the side of a vessel, or fire monitor spray systems. The encounter rate for vessel-mounted dispersant spray systems is substantially less when compared to aerial application systems. Depending upon the spill distance from the vessel port, the transit time for a vessel-mounted spray system to arrive on scene can be significantly longer than aircraft. Once on scene, vessels can remain on scene for an extended period of time and can continue to treat oil slicks until their payload of dispersant stockpile (which can be significantly greater than on an aircraft) is exhausted. Vessel-mounted dispersant systems can be used to target particularly thick slicks that would require multiple spray passes from aerial dispersant systems. They can also target spray to disperse specific surface slicks approaching a particularly vulnerable area, e.g., nesting site. Vessel-mounted dispersant systems may also be used near the source of the discharge to reduce VOC concentrations over the water's surface for worker safety.

7.2.2 Aerial Dispersants

The rapid transit speeds and high oil encounter rates for aerial dispersant aircraft allow for timely applications of dispersant to large amounts of oil on the water surface. Dispersant aircraft range in size, application rates and ranges.

Oil spill surveillance/reconnaissance, tracking, and spotter aircraft must be capable of arriving on scene prior to the start of dispersant spray operations. Spotter aircraft will assist the spray application aircraft in applying dispersants over the patches and streamers of oil. Spotter aircraft will also evaluate the effectiveness of the applications in dispersing the oil into the water. For smaller offshore spills, monitoring of oil dispersed by aircraft may be done by teams employing Special Monitoring of Applied Response Technologies (SMART) protocols. For larger offshore spills, monitoring of oil dispersed into the water column using aircraft must follow the requirements established in Subpart J of the NCP (40 CFR part 300).

7.2.3 Dispersant Management Plan (DMP)

Early in the response when dispersants are considered as part of the CONOPS, a Dispersant Management Plan (DMP) should be developed forecasting aerial and vessel dispersant consumption rates over the duration of the incident. This plan should include details on the allocation of stockpiles to support different tactical uses of dispersants, and if necessary, the arrangements for the replenishment of dispersant stockpiles. The DMP should also address the logistics that will be required to support dispersant operations.

7.3 In-Situ Burning (ISB)

In-situ burning in the offshore environment typically involves the collection, containment, and controlled burning of spilled oil inside of boom, either fire-resistant boom which could be reused or single use boom. These “fire booms” are towed through the water in a U-configuration at a slow speed to collect and contain the oil, separate the oil from the source in order to prevent secondary fires, and then to maintain a desired thickness of oil in the boom catenary that is necessary for sustained combustion. Hand-held pyrotechnic devices and helicopter-slung torches are the primary tools used for the ignition of the oil.

Pool fires of oil in open water require that the oil be sufficiently thick to burn (at least 2-3 mm) and is fresh enough to give off the oil vapors that are needed for combustion. The window of opportunity for using traditional open water ISB techniques will depend upon the oil weathering properties, metocean conditions, and whether it can be effectively collected and contained while it is still relatively fresh. Considerable research has been conducted to extend the window of opportunity for burning oil, improving the efficiency of the burn, and reducing the smoke and particulate emissions.

For a well blowout that provides a continuous discharge of fresh oil over an extended period of time, in-situ burning may be a good strategy to use offshore. It would most likely be implemented within the FORD where the oil will be thicker and will have lower viscosities suitable for burning.

Depending on the burn efficiency, less than 10% of the original oil volume often remains as burn residue, but this figure could approach 30% for less efficient burns of weathered or thin oil. The term *residue* refers to the unburned portion of the original spill remaining on the water surface when the fire extinguishes naturally. Burn residue generally appears as a viscous taffy-like substance that can be picked up in nets or with shovels and pitchforks over the side of a vessel or on solid ice. Industry-funded research programs have examined the likelihood of burn residue sinking as it cools. Results show that residue from many crudes remain neutrally buoyant for some time, allowing mechanical recovery. Burn residues from efficient burns of heavier crude oils <32 °API may sink once the residue cools (Buist and Trudel, 1995; S.L. Ross, 2002). Field tests conducted in Canada and the US over the past 40 years with a wide range of crudes (Alaska North Slope, Norwegian etc.) reported no instance of residue sinking before it could be recovered over the course of a few hours.

In response to public concerns over the issue of burn residue sinking, the Alaska Department of Environmental Conservation (2001) stated that: *The environmental advantages of in-situ burning outweigh the potential environmental drawbacks of burn residue, including the possible environmental harm if the burn residue sinks. Therefore, the on-scene coordinators do not need to consider the potential impacts of burn residue when deciding whether to authorize an in-situ burn. Nevertheless, the responsible party or applicant is required to have a plan for residue collection.*

A number of studies in the 1990s examined the toxicity of burn residue. Researchers found very little or no acute toxicity to oceanic organisms for burn residue (Daykin et al. (1994), Blenkinsopp et al. (1997), Gulec and Holdway (1999)).

The Prince William Sound Regional Citizens Advisory Council (2004) further considered the potential risks to marine life posed by burn residues as being extremely low. They concluded: "*Alaska North Slope crude burn residues were composed almost exclusively of high boiling point fractions (HBPF). From an environmental perspective, the burning removes most if not all of the lower-molecular weight aromatic hydrocarbons, which tend to be the more toxic and more bio-available components of the crude oil" (Fingas and Punt, 2000).*

The DWH oil spill is a recent example of using this tactic on an oil well blowout, where the over 400 in-situ burns were conducted over the duration of the 87 days of oil discharge. UC during the DWH spill elected not to expend valuable resources to collect floating residues from the highly effective burns.

Appendix II, the ARRT In-situ Burning Guidelines for Alaska, of the Alaska RCP govern use of ISB in Alaska (RE: IN-SITU BURNING APPLICATION AND BURN PLAN FOR OIL DISCHARGE AND HAZARDOUS SUBSTANCE RELEASE RESPONSES IN ALASKA). The ARRT may authorize ISB when mechanical containment and recovery by themselves are incapable of controlling the oil spill, burning is feasible, and the burn will lie a safe distance from populated areas. This safe distance is generally defined as more than 3 miles downwind of an ISB site for burns within 3 miles of shore and 1 mile for burns more than 3 miles from shore. There are currently no preauthorization agreements in the Alaska region for ISB. If a chemical agent is required for the burn, the FOSC must receive concurrence from the Environmental Protection Agency (EPA) and the State of Alaska representatives to the ARRT.

Numerous agencies, primarily in the United States, established guidelines for the safe implementation of ISB as a countermeasure. For example, the U.S. National Institute of Standards and Technology, NOAA, and Environment Canada developed computer models that can be used to predict safe distances for downwind smoke concentrations. In 1994, the ARRT, comprised of multiple state and federal agencies, incorporated ISB guidelines for Alaska into its Unified Response Plan, becoming the first Arctic area to formally consider ISB as an oil spill countermeasure (Alaska Regional Response Team, 2008). Their guidelines are considered the most fully developed to date.

The American Society of Testing and Materials began developing standards associated with ISB in the late 1990s (ASTM, 2009), while the USCG produced an Operations Manual that details considerations and steps to be taken for open water ISB with fire booms (Buist et al., 2003b). The American Petroleum Institute (API) developed a guide to in-situ burning for decision-makers that summarizes much of the available knowledge pertaining to impacts and procedures for mitigating and avoiding human health issues during an actual response (Scholz et al., 2004). Buist et al. (2013)

provide an exhaustive summary of the state of knowledge surrounding the use of in-situ burning in the Arctic, including operational procedures to monitor the smoke plume and select safe distances from human populations to avoid any health concerns.

Table 4 presents the advantages and disadvantages of in situ burning.

Table 4. Oil Removal Strategy – In-Situ Burning.

