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REVIEW PAPER

In Situ Burning of Spilled Oil in Freshwater Inland Regions of the United States

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In situ **burning is being utilized in the United States to remove oil from inland oil spills, usually when physical recovery is not feasible. Studies have found that habitats may recover from the effects of burning in less than a year under optimal conditions but recovery may take much longer. Policies authorizing the use of** ***in situ*** **burning across the US are very inconsistent. Some states use it routinely, but others do not allow it. Inland** ***in situ*** **burning can be a useful response tool and the federal government needs to issue more guidance to the states. Responders also need to collect more data on the environmental impacts of burning.**

Keywords: ***In situ*** **burning, inland, freshwater, wetland**

Introduction

Spilled oil has burned accidentally many times. Spill responders have been attracted to the large amounts of oil quickly removed from the environment during burns and have looked at the possibility of burning spilled oil *in situ* under safe and relatively controlled conditions. *In situ* burning of oil spilled in the inland regions of the United States has a much different history than burning oil spilled on the oceans. Marine *in situ* burning has been studied extensively by researchers over the last 20 years, but there have been no burns at actual spills other than a trial burn during the Exxon Valdez spill response. The situation is completely opposite for inland spills. Little research exists, but many burns have been conducted.

Most people's knowledge of inland *in situ* burning consists solely of the wetland and marsh burns during the 1990's in Maine (Eufemia, 1994), Texas (Gonzalez & Lugo, 1994), and Louisiana (Hess *et al.*, 1997), but many other places in North America use burning quite frequently. Most inland burns are small (less than 3 cubic meters or 20 barrels of oil), occur in rural areas, and are often associated with pipeline breaks. Burning is most often used when physical recovery is not feasible, usually because of poor access to the spill site. In these cases, burning results in a relatively quick and efficient cleanup with much less environmental damage than if traditional recovery methods had been used.

Considerations and Factors

Experience has shown that a successful burn must take into consideration a number of factors (API, 1999; May & Wolfe, 1997). When oil is spilled, as much as possible is always recovered, and *in situ* burning is used as an alternative treatment to remove the oil that cannot be recovered. When the decision is made to burn the oil that cannot be recovered, safety is the primary consideration when planning a burn. Keeping the fire contained and under control is paramount, and the soil and plant moisture levels are

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important parameters to take into account. Responders have created fire breaks and wet the area surrounding the spilled oil to limit the potential for spreading. Often the excessive moisture from rain or water naturally present makes the ground too soft for recovery equipment, but this same moisture in turn improves the safety of the burn. Figures 1 and 2 are photographs of oil spills that were in areas where excessive moisture made mechanical recovery too difficult and damaging but also made the use of *in situ* burning a safe alternative.

Plants subjected to *in situ* burns can be very tolerant of the effects of the heat (API, 1999; Mendelssohn *et al.*, 1996; Mendelssohn *et al.*, 2001). Fire is part of the natural life-cycle for some ecosystems (such as wetlands and prairies), but burning spilled oil may produce a hotter, more intense burn than the plants can safely tolerate. Protecting the roots from excessive heat levels is the most important factor, and the moisture level is again the most important consideration. High soil moisture levels protect the roots from heat effects and improve the chances for recovery. The environmental effects of the burn can also be strongly affected by the time of year. Winter is the best time to burn because plants are dormant, and the late summer is the worst time to burn because plants are least able to withstand the stress. Figure 3 demonstrates that when moisture is adequate, the burn will stop at the edge of the oiling.

Fig. 1 A Louisiana marsh burn. Note the muddy surface in the foreground. Oil (condensate) is burning in the background (API, 2002).

Fig. 2 A peat bog in Minnesota was burned to prevent crude oil from migrating into the nearby Mississippi River. Wooden mats needed to be placed on the bog to allow access by heavy equipment (photo courtesy State of Minnesota).

Fig. 3 Burning oil damaged trees in the foreground, but moisture was adequate to prevent the burn from spreading to the unoiled trees in the background (photo courtesy State of Minnesota).

Weather conditions are also a major consideration. Steady, low winds are desired that will allow the smoke plume to loft and disperse downwind in the desired direction. If storms are threatening or weather shifts are forecasted, burns should be delayed or canceled because shifting, unpredictable winds can threaten the safety of the burn. An *in situ* burn is sometimes conducted because rain may increase the area impacted by the spill, but the burn needs to be completed before the storm's onset. Weather conditions are usually not ideal and compromises may be needed, but the risks of the fire spreading beyond the oiled area must always be considered.

