ANNEX F: CHEMICAL COUNTERMEASURES: DISPERSANTS, CHEMICAL AGENTS, AND OTHER SPILL MITIGATING SUBSTANCES, DEVICES OR TECHNOLOGY

General: This annex includes the following chemical countermeasure documents that have been approved by the ARRT: (1) Oil Dispersant Guidelines for Alaska; and (2) In Situ Burning Guidelines for Alaska. These documents were developed by the ARRT Response Technology Working Group in accordance with provisions of the National Contingency Plan. Updates and future changes to these guidelines will be made by the ARRT and provided for inclusion into this Annex. Appendix III provides technology protocols appropriate for the State of Alaska as developed by the Hazardous Substance Spill Technology Review Council. The inclusion of these protocols in the Unified Plan does not represent approval or endorsement by the Alaska RRT, Science and Technology Committee, or **ALL** Federal agencies that are members of the Alaska RRT.

APPENDIX I: RRT OIL DISPERSANT GUIDELINES FOR ALASKA

This Appendix contains Oil Dispersant Guidelines for Alaska and specific guidelines for Cook Inlet. Both documents were approved by the ARRT in April 1986. The specific guidelines for Prince William Sound were approved by the ARRT on March 6, 1989.

1. Background:

The capability to adequately respond to an oil spill in Alaska can be hampered by the great distances involved, poorly developed transportation networks, an inadequate labor force, limited mechanical spill cleanup technology, and severe weather conditions. The use of oil dispersing chemicals provides a supplemental response method to existing conventional cleanup techniques and allows spill-response personnel some additional control over the type and location of spill impacts.
Oil-spill "dispersants" are complex chemical formulations consisting of a blend of surfactants, or detergents, in a mixture of solvents. Dispersants, when applied to a slick of floating oil, reduce the interfacial tension between the oil and the water and thus allow the oil to be broken into small droplets by the action of the wind, waves, and currents. This process disperses oil into the water column and reduces hydrocarbon concentrations on the water surface.

Dispersant use is an important issue in Alaska because Alaskan marine waters support extremely valuable commercial, subsistence, and recreational fisheries; large and important populations of birds and mammals; and a growing oil industry. Since dispersants can be utilized to mitigate the extent of oil-spill impacts, specific resources can be protected, if necessary. For example, some resources such as birds are known to be more vulnerable to spilled oil than others, an acceptable compromise may be to protect these resources by dispersing an oil slick in a less sensitive, deep-water environment. In general, the compromise that must be evaluated is between the short-term impacts of introducing dispersed oil into the upper water column, and the long-term impacts of allowing oil to continue to float on the water surface and/or strand. In many cases, adverse effects from chemically dispersed oil are much less than those that result from stranded oil in biologically sensitive areas, or to sea birds or marine organisms that float at the water surface, such as some fish eggs.

To be effective, dispersants must be applied in a timely manner; oil allowed to weather on the ocean surface becomes difficult, if not impossible, to disperse chemically. At present, as authorized by the National Oil and Hazardous Substances Contingency Plan, the U.S. Coast Guard On-Scene Coordinator (OSC) may use dispersants in response to a spill that endangers human life, or to prevent or substantially reduce hazard to human life. Alternatively, the OSC, with the concurrence of the Environmental Protection Agency (EPA) representative to the Regional Response Team (RRT) and the State of Alaska, may use those dispersants on the NCP Product Schedule list to mitigate the effects of spilled oil. In either case, the OSC must examine conventional response alternatives, such as containment and cleanup, for comparison to dispersant application. Dispersant use would be considered only when an effective conventional response is not feasible or not totally adequate in containing/controlling the spill. Figure 1 outlines the logic used by the OSC to determine the feasibility of chemically dispersing oil spills in environmentally sensitive areas.

These guidelines are subject to periodic review and update, and are designed to streamline and expedite the decision-making process. They allow the timely and effective use of dispersants as an oil-spill-response tool to minimize environmental impacts. The guidelines are to be in force for the application of dispersants in any marine waters of Alaska.

2. Effects of Dispersants.

Decisions concerning potential dispersant use must be based on an evaluation of potential impacts from dispersed versus undispersed oil since dispersing a slick at one site introduces more oil into the water column than would be caused by a surface slick. This means that effects on water column organisms may be increased at one site so that effects can be decreased or eliminated at other sites. Examples of such compromises include untreated oil threatening highly aggregated populations of surface utilizing organisms (migrating or staging populations of seabirds, breeding sites of birds or mammals) or particularly oil-sensitive coastal areas (spawning, nursery or feeding areas for fish, salt marshes, seagrass beds), and dispersed oil threatening aggregated populations of water column organisms (migrating salmon, fish or crab eggs or larvae).

The effects of oiling on marine birds and fur-bearing marine mammals are well-known: the extremely long residence time of stranded oil and the resulting high probability of chronic impact on both the subtidal benthos and the water column have been illustrated by the Baffin Island Oil Spill (BIOS) experiment (Boehm, 1983). Alternatively, the effects of chemically dispersing oil into the water column are transient, but may be severe.

For the most sensitive organisms, exposure to hydrocarbon concentrations greater than 0.1 parts per million (ppm) for 96 hours may result in the death of 50 percent or more of the exposed organisms (Moore and Dwyer, 1974, corroborated for Alaskan species by Rice et al., 1984); exposure to similar concentrations for lessening periods of time usually results in declining mortalities. Because of the proven rapid decline in the concentrations of hydrocarbons in the water column after the chemical dispersion of an oil slick, it is expected that mortalities will be low. Zooplankton, specifically crustacean larvae and pelagic fish eggs and larvae, are among the most sensitive organisms and will suffer the largest mortalities. Larger and non-surface layer-dwelling organisms will suffer lesser mortalities. However, predicting the exact expected mortalities is difficult due to the rapidly changing concentrations of hydrocarbons in the water column.

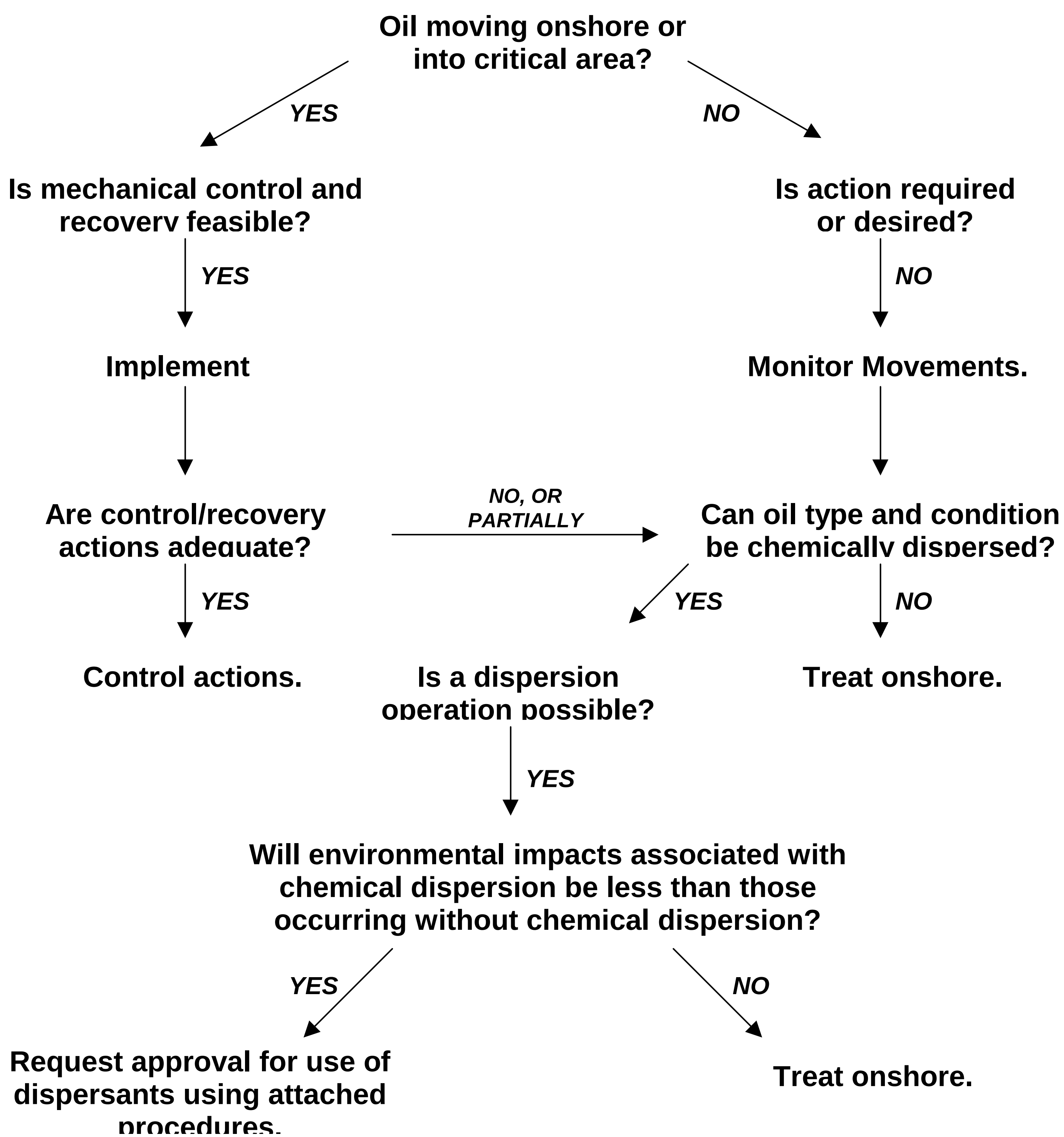
In theory, if a slick 0.1-1.0 mm in thickness is completely mixed into a static water column one meter deep, concentrations of dispersed oil of 100-1,000 ppm can be achieved (Table 1). In an actual situation, the water column would not be static, and vertical and horizontal diffusions would rapidly dilute the dispersed oil. In a series of field experiments performed off the coast of New Jersey, a dispersed oil concentration of 100+ ppm was measured in the top one-third meter of the water column one minute after application of the chemical dispersant. A second measurement made one hour after dispersant application indicated that this concentration had declined to 5 ppm. At one meter deep in the water column, the maximum concentration of dispersed oil measured was 30 ppm. At all depths, the measured concentration of dispersed oil declined rapidly until it was almost undetectable at 5 hours after dispersant application (Figure 2; Mackay and Wells, 1983; McAuliffe et al., 1980).

The toxicity of the dispersants presently stockpiled for use in marine waters is low, compared to that of petroleum hydrocarbons. For most of the dispersants presently on the U.S. EPA acceptance list, concentrations of 1 to 30 ppm were lethal to 50 percent of Mysidopsis bahia, a crustacean zooplankter, exposed to that concentration for 96 hours (Table 2). M. bahia is an excellent organism to use in toxicity assays as it is extremely sensitive.

Other marine organisms exhibit LC_{50}'s ranging up to 100,000 ppm for these same dispersants (Table 3). In any case, the possibility of exposing organisms to concentrations of 1 ppm (or greater) of dispersants or dispersed oil for 96 hours, as the result of the dispersion of a real spill, is moderate to low. This is dependent on the size of the slick treated and the vertical and horizontal diffusivities in the water under and around the slick.

The BIOS, an experimental oil spill designed to examine the "worst case" effects of dispersant use on the biota of nearshore areas in the Arctic, released chemically dispersed oil from a diffuser pipe placed near the bottom of the study bay. Concentrations of dispersed oil exceeding 160 ppm were measured at one point during this release. More widespread and sustained concentrations of 50 ppm for 4 to 5 hours rapidly declined to 0.03-0.05 ppm (Figure 3). Subsequent examination and long-term monitoring over a three year period of the benthic community in this bay revealed that, while there was some stressing of the organisms as indicated by gaping clams immediately after the spill, chemically dispersed oil concentrations of this magnitude and duration had no significant long-term effects on the sediments or the biota (Cross et al., 1984). In comparison, a similar amount of oil allowed to strand without treatment on the beach of a nearby bay is gradually leaching off the beach into the subtidal area, where it is being accumulated by the benthic organisms.

Figure 1 - Dispersant Decision Matrix



NOTE: Immediate threat to life PRE-EMPTS the necessity to use this matrix.

Figure 2 - Illustrative Plot of Total Concentration of Oil Under a Chemically Dispersed Slick Formed From 100 Barrels of Dispersant-Treated Oil at Stated Depths as a Function of Time
(Mackay and Wells, 1983; McAuliffe et al, 1980)

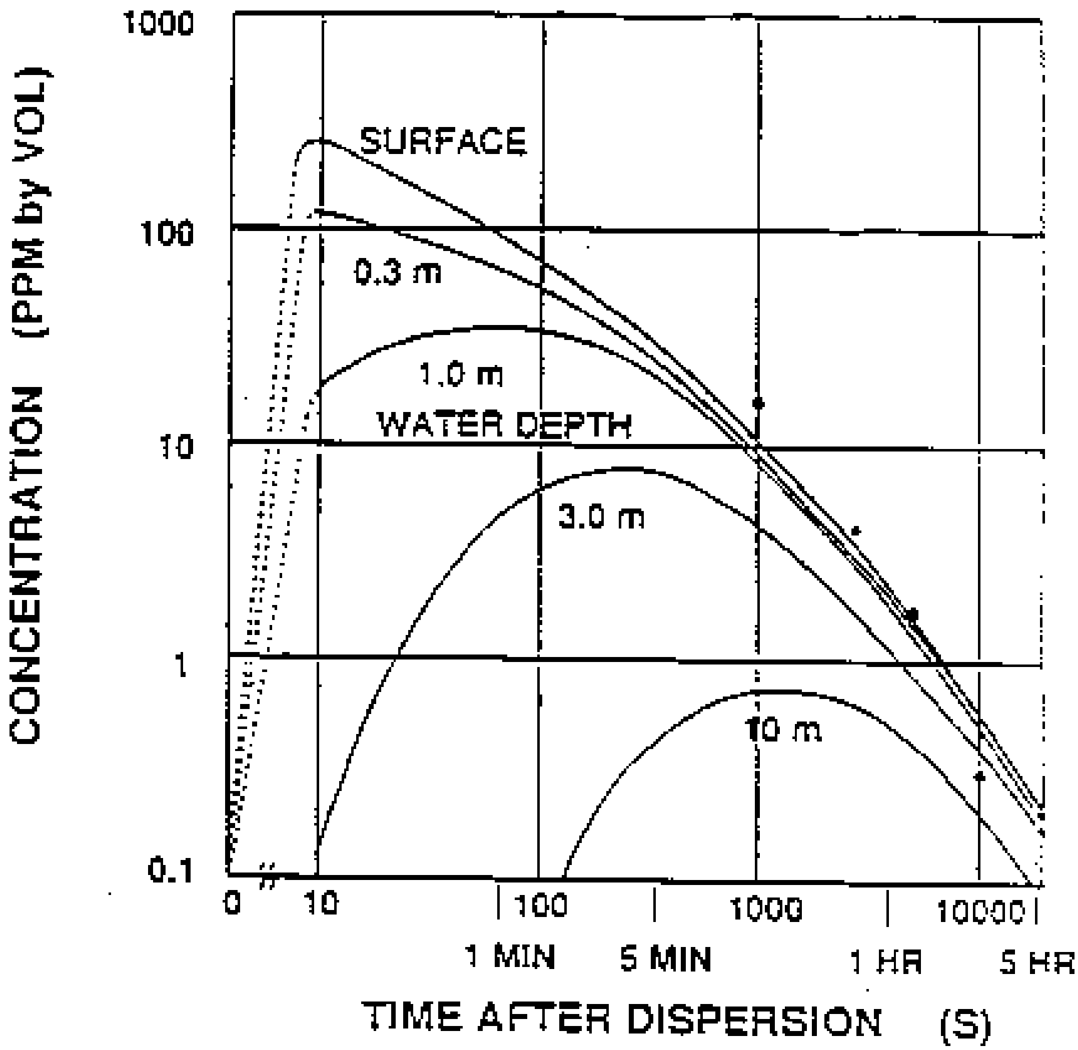


Figure 3 - Concentrations of Dispersed Oil Measured at a Point Approximately 120 m from the Diffuser Pipe (8 m of Depth) Before, During, and After the BIOS Dispersed Oil Release

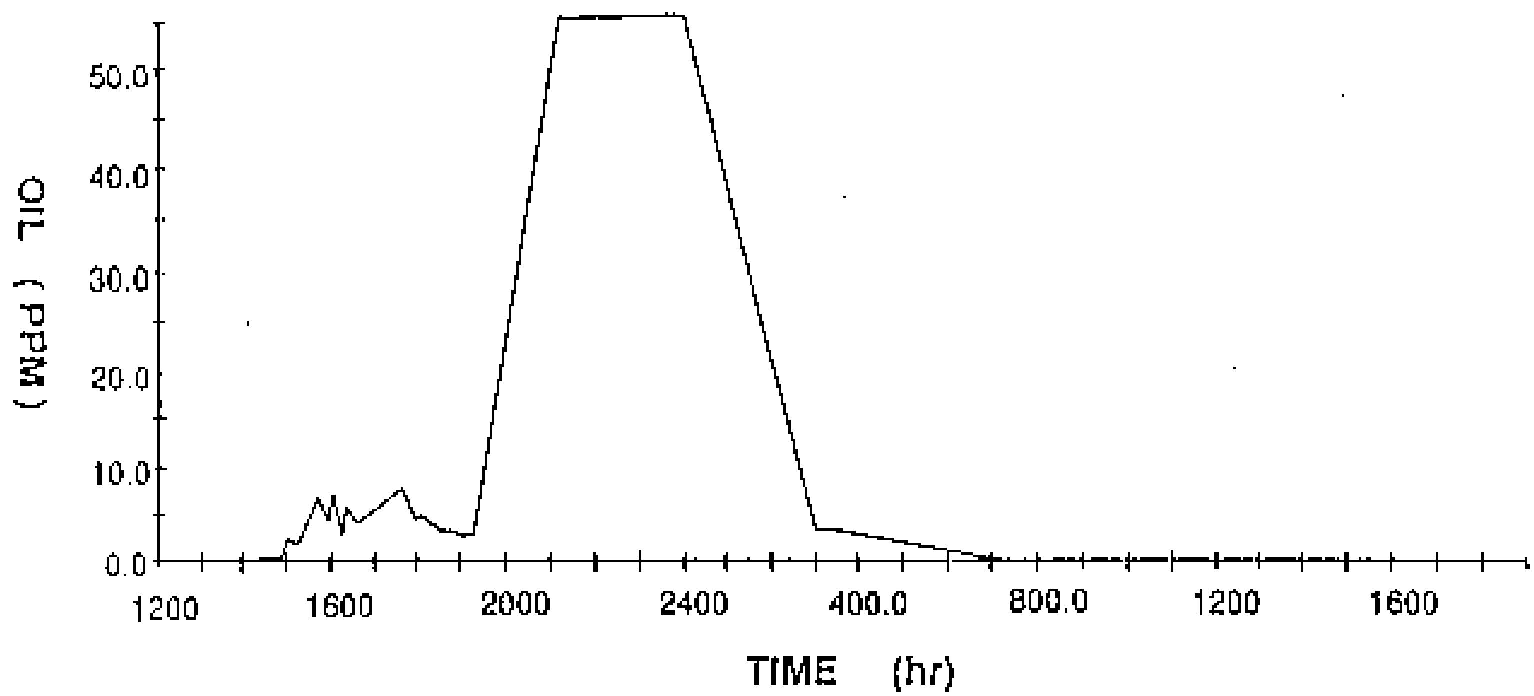


Table 1. Concentrations of Dispersed Oil in Water as Functions of Oil Thickness and Water Depth.

Appearance of Oil on Water	Approximate Oil Thickness (mm)	Concentration of Dispersed Oil in Water (ppm) if Uniformly Mixed, When the Water Depth Is:				
		1m	2m	5m	10m	20m
Barely visible	4×10^{-5}	0.04				
Silvery sheen	8×10^{-5}	0.08	0.04			
First trace of color	1.5×10^{-4}	0.15	0.08	0.03		
Bright bands of color, iridescent	3×10^{-4}	0.3	0.15	0.06	0.03	
Colors tend to be Dull	1×10^{-3}	1.0	0.5	0.2	0.1	0.05
Colors are fairly dark, little evidence of rainbow tints	2×10^{-3}	2.40	1.0	0.4	0.2	0.1
Brown or black	0.01	10.0	5.0	2.0	1.0	0.5
Black/dark brown	0.1	100.0	50.0	20.0	10.0	5.0
Black/dark brown	1.0	1000.0	500.0	200.0	100.0	50.0

Table 2. Relative Effectiveness and Toxicity of Some Chemical Dispersants on U.S.Environmental Protection Agency Approval List to <u>Mysidopsis Bahia</u>, a Crustacean Zooplankter (Anderson et al., 1985).

Dispersant	(15°C) Dispersant:Oil Ratio (DOR90)*	(25°C) 96-h LC_{50} ppm
Atlantol AT-7	0.130	6.6
BP1100WD	0.009	1.4
Finsol OSR-7	0.038	204.0
Arcochem D-609	0.007	29.0
Corexit 9527	0.009	31.9
Corexit 7664	0.500	515.0
Corexit 8667	0.028	2.0
Petrocon N/T#4	0.018	15.0
Ameriod OSD/LT	0.110	6.7
Slick-A-Way	0.240	16.0
Conco K	0.580	3.5
BP1100X	0.150	17.0
Magnus Maritec	0.012	8.0
Petromend	0.008	3.7

*DOR_{90} is the ratio of dispersant to oil required to disperse 90 percent of the oil (i.e., a low ratio indicates high effectiveness).