Oil Removal Strategy	Advantages	Disadvantages
In-Situ Burning (ISB)	• Rapidly removes large amounts of oil from the water surface. • Minimal labor and equipment requirements (compared to Mechanical). • No need for temporary storage offshore. • Very little residue remains after burning the oil. • Ice can serve as containment and therefore ISB can be an especially effective strategy for remote areas in winter. (See Section 7).	• Limited encounter rate similar to mechanical recovery. At sea, oil must be contained in a boom to burn. • Requires special permits and approvals (including any chemical gelling agents used for ignition). • Creates a smoke plume that requires air monitoring. • Negative public perception. • Dependent upon oil properties (e.g., emulsification) and metocean conditions, the timeframe for effective use may be relatively short. • Limited by similar wind and wave criteria that govern booming operations for mechanical recovery. • Burn residue may sink (in small volumes)

7.3.1 Surface Collection Agents (aka Herders)

Surface Collecting Agents (SCA), or herding agents, are an oil collection and containment tool available to the FOSC. These chemical countermeasures are applied around the periphery of an on-water oil spill, limiting the oil's ability to spread and therefore decrease in thickness.

The 2012 report, *"Research on Using Oil Herding Agents for Rapid Response in-situ Burning of Oil Slicks on Open Water"*[2], identified some of the potential benefits of herders in conjunction with ISB:

- Potential elimination of the need for fire boom and boom tending vessels, as the herder provides containment of the oil.
- A more rapid in-situ burn response due to the reduced logistical footprint.

As noted, if the FOSC wishes to utilize this countermeasure, the FOSC must first seek ARRT concurrence as their use has not been preauthorized. In addition, the FOSC will need to ensure that the agent is included on the National Product Schedule. Chapter 7 provides additional discussion of the potential use of herders to thicken oil for burning without booms in open pack ice conditions.

7.4 Vessel and Aircraft Tracking Capabilities

For both traffic safety management and situational awareness of response operations during a large spill response, tracking technologies for vessels, aircraft, and any other deployed resources in the incident area should be implemented. Technologies may include the use of radar-based air traffic control systems and Automatic Identification System (AIS) trackers placed on vessels. These tracking systems are important for monitoring and coordinating operations, tracking the deployment of resources, ensuring adequate separation of different response activities, and deconflicting the air space over the incident to prevent mishaps. For example, during the Deepwater Horizon incident, due to the high volume of air traffic in the area, both spill-related and routine oil industry support, it was a high priority of the UC and its Operations Section to make viable, safe procedures for best utilization of the airspace. An airspace coordinator from Tyndall Air Force Base was present early and was soon joined by a Federal Aviation Administration (FAA) representative. Together, they created the Temporary Flight Restriction, or TFR, from the surface to 3,000 feet to keep uninvolved air traffic out of the area. All flights were coordinated with the airspace coordinator to avoid midair collisions.

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[2] BSEE, S.L. Ross Environmental Research, Research on Using Oil Herding Agents for Rapid Response in-situ Burning of Oil Slicks on Open Water, 2012.

8 Response in the Presence of Ice

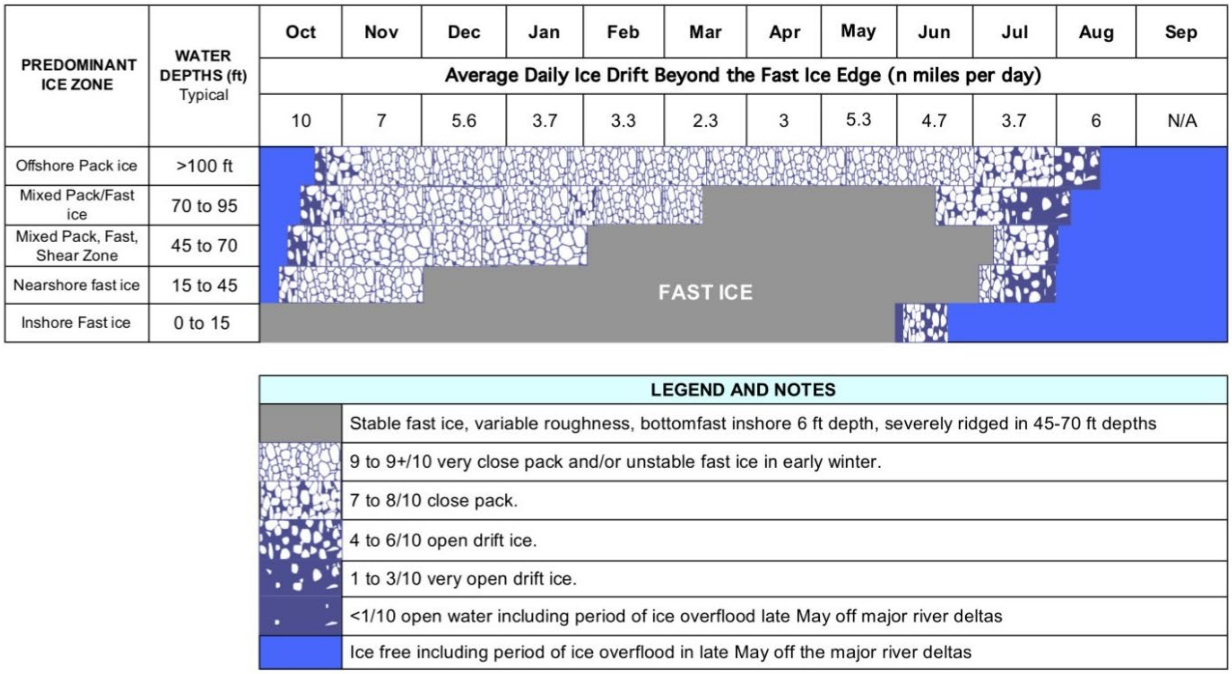
In any spill, environmental factors, such as marine weather (wave frequency/height, wind velocity, visibility, temperatures), will greatly impact the effectiveness of the response and choice of countermeasures. In the Beaufort Sea, these constraints are amplified by extreme temperatures, long periods of continuous and broken ice cover, and limited daylight hours through much of the winter.

The presence of sea ice affects almost every aspect of spill response in the Beaufort Sea for over nine months of the year in water depths outside the barrier islands (typically beyond 15 feet). The physical characteristics of the ice and bathymetry dictate when and if a particular response strategy is feasible.

Examples of these physical factors are:

- Stability – Is the ice attached to shore (referred to as "fast)" and static, or drifting with wind and current?
- Ice concentration – What is the % area ice coverage? The ice coverage greatly affects the viability of conventional marine response as well as the use of burning and dispersants.
- Water depth – Is the sea ice free-floating or bottom-fast (resting on the seabed) as is typical in water depths less than 1.5-1.8 m (5-6 ft)?
- Thickness – Is the ice thick enough to safely support response crews and equipment?
- Ice roads – Is it possible to construct and maintain an ice road from shore to the spill site?
- Surface conditions – Is the oil absorbed into dry snow on the surface or contained in melt pools on a melting ice sheet?

Figure 18 illustrates a typical seasonal ice cycle in the vicinity of Prudhoe Bay moving out from shore to water depths beyond 100 feet (Dickins, 2007)~~.~~



PREDOMINANT ICE ZONE	WATER DEPTHS (ft) Typical	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
		Average Daily Ice Drift Beyond the Fast Ice Edge (n miles per day)											
		10	7	5.6	3.7	3.3	2.3	3	5.3	4.7	3.7	6	N/A
Offshore Pack ice	>100 ft												
Mixed Pack/Fast ice	70 to 95												
Mixed Pack, Fast, Shear Zone	45 to 70												
Nearshore fast ice	15 to 45												
Inshore Fast ice	0 to 15												

	LEGEND AND NOTES
■	Stable fast ice, variable roughness, bottomfast inshore 6 ft depth, severely ridged in 45-70 ft depths
▦	9 to 9+/10 very close pack and/or unstable fast ice in early winter.
▩	7 to 8/10 close pack.
▨	4 to 6/10 open drift ice.
▪	1 to 3/10 very open drift ice.
·	<1/10 open water including period of ice overflood late May off major river deltas
🟦	Ice free including period of ice overflood in late May off the major river deltas

Developed by DF Dickins Associates (2007) and published by Dickins and Allen for Shell Exploration and Production

Figure 18 Typical Beaufort Sea Seasonal Ice Cycle vs. Water Depth.

