ASSESSING ISB BENEFITS AND RISKS
IN-SITU BURNING

Things You Should Know

When an oil spill occurs, decision-makers must be prepared to quickly determine the best response option for the incident-specific conditions.

When considering ISB for an oil spill on water or land, tradeoffs between exposure of responders and wildlife to fresh oil must be weighed with potential exposure to burn residue and smoke.

The benefits of rapidly removing spilled oil via ISB can often outweigh any negative effects from a burn.

A Spill Impact Mitigation Assessment (SIMA) is a process used to compare the benefits and risks across different oil spill response options to help identify preferred options for a particular spill scenario.

Overview

In-situ burning (ISB) is a response technique that removes spilled oil from a land, snow, ice, or water surface by igniting and burning the oil. ASTM International (2014) defines controlled in-situ burning as "burning when the combustion can be started and stopped by human intervention." The combustion by-products (primarily carbon dioxide and water but also particulates, gases, and other minor components) are released to the atmosphere, with the possibility of some unburned oil or incompletely burned oil residue remaining at the conclusion of a burn.

One of the greatest benefits from ISB is that a burn can rapidly reduce the volume of spilled oil and minimize or eliminate the need to collect, store, transport, and dispose of recovered oil and oily wastes. Decision-makers from federal, state and local agencies or other stakeholders must consider the benefits and risks of conducting a burn versus using other response options, since all options have potential environmental and human health risks. ISB also has the potential to significantly reduce the duration of cleanup operations. In certain instances, ISB might provide the only means of quickly and safely eliminating large amounts of oil.

In most instances, government decision-makers conduct a rapid Spill Impact Mitigation Assessment (SIMA)[1] to compare and rank the benefits and risks (or "trade-offs") of different response options relative to the spilled oil's potential impact on resources and the environment. ISB is one of several response options that can be analyzed and compared in a SIMA.

This fact sheet describes in more detail the risk and benefit tradeoffs in using ISB, which is facilitated by the Spill Impact Mitigation Assessment (SIMA).

Fact Sheet Series

- Introduction to It-Situ Burning
- Fate of Burning Oil
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Introduction

When an oil spill occurs, decision-makers must be prepared to quickly determine the best response options for the incident-specific conditions. The primary goal of a spill response is to minimize impacts to the environment and people using knowledge gathered from years of experience and research and selecting the most appropriate response options based upon the spill conditions. In most instances, government decision-makers conduct a rapid Spill Impact Mitigation Assessment (SIMA)[1] to compare and rank the benefits and risks (or "trade-offs") of different response options relative to the spilled oil's potential impact on resources and the environment. This consensus-based planning tool brings together stakeholders including regulatory and natural resource trustees to address resource-management decision-making needs for an oil spill response. In some cases, SIMA is performed in advance of a potential spill during planning stages and is then validated during a spill in an expedited manner.

For each spill, the response options are evaluated to determine which option or set of options, given the incident-specific conditions, result in the best outcome for the environment including socio-economic and cultural considerations. Decision-makers must determine if it is better to allow surface oil to remain, which could impact sensitive habitats and wildlife, or use response options like ISB, which could minimize the risk to surface resources but increase the impacts to air from burning oil.

What is SIMA?

SIMA is a process that examines which option or combination of options should be used to remove and/or recover spilled oil in order to minimize the oil's overall impact on resources and the environment. The response options used must be considered in relation to area-specific resources at risk, e.g., biological resources, environmentally-sensitive habitats, and socio-economic and cultural considerations such as tourist beaches, marinas and areas of historical significance. This process also allows decision-makers to determine the relative benefits and risk of a particular response option against natural recovery.

SIMA is best performed during pre-spill response contingency planning for a particular location or facility when adequate time exists for the analysis. In these cases, the SIMA process uses oil spill planning scenarios and compares response options to identify the ones with the fewest ecological, socio-economic and cultural impacts (ASTM, 2013). This pre-spill contingency planning provides a greater opportunity for participation from representatives from government regulatory and resource agencies, oil and spill response industries, environmental groups, and other stakeholders in the community.

The pre-spill planning SIMA uses area-specific information to predict and compare outcomes from various response options for each planning scenario. Area-specific information can include the fate and transport of the oil, plant and animal species present, economic and cultural factors, and predicted oil removal effectiveness for each response option.

