Prince William Sound Regional Citizens' Advisory Council
In Situ Burning Position Paper
11/2/04

Subject
This document is PWSRCAC's position on use of in situ burning during an oil spill in the PWSRCAC region that includes Prince William Sound and Gulf of Alaska.

Introduction
The Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) is an independent non-profit corporation whose mission is to promote environmentally safe operation of the Valdez Marine Terminal and associated tankers. Our work is guided by the Oil Pollution Act of 1990, and our contract with Alyeska Pipeline Service Company. PWSRCAC's 18 member organizations are communities in the region affected by the 1989 Exxon Valdez oil spill, as well as commercial fishing, aquaculture, Native, recreation, tourism and environmental groups.

One of PWSRCAC's responsibilities is to provide advice to oil spill responders during an incident. It is essential that PWSRCAC be prepared to provide advice on oil spill response techniques, including the use of in situ burning. This paper outlines PWSRCAC's basic position on the use of in situ burning. As relevant knowledge about in situ burning is gained, PWSRCAC will re-evaluate its position on in situ burning.

What is in situ burning?
In situ burning is an oil spill response technique or tool that involves the controlled ignition and burning of oil at or near the spill site on the surface of the water. There is a limited window-of-opportunity to conduct a successful burn operation if the slick is contained by boom, but a wider window-of-opportunity if the slick is contained by natural barriers such as shorelines or pack ice conditions. Once spilled, oil begins to form a stable emulsion and when the water content exceeds 25% most slicks are not ignitable[1] Weathered crude oil burns more efficiently than fresh, but is harder to ignite. Stable emulsions may not burn.

Advantages and Disadvantages of In situ burning

Advantages	Disadvantages
• Removes oil with 95% efficiency with minimal equipment and manpower	• Not removing oil from environment; trading one form of pollution for another
• Reduces waste storage and disposal requirements	• Smoke plume is unpleasant and contains fine particulate matter,

	PAH's, and other chemicals
• Has a wider window-of-opportunity over mechanical means if slick is contained by natural barriers and shorelines	• Same window-of-opportunity as removing oil mechanically
• Removes most of the lower weight aromatic hydrocarbons which are the more toxic and bioavailable components of crude oil	• Some higher molecular weight compounds may be created • Stable emulsions do not burn
• Reduce chronic impact on some shoreline habitats	• Burning poses risks to response personnel
• Capable of removing crude oil in broken ice conditions	• Burn residues may sink and affect benthic natural resources*
•	• Difficulty of Ignition

*The longer-term effects of burn residues on exposed populations of marine organisms have not been investigated. It is not known whether these materials would be significantly toxic in the long run.

Basic Position

Of the various response options, PWSRCAC endorses mechanical recovery as the primary response strategy. PWSRCAC recognizes that there may be times when in situ burning in Prince William Sound and the Gulf of Alaska may be appropriate but only after mechanical recovery has been ruled out as the primary strategy. Generally, in order to achieve conditions for in situ burning, oil must first be contained with boom or by barriers such as ice or remote shorelines and the slick thick enough to insulate itself from the underlying water. This depth is 2-3 millimeters[2]. If the oil is contained with boom, oil can be removed by mechanical means under any weather conditions compatible with booming operations. Burning should never hinder an on-going mechanical recovery operation. Therefore, any window in which to consider burning in open water conditions may have limitations. However, PWSRCAC does acknowledge that in situ burning may be useful in high latitude waters where other techniques may not be possible due to the physical environment (extreme low temperatures and pack ice conditions), or the remoteness of the impacted area.

Research

Biological Impacts

Adverse biological impacts may result from localized temperature elevations at the sea surface. This may include organisms in the upper most layers of the water column including fish larvae and eggs. There is little doubt that in situ burning would kill the organisms in the area of the burn and these may be killed by the oil alone, but the rapid renewal of the surface micro layer from adjacent areas would minimize the local damage.

Properties of in situ burn residues

PWSRCAC recognizes that residue from burns of Alaska North Slope (ANS) crude oil has the potential to sink. Residue from test burns of fresh ANS crude exceeded a density of 1.025 g/cm3 at 15 degrees C and sank in both salt and fresh water after it cooled[34].

ANS 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 bioavailable components of the crude oil[5]. Bioassays with water from laboratory- and field-generated [Newfoundland Offshore Burn Experiment (NOBE)] burn residues of Alberta Sweet Mix Blend showed little or no acute toxicity to sand dollars (sperm cell fertilization, larvae, and cytogenetics), oyster larvae, and inland silversides[6]. Bioassays using NOBE burn residues showed no acute aquatic toxicity to fish (rainbow trout and three-spine stickleback) and sea urchin fertilization[7].

Localized smothering of benthic habitats may be the most significant concern when semi-solid or semi-liquid residues sink. All residues, whether they floated or sank, could be ingested by fish, birds, mammals, and other organisms, and may also be a source for fouling of gills, feathers, fur, or baleen. However, these impacts would be localized to a burn and expected to be much less severe than exposure to a large, uncontained oil spill[8].

Emissions

Fine particulate is the emission of most concern. Concentrations at ground level [1 m (3.3 ft)] can still be above normal health concern levels (150 $\mu g/m^3$) as far downwind as 500 m from a small crude oil fire. The greatest concern is the smaller or respirable particulates. The PM-10 fraction, or particulates less than 10 µm, are generally about 0.7 of the total particulate concentration (TSP) of all particulates measured. The PM-2.5 fraction is not easily measured, nor are all facets of particulate understood at this time.

