

ANNEX 4
Policy and Guidelines on Use of
In Situ Burning and Chemical Oil Spill Treating Agents
for Region 7
TABLE OF CONTENTS

Topic	Page
Section I. OIL SPILL COUNTERMEASURES POLICIES FOR REGION 7	
.....	Section I Page1
General Policy	Section I Page1
Special Policy for FOOSC Directed Burns	Section I Page2
Section II. IN SITU BURN CHECKLIST	Section II Page1
ISB Decision Tree	Section II Page1
ISB Reference Sources	Section II Page5
Section III. CHEMICAL OIL SPILL TREATING AGENTS (COSTAs) ...	Section III Page1
What a Responder Needs to Know to Consider Use of a COSTA	Section III Page1
COSTA Decision Tree	Section III Page1
Appendix 1 Potential Effectiveness of ISB	Appendix 1 Page 1
Appendix 2 ISB Relationship to Other Countermeasures and Potential Environmental Tradeoffs	Appendix 2 Page 1
Appendix 3 Proposed Guidelines for ISB in Marshes	Appendix 3 Page 1
Appendix 4 Air Monitoring Guidelines for Human Health Impacts of ISB	Appendix 4 Page 1
Appendix 5 Public Notification for ISB	Appendix 5 Page 1
Appendix 6 Ecological Considerations for ISB	Appendix 6 Page 1
Appendix 7 Safety and Health Considerations and By-products of ISB	Appendix 7 Page 1
Appendix 8 Operational Considerations for Conducting ISB	Appendix 8 Page 1

Section I. OIL SPILL COUNTERMEASURES POLICIES FOR REGION 7

This policy is applicable to the navigable waters of Region 7, including backwaters, except for those areas that are covered by a Sub-Area Contingency Plan (SACP). Sub-Area Planning Committees may develop specific policies for in situ burning and other countermeasures, as long as they are consistent with local, state, and federal regulations.

Oil spill responders have a limited number of techniques available to them that will minimize environmental impacts and facilitate effective cleanups. These include mechanical methods, the use of certain chemical oil spill treating agents, and in situ burning. All four states, the local authorities, and the federal agencies with jurisdiction over the Region 7 advocate the use of mechanical containment and cleanup as primary spill response methods. These methods include the use of absorbent pads, containment boom, skimmers, and similar equipment. In general, the use of dispersants is not promoted within the boundaries of the Region 7 Regional Response Teams (RRT).

General Policy

The Federal On-scene Coordinator (FOSC) has the authority to utilize, or approve, any actions necessary to prevent, or substantially reduce, the threat to human life. This includes, but is not limited to, the use of Chemical and Oil Spill Treating Agents (COSTAs) and in situ burning (ISB) (see 40 CFR 300.910(d)). The FOSC will inform the affected RRTs as well as the RRT representatives of any affected states of these actions. Other interested parties such as natural resource trustees should be informed as appropriate.

When there is no longer an immediate threat to human health and welfare, the use of COSTAs and/or ISB will be evaluated on a case by case basis, and is to be conducted in accordance with the remainder of this policy.

1. COSTA Procedure

For COSTAs the approving authority is the Federal On-Scene Coordinator (FOSC) when the FOSC has obtained the concurrence of both the Regional Response Team EPA co-chair and the affected State representative, and, to the maximum extent practicable, consulted with the federal natural resource trustees' representatives on the RRT (40 CFR 300.305(e)).

2. ISB Procedure

In situ burning, for the purposes of this guidance, is defined as the intentional ignition of spilled oil that will burn due to its intrinsic properties, and does not include the adding of a separate burning agent to initiate or sustain the burn. The addition of burning agents requires the COSTA procedure approval because such agents are considered to be in the same category as COSTAs. In situ burning can be performed on the open water and near or on shore.

The use of in situ burning in these guidelines is not for disposal purposes; rather, it is a response technique to be employed when an oil slick has the potential to spread and contaminate additional areas. It is also considered as a cleanup technique for oiled shoreline habitats such as wetlands, where it is used in conjunction with other cleanup methods.

For in situ burns (ISB) for Region 7, the approving authority designated by this policy is the local Incident Commander (or Unified Command as applicable) and the State On-Scene Coordinator (SOSC) (who may need to obtain internal permission).

- A. If the proposed burn is on a local, state, tribal, or federally owned or managed natural resource area, the concurrence of the land owner/manager must be obtained.
- B. Because state or federally listed threatened or endangered species, migratory birds, managed natural resource areas, or other natural resources could be affected, all responders and trustees share interest in timely and effective removal of spilled oil in ways that protect natural resources and the public's safety. Local incident commanders and state and federal on-scene coordinators shall consider the size, nature, and location of a spill, and the type and proximity of resources, and shall, to the maximum extent practicable, consult with state and federal, and, as appropriate, tribal, trustees before deciding to conduct in situ burning. It is the expectation of the members of the Region 7 RRT that, except in extraordinary cases, a local incident commander or state or federal on-scene coordinator shall contact appropriate trustees and allow at least three hours for trustees to advise before proceeding with any proposed in-situ burn.

In addition, whenever the time available permits, the views of the FOSC should be sought and considered.

Because the time frame for making decisions regarding ISB is often very short, guidelines are included in Section II to assure that the most significant issues are considered. This decision-making methodology for burning is approved by the Region 7 Regional Response Team.

Special Policy for FOSC Directed Burns

Region 7 burns are governed by the NCP and state and local regulations.

It is the Region 7 policy that all burns for Region 7 must comply with local, state, and federal regulations.

The FOSC is authorized to use any countermeasure without requesting permission if he or she believes its use is necessary to prevent or substantially reduce a hazard to human life (40 CFR 300.910 (d)). SOSCs may have similar authority under applicable state laws and regulations.

Section II. IN SITU BURN CHECKLIST

The following checklist will assist OSCs at any level to ensure that reasonable decisions are made on the use of ISB for Region 7.

ISB Decision Tree

Step 1: Site Conditions and Desirability

- Access routes to the scene?
- Locational information to include: River mile or latitude/longitude or other precise geographical description?
- Material, amount, size, age, phases, condition of the spill?
- Environmental conditions: air temperature, wind speed, lake/river current speed, wave heights, waters temperature, ice conditions?
- Will the use of ISB prevent or reduce further damage by the spill?
- Are mechanical containment and recovery adequate? If so, explain why burning is being considered.
- Ecological factors such as environmentally sensitive areas? See Appendix 6 for Ecological Considerations.

Step 2: Feasibility

- Can worker safety be reasonably assured?
- Can the fire be contained?
- Are environmental conditions favorable? Wind speeds less than 20 knots (23 mph, 34 feet/sec), currents less than 3/4 of a knot (0.9 mph, 1.3 feet/sec), and waves less than 3 feet?
- Will the smoke plume lower the visibility enough to adversely impact transportation via air, water, or land?
- Are atmospheric conditions very stable (i.e., winds are light and fog or low stratus clouds are present)? Then, the smoke plume will likely be more difficult to disperse and you might not want to burn unless there will be no human impact.
- Is the oil burnable? Recommended thicknesses are 2 to 3 mm for fresh crude oil, 3 to 5 mm for diesel and weathered crude, and 5 to 10 mm for emulsions and bunker C. Water-in-oil emulsions containing more than 30 to 50% water are difficult to ignite and support combustion. Most oils readily burn if the water content is less than 25%. Most crude oils require an evaporative loss of less than 30% to burn.
- Residues: The removal of burn residues should be considered since the potential exists for undefined levels of environmental impacts even with a successful burn. See final pages of Appendix 8 for additional information.
- Is the product ignitable without adding a burning agent? COSTA procedure approval is required for use of burning agents.

The term "burning agents" means those additives that, through physical or chemical means, improve the combustibility of the materials to which they are applied. It is recommended that,

when addition of a burning agent is being evaluated, first consideration be given to the more environmentally friendly products such as kerosene or jet fuel "A" before considering the more environmentally hostile products such as gasoline or diesel.

- Is the product gasoline or other light petroleum product? If so, both mechanical techniques and ISB are still viable options. However, due to the greater risk of flammable hazard, uncontrolled sources of ignition should be removed from the area, only intrinsically safe equipment should be used on the site, and combustible gas indicators should be used to monitor for flammable vapors.
- Is the area forested or are conditions very dry? If so, then it may not be safe to burn.
- If in a marsh or wetlands area, see Appendix 3.
- Is adequate fire boom, towboats, and igniters available?
- Is adequate helicopter/monitoring equipment available?
- Can notices to mariners, aircraft, and populations be issued in time?
- Can personnel and equipment be mobilized in time?
- Can authorization be secured in time?