During SIMA, technical specialists and representatives from key stakeholders achieve consensus regarding preferred response options for specific spill scenarios. The following list highlights the key steps in the SIMA process (API, n.d. and ASTM, 2013):

- **Compile and Evaluate Data** – Identify spill planning scenarios and for each one or the actual spill, define the incident specifics (volume, type, location, and duration of the spill and environmental conditions), the probable impact area (typically using spill trajectory modeling), the resources at risk within the probable impact area and the applicable response options.
- **Predict Outcomes/Impacts** – Using the data from the previous step for each scenario, predict the relative level of impacts to the resources at risk for the No Intervention (natural recovery) option and evaluate the potential for each applicable response option to mitigate those predicted resource impacts. Then rank the response options based on their impact mitigation potential
- **Balance Trade-offs** – Incorporate stakeholder input on the risks versus benefits of each response option's impact mitigation potential and adjust the evaluations and rankings accordingly.
- **Select Best Response Option(s)** – Based on the outcome of the Balance Trade-offs discussions, the best response option or combination of options are selected to form a strategy that will minimize the spill's overall ecological, socio-economic and cultural impacts and promote rapid recovery.

It is important to note that the process outlined above is qualitative and only one of many valid approaches to conducting a SIMA that range from a verbal, highly qualitative discussion to a detailed and well documented quantitative assessment.

[1] The term Net Environmental Benefit Analysis and its acronym NEBA have been used extensively over the years to describe a process used by the oil spill response community for guiding selection of the most appropriate response option(s) to minimize the net impacts of spills on people, the environment and other shared values. Industry has consulted directly with non-industry stakeholders who have expressed support for transitioning to a more appropriate term. Industry is thus introducing the term Spill Impact Mitigation Assessment (SIMA) as a replacement for NEBA. For purposes of this document, all references to SIMA should be understood to mean NEBA in its broader context.

Relative Risk Comparisons

Relative risk is a way to understand the degree of effects of an oil spill to environmental, socio-economic and cultural resources using a ranking system. This ranking system enables SIMA participants to identify a "level of concern" about impacts from a response option to the resources at risk for a specific scenario. The relative risk comparison is often based on the predicted proportion of a resource affected versus an estimated recovery time using a risk matrix (Walker et al. 2016; **Figure 1**).

ISB is one of several response options that can be analyzed and compared in a SIMA. **Figure 2** compares the general benefits and risks of common response options. During a SIMA, the relative benefits and risks for each candidate response option (i.e., ISB, mechanical recovery, dispersants, and natural removal) are analyzed for a specific scenario. These results are used to identify response option preferences for a given scenario.

FIGURE 1. Sample relative risk matrix. (Walker et al. 2016)

		RECOVERY TIME			
		Rapid	**Moderate**	**Moderate**	**Slow**
		< 1 year (4)	1 to 4 years (3)	5 to 10 years (2)	> 10 years (1)
Ecological Severity		**4D**	**3D**	**2D**	**1D**
	Inpaired (C)	**4C**	**3C**	**2C**	**1C**
	Significant (B)	**4B**	**3B**	**2B**	**1B**
		4A	**3A**	**2A**	**1A**

Legend: ■ cells represent a "limited" level of concern; ■ cells represent a "moderate" level of concern, and ■ represent a "high" level of concern.

FIGURE 2. The relative benefits and risks of response options. (Adapted from API NEBA)

METHOD	BENEFITS	RISKS
Natural Removal (i.e., monitor and observe)	• Avoids removal/cleanup techniques or chemical treatments which could further damage the environment • Allows for natural oil biodegradation • Can be a preferred option for sensitive habitats if there is little or no threat to human or environmental well-being • Requires no interim recovered oil waste storage or disposal	• Oil is not actively removed from environment • Wind and currents can remobilize oil on water to sensitive areas • Public perception that responders are doing nothing
In-situ burning	• High oil elimination rates are possible • High efficiency rates are possible • Reduces vapors at the water surface, which reduces hydrocarbon exposure to responders • Has little recovered oil interim storage and disposal requirements (except for burn residue) • Results in much less oil for disposal • Is effective over wide range of oil types and habitats • Requires less equipment and labor than mechanical recovery • Minimizes environmental impact	• Requires special approvals • Is less effective in high winds and seas • Has limited window-of-opportunity for spills on open water • Black smoke is perceived as a significant aesthetic effect • Results in localized reduction of air quality • Requires specialized equipment and expertise • Has risk of fire spreading • Burn residue can be difficult to recover • Recovery time of habitat
Mechanical Recovery on Water	• Is widely accepted and requires no special approvals • Removes oil with minimal environmental impact • Is effective over wide range of oil types	• Has slow and labor-intensive recovery and needs interim storage and long-term disposal capability • Is less effective in high winds and seas • Comparably low effectiveness to other options • Requires specialized equipment