Ice extends the time available to plan and execute an offshore response by containing, concentrating, and trapping the oil for long periods, often-in a close to fresh state (especially true for oil spilled under ice). At the same time, low temperatures, snow cover, and increased oil thickness can reduce the rate of evaporation for oil deposited on the solid ice surface and in openings within pack ice. Intermediate pack ice concentrations often referred to as "broken ice" found mainly during the shoulder season of break-up can be particularly challenging. Rapidly shifting ice conditions may force frequent shifts in response strategy, e.g., from mechanical to burning.

In terms of fate and behavior, spills in ice are fundamentally different from spills in open water. Understanding this difference is critical for detection, trajectory analyses, and strategic planning. Response techniques that work in open water and temperate regions may be ineffective or provide much reduced effectiveness in cold, snow, and ice.

Any significant ice concentrations will severely limit the effectiveness of traditional mechanical containment and recovery (booms and skimmers) in dealing with large spills. At the same time, the presence of ice and cold water can potentially increase the window of opportunity for successful burning and/or dispersant applications (that period when the oil remains unemulsified, thick, and relatively fresh).

At freeze-up, the transition from open water to a close to continuous cover of new ice can occur in a matter of days, effectively curtailing all mechanical recovery until the ice is thick enough to support on-ice operations (through natural growth or artificial thickening by spraying). During this time, ISB with aerial ignition may be the only practical response strategy apart from waiting and doing nothing.

During the winter period when the ice sheet is thick, stable, and attached to shore (fast ice), both ISB and mechanical recovery are feasible in some areas, using the ice sheet as a working platform to transport recovered oily waste to shore and/or to support response crews and equipment concentrating the oiled snow for burning.

During the melt period in May/June as the ice sheet remains intact but with badly deteriorated surface conditions, opportunities for mechanical removal diminish through lack of access. At the same time, aerial ignition remains viable and potentially effective.

Through break-up, lasting 4-6 weeks in June and July, a mix of all three response strategies is possible depending on ice concentrations, water depth, and other factors. Due to ice interference with booms and skimmers, mechanical recovery of oil on water can only resume when the ice coverage consistently falls below ~30% (7.1).

The following sections present a more detailed overview of potential oil in ice response strategies suited to different ice conditions. Guides to oil spill response options and tactics in ice can be found in a number of publications including:

- *Alaska Clean Seas Technical Manual* – Vol. 1 Tactics Descriptions. Rev. 12, Jan 2015 http://www.alaskacleanseas.org/wp-content/uploads/2016/03/Volume_1_Tactics_Descriptions.pdf

- Field Guide for Oil Spill Response in Arctic Waters, 2nd Edition. https://oaarchive.arctic-council.org/bitstream/handle/11374/2100/EPPR_Field_Guide_2nd_Edition_2017.pdf?sequence=12

- *Guide to Oil Spill Response in Snow and Ice Conditions in the Arctic*, 2015, Owens E., and D.F. Dickins for EPPR, Arctic Council https://oaarchive.arctic-council.org/handle/11374/403

Full citations for the references used to support discussions in Sections 7.1-7.3 can be found in Owens and Dickins (2015)

8.1 Mechanical Recovery in the Presence of Ice

The Deepwater Horizon response highlighted a key drawback of mechanical containment and recovery systems when confronted by a large, rapidly spreading oil slick: the encounter rate is insufficient to allow the skimmers to achieve a substantial percentage of their theoretical recovery capacity. This problem is greatly amplified by the presence of any significant ice cover.

There are fundamental limitations associated with maintaining and operating booms and skimmers in areas like the Beaufort Sea where ice is present for much of the year. The National Research Council in their report *Responding to Spills in the U.S. Arctic Marine Environment* concluded that "very large oil spills require a response approach that does not solely depend on mechanical recovery" (NRC, 2014).

The following discussion covers the different mechanical strategies that are possible in the presence of ice, moving through the ice season from freeze-up to break-up. The focus is on dealing with surface spills that involve oil either being deposited on the water or ice surface. The special case dealing with oil deposited beneath solid ice is covered briefly, for example a subsea pipeline leak. The behavior of oil in different ice types is maintained as a consistent thread needed to understand the limitations of different strategies throughout the ice season.

Freeze-up

Oil spilled during freeze-up will initially be mixed with the newly forming ice in early October. This ice is still mobile and subject to widespread fracturing and rafting with the thin sheets riding over each other in response to wind action (finger rafting). Through these ice deformation processes, some of the oil deposited on the surface at this time could be redistributed and trapped between ice layers to remain inaccessible until the spring melt.

Traditional advancing mechanical recovery operations are not feasible with new ice forming in freezing water. In the nearshore Beaufort Sea area, the transition from close to freezing open water to continuous coverage of new ice (or nilas) on the water surface can occur overnight, depending on wind and waves. As ice concentrations exceed 10% coverage (1/10), towing booms to collect oil will result in a thick layer of slush and grease ice that effectively prevents oil from flowing to the skimmer head. Beyond 30% coverage (3/10), continued containment and skimming becomes close to impossible due to ice interference. This sharp degradation of mechanical response effectiveness in relatively low concentrations of drift or pack ice has been documented in full scale field trials on the North Slope (Bronson et al., 2002) and in basin tests at BSEE's OHMSETT facility (Schmidt et al., 2014).

Certain skimmer systems may be able to process some oiled slush in small volumes, but the oil encounter rate drops dramatically while the water content of recovered product increases sharply. The risk to responders is greatly increased by working on the potentially slick decks of small work boats during freeze-up. With rapidly diminishing daylight (less than 7 hours at the end of October) and onset of double-digit sub-freezing temperatures, response strategies through the freeze-up period will need to consider alternative countermeasures – see ISB discussed in 7.3.

Winter – Oil on Ice

The early winter period (November – December) is characterized by an expanding zone of fast ice, increasing in stability as the ice thickens and becomes more able to resist early winter storms. The fast ice edge expands seaward to reach an average water depth of ~45 ft in December (Figure 18). By this time, the average thickness of the fast ice is in the order of 25 inches. By late December, it becomes possible to start construction of ice roads to offshore locations, such as Northstar, a process of surveying and flooding that can take 6 weeks or more of round-the-clock work.

Unfortunately, there are less than 3 hours daylight from November 18 to January 25. Close to total darkness combined with extreme cold temperatures makes extensive on-ice response operations difficult. The UC can consider the IWI procedures in the AWA ACP based on the incident.

Without any removal of oil accumulating rapidly on the ice surface, the oil may spread laterally outside of the initial contaminated area. However, when warm oil hits the ice, it also may thicken given the cold temperatures, achieving a ‘peanut butter’ consistency, and will not move far across the ice. The oil behavior will depend greatly on the API gravity of the oil. Assuming an equilibrium thickness in the order of several inches, a winter Worst Case Discharge (WCD) running for 30 days could contaminate the surface of solid ice around a production island over an overall area in the order of ~4 square miles. Although this area seems huge, it is important to keep in mind that the equivalent spill on open water could potentially contaminate an area thousands of times larger.

Once the ice road is in condition to accept wheeled vehicles, offshore access becomes easier. Heavy lift helicopters can also land safely on the ice, and response crews can begin to work with heavier equipment, such as bobcats and loaders and eventually tandem dumps, to facilitate mechanical recovery (and burning). Daylight constraints recede with over 13 hours available by the end of March.

In March and April, the ice roads are usually still in good condition, allowing reliable access to oiled ice areas in the relatively smooth ice zone (out to ~45 ft water depths) with heavy equipment, making use of the extended daylight. Loaders and lined tandem dumps can move oiled snow to shore for disposal, but the logistics of this operation quickly become overwhelming for a large spill. For example, in an extreme case, using a typical tandem dump capacity of 18 yd^3, it would take ~25,000 loads to transport just the oil volume accumulated over 30 days at 91,000 barrels per day (bpd) with an assumed evaporation of 20%. Moving just 10% of the oil and snow in March (assuming that the snow is 40% oil by volume) would involve ~25 trips an hour during daylight, over three weeks. BSEE developed a Response of Oil, Snow, and Ice (ROSI) Calculator[3] in 2023 as a tool to verify the recovery and handling capacity using Yellow Iron equipment during snow and ice conditions. This calculator will be available on BSEE's website.