See Appendix 8 for information operational considerations: open water burning, inland environment burning, ice conditions, fire boom, ignition, oil thickness, weathering, emulsification, and burn residues.

Step 3: Acceptability

- Distance between burn and human population?
- Will ambient PM-10, averaged over 1 hour, near humans, be above 150 micrograms per cubic meter? If so, evacuate or shield them, or do not conduct the burn.

Generally, burning should not be conducted if human population centers exist within 6 miles downwind of the burn or 3 miles in other directions. These distances are only a rule of thumb - they may be longer or shorter depending on the circumstances of the case. In general, a safety margin of 45 degrees of arc on either side of the wind vector should be allowed to account for wind shifts. This means that burning is not recommended if there is a human population center within 6 miles from the burn measured along the wind direction and expanded 45 degrees on either side of the wind direction. A 3-mile safety margin is recommended in other directions.

Other considerations include:

- Does the landowner concur with the decision to burn?
- Are there cultural, historical, or archaeological resources that could be affected by the burn? If so, probably should not burn.
- Does the proposed burn area contain state or federal threatened or endangered species populations or their critical habitats? If so, and the proposed burn appears likely to result in greater overall injury to those species or habitats than other response actions, including "no action," the state and federal natural resource trustees will likely object to it.

Step 4: Authorization and Conditions

- Are forecasted weather conditions favorable?
- The Site Safety Plan should be reviewed to ensure that ISB is adequately addressed.
- Unified Command authorities to start, proceed, limit, or halt the burn must be recognized.
- Conduct trial burns to evaluate smoke plume drift and dispersion.
- Burn extinguishing measures are available?
- Public notification. See Appendix 5 for guidelines on Public Notification.
- A written description of the incident and burn plan should be provided to the OSC and other pertinent players.

Step 5: Monitoring

The primary operational purpose in monitoring the burning of spilled oil is to determine if burning requirements and objectives are met. Although the current body of knowledge about burning is limited, each operational use provides an opportunity to gather further information. Operational monitoring should occur during a response involving the use of in situ burning and should be accompanied by a detailed monitoring plan.

Operational monitoring should include such parameters as:

- type and amount of oil spilled;
- weather and water conditions;
- trajectory of the slick and smoke plume;
- estimated volume of oil to be burned;
- estimated volume of oil actually burned and remaining;
- observation of the effectiveness of residual material collection;
- observations of adverse effects to natural resources both pre- and post-burn (e.g., number of dead organisms)
- effects on human health (see Appendix 4 for Air Monitoring Guidelines)

In an effort to gather more data about in situ burning, spill-of-opportunity research possibilities involving a broad range of physical, biological, and chemical issues, is encouraged. Research monitoring might involve:

- collection of oil sample prior to burning for analysis;
- observations of residual material behavior and fate;
- collection of residual material for analysis;
- upwind and downwind air sampling;
- number and location of sampling stations;
- determination of compounds (PAHs, particulates) to be monitored;
- Species and numbers of biota (e.g., waterfowl, aquatic organisms, vegetation) in the area.

Step 6: Reports

- A lessons learned report should be submitted by the Unified Command to the FOSC (and thence to the RRT), SOSC, state and federal natural resource trustees, and local incident commander. The feedback from these reports will help in evaluating policies and procedures and improving them as needed, especially since burning is a relatively new countermeasure for Region 7.
- Post burn monitoring of the site should be considered.

ISB Reference Sources

National Contingency Plan, 40 CFR Parts 300 to 399.

API/NOAA manual "Options for Minimizing Environmental Impacts of Freshwater Spill Response, September 1994", also known as the Freshwater Manual.

Region 5 In Situ Burn Guidelines adopted in June 1996.

Alternative Response Tool Evaluation System (ARTES) adopted by RRT-5 in June 1996.

NOAA HAZMAT In Situ Burning Planning Guidelines, 11 June 1996.

Alaska Regional Response Team In Situ Burn Guidelines for Alaska, May 1994.

S.L. Ross Environmental Research Ltd., Alaska Clean Seas, Alaska Department of Environmental Conservation, In Situ Burning: A Valuable Tool for Oil Spill Response, April 1995

Regional Response Team 2 - In Situ Burning Decision Flow Chart, DRAFT 11/12/96.

Regional Response Team 6, In Situ Burn Decision Tree.

Smart Guidelines - U.S. Coast Guard

Section III. CHEMICAL OIL SPILL TREATING AGENTS (COSTAs)

What a Responder Needs to Know to Consider Use of a COSTA

Except for specific circumstances (i.e., to prevent or substantially reduce a hazard to human life in accordance with 40 CFR 300.910 (c)) the use of chemical oil spill treating agents (COSTAs) will be considered on a case-by-case basis. Chemical oil spill treating agents include dispersants, herding agents, emulsion treating agents, solidifiers, elasticity modifiers, shoreline cleaning agents, shoreline pre-treatment agents, oxidation agents, and bioremediation agents.

In general, the use of dispersants is not promoted within the boundaries of the Region 7 Regional Response Team (RRT).

Region 7 has no preapprovals in place for any COSTAs.

Consistent with the National Contingency Plan (NCP), in situations when a human hazard is not present, the federal on-scene coordinator (FOSC) must receive the concurrence of the U.S. Environmental Protection Agency (USEPA) Regional Response Team (RRT) representative(s), and the RRT representative of the affected state(s) to use any chemical product. The FOSC must also consult with the Department of Interior (DOI) and Department of Commerce (DOC) natural resource trustees, where practicable, before authorizing the use of a chemical product. Any on-scene coordinator (OSC) or responders must comply with applicable local, state, and federal regulations.

Note that the FOSC is authorized to use any chemical product without requesting permission if he or she believes its use is necessary to prevent or substantially reduce a hazard to human life (40 CFR 300.910 (c)). If a chemical product is used under these circumstances, the FOSC must notify the USEPA RRT representative and the state(s) RRT representative of its use as soon as possible. This policy should be applicable to any OSC whether local, state, or federal.

General COSTA show stoppers:

- Is the product on the National Product Schedule? If not, then it should not be used except as noted in 40 CFR 300.910 (c).
- Are all players in agreement on its use? If not, then it should not be used. These players shall include the Local Incident Commander, FOSC, SOS, and the State and Federal natural resource trustees.
- COSTAs require RRT approval.

COSTA Decision Tree

The following information is excerpted from the API/NOAA manual "Options for Minimizing Environmental Impacts of Freshwater Spill response," 1994.

Dispersants

Objective:

To remove floating oil from the water surface and disperse the oil into the water column, to reduce impacts to sensitive shoreline habitats and animals that use the water surface.

Description:

Specially formulated products that contain surface-active agents are sprayed at concentrations of about 5 percent of the oil onto the slicks by aircraft or from boats. The products can be applied undiluted or mixed with water. The dispersants reduce the oil/water surficial tension and decrease the energy needed for the slick to break into small particles and mix into the water column. Some physical energy is needed to mix the dispersant into the oil and treated oil into the water.

Applicable Habitat Types:

Open water and large rivers with sufficient depth and volume for mixing.

When to Use:

When the impact of the floating oil has been determined to be greater than impacts resulting from mixing of oil into the water column.

Biological Constraints:

Not suitable in shallow water depths where the dispersed oil could affect benthic resources. The dispersed oil must not affect water intakes.

Environmental Effects:

May increase effects on water-column organisms, particularly plankton and larval fish. Dispersion will only be partially effective, so some water surface impacts will still occur.

Other Limitations:

Effective application needs enough wind, but not too much (generally less than 25 knots). Dispersants are not too effective after approximately 12 hours due to weathering of oil and increased viscosity. In general, lighter petroleum products are more dispersible than heavier products. Dispersants should not be used if water intakes are nearby. For aerial application of dispersants the visibility should be 3 miles or better, the ceiling should be 1000 feet or higher, and the wind speed should be 25 knots or lower.

Emulsion treating agents

Objective:

To break or destabilize emulsified oil into separate oil and water phases. Can also be used to prevent emulsion formation.