Table 3. Acute Lethal Toxicity of Some Oil Spill Dispersants to Marine Organisms--A Selection of Current Data (modified Wells, 1984).

Species/Stage	Dispersant	Threshold Concentrations Expressed as Four-Day LC50's, ppm[a,b,c]
Invertebrates		
Stony coral (Madracis mirabilis)	Shell Dispersant LTXE	162 (1 day)
Oligochaete (Marionina subterranea)	Corexit 766	
	Finasol OSR-2	>1000
	Finasol OSR-5	
Intertidal limpet	BP1100X	3700 (approx.)
(Patella vulgata)	BP1100WD	270 (approx.)
Crustaceans		
Amphipods (Gammarus spp.)	Water-based dispersants	>10000
	Petroleum-based dispersants	200 " 130
Mysids (Neomysis sp.)	Water-based dispersants	>4500
	Petroleum-based dispersants	-150
Amphipod (Gammarus oceanicus)	AP oil dispersant	10-100 (1.5 days)
Brown shrimp (Crangon crangon)	10 conventional dispersants	3300->10000 (2 days)
	7 concentrated dispersants (unnamed)	2800->10000 (2 days)
Grass shrimp	Corexit 7664	>104 (27°C)
(Palaemonetes pugio)		nontoxic (17°C)
	Atlantic-Pacific	1000 (27°C), 1800(17°C)
	Gold Crew	150 (27°C), 380 (17°C)
	Nokomis-3	140 (27°C), 250 (17°C)
Fish		
Fish larvae (Pleuronectes platessa, Solea solea)	Corexit 7664	400
Gobies (Chasmichthys,Luciogobius)	Shell dispersant LT	440-480
Stickleback (Gasterosteus aculeatus)	Water-based dispersants	950 " 250
	Petroleum-based dispersants	>10000
Dace (Phoxinus phoxinus)	Water-based dispersants	1400 " 200
Coho salmon (Oncorhynchus kisutch)	BP1100X	1700
Killifish (adult) (Fundulus heteroclitus)	AP oil dispersant (GFC Chemical Co.)	Approx. 100 (2 days), 50-100 (3 days)

[a] Unless otherwise noted.

[b] Examples of water-based dispersants are Corexit 7664, Cold Clean 500, and Finasol OSR-7.

[c] Examples of petroleum-based dispersants are Corexit 8667, Corexit 9550, and BP-1100x.

3. General Alaska Dispersant Use Criteria.

The dispersant use criteria developed for Alaska classify coastal waters into three dispersant use zones. In all cases, the use of dispersants will be based on the determination that the impact of dispersants or dispersed oil will be less harmful than non-dispersed oil. These zones are defined by: 1) physical parameters such as bathymetry and currents; 2) biological parameters such as sensitive habitats or fish and wildlife concentration areas; 3) nearshore human use activities; and 4) time required to respond.

a. Zone 1.

The use of dispersants in Zone 1 is acceptable and should be evaluated after consideration of mechanical means as a response tool to mitigate oil-spill impacts. The OSC is not required to acquire approval from EPA or the State of Alaska prior to use of dispersants in this zone. However, the OSC will notify the EPA and the State of the decision as soon as practicable.

Zone 1 is defined as an area in which dispersant use should be considered as a means to prevent or reduce the amount of oil reaching the shoreline or other sensitive resources, including:

- endangered or threatened species protected by Federal and State governments;
- nesting, spawning, breeding, and nursery areas for mammals, birds, fish, and shellfish;
- fish and wildlife concentration areas where these animals feed, rest, or migrate;
- sensitive marine habitats, including:
    - seagrass beds
    - kelp beds
    - shellfish beds
    - tidal flats
    - marshes
    - shallow subtidal areas
    - low energy bays and harbors
    - rocky intertidal areas;
    - aquaculture and commercial areas which are shallow enough to allow impacts from oil spills; and
    - recreational and industrial areas.

Zone 1 areas are characterized by water conditions (depth, distance, and currents) that will allow dispersed oil to be rapidly diluted to low concentrations, and are far enough away from sensitive resources that dispersant operations would not cause disturbances. In this zone, there is a significant likelihood that spilled oil will impact sensitive resources, and an immediate response is required in order to mitigate environmental consequences.

b. Zone 2.

The use of dispersants is conditional in Zone 2 in order to protect sensitive wildlife and other resources. The Federal OSC is required to consult with the RRT and obtain approval of the EPA and the State of Alaska prior to the use of dispersants in Zone 2. A spill in Zone 2 must be continuously monitored and the need for dispersant-response actions reappraised accordingly.

Zone 2 areas are characterized by water conditions (depth, distance, and currents) that will allow rapid dilution of dispersed oil to low concentrations, a sufficient distance from sensitive resources that an immediate response is not necessary and dispersant operations would not cause disturbances.

c. Zone 3.

The use of dispersants is not recommended in Zone 3. Dispersants may be used in Zone 3 if, on a case-by-case basis, it is determined that the disturbance of the organisms and/or direct exposure to dispersants or dispersed oil would be less deleterious than the impact of spilled oil. As in Zone 2, the OSC is required to consult with the RRT and obtain approval of the EPA and the State of Alaska prior to the use of dispersants in Zone 3.

Zone 3 is defined as the area immediately in or around the resources requiring protection, including the resources themselves. Dispersant use in this area may disturb resources, may not have adequate time for effectiveness, may directly expose the resources to dispersants, or may expose other resources to unacceptably high levels of dispersed oil. Examples of these resources are provided below:

- endangered or threatened species protected by Federal and State governments;
- nesting, spawning, breeding, and nursery areas for mammals, birds, fish, and shellfish;
- fish and wildlife concentration areas where these animals feed, rest, or migrate:
- sensitive marine habitats, including:
    - seagrass beds
    - kelp beds

- shellfish beds
- tidal flats
- marshes
- shallow subtidal areas
- low energy bays and harbors
- rocky intertidal areas;

- aquaculture and commercial areas which are shallow enough to allow impacts from oil spills; and

- recreational and industrial areas.

4. Oil Spill Response Checklist: Dispersant Use.

The Oil Spill Response Checklist: Dispersant Use in Zone 1, and the Oil Spill Response Checklist: Dispersant Use in Zones 2 and 3 and in Undesignated Areas are included as Tabs C and D, respectively. These checklists serve as guidelines for the FOSC to seek RRT approval for dispersant use. The FOSC will use the incident specific information provided in the checklists in conjunction with the "Oil Dispersant Guidelines for Alaska" as the basis for his/her decision regarding dispersant use.

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TAB A: Specific Guidelines for the Use of Dispersants in Cook Inlet.

General: Because of the presence of large numbers of commercially valuable adult salmon, that section of Cook Inlet north of a line drawn along the latitude at Anchor Point north of Kachemak Bay is considered to be Zone 3 during the period from July 1 to August 15. The general rationale is presented below and illustrated in Figure 4.

a. Upper Cook Inlet (North of Point Possession and North Foreland). (See Figure 4)

Upper Cook Inlet is unique because the extreme upper portion contains two Zone 3 designations (dispersant use not recommended) which are based upon tidal stages. During the first three hours of an ebb tide, the Zone 3 boundary is roughly defined by the five-fathom isobath. For periods outside this time window, Zone 3 is defined as the area north of a line between Point Possession and North Foreland.

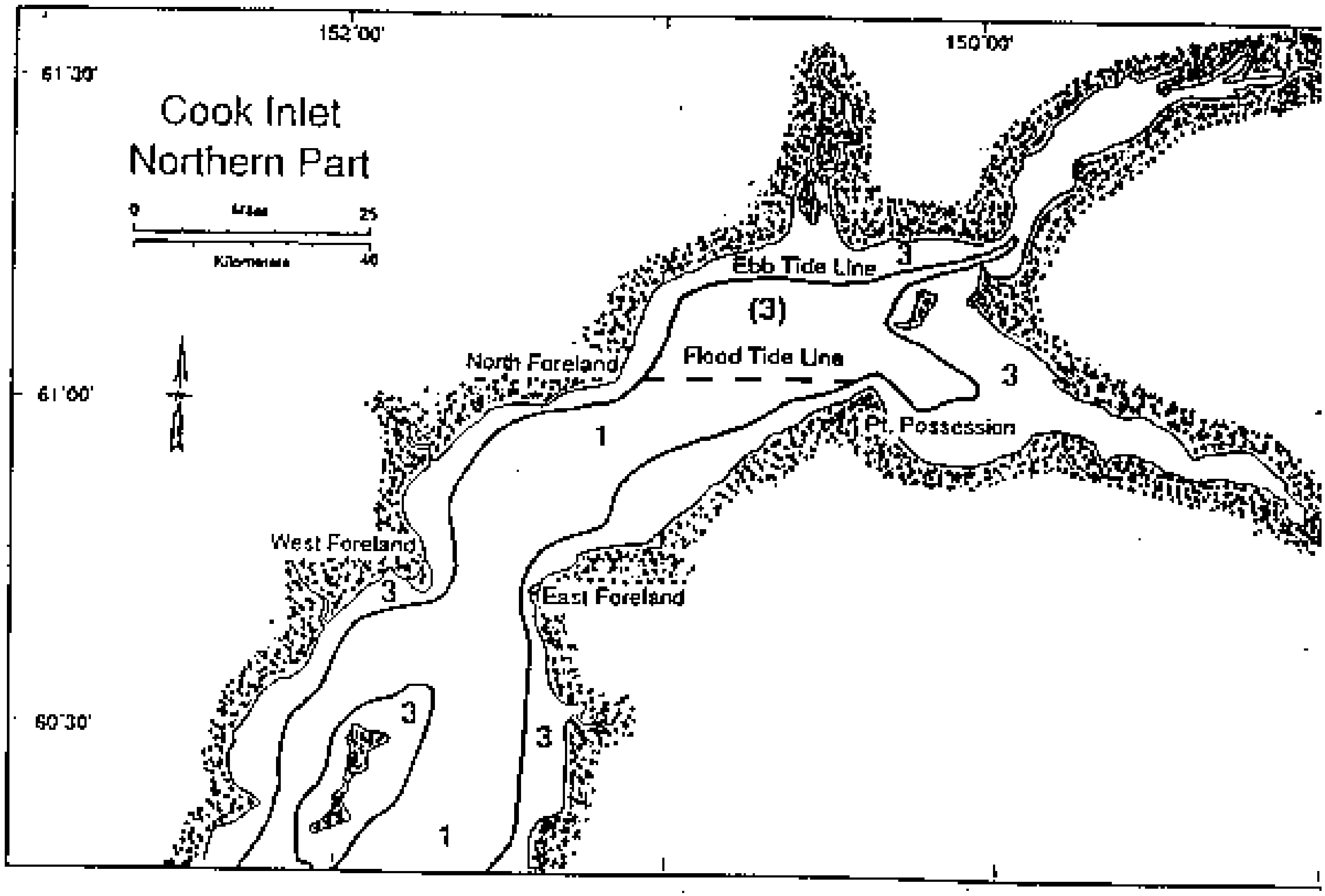
A dual Zone 3 designation is needed because dispersant use during a flood tide could result in relatively high concentrations of dispersed oil impacting shallow waters or intertidal habitats. Restricting dispersant use in this area to the ebb tide period eliminates these concerns while still allowing dispersant use in the northern portion of Upper Cook Inlet. Providing the option for dispersant use in this area is deemed desirable due to:

- the high spill potential;
- the difficulty in mechanically containing spills;
- the extreme tidal fluctuations which rapidly transport spilled oil; and
- sensitive coastal habitats requiring protection from potential oil contamination.

(1) Zone 3 - Ebb Tide.

The Ebb Tide Zone 3, which exists only during the first 3 hours of an ebb tide, occurs shoreward of the five-fathom isobath. This shallower isobath is used because: 1) the ebb tide will rapidly transport the dispersed oil to deeper waters; 2) benthic communities in Upper Cook Inlet exhibit relatively low productivity; and 3) increased water depths from the high tide stage will enhance dilution capabilities.

Figure 4 - Cook Inlet Dispersant Use Zones, Northern Sector



(2) Zone 1 - Ebb Tide.

The Ebb Tide Zone 1, which exists only during the first 3 hours of an ebb tide, extends outward from the five-fathom isobath. Dispersant use is restricted to an ebb tide period to prevent high concentrations of dispersed oil from being transported to shallow nearshore waters.

(3) Zone 3 - Flood Tide.

The Flood Tide Zone 3 is defined as the area north of a line extending from Point Possession to the North Forelands, for all periods outside of the first three hours of an ebb tide. This designation is necessary due to the potential for strong tidal currents to rapidly transport high concentrations of dispersed oil into important shoreline habitats.

b. Middle Cook Inlet - South of a Line Between Point Possession and North Foreland to East Foreland and West Foreland. (See Figures 4 and 5)

(1) Zone 3.

Zone 3 occurs inshore of the five-fathom isobath near the northeast shoreline of this section. The five-fathom isobath is used in this area due to a lack of fish and wildlife resources and the presence of strong currents that run parallel to the shoreline. The Zone 3 designation extends out to the 10-fathom isobath along the southeast shoreline to provide protection to the Swanson River estuary area. Along the west shoreline, the Zone 3 boundary follows the 10-fathom isobath.

(2) Zone 1.

The remaining waters within this Inlet section are designated as Zone 1. This designation will allow for an immediate dispersant use decision to protect important fish and wildlife resources in Cook Inlet.

c. Lower Cook Inlet - South of East and West Forelands.

(1) Zone 3.

Zone 3 occurs inshore of the 10-fathom isobath. The 10-fathom isobath provides ample protection to the razor clam beaches and several river estuaries along the east and west shorelines, including Redoubt Bay where large numbers of birds seasonally reside. Around Kalgin Island, a Zone 3 designation is established along the five-fathom isobath due to strong currents that run parallel to the shoreline and the two- to five-mile buffer provided by the five-fathom isobath. Kachemak and Kamishak Bays are given special protection through an expanded Zone 3 area due to the important fishery resources associated with these bays. The shoreline in the extreme southern portions of Cook Inlet drops off rapidly resulting in the 10-fathom isobath being located very near the shoreline. Consequently, Zone 3 is defined as an area extending one mile out from the shoreline for areas exhibiting such shoreline characteristics. The one-mile buffer distance will allow for dilution of dispersed oil prior to impacting the shoreline or shallow-water areas. See Figure 5 for dispersant use zones.

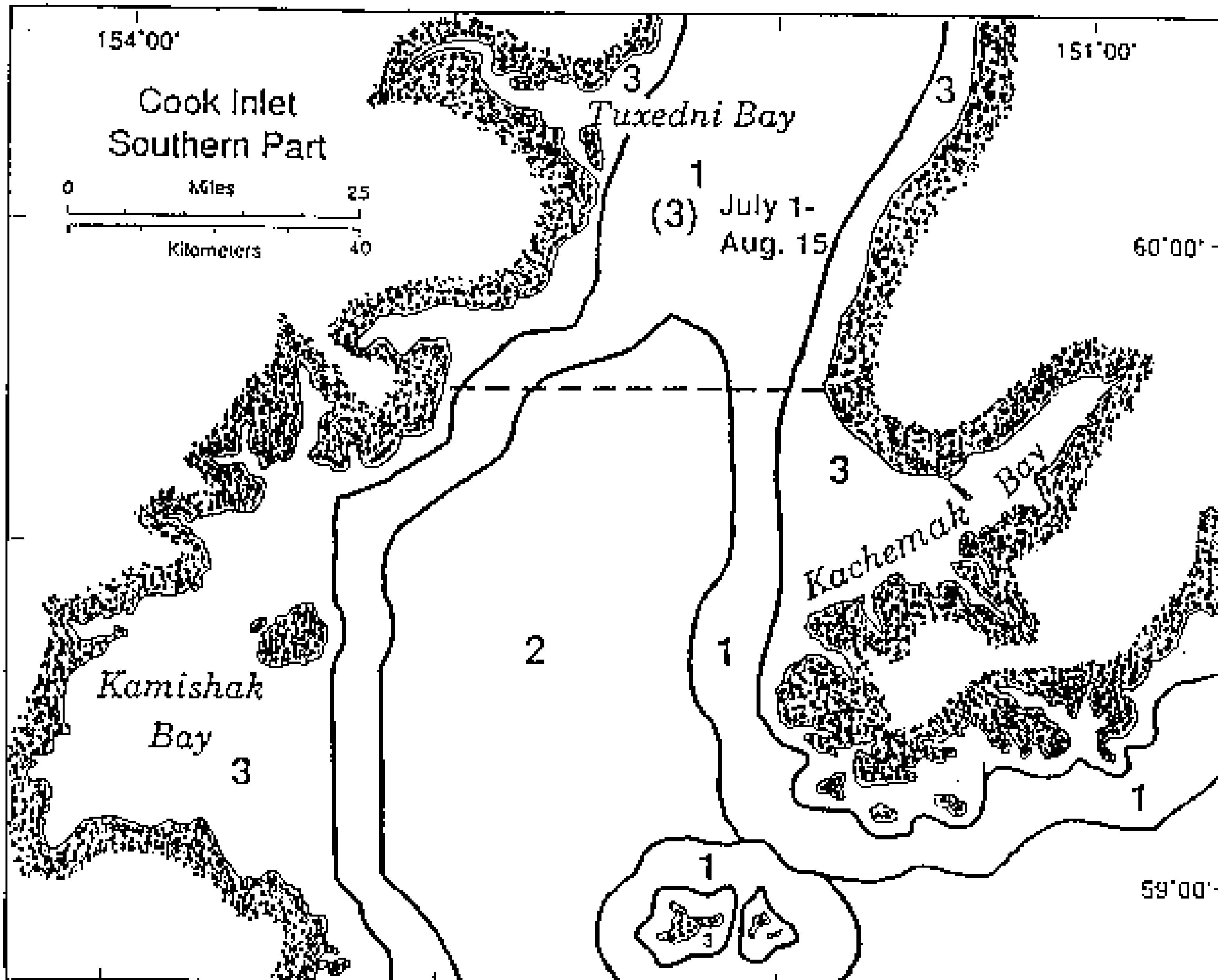
(2) Zone 1.

Zone 1 is identified as an approximately five-mile wide buffer area extending outside of Zone 3. It is believed that the five-mile wide Zone 1 area will provide adequate time to conduct a dispersant response prior to oil entering the sensitive Zone 3 area.

(3) Zone 2.

The remaining waters within this section of Cook Inlet are designated as Zone 2.

Figure 5 - Cook Inlet Dispersant Use Zone, Southern Sector



TAB B: SPECIFIC GUIDELINES FOR THE USE OF DISPERSANTS IN PRINCE WILLIAM SOUND

General. The dispersant use guidelines for Prince William Sound focus on the tanker traffic lanes and reflect the remoteness and fjord geomorphology of the Sound. Designation of the tanker lanes primarily as Zone 1 was deemed desirable due to:

- the large volume of oil transported through the sound via these lanes;
- the difficulty in mechanically containing and removing spilled oil; and
- the likelihood that dispersant use would assist in minimizing the environmental effects of a spill, particularly oil contamination of sensitive coastal resources and habitats.

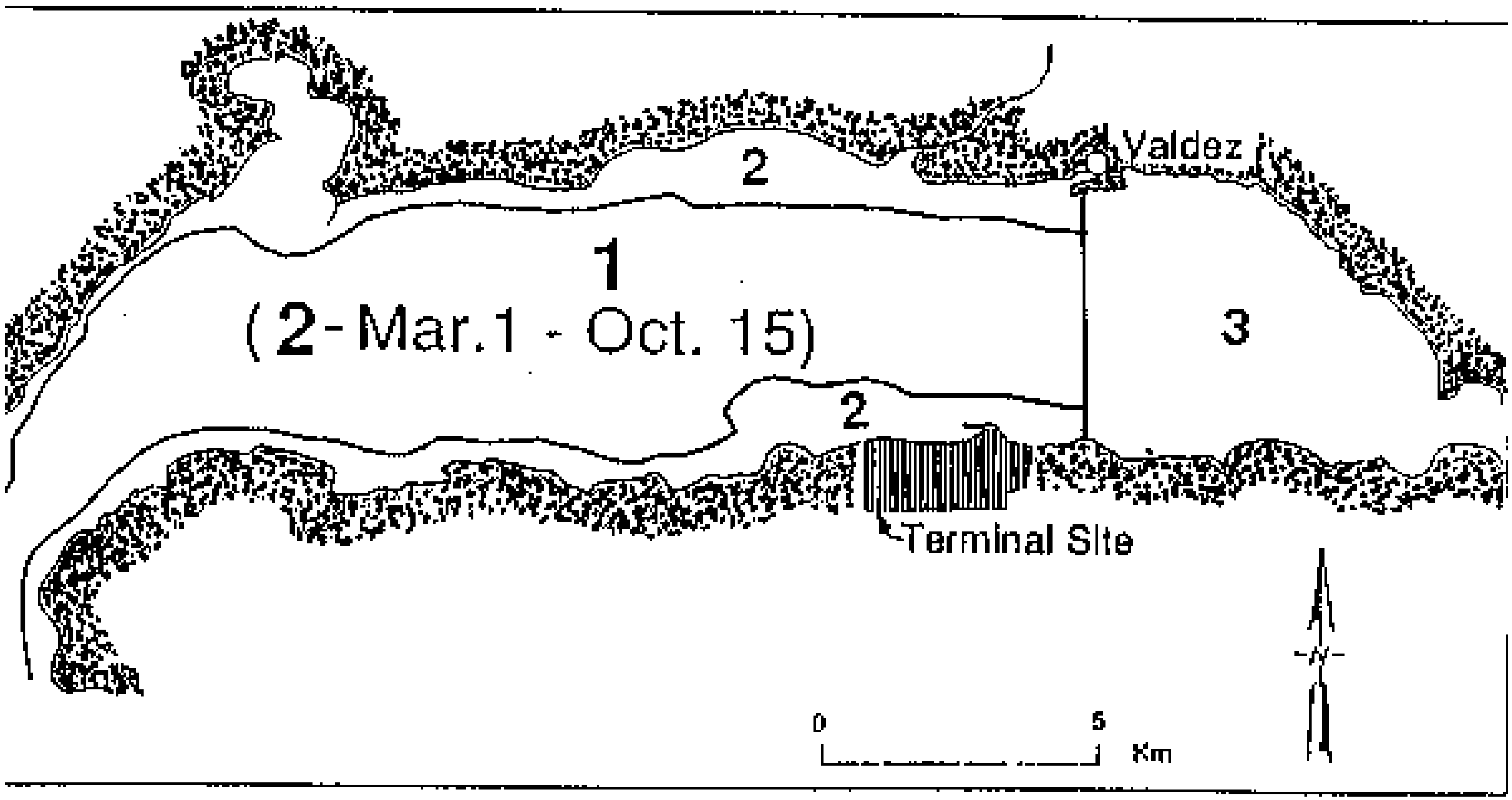
Most of the area outside the tanker lanes has been designated as Zone 3 due to the variety and abundance of biological resources in Prince William Sound. The general rationale for the guidelines is presented below. The specific zones are illustrated in **Figure 6.**

a. Port of Valdez and Valdez Arm (North of Latitude 60^{o} 47') - Figure 6.