High traffic volumes with heavy loads may create serious ice road maintenance issues. An additional concern involves the need to avoid the resonant speed for moving heavy loads on floating ice sheets as a function of water depth. While not a factor in deeper water or very shallow water where the ice is grounded, decelerating through the critical speed zone (typically 12-15 mph) in certain water depths can cause sudden buckling failure of the ice sheet and major damage to the ice road. This constraint needs to be factored into transit times and available calculators (such as the one recently developed by BSEE, 2023). Strict monitoring of safe parking times for heavy vehicles at the offshore loading site is also essential to avoid break-through and loss of equipment and/or fatalities.

In summary, there are major issues involved with mounting a large-scale mechanical on-ice recovery operation to deal with a large spill where oil is deposited to the ice surface.

- Ice roads cannot start construction typically until December.
- The useful window for ice roads is ~ 3-4 months.
- Heavy, repeated traffic will break down the ice road surface and speed restrictions in critical water depths could increase transit times and decrease efficiency.
- Using heavy equipment to scrape large ice areas and load trucks is not possible on ice that has not been already built up by spraying and flooding – this cannot be done with ice that is already heavily oiled.

Beginning in May, shore access to the ice road can become problematic as a narrow band of melt water develops along shore in shallow water. After mid-May, wheeled vehicle access is usually not possible. However, tracked vehicles and specialized low pressure-tired equipment, like Rolligons, can still operate into June at some locations if they can find safe access points from shore.

By early June, melting snow on the offshore ice surface starts to create numerous melt pools with excess water draining through cracks and seal holes. Winds will herd oil remaining or deposited on the melt pools at this time into thickened patches. Surface access and working conditions on the ice become gradually more difficult moving through June, until at some point, the ice is too deteriorated to support safe operations with responders or heavy equipment. The ACS Tactics Manual contains established guidelines for operating a wide range of equipment on ice at different times of the year, including late in the season on warming ice.

Outside of the Barrier Islands in water depths of 15-45 ft, the fast ice remains stable and relatively static until the end of June or the first week of July on average. Continued offshore surface access

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[3] Research to Support Analysis of Oil Spill Response plans for spills on snow and solid ice (bsee.gov)

during these last weeks of intact ice cover could use hovercraft, airboats, or helicopters but without any opportunity to mechanically remove large volumes of oil from the ice surface.

Winter – Oil Under Ice

Mechanical recovery of oil trapped under solid ice is challenging. Oil spilled under ice, for example from a pipeline rupture or leak, will rise to remain in scattered pools or patches under the ice. Under winter conditions (December to April), oil can quickly become encapsulated (within ~48-72 hours) by new ice growing beneath the oil.

There are limited options to accurately locate and map oil trapped beneath the ice or encapsulated within the ice sheet. In the past, crews used multiple drillholes to find and delineate trapped oil pockets. Over the past decade, multiple field trials in the U.S. and Norway have demonstrated that Ground Penetrating Radar (GPR) is able to detect and map oil under or in cold ice. It may be possible to find oil soon after it has spilled under ice (within 72 hours) by "flying" an autonomous underwater vehicle (AUV) under the ice with upward looking sonar or optical cameras. BSEE has an ongoing project (2023/24) to develop this technology and test promising sensors. Once the trapped oil is located, it may be possible to gain access through a combination of trenching, cutting, and drilling, while using the ice cover as a working platform (ACS Tactics Manual, 2013). Depending on location, recovered oil can be transported to shore for disposal and/or reinjection in onshore wells.

At the end of April, when the ice has almost stopped growing, the oil will remain as a trapped layer in a fresh state within the ice. Beginning in May, the sea ice becomes porous enough to permit the oil to naturally migrate to the surface. Once this happens, the oil becomes accessible, floating on melt pools and available for mechanical recovery and/or burning as long as the ice remains intact with shore access.

Break-up

Following the initial fracturing and movement in early July, the ice sheet deteriorates rapidly into increasingly thinner and smaller floes, leading to open water (defined as less than 10% ice cover) by late July on average outside the Barrier Islands (Figure 19). During this transition period from solid ice to open water, ice concentrations can be highly variable from hour to hour depending on the winds.

As the surrounding ice breaks up and becomes mobile, any oil remaining from being deposited on the solid ice surface in the winter will enter the water and rapidly drift and spread much like an open water spill. One difference is that this oil will enter the water in a partially weathered state (evaporated but not significantly emulsified).

Once the ice concentrations reduce to ~30% or less, setting boom (or ISB with fire booms) becomes feasible again but, even at very low ice concentrations, mobile ice can greatly interfere with containment and mechanical recovery as discussed previously under "freeze-up."

Intensive and costly international efforts to develop dedicated mechanical systems for operations in naturally broken ice have not progressed beyond the small-scale prototype stage, for example the MORICE project (Mullin et al., 2003). The problems and impracticality of scaling up such systems to achieve useful oil encounter and recovery rates in an Arctic environment have stalled further developments of practical systems dependent on ice cleaning or processing.

The practicality of deploying booms during the break-up period depends on the severity of the ice conditions. Any limited containment of oil, which may be possible in very open drift ice (10 to 30% coverage), requires rugged, high-strength booms to withstand contact with the ice and the increasing loads imposed as ice builds up inside the towed boom. Field trials in 2008 and 2009 in Norway demonstrated that, although heavy fire boom could collect and contain significant amounts of ice distributed as small floes (5-15 ft diameter) at slow speeds without failure, the only practical means of removing the oil in ice after collection in this situation was through burning (7.3).

8.2 Dispersants in the Presence of Ice

With the rapid transition from predominantly open water to continuous ice cover in October, dispersants become ineffective. Once the nearshore ocean areas surrounding oil production facilities are covered by stable fast ice in late October, there is no possibility of considering dispersants again until break-up in July.

As with any dispersant application in open water, the issue of gaining approvals in a timely manner by demonstrating a clear net environmental benefit will always present an additional challenge (with or without ice present). The water depth limitations discussed earlier in Section 6.2 are still applicable through the ice season. The following discussion focuses mainly on the potential aerial application of dispersants to oil contained within drift ice at break-up in the 40 to 60% coverage (4-6/10) range. This ice regime during break-up is most likely to avoid interference from slush and newly forming ice, while having enough floe interactions to provide the necessary dispersant mixing energy. The 60% cutoff is not absolute, but it marks the transition to close pack ice where most of the dispersant would be wasted landing on the ice rather than oil on water.

An initial concern about using dispersants in the Arctic was that, as the temperature decreases, chemical processes slow down and oil viscosity increases, making it more difficult to disperse. Over the past three decades, a series of tank and basin tests and field experiments proved that oil can be dispersed successfully in cold and ice-covered waters. (Brown and Goodman, 1996; Spring et al., 2006; Nedwed et al., 2007; Mullin et al., 2008; Owens and Belore, 2004). Research shows that dispersants are effective on unemulsified oil at freezing temperatures if oil viscosity does not increase significantly.

The SINTEF Oil in Ice Joint Industry Program (JIP) evaluated the effectiveness of dispersants under a wide range of Arctic conditions, including under cold air and water temperatures, in the presence of ice, and in brackish water from melting ice and river outflows (Daling et al., 2010). As part of this project, a new controllable applicator arm was developed to deliver dispersant more effectively to isolated oil pockets in pack ice (Figure 19). Prop wash was needed after application to achieve dispersion. This approach is applicable to relatively small spills contaminating a local area within the ice field.