Description:

Emulsion treating agents are water-soluble surfactants that are applied to emulsified oil at low concentrations (0.1-2 percent). They can be injected into skimmer reservoirs to break the emulsion so that excess water can be separated from recovered oil. They also can be sprayed (similar to dispersants) directly onto slicks to break or prevent emulsions.

Applicable Habitat Types:

On all water environments where emulsified oil is present.

When to Use:

For recovered oil, where storage capacities are very limited, to separate the oil and water so that the water can be treated and discharged. On floating slicks, when formation of emulsified oil has or could reduce skimmer efficiency.

Biological Constraints:

Unknown at this time.

Environmental Effects:

Because this is a new application approach, there are very little data available on which to evaluate environmental effects. Effective dosages are 1-2 orders of magnitude lower than dispersants. There are concerns about application to slicks on how treatment might change the physical or chemical properties of the oil, whether the oil will be more readily dispersed, and how the treated oil will behave upon contact with birds, mammals, and shorelines.

Elasticity Modifiers (visco-elastic agents, elastimers, viscosity modifying agents)

Objective:

To impart visco-elastic properties to treated oil and increase skimming rates.

Description:

A chemical agent is applied as a liquid spray or a slurry onto the oil in the proper dosage. Treated oil is rendered visco-elastic, but still fluid, gelatinous, or semisolid; there is no chemical change in the oil. The primary purpose is to increase the efficiency in removal rates by skimmers. Increases the recovery by drum skimmers, but can clog weir-type skimmers.

Applicable Habitat Types:

On all water environments where oil can be contained for recovery with skimmers. Not for use adjacent to wetlands or debris because of an increase in adhesive behavior of the treated oil.

When to Use:

When recovery efficiency of skimmers needs to be increased. Must be used in conjunction with booming or other physical containment. Not for use on heavy oils which are already highly viscous.

Biological Constraints:

Not suitable for vegetated shores or where there is extensive debris mixed in the oil. Should be avoided when birds or other wildlife that may be more adversely impacted by the treated oil cannot be kept away from the treated oil.

Environmental Effects:

May enhance the smothering effect of oil on organisms. Thus, the treatment should be considered only where recovery of the treated oil is likely.

Herding Agents

Objective:

To collect or herd oil into a smaller area and thicker slick, thus increasing recovery. Also, can be used to herd oil away from sensitive areas.

Description:

Chemical agents which are insoluble surfactants and have a high spreading pressure are applied in small quantities (1-2 gallons per lineal mile) to the clean water surrounding the edge of a fresh oil slick. They contain the oil, prevent spreading, but do not hold the spill in place. Hand-held, vessel-mounted, or aircraft systems can be used. Must be applied early in the spill, when oil is still fluid.

Applicable Habitat Types:

On all water environments.

When to Use:

Potential use for collection and protection. For collection, use to push slicks out from under docks and piers where it has become trapped, or in harbors, where the equipment is readily accessible for use early in the spill. For protection, in low-current areas, use to push slicks away from sensitive resources, such as wetlands. Not effective in fast currents, rough water, or rainfall.

Biological Constraints:

Not suitable for use in very shallow water or fish spawning areas.

Environmental Effects:

Direct acute toxicity to surface layer organisms, though available products vary greatly in their aquatic toxicity.

Solidifiers

Objective:

To change the physical state of spilled oil from a liquid to a solid.

Description:

Chemical agents (polymers) are applied to oil at rates of 10-45 percent, solidifying the oil in minutes to hours. Various broadcast systems, such as leaf blowers, water cannons, or fire suppression systems, can be modified to apply the product over large areas. Can be applied to both floating and stranded oil.

Applicable Habitat Types:

All water environments, bedrock, sediments, and man-made structures.

When to Use:

When immobilization of the oil is desired, to prevent re-floating, penetration into the substrate, or further spreading. However, full solidification may not occur unless the product is mixed well with the oil, and may result in a mix of solid and untreated oil. Generally not used on spills of heavy oil because the product cannot be readily mixed into viscous oils.

Biological Constraints:

Must be able to recover all treated material.

Environmental Effects:

Available products are insoluble and have very low aquatic toxicity. Unrecovered solidified oil may have longer impacts because of slow weathering rates. Physical disturbance likely during application and recovery.

Chemical Shoreline Pre-Treatment

Objective:

To prevent oil from adhering to or penetrating the substrate.

Description:

Various types of chemicals, either solidifiers, surfactants, or film-forming agents, are applied to habitats in advance of the oil to prevent oil adhesion and penetration. Application must occur just prior to stranding of the oil, thus it is time-critical.

Applicable Habitat Types:

For solidifiers, bedrock, sand and gravel habitats, and man-made structures. For surfactant-type products and film-forming agents, sand to gravel habitats.

When to Use:

When oil is projected to impact an applicable shoreline, particularly those which have high recreational or aesthetic value. However, lack of information on the availability, effects, and effectiveness of most products greatly limits their use.

Biological Constraints:

The toxicity of currently available products vary over three orders of magnitude, thus each product should be evaluated prior to consideration for use. Solidifiers should not be applied where smothering of organisms is of concern.

Environmental Effects:

Product-specific. Solidified oil will have higher smothering effects. Products which disperse oil will affect nearshore resources. See discussion for dispersants and solidifiers.

Shoreline Cleaning Agents

Objective:

To increase the efficiency of oil removal from contaminated substrates.

Description:

Special formulations are applied to the substrate, as a presoak and/or flushing solution, to soften weathered or heavy oils to aid in the efficiency of flushing methods. The intent is to be able to lower the water temperature and pressure required to mobilize the oil from the substrate during flushing.

Applicable Habitat Types:

On any habitat where water flooding and flushing procedures are applicable.

When to Use:

When the oil has weathered to the point where it will not flow using warm to hot water. This approach may be most applicable where flushing decreases in effectiveness as the oil weathers.

Biological Constraints:

The released oil should be recoverable rather than dispersed into the water column. Use may be restricted where suspended sediment concentrations are high, adjacent to wetlands, and near sensitive nearshore resources.

Environmental Effects:

If more oil is dispersed into the water column, there could be more oil sorbed onto suspended sediments and transferred to nearshore habitats, particularly along sheltered shorelines.

Nutrient Enrichment

Objective:

To speed the rates of natural microbial degradation of oil by addition of nutrients (generally nitrogen and phosphorus).

Description:

Nutrients are applied to the habitat in one of several methods: soluble inorganic formulations which are dissolved in water and applied as a spray, requiring frequent applications; slow-release formulations which are applied as a solid and designed to slowly dissolve; and oleophilic formulations which adhere to the oil itself, thus they are sprayed directly on the oiled areas.

Applicable Habitat Types:

Could be used on any habitat type where safe access is allowed.

When to Use:

On moderately to heavily oiled substrates, after other techniques have been used to remove as much oil as possible; on lightly oiled shorelines where other techniques are destructive or not effective; and where nutrients are a limiting factor in natural degradation. Most effective on diesel-type and medium oils that do not have large amounts of high-molecular weight, slowly degrading components. Less effective where oil residues are thick. Not considered for gasoline spills which will be completely removed by evaporation at faster time frames than microbial degradation.

Biological Constraints:

Not suitable in shallow water or restricted waterbodies where nutrient overloading may lead to eutrophication, or where toxicity of nutrients, particularly ammonia and nitrates are a concern. Contact toxicity of oleophilic formulations may restrict areas of direct application. Toxicity tests should be evaluated carefully, as other chemicals in the product could be toxic to aquatic organisms.

Environmental Effects:

Very little information available on effects in freshwater.

Natural Microbe Seeding

Objective:

To speed the rates of microbial degradation of oil by addition of nutrients and microbial products.

Description:

Formulations containing hydrocarbon-degrading microbes and fertilizers are added to the oiled area. The argument is made that indigenous organisms will be killed by the oil or not able to degrade the oil, so new microbial species need to be added to speed the process of biodegradation.

Applicable Habitat Types:

Could be used on any habitat type where safe access is allowed.

Biological Constraints:

Not suitable in shallow water or restricted waterbodies where nutrient overloading may lead to eutrophication, or where toxicity of nutrients, particularly ammonia, is of concern. Toxicity tests should be evaluated carefully, as other chemicals in the product could be toxic to aquatic organisms.

Environmental Effects:

Very little information available on effects in freshwater.