(1) Zone 3. Tatitlek Narrows and Columbia Bay are designated as Zone 3.

(2) Zone 2. In general, the areas inshore of the 100-fathom isobath and north of Rocky Point and Point Freemantle are designated as Zone 2.

Figure 6 - Prince William Sound Dispersant Use (Valdez Arm)



(3) Zone 1/Zone 2 (Seasonal Designation).

This small portion of Prince William Sound consists almost entirely of tanker traffic lanes and includes the tanker loading berths at the terminus of the Trans-Alaska Pipeline. The Port of Valdez and Valdez Arm also support sensitive fisheries resources, such as outmigrating juvenile salmon, herring spawning and rearing areas, immigrating adult salmon; and commercial fishing activities. Consequently, this portion of the Sound has been designated Zone 1 from October 16 to February 28, when fisheries resources are least abundant; and Zone 2 from March 1 to October 15, when fisheries resources and harvest activities are at a peak. The Zone 2 designation will allow a case-by-case decision on dispersant use. Such a decision will be based on the potential for impact(s) to environmental resources.

b. Main Body of Prince William Sound - Figure 7.

(1) Zone 3.

The majority of the waters within this section of Prince William Sound are designated as Zone 3. This provides protection for abundant and diverse biological resources of these areas and eliminates the procedural difficulties of classifying the complicated and extensive shoreline.

(2) Zone 1.

The tanker traffic lanes and a variable extending on either side of these lanes are designated as Zone 1. The width of this zone is determined by the need to minimize adverse effects on sensitive resources and the morphology of the Sound.

c. Hinchinbrook Entrance.

(1) Zone 1/Zone 3.

Hinchinbrook Entrance, which is included in the tanker traffic lanes is designated Zone 1, with the exception of an area one nautical mile in radius around Seal Rocks. The area around Seal Rocks is designated as Zone 3, reflecting the importance of this area to marine mammals and seabirds.

d. Copper River Delta (East of Hinchinbrook Entrance) - Figure 8.

(1) Zone 3.

The area inshore of the three-mile (statute miles) territorial limit along the coast from Cape Hinchinbrook to Kayak Island is designated as Zone 3.

This wide Zone 3 designation provides protection for the coastal resources and sensitive marsh and tidal flat habitats of the Copper River Delta area.

(2) Zone 1.

Zone 1 is identified as an approximately five nautical-mile wide buffer extending seaward of Zone 3. This width should provide adequate time to conduct a dispersant response to oil entering the sensitive Zone 3.

(3) Zone 2. The waters seaward of Zone 1 are designated as Zone 2.

e. Montague Island (West of Hinchinbrook Entrance).

(1) Zone 3.

Zone 3 occurs inshore of a line drawn approximately one nautical-mile off the outside coasts of Montague and Elrington Islands and extending east to Cape Junken. In this area, the water depth increases rapidly with distance offshore. A distance of one nautical-mile should provide sufficient depth for adequate mixing and dilution of dispersed oil.

(2) Zone 1.

Zone 1 is identified as an approximately five nautical-mile wide buffer area extending seaward of Zone 3. This designation will allow for a rapid decision on dispersant use to minimize adverse effects on the sensitive resources in Zone 3.

(3) Zone 2. The waters seaward of Zone 1 are designated as Zone 2.

(4) Zone 1/Zone 2 (Seasonal Designation).

The southern end of Montague Strait--south from a line drawn from the northern end of Latouche Island to Point Bazil and to a line drawn between Point Cleare and a point 0.5 nautical-miles south of Point Elrington (59 55 latitude and 148 15 longitude)--is designated as Zone 1 from October 1 to March 31 and as Zone 2 from April 1 to September 30. This dual designation is due to the presence of fisheries resources and commercial harvest activities as well as the potential use of the area by oil tankers.

Figure 7 - Prince William Sound Dispersant Use (Main Body)

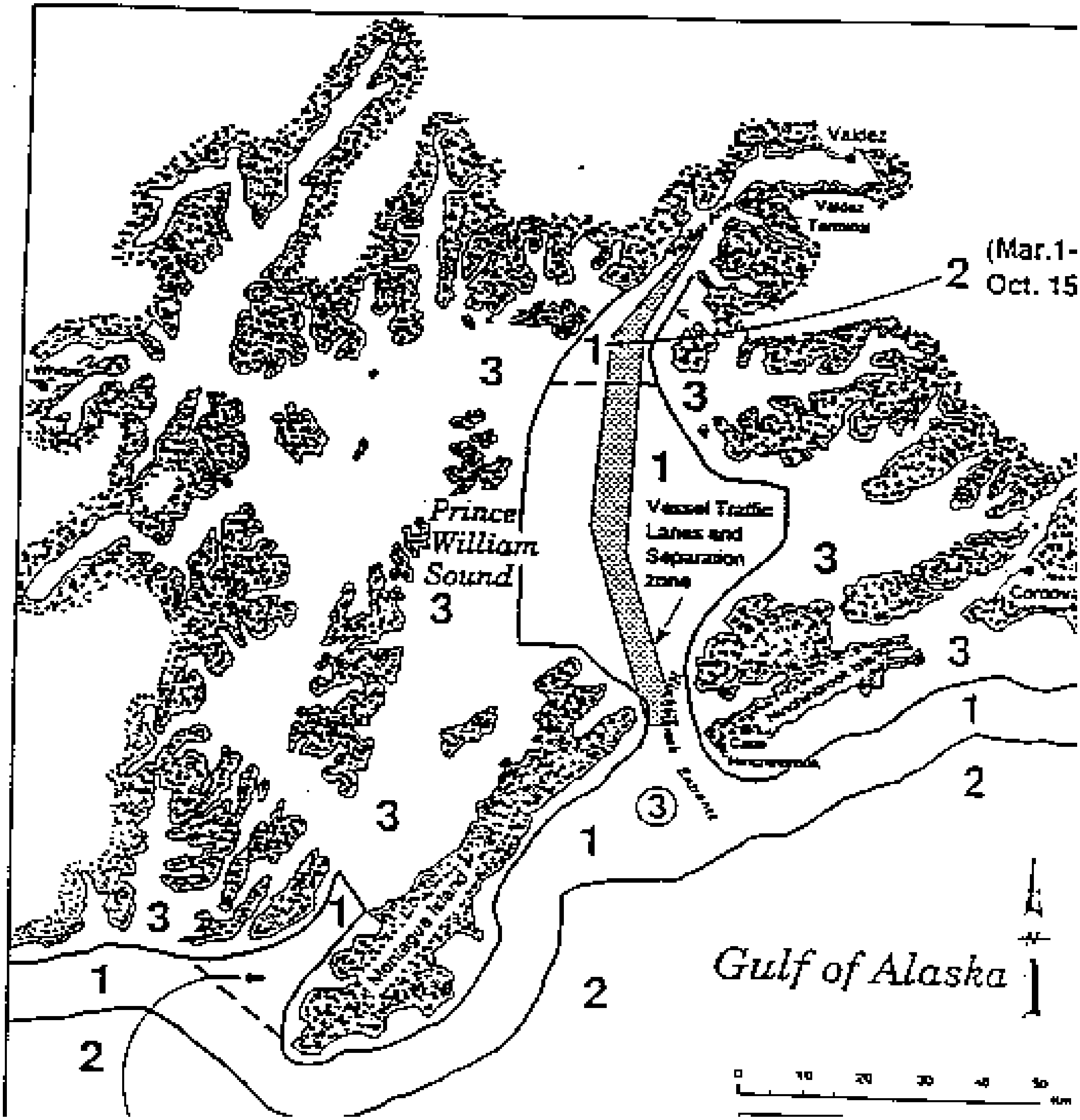
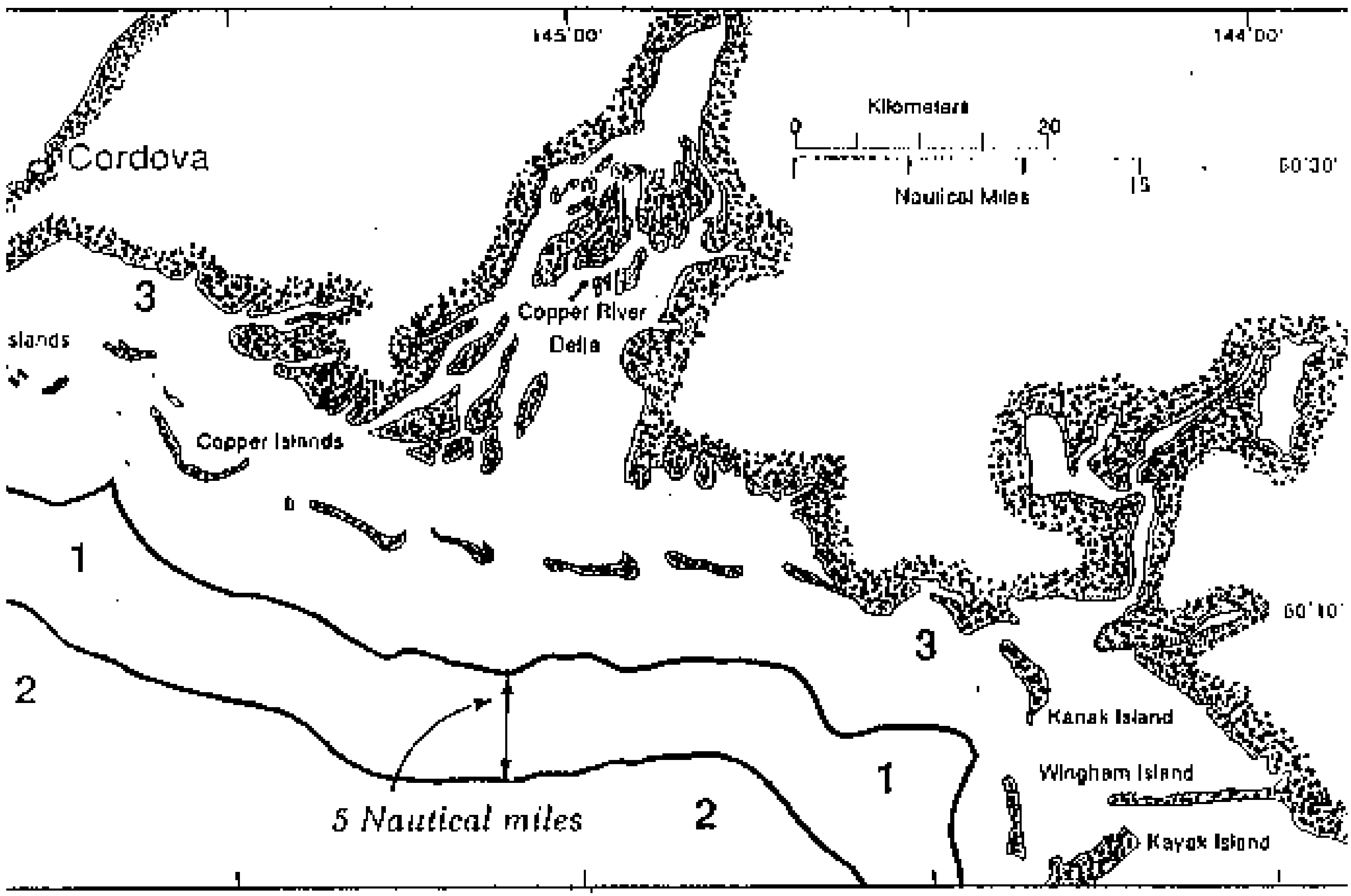


Figure 8 - Prince William Sound Dispersant Use (Copper River Delta)



TAB C: OIL SPILL RESPONSE CHECKLIST: DISPERSANT USE IN ZONE 1

I. SPILL DATA (TO BE COMPLETED BY RESPONDING PARTY AND SUBMITTED TO FEDERAL ON-SCENE COORDINATOR)

A. Name of incident:____

B. Date and time of incident: Month/Day/Year__________, Time________

C. Incident: Grounding____ Transfer Operations____ Explosion____

Collision____ Blowout____ Other____

D. Did source burn? Yes____ No____

Is source still burning? Yes____ No____

E. Spill location: Latitude________________; Longitude________________

F. Distance (in miles) and direction to nearest land: ___________________________________;

nearest town____

G. Product released: North Slope Crude____ Cook Inlet Crude____

Chevron Residual____ Diesel #2____ JP4____ Other:____________________________________

H. Product easily emulsified? Yes____ No____

I. Product already emulsified? No____ Light emulsion (0-20%)____

Moderate emulsion (21-50%)____ Heavy emulsion (>51%)____ Unknown_____________________

J. Estimated volume of released product: ____________________________ gals____ bbls____

K. Estimated volume of product potentially released: ________________ gals____ bbls____

L. Release status: Continuous____ Intermittent____

One time only, now stopped____

If continuous or intermittent, specify rate of release: __________ gals____ bbls____

M. Estimated water surface covered (square miles): ______________________________________

II. PROPOSED DISPERSANT USE PLAN (TO BE COMPLETED BY RESPONDING PARTY AND SUBMITTED TO FEDERAL ON-SCENE COORDINATOR)

A. Reason(s) for requesting dispersant use: ____

B. Will dispersant use be requested in other zones? Yes____ No____ Maybe____

If so, which zone(s)? Zone 2____ Zone 3____

(Note: Use of dispersants outside Zone 1 requires submittal of checklist for Zones 2 and 3.)

C. Location of the area to be treated relative to the following, as shown on attached chart:

Slick/trajectory
Dispersant zone
Nearest land

D. Name of the dispersant proposed for use:

COREXIT 9527____ COREXIT 9550____ OFC D-609____ Other_________________

E. Application Platform(s): Hercules C-130____ Helicopter____ Vessel____

Safety plan for applicable platform in place? Yes____ No____

F. Dispersant dosage goals:

Ratio of dispersant-to-oil: 1:20____ Other:____

Gallons per acre: ____5 gals per acre Other:______________________________________

G. Total amount of dispersant to be used: _________________gals

H. Time of dispersant application: Start time______________ Day______________;

Finish time______________ Day_____________.

I. Estimated percentage of spill area to be treated:

1-5%____ 6-20%____ 21-40%____ 41-70%____ 71-99%____ 100%____

Signature of Requestor:____

Printed Name of Requestor:____

Title of Requestor: ____

Requestor Affiliation: ____

Requestor Representing: ____

Time and Date Request Submitted to Federal On-Scene Coordinator: ___________________________

III. FEDERAL ON-SCENE COORDINATOR'S DECISION REGARDING DISPERSANT USE - BASED ON ARRT GUIDELINES AND DECISION MATRIX (TO BE COMPLETED BY FEDERAL ON-SCENE COORDINATOR)

Time and Date Request Received by Federal On-Scene Coordinator: ____________________________

A. ____No dispersants may be applied.

B. ____Dispersants may be used under noted conditions (if any) and in limited or selected areas (see attached chart).

C. ____Dispersants may be applied as requested above in Section II.*

*Requests exceeding 20 gallons per acre require Alaska Regional Response Team Approval

Signature of Federal On-Scene Coordinator: ____

Printed Name of Federal On-Scene Coordinator: ____

Time and Date of Decision: ____

[ARRT Approved on 4/15/92]

TAB D: OIL SPILL RESPONSE CHECKLIST: DISPERSANT USE IN ZONES 2 AND 3 AND IN UNDESIGNATED AREAS

I. SPILL DATA (TO BE COMPLETED BY RESPONDING PARTY AND SUBMITTED TO FEDERAL ON-SCENE COORDINATOR)

A. Name of incident: ____

B. Date and time of incident: Month/Day/Year______________________; Time___________________

C. Incident: Grounding____ Transfer Operations____ Explosion ____

Collision____ Blowout____ Other____

D. Did source burn? Yes____ No____

Is source still burning? Yes____ No____

E. Spill location: Latitude________________; Longitude________________

F. Distance (in miles) and direction to nearest land: _____________________________________;

nearest town____

G. Product released: North Slope Crude____ Cook Inlet Crude____

Chevron Residual____ Diesel #2____ JP4____ Other: ___________________________________

H. Product easily emulsified? Yes____ No____

I. Product already emulsified? No____ Light emulsion (0-20%)____

Moderate emulsion (21-50%)____ Heavy emulsion (>51%)____ Unknown____

J. Estimated volume of released product: ______________________________ gals____ bbls____

K. Estimated volume of product potentially released: __________________ gals____ bbls____

L. Release status: Continuous____ Intermittent____

One time only, now stopped____

If continuous or intermittent, specify rate of release: ____________ gals____ bbls___

M. Estimated water surface covered (square miles): ______________________________________

II. WEATHER AND WATER CONDITIONS AT THE TIME AND LOCATION OF SPILL (TO BE COMPLETED BY RESPONDING PARTY AND SUBMITTED TO FEDERAL ON-SCENE COORDINATOR)

A. Temperature: Air_________°F Water________°F

B. Weather: Clear____ Partly Cloudy____ Overcast____ Rain____ Snow____ Fog____

C. Tidal State: Slack tide____ Incoming (flood)____ Outgoing (ebb)____

D. Dominant current, net drift: Speed__________knots Direction (from)___________________

E. Wind Speed: _______knots Direction (from):___________

F. Sea state: Calm____ Choppy____ Swell____Waves: <1ft____ 1-3ft____ >3ft____

G. Water depth (fathoms____ feet____): 0-3____ 4-10____ 11-30____ 31-99____ >100____

H. Ice Present: Yes____ No____; Percent coverage: <10%____ 11-30%____ 31-50% ____

51-100%____

I. Other considerations: Low visibility____ Rip tides____ Whirlpools____ Eddies____

Other____

NOTE: (1) SEE SECTION IV FOR WEATHER AND WATER CONDITIONS FORECAST (TO BE COMPLETED BY NOAA SCIENTIFIC SUPPORT COORDINATOR).

(2) SEE SECTION V FOR PREDICTED OIL BEHAVIOR (TO BE COMPLETED BY NOAA SCIENTIFIC SUPPORT COORDINATOR).

(3) RESPONDING PARTY HAS OPTION OF ALSO SUBMITTING INFORMATION ON PREDICTED OIL BEHAVIOR TO FEDERAL ON-SCENE COORDINATOR.