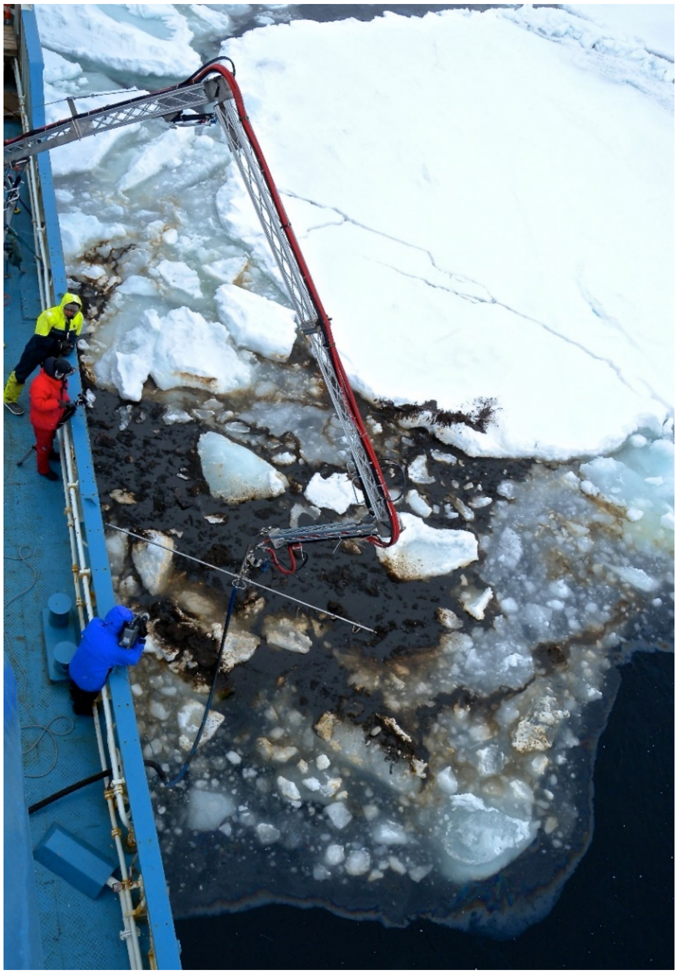

Figure 19. View of the specialized dispersant application arm developed and tested in the SINTEF Oil in Ice JIP in 2009 in the Norwegian Barents Sea with the aim to improve the targeting and delivery of dispersant to isolated oil patches among ice floes (Photo: D. Dickins).

The presence of ice may increase the length of time that dispersants can be used after the oil is spilled, by slowing the rate of oil weathering and emulsification. In the past, concerns were that the natural wind-wave action and surface turbulence that facilitates dispersion in open water would be so reduced by the presence of ice that dispersion would not occur. However, large-scale tank tests at OHMSETT in 2004 showed that in open drift ice (40-60% cover) the mixing energy created by the interaction and jostling of individual ice floes can result in even more effective dispersion than would otherwise be possible without ice under similar low wind conditions (Owens and Belore, 2004). In higher ice concentrations such as shown in Figure 20, additional mechanical mixing will likely be needed to promote dispersion.

Motivated by concerns about the rate and extent of oil biodegradation in cold arctic waters, laboratory studies at Point Barrow, Alaska, demonstrated that indigenous Arctic microorganisms effectively degraded both fresh and weathered oil. Most importantly, Arctic species and their counterparts in southern waters exhibit similar tolerance to dispersed oil and the use of dispersant was not observed to increase the toxicity of the oil (Gardiner et al., 2013).

Prince et al. (2013) suggested that biodegradation in arctic waters would be rapid and extensive when oil is present at concentrations expected with dispersant use. Subsequent mesocosm studies by McFarlin et al. (2014) with Arctic seawater collected from the Chukchi Sea, incubated at −1°C, supported this hypothesis. Indigenous Arctic microorganisms effectively degraded both fresh and weathered oil at environmentally relevant concentrations, with oil losses ranging from 46−61% over 60 days.

The use of aircraft to apply dispersant to marine surfaces allows for a much wider coverage area within a shorter period of time than spray systems based on vessels. The Boeing 727 and 737 jet aircraft dispersant delivery systems can provide significantly reduced mobilization times to remote areas and increase the application rate for large-scale operations (compared to C-130-based systems). Two 727s and a 737 aircraft are now certified and fully operational and are available respectively through OSRL in the UK and MSRC in the USA, (Figure 20). MSRC's dispersant aircraft Boeing 737, and dispersant stockpiles, are staged in locations to meet the planning time requirements of the OPA 90 USCG vessel guidelines. MSRC's dedicated Boeing 737 aircraft based in Moses Lake, WA has a speed and range that can service the Lower 48 and Prince William Sound (PWS), Cook Inlet, and Juneau, Alaska, with 4,125 gallons of aerial dispersant application within 7 hours of deployment.

Other propeller-driven aerial dispersant aircraft are also available in the lower 48 for cascading to Alaska, if needed.

Figure 20. MSRC Boeing 737 demonstrating its dispersant spraying capabilities over ice in the Bering Strait, June 7, 2023 during an exercise with the U.S. Coast Guard (USCG courtesy photograph)

Although faster aircraft can significantly improve response times, as with any aerial application system, operations are still limited to daylight hours under conditions of good visibility and adequate ceiling, persistent fog, and low cloud ceilings are possible constraints throughout the year, with operating limitations becoming increasingly severe during the fall and winter with limited or no daylight in the Beaufort Sea.

8.3 ISB in the Presence of Ice

ISB in snow and ice-covered environments is a safe and proven technique with numerous successful applications in large-scale field experiments and accidental spills over the past 50+ years. ISB is especially suited for use on spills in ice where the ice cover itself often provides a natural barrier to maintain the necessary oil thicknesses for ignition, without the need for booms.

There is a long history of successful burning of crude oil and fuel oil in Arctic environments. The USCG carried out pioneering field experiments with burning on snow and ice in Alaska in the 1970s (McMinn, 1972). Many large-scale experiments successfully used ISB on oil that surfaced in spring melt pools after being spilled beneath the ice and trapped through a full winter in the Canadian Beaufort Sea and Norwegian Barents Sea - 1975, 1980, 1981, 1993, 2006 and 2008/9 (e.g., Norcor, 1975; Dickins and Buist, 1981; Brandvik et al., 2006). A number of responses to vessel spills have involved burning oil on and in ice, for example: *Othello/Katelysia,* Sweden 1970; *Imperial St. Clair*, Canada 1979; and the *Edgar Jordain*, Canada 1983.

Ignition tools have included gelled fuel, ignitors, or hand deployment on the surface, and the Helitorch slung beneath a helicopter. The Helitorch™ was originally developed for the U.S. Forest Service to set deliberate fires and was adopted by oil spill responders in the 1980s as a means to ignite oil slicks at sea and on ice (Allen, 1987). This is a proven, safe device that has been considered an operational tool for Arctic spill response for over 40 years. In the mid-1990s, new formulations for the gelled Helitorch fuel improved the ignition of emulsified and hard-to-light slicks. The Helitorch™ is used by ACS in on the North Slope.

In addition, there are simple proven systems that can be used from the surface to ignite contained oil in booms or among ice floes. Most of these involve some combination of ignition source such as a flare and gelled gasoline, as was used very successfully in the Deepwater Horizon response to ignite over 400 burns, released from small boats updrift of the oil-filled boom. Consideration is should also be given to using the new generation of disposable unmanned air vehicles as possible disposable ignition devices or as a means of deploying ignitors into multiple oil pools.

In the case of spills under or on solid ice nearshore, the choice of whether to burn on site or remove the oil to shore depends on the time of year, ice conditions, and water depth. Initiating burning of thick oil on the ice surface can often be accomplished without regard for ice thickness or surface condition by using a Helitorch ™. As with an ISB response during the open water season, any burning within the exclusion zone around the discharge point will need to consider the possibility of accidental wellhead ignition as well as exposure limits to VOCs for any response crews on the surface. A safer alternative might be to wait until the well is capped, and the flow stopped before initiating large-scale burning in close proximity to the facility.

In many years, crews may have to wait until January to use ice roads to access offshore spill sites in the fast ice zone. This leaves burning with aerial ignition as the only feasible response strategy for up to three months after freeze-up in early October.

From January to mid-May, mechanical removal is possible with heavy equipment moving oiled snow and recovered oil to shore for disposal as discussed in Section 7.1. However, directly burning oil deposited on top of snow-covered ice in-situ during this period could enable a much more efficient response with a fraction of the effort associated with mechanical recovery.

Once the ice is thick enough to support crews and light equipment, from December on, it may be possible to burn a significant portion of thick oil mixed with snow on the ice surface, progressively igniting the upwind edges with torches from the surface or a Helitorch™ from the air. If crews and equipment can access the site, ploughing the oiled snow into concentrated snow “volcanoes” can enable very efficient localized burns (see ACS Tactics Manual). Dealing with the enormous volume and large contaminated area associated with a very large spill such as a surface blowout ,will likely require multiple burns (hundreds) over a period of several months.