When to Use:

On moderately to heavily oiled substrates, after other techniques have been used to remove as much oil as possible; on lightly oiled shorelines where other techniques are destructive or not effective; and where nutrients are a limiting factor in natural degradation. Most effective on diesel-type and medium oils that do not have large amounts of high-molecular weight, slowly degrading components. Less effective where oil residues are thick. Not considered for gasoline spills which will be completely removed by evaporation at faster time frames than degradation.

Appendix 1 Potential Effectiveness of ISB

Although in situ burning is a relatively simple technique, its effectiveness can be limited by spill circumstances. Whether and how oil burns is the result of the interplay among a number of physical factors related to the oil itself and the extent to which the oil has been exposed to the environment. Critical factors-such as oil thickness, degree of weathering, and extent of emulsification-generally change with the passage of time, and the changes that occur make it more difficult to burn the oil. As a consequence, in situ burning is most easily and effectively implemented during the early stages of a spill.

The efficiency of in situ burning is highly dependent on a number of physical factors. Test burns and actual spill situations suggest it can be very effective in removing large quantities of oil from the water. Burn efficiencies of 50 to 90 percent can be expected making this response method more efficient than others methods. In comparison, mechanical removal (such as skimming) typically has an efficiency of 10-20 percent. .

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

Appendix 2 ISB Relationship to Other Countermeasures and Potential Environmental Tradeoffs

Relationship to Mechanical and Other Response 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 alone.

While physical containment and mechanical removal of spilled oil is the primary objective of any response, prudent planning dictates the consideration of alternative countermeasures.

Summary of Potential Tradeoffs Relevant to ISB

As is the case with all response methods, the environmental tradeoffs associated with in situ burning are situation dependent and cannot be considered independently from operational tradeoffs. In situ burning 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.

Advantages

- In certain areas where other techniques may not be possible or advisable due to the physical environment (e.g., ice conditions or wetlands) or the remoteness of the region, burning may represent one of the few viable response choices besides no action.
- In situ burning may prevent or significantly reduce the extent of shoreline impacts, including exposure of sensitive biological resources, wildlife habitats, and the oiling of high value recreational or commercial beaches.
- The magnitude of a spill may overwhelm the containment and storage equipment deployed or available for a region, necessitating the consideration of other methods in an overall response strategy.
- Burning can rapidly remove a large volume of oil from the surface of the water, reducing the magnitude of subsequent environmental impacts of stranded oil.

Disadvantages

- Large quantities of highly visible black smoke is generated that may adversely affect human and other exposed populations downwind.
- There may be the potential for mortalities and other adverse biological impacts from localized temperature elevations at the water surface. Although this would be expected to occur in 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. Adverse impacts from temperature elevation

should be considered relative to the toxic effects of the spill if burning is not employed.

- The longer-term effects of burn residues on exposed biological populations has not been investigated. It is not known whether these materials represent a significant source of toxicity.
- In situ burning must be carefully controlled in order to maintain worker safety and to prevent unintended environmental impacts.
- 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.

Appendix 3 Proposed Guidelines for ISB in Marshes

Based on the available data on effectiveness and effects of burning on oiled marshes, the following guidelines are proposed:

- Make sure that it is possible to contain and control the fire; it is not as easy to put out a fire in vegetation as it is with oil contained in a fireproof boom.
- □ Impacts to below ground vegetation are likely to be lower if there is a water layer between the oil and the substrate.
- □ A standing water layer of just a few inches may get hot enough to kill shallow roots anyway, however, little information is available regarding this effect.
- □ Burning of oiled woody wetland vegetation (compared to grasses and sedges) should not be considered.
- Not enough is known about seasonal effects on the ability of burned, oiled vegetation to recover, yet burning in late fall to early spring, when the vegetation is dormant and before production of new growth seems to be the best time.
- If it can be done with minimal impacts, heavy accumulations of oil should be removed using other methods, to reduce the amount of burn residues which may cause long-term impacts to both vegetation and animals returning to the habitat.
- □ Light fuels oils and crudes burn more efficiently and generate less residues, which should reduce the potential for long-term impacts.
- □ Burning of oil trapped in ice appears to have the least environmental impacts because the burn area is contained, the plants are dormant, and the above-ground vegetation is dead.
- □ There is some concern that burning of muddy substrates could alter their physical properties(i.e., make them hard) thus degrading their biological productivity.
- Every wetland is different in terms of the type of wetland, the species growing there, the condition (optimal or marginal for species use), and the known or estimated tolerances of that type of system to physical and chemical disturbances. Biologists or botanists should be consulted prior to the use of burning as a cleanup technique in a wetland.
- Mechanical or manual alternatives to in situ burning may compact oil into sediments, where it persists longer. Therefore, the relative damages from different response options should be weighed carefully.

ISB in Wetland Habitats.

There are few studies on the relative effects of burning oiled wetlands compared to other techniques or natural recovery and most of the experience is derived from estuarine habitats. However, in situ burning in wetlands can be effective since it can remove a large quantity of oil with a minimum of physical disturbance. The type of wetland vegetation and the season of the year along with many other factors will dictate whether burning is feasible in a particular wetland.

Refuge managers have historically conducted prescribed burns of wetlands to rejuvenate wetlands that have accumulated high litter loads, generate green vegetation or open spaces to attract wildlife, release nutrients for re-cycling, and to restore habitats in areas that were historically subject to frequent wildfires to their natural conditions. The presence of oil in a wetland may have two important effects: the high BTU of the oil may increase the temperature and heat penetration of the burn, and there is often an oil residue which can cause toxicity. However, the experiences of fire ecologists and practitioners can greatly contribute to the development of guidelines for burning wetlands as a spill-response strategy. Guidance is being developed for specific types of wetlands such as:

- ☐ Wooded swamps
- ☐ Fresh-to-brackish impoundment marshes
- ☐ For Region 7 marshes (lock and dam pools)
- ☐ Riparian wetlands
- ☐ Inland freshwater marshes
- ☐ Potholes

Based on discussions with refuge staff with fire management duties, the following general considerations for use were developed:

Pros

- ☐ Where access is limited or mechanical/manual removal has the potential to cause more damage by equipment and trampling, burning can rapidly remove oil from sensitive areas.
- ☐ It provides a response option when no others are acceptable, or where likely oil residues will be unacceptably high with other options, including natural recovery.
- It rapidly removes oil from the habitat when there is a time-critical element, such as a short-term change in the physical conditions which will likely cause loss of containment and further spreading, or a seasonal increase in wildlife use, such as arrival of large numbers of migratory waterfowl.

Cons

- ☐ Burning can cause substantial initial plant damage because the above-ground vegetation is removed.
- ☐ Burning can cause long-term impacts to vegetation, especially if the fire is so hot that the below-ground plant parts are killed.
- ☐ There is a potential for burning to increase oil penetration into the substrate, when there is no standing water.
- ☐ Any animals present and unable to escape (such as gastropods on clean vegetation above the oiled area) will be killed.

Appendix 4 Air Monitoring Guidelines for Human Health Impacts of ISB

In situ burning may affect two groups of people: the workers conducting the burn (the responders), a fairly homogeneous group of young, healthy adults, and the general public, which is much more heterogeneous and includes individuals who are more susceptible to toxic agents. The basic premises and possible monitoring options for each group are discussed below.

Monitoring for Responders

The responders, i.e., the workers assigned to conduct the in situ burn, are likely to be healthy and physically fit adults. Responders' locations will vary with the nature of the burn and the stage at which it is conducted. Most of the time they are expected to be upwind of the slick and the smoke plume. However, at times they may be downwind of the evaporating slick and therefore be exposed to volatile organic compound (VOCs). Responding crews may also be downwind and near the burning oil where they can be exposed to combustion products.

Responders may be exposed to VOCs from the evaporating slick, similar to what is expected during skimming operations, and to combustion by-products from the burning oil: carbon dioxide, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulates, and other combustion products. Air concentration of those substances depends on many variables, and we can expect substantial variability. Responders may be exposed to levels of gases and particulates above the permissible occupational exposure limits, and should therefore be provided with personal protective equipment and be trained in its proper use. In reality, responders' exposure is likely to be intermittent, and will vary greatly depending on location, weather conditions, and assigned tasks. Overall exposure duration is expected to vary from minutes to several hours.

Sampling Purpose

Sampling the responders' exposure level should serve several purposes, among them:

- ☐ Characterize exposures and hazards associated with the operation to provide better protection;
- ☐ Compliance with OSHA requirements, per 29 CFR 1910.134 b.(8)1 and 29 CFR 1910.120.q.3.(ii)2;
- ☐ Data collection for scientific purposes.