III. PROPOSED DISPERSANT USE PLAN (TO BE COMPLETED BY RESPONDING PARTY AND SUBMITTED TO FEDERAL ON-SCENE COORDINATOR)

A. Reason(s) for requesting dispersant use: ______________________

B. Dispersant zone where dispersant would be applied (check one or more):
Zone 1___ Zone 2___ Zone 3__

C. Location of area to be treated relative to the following, as shown on attached chart:

Slick/Trajectory
Dispersant zone
Nearest land

D. Name of dispersant proposed for use:

COREXIT 9527___ COREXIT 550___ OFC C-609___ Other______________

E. Application platform(s): Hercules C-130___ Helicopter___Vessel___

Safety plan for applicable platform in place Yes__ No__

F. Dispersant dosage goals:

Ratio of dispersant-to-oil: 1:20__ Other____________________

Gallons per acre: 5 gals per acre__ Other___________________

G. Total amount of dispersant to be used:______gals

H. Time of dispersant application: Start time_____ Day____;

Finish time______ Day_____

I. Estimated percentage of spill area to be treated:

1-5%__ 6-20%__ 21-40%__ 41-70%__ 71-99%__ 100%__

Signature of Requestor: ____

Printed Name of Requestor: ____

Title of Requestor: ____

Requestor Affiliation: ____

Requestor Representing: ____

Time and Date Request Submitted to Federal On-Scene Coordinator: _________________________

IV. WEATHER AND WATER CONDITION FORECAST FROM TIME OF SPILL. (TO BE COMPLETED BY NOAA SCIENTIFIC SUPPORT COORDINATOR)

A. Wind Speed (knots):

24-hour projection: _____________________

48-hour projection: _____________________

B. Wind Direction (from):

24-hour projection: _____________________

48-hour projection: _____________________

C. Sea conditions:

24-hour projection:

Calm____ Choppy____ Waves <1ft____ Waves 1-3 ft____ Waves >3ft____

48-hour projection:

Calm____ Choppy____ Waves <1ft____ Waves 1-3 ft____ Waves >3ft____

D. Tidal information for three tidal cycles (see attached graph).

E. Dominant current (net drift):

Speed: ___________________________knots Direction (from): _______________

V. PREDICTED OIL BEHAVIOR (TO BE COMPLETED BY NOAA SCIENTIFIC SUPPORT COORDINATOR)

Untreated oil forecast:

Estimated trajectory (see attached graph): ____

Expected area(s) and time(s) of land fall: ____

Estimated percent naturally dispersed and evaporated within first 24 hours: ___________

VI. RESOURCES AT RISK (TO BE COMPLETED BY RESOURCE AGENCIES)

A. Habitats (see attached charts):

____Sheltered tidal flats

____Coastal marshes

____Other

B. Biological Resources (see attached charts):

	Distribution		Estimated Numbers of Individuals				
Taxon	General	Concentrated	1-10	11-50	51-100	101-1000	>1000
Endangered/Threatened Species							
1.							
2.							
3.							
Non-Endangered/Threatened Species							
Sea otters							
Fur seals							
Other seals							
Toothed whales							
Baleen whales							
Polar bears							
Walrus							
Waterfowl							
Seabirds							
Diving birds							
Shorebirds							
Raptors							
Ungulates							
Bears (Brown & Black)							
Furbearers							

Fish:

Pelagic & Larval____

Bottomfish: ____

Intertidal mollusks: ____

Crustacea: ____

C. Human Resources:

Commercial facilities and enterprises______(see attached chart)

Public facilities and enterprises______(see attached chart)

Historic and archaeologic resources:

Present____, (Appropriate information to be provided to FOSC)

Not present____

Unknown____

Commercial harvest areas:

Generally distributed____

Concentrated______(see attached chart)

Subsistence harvest areas:

Generally distributed____

Concentrated______(see attached chart)

VII. FEDERAL ON-SCENE COORDINATOR'S EVALUATION OF RESPONSE OPTIONS (TO BE COMPLETED BY FEDERAL ON-SCENE COORDINATOR)

A. Has mechanical clean-up been fully evaluated? Yes____ No____

B. Has in-situ burning been fully evaluated? Yes____ No____

C. Why is dispersant use necessary? ____

D. Will dispersants be used in addition to mechanical recovery and/or in-situ burning?

Yes____ No____

E. Will dispersants be used instead of mechanical recovery and/or in-situ burning?

Yes____ No____

VIII. ALASKA REGIONAL RESPONSE TEAM RECOMMENDATION TO FEDERAL ON-SCENE COORDINATOR REGARDING DISPERSANT USE (TO BE COMPLETED BY ALASKA REGIONAL RESPONSE TEAM CO-CHAIRMAN)

Time and Date Request Received by Alaska Regional Response Team Co-Chairman: _______________

A. ____No dispersants may be applied.

B. ____Dispersants may be used under noted conditions (if any) in limited or selected areas (see attached chart).

C. ____Dispersants may be applied as requested above in Section III.*

*Requests exceeding 20 gallons per acre require Alaska Regional Response Team approval

Signature of Alaska Regional Response Team Co-Chairman: ______________________________________

Printed Name of Alaska Regional Response Team Co-Chairman: ___________________________________

Time and Date of Recommendation: ____

IX. FEDERAL ON-SCENE COORDINATOR'S DECISION REGARDING DISPERSANT USE (TO BE COMPLETED BY FEDERAL ON-SCENE COORDINATOR)

Time and Date Request Received by Federal On-Scene Coordinator: ____________________________

A. ____No dispersants may be applied.

B. ____Dispersants may be used under noted conditions (if any) in limited or selected areas (see attached chart).

C. ____Dispersants may be applied as requested above in Section III.

Signature of Federal On-Scene Coordinator: ____

Printed Name of Federal On-Scene Coordinator: ____

Time and Date of Decision: ____

[ARRT Approved on 4/15/92]

Alaska Regional Response Team

The Alaska Federal/State Preparedness Plan
for Response to Oil and Hazardous Substance
Discharges/Releases

Unified Plan

Appendix II
Annex F

In Situ Burning Guidelines for Alaska

Revision 1

PICTURE

RRT

Environmental Protection Agency	Department of the Interior	Department of State	Department of Health and Human Services	Department of Labor
United States Coast Guard	Department of Agriculture	Department of Justice	Federal Emergency Management Agency	State of Alaska
Department of Commerce	Department of Defense	Department of Transportation	Department of Energy	

TABLE OF CONTENTS

PART II: ISB REVIEW CHECKLIST

PART III: APPLICATION FOR ISB

PURPOSE: These Guidelines provide background information relating to the use of In Situ Burning (ISB) as an oil spill response countermeasure. They also establish a procedure for requesting, evaluating, and authorizing the use of ISB during a response. Finally, the guidelines may also be used by contingency planners for preparedness and pre-planning activities that the Alaska Regional Response Team (ARRT) expects owners and operators of facilities or vessels to conduct prior to a spill if they wish to consider the use of ISB.

ACKNOWLEDGMENTS: These guidelines were drafted by the Response Technology Work Group of the Alaska Regional Response Team. Member agencies include the United States Environmental Protection Agency (USEPA), Alaska Department of Environmental Conservation (ADEC), United States Coast Guard (USCG), United States Department of the Interior (DOI), United States Department of Commerce (DOC), Alaska Department of Fish and Game (ADF&G), National Oceanic and Atmospheric Administration (NOAA), and advisory representatives from the oil industry, Native Communities, fishing industry, an the Regional Citizens Advisory Councils. From time to time, other entities have provided significant contributions. These include, but are not limited to, Cook Inlet Spill Prevention and Response Incorporated, Alaska Clean Seas, Alyeska Pipeline Service Company, Alaska Fishermen United, and the Pacific Rim Native Corporation.

Additionally, parts of these guidelines incorporate existing informational documents prepared by Environment Canada; the National Response Team, R&D Committee; NOAA HAZMAT; Alyeska Pipeline Service Company; Alaska Clean Seas; and others.

DISCLAIMER: These guidelines attempt to provide current information regarding the use of ISB. Revisions will be necessary to keep pace with new developments. These guidelines are not regulations and do not carry the force of law or promulgated Federal and State regulations. They are intended to establish a common set of "ground rules" for evaluating the use of ISB, thus providing all involved and interested parties with the expectations of the Federal and State spill response agencies, i.e., the Federal and State On Scene Coordinators and their Command Staffs, the ARRT, and Alaska Area Committee members.

PREVIOUS APPROVALS: In March 1989, the ARRT adopted the "Oil Spill Response Checklist: In Situ Burning" for the use by a party responding to a spill. This checklist was subsequently revised and approved by the ARRT on July 15, 1992. On February 4,1991, the ARRT approved the "Alaska Regional Response Team In Situ Burning Memorandum of Agreement: Beaufort and Chukchi Seas and Selected North Slope Areas." Both the current version of the checklist and the Memorandum of Agreement are superseded by this document.

PART I: BACKGROUND

100 AUTHORIZATION PROCEDURES FOR PRE-APPROVAL OF ISB

110 Regulatory Background and ARRT Pre-Approval

The use of ISB as a response countermeasure to an oil discharge is regulated by the provisions of the National Contingency Plan and State of Alaska law. From a Federal perspective, "burning agents" must be authorized according to the provisions of the National Contingency Plan (NCP), 40 CFR Part 300.910. This provision enables the Federal On Scene Coordinator (FOSC) to "authorize" the application of burning agents when he or she believes it is appropriate, after key members of the Alaska Regional Response Team (ARRT) have been consulted and concur. Specifically the EPA and State members must concur with the FOSC's recommendation to authorize the use of burning agents. Additionally, the FOSC must consult with the Department of the Interior and Department of Commerce ARRT representatives when practical. From a State perspective, ISB constitutes an open air burn for which a permit is required under Alaska State air quality regulations. Alaska Department of Environmental Conservation (ADEC) Regional Administrators, who are also predesignated as State On Scene Coordinators (SOSC's), are authorized to issue these permits and must approve the use of burning.

These guidelines provide a common decision making process to evaluate the appropriateness of using ISB during a spill response and, if followed, will permit the FOSC to authorize burning without further consultation with the ARRT. These guidelines, if followed, will also satisfy the State of Alaska, Air Quality Control Regulations for Open Burning, 18AAC 50.030, and will allow the SOSC to simultaneously permit ISB.

Under these guidelines, authorization requires consultation and concurrence from the FOSC and SOSC but the number of government decision makers is reduced from five to two. The remaining consultation and concurrence between Federal and State OSC's is greatly expedited by the use of the Incident Command System, Unified Command Structure, and by the establishment of a single application, review checklist and mutually agreed upon operational controls.

120 Unified Command Decision Making

The Unified Command Structure as described in the "Response Organization" of the Federal/State Unified Area Plan shall be used to expedite ISB decision making. A detailed description of the Incident Command System and Unified Command is included in Annex B of the Federal/State Unified Plan.

As per the provisions of the Unified Plan: "whenever there is an incident involving more than one agency with jurisdiction the Unified Command is implemented." The requests to utilize ISB shall be initially evaluated by the Federal and State OSCs with the responding party's incident commander. If the proposed burn is conducted in accordance with the following guidelines, then no further consultation with the ARRT is necessary. If the proposed burning is NOT conducted in accordance with the following guidelines, then concurrences and consultation with the ARRT is required.

130 ISB Review Process

These guidelines were developed primarily for an open water marine spill scenario where oil would be burned in a fire resistant boom. A predictive model was used to determine safe distances and is based on flat terrain. Many of the models concepts, however, may be applicable to non-marine spills. The review and decision making process may be used for any request, for emergency burning of oil on water, to prevent the spread, and minimize environmental damage. They do not apply to requests for disposal. Best professional judgement must be employed in cases where results of the model are not applicable.

The request and approval process must be initiated by the responsible party by submitting the Application for ISB included as Part III of these guidelines to the Unified Command for their review. The Unified Command will review the application using the ISB Review Checklist included as Part II of these guidelines and render a decision, e.g., approve, disapprove, or approve with conditions.

200 ISB AS AN OIL SPILL RESPONSE TOOL - OVERVIEW

210 ISB Defined for Purposes of These Guidelines

ISB, for the purpose of these guidelines, is defined as the use of an ignition source to initiate the combustion of spilled oil that will burn due to its intrinsic properties and does not include the adding of a burning agent to sustain a burn.

The use of ISB as described in these guidelines is not for disposal or well control; rather, it is a response technique to be employed when an oil spill is virtually uncontrolled with the potential to spread and contaminate additional areas.

220 Potential Effectiveness of ISB

For burning to be effective, it must be employed early in the spill and in a timely manner before the spilled oil weathers and loses its highly flammable constituents.

The efficiency of ISB is highly dependent on a number of physical factors. Test burns and applications in actual spill situations suggest that it can be very effective in removing large quantities of oil from the water. For example, Benner et al. (1990) realized burn efficiencies up to 83 percent in laboratory tests. Allen (1990) and Evans et al. (1990), report that in 1989, during a test burn of approximately 15,000 to 30,000 gallons of North Slope crude oil conducted at the end of the second day of the Exxon Valdez spill a burn efficiency of 98 percent or better was estimated. Evans et al. (1989) cited experimental burn efficiencies of 50 to 90 percent. These removal efficiencies can be greater than those for other response methods such as skimming.

ISB has been most often considered and tested with crude oil spills. However, its feasibility with other kinds of products (e.g., marine diesel fuel and Bunker C fuel) has been demonstrated (Twardus, 1980). Difficulties with establishing and maintaining necessary slick thicknesses (in the case of lighter oils) and ignition (for heavier oils) make in situ combustion a less viable alternative for those materials other than crude oils.

230 ISB in Relation to Mechanical Methods

Spill prevention is the first line of defense in spill response planning; however, acceptance of the probability that a spill can and will occur is essential to successful preparedness. Burning will be considered as a possible response option only when mechanical containment and recovery response methods are incapable of controlling the spill.

While physical containment and mechanical removal of spilled oil is the first preference of the ARRT and should be the number one objective of response preparedness activities, prudent planning must consider alternatives.

240 Importance of ISB as a Response Tool in Alaska

The use of burning as a response method is important both the coastal and inland zones of Alaska.

The capability to adequately respond to an oil spill in Alaska can be hampered by a number of critical factors including: great distances; severe weather and oceanographic conditions; lack of well developed transportation networks leading to logistical problems in delivering equipment; and inherent limitations of existing mechanical containment and recovery techniques. These factors, combined with the potential to experience catastrophic and subcatastrophic spills from petroleum exploration, production, transportation and storage facilities, require proper use of other tools including chemical, biological, and physical methods such as ISB. These methods should be preplanned and immediately available to responders and governmental officials responsible for ensuring a safe, efficient, and adequate response to spill events.

The Alaska environment supports extremely valuable and often vulnerable populations of birds, mammals, and fish. These habitat areas have commercial, subsistence, and recreational uses essential to the health and welfare of the State's citizens. The application of ISB may provide significant protection for fish, wildlife, and sensitive environments as well as commercial, subsistence, cultural (historic and archaeological), and recreational resources. Implementation of ISB may: (1) prevent these resources from coming into contact with any spilled substances; (2) reduce the size of the spill and thus the amount of spilled substance available to contact natural resources; and (3) allow the environment to recover to the prespill state sooner.

Naturally occurring conditions associated with the Alaska environment often render the preferred physical containment and recovery methods ineffective and unsafe to use. Broken ice conditions are commonly found in the Chukchi and Beaufort Seas, Cook Inlet, and in all of the inland waters of the state's interior. Oceanographic and river conditions such as fast moving currents and turbulent waters create physical barriers that limit the efficiency of physical containment and recovery. Fast changing weather and severe conditions associated with year-round storms and frigid winter conditions impede the performance of traditional recovery methods and place response personnel in hazardous, life threatening conditions.

During worst case situations, alternate response techniques must be available to mitigate the spill's adverse effects. The proper use of ISB at the right time, the right place, and under the right conditions provides a supplemental response method to existing conventional cleanup techniques. ISB use allows response personnel some additional control over the type and location of an oil spill's impact on human health, wildlife and the environment they share.

300 BY-PRODUCTS OF ISB

310 Combustion - General

ISB, as is the case with all burning processes, produces by-products due to incomplete combustion. Complete combustion results in carbon dioxide (CO_2); water; an assortment of other sulfur and nitrogen residues; and other minor compounds such as metals. However, ISB of oil does not achieve complete combustion, and a wide range of intermediate combustion products result. Although the exact mix of burn residues varies considerably, some general observations can be made. By-products can be categorized into three general groups: unburned oil, airborne components, and combustion residues.

320 Airborne Components

Since many of the concerns associated with this method stem from the generation of a large smoke plume, the airborne components of burn by-products have been the subject of intense study in both small-scale and large-scale burn experiments. For example, Evans et al. (1988) monitored the amount of polynuclear aromatic hydrocarbons (PAH's), which are a concern because they are carcinogenic; carbon dioxide (CO2); carbon monoxide (CO), nitric oxide (NO); and other nitrogen oxides (NOx) emitted during ISB.

Evans et al. (1988) determined that 10 percent of the original amount of a crude oil was converted into smoke during combustion, ie. airborne particulate matter. The particulate portion of the smoke was largely comprised of elemental carbon (90%). The primary gaseous product was CO2. CO was present in a concentration about 25 times lower than CO2, and nitrogen oxides were much less prevalent, about 1,000 times lower than the concentration of CO2. Although the suite of PAHs occurring in the smoke was nearly the same as that in the crude oils, the relative proportions were altered by the combustion process. That is, the PAH content of the smoke was enriched in higher molecular weight compounds. Benner et al. (1990) found ISB of oil increased the relative proportion of PAHs with five rings or more by a factor of 10 to 20. They also found that as the thickness of the oil layer increased, the smoke yield increased as well.

Land-based incineration of chemical wastes may result in the production of highly toxic compounds in burn residues, and this potential problem has been studied in test burns of oil. Results from a mesoscale test burn in Mobile Bay, Alabama, in 1991 indicate that oxygenated compounds of concern such as dioxins or dibenzofurans were not produced in measurable quantities during the burning of crude oil on sea water.

330 Unburned Oil

Although ISB has the potential for removing a large proportion of the mass of an oil spill from the surface of the water, some of the source material will not be consumed and will remain as a concern. Researchers at the National Institute of Standards and Technology (Evans et al., 1988) found the oil residue that remained following burn completion varied with the type of oil and the layer thickness. For example, thicker layers of oil on the water resulted in more oil remaining after a burn, and the burning of one type of crude (La Rosa) resulted in slightly more residual oil than with other crude oils (Alberta Sweet, Murban).

The operational implication from this is that some provision will have to be made for cleanup of the unburned product remaining after combustion, and the potential exists for an undefined level of shoreline impacts even with a successful in situ burn.

340 Solid Burn Residues

Similar to the hydrocarbon distribution for smoke, the composition of the residue remaining after a burn is similar to the original oil, but the residue is depleted in volatile hydrocarbons with low boiling points, such as short-chain alkanes, cycloalkanes, and volatile mono-ring aromatic hydrocarbons such as benzene, toluene, and xylene. Density and viscosity of residues are greater than that of unburned oil.

In the controlled test burn during the Exxon Valdez spill, an estimated 15,000 to 30,000 gallons of Prudhoe Bay crude oil was reported to have been burned. Following this burn, about 300 gallons of "stiff, taffy-like burn residue that could be picked up easily" remained (Allen, 1990). Tennyson (1991) commented that the resultant "tar paddy" burn residue had no detectable acutely toxic compounds, and also noted the increase in density of this material relative to the original oil makes prompt collection of residues necessary to prevent impacts from sinking.

Although sinking of burn residues has seldom been observed in test burns, during the 1991 explosion and burning of the tanker Haven off Genoa, Italy, sinking of burned oil residues was observed (Moller, 1992). Reliable estimates of the amount of oil actually burned were not possible, but the tanker was laden with 141,000 tons of Iranian heavy crude, and very little remained in the wreck following the accident and fire. Moller reported that several surveys during 1991 confirmed that sunken oil was present offshore and along the coast. Two mechanisms were identified for the observed sinking: (1) density increases as a result of the combustion of components with burning points less than about 450EC; and (2) the incorporation of sediment grains with oil residues by wave action. This implies that residue recovery efforts would be complicated by the sinking of oil, particularly if it is largely due to the density increase resulting from combustion. Moller has noted that technology for recovering sunken oil is severely limited, with methods confined to relatively inefficient techniques like dredging or suction.

It should be noted that the product involved in the Haven incident was a heavy crude oil, and Moller has recently emphasized that the circumstances specific to this situation should not be used as the basis for generalization in all burning scenarios (J. Michel, Research Planning, Inc., pers. comm.).

400 HUMAN HEALTH AND SAFETY CONCERNS RELATED TO ISB

410 General Toxicological Considerations
(Source: G. Shigenaka, NOAA)

Studies of the effects of oil fire smoke exposure on human health are lacking. As a result, toxicological assessments are indirect and based in large part upon health studies for individual known constituents of oil fire smoke. Moreover, until recently, many assessments have focused on skin exposure, as opposed to the inhalation effects of these compounds. Sharratt and Butler (1992) reviewed literature evaluating the effects of smoke on human health as a result of the Kuwait oil fires following the 1991 war with Iraq. While the Kuwait situation was different from that expected in an ISB incident, many of their comments are relevant. In short, the Kuwait situation offers a real-world example of exposure of a significant human population to smoke from oil fires, and may offer insight into anticipated health concerns from implementation of ISB.

Sharratt and Butler (1992) note that the toxic hazards from inhalation of complex mixtures is dependent on many factors, including: the components present in the air; the concentrations of those components; the extent to which the components interact chemically and physically; the extent to which their toxic activity is independent, additive, or synergistic; the degree, length, and extent of fluctuations in exposure; the depth of penetration of components into the respiratory system; and the sensitivity of the exposed population to the particular mixture. Sharratt and Butler observe that with oil smoke, so many uncertainties exist that assessing the toxic hazard must be conjectural. However, they also note that some insights on possible effects can be extrapolated from available literature. After reviewing toxicological data on organic and inorganic constituents of oil fire smoke, they concluded there was little evidence of significant health risks from respiratory exposure to chemical compounds expected to be found in oil smoke, even from the unique situation in Kuwait.

Interestingly, Sharratt and Butler advise against toxicological studies to clarify potential impacts of oil fire smoke unless a specific question about a specific substance can be answered. They maintain that toxicological studies can raise more questions than answers by generating information difficult to interpret from a human health perspective. As an example, they point out that solvent extracts of smoke will give positive indications of mutagenicity (the ability to cause mutations), but these results are impossible to interpret with respect to the actual health hazard.

Many human health experts feel the most significant human health risk resulting from ISB would be that posed by inhalation of the fine particulate material that is a major constituent of the smoke produced. Early investigations into the health concerns attributable to the Kuwait oil fires (ATSDR, 1991) identified the less than 10 micron particulate matter (PM-10) as representing the greatest health hazard in that situation. It has been well-documented from long-term studies in exposed human populations that PM-10 presents a significant health problem (R. Etzel, Centers for Disease Control, pers. comm.); the extent to which these particles would present a health risk during ISB would be dependent on the nature of exposure, i.e., the concentration and duration which an exposed population experiences.