As with early winter, burning oil on the ice surface in-situ may be the only possible recovery option in the late winter period (May/June) when the ice surface could be too deteriorated to enable vehicle access and heavy equipment operation. Any oil spilled under the ice earlier in the winter will surface naturally at this time and become available for aerial ignition on melt-pools while being herded by wind action into thick patches.

Oil saturated snow has a much lower albedo than clean ice. As a consequence, oil remaining on the ice from a winter blowout could accelerate the local ice melt process by efficiently absorbing solar radiation. As a result, the oiled area could become free of ice one to weeks earlier than the surrounding clean ice cover. This scenario could produce a large opening surrounded by still intact, clean fast ice. Wind action would move the oil in the opening (polynya) to collect in thick films along the still intact ice edge. This would provide an ideal opportunity to efficiently burn a high percentage of the remaining oil on the water surface prior to natural break-up of the remaining ice cover.

As floes reduce in size and break-up in July, oil remaining on the ice surface will enter the water while oil still being released, for example through an uncontrolled blowout will be deposited partly on the rotting ice and partly in the water between floes. . Depending on the ice concentration, oil may be contained naturally in thick enough films for ignition either by helicopter or response vessels. Close pack ice (6/10 ice concentration or more) can enhance ISB by maintaining the original as-spilled thickness and preventing subsequent thinning through spreading (Buist and Dickins, 1987). See Figure 21 below showing highly efficient burns of oil concentrated in slush filled openings between floes.

Figure 21. Aerial and surface views of burning crude oil spilled in slush between floes during the 1986 Canadian East Coast" Oil in Pack Ice" experiment (Buist and Dickins, 1987) (Photos: L, R: R. Belore, D. Dickins).

At some point, once ice concentrations drop below 30% (3/10), typically mid-July (Figure 18), it becomes possible to deploy conventional booms to restart mechanical recovery or use fire booms to continue ISB. . Both operations could proceed concurrently within the same general area. Surface collecting agents (herders) provide an opportunity to burn in-situ without the need for booms, either in open water or light ice where floe concentrations are not sufficient to naturally maintain thick oil films (Section 7.3.1).

Overall removal rates in burning oil in or on ice have ranged from 65 to over 90%, depending mainly on the size distribution of the melt pools (if burning on the ice surface in spring) and the starting oil film thickness. In an experimental spill under solid ice in Svalbard in 2006, 28 barrels of crude oil were allowed to surface naturally through the ice and then burned with an overall removal efficiency of 96%. A portion of this oil was exposed to weathering on the ice surface for over one month before it was successfully ignited.

Potter and Buist (2010) reported highly effective (~90%) burning of oil within small ice pieces and brash collected within a fire-resistant boom during 2009 field experiments in the Norwegian Barents Sea (Figure 22). In the same project, oil that was allowed to drift and weather in very close pack ice for over a week was also successfully ignited and burned (Sørstrøm et al., 2010).

Figure 22. Burning crude oil spilled into a field of small ice cakes collected in a fire-resistant boom – Norway 2009 (Potter et al., 2012).

Despite these and other successful test results over four decades, concerns remain that actual spill conditions could reduce the effectiveness of ISB to far below these theoretical maximums. In practice, experiences with very large burns at sea (most recently during the DWH response) demonstrate that burn efficiencies increase with scale, as the oil is pulled into the burn area by strong radial inflow winds at the surface. The influx of air feeding the burn acts to continually thicken the remaining slick. Under these conditions, even highly emulsified crude oil can ignite and burn effectively (Allen, personal communication, 2023).

Experience with burning fresh, weathered, and emulsified oils and petroleum products in a range of ice conditions over the past 50 years, has led to some basic "rules of thumb" (Buist et al., 2003). The most important parameter that determines the likelihood of success and expected removal efficiency is the oil thickness. To achieve 60-80% removal efficiency in most situations, the starting thickness of crude oil needs to be in the order of 3-5 mm. With relatively fresh oil that is wind-herded into thick patches against an ice edge or on melt pools in the spring, removal efficiencies in excess of 90% are achievable.

These rules are summarized as:
- 1 mm minimum oil thickness for light crudes and gasoline.
- 2-5 mm oil thickness for weathered crudes and middle-distillates (diesel and kerosene).
- 10 mm oil thickness for residual fuel oils and emulsified crudes.
- For a given spill diameter, the burn rate in calm conditions is about halved on relatively smooth frazil/slush ice and halved again on rougher, brash ice.
- Wave action within the ice field or new ice sheet, also tends to reduce the burn rate.
- The oil to be ignited should not exceed an emulsification of ~25% water-in-oil.
- Ignition is most likely to be successful when winds are below ~19 knots (10 m/s).
- Cold air temperatures are not an impediment to successful ignition.
- Ignition is easiest with fresh, unemulsified oils, likely to persist for a longer period of time in the Arctic as result of lower weathering rates.

8.3.1 Surface Collection Agents (aka Herders)

Research over the past two decades has resulted in proof of concept for the aerial application of herding agents and ignitors to create a new rapid response tool for spills in open drift ice (20-50%) where the ice concentrations may be insufficient to naturally maintain an ignitable film thickness between the floes, but too much to deploy and maintain fire booms to thicken the oil as was done during the DWH response. Pioneering research in this area started in 2004 with a multi-year joint industry and government project led by the Mineral Management Service (MMS) (pre – BSEE). Small-scale laboratory experiments were followed by mid-scale testing in large basins. The cold-water herder formulation used in these experiments proved effective in significantly contracting oil slicks in brash and slush ice concentrations of up to 70% ice coverage. Herded slicks routinely thickened in excess of 3 mm and were ignited and burned at air temperatures as low as minus 17°C. Burn efficiencies were only slightly less than the theoretical maximums achievable for equivalent-sized, physically contained slicks on open water (Buist et al., 2011).

Herders were successfully applied from small boats to thicken crude oil spilled in an open pack ice field in the Norwegian Barents Sea in 2008. The aerial application of herders followed by aerial ignition was demonstrated for the first time at Poker Flat outside of Fairbanks in 2015. The strategies most applicable to the break-up period in July when air temperatures are above freezing and the openings between floes are open, with minimal slush and no new ice forming overnight. Although trials to date have involved small spills, there is no indication that herders would work any less effectively on much larger spills and hopefully, future testing can expand the scale and provide conclusive documentation to support this expectation.

9 Monitoring Operations

For an offshore response, environmental monitoring (air, water, soil/sediment, and wildlife) may be carried out to assess the initial situation, inform safety and operational plans, provide feedback on the effective use of alternative response countermeasures (such as dispersants and ISB), track and characterize the fate and effects of the spilled oil, and protect wildlife. At the outset of a large offshore response, the UC should develop a program to address monitoring/sampling needs, including quality assurance and control. The overlap or separation of response and Natural Resource Damage Assessment (NRDA) samples should be considered in the overall design of the monitoring program for the spill. EPA general references include "Selecting a Sampling Design" and "Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan" The following sections covering Monitoring activities are applicable to both open water and ice response.

9.1 Monitoring during an Initial Site Safety Assessment

During any oil spill, air quality is important to monitor for worker health and safety. Protocols for OSROs, upon notification of a large offshore oil spill incident, is to deploy a vessel to conduct a site assessment that will conduct air monitoring for explosive vapor mixtures, hydrogen sulfide (H_2S), and VOCs to ensure they are all within safe levels. If these readings are above safe levels, no responders will enter the area until the Safety Officer for the incident defines the levels of personnel protective equipment and mitigation measures that are required for the incident. Once this safety assessment is complete, and entry is approved, oil recovery operations can begin; in general, oil spill removal operations on the surface are limited to environments where Level D personnel protective equipment is all that is required. Air monitoring will be consistently conducted throughout recovery operations to ensure that the values for any airborne hazards do not exceed acceptable levels; necessary adjustments will occur if values do exceed prescribed acceptable levels.