Air sampling should not substitute for workers' protection and safe work practices. Responders should be protected from overexposure regardless of monitoring and air sampling.

Exposure Limit

Exposure limits for responding personnel should be based on occupational exposure guidelines (see Table 1) such as OSHA's Permissible Exposure Limits (PEL) or applicable State standards. Exposure to the general public should not exceed the National Ambient Air Quality Standards (NAAQS).

Table 1. Occupational Exposure Limits and the National Ambient Air Quality Standard for the Most Significant Products of ISB

COMPOUND	OSHA PEL ¹	ACGIH TLV ²	NAAQS ³
benzene (in VOC)	1 ppm (5 ppm)*	10 ppm (32 ppm)	N/A
nitrogen dioxide	(1 ppm)	3 ppm (5 ppm)	0.053 ppm annual average
sulfur dioxide	2 ppm (5 ppm)	2 ppm (5 ppm)	0.03 ppm annual average (0.14 ppm 24 hour average)
carbon monoxide	35 ppm (200 ppm)	25 ppm	9 ppm
PAHs	0.2 mg/m ³	0.2 mg/m ³	N/A
particulates PM-10	5 mg/m ³	5 mg/m ³	0.05 mg/m ³ annual average (0.15 mg/m ³ 24 hour average)

1. U.S. GPO, 1993. 29 CFR 1910.1000, Table 2.

2. American Conference of Government Industrial Hygienists, 1993. Threshold Limit Values for Chemical Substances and Physical Agents, 1993-1994. Cincinnati, OH.

3. U.S. GPO, 1993. 40 CFR 50.4 to 50.11.

* Numbers in parentheses indicate short-term exposure limits (STEL)

When To Sample

Sampling should be done as long as there is a potential for exposure .

Sampling Method

Industrial hygiene equipment and methods may be used. This may include personal sampling pumps, passive dosimeters, and real-time instruments. In general, the sampling should:

- follow sound industrial hygiene practices and procedures, including taking blank samples, proper sample packaging, etc.;
- be a combination of area samples (e.g., instruments placed on the boom towing boats), and personal sampling on the workers themselves;

- include both short-term peak exposure and time-weighted average, taken over the total length of exposure;
- be done for all substances of concern, making VOCs and particulates the top priority;
- determine background levels before and after the burn; and
- avoid erroneous readings caused by sources of smoke or fuel on the vessels, e.g., exhaust fumes, fuel vapors.

Protection

Responders should use safe operating procedures such as staying upwind of the burn and the slick as much as possible and keeping safe distances from the fire. Responders should use respiratory protection and protective clothing as needed. It should be emphasized that safety risks such as heat and cold stress, falling overboard, or vessel collisions are just as real as chemical exposure, and more acutely dangerous. Responders should receive safety training that should include description of the hazards involved, precautions to be taken, and proper use of the safety equipment.

Monitoring for General Public

The general public usually includes people of all ages. It also includes individuals with allergies and with respiratory, cardiovascular, and other diseases. The vulnerability of these individuals to combustion by-products may be much greater than that of the responders. The distance between the general public and the burning site may vary greatly, depending on the specifics of the burn. The operational guidelines suggest six miles when the wind blows toward shore. However, burns may be conducted closer than six miles if conditions permit. Similarly, a burn may be inappropriate at six miles or a greater distance, if conditions are unfavorable.

Several miles downwind of the burn, levels of vapors evaporating from the slick and gaseous by-products the fire are expected to be near background levels. Particulate level is the main concern. Based on data from experimental burns and from computer models, the level of particulates in the center of the plume three miles downwind of the burn is expected to be around 150 mg/m³ (McGrattan et al. 1993). If the burning is conducted according to the operational guidelines suggested above, PM-10 levels six miles away from the burn should be significantly lower than 150 mg/m³ in the center of the plume, and much lower than that at ground level. Concentrations at any one location will depend on specific atmospheric conditions at the time of the burn.

Visual Observations

Visual observations should be conducted to track plume direction and height, and to verify that the smoke behaves as predicted by the weather reports. Observations from ships and aircraft should continue as long as the burning takes place.

Monitoring Considerations

There are legitimate concerns about exposure to the smoke plume by the general public and environment. In order to make decisions concerning the continuation of an in situ burn, it is advisable to collect information concerning concentrations of smoke particulates of 10 ppm (PM-10) or less. Monitoring should be established when there is reason to believe that the weather conditions and/or location of the burn could produce a situation in which the general public or sensitive environments could be affected by fallout from the smoke plume. Depending on circumstances, the burn may be monitored by qualitative assessment (i.e., visual observation) and/or by quantitative methods that employ air sampling.

Exposure Limits

Exposure limits for the general public should be based on the National Ambient Air Quality Standards, which is used by EPA for air quality control. The standard for respirable particulates 10 ppm in diameter and smaller (PM-10) is shown in Table 1. To err on the side of safety, this Region 7 policy adopts an action level of a 150 mg/m³ average over one hour. Concentrations above this level should result in operational measures to control the rate of burn/smoke formation.

Sampling Limitations

In general, air sampling should not be regarded as a requirement for conducting in situ burning but as an option if the situation warrants. Sampling should not be used as the means to determine whether the public is adequately protected: the public should be protected regardless of air sampling. We believe that such protection may be achieved by adhering to operational guidelines. Sampling, however, may be valuable by providing feedback information to the OSC, by increasing the comfort level of both those conducting the burn and those potentially exposed to it, and by collecting data that may be of value for future in situ burning. Trends are more important than a single number. The readings of a real time particulate monitor may fluctuate widely, depending on nearby activity such as passing cars or smoke from fireplaces in nearby houses. A single reading may be misleading. Averaging the concentration readings over a period of time (e.g., 15 minutes) should provide an indication of the trend, that is, whether particulates concentration goes up or remains steady. Visual observations coupled with sampling that could provide the general trend of particulate concentration should be useful in ascertaining the effect of the burn on exposure of the general population to particulates.

It is also important to state clearly the limitations and shortcomings of sampling data. These data should be interpreted correctly, and the numbers should be presented with the associated uncertainty and possible interferences and inaccuracies. Otherwise, the numbers may not mean much or, worse yet, be misleading.

Sampling

Sampling may be conducted for several reasons:

1. To assess exposure levels at different points, in order to provide immediate feed back to the OSC, and to verify visual observations of plume behavior.
2. Validation of air dispersion models
3. To satisfy other scientific or historical data collection needs

Based on previous experience, the concentration of gases in the plume would drop to below the exposure limit within several hundred yards of the burn. Particulate concentration in the center of the plume may remain above the level of concern for several miles downwind. Sampling of particulates should therefore be the main effort.

When To Sample

Sampling is an option that may be exercised anytime during the burn. It may be desirable when there is a potential for exposure (even if it is expected to be below the limit). Therefore, sampling may be done when the plume drifts over a populated area, over natural resources, or for scientific data collection, at various locations downwind of the burning site. Since the purpose of this sampling is to monitor in situ burning effects on sensitive populations, there is no need to require it when there is no reason to believe that a sensitive population will be affected. If the smoke plume is expected to be carried away from population centers or sensitive areas, sampling should not be required.

Sampling Equipment

Sampling equipment should be:

- ☐ Portable, easily deployable, and available when needed;
- ☐ Sensitive, accurate, and precise enough to provide meaningful data;
- ☐ If possible, provide real-time readings for immediate feedback and, in addition, have the capability to log readings over several hours, to get the average concentration over an extended period of time.

Real-time particulate samplers are commercially available from several manufacturers.

In addition, sampling pumps using filter media may be deployed at various locations. Their data, which is not real time, may be used for exposure assessment, model validation, and to provide information for future in situ burning.

Recommended Air Monitoring Equipment for ISB

The primary health concern for in situ burning is the evolution of particulates from the burning of crude oil, fuel products or other hydrocarbons. Secondly, within the first several hours of the burn, the generation of volatile organic compounds (VOCs) and polynuclear aromatic hydrocarbon's (PAHs) vapors could be additional health and safety concerns in the immediate area. Air monitoring is an important tool in communicating risks involved to the public at an emergency response. If it is determined that a burn will be conducted and there is risk of exposure to a human population center, then air monitoring should be completed (see pages 16 to 19). The Responsible Party (RP) may conduct air monitoring in conjunction with a burn, either independently or with government oversight. The air monitoring results should be immediately reviewed and assessed to determine the effectiveness of the burn and to address any public health concerns.