FIGURE 2. The relative benefits and risks of response options. (Adapted from API NEBA)

METHOD	BENEFITS	RISKS
Dispersants	• Removes surface oil that could harm wildlife and rapidly dilutes it in the water column • Keeps oil from spreading to shorelines • Enhances natural biodegradation of oil • Rapidly treats large amounts of spilled oil • Requires little recovered oil interim storage or disposal • Has lower manpower requirements	• Requires special approvals • Dispersed oil can affect water column-dwelling wildlife and vegetation • Adds chemicals into the marine environment • Has limited window-of-opportunity • Needs specialized equipment and expertise
Physical Removal on Habitats	• Non-aggressive methods can have minimal environmental effects • Reduces secondary impacts to animals that reside on shorelines • Prevents remobilization of oil and potential for oil spreading further	• Aggressive removal methods can impact habitat function and organisms, and cause further environmental damage • Removal techniques are slow, labor-intensive, and needs interim storage and disposal capability

Balance Trade-Offs or Relative Risk Examples for ISB

When considering ISB for an oil spill on open water or land, the main risk-benefit tradeoffs are the potential negative effects from inhalation of particulates in the smoke plume and physical effects from the remaining burn residue versus the potential beneficial effects from the rapid removal of oil from the land or water surface. The rapid removal is associated with a reduction in wildlife and sensitive habitat exposure to the spilled oil and a reduction in need for inland and shoreline clean-up. Typical questions on risk tolerance that are addressed during the SIMA process include:

- What is the degree of surface oil removal by ISB and how quickly can it be removed?
- What is the likelihood and degree of inhalation effects from smoke particulates?
- What is the predicted quantity and degree of cover from any un-recovered burn residue?
- What is the anticipated degree of habitat oiling and degree of impact from mechanical clean-up or dispersant use if ISB is not used?

Considerations for Open Water Scenarios

Consensus in favor of ISB for open water scenarios is likely to revolve around whether the benefit of quickly removing as much surface oil as possible before the oil reaches sensitive habitats (typically coastal areas), where mechanical oil removal might be slow and possibly damaging due to heavy equipment operation and high foot traffic, outweighs the risks of adverse air quality from smoke particulates. **Figure 3** shows an ISB during the Deepwater Horizon incident where smoke produced by the burn was far offshore and not considered as a risk to the public.

FIGURE 3. A marine ISB during the Deepwater Horizon response. (NOAA 2010)

Considerations for inland scenarios

The trade-off or risk comparison for an inland ISB scenario can be more complex than for an open water location because of the potential proximity of population centers, wildlife and potentially sensitive ecosystems, as well as the increased number of competing mechanical (including manual) response options. For most inland spills, especially small ones, the default initial spill response option is manual recovery; alternatives are only considered if problems are encountered.

Consensus in favor of ISB for inland scenarios is likely to revolve around whether the benefit of quickly removing as much surface oil as possible to limit exposure to wildlife and habitats outweighs the risks of adverse air quality from smoke particulates and fire control. **Figure 4** shows an inland burn of a gas crude oil spill in a Louisiana saltwater marsh where it was too shallow to deploy typical mechanical recovery equipment. Instead sorbents were applied (Henry, 2008; Michel and Miles, 2002) but were overwhelmed by the amount of condensate which spread through the wetland. An oil spill management decision to conduct a burn was made almost a week later. In this case, alternatives to ISB were tried and found to be inadequate, yet the benefits from a delayed burning (rapid oil removal, no recovered oil storage requirements, limited additional environmental effects, and easy implementation) were still attained.

FIGURE 4. An inland burn of gas condensate oil in a salt marsh in Louisiana shows burning grass in the habitat and smoke propagating downwind. (NOAA 2008)

Figure Sources

Figure 1 - Walker, A.H., Stern, C., Scholz, D., Nielsen, E., Csulak, F. and Gaudiosi, R., 2016. Consensus Ecological Risk Assessment of Potential Transportation-related Bakken and Dilbit Crude Oil Spills in the Delaware Bay Watershed, USA. Journal of Marine Science and Engineering, 4(1).

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Figure 3 – NOAA. 2010. Overflight of ISB during Deepwater Horizon response – photo. Retrieved from: http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/in-situ-burn-emissions-comparisons.html

Figure 4 – NOAA (2008). In-situ burning for inland oil spills: Requirements and considerations to plan for and implement an in-situ burn of spilled oil. Short course presented at the 2008 International Oil Spill Conference.

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