9.2 Monitoring during Surface-based Dispersant Operations

When dispersants are preauthorized for use offshore, monitoring will be conducted in accordance with the SMART Protocols, and as appropriate, the requirements in Subpart J of the NCP; 40 CFR 300.913. SMART establishes a monitoring system for rapid collection of real-time information to assist the FOSC in assessing the efficacy, health, and safety of dispersant (or in-situ burning) operations. The FOSC, in consultation with the NOAA SSC, may develop revised monitoring protocols to address incident specific needs. The USCG National Strike Teams have special capabilities and trained personnel to perform SMART monitoring. FOSCs are highly encouraged to request USCG National

Strike Force (NSF) assistance when applied response technologies are being considered as a response tactic.

Any use of dispersants will require SMART monitoring to evaluate the effectiveness of the dispersant applications on the spilled oil . This is typically done with visual observations by a trained observer to confirm the oil is dispersing from a spotter plane. Appendix 1 of the Alaska RCP includes the SMART Protocol.

For large offshore oil spills (greater than 100,000 gallons in a 24-hour period), or where surface-based dispersant application operations are carried out over a period greater than 96 hours, water monitoring will also need to be conducted for tracking the dispersed oil and characterizing the potential for biological exposure/impacts. The responsible party is responsible for these water monitoring requirements, contained primarily in Subpart J of the NCP, 40 CFR 300.913. These dispersant monitoring requirements are meant to support operational decision-making and should be implemented as soon as possible. Additional guidance for these monitoring operations can also be found in the NRT guidance document "Environmental Monitoring for Atypical Dispersant Operations: Including Guidance for Subsea Application and Prolonged Surface Application." It should be noted that the requirements in Subpart J, effective 22 January 2022, take precedence over the NRT guidance document, which was published in 2013, in any instance where the contents of these documents may be dissimilar. It should also be noted that the monitoring operations conducted under the SMART Protocol and those required under Subpart J are meant to be complementary in nature for the use of dispersants. While monitoring under the SMART Protocol may be carried out by the NSF, the responsible party for the spilled oil is responsible for implementing the monitoring requirements contained in Subpart J.

9.3 Monitoring during ISB Operations

When ISB is approved for use offshore, potential air quality risks to responders, oil rig workers, wildlife, and the general public from burning large quantities of oil must be monitored. Air monitoring efforts should follow the guidance in the SMART Protocols. Visual and air quality data must be collected at identified locations specified in the ISB plan. Monitoring teams may be staffed by USCG NSF and/or other qualified personnel. For Alaska, Appendix II of the Alaska RCP specifies air monitoring requirements for ISB in the offshore environment.

9.4 Monitoring for Environmental Impacts

During an offshore response, waters in an affected area will be monitored for various purposes, e.g., determining the extent of oil contamination, characterizing potential biological effects, and addressing seafood safety concerns.

9.5 Wildlife Monitoring

Responders must work to mitigate the potential effects of spilled oil and response actions on wildlife, especially any species that are protected by law. Wildlife can be impacted by mechanical cleanup, dispersants/dispersed oil, or by ISB. Monitoring needs to be carried out to ensure these response countermeasures do not adversely impact marine mammals, birds, or other wildlife.

9.5.1.1 Wildlife Monitoring During Water Surface Dispersant Operations

When surface dispersant application, whether applied by aircraft or vessel spray, is proposed in an area that is adjacent to or near waters less than 30 feet in depth, due consideration shall be given to the trajectory of the dispersed oil. If resources in adjacent shallow areas are at risk, consultation with the trustees must be conducted. Prior to commencing dispersant application operations, an on-site survey should be conducted, in consultation with natural resource specialists, to determine if any threatened or endangered species or designated critical habitat are present in the projected application areas or otherwise at risk from dispersant operations. Dispersants should not be applied near areas known to contain rafting birds. Survey flights in the area of application should be conducted during dispersant operations. Dispersant operations should not be conducted within 2 nautical miles of marine mammals identified through aerial spotting per BMPs. If the detection of species is not possible during certain weather conditions (e.g., fog, rain, wind), the biological monitor/natural resource trustees will assess conditions and will coordinate with the UC to determine what operational adjustments may be feasible.

9.5.1.2 Wildlife Monitoring during In-Situ Burn (ISB) Operations

A trained observer (if available) should be dedicated to looking for marine mammals during ISB operations. Each sighting event, including GPS location, species (if known), and description of encounter should be recorded on a Marine Species Observation Form. The observer or crew member should be looking for marine mammals and sea turtles that may be affected by the burn or are impacted by oil. ISB operations should avoid burning unoiled or lightly oiled sargassum where juvenile sea turtles are known to hide from predators. A survey for marine mammals/sea turtles must be conducted by a designated observer on the ignition vessel. The observer on the ignition vessel will monitor the following areas prior to the burn:

- The area in front of the collection vessels;
- The oil concentrated in the boom; and
- Any oil trailing behind the boom.

If marine mammals/sea turtles are sighted in the in-situ burn safety zone, measures must be taken to prevent harm such as implementing sea turtle retrieval protocols, relocating the burn area, or standing down until the animals exit the area.

10 Best Management Practices

Best Management Practices (BMPs) are protective actions and procedures carried out in conjunction with oil spill removal activities to ensure any harm to nearby wildlife is minimized to the maximum extent practicable. Some BMPs can be pre-identified and incorporated into ACPs, while others must be developed and/or tailored to the specific circumstances of an incident.

Regardless, the UC must engage with federal, state, and local natural resource trustees to review, adopt, or develop the BMPs that will be used during a large offshore oil spill incident. The BMPs listed below are general in nature and can be used as a starting point for engagement with resource trustees during an incident. These BMPs are grouped according to their applicability to different response strategies. The Arctic and Western Alaska Technical Document #5, "Sensitive Species Profiles", groups the same set of BMPs based on the natural resource type. The Alaska Regional Response Team Wildlife Protection Committee developed the Wildlife Protection Guidelines for Oil Spill Response in Alaska. These guidelines were incorporated into this section.

10.1 General BMPs

10.1.1 Marine Mammals and Birds

Watch for and avoid collisions with wildlife and report all distressed or dead marine mammals to the Wildlife Hotline (If no hotline is yet operating, call 877-942-5343 (877-WHALEHELP)). NOAA's Vessel Strike Avoidance Measures and Reporting for Mariners should be implemented to reduce the risk associated with vessel strikes or disturbance of protected species to discountable levels. If marine mammals are sighted oiled or swimming in oil, call 877-WHALEHELP.

Observations of entangled wildlife during a spill response should be immediately reported to the following numbers:

- For whales, seals, sea lions, porpoises, and dolphins: National Marine Fisheries Service (NMFS) Marine Mammal Stranding Network Hotline (877) 925-7773 or (877) 9-AKR-PRD.
- For walruses, sea otters, polar bears, or birds: US Fish and Wildlife Service (USFWS) Alaska Region Spill Response Team (907) 242-6893 or fwsakspillresponse@fws.gov.

10.1.2 Marine Mammals: Cetaceans

Whales – Deterrence/Hazing Methods: In-situations where immediate action is necessary to prevent Cook Inlet beluga whales from entering oil, managers may choose to use the deterrence/hazing methods that have been pre-approved for the Southern Resident Killer Whale population. These pre-approved methods are wholly reproduced from the Southern Resident Killer Hazing Plan and briefly recounted below:

For the Southern Resident Killer Whale population, NOAA Fisheries has pre-approved; helicopters, oikami pipes, and underwater firecrackers (seal bombs) deployed from vessels; for use by response personnel under the direction of the Branch Director and UC to attempt to herd/move whales.

Pre-approved deterrents should be deployed if the risk of entering oil exceeds the risk of disturbing the whales through hazing techniques. Risk to the whales should be assessed based on the proximity of the whales to the oil and their likelihood of entering the oil as well as the type and condition of the oil. The Branch Director will determine whether to activate the Marine Mammal Hazing Unit to implement hazing activities or, if exposure is imminent, to order "on-scene" personnel to attempt hazing. Selection of the most appropriate hazing technique will depend on the particular spill conditions, location of whales, level of risk to the whales, and available assets.