The U.S. EPA Region 7 Emergency Response Branch and its contractors, along with the U.S. EPA Environmental Response Team (ERT) and United States Coast Guard Strike Teams, are often called in emergencies to conduct perimeter and on site air monitoring. The U.S. EPA regional offices maintain a 24 hour readiness along with contractor support to provide air monitoring equipment at an emergency response. Equipment arrival time would depend on the mobilization time to the scene from the Regional Office. For a spill on the upper Mississippi this would translate to 3 to 10 hours. The Federal On-Scene Coordinator (FOSC) can mobilize additional air monitoring resources from the ERT or from the USCG Strike Teams. The State Emergency Response Coordinator, or local HAZMAT team, can also mobilize air monitoring resources during an emergency.

The ERT in Edison, New Jersey, is on call 24 hours and is equipped and specialized in supporting OSC's in conducting air monitoring. The ERT can mobilize to the site within 12 to 24 hours after being notified by a FOSC to support air monitoring activities. The United States Coast Guard maintains the Strike Teams to provide assistance to the OSC during an emergency. The Strike Teams are equipped and trained to provide air monitoring, safety monitoring, and other assistance to the OSC as needed. The Strike Teams can mobilize to the site in 12- 24 hours to provide air monitoring assistance.

During an incident when in situ burning is being evaluated, and humans could be exposed to the smoke plume, it is recommended that the Incident Commanders plan to have air monitoring set up prior to and during the burn event. The U.S. EPA and its contractors would immediately mobilize staff and equipment to monitor for particulates using Real Time Aerosol Monitors (RAMs). In addition, carbon monoxide, carbon dioxide, and VOCs can be monitored directly at the burn location. The U.S. EPA 7 office and its contractors maintain air monitoring equipment to support these operations.

It is recommended that direct reading instrumentation be used to monitor the effectiveness and potential health concerns during a burn. The data should be evaluated, assessed and communicated to the workers and to the public as soon as the results become available. The Real-Time Aerosol Monitors (RAMS), Mini Real-Time Aerosol Monitors (Mini-RAMS), or equivalents, serve as valuable tools to access the particulates in a plume which could impact humans during an in situ burn. The current guidelines for safe levels of particulates are a PM-10 (particulate matter less than 10 microns) concentration of less than 150 micrograms per cubic meter. The proposed Clean Air Act Amendments may change the PM-10 standard. The RAM and Mini-RAM instruments will directly read a measure of the total particulate in milligrams per cubic meter and give real time data for monitoring the particulates in air. The instruments can be used to screen residential areas during an in situ burn so that particulate concentrations can be monitored and the risk to the public and on-site workers may be assessed. The RAMS and Mini-RAMS have been used successfully at tire fires, train derailments involving flaring of hydrocarbons, and other chemical fires where an observable plume is seen.

In addition to the above instruments, the U.S. EPA would mobilize a flame ionization detector, explosimeter, and a portable gas chromatograph to monitor volatile emissions directly at the source of the burn. The U.S. EPA maintains portable gas chromatographs, colorimetric tubes, and fixed sampling pumps, to monitor volatile emissions, PAHs, particulates, carbon monoxide and carbon dioxide during an in situ burn.

The air monitoring equipment described in the following table can be mobilized to an emergency by calling the U.S. EPA Regional Office or the National Response Center.

U.S. EPA Region 7 (24 hour Spill Line) 913-281-0991

National Response Center 800-242-8802
(Manned by USCG can tie into USEPA regional Office or USCG Office)

The State Emergency Response Section or Local HAZMAT team can also mobilize air monitoring equipment to the scene. Both can be contacted through the State Emergency Response telephone numbers found in the Notification Section of the Region 7 Integrated Contingency Plan.

Another resource for air monitoring equipment can be vendors, such as industrial hygiene subcontractors, who rent air monitoring equipment. These vendors can make equipment available within 24 hours of an incident.

The NOAA Scientific Support Team can also provide air monitoring resources from its field office at Louisiana State University.

Table 2 shows the current inventory of air monitoring capabilities for in situ burning in U.S. EPA Region 7.

Table 2. USEPA Region 7 Air-Monitoring Capabilities For ISB

INSTRUMENT OR TECHNIQUE	TARGET COMPOUND(S)	SAMPLING PERIOD OR TURNAROUND TIME	COMMENTS\ LIMITATIONS
Combustible Gas and Oxygen Alarm Model 261	Measures levels of oxygen and flammables	Real-time monitoring	Indicates whether it is safe to enter an area; won't measure mists of some oils.
Minirams (Total particulate Miniature Real-time Aerosol) Model PDM-3	Will yield measure of total particulates in milligrams per cubic meter.	Once calibrated, they will give reading 36 seconds after turned on and then a reading every 10 seconds for 500 minutes.	Three available at START KC office. Could be zeroed out before ignition of spill. No analysis of components of particles measured.
Gilian Personal Sampling Pumps HFS Air Sampling Systems	Capable of sampling for wide range of compounds, including PAHs.	Sample duration of at least 4 hours necessary, longer for some compounds.	START has access to 15 and there are 15 at EPA Region 7. A realistic startup is 48 hours after notice, because of need for charging and calibration, and purchase of unique sampling trains, which include absorbent tubes, cassettes, filters and microimpinger traps.
Draeger Tubes	Region has tubes for H ₂ S, CO, CO ₂ , TPHs, SO ₂ , benzene, toluene and xylenes. No PAH tube on market.	Real-time results that are quasi-quantitative.	Almost instantaneous results. EPA also has Sensidyne kits, which will give similar results.
OVAs	Provides concentrations of unidentified total volatiles.	Gives real-time results of total volatiles.	3 OVAs in KC START office, 2 in St. Louis; it does not provide chemical-specific results

INSTRUMENT OR TECHNIQUE	TARGET COMPOUND(S)	SAMPLING PERIOD OR TURNAROUND TIME	COMMENTS\ LIMITATIONS
HNU	Provides analysis of total volatiles present; some limitations in reading, compounds depending on span in photo-ionization detection (PID) lamp.	Gives real-time results of total volatiles.	3 HNU's in KC START office, 2 in St. Louis; use limited in wet conditions; soot during burn would likely coat lamp, making it unusable. No chemical-specific results.
TVA-1000	Analysis of total volatiles, with both flame ionization detector and photo-ionization detector.	Gives real-time results of total volatiles. Can be set for 8-hour exposure mode.	2 Available in KC START office; lamp of PID less exposed to moisture and soot, so of a little more use than HNU.
Monitox	Designed for confined space, rather than ambient sampling. Only H ₂ S and HCN available.	Designed to show whether threshold levels of gases exist.	2 of each in KC START office.
Polyurethane foam (PUF) samplers	Could be used to collect volatile and semivolatile samples; use on PAHs in region been very limited.	Sampling durations of several hours -- up to 3 days -- are standard.	Eight are regularly available in Kansas City, but more are available from other regions. Require power source.
PM-10 Air Samplers	Will measure particles of <10 microns.	Sampling durations of several hours are required.	Require power source; is a radioactive element involved.
Single Point Monitor from MDA Scientific	Inorganics, including ammonia, hydrogen cyanide and sulphuric acid	The SPM is designed to work with specific key, and cassette, which must be kept frozen. They are not kept on hand by START. Acquisition time would be 48 hours.	The setup time and limitation of sampling to such analytes as cyanides, acids and amines makes its use during any in situ burn response unlikely.

INSTRUMENT OR TECHNIQUE	TARGET COMPOUND(S)	SAMPLING PERIOD OR TURNAROUND TIME	COMMENTS\ LIMITATIONS
Summa Canisters	Summas can be used to collect a wide range of volatile compounds, but they do not lend themselves to collection of semi-volatiles, particularly PAHS, which stick to the inside of the canister.	Sampling periods vary from minutes to several hours. 24-hour analytical turnarounds are possible.	Real-time applications must be tied to presence of Mobile Laboratory or use of portable GC, such as Photovac. Not applicable to nonvolatiles.
Portable Gas Chromatograph, Photovac	Volatile Compounds	Estimated 2-3 hours after arrival at spill.	The Photovac has been used primarily to analyze head space samples from soil in the region. It has the potential to analyze air samples collected in Summa canisters, but it is necessary to extract samples collected from Summas. It does not lend itself to analysis of semi-VOCs.
EPA Mobile Lab	Can measure volatiles from samples collected from air, water or soil.	Will ultimately be capable of prompt turn-around of field samples collected in Summas or soil-gas bottles. The Lab is currently being retrofitted and updated.	Mobile Lab must be driven to spill site; it will require four additional hours to calibrate equipment. Some extractions will require 24-48 hours. Could be used for samples containing VOCs, semi-VOCs, PCBs and PAHs.