420 Particulates

Epidemiological experts appear to agree that the greatest health risk posed by emissions from oil fires stems from the particulate matter. This includes both the soot (elemental carbon) and the hydrocarbon particulates (unburned oil). At high concentrations, particulates may burden the respiratory tract. However, it is particulate size that plays the most important role in determining the risk to humans. Particles larger than 10 micrometers (μm) in diameter tend to settle in the environment and generally are not inhaled. Particulates 5 to 10 μm in diameter may be inhaled, but most are deposited in the upper respiratory tract. Only particles smaller than 5 μm in diameter reach the sensitive alveolar portion of the lungs, and of these, the median size is 0.5 μm. Fewer than 0.2 percent of the particulates deposited would be larger than 5 μm in diameter (Wright, 1978). Particles ranging in size from 5 to 10 μm will be deposited along the respiratory tract, and be cleared by mucociliary action, which is efficient and relatively rapid. Clearance of particulates reaching the deeper portions of the lungs is much slower and less efficient. Some would be moved up and cleared eventually by the mucociliary mechanism. Some would be engulfed by macrophages and possibly cleared by this route. Others could be dissolved or would disintegrate. Overwhelming the respiratory tract with respirable particulates will cause breathing difficulties, especially to sensitive individuals. Significantly, the median size of the particulates in the smoke from oil fires is 0.5 μm, which is respirable, and these may reach and settle into the deeper portions of the lungs.

Analysis of oil pool fires in Kuwait determined that combustion was more efficient than expected. Approximately 95 percent of the fuel was converted to CO2, 2 to 3 percent of the fuel was converted to soot (10-12 % had been predicted), and the rest was composed of hydrocarbons and gases (Ferek et al., 1992). The highest concentration of total particulates found in Kuwait was 5.4 mg/m3, at ground level in the plume (Campagna and Humphrey, 1992), and 1.1 mg/m3 of particulates smaller than 3.5 μm in diameter, in the plume of an oil fire (Ferek et al; 1992).

The largest amount of total particulates in the plume during an experimental oil burning was 112 mg/m3 (L.E. Booher, Exxon Co. USA, pers. comm.). At ground level, the highest reading in that experiment was 8.1 mg/m3, 50 ft from the burn basin. The National Ambient Air Quality Standard (NAAQS) for PM-10 is 50 μg/m3 annual mean, and 24 hour average of 150 μg/m3. The U. S. Occupational Safety and Health Administration (OSHA) 8 hour Permissible Exposure Limit (PEL) for total particulates is 15 mg/m3, and 5 mg/m3 for respirable particulates. The U.S. EPA is considering replacing the PM-10 standard with a PM-2.5 standard for particulate matter smaller than 2.5 microns in diameter. This is based on studies which indicate PM-2.5 may be more hazardous to individuals than PM-10.

430 Gases

Carbon monoxide (CO) is a by-product of incomplete combustion. The toxicity of CO stems from its high affinity for the hemoglobin molecule in the red blood cell, which is the carrier for oxygen in the circulatory system. Thus, CO would chemically displace oxygen from the blood and cause oxygen deprivation, which in serious cases may lead to death. Both in Kuwait and in controlled experimental burning, the level of CO was found to be much below levels considered to be dangerous (Ferek et al., 1992; L.E. Booher, Exxon Co. USA, pers. comm.). CO is regulated under the Clean Air Act. The yearly average should not exceed 9 ppm as an 8 hour average, with 1 hour excursion of 35 ppm. The OSHA PEL for CO is 35 ppm for a time-weighted average over an 8 hour workday.

Sulfur dioxide (SO_2) is formed when sulfur in the oil or hydrogen sulfide coming out of a well oxidizes during the combustion process. This gas is toxic and may cause severe irritation to the eyes and respiratory tract. Because of its high solubility, SO_2 usually does not reach the deeper portion of the lungs (Amdur, 1986). The concentration of SO_2 depends on the sulfur content of the oil. Concentrations measured in oil fires and controlled laboratory experiments ranged from a few parts per billion (ppb) to 0.8 parts per million (ppm). Most readings were below 0.1 ppm. The OSHA PEL for an 8 hour workday is 2 ppm. The NAAQS for SO_2 are 0.03 ppm, annual arithmetic mean; 0.14 ppm maximum for 24 hour concentration as primary standards; and 0.5 ppm for 3 hours as secondary standards (40 CFR 50.2).

Nitrogen dioxide (NO_2) is another gaseous by-product of oil combustion. It is reactive, very toxic, and a strong irritant to the eyes and respiratory tract. Nitrogen dioxide, a less soluble gas than sulfur dioxide, reaches the deep portions of the lungs, and even low concentrations may cause fatal pulmonary edema, which is often delayed (Amdur, 1986). The maximum concentration of NO_2 found in the Kuwait oil fires was 0.02 ppm (Ferek et al., 1992). Nitrogen dioxide is a criteria air pollutant and is regulated by the Clean Air Act. The NAAQS for both primary and secondary standards is 0.053 ppm (40 CFR 50.2); OSHA PEL (short term exposure only) is 1 ppm.

440 Polynuclear Aromatic Hydrocarbons

Polynuclear aromatic hydrocarbons (PAHs) are a group of hydrocarbons characterized by several benzene rings. Some members of this group are known or suspected carcinogens. They are found in oil and oil smoke, where their relative concentrations in the latter tend to be higher than in the oil itself. Possible carcinogenicity of some members make this group a serious health concern, although it is generally long-term exposure to the higher molecular weight PAH's that is the basis for concern.

Levels of PAHs found in the Kuwait oil fires at ground levels were in the sub-parts per billion level (Campagna and Humphrey, 1992). Relatively low levels of PAHs have also been recorded in experimental oil burns, with levels in the plume not exceeding 0.09 mg/m^3 of air, which is less than 0.01 ppm. Emission at ground level at those experiments was barely detectable (L.E. Booher, Exxon Co. USA, pers. comm.). The OSHA exposure limit for volatile PAH's is 0.2 ppm.

450 Health Summary

Human health concerns represent the main impediment to operational implementation of ISB. Health considerations rank high on priority lists for decision makers to address in contingency planning, experimental burn experiments, and during actual spill incidents. While information exists permitting a limited assessment of health effects from ISB, the largely indirect nature of these evaluations also emphasizes a need for health-oriented studies during meso-scale or full-scale test burns.

The currently available information suggests that although health concerns exist for exposure to smoke from oil fires, many experts (e.g., Booher, Ferek, Butler, Laursen, Hobbs, and Allen) believe that in most cases the public health risk is relatively small. This assessment, coupled with the likelihood that the lighter fraction of spilled oil will evaporate unless burned, suggests the risk is worth considering.

The following table presents a comparison of pollution standard index (PSI) values with pollutant concentrations, descriptor words, and generalized health effects and cautionary statements. (source: CDC)

COMPARISON OF POLLUTION STANDARD INDEX (PSI) VALUES WITH POLLUTANT CONCENTRATIONS, DESCRIPTOR WORDS, GENERALIZED HEALTH EFFECTS, AND CAUTIONARY STATEMENTS

INDEX VALUE	AIR QUALITY LEVEL	POLLUTANT LEVELS					HEALTH EFFECT DESCRIPTOR	GENERAL HEALTH EFFECTS	CAUTIONARY STATEMENTS
		PM (24-hour) ug/m^3	SO_2 (24-hour) ug/m^3	CO (8-hour) ppm	O_3 (1-hour) ppm	NO_2 (1-hour) ppm			
500	SIGNIFICANT HARM	600	2620	50	0.6	2.0		Premature death of ill and elderly. Healthy people will experience adverse symptoms that effect their normal activity.	All persons should remain indoors, keeping windows and doors closed. All persons should minimize physical exertion.
400	EMERGENCY	500	2100	40	0.5	1.6	HAZARDOUS	Premature onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons.	Elderly and persons with existing diseases should stay indoors and avoid physical exertion. General population should avoid outdoor activity.
300	WARNING	420	1600	30	0.4	1.2			
200	ALERT	350	800	15	0.2	0.6	VERY UNHEALTHFUL	Significant aggravation of symptoms and decreased exercise tolerance in persons with heart or lung disease, with widespread symptoms in the healthy population.	
100	NAAQS	150	365	9	0.12	a	UNHEALTHFUL		Elderly persons with existing heart or lung diseases should reduce physical activity.
50	50 % OF NAAQS	50	80[b]	4.5	0.06	a	MODERATE	Mild aggravation of symptoms in susceptible persons, with irritation symptoms in the healthy population.	
0		0	0	0	0	a	GOOD		Persons with existing hears or respiratory ailments should reduce physical exertion and outdoor activity.

[3]No index values reported at concentration levels below those specified by "Alert Level" criteria. [b]Annual primary NAAQS.

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460 Safety of Personnel

The safety of personnel during both ignition and burn phases of large amounts of combustible liquids on the surface of the water presents some unique safety concerns for workers and response personnel. Many of these concerns are addressed in greater detail in operationally oriented references, and include, but are not limited to, the following:

Fire hazard. ISB is a process that involves setting up fires. Extreme care must be taken to control the fire at all times and to prevent secondary fires from being ignited. Personnel and equipment managing the process must also be protected.

Ignition hazard. Ignition of the oil slick should receive careful consideration. Involvement of aircraft for aerial ignition with gel or other ignition methods must be well coordinated. Weather and water conditions should be kept in mind, and proper safety distances be kept at all times.

Vessel Safety. ISB at sea will involve several vessels, working in relatively close proximity to each other, perhaps at night, or in poor visibility. Such conditions are hazardous by nature, and vessels and crews working in these conditions require a great degree of practice, competence, and coordination.

Other hazards. Personnel involved in ISB may be exposed to extreme heat from the compounded effects of hot weather and fire, or extreme cold in places like Alaska. Working under time constraints may impair judgment or increase the tendency to attempt costly shortcuts. It is important that good and thorough training and strict safety guidelines be part of any ISB operation.

In the test burn during the Exxon Valdez spill, Allen (1990) noted that the area of the burning oil could be easily controlled by adjusting the speed of the towing vessels. At the peak of the burn, when flames extended 45 to 60 meters into the air, and the distance from the stern of each towing vessel was about 200 meters, heat from the fire was noticeable but not uncomfortable or dangerous.

Unique features presented by burn situations necessitate the anticipation of problems and safety concerns prior to implementation of an operational plan. The ISB resource document prepared for the Alyeska Pipeline Company (1992) discusses a number of safety related issues, from notification of potentially exposed public populations to worker safety to vessel and aircraft operations. Recognizing that this effort was tailored to Prince William Sound waters, it nonetheless could provide a basis for the crafting of a region-specific approach to addressing the same issues of safety.

500 POTENTIAL ECOLOGICAL EFFECTS OF ISB

(Source: G. Shigenaka, NOAA)

510 General Concerns

Potential ecological impacts resulting from the use of ISB have not been extensively discussed or studied. As a result, the answers to questions concerning ecological impacts are largely speculative in nature and based on documentation of physical effects in the laboratory and in limited test burns. Recently, the possibility of using the environmental effects of oil well fires, that resulted from the war with Iraq in 1991, as a surrogate for assessing ecological as well as human health impacts of ISB has been proposed. However, investigations by NOAA chemists, among others, determined that the situation in Kuwait was qualitatively different from that which might be expected to result from the burning of an oil spill at sea. In particular, the emissions from the Kuwait oil well fires included a large constituent of unburned crude oil which profoundly influenced the chemical composition of the emissions as well as the nature of physical interactions among airborne constituents by acting as a substrate (C. Henry, Louisiana State University, pers. comm.). In addition, the areal impact in Kuwait, where hundreds of wells were deliberately set ablaze, was much more extensive than would be expected for a controlled ISB arising from a single spill incident.

520 Temperature

Although area effects would presumably be relatively small, burning oil on the surface of the water could adversely affect those organisms at or near the interface between oil and water through elevated temperature impacts.

530 Surface Microlayer

The surface of the water represents a unique and important ecological niche called the surface microlayer, which has been the subject of many recent biological and chemical studies. The microlayer is variously defined but often considered to be the upper millimeter or less of the water surface. This layer is a habitat for many sensitive life stages of marine organisms, including eggs and larval stages of fish and crustaceans, and reproductive stages of other plants and animals. It is known that cod, sole, flounder, hake, anchovy, crab, and lobster have egg or larval stages that develop in this layer. Although most studies of the microlayer have been conducted nearshore, some results suggest that even far off the east and west coasts of North America, eggs and larval stages of fish concentrate at the surface at certain times of the year. For example, Kendall and Clark (1982) found densities of Pacific saury larvae more than 250 miles offshore were equal to or greater than densities nearshore.

The surface microlayer frequently contains dense populations of microalgae, with species compositions distinct from the phytoplankton below the microlayer. Hardy (1986) speculated the surface layer phytoplankton may play an important biogeochemical role by providing biologically mediated high rates of atmospheric carbon dioxide reduction.

The microlayer also is a substrate for microorganisms and as such, is often an area of elevated microbial population levels and metabolic activity. Carlucci and Craven (1986) found microlayer organisms play an active role in the metabolism and turnover of amino acids.

Evans et al. (1988) observed during the peak of the burn period for an experimental combustion of crude oils on water, the water immediately below the oil was brought to a vigorous boil. However, observations during large-scale burns using towed containment boom (Evans et al., 1990) did not give any indication of such an impact on surface waters. It was suggested that because ambient temperature seawater is continually supplied below the oil layer in the case of towed boom in ISB, the residence time of the burning layer over a given water surface may be too brief to induce boiling.

The ecological importance of the surface microlayer and the potential impacts to it from burning activities have been discussed in a different but related context, ocean incineration. The Office of Technology Assessment (1986) noted in an evaluation of the technique, "given the intermittent nature of ocean incineration, the relatively small size of the affected area, and the high renewal rate of the surface microlayer resulting from new growth and replenishment from adjacent areas, the long-term net loss of biomass would probably be small or non-existent."

Despite the obvious differences between shipboard incineration of hazardous wastes and surface burning of spilled oil, the above rationale is applicable for ISB. Accordingly, potential impacts to the ecologically important surface microlayer can, to some extent, be tempered by the presumably ephemeral nature of the burn and its associated residual material.

540 Toxicological Considerations

Beyond the direct impacts of high temperature, the by-products of ISB may be of toxicological significance. Although analysis of water samples collected from the upper 20 cm of the water column immediately following a burn of crude oil yielded relatively low concentrations of total petroleum hydrocarbons (1.5 ppm), compounds that have low water solubility or that associate with floatable particulate material tend to concentrate at the air-water interface (USEPA, 1986). Strand and Andren (1980) noted that aromatic hydrocarbons in aerosols originate from combustion of human origin, and that these compounds accumulate in the surface microlayer until absorption and sedimentation remove them. Higher molecular weight aromatic hydrocarbons, such as those produced by the combustion of petroleum, have been associated with the incidence of histopathological abnormalities (i.e., tumors) and possible reproductive disorders in populations of marine fish. Some of these heavier aromatic hydrocarbons are known carcinogens in humans and other mammals. Not unexpectedly, due to the greater proportion of the heavier molecular weight aromatics in burn residues, Sheppard and Georghiou (1981) found precipitated material from the plume of a control burn of Prudhoe Bay crude oil was mutagenic, an indication of possible carcinogenicity.

Serious pathologies like tumors have generally been associated with longer-term, or chronic, exposures to the hydrocarbons. However, exposures attributable to ISB would likely be short-term and may not result in toxicologically significant exposures.

That the observed density increase that either occurs during the course of a burn, or through the incorporation of sand and other sediment material with viscous residues may cause residues to sink could be a cause for concern from an ecological perspective. As Moller (1992) observed at the Haven spill, residues following the intense burn definitely did sink. Moller discussed this as a problem from a fishing gear and seafood contamination perspective, but large amounts of sunken burn residues could also affect benthic resources of an area that would not otherwise be significantly impacted by a spill at the surface of the water. Moller cited the example of a spill of Arabian heavy crude from the Honam Jade off South Korea in 1983, in which cleanup contractors ignited the main slick, which measured about 3 km in diameter. The fire burned intensely for about 2 hours, and the resultant burn residue sank and adversely impacted crabs being reared in nearby submerged pens.

Burn residues could also be ingested by fish, birds, mammals, and other organisms, and might also be a source for fouling of gills, feathers, fur, or baleen. However, these impacts would be expected to be much less severe than those manifested through exposure to a large, uncontained oil spill. While the possibility remains that contamination at the sea surface or from sinking residues could impact certain unique populations as well as organisms that use surface layers of the water column at certain times to spawn or feed, impacts resulting from alternative actions should be factored into an overall assessment of potential effects and the crafting of response strategies.

A footnote on phytoplankton impacts: Recently, oceanographers studying the interaction of phytoplankton with the cycling of carbon dioxide in the open ocean have postulated that by adding large amounts of iron to the ocean waters, the primary productivity of planktonic plants could be stimulated and additional amounts of carbon dioxide, considered to be a causal agent for the often-discussed "greenhouse effect," could be removed from the atmosphere. Although by no means universally accepted by the oceanographic community, these observations on the potential effect of iron addition to ocean waters raise the question of the potential impact of ferrocene addition during an oil spill and in an ISB situation, i.e., could the use of ferrocene affect phytoplankton populations and possibly cause an unanticipated bloom in a treated area? Based on available information, the answer appears to be "no," for two reasons: first, the amount of ferrocene that would be used for smoke reduction would be very small relative to that necessary to affect phytoplankton populations on a measurable scale; second, ferrocene is insoluble in water (Mitchell, 1990), which precludes it from affecting phytoplankton growth. It is soluble iron that in some situations can limit the photosynthetic activity of plankton (H. Curl, NOAA, pers. comm.).

600 POTENTIAL TRADEOFFS RELEVANT TO ISB

As is the case with all response methods, the environmental tradeoffs associated with ISB are situation dependent and cannot be considered independently from operational tradeoffs. ISB can offer important advantages over other response methods in specific cases, and may not be advisable in others, depending on the overall mix of circumstances.

610 Pro's

ISB has the potential for removing large quantities of oil from the surface of the water with a relatively minimal investment of equipment and manpower.

ISB may offer the only realistic means of removal prior to shoreline impacts in the event of an oil spill resulting in large amounts of product on the water, where containment and storage facilities may be overwhelmed, or in remote or inaccessible areas.

ISB may prevent or significantly reduce the extent of shoreline impacts, including exposure of sensitive birds, mammals, and the oiling of high value recreational or commercial beaches if properly planned and implemented.

Control of burn activities on water is relatively simple, provided containment is appropriate, and the burning is occurring safely and is separated from the source of the spill. A burn may be extinguished by removing the containment boom and allowing the oil to spread, thus reducing the thickness of the slick below the minimal amount required to sustain a burn.

620 Con's

The ISB method, when employed in its simplest form, generates large quantities of highly visible black smoke that may adversely affect human and other exposed populations downwind.

Burn residues may sink, resulting in decreased recovery efficiency and the potential exposure of benthic organisms.

There may be mortalities and other adverse biological impacts from the localized temperature elevations at the sea surface. Although these could be expected to occur over a relatively small area, in specific bodies of water at specific times of the year, affected populations may be large enough or important enough to represent reasons for not considering burning as a cleanup technique.

The longer-term effects of burn residues on exposed populations of marine organisms have not been investigated, and it is not known whether these materials would represent a significant source of toxicity.

ISB must be carefully controlled in order to maintain worker safety and to prevent unintended environmental impacts. It is important to note that an ISB in broken ice is not easily extinguished once started.

There is a relatively short window of opportunity to use burning after a spill occurs prior to the oil weathering and losing its flammable characteristics.

700 OPERATIONAL CONSIDERATIONS FOR CONDUCTING ISB

710 Minimal Conditions/Limitations for Effective Burning

711 Heat

Fire must be kept hot enough to sustain combustion. The heat produced by the fire must equal the heat required to maintain vapor flow back to the fire (USEPA, 1991). According to Buist (1987), an oil slick continues to burn until its thickness reaches some minimum value (see subsequent discussion in this section), at which point the heat loss to the water uses all the heat to the slick from the flame above it.

712 Thickness

Thicker layers of oil are easier to ignite and sustain. Research on ISB has determined that combustion of an oil slick is sustained as long as the slick is some minimum thickness. This threshold thickness has been reported to range from 0.8 mm (Buist, 1987) to 3 mm (Tennyson, 1991). Twardus (1980) found that the thicknesses necessary for successful ignition of oil slicks increased with the state of weathering and viscosity of oils. For example, the minimum ignitable thickness for Bunker-C fuel oil was estimated to be 10 mm.

A summary produced by the USEPA (1991) noted the variation in burn efficiency with slick thickness: with a slick of 10 mm thickness, approximately 80 to 90 percent of the oil is burned; with a slick of 100 mm thickness, approximately 98 to 99 percent is burned. This consideration implies that in many situations, spilled oil must be concentrated by some means of containment to prevent spreading and the resultant thinning of surface layers. In the case of oil spills in cold weather environments, naturally occurring ice may offer sufficient containment to permit ISB. Under open water conditions, containment is usually accomplished through the use of fire-resistant boom material, which resembles standard containment booms but is constructed with high temperature materials such as ceramics (Allen and Fischer, 1988).