Polyaromatic hydrocarbons (PAHs) are a primary concern in the emissions from burning crude oil, both in the soot and gaseous emissions. Crude oil burns result in polyaromatic hydrocarbons (PAHs) downwind of the fire, but the concentration on the particulate matter, both in the plume and the particulate precipitation at ground level, is often an order-of-magnitude less than the concentration of PAHs in the starting oil. This includes the concentration of multi-ringed PAHs, which are often created in other combustion processes such as low-temperature incinerators and diesel engines. There is a slight increase in the concentration of multi-ringed PAHs in the burn residue. When considering the mass balance of the burn, however, most of the five- and six-ringed PAHs are destroyed by the fire.

The gaseous products emitted by the fire (carbon dioxide, carbon monoxide) are not of serious concern to human health or the environment. However, the burn is oxygen-starved and not very efficient, so that it generates black soot particulates that absorb sunlight and create unsightly black smoke. It should also be noted that Volatile Organic Compounds (VOCs) are measured at much higher concentrations from an evaporating slick that is not burning[9].

Human Health

The threat to the general population is avoided by ensuring that no PM-10 concentration greater than 150 ug/m3, averaged over one hour, is produced by the smoke plume at any populated locations downwind of the burn. Of specific concern are the very small particles 10 microns or less in diameter (a micron equal's one-millionth of a meter, or 0.0004")[10]. To prevent possible exposure to human populations, guidelines must be established to limit the effects of in situ burning to the general population. This is best accomplished by ensuring adequate separation between in situ burning operations and population centers and that favorable meteorological conditions exist for plume dispersion. Ground level concentrations (1m) can exceed the regulated health levels as far as 500 meters downwind of the burn. Airborne emissions are not a serious health or environmental concern at distances a few kilometers from the burn[11].

RCAC recognizes the additional hazards and risks involved with in situ burning verses mechanical clean-up. Care is needed to control the spread of fire and ensure personnel and equipment is protected from the heat and smoke. An on-water burn may be extinguished by increasing the tow speed so that oil is entrained in the water, by slowing down to reduce the rate at which the boom encounters oil, or by releasing one side of the boom.

It is possible to estimate the safe downwind distances from historical burns[12]. The following table shows these values:

Safe Distance Calculations
(based on PM-10 concentrations)

	Safe distance in kilometres	Safe distance in miles
Crude Oil Burns		
small area 250 m^2 ($2700 ft^2$)	0.08	0.05
full boom pull 500 m^2 ($5400 ft^2$)	0.5	0.3
large boom pull 750 m^2 ($8100 ft^2$)	3.2	2
Diesel Burns		
small area 250 m^2 ($2700 ft^2$)	0.35	0.2
full boom pull 500 m^2 ($5400 ft^2$)	6.9	4.3

Recommendations for further study

Bioassays with water from laboratory- and field-generated burn residues from other crude oils showed little or no acute toxicity to sand dollars, oyster larvae, fish (rainbow trout and three-spine stickleback) and sea urchin fertilization. PWSRCAC may be interested in determining the acute and chronic toxicity of ANS burn residues to representative pelagic, demersal, and benthic organisms found in PWS.

---

[1] Buist, Ian. "Window-of-Opportunity for In Situ Burning". S.L. Ross Environmental Research Ltd., Ottawa, Ont., Canada. Spill Science & Technology Bulletin, Vol. 8, No. 4, pp. 341-346, 2003.

[2] A Review of In Situ Burning as a Response for Spills of Alaska North Slope Crude Oil in Prince William Sound". S.L. Ross Environmental Research Ltd., May 20, 1997.

[3] Buist, Ian, Trudel, Ken, Morrison, Jake, and Don Aurand; "Laboratory Studies of the Properties of In-Situ Burn Residues". 1997 International Oil Spill Conference.

[4] Moller, T.H. 1992. "Recent Experience of Oil Sinking." Proc. Fifteenth Arctic and Marine Oilspill Program Technical Seminar, Environment Canada, Ottawa, Ontario, pp. 11-14.

[5] Fingas, M.F. and M. Punt, "In-Situ Burning: A Clean-up Technique for Oil Spills on Water", Environment Canada Special Publication, Ottawa, Ontario, 214 p., 2000.

[6] Daykin, M., Ga. Sergy, D. Aurand, G. Shigenaka, Z. Wang, and A. Tang. 1994. Aquatic toxicity resulting from in situ burning of oil-on-water. Proc. Seventeenth Arctic and Marine Oilspill Program Technical Seminar, Environment Canada, Ottawa, Ontario, pp. 1165-1193.

[7] Blenkinsopp, S., G. Sergy, K. Doe, G. Wohlgeschaffen, K. Li, and M. Fingas. 1997. Evaluation of the toxicity of the weathered crude oil used at the Newfoundland Offshore Burn Experiment (NOBE) and the resultant burn residue. Proc. Twentieth Arctic and Marine Oilspill Program Technical Seminar, Environment Canada, Ottawa, Ontario, pp. 677-684.

[8] Moller, pp. 11-14.

[9] Fingas, M.F., P. Lambert, Z. Wang, K. Li, F. Ackerman, M. Goldthorp, R. Turpin, P. Campagna, R. Nadeau, and R. Hiltabrand, "Studies of Emissions from Oil Fires:, in *Proceedings of the Twenty-Fourth Arctic and Marine Oil Spill Program Technical Seminar*, Environment Canada, Ottawa, Ontario, pp. 767-823, 2001.

[10] http:// response.restoration.noaa.gov/oilaids/ISB/FAQtopics/Health.html

[11] Fingas, M.F. and M. Punt, 214 p., 2000.

[12] Fingas, M.F. and M. Punt, 214 p., 2000.