The local fire department must often be consulted, and it needs to be in agreement with the burn plan. Fire department equipment and personnel often attend the burn to ensure it's safety. Natural resource specialists may also need to be consulted to determine if sensitive wildlife or habitat resources are at risk from the burn. In some areas, air quality officials must be consulted to ensure that public health issues regarding the smoke are taken into account. As Figures 4 and 5 illustrate, burning oil produces large amounts of black smoke, and the downwind consequences should be evaluated.

In situ burning usually leaves a residual that often requires treatment or removal. Figure 6 is a photo-

Fig. 4 *In situ* burning produces large amounts of smoke, and its potential effects downwind should be evaluated before the burn commences (photo courtesy State of Minnesota).

Fig. 5 An atmospheric inversion caused this smoke plume to spread out across the sky (photo courtesy State of Minnesota).

Fig. 6 Tarry residue resulting from a crude oil burn in a ponded freshwater wetland in Minnesota was picked up in sheets (API, 2002).

graph of the residue floating on the water surface from a crude oil burn in a ponded freshwater wetland. This residue may not be recoverable in a marsh or wetland. However, for spills in open fields, it is common to till the area, fertilizer it, and then reseed it with appropriate plants. The resulting biodegradation from the plants and soil microbes removes much of the remaining oil.

Government Policies and Regulations

Few guidelines for inland *in situ* burning exist, and none of the US Regional Response Team's (RRT's) have preauthorization policies. At least one regional team, (RRT 5 – the Great Lakes states) does have a written *in situ* burn policy, and it requires RRT consultation before allowing *in situ* burns to proceed. However, while the US Environmental Protection Agency (EPA) usually supplies the US government's Federal On-Scene Coordinator (FOSC) to inland spills, it responds to a only small fraction of the spills that occur. Most states also do not send a State On-Scene Coordinator (SOSC) to many smaller spills either. In these cases, local government and industry responders merely consult with state and federal agencies (as needed) over the phone. As a result, states, and even local authorities, have much latitude in their response activities, and the EPA will allow *in situ* burns with no RRT consultation. The box below excerpts key points from the RRT 5 *in situ* burn policy. Note that it only applies to *in situ* burns conducted by an FOSC.

States that burn require some consultation, if only over the phone, and some have formal guidelines. Minnesota developed criteria for *in situ* burning as part of the Minneapolis/St. Paul. SubArea Contingency Plan that was formally approved by RRT 5. Even though the RRT requires a full consultation for burns at spills with federal government oversight, it approved this subarea policy, and Minnesota uses it for the whole state. The policy requires permission to burn from the local fire chief, the state emergency response team (can be obtained with a phone consultation), and natural resource agencies, including the US Department of Interior, if certain natural resources are affected.

In contrast, the Northern Michigan Sub-Area Contingency Plan requires state and RRT 5 approval before an *in situ* burn is allowed. It has a six page checklist that must be signed by the FOSC and the SOSC and submitted for approval.

In Region 8 (RRT 8 – Rocky Mountain states and the Dakotas), Wyoming authorizes *in situ* burns under its regulations for burning wastes. It requires a phone consultation with the Division of Air Quality in which details of the burn are discussed along with reasons why other methods cannot be used. The local fire

REGION 5 OIL AND HAZARDOUS SUBSTANCES INTEGRATED CONTINGENCY PLAN APPENDIX VIII: *IN SITU* BURNING OF OIL

1. RRT 5 POLICY FOR USING IN SITU BURNING AS AN OIL SPILL RESPONSE TOOL

RRT 5 strongly recommends that *in situ* oil burning be considered as a means to avert potential oil spill impacts to the region's beaches, wetland environments, and Great Lakes and inland resources. *In situ* burning should augment, not replace, other oil spill response techniques such as mechanical removal or chemical countermeasures…

(a) The requirements of this policy apply only to responses under the direct oversight of an FOSC, but its general application is strongly encouraged.
(b) The appropriate State's approval is always required.
(c) The US Environmental Protection Agency (US EPA) must concur with the Federal OSC's recommendation to authorize the use of *in situ* burning.
(d) The US Department of Interior (DOI) must also concur with the decision to burn during a spill response overseen by a Federal OSC.
(e) As a natural resource trustee, the Department of Commerce (DOC/National Oceanic and Atmospheric Administration (NOAA) should be consulted when considering an *in situ* burn.
(f) Native American community official(s) must be consulted on any decision to use *in situ* burning when a burn would reasonably be expected to impact those designated areas of Native American interests.
(g) Finally, this approval must also be in concert with Canadian Federal Government officials, adjoining States and/or provinces, and local officials with approving jurisdictions, where deemed appropriate or necessary.

department is also required to approve the burn before permission from the state is granted.