713 Effects of Weathering

Weathering decreases ignitability and combustibility. A study of the effects of weathering and the formation of water-in-oil emulsions on burning was performed by Hossain and MacKay (1981). They found weathering resulted in loss of volatile compounds, more difficult ignition, slower combustion, and surprisingly, in some cases, a higher proportion of oil burned. Percent weathering (i.e., evaporation) up to about 20 percent appeared to not affect the burn efficiency of crude oil. Between 20 and 35 percent, weathering increased the efficiency beyond which efficiency declined.

Twardus (1980) found that despite the loss of most volatile hydrocarbons in crude oil during the first 2 days of aging, in situ combustion of weathered oil was still possible (Twardus primed the burn of a crude oil slick aged for 4 weeks with the addition of fresh crude oil.).

714 Effects of Emulsification

Emulsification decreases ignitability and combustibility. Norwegian research efforts cited by Bech et al. (1992) noted that oil at sea tends to emulsify, and after 1 day the water content of emulsifications can be as high as 70 percent. Bech et al. found that the burning of oil/water emulsions differed from the burning of unemulsified oil, and because the formation of emulsions can be expected to be a common event, its consideration as a variable ISB is important. According to Bech et al., the controlling factor in the combustion of emulsions is the removal of water, which is accomplished either through the boiling of the water out of the emulsion, or by breaking the emulsion thermally or chemically.

715 Efficiency

Although the efficiency or the ability of burning to reduce the volume of oil spilled by ISB is highly dependent on a number of physical factors, test burns and applications in actual spill situations suggest that it can be very effective in reducing large quantities of oil from the water. Reported burn efficiencies are mentioned in Section 220.

ISB has been most often considered and tested with crude oil spills. However, its feasibility with other kinds of products (e.g., marine diesel fuel and Bunker C fuel) has been demonstrated (Twardus, 1980). Difficulties with establishing and maintaining necessary slick thicknesses (in the case of lighter oils) and ignition (for heavier oils) make in situ combustion a less viable alternative for those materials than for crude oils.

720 Ignition

If ISB is to be used as a response method, the spilled oil must be ignited. Considerations of safety and efficiency necessarily enter into this discussion. Several methods have been used to experimentally and operationally ignite oil slicks. These include pyrotechnic igniters, laser ignition systems, and aerial ignition systems. Pyrotechnic devices have been successfully used to ignite floating oil slicks under a range of environmental conditions. Disadvantages to their use are associated with safety, shelf life, availability, speed of deployment, and cost (Spiltec, 1987). Laser ignition, while a promising technique, remains experimental in nature with drawbacks associated with difficulties in beam focusing from the air, wind effects during oil preheating, energy requirements, and cost. Aerial ignition systems using gelled gasoline dropped from helicopters appear to be a more viable technique applicable in a range of environmental conditions.

In the Exxon Valdez test burn, gelled gasoline was used as the ignition source. However, concerns about using an aerial "Helitorch" gelled gasoline system after dark motivated a switch to a handheld ignition device (Allen, 1990). A "small plastic bag" of gelled gasoline was ignited and allowed to float back into the contained crude oil, and while it took some time to fully ignite the entire slick surface, the method was ultimately successful in igniting the oil contained within the fire resistant boom.

Twardus (1980) and Buist (1989) found that combustibility of a given crude oil was reduced with increasing emulsification with water. ISB of water/oil emulsions was found to be possible, with mixtures of up to 20-percent water easily ignited by match. However, emulsions with a higher water content required a much stronger ignition source (i.e., a flame with a minimum diameter of 0.5 m) in order for the flame to spread over the slick surface. An emulsion of Lloydminster crude oil with a 50 percent water content foamed during combustion attempts to the extent that burning was not possible, even when primed with fresh crude oil.

Bech et al. (1992) tested gelled gasoline as an igniter, and found that while it worked with many combinations of weathering and emulsification, there were limitations that required alternative igniter mixtures. These included gelled diesel, and liquid and gelled crude oil. The alternative ignition mixtures burned hotter than did the gelled gasoline (2000EC for crude oil vs. 1000EC for gasoline), and thus were able to ignite more combustion-resistant oils. They listed three critical properties for an igniter for emulsions: (1) it must burn long enough and with sufficient heat to create an oil layer on top of the emulsion; (2) the igniter must create an oil layer that is thick enough to burn and ignite the emulsion layer; and (3) the igniter must ignite oil in an area large enough to ensure a self-sustaining burn.

730 Summary of Conditions for Effective Burning

While a number of variables may affect the success of a burn, oil thickness and emulsification may be the most limiting factors. A minimum oil thickness is required to light the slick. In addition, the efficiency of a burn is largely a function of the oil thickness and increases with slick thickness (Buist, 1989). In general, large oil pools burn more efficiently than small pools. Water content is probably the second most influential variable affecting the ignition and efficiency of the burn. In a series of small-scale test burns, Buist (1989) concluded that for a given thickness of oil, ignition times increased only slightly with weathering but increased dramatically with emulsification. In the same experiments, water content also had a greater effect on oil removal efficiency than weathering. Allen (in prep.) states it is reasonable to assume that if the water content of an emulsified oil reaches the 30 to 50 percent level, the chances are very great that the successful ignition will require large ignition areas (e.g., achievable with Helitorch mode of ignition), the use of special wicking agents or promoters of ignition, or the use of chemical de-emulsifiers. Fingas and Laroche (1991) state that current research indicates oil type and water content have only a marginal effect on efficiency provided the oil can be ignited. If ignited, a large pool of oil will burn at a rate of 2 to 3 mm per minute, a rate not significantly altered by oil type, weathering, and water content.

Table 2
A Summary of Conditions for Effective Burning of North Slope Crude Oil.

Conditions for Effective Burning	
Oil Thickness	Ë 2-3 mm required for ignition. Ë Efficiency (% of oil removed) increases with thickness.
Weathering:	Ë Relatively fresh, less than 2-3 days of exposure, best for ignition; difficulty of ases with further weathering.
Emulsification:	Ë < 25% water content for optimal ignition and efficiency. Ë Ease of ignition and removal efficiency decreases with increasing water Ë Emulsified oil with a water content over 75% is nearly impossible to ignite onal ignition systems.
Wind:	Ë < 20 knots desired for ignition.
Waves:	Ë < 3 ft. in choppy, wind driven seas (short period waves, < 6 seconds). Ë < 5.7 ft. in large swells (long period waves, > 6 seconds). Ë Waves primarily impact booming effectiveness by splash-over.
Currents:	Ë < 0.75 knots relative velocity between the boom and the water.
Ice:	Ë Variable effects depending upon geometry. Ë High efficiencies possible where ice prevents the spreading of oil. Ë Isolated floes may interfere with booming operations.

Source: Alyeska Resource Document VII.

Note - weathering times vary among crude oil types.

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PART II: ISB REVIEW CHECKLIST

Upon receipt of an Application for ISB, included as Part III of these guidelines, the OSC staff will immediately initiate a review. The review will be conducted by OSC staff assigned to the Unified Command and include both Federal and State representatives. The application will be reviewed using this Review Checklist, Background included as Part I, and other resources as may be necessary. There are four basic steps the OSC must work through to determine if burning may be approved in accordance with these guidelines. OSC as used in these guidelines includes both the Federal and State On Scene Coordinators. The review Steps are as follows:

STEP ONE - **EVALUATION**
STEP TWO - **FEASIBILITY**
STEP THREE - **ACCEPTABILITY**
STEP FOUR - **AUTHORIZATION AND CONDITIONS**

Each of the four steps is described in detail on the following pages.

STEP ONE - EVALUATION

In this step the OSC determines the need for ISB by evaluating the response measures being deployed or the potential options that may be viable under the spill circumstances. There must be a full evaluation of mechanical containment and recovery operations and the capability to determine if mechanical options are feasible, adequate, and available.

The following STEP ONE checklist includes the criteria which should be reviewed to evaluate the need for burning.

If the mechanical containment and recovery option is not sufficient or feasible, than the OSC may consider the use of burning and proceed with STEP TWO.

Nature, Size, and Type of Product Spilled:

A. Name of incident:____

B. Date and time of incident: Month/Day/Year__________ Time________

C. Incident: Grounding_____ Transfer Operations_____ Explosion _____
Collision_____ Blowout_____ Other________________________________

D. Did source burn? Yes___ No___
Is source still burning? Yes___ No___

E. Spill Location: Latitude____________ Longitude____________

F. Distance (in miles) and direction to nearest land:__________________

G. Nearest human use area:_________ Nearest Class I Airshed: ___________

H. Product released: North Slope Crude____ Cook Inlet Crude____
Chevron Residual____ Diesel #2____ JP4____ Other__________________

I. Product easily emulsified? Yes____ No____

J. Product already emulsified? No____ Light emulsion (0-20%)____
Moderate emulsion (21-50%)____ Heavy emulsion (>51%)____ Unknown____

K. Estimated volume of released product: gals____ bbls____

L. Estimated volume of product potentially released: gals____ bbls____

M. Release status: Continuous____ Intermittent____
One time only, now stopped____
If continuous or intermittent, specify rate of release: gals____ bbls___

N. Estimated water surface covered (square miles):__________________________

Weather and Sea Conditions:

A. Weather: Clear____ Partly Cloudy____ Overcast____ Rain____ Snow____ Fog____
24-hour projection: _______
48-hour projection: __________

B. Wind Speed: _______knots Direction (from):___________
24-hour projection: _____knots Direction (from)___________
48-hour projection: _____knots Direction (from)___________

C. Stability Class: A___ B___ C___ D___ E___ (see stability class table in STEP FOUR)

D. Tidal State: Slack tide____ Incoming (flood)____ Outgoing (ebb)____

E. Dominant current, (set, drift): Speed__________knots Direction (from)_____

F. Sea state: Calm____ Choppy____ Swell____ Waves: <1ft___ 1-3ft___ >3ft___
24-hour projection: ___________
48-hour projection: ______________

G. Ice Present: Yes____ No____ Percent coverage: <10%____ 11-30%____ 31-50% ____
51-100%____

Spill Trajectory:

A. Estimated trajectory (see attached chart/map):

B. Expected area(s) and time(s) of landfall:____

Evaluation of Response Operations:

A. Is mechanical cleanup alone adequate to control the spill, considering spill size, forecasted weather and trajectories, amount of available equipment, time to deploy, and time to recover? Yes____ No____

B. Has dispersant use been fully evaluated? Yes____ No____

C. Why is ISB preferred? (provide a brief explanation)

D. Will ISB be used in addition to mechanical recovery and/or dispersant use? Yes____ No____

E. Will ISB be used instead of mechanical recovery and/or dispersant use? Yes____ No____ (If so, provide a brief explanation)

C. Estimated percent naturally dispersed and evaporated within first 24 hours:

STEP TWO - FEASIBILITY

In this step the OSC must evaluate if the operational considerations and physical conditions associated with the spill are conducive to burning. The following STEP TWO checklist includes the criteria to be reviewed and considered to evaluate the feasibility of ISB.

The OSC may proceed to STEP 3 if the OSC determines that burning is both preferred and feasible.

Weather, Sea, and Oil Conditions:

A. Wind: <20 Knots? Yes___ No___

B. Waves: <3 feet in choppy wind driven seas? Yes___ No___
<5.7 feet in large swells? Yes___ No___

C. Currents: <0.75 knots relative velocity of boom/water Yes___ No___

D. Visibility: Sufficient to see oil, vessels towing boom, and suitable for aerial overflight for burn observation? Yes___ No___

E. Oil Condition:
1. Fresh oil, < than 2-3 days exposure: Yes___ No___
2. >2-3 mm (0.1 inch) thickness: Yes___ No___
3. < 25% water content for optimal ignition: Yes___ No___

Equipment and Personnel:

A. Vessels, fire boom, residue containment equipment available? Yes___ No___
Vessels equipped with appropriate fire fighting gear? Yes___ No___

B. Aircraft(s) for ignition and aerial observation available? Yes___ No___
(Flight requirements for daylight hours; visibility >1 mile; ceiling >500 feet; FAA certified for helitorch)

C. Ignition System:
1. Available? Yes___ No___
2. Type/method to be used? __________________________
3. Burn promoters? Yes ____ No_____

D. Personnel properly trained, equipped with safety gear, and covered by site safety plan addressing burning operations? Yes___ No___

E. Communications System available to communicate with aircraft, vessels, and control base available and working? Yes___ No___

Burn Plan:

A. Proposed burning strategy (circle appropriate responses):

1. Ignition away from source after containment and movement to safe location, ie., controlled burn;
2. Immediate ignition at or near source without controls;
3. Ignition of uncontained slick(s) at a safe distance from the source.

B. Estimated amount of oil to be burned in boom, expressed in sq. ft.:

C. Estimated duration of burn in minutes:_________________

D. Are simultaneous burns planned? Yes___ No___
If yes, how many? _________

E. Are sequential or repeat burns planned (not simultaneous)? Yes___ No___

F Method for terminating the burn:
____
____
____
____

G. Proposed method for ignition:
____
____
____

H. Ability to collect burned oil residue: Yes___ No___

I. Estimated smoke plume trajectory (miles): ________________

STEP 3 - ACCEPTABILITY

In this step the OSC must evaluate the proposed location, size, number, and anticipated duration of the burning activity and consider downwind/surrounding areas for human presence that could be affected by the burn emissions. Using this information and a downwind distance provided by air modeling, the OSC must determine if atmospheric conditions will disperse the particulate emissions to a concentration of below 150 micrograms per cubic meter before it impacts human population areas.

To assist the OSC in determining what a "safe distance" is for burning operations, the ARRT with funding from the State of Alaska, consulted with nationally recognized experts employed by the U.S. Department of Commerce, and the National Institute of Standards and Technology (NIST), who have developed a computer model that predicts anticipated particulate air emissions for an ISB on open water.

The distances established in these guidelines are based on a predictive model for particulate matter less than 10 microns (PM-10) in size. PM-10 was selected as the basis for determining safe downwind distances because it:

(1) reflects the size of particulates which present the greatest human health hazard;

(2) is an established standard; and,

(3) is thought to be an acceptable surrogate for assuming safe levels for PAH's, metals, gases, and other combustion by-products sometimes known as "air toxics."

The model, developed by NIST to support these guidelines, is based on flat terrain using heat emission factors for two types of Alaska crude (Cook Inlet and North Slope), typical meteorological conditions for Cook Inlet and the North Slope, and known burn area sizes of 2,500 sq. ft., 5,0000 sq. ft. and 10,000 sq. ft. The model is in the developmental stage, and the principal investigators have recommended a safety factor of 2X to account for uncertainties. Additional work is being pursued to validate the model, modify it to accommodate complex terrain, and verify that PM-10 is an acceptable indicator for safe levels of other combustion by-products as well as installing it in Alaska. These guidelines will be updated to reflect the result of any future work.

Based upon the finding of the NIST report "Smoke Plume Trajectory from In Situ Burning of Crude Oil in Alaska," the ARRT has set a worse case, conservative downwind distance of 10 kilometers or approximately 6 miles as the primary value for "a safe distance" to conduct burning operations away from the human populations. If a small number of people are initially present within the "safe distance" and they can be evacuated/relocated prior to burning in accordance with the controls discussed in STEP FOUR burning may proceed. For the purposes of these guidelines, one or more members of the general public, who are not spill responders under the control of the unified command and protected by a spill-specific worker safety plan is considered to be a human presence.

This distance may be modified (decreased or increased) after evaluating spill specific data such as location of spill, type of oil, and stability class of current meteorological conditions. If the burn involves either Cook Inlet or North Slope Crude and is located on the North Slope or in South Central Alaska, i.e., Cook Inlet/Prince William Sound, values from Table 9 of the NIST report, which presents a summary of smoke trajectory runs, may be utilized with a safety factor of 2X. Table 9 is included as an attachment to this review checklist.

After additional information is gathered from actual burning operations, this value may again be modified (increased) to account for specific weather and burn conditions that are influencing the dispersion of emissions. Increasing the downwind distance may be required if the smoke plume does not dissipate in a direction and space anticipated by the model.

Once the OSC has evaluated STEP THREE considerations and has determined ISB is acceptable, STEP FOUR provides the final conditions and considerations for authorizing a burn in accordance with these guidelines.

The following STEP THREE checklist includes the criteria that should be reviewed and considered to evaluate the acceptability of burning.

Evaluation of Anticipated Emissions:

A. Using a section of an appropriate chart, plot, calculate, and determine the following locations and distances:

1. Location of proposed burn in reference to source;

2. Location of proposed burn in reference to nearest ignitable oil slick or slicks;

3. Location of proposed burn in reference to nearest land;

4. Location of nearby human habitation/use areas (e.g., towns/villages, fishing/recreation, camps/airports/strips, roads, etc.);

5. Distance between burn and nearest land;

6. Distance between proposed burn and spill source;

7. Distance between burn and human habitation/use area;

8. Surface area of the proposed burn or burns;

9. Effects on airports from impairment of visibility.

10. Will the topography of the nearest land invalidate the flat-terrain assumption used to determine the safe distance in Table 9

B. Consider (if applicable) the risk of accidental (secondary) fires:

C. Can burning be conducted in a controlled fashion? Yes___ No____

D. Using a distance of 6 miles (or an alternate value from Table 9 attached to this ISB review checklist) with the forecasted wind direction, plot the estimated smoke plume with particulate concentration >150 ug/cubic meter

E. Determine if the anticipated smoke plume will disperse as predicted in Table 9.

Determination of Acceptability:

A. Does the estimated smoke plume with particulate concentration >150 ug/cubic meter impact a populated area? Yes ___ No ___

If No, burning is acceptable. Proceed to STEP FOUR. If Yes, continue with B.

B. Can the impacted population be temporarily relocated prior to burning? Yes ___ No ___

If Yes, initiate warning or evacuation and authorize burning AFTER population is protected. Proceed to STEP FOUR. If No, do not authorize burning.

STEP FOUR - AUTHORIZATION AND CONDITIONS

In this step the OSC must evaluate the manner in which burning will be conducted and determine the conditions which are necessary. The conditions will become part of the authorization issued in this step.

The following STEP FOUR checklist includes the criteria which should be reviewed and evaluated to issue an authorization to conduct ISB.

Forecasted Weather Conditions:

Prior to authorizing any ISB, the National Weather Service (NWS) shall be called to obtain current and forecast weather data, wind speed and direction, and determine the atmospheric stability class. These data will be used to anticipate the area where a smoke plume will drift and disperse. The stability class is a rating of atmospheric stability based on wind speed and insolation. Incoming solar radiation is estimated from the sun angle, time of year, and cloud cover. A description of stability class is shown in the following table.

From this table, Class A is the most unstable, Class F is the most stable, and Class D is considered neutral.

STABILITY CLASS TABLE

Surface Wind Speed (knots)	Day			Night[a]	
	Incoming Solar Radiation			> 50% Cloud Cover	< 50% Cloud Cover
	Strong	Moderate	Slight		
<4	A	A-B	B	E	F
4-7	A-B	B	C	E	F
7-11	B	B-C	C	D[b]	E
11-13	C	C-D	D	D	D
>13	C	D	D	D	D

[a]Night refers to the period one hour before sunset to one hour after sunrise. Choose D stability if the sky is completely overcast, regardless of wind speed or whether it is day or night.

[b]D for complete overcast conditions during day or night.

Source: (Turner, 1970)

Trial Burn:

A trial burn consisting of one fire-resistant boom full of oil shall be initially authorized to confirm anticipated plume drift direction and dispersion distances downwind. All burn authorizations, including a trial burn, shall be granted in accordance with these guidelines (specifically the use of STEP ONE through STEP FOUR).

The resulting smoke plume shall be monitored by aerial observation performed by representatives from lead government agencies responsible for monitoring or directing the response (e.g., for coastal, USCG and ADEC; for inland, EPA and ADEC). The purpose of this monitoring is to ensure the resulting smoke plume is visually comparable to the anticipated emission pattern (i.e., size, direction of drift, and dispersion). If the plume does not travel in a consistent downwind direction as anticipated, then the 6 mile downwind distance shall be expanded to the area of a circle centered at the burn with a radius of 6 miles extending in all directions.

Continued Authorization:

After evaluating the results of the initial test burn, decisions to continue authorization or prohibit/limit future ISB shall be decided by the Federal and State OSCs.

Burn Extinguishment Measures:

Should a burn be authorized by the OSC a method for terminating the burn and extinguishing the fire shall be available for use, with sufficient means of communications to response workers who will implement the procedures. For burns in broken ice, this control is not practicable; therefore, OSC's shall authorize ISB occurring in broken ice in locations located at least 6 miles away from human presence and under appropriate weather conditions that will ensure dispersion of harmful concentrations of particulates before reaching a populated area. An alternate value from Table 9, attached to this review checklist, may be used if the size of the burn is comparable to the sizes listed in the table and a safety factor of 2X is utilized.

Secondary Operational Controls:

Secondary operational controls are those conditions that would be imposed to assure a burn could be conducted safely in an area near or adjacent to existing human populations or human use areas. These controls may include one or more of the following:

PUBLIC NOTIFICATIONS/WARNINGS

LEVEL 1. Initiation of a public notification/warning that burning is occurring and the area is to be avoided (examples include radio/TV broadcasts, road closures, marine safety zones, and broadcasts to mariners, etc.). Such notification is IMPLEMENTED FOR ALL BURNS.

LEVEL 2. Initiation of a public notification/warning involving a medical alert to persons with existing conditions that put them at risk to air quality degradation. Such notification is IMPLEMENTED WHEN AIRBORNE PM-10 levels are anticipated to EXCEED ESTABLISHED National Ambient Air Quality Standards in an area with human presence (Note: if the OSC authorizes a burn in accordance with the guidelines, using a "safe distance," than this warning should not be necessary but is included as a contingency if the plume does not dissipate as modeled.).