Helicopter hazing may be the most immediately available technique, particularly if there are aircraft available and in use for reconnaissance. Multiple pre-approved techniques may be implemented in combination (i.e., oikami pipes and firecrackers deployed from the same vessels) or in sequence based on observations of the whales and time needed to mobilize hazing teams. The incident-specific deterrence plan should explicitly evaluate how deterrence measures might contribute additional risk to marine mammals and to subsistence uses of those marine mammals and should outline mechanisms for minimizing risk.

It is essential for appropriately trained individuals to conduct hazing/deterrence activities not only for the safety of all responders, but also to minimize impacts to the animals being hazed/deterred and to prevent inadvertently disturbing non-target species. Wildlife can respond in unpredictable ways to disturbance; therefore, it is imperative that responders conducting hazing/deterrence activities are trained to understand animal behavior.

10.1.3 Marine Mammals: Pinnipeds

Implement 1,500-foot restricted access zones around all known Steller sea lion haul outs and rookeries.

10.1.4 Marine Mammals: Other

Sea Otters: When operating marine vessels during spill response, all operators should abide by the following Boat Operation Guidance to Avoid Disturbing Sea Otters:

- While operating boats in near shore areas, scan the water surface ahead of the boat vigilantly for otters. In choppy water conditions sea otters are difficult to spot. If you are boating with another person, place them in the bow to help search. You may encounter otters as individuals, a mother and a pup, or rafts of 10 or more.

- When you see an otter(s), alter your course and slow down to avoid disturbance and collision. Once you have spotted an otter(s), you should not assume that the otter(s) will dive and get out of the way. Even if they are alert, capable, and do dive, your action of knowingly staying your course would be considered harassment.
- Do not operate a vessel at ANY rate of speed heading directly at the otter(s). A good rule of thumb is that your buffer should be great enough that there is ample room for the otter(s) to swim away without startling them. It is your responsibility to minimize the stimulus and threat of a loud boat approaching quickly.
- The more otters you see, the wider the berth you need to give. Also, do not pass between otters, but rather go around the outside perimeter, plus add a buffer.
- It is illegal to pursue or chase sea otters. Do not single out or surround an otter(s). All support vessels and aircraft will be required to maintain a 1-mile buffer area around groups of walruses hauled out on land.

<u>Walruses:</u> Large numbers of walruses could be encountered in the Chukchi Sea July through September. Contact USFWS for additional mitigation measures, such as seasonal restrictions, reduced vessel traffic, or rerouting vessels, that may be appropriate for activities within these areas.

<u>Polar Bears:</u> All polar bears pose a significant safety risk to response personnel. During an oil spill event, all field response personnel working in polar bear habitat should have or receive bear awareness safety training (as well as whatever additional training is required by their agency or company). To minimize the potential for injuries to both response personnel and bears, wildlife agency representatives will coordinate with the UC to determine if bear guards (i.e., individuals with expertise in avoiding bear-human conflicts) should accompany work crews.

10.1.5 Birds

Watch for and avoid collisions with wildlife and report all distressed or dead birds. Avoid hovering or landing of aircraft near bird concentration areas. Observers expected to notify vessel captains/pilots about minimizing impacts and to record sightings. All responders and wildlife observers shall report all sightings of healthy, oiled, or injured wildlife in or near the response area in real time to Wildlife Branch or Environmental Unit. Adhere to incident-specific flight restrictions over sensitive habitats and avoid hovering or landing aircraft in these areas. Adhere to flight altitude restrictions over wildlife management areas and other managed lands.

10.1.6 Fish

Use a properly screened water intake to avoid impacts to fish, especially juvenile or small resident fish. The intake should be centered with a screened enclosure to reduce the potential for fish to be entrained, impinged, or injured. Contact Alaska Department of Fish and Game (ADF&G) for recommendations on screen mesh sizes and minimum water velocity depending on the location and timing of water withdrawal activities.

10.1.7 Invertebrates

Secure all materials on vessels to prevent inadvertent loss overboard.

10.2 Mechanical Recovery BMPs

Response vessel operators shall avoid close approach (<300-500 feet) to marine mammals in the water. Vessel speeds shall be reduced to <13 knots when marine mammals sighted within 1,000 feet. To avoid entangling marine mammals, a trained observer or crew member is required for all skimming operations. Protected species observers should be present to monitor take of ESA-listed species from all response activities.

10.3 Booming BMPs

Make efforts to reduce slack in boom lines and if possible, use stiff, non-tangling material. If a marine mammal is observed trapped or entangled in a boom, open the boom carefully until the animal leaves on its own, and call to report at 877-942-5343 (877-WHALEHELP).

If sea otter pupping areas are identified, booms will need to be placed far enough away to minimize disturbance and prevent driving sea otters into oiled areas.

If marine mammals, birds, or fish become trapped or entangled in boom, anchor lines, or other response equipment, notify wildlife agency representatives for instructions. Install and monitor underwater equipment or booms to prevent entrapment of fish and wildlife. Maintain control of all materials to prevent inadvertent release and sinking.

10.4 In-Situ Burning BMPs

Watch for and avoid marine mammals while operating vessels or aircraft involved directly or in support of in-situ burn operations. Marine species observer on the ignition vessel will monitor 3 areas prior to the burn (the area in front of the tow boats, oil concentrated in the boom, and any oil trailing behind the boom). A survey should be conducted in the burn area after the burn is complete and any distressed or dead marine mammals should be counted and reported to 877-942-5343 (877-WHALEHELP).

Avoid burning near bird concentration areas and minimize bird exposure from wind drift of smoke.

If incident specific RRT approval allows burning over nearshore habitat for the sunflower sea star, recover any floating burn residue as quickly and efficiently as possible.

10.5 Surface Dispersant BMPs

Comply with the North Pacific right whale Critical Habitat Avoidance Area and the 20-mile buffer around that Critical Habitat, and the North Pacific right whale biologically important areas designated in the Arctic and Western Alaska ACP.

Comply with the short-tailed albatross Critical Habitat Avoidance Areas in the Dispersant Use Plan and the short-tailed albatross Concentration Areas in the Arctic and Western Alaska ACP.

Dispersants applications will maintain a minimum 500 meters (1,640 feet) horizontal separation from swarming fish, rafting flocks of birds, marine mammals in the water, and/or marine mammal haul-outs.

To avoid disturbances at walrus haul-outs, any dispersant-related aircraft will comply with any Federal Aviation Administration Temporary Flight Restriction(s) and Notice to Airmen and/or aviation restrictions issued by the USFWS. In addition, any dispersant-related vessel(s) will comply with any USCG Notice to Mariners and/or USFWS restrictions for walrus haul-outs.

Any monitoring required by USFWS and/or NMFS for Endangered Species Act Section 7 compliance will be conducted. Follow any spill specific RRT guidance.

Atypical Dispersants: Follow spill-specific special considerations, constraints, permit requirements, and/or special authorizations as part of the case-by-case approval process. Atypical use of dispersants is defined as full scale dispersant application ongoing for, or expected to exceed or exceeding 96 hours following the dispersant application field test.

10.6 Unmanned Aerial Systems (UAS) Use BMPs

The Arctic and Western Alaska Area Committee sponsored the development of a UAS protocol, which is posted on the ADEC's References and Tools page as "Protocol for using UASs during an oil spill response or exercise."

Coordinate with NMFS to understand incident-specific protection measures regarding UAS use near seals and sea lions.

For walruses, coordinate with USFWS to understand incident-specific protection measures regarding UAS use. Do not fly within 0.5 mile (direction or altitude) of hauled-out walruses or known walrus haul-out locations. Maintain 2,000-foot distance from individual animals or small groups on ice. Regardless of distance or group size, if walrus change behavior in response to a UAS, move the aircraft away and report these events to USFWS.

Do not conduct flights at an altitude less than 150 feet over birds; do not use predator (raptor)-shaped UASs when flying near birds; do not fly within 300 feet of bald eagle nests; ground or move aircraft away if perched or flying eagles are encountered.

Coordinate with USFWS to understand incident-specific protection measures regarding UAS use in the vicinity of sea otters and polar bears. Maintain 1,500-foot distance; greater distances from active polar bear dens may be required. If polar bears or sea otters change behavior in response to a UAS, move the aircraft away and report these events to USFWS.