Also in Region 8, North Dakota uses a two-page form titled "Application for Approval to Burn Liquid Hydrocarbons" that must be faxed to the Division of Environmental Engineering in the Department of Health. It requires information about the spill, where the burn will occur, and a sketch that shows the location of all of the occupied residences within 1.6 km (one mile) of the proposed burn.

Perception and Acceptance

Attitudes towards inland *in situ* burning vary tremendously throughout the US. For example, in Region 5, Illinois frequently burns spilled oil, and Minnesota, Indiana, and Ohio have all conducted burns. Wisconsin and Michigan are much more reluctant to authorize burns but have evaluated their policies. Texas and Louisiana in Region 6 have conducted many *in situ* burns, especially in wetlands. In Region 8, North Dakota and Wyoming routinely burn spilled oil, but Colorado does not. In general, states that do not permit *in situ* burns are concerned about the air quality issues from the smoke.

Despite the frequent use of *in situ* burning in some inland areas of the US, little monitoring of the effects on the environment has occurred. Studies have occurred on a large Texas spill (Hyde *et al.*, 1999; Tunnel *et al.*, 1995) and a Louisiana spill (Pahl *et al.*, 1997). They showed that plant regrowth can occur quite rapidly but that full plant diversity may take years to occur. Another study looking at the recovery of four sites subjected to *in situ* burning showed that recovery may be quick or may be long depending upon the conditions of the spill and burn (API, 2002). The study showed that some of the delay in recovery may not be due to the burn but due to the response actions taken before and after the burn and to the effects of the oil on the environment before the burn was initiated. A study to collect existing monitoring data from inland *in situ* burns found little data, and the data that was found consisted mostly of soil total petroleum hydrocarbon levels (API, 1999).

The lack of data on the effects of inland burns may be because most burns tend to be small and occur on habitats that have been heavily altered by human activities, primarily farming. As a result, any damage is perceived to be minimal and short-term. Regions of the US where grasslands and wetlands are commonly burned to control the habitat tend to view *in situ* burning of oil spills as a similar practice and believe that the long-term environmental consequences are similar.

Summary and Recommendations

In situ burning of spilled oil is routine in some of the inland regions of the United States, most often for small remote spills in inaccessible areas. It has proven to be capable of effectively removing oil spilled in remote and inaccessible sites with minimal environmental damage. Although open-water burning of marine oil spills has been extensively researched, burns of oil spilled on land and in wetland habitats have been poorly studied, and only a few burns have been monitored for environmental impacts. Nevertheless, most regulators in the states that do allow inland burns are comfortable with the practice and believe that burning can be a safe and environmentally friendly response technique for situations where physical recover of spilled oil would cause extensive damage.

Except for a few well-documented burns of spills in wetlands along the US Gulf Coast, *in situ* burning for inland spills is not well known in the oil spill response community. Many industry and state responders seem reluctant to acknowledge their use of this technique as if they are afraid that the RRT or the US EPA will stop them from using it. Of course, the RRT's and the EPA know that *in situ* burning is used for inland spills but have issued little guidance on how it should be authorized or conducted. Some states interested in establishing an *in situ* burn policy are wrestling with the air pollution issues associated with the smoke plume and would find useful any guidance from the EPA on how to balance the benefits of a successful burn with the need to protect the health of the public.

The US Forest Service has many experts on habitat burning resulting from their controlled burning programs and their responses to forest fires. The US EPA and the RRT's should seek out their expertise and employ it at burns of spilled oil. These fire experts should also be consulted in the preparation of guidance documents.

More information on the ecological effects of inland burns would be useful, and industry and government responders could help our understanding by documenting better *in situ* burns that they conduct. Basic data should be collected, such as: the type and quantity of oil spilled, type of habitat impacted, effectiveness of the burn, amount of oil remaining after the burn, concentration of oil residual in the soil after the burn, and pictures of the impacted area before and after the burn. This information can be easily acquired at a spill at minor costs.

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