LEVEL 3. Initiation of a public notification/warning with in-place sheltering instructions for a specified period of time. Such notification is IMPLEMENTED UPON THE DISCRETION OF THE OSC AS APPROPRIATE or when modeled air emission patterns indicate a PM-10 level greater than State air quality alert/warning levels (Note: if the OSC authorizes a burn in accordance with the guidelines, using a "safe distance," than this warning should not be necessary but is included as a contingency if the plume does not dissipate as modeled.).

LEVEL 4. Initiation of a public notification/warning to evacuate the area temporarily. Such notification is IMPLEMENTED UPON THE DISCRETION OF THE OSC AS APPROPRIATE. This is the most stringent and extreme measure of public notification/warning and is only anticipated to be used to relocate a small number of people for a short period of time (i.e., fisherman, hunters, rural residents, offshore platform operators, pump station or highway camp personnel, etc.). The authority to order such an evacuation is vested in local government or State officials if no local government exists.

Note: For these types of warnings to be effective, involvement of local government or State emergency service personnel with access to established public warning systems and authority to use them to issue warning is necessary. It is expected that contingency planners using these guidelines will involve these individuals in developing plans to burn before an incident and utilize a unified command system during a spill to coordinate and activate plan provisions.

Operational Controls Required for all Burns:

A. Forecasted weather, winds, and atmospheric stability class obtained? Yes ___ No ___

B. Trial burn conducted, observed, and anticipated smoke plume behavior confirmed? Yes ___ No ___

C. Safe downwind distance validated, or expanded if winds are inconsistent with anticipated forecast?
Yes ___ No ___

D. Burn extinguishment measures in place and available? Yes ___ No ___

E. Level 1 Public Notification (e.g., radio broadcast to public, safety zone broadcast to mariners, road closure, etc.). implemented? Yes ___ No ___

F. Provisions to initiate Level 2, 3, or 4 notifications/warnings available (if appropriate)? Yes ___ No ___

Authorization and Conditions:

Time and date STEP ONE through FOUR review completed with all required controls/conditions. ____

A. ____Do not conduct ISB

B. ____ISB may be conducted in limited or selected areas (see attached chart)

C. ____ISB may be conducted as requested in STEP THREE

Conditions:

Signature of Federal On-Scene Coordinator:

Printed Name of Federal On-Scene Coordinator:

Signature of State On-Scene Coordinator:

Printed Name of State On-Scene Coordinator:

Time and Date of Decision:

Table 9: Summary of NIST Smoke Plume Trajectory Model Runs. Distance to 150 μg/m3 Particulate Concentration Level.

Location	Season	Stability Class	Wind Speed (knots)	150 μg/m3 (miles/km)	Factor X2
Burning Area of 232 m2 (2500 ft2)					
Cook Inlet	Summer	C	8	<0.6 / <1.0	<1.2 / <2.0
Cook Inlet	Summer	D	16	<0.6 / <1.0	<1.2 / <2.0
Cook Inlet	Summer	D	23	0.9 / 1.5	1.8 / 3.0
Cook Inlet	Winter	C	8	<0.6 / <1.0	<1.2 / <2.0
Cook Inlet	Winter	D	16	<0.6 / <1.0	<1.2 / <2.0
Cook Inlet	Winter	D	23	1.2 / 2.0	2.4 / 4.0
North Slope	Summer	C	8	1.5 / 2.5	3.0 / 5.0
North Slope	Summer	D	16	1.8 / 3.0	3.6 / 6.0
North Slope	Summer	D	23	1.5 / 2.5	3.0 / 5.0
North Slope	Winter	C	8	1.8 / 3.0	3.6 / 6.0
North Slope	Winter	D	16	2.4 / 4.0	4.8 / 8.0
North Slope	Winter	D	23	1.5 / 2.5	3.0 / 5.0
Burning Area of 465 m2 (5000 ft2)					
Cook Inlet	Summer	C	8	<0.6 / <1.0	<1.2 / <2.0
Cook Inlet	Summer	D	16	<0.6 / <1.0	<1.2 / <2.0
Cook Inlet	Summer	D	23	0.6 / 1.0	1.2 / 2.0
Cook Inlet	Winter	C	8	<0.6 / <1.0	<1.2 / <2.0
Cook Inlet	Winter	D	16	<0.6 / <1.0	<1.2 / <2.0
Cook Inlet	Winter	D	23	1.2 / 2.0	2.4 / 4.0
North Slope	Summer	C	8	0.6 / 1.0	1.2 / 2.0
North Slope	Summer	D	16	2.4 / 4.0	4.8 / 8.0
North Slope	Summer	D	23	2.4 / 4.0	4.8 / 8.0
North Slope	Winter	C	8	3.0 / 5.0	6.0 / 10.0
North Slope	Winter	D	16	3.0 / 5.0	6.0 / 10.0
North Slope	Winter	D	23	2.7 / 4.5	5.4 / 9.0
Burning Area of 930 m2 (10,000 ft2)					
Cook Inlet	Summer	D	16	<0.6 / <1.0	<1.2 / <2.0
Cook Inlet	Winter	D	16	1.2 / 2.0	2.4 / 4.0
North Slope	Summer	D	16	1.2 / 2.0	2.4 / 4.0
North Slope	Winter	D	16	4.2 / 7.0	8.4 / 14.0

PART III: APPLICATION FOR ISB

I. APPLICANT: (Name of responsible person, title, company, address, phone, fax)

____
Printed Name of Requestor

____
Title of Requestor

____
Requestor Affiliation

____
Requestor Address

____
Phone and Fax numbers (if applicable)

____
Time and Date Application Submitted to OSC

II. EVALUATION OF ISB: (provide a brief explanation including why mechanical recovery is not feasible)

____
____
____
____
____
____
____
____

III. PROPOSED BURN PLAN: (describe the plan for burning)

A. Proposed burning strategy (describe strategy and circle appropriate response)

1. Ignition away from source after containment and movement to safe location, i.e., controlled burn:
2. Ignition at or near source without controls:
3. Ignition of uncontained slick(s) at a safe distance from the source:

B. Estimated amount of oil to be burned in boom, expressed in sq. ft.:______________

C. Estimated duration of burn in minutes:_________________

D. Are simultaneous burns planned? Yes___ No___
If yes, how many? _________Specify locations:____

E. Are sequential or repeat burns planned (not simultaneous)? Yes___ No___

F. Method for terminating the burn:____
____
____
____
____

G. Proposed method for ignition:____
____

H. Ability to collect burned oil residue? Yes___ No___

I. Estimated smoke plume trajectory (in miles): _________________

IV. EQUIPMENT AND PERSONNEL: (describe the vessels, aircraft, ignition system, personnel, and communications that will be used to conduct the burning)

A. Describe types of vessels, lengths of fire boom, and types of residue containment equipment to be used:
____
____
____
____
____
____
____
____

B. Are vessels equipped with appropriate fire fighting gear? Yes___ No___
Provide a brief description of fire fighting capabilities:
____
____
____
____

C. Describe aircraft(s) to be used for ignition and aerial observation:
____
____
____
____
____
____
____
____

D. Ignition System:

1. Available? Yes___ No___
2. Type/method to be used? ________________________
3. Burn Promoters? Yes ____ No_____

E. Are personnel properly trained, equipped with safety gear, and covered by a site safety plan addressing burning operations? Yes___ No___

Provide a brief description of available safety gear and certify that a safety plan that specifically addresses the proposed burning operations has been developed and implemented.

Safety equipment available:

____
____
____
____
____

I certify that a comprehensive site safety plan for this specific incident has been developed to specifically address the proposed burning operations and that affected response workers have read the plan and are familiar with its requirements.

___________________________________ ____________________

Signature Date

F. Are communications systems available to communicate with aircraft, vessels, and control base available and working? Yes___ No___

V. EVALUATION OF ANTICIPATED EMISSIONS: (determine and evaluate the effects of burning)

A. Using a section of an appropriate chart, plot, calculate and determine the following locations and distances:

1. Location of proposed burn in reference to source;

2. Location of proposed burn in reference to nearest ignitable oil slick or slicks;

3. Location of proposed burn in reference to nearest land;

4. Location of nearby human habitation/use areas, (e.g., towns/villages fishing/recreation camps, airports/strips/roads etc.);

5. Distance between burn and land, or non-flat terrain;

6. Distance between proposed burn and spill source;

7. Distance between burn and human habitation/use area;

8. Surface area of the proposed burn or burns;

9. Effects on airports from impairment of visibility.

B. Describe (if applicable) the risk of accidental (secondary) fires:_______________________________________

C. Can burning be conducted in a controlled fashion? Yes___ No____

VI. BURN EXTINGUISHMENT CONTROLS: (provide a brief description of the ability and procedures available to extinguish the burn if necessary or directed to do so)

____
____
____
____
____
____
____

____
SIGNATURE OF APPLICANT

Rev. 5/94

APPENDIX III- Technology Protocols Appropriate for the State of Alaska

(Note: This appendix provides technology protocols appropriate for the State of Alaska as developed by the Hazardous Substance Spill Technology Review Council. The inclusion of these protocols in the Unified Plan does not necessarily represent approval or endorsement by the ARRT, Science and Technology Committee, or **ALL** Federal agencies that are members of the ARRT.)

TAB A: INTRODUCTION

In 1990, the Sixteenth Legislature reviewed issues related to response actions and planning involved in the release or threatened release of oil or a hazardous substance. One of the outcomes of that review was the establishment of Title 46, Chapter 13, which founded the Alaska State Emergency Response Commission (SERC) and the Hazardous Substance Spill Technology Review Council (HSSTRC). AS 46.13.100 indicates that the legislature "(1) finds and declares that there exists a lack of scientific knowledge concerning the availability, properties, and effectiveness of various hazardous substance containment and cleanup technologies; and (2) concludes that it is in the best interest of the state and its citizens to establish a Hazardous Substance Spill Technology Review Council...to assist in the identification of containment and cleanup products and procedures for arctic and sub-arctic hazardous substance releases and make recommendations to the departments and agencies of the state regarding their use and deployment".

As a consequence of this conclusion, AS 46.13.120 mandates that the Council establish testing protocols to be used by the Department of Environmental Conservation to evaluate the effectiveness of hazardous substance spill technologies for use in the state. Prior to developing testing protocols, the Council recommended to staff the need to research the status of protocol and standards development on a national and international level. The staff's finding on testing protocol/standards development are:

1. The American Society for Testing and Materials (ASTM) established the F-20 Committee on Hazardous Substances and Oil Spill Response. The scope of the committee is to formulate test methods, specification, classifications, standard practices, definitions and other standards pertaining to performance, durability, strength of systems and techniques used for the control of oil and hazardous substance spills.

2. The Canadian General Standards Board (CGSB) established a sorbent subcommittee to develop a testing protocol and manage a qualification and certification list for sorbent materials. Environment Canada had taken the lead in organizing and coordinating the development of sorbent testing standards for oil and hazardous substance spill response. In cooperation with the U.S. Coast Guard, Marine Spill Response Corporation and Environment Canada, a sorbent database has been developed to assist consumers with the selection of sorbents for industrial, freshwater, marine and land application.

3. The Department of Interior, Minerals Management Service (MMS), U.S. Environmental Protection Agency (EPA), U.S. Coast Guard, U.S. Navy and Environment Canada developed two protocols for testing containment booms and skimmers in a test basin environment with petroleum products.

4. The National Environmental Technology Applications Corporation (NETAC) and the EPA Bioremediation Action Committee prepared a draft Oil Spill Bioremediation Products Testing Protocol Methods Manual in 1992. The protocols are designed to standardize procedures for identifying the effectiveness and safety of different bioremediation products.

A conclusion from the research was that a gap exists for protocols/standards relating to the use of chemical and biological products for arctic and sub-arctic conditions. The NETAC bioremediation protocols indicate the use of seawater from the southeast portion of the United States which does not provide a realistic medium for Alaskan waters.

The Protocol for Chemical Product Use and Bioremediaton Product Use on Spills in Alaskan Waters is designed as a literature review criteria for evaluating response technologies and also provides an initial series of testing procedures for spills in arctic/sub-arctic conditions. The protocols are designed to be used prior to, rather than during a spill event to expedite the approval and potential use of a new product that has never been utilized on a spill in the State of Alaska.

TAB B: PURPOSE

The purpose of the protocol package is: 1) to develop a criteria to be used to evaluate chemical and bioremediation response technologies; 2) to provide direction to vendors, manufacturer's and proponents on approval procedures for product use on spills in Alaska; and 3) to provide an initial series of testing procedures for chemical and bioremediation products to be used in marine/freshwater, arctic/sub-arctic conditions.

The methods described in this package are intended to provide the product proponent basic means to develop information which may demonstrate the ability of their particular product. The protocols are not designed to preclude research and development of future innovative technologies.

Although the protocols represent a Council consensus regarding the demonstration of a products capability, they are by no means the only methods to provide such information. Using these protocols and gathering the data is no guarantee that any particular product will be selected by a spiller, the State, or the Alaska Regional

Response Team (ARRT) for use on a spill. Products which do not have this type of information may find difficulty in demonstrating their value for spill response. A product proponent, manufacturer and/or vendor is required by the National Contingency Plan (NCP), Subpart J, to submit a "Request for Authorization of Use" to the ARRT prior to field testing in Alaska. It is the responsibility of the spiller, Federal On-Scene Coordinator (FOSC), and State On-Scene Coordinator (SOSC) with assistance from the ARRT and the federal/state resource trustees to make the decisions as to how they will manage the response to a spill. Product data gathered using the protocols will be provided to the FOSC, SOSC and ARRT to assist in the decision-making process. Figure 1, illustrated the general structure used by government response agencies when determining product use in Alaska.

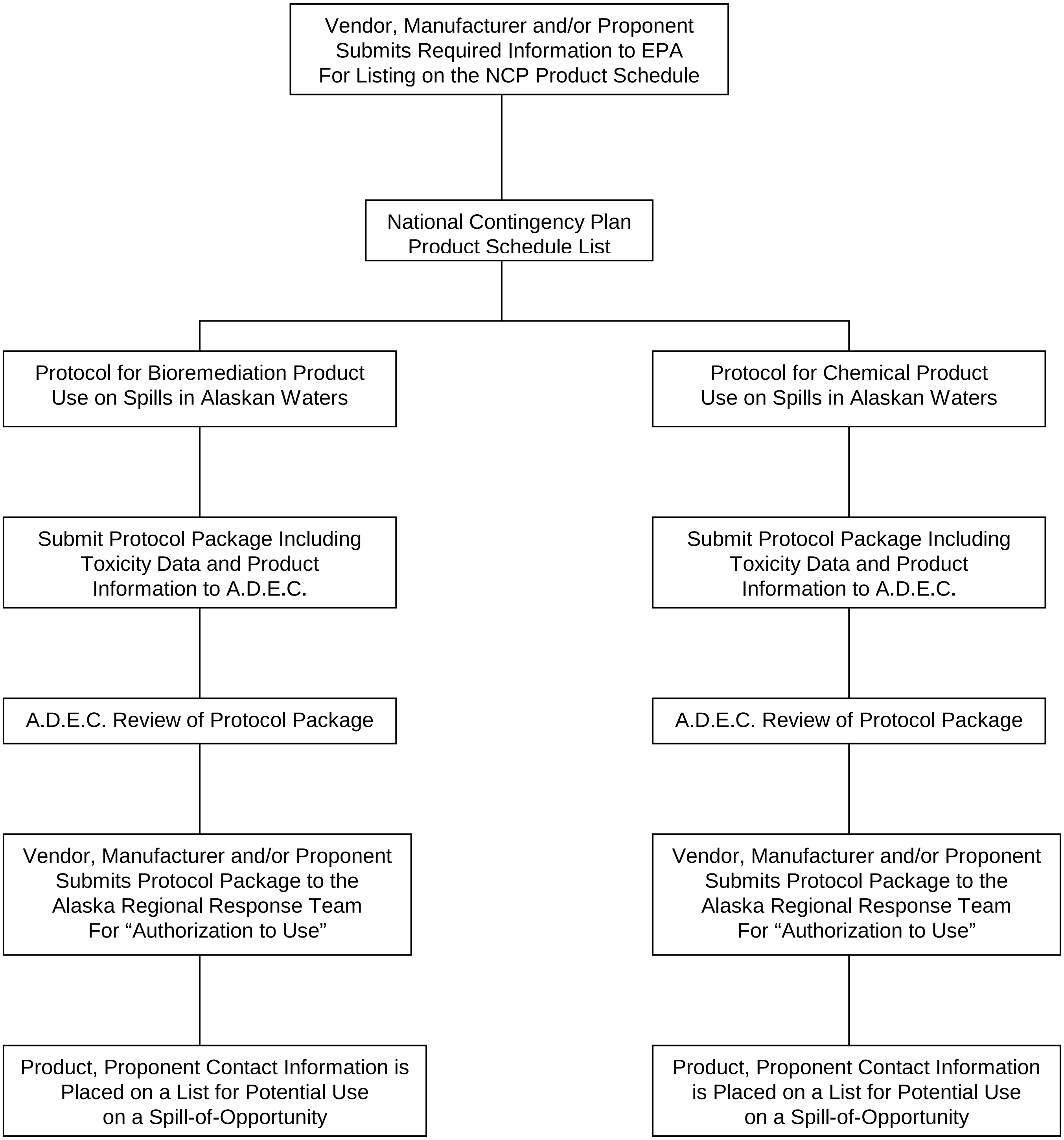

Figure 1 – General Structure for Determining Product Use

TAB C: POTENTIAL CRITERIA FOR TECHNOLOGY EVALUATION

In order to comprehensively evaluate various types of technology for dealing with spills, it is necessary to have a set of well defined criteria that may be used to balance performance and net environmental benefit. The types of criteria that should be considered include: efficiency, risk analysis and feasibility.

Efficiency. Efficiency is defined as the ability of a method to meet established clean up goals. Efficiency measures might include such factors as the percentage of spilled product recovered or neutralized, and such measures could vary greatly depending on the environmental setting. While inherently simple in concept, efficiency measures may be quite difficult to implement in the field. For example, oil recovered after a spill contains a certain amount of water that, if not accounted for, may give a positive bias to the amount of oil recovered. Also, the success of bioremediation techniques measured on the basis of respirometric measurement of oxygen consumption could be biased by other factors that affect oxygen consumption. Careful controls, proper selection of analytical procedures, and explicit quality assurance programs will be necessary to firmly and quantitatively establish the efficiency of any particular type of technology.

Risk Analysis. The proponent of a product should be capable of showing how risk to aquatic life and resources is in fact reduced by their product and application. In determining risk factors involved in using a product, it is important to consider any potential human health impact due to toxic considerations. Additionally, it is important to consider the toxicity of a product and a product/spill material mixture to a suite of species from various taxa. Testing a suite of species will account for individual species tolerance to different classes of compounds. Toxicity must be examined as a function of area impacted, relative level of toxicity, and the duration of toxic conditions. Potential bioaccumulation concerns should be addressed, and toxic consequences should be thoroughly researched through literature review. It is important to have preliminary knowledge of both acutely toxic levels and chronic or sublethal toxic levels. There are environmental endpoints other than toxicity that should be targets of technology performance and safety. For example:

1. eutrophication (from nutrients or other biostimulatory substances);

2. bioaccumulation (trace elements in nutrient and bioremediation mixes, synthetic chemicals in chemical treatments, dispersants, sorbent material, etc.);

3. biological communities integrity and recovery (ie., washing temperatures or pressure that strike a balance between shoreline ecosystem damage and oil removal);

4. geomorphological integrity of shorelines (ie., berm relocation, washing pressure or dispersants affecting grain size, porosity and thus inhabitants such as clams).

Feasibility and Logistical Analysis. The protocol process for spill technologies considers the relative feasibility of different products in relation to Alaska locales. The following are factors that should be considered in evaluation of feasibility:

1. availability in relation to Alaska locations;
2. time required to execute the methodology;
3. type of spill the technology is effective on at the surface, near surface, and subsurface;
4. cost/efficiency comparison for the methodology and other potential techniques;
5. logistic consideration necessary for implementation and demobilization of the methodology;
6. setting restrictions for the methodology;
7. environmental variables, concentration of material and their potential influence on the efficiency of the methodology (e.g. temperature and other climatic factors; competitive uptake of nutrients by shore plants and algae); and,
8. liquid and solid waste streams generated by the method, including analysis of stability, bio-degradable characteristics, re-usability, and disposal options.

Impacts such as trampling marshes to apply a product or the disturbance to wildlife reproduction from machinery are additional logistical considerations for testing a product.

A comprehensive protocol procedure must take into consideration all of the factors that play a role in determination of the ultimate feasibility of a technology for the multitude of settings and environmental conditions found in the State of Alaska. It will not be enough for a product to be shown to be benign in a risk analysis and effective in one or possibly more field applications. To receive support from the FOSC, SOSC and ARRT the technology must be shown to be effective under all of the settings and environmental conditions for which its use is proposed.

TAB D: PROTOCOL OVERVIEWS

AS 46.13.120 mandates that the Hazardous Substance Spill Technology Review Council establish testing protocols to be used by the Department of Environmental Conservation to evaluate the effectiveness of spill technologies for use in the state. The purpose of this section is to:

1) provide protocol overviews for the two categories of technology- chemical and biological; and,

2) provide guidance for testing sorbent and mechanical products to manufacturers and vendors.