Sampling Location

Sampling location should be based on priority concerns, with the first priority given to population centers downwind of the burn. For scientific data collection, (e.g., model validation) we recommend that samplers be placed at different distances from the burn to collect particulate concentration data at ground level. Data collected would be extremely valuable for future burns.

If it is determined that sampling is needed, real-time particulate samplers (PM-10) should be positioned on: 1) the shoreline, at the expected centerline of the plume; 2) at the population center of concern; and 3) in several locations in the vicinity of the population downwind of the burn. PM-10 samplers which can operate for more than eight hours, can collect PM-10 reading before the burn commences, (to gather background data during the burn), during the actual burn, to assess the burn effect; and, if possible, after the burn is over, to collect post-burn readings. Sampling results should be relayed to the FOSC. If it is established that the readings exceed the level of concern, the FOSC will be so advised.

Other Sampling Considerations

1. Area background readings should be taken before and after the burn to determine baseline levels.
2. EPA and regional air monitoring stations may be able to assist by providing historical data, and by conducting air sampling during the burn itself.

Appendix 5 Public Notification for ISB

Notification of the public of an impending burn is critical to the overall success of an in situ burn effort. The notification, coordinated through the joint information center, should focus on conveying the following messages:

- Burning is a simple, well understood, and controlled practice.
- Strict health and environmental criteria are being used in deciding whether or not to burn.
- Burning is being conducted because it presents the opportunity for greater health and environmental protection than could be achieved by other spill response methods or no response.
- Health and environmental precautions will accompany burning.
- The burns will be carried out by specially trained personnel and will be closely monitored.
- The public will be notified of each burn before or as it begins.

Public notification can be initiated through radio/TV broadcasts. If necessary, local government and state emergency service personnel with access to established public warning systems and authority to use them can facilitate this notification.

Materials to educate the public and media about burning, its risks, tradeoffs with other countermeasures should be developed ahead of time and available for dissemination during the burn. This material would cover the trade-offs involved in choosing response countermeasures, and relate the risks of in situ burning to better known risks (e.g. forest fires). Distribution of this information can be through the agencies' public affairs offices prior to a spill and through a joint information center established during a spill.

Suggested Public Notice for ISB

At (time) on (date), a release of oil occurred at (location). Following an evaluation of the situation, local, state, and federal officials have determined that burning the oil in place is the safest and most effective way to protect the public health and environment. The burn will be conducted under controlled conditions to ensure that the fire will be a minimum threat to the public, property, or environment.

The decision to burn was made after considering strict health and environmental criteria. Officials have determined that the burning will present an opportunity for greater health and environmental protection than can be achieved by using other spill response methods, including not responding. Health and environmental precautions will accompany the burning.

The burns will be carried out by specially trained personnel and will be closely monitored. The burn will begin at approximately (time), and the public will be advised when the burn is complete. Questions should be directed to (person or organization) at (telephone number).

Appendix 6 Ecological Considerations for ISB

Open Water ISB

Potential ecological impacts of open water in situ burning have not been extensively discussed or studied. Conclusions are based on documented physical effects observed in the laboratory and at limited test burns.

The surface area affected by in situ burning is likely to be small relative to the total surface area and depth of a given body of water. This does not necessarily preclude adverse ecological impacts, particularly if rare or sensitive species use the waters in question. Organisms that may be affected by in situ burning include those that use the uppermost layers of the water column, those that might come into contact with residual material, and possibly some benthic (bottom-dwelling) plants and animals.

Direct Temperature Effects

Burning oil on the surface of the water could adversely affect those organisms at or near the interface between oil and water, although the area affected would presumably be relatively small. Observations during large-scale burns using towed containment boom did not indicate a temperature impact on surface waters. Thermocouple probes known to be in the water during the Newfoundland burn showed no increase in water temperatures during the burn (NOBE Facts, January 1994). It appears that the length of time the burning layer resides over a given water surface may be too brief to change the temperature due to the fact the ambient temperature water is continually being supplied below the oil layer as the boom is towed.

Surface Microlayer

Role and importance of the surface microlayer - The surface of the water represents a unique ecological niche called the "surface microlayer," which has been the subject of many recent biological and chemical studies. Although most studies of the microlayer have been conducted in the marine environment, the results can also be applied to the freshwater environment. The microlayer, variously defined but often considered to be the upper millimeter or less of the water surface, is a habitat for many sensitive life stages of aquatic organisms, including eggs and larval stages of fish and crustaceans, and reproductive stages of other plants and animals. The microlayer also is a substrate for microorganisms and, as such, is often an area of elevated microbial population levels and metabolic activity.

Potential effects of burning on the surface microlayer - The ecological importance of the surface microlayer and the potential impacts to it from burning activities have been discussed in the different, but related, context of 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 to in situ burning. Accordingly, potential impacts to the ecologically important surface microlayer are, to some extent, offset by the presumably short-lived nature of the burn and its associated residual material.

Environmental Toxicological Considerations

Although many studies to define the physical and chemical characteristics that result from in situ burning have been performed, there has been little research on potential ecological effects. To address some of these information shortfalls, Environment Canada coordinated a series of studies to determine if in situ burning resulted in water column toxicity beyond that attributable to allowing the slick to remain on the surface of the water. While these studies centered on the Newfoundland in situ burn field trials conducted in August, 1993, they also included laboratory tests to investigate potential effects in a more controlled environment.

Toxic effects were evaluated using three standard marine test organisms: sand dollar, oyster, and fish. In both the laboratory and the field experiments, sensitive toxic endpoints in these organisms were studied in the three situations of no oil, no burning; oil on water, no burning; and oil on water, burned. Results from the laboratory and field studies indicated that although toxicity increased in water samples collected below burning oil on water, this increase was generally no greater than that caused by the presence of an unburned oil slick on water. Chemical analyses performed in conjunction with the biological tests reflected low hydrocarbon levels in the water samples. In addition to water column samples, the residues remaining after the laboratory and Newfoundland field burns will be subjected to aquatic toxicity testing.

Beyond the direct impacts caused by high temperatures, the by-products of in situ burning may be toxicologically significant. 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 (U.S. EPA 1986). Strand and Andren (1980) noted that aromatic hydrocarbons in aerosols originate from combustion associated with human activities, and that these compounds accumulate in the surface microlayer until absorption and sedimentation remove them.

Burn residues could be ingested by fish, birds, mammals, and other organisms, and may also be a source for fouling of gills, feathers, and fur. However, these impacts would be expected to be much less severe than those manifested through exposure to a large, uncontained oil spill.

Contamination is likely to be local in scale affecting certain unique populations and organisms that use surface layers of the water column at certain times to spawn or feed. In crafting an effective and protective response strategy, these effects should be weighed against effects resulting from alternative actions.

Appendix 7 Safety and Health Considerations and By-products of ISB

Safety of Response 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 - Care must be taken that the burn be controlled at all times to ensure the safety of personnel and property. This precludes burning at sources such as tankers, barges, pipelines, or tank farms unless means are taken to ensure that the flame cannot propagate from the burn location to the source.

Ignition Hazard - Personnel and equipment involved in ignition of the oil slick must be well coordinated. Weather and water conditions need to be kept in mind and adequate safety distances be kept at all times. Specialized ignition equipment, unknown fire behavior and uncertain flash-points introduce safety risks.

Vessel Safety - Burning on waterways may involve the use of several vessels operating in close proximity, perhaps at night or in conditions of poor visibility. These conditions are hazardous by nature and generally require training and close coordination. Maneuverability while towing boom or positioning other containment equipment will require skilled personnel.

Training - Training of personnel to operate equipment for in situ burning should be developed to minimize the risk of injury and accident. Training should meet all applicable OSHA regulations and guidelines.

Response personnel working in close proximity to the burn may be exposed to levels of gases and particulates that may require the use of personal protective equipment. Training for burn personnel should include proper use of use of personal protective equipment which may be used to minimize inhalation of, and skin contact with, combustion by-products. Exposure limits such as OSHA's PELs (Permissible Exposure Limits) are applicable to this group of typically healthy adults.