Description of Protocols

The overview for each category is a procedural outline which provides a framework for the development of a detailed and definitive review structure. The Protocol for Chemical Product Use on Spills in Alaskan Waters is patterned after the State of Alaska Protocol (Viteri and Clark, 1990). The Protocol for Bioremediation Product Use on Spills in Alaskan Waters, is patterned after the combined NETAC/ADEC protocol for bioremediation (NETAC, 1992). These protocols will determine a criteria that may be used to balance product performance and net environmental benefit. The types of criteria considered include efficiency, efficacy, toxicity and risk analysis.

All of the protocols include and allow for product testing on "spills-of-opportunity". Prior to testing a product on a "spill-of-opportunity", the proponent must obtain a letter from the ARRT giving them "Authorization for Use".

Vendors, manufacturers and proponents of sorbent products are recommended to contact:

Environment Canada
Emergencies Engineering Division
3439 River Road
River Road Environmental Technology Centre
Ottawa, Ontario K1A OH3
Phone Number: (613) 990-0100
Fax Number: (613) 991-1673

Environment Canada has taken the lead in developing and testing sorbent products for oil and hazardous substance spill response. A sorbent database has been developed by the U.S. Coast Guard, Marine Spill Response Corporation and Environment Canada to assist consumers with the selection of sorbent products. Information obtained from the sorbent tests performed by Environment Canada should be submitted to the Alaska Department of Environmental Conservation, Division of Spill Prevention and Response, 410 Willoughby Avenue, Suite 105, Juneau, Alaska 99801.

PROTOCOL FOR CHEMICAL PRODUCT USE ON SPILLS IN ALASKAN WATERS

1. Scope

1.1 This protocol covers a preliminary review of product information, provided by the vendor, manufacturer and/or proponent and laboratory test data which describes the performance of chemical products used to remove oils and other compatible fluids from water at an approved test laboratory.

1.2 This protocol does not address all of the safety problems associated with its use. It is the responsibility of the user of this protocol to establish appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2. Definitions

2.1 *EC_{50}*- median effective concentration.

2.2 *Efficiency*- power to produce effects or intended results.

2.3 *Hazardous Substance*- an element or compound which, when it enters into the atmosphere or in or upon the water of surface or subsurface land of the state, presents an imminent and substantial danger to the public health or welfare, including but not limited to fish, animals, vegetation, or any part of the natural habitat in which they are found (AS 46.03.826 (5)(A)).

2.4 *LC_{50}*- median lethal concentration.

2.5 *Oil*- a petroleum products of any kind and in any form, whether crude, refined, or a petroleum by-product, including petroleum, fuel oil, gasoline, lubricating oils, oily sludge, oily refuse, oil mixed with other wastes, liquified hydrocarbons regardless of specific gravity (AS 46.08.900 (7)).

2.6 *Product*- that which is listed on the National Oil and Hazardous Substance Pollution Contingency Plan, Part 300, Subpart J, "Use of Dispersant and other Chemical Product Schedule".

2.7 *Proponent*- a person or organization who makes a proposal or proposition.

2.8 *Recovery Rate*- the volume of substance recovered by the product per unit of time and area treated.

2.9 *Risk Analysis*- a determination of potential health effects including effects of containment exposure through inhalation, ingestion, dermal absorption, and other means, and the assessment of risk to human health and the environment from contaminants remaining in the land, air, or water as a result of a release (AS 46.03.450 (9)).

2.10 *Waters of Alaska*- includes lakes, bays, sounds, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, straits, passages, canals, the Pacific Ocean, Gulf of Alaska, Bering Sea, and Arctic Ocean, in the territorial limits of the state, and all other bodies of surface or underground water, natural or artificial, public or private, inland or coastal, fresh or salt, which are wholly or partially in or bordering the state or under the jurisdiction of the state (AS 46.03.900 (34)).

3. Referenced Documents

3.1 ADEC-QA-006/88 Guidelines for Preparing Quality Assurance Project Plans

3.2 EPA 600/4-85/013 Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms

3.3 40 CFR Part 300.900 The National Oil and Hazardous Substance Pollution Contingency Plan, Part 300, Subpart J, "Use of Dispersant and other Chemical Product Schedule"

3.4 E 729 ASTM Standard Practice for Conducting Acute Toxicity Tests with Fish, Macro invertebrates, and Amphibians

3.5 E 1022 ASTM Standard Practice for Conducting Bioconcentration Tests with Fish and Saltwater Bivalve Molluscs.

3.6 E 1023 ASTM Standard Guide for Assessing the Hazard of a Material to Aquatic Organisms and Their Uses.

3.7 Alaska Department of Labor; Occupational Safety and Health Standards-Hazardous Waste Operations and Emergency Response.

3.8 21 CFR Part 182, 184, 186; FDA Generally Regarded as Safe List.

4. Summary of Method

4.1 The preliminary review of product information will determine what level of laboratory and field testing that's been conducted on the product. The product information will also be used to determine additional requirements necessary to meet this protocol.

4.2 The chemical product shall be tested in a certified laboratory with a controllable test environment. Controlled test variables include testing substance properties and thickness, water and product temperatures, testing period and toxicity tests of specific index species found in Section 7 of this protocol. It is essential that the product parameters are monitored, measured, sampled and recorded during the test period.

4.3 The chemical product will be tested using established ASTM and/or EPA methods, where applicable, and specifically developed test for performance factors.

5. Significance

5.1 This protocol will determine a criteria that may be used to balance product performance and net environmental benefit for the State of Alaska. The types of criteria considered include: efficiency, efficacy, toxicity and risk analysis.

6. Product Information

AS 46.04.025 insures confidentiality of product information when requested by the manufacturer, vendor or proponent.

6.1 Physical and chemical data, as well as formulation characteristics and previous use of the product must be provided. This includes:

6.1.1 exact chemical composition;

6.1.2 application rate;

6.1.3 application method;

6.1.4 mode of cleansing action and efficacy;

6.1.5 history of use; and,

6.1.6 environmental fate and persistence.

6.2 Published and unpublished product and chemical database information for the evaluation of chemical components, and product formulation must be provided. This includes:

6.2.1 Chemical properties of constituents, including data and other information used to support the application for product listing in the National Contingency Plan's Product Schedule List;

6.2.2 Potential toxicity or bioaccumulation of the product for humans, marine mammals, birds, other wildlife and aquatic resources, including results of any acute or chronic toxicity tests performed on the product.

6.2.3 Certification that the product does not contain carcinogenic, mutagenic, teratogenic, pathogenic or hazardous substances.

6.2.4 An indication that proposed use of the product can comply with all applicable federal, state, or local laws and regulations.

6.2.5 A statement of corporate or organization qualifications, including previous experience with hydrocarbon degradation, observed results, personnel resources and capabilities.

7. Toxicity Tests

7.1 Acute and chronic toxicity testing will not be required if the proponent of the chemical product can provide documentation which supports its listing on the Food and Drug Administrations-Generally Regarded as Safe List and that the chemical constituents of the product are below acute and chronic toxicity for the index species listed in 7.3.

7.2 Acute and chronic toxicity tests shall be conducted using American Society of Testing Materials (ASTM) or U.S. Environmental Protection Agency (USEPA) methods.

7.3 Conduct three comprehensive laboratory toxicity tests on each of the species listed below. The toxicity tests shall be conducted:

7.3.1 on the product and test species;

7.3.2 on the test substance and species;

7.3.3 on the product, test substance and species.

The following information must be provided by the proponent using ASTM Standards of the selected testing substance:

7.3.4 Pour Point; D97 ASTM Standard Test Method for Pour Point Petroleum Oils.

7.3.5 Viscosity; D445 ASTM Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity).

7.3.6 Specific Gravity; D1298 ASTM Standard Test Method for Density Relative Density (Specific Gravity) or API Gravity of Crude Petroleum Products by Hydrometer Method.

7.3.7 pH; D1293 ASTM Standard Test Methods for pH of Water.

7.3.7 Substance composition and common name.

The following suite of test species will be used to obtain toxicity data:

7.3.8 acute toxicity test (24-48-96-hr) with brine shrimp (A. salinas); Use USEPA NCP 40 CFR Part 300, Subpart H, Appendix C Revised Standard Dispersant Effectiveness and Toxicity Method.

7.3.9 acute toxicity test (96-hr) rainbow trout (O. mykiss); Use 40 CFR Part 797.1400 "Fish acute Toxicity test" USEPA 1989 and 40 CFR Part 300 Subpart J "Revised Standard Dispersant Effectiveness and Toxicity Test, USEPA 1984, Revised 1990.

7.3.10 chronic estimator test (7-day) with Pacific herring (Clupea) or silversides (M. beryllina);

7.3.11 acute toxicity test (48hr EC50) on the larvae stages of Pacific oyster (C. gigas) and (M. edulis) using ASTM E-724 and Bioassay Procedures for Mollusks, Standard Methods, 14th ed. APHA 1975.

7.4 All data obtained within Section 7 of this protocol shall be submitted to the Alaska Department of Environmental Conservation, Division of Spill Prevention and Response, 410 Willoughby Avenue, Suite 105, Juneau, Alaska 99801. The manufacturer, vendor and/or proponent will receive a letter from the Department acknowledging receipt of the information and a date indicating when the review will be completed.

8. "Spill of Opportunity" Testing Plan

8.1 "Spill-of-Opportunity" is defined as:

8.1.1 A spill where there is no identifiable responsible party and/or the responsible party is not capable of controlling, containing and cleaning up the spill.

8.1.2 A spill where there is a responsible party and the proponent has entered into a legal agreement to test the product. Documentation of this agreement must be included in the Testing Plan.

8.2 A Quality Assurance Project Plan shall be prepared by the manufacturer, vendor and/or proponent. The plan will include:

8.2.1 a sampling plan for sediments and water which can evaluate the effectiveness of the product in a real spill response. Samples shall be taken from an untreated control plot.

8.2.2 a list of all spill response equipment that will be used during the test.

8.3 A health and safety section must be included in the test plan. This section shall include:

8.3.1 Photocopy documentation that personnel are adequately trained to perform hazardous waste operations and emergency response as stated in the ADOL Occupational Safety and Health Standard, Subchapter 10.

8.3.2 Description of the protective clothing and equipment to be worn by personnel during the operation.

8.3.3 Describe and site specific medical surveillance requirements.

8.3.4 Establish decontamination procedures for personnel and equipment.

8.4 Proponent will specify what types and amount of spilled substance his proposed technology would be used on.

8.5 Proponent will specify in the test plan:

8.5.1 Types of affected environment (terrestrial, marine rocky shoreline, sandy substrate, wetland marshes, etc.) the product will be applicable for use.

8.5.2 The location or region of Alaska for cost effective mobilization and product use.

8.5.3 Contact phone numbers for emergency notification, call out and mobilization.

8.6 The vendor, manufacturer and/or proponent will provide copies of the following permits and clearance letters to the Alaska Department of Environmental Conservation, Division of Spill Prevention and Response:

8.6.1 Alaska Department of Natural Resources Land Use Permit;

8.6.2 A land use and/or clearance letter for the private land owner.

8.6.3 A letter of clearance from the Alaska Department of Natural Resources State Historic Preservation Office.

8.7 The vendor, manufacturers and/or proponents will submit a complete packet to the Alaska Regional Response Team co-chairs requesting an "Authorization for Use" letter.

8.8 The Department of Environmental Conservation, Division of Spill Prevention and Response will notify the vendor, manufacturer and/or proponent of their listing for product testing on a spill-of-opportunity.

PROTOCOL FOR BIOREMEDIATION PRODUCT USE ON SPILLS IN ALASKAN WATERS

1. Scope

1.1 This protocol covers a preliminary review of product information, provided by the vendor, manufacturer and/or proponent and laboratory test data which describes the performance of a bioremediation product used to remove oils and other compatible fluids from water at an approved test laboratory.

1.2 This protocol does not address all of the safety problems associated with its use. It is the responsibility of the user of this protocol to establish appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2. Definitions

2.1 *EC_{50}*- median effective concentration.

2.2 *Efficiency*- power to produce effects or intended results.

2.3 *Hazardous Substance*- an element or compound which, when it enters into the atmosphere or in or upon the water of surface or subsurface land of the state, presents an imminent and substantial danger to the public health or welfare, including but not limited to fish, animals, vegetation, or any part of the natural habitat in which they are found (AS 46.03.826 (5)(A)).

2.4 *LC_{50}*- median lethal concentration.

2.5 *Oil*- a petroleum products of any kind and in any form, whether crude, refined, or a petroleum by-product, including petroleum, fuel oil, gasoline, lubricating oils, oily sludge, oily refuse, oil mixed with other wastes, liquified hydrocarbons regardless of specific gravity (AS 46.08.900 (7)).

2.6 *Product*- that which is listed on the National Oil and Hazardous Substance Pollution Contingency Plan, Part 300, Subpart J, "Use of Dispersant and other Chemical Product Schedule".

2.7 *Proponent*- a person or organization who makes a proposal or proposition.

2.8 *Recovery Rate*- the volume of substance recovered by the product per unit of time and area treated.

2.9 *Risk Analysis*- a determination of potential health effects including effects of containment exposure through inhalation, ingestion, dermal absorption, and other means, and the assessment of risk to human health and the environment from contaminants remaining in the land, air, or water as a result of a release (AS 46.03.450 (9)).

2.10 *Waters of Alaska*- includes lakes, bays, sounds, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, straits, passages, canals, the Pacific Ocean, Gulf of Alaska, Bering Sea, and Arctic Ocean, in the territorial limits of the state, and all other bodies of surface or underground water, natural or artificial, public or private, inland or coastal, fresh or salt, which are wholly or partially in or bordering the state or under the jurisdiction of the state (AS 46.03.900 (34)).

3. Referenced Documents

3.1 ADEC-QA-006/88 Guidelines for Preparing Quality Assurance Project Plans

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3.3 40 CFR Part 300.900 The National Oil and Hazardous Substance Pollution Contingency Plan, Part 300, Subpart J, "Use of Dispersant and other Chemical Product Schedule"

3.4 E 729 ASTM Standard Practice for Conducting Acute Toxicity Tests with Fish, Macro invertebrates, and Amphibians

3.5 E 1022 ASTM Standard Practice for Conducting Bioconcentration Tests with Fish and Saltwater Bivalve Molluscs.

3.6 E 1023 ASTM Standard Guide for Assessing the Hazard of a Material to Aquatic Organisms and Their Uses.

3.7 Alaska Department of Labor; Occupational Safety and Health Standards- Hazardous Waste Operations and Emergency Response.

3.8 21 CFR Part 182, 184, 186; FDA Generally Regarded as Safe List.

3.9 Interim Guidelines for Preparing Bioremediation Spill Response Plans, Subcommittee on National Bioremediation Spill Response- Bioremediation Action Committee, USEPA, 1991.

3.10 National Environmental Technology Application Corporation; Bioremediation Product Screening and Evaluation Protocol- Draft 1991.

4. Summary of Method

4.1 The preliminary review of product information will determine what level of laboratory and field testing that's been conducted on the product. The product information will also be used to determine additional requirements necessary to meet this protocol.

4.2 The bioremediation product shall be tested in a certified laboratory with a controllable test environment. Controlled test variables include testing substance properties and thickness, water and product temperatures, testing period and toxicity tests of specific index species found in Section 7 of this protocol. It is essential that the product parameters are monitored, measured, sampled and recorded during the test period.

4.3 The bioremediation product will be tested using established ASTM and/or EPA methods, where applicable, and specifically developed test for performance factors.

5. Significance

5.1 This protocol will determine a criteria that may be used to balance product performance and net environmental benefit for the State of Alaska. The types of criteria considered include: efficiency, efficacy, toxicity and risk analysis.

6. Product Information

AS 46.04.025 insures confidentiality of product information when requested by the manufacturer, vendor or proponent.

6.1 Physical, biological and chemical data, as well as formulation characteristics and previous use of the product must be provided. This includes:

6.1.1 exact chemical composition;

6.1.2 application rate;

6.1.3 application method;

6.1.4 mode of cleansing action and efficacy;

6.1.5 history of use; and,

6.1.6 environmental fate and persistence.

6.2 Published and unpublished product and chemical database information for the evaluation of chemical components, and product formulation must be provided. This includes:

6.2.1 Biological properties of constituents, including data and other information used to support the application for product listing in the National Contingency Plan's Product Schedule List;

6.2.2 Potential toxicity or bioaccumulation of the product for humans, marine mammals, birds, other wildlife and aquatic resources, including results of any acute or chronic toxicity tests performed on the product.

6.2.3 Certification that the product does not contain carcinogenic, mutagenic, teratogenic, pathogenic or hazardous substances.

6.2.4 An indication that proposed use of the product can comply with all applicable federal, state, or local laws and regulations.

6.2.5 A statement of corporate or organization qualifications, including previous experience with hydrocarbon degradation, observed results, personnel resources and capabilities.

7. Toxicity Tests

7.1 Acute and chronic toxicity testing will not be required if the proponent of the bioremediation product can provide documentation which supports its listing on the Food and Drug Administrations-Generally Regarded as Safe List and that the chemical constituents of the product are below acute and chronic toxicity for the index species listed in 7.3.

7.2 Acute and chronic toxicity tests shall be conducted using American Society of Testing Materials (ASTM) or U.S. Environmental Protection Agency (USEPA) methods.

7.3 Conduct three comprehensive laboratory toxicity tests on each of the species listed below. The toxicity tests shall be conducted:

7.3.1 on the product and test species;

7.3.2 on the test substance and species;

7.3.3 on the product, test substance and species.

The following information must be provided by the proponent using ASTM Standards of the selected testing substance:

7.3.4 Pour Point; D97 ASTM Standard Test Method for Pour Point Petroleum Oils.

7.3.5 Viscosity; D445 ASTM Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity).

7.3.6 Specific Gravity; D1298 ASTM Standard Test Method for Density Relative Density (Specific Gravity) or API Gravity of Crude Petroleum Products by Hydrometer Method.

7.3.7 pH; D1293 ASTM Standard Test Methods for pH of Water.

7.3.7 Substance composition and common name.

The following suite of test species will be used to obtain toxicity data:

7.3.8 acute toxicity test (24-48-96-hr) with brine shrimp (A. salinas); Use USEPA NCP 40 CFR Part 300, Subpart H, Appendix C Revised Standard Dispersant Effectiveness and Toxicity Method.

7.3.9 acute toxicity test (96-hr) rainbow trout (O. mykiss); Use 40 CFR Part 797.1400 "Fish acute Toxicity test" USEPA 1989 and 40 CFR Part 300 Subpart J "Revised Standard Dispersant Effectiveness and Toxicity Test, USEPA 1984, Revised 1990.

7.3.10 chronic estimator test (7-day) with Pacific herring (Clupea) or silversides (M. beryllina);

7.3.11 acute toxicity test (48hr EC50) on the larvae stages of Pacific oyster (C. gigas) and (M. edulis) using ASTM E-724 and Bioassay Procedures for Mollusks, Standard Methods, 14th ed. APHA 1975.

7.4 All data obtained within Section 7 of this protocol shall be submitted to the Alaska Department of Environmental Conservation, Division of Spill Prevention and Response, 410 Willoughby Avenue, Suite 105, Juneau, Alaska 99801. The manufacturer, vendor and/or proponent will receive a letter from the Department acknowledging receipt of the information and a date indicating when the review will be completed.

8. "Spill of Opportunity" Testing Plan

8.1 "Spill-of-Opportunity" is defined as:

8.1.1 A spill where there is no identifiable responsible party and/or the responsible party is not capable of controlling, containing and cleaning up the spill.

8.1.2 A spill where there is a responsible party and the proponent has entered into a legal agreement to test the product. Documentation of this agreement must be included in the Testing Plan.

8.2 A Quality Assurance Project Plan shall be prepared by the manufacturer, vendor and/or proponent. The plan will include:

8.2.1 a sampling plan for sediments and water which can evaluate the effectiveness of the product in a real spill response. Samples shall be taken from an untreated control plot.

8.2.2 a list of all spill response equipment that will be used during the test.

8.3 A health and safety section must be included in the test plan. This section shall include:

8.3.1 Photocopy documentation that personnel are adequately trained to perform hazardous waste operations and emergency response as stated in the ADOL Occupational Safety and Health Standard, Subchapter 10.

8.3.2 Description of the protective clothing and equipment to be worn by personnel during the operation.

8.3.3 Describe and site specific medical surveillance requirements.

8.3.4 Establish decontamination procedures for personnel and equipment.

8.4 Proponent will specify what types and amount of spilled substance his proposed technology would be used on.

8.5 Proponent will specify in the test plan:

8.5.1 Types of affected environment (terrestrial, marine rocky shoreline, sandy substrate, wetland marshes, etc.) the product will be applicable for use.

8.5.2 The location or region of Alaska for cost effective mobilization and product use.

8.5.3 Contact phone numbers for emergency notification, call out and mobilization.

8.6 The vendor, manufacturer and/or proponent will provide copies of the following permits and clearance letters to the Alaska Department of Environmental Conservation, Division of Spill Prevention and Response:

8.6.1 Alaska Department of Natural Resources Land Use Permit;

8.6.2 A land use and/or clearance letter for the private land owner.

8.6.3 A letter of clearance from the Alaska Department of Natural Resources State Historic Preservation Office.

8.7 The vendor, manufacturers and/or proponents will submit a complete packet to the Alaska Regional Response Team co-chairs requesting an "Authorization for Use" letter.

8.8 The Department of Environmental Conservation, Division of Spill Prevention and Response will notify the vendor, manufacturer and/or proponent of their listing for product testing on a spill-of-opportunity.