Other hazards can include the exposure of personnel to extreme heat conditions, smoke and fumes; working under time constraints or extended periods of time. Personnel involved with burning operations must be well briefed on the plan of operations, with safety stressed, and must be notified of all changes from the approved burn plan. The need for burning must be constantly evaluated and should be reconsidered if conditions (e.g., weather, operations, equipment) pose a threat or danger to human health and safety, or facilities. As more knowledge is gained from burning, it is most likely that additional safety concerns will be identified.

General Public Health Considerations

Burning oil produces a visible smoke plume containing smoke particulates, combustion gases, unburned hydrocarbons, residue left at the burn site and other products of combustion. It also results in the evaporation and release of volatile compounds from the oil. Public health concerns relate to the chemical content of the smoke plume and the downwind deposition of particulates. It should be noted that not burning an oil spill also introduces its own air quality concerns. Analysis of the physical behavior of spilled oil has shown that 50 percent of a light crude oil spill can evaporate fairly readily, and it is the acutely toxic lighter fractions of a crude oil mix that quickly move into the atmosphere.

Results of recent burn tests indicate that in situ burning does not yield significant emissions above that expected for similar types of combustion such as forest fires. Many human health experts feel that the most significant human health risk resulting from in situ burning is inhalation of the fine particulate material that is a major constituent of the smoke produced. An early assessment of health concerns attributable to the Kuwaiti oil fires identified the less than 10-micron particulate matter as representing the greatest health hazard in that situation. The extent to which these particles present a health risk during an in situ burn depends on the concentration and duration of exposure. It is important to remember that particulates in these concentrations are so small that they do not settle readily. They will be carried by the prevailing wind over large distances, over which their concentrations will rapidly decline.

Polynuclear aromatic hydrocarbons (PAHs) are a group of hydrocarbons produced during in situ burning. They are found in oil and oil smoke, where their relative concentration 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 PAHs that is the basis for concern. Sulfur dioxide (SO₂) and nitrogen dioxide (NO₂) are eye- and respiratory tract irritants that are produced by oil combustion. Concentrations of PAHs decline downwind as smoke from the fire is diluted by clean air. The concentrations of other by-products of burning oil (i.e., combustible gases) also decline downwind.

Burning should not be allowed if downwind human populations are at risk. The downwind extent of human risk has not been empirically determined although it is an area of very active research. There are no exposure standards for respirable particles generated by a burn that could be applied directly to determine safe downwind distances. Atmospheric dispersion models, if available for the specific area, could be utilized to help refine potential downwind exposures. If models are not available, whenever possible, a small pilot burn could be conducted before a larger burn in order to gauge the effectiveness of the ambient conditions to disperse the smoke and gasses resultant from the burned material. Because wind direction meanders under most circumstances, no population should be within a 45° arc to either side of the wind direction. Local wind and weather events (e.g., air stability class, lake breezes, and frontal passages) must be considered when determining downwind directions.

By-products

By-products of in situ burning exist because no combustion process is completely efficient in oxidizing a given source material. Besides the normal results of burning, CO₂, H₂O, and an assortment of other sulfur and nitrogen residues, a wide range of intermediate combustion products are generated. Although the exact mix of burn residues varies, by products can be categorized into three groups: unburned oil, airborne components, and combustion residues.

Appendix 8 Operational Considerations for Conducting ISB

Open Water Burning

An open-water in situ burning technique most likely to be used would involve the use of boats towing fire resistant booms that could be used to contain the spilled oil and keep it from spreading. The boom, attached to the boats by towing lines, would be towed such that it forms a U shape. The open end of the U is maneuvered through the oil slick, and a "boomfull" of oil is collected. The boom is towed away from the main slick and the oil is ignited. During the burning the boom is pulled in such a way as to slowly advance ahead to ensure that the oil is concentrated at the back end of the boom and to maintain maximum thickness. A burn can be terminated by letting the oil layer thin out by releasing one end of the boom. After the oil is consumed the process is repeated. Other techniques may include containing the oil continuously spilling from a burning oil rig, or placing fire boom around a vessel or facility that caught fire.

Burning in Other Inland Environments

Although it is widely held that in situ burning does take place in the inland zone, little technical information exists on techniques and impacts of burning in environments other than open water. In most cases these involve burning in ice conditions and in wetlands and the results are varied and anecdotal.

Burning in Ice/Winter Conditions - Containment is almost always required to maintain the minimum 2-3 mm thickness necessary to burn oil. Ice edges can act as natural barriers, and as long as the oil is of sufficient thickness, combustion is possible. However, wind and/or low currents may be necessary to herd the oil into sufficient thickness along the edge. Oil trapped under the ice may also accumulate in sufficient thicknesses along leads in broken ice resulting in favorable conditions for burning. Test burns in a 1986 Esso wave basin showed burning efficiencies of up to 90% where moderate winds herded the oil into long narrow leads. Burning in other lead geometries and along brash ice resulted in less efficient burns. Arctic studies have also shown it is possible to ignite and burn fresh, weathered, and emulsified oil at temperatures as low as -35°C . It is important to note that an in situ burn in broken ice is not easily extinguished once ignited

Burning oil in snow conditions is similar to burning oil on water since as the snow melts during the burn it can form a meltwater pool upon which the oil continues to burn. Certain conditions such as wind, snow properties, and concentration of the oil in the snow all can impact the success of the burn. Burn efficiencies of 90-99% have been shown during field studies and actual spills. Oil/snow mixtures of up to 75% can be ignited with a diesel or gasoline soaked rag. [This section was from Detection of Oil in Ice and Burning Oil Spills in Winter Conditions, PROSCARAC, Inc., March 1992]

Fire Resistant Boom

The application of in situ burning requires the physical collection and containment of oil to maximize the efficiency of the burning process and to provide a means to control the burn. Generally, this is accomplished by the use of a fire boom or some type of fire resistant containment. If fire boom or other fire containment device is not available and/or the equipment to deploy the boom is unavailable or inadequate, approval for use of in situ burning may be denied.

Ignition

Heavy oils require longer heating times and a hotter flame to ignite compared to lighter oils. Many ignition sources can supply sufficient heat. 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. Whichever method is used considerations of safety and efficiency must enter into the decision process.

Oil Thickness

In general, oil slicks can be effectively burned if they are consistently 2 to 3 mm thick. This number can vary with oil viscosity and degree of weathering, with more viscous and more weathered oils requiring a considerably thicker layer of oil (estimated to be nearly 10 mm). Also, burn efficiencies increase as thickness of the slick increases. This consideration, therefore, implies that spilled oil must be contained by some means (fire resistant boom, ice, etc.) in order to prevent oil spreading and the resultant thinning of surface layers.

Effects of Weathering

Weathered oil requires a longer ignition time and higher ignition temperatures. However, igniting weathered oil is generally not a problem with most ignition sources because they have sufficient temperature and burn time to ignite most oils. Weathering, as it affects the ability to burn oil, is currently under study in laboratory and field experiments.

Effects of Emulsification

The effect of water content on oil ignition is thought to be similar to that of weathering, in that it decreases ignitability and combustibility. However, oil containing some water can be ignited and burned. 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. The effect of emulsions on the ability to burn oil is currently under study in laboratory and field experiments.

Unburned Oil and Solid Burn Residues

Although in situ burning has the potential for removing a large proportion of the mass of an oil spill from the water surface, some of the source material will not be consumed and will remain as a concern. Similarly, combustion residues, described as stiff, taffy-like material will remain after the burn. Provisions for the removal of these materials must be made as the potential exists for undefined levels of shoreline impacts even with a successful burn.

Although sinking of burn residues has seldom been observed in test burns, a slight increased in density relative to the original oil has been observed. In the 1991 explosion and burning of the tanker Haven off Genoa, Italy, burn residues were thought to have sunk. 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. It was reported that several surveys during 1991 confirmed that there was sunken oil offshore and along the coast. The sunken oil is now thought to have resulted from the extraordinary heating of the contained product inside the cargo holds of the vessel. This oil basically underwent a crude distillation, in which lighter components were driven off and a denser-and in this case, heavier than sea water-material remained.

It should be emphasized that the circumstances specific to this situation should not be used as the basis for generalization in all burning scenarios.

- 1 Regulations concerning respiratory protection
- 2 Regulations concerning Hazardous Waste Operations and Emergency Response (HAZWOPER)