# POLICY AND TECHNICAL GUIDELINES ON USE OF ISB AND CHEMICAL & BIOREMEDIATION COUNTERMEASURES

Note: Technical guidance in Sections IV.A through IV.F of this document were previously included in the 2024 Region 7 Regional Integrated Contingency Plan (RICP).

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# POLICY AND GUIDELINES ON USE OF ISB AND CHEMICAL & BIOREMEDIATION COUNTERMEASURES

## ANNEX IV TO REGION 7 INTEGRATED CONTINGENCY PLAN

## TABLE OF CONTENTS

**Section** **Page**

1.0 OIL SPILL COUNTERMEASURES POLICIES FOR REGION 7 .................... 1

1.1 General Policy .................... 1

1.1.1 CBC Procedure .................... 2
1.1.2 ISB Procedure .................... 2

1.2 Special Policy for FOSC Directed Burns .................... 3

2.0 ISB .................... 4

2.1 Potential Effectiveness of ISB .................... 4
2.2 Relationship to Mechanical and Other Response Methods .................... 4

2.2.1 Summary of Potential Tradeoffs Relevant to ISB .................... 5
2.2.2 Advantages .................... 5
2.2.3 Disadvantages .................... 5

2.3 ISB Decision Process .................... 6

2.3.1 Step 1: Site Conditions and Desirability .................... 6
2.3.2 Step 2: Feasibility .................... 6
2.3.3 Step 3: Acceptability .................... 7
2.3.4 Step 4: Authorization and Conditions .................... 8
2.3.5 Step 5: Monitoring .................... 9
2.3.6 Step 6: Reports .................... 9

2.4 ISB Reference Sources .................... 10

3.0 CHEMICAL & BIOREMEDIATION Countermeasures (CBC) .................... 11

3.1 What a Responder Needs to Know to Consider Use of a CBC .................... 11
3.2 CBC Decision Process .................... 12

3.2.1 Step 1: Site Conditions and Desirability .................... 12
3.2.2 Step 2: Feasibility .................... 12

APPENDIX IV.A PROPOSED GUIDELINES FOR ISB IN MARSHES .................... 14

IV.A.1 ISB in Wetland Habitats .................... 15
IV.A.2 Pros .................... 15
IV.A.3 Cons .................... 16

APPENDIX IV.B AIR MONITORING GUIDELINES FOR HUMAN HEALTH IMPACTS OF ISB .................... 17

IV.B.1 Monitoring for Responders .................... 17

## TABLE OF CONTENTS (Continued)

**Section** **Page**

IV.B.1.1 Sampling Purpose ........ 18
IV.B.1.2 Exposure Limits ........ 18
IV.B.1.3 When To Sample ........ 19
IV.B.1.4 Sampling Methods ........ 19
IV.B.1.5 Protection ........ 20

IV.B.2 Monitoring for General Public ........ 20

IV.B.2.1 Visual Observations ........ 21
IV.B.2.2 Monitoring Considerations ........ 21
IV.B.2.3 Exposure Limits ........ 21
IV.B.2.4 Sampling Limitations ........ 21
IV.B.2.5 Sampling Rationale ........ 22
IV.B.2.6 When To Sample ........ 22
IV.B.2.7 Sampling Equipment ........ 23
IV.B.2.8 Recommended Air Monitoring Equipment for ISB ........ 23
IV.B.2.9 Sampling Locations ........ 28
IV.B.2.10 Other Sampling Considerations ........ 28

APPENDIX IV.C PUBLIC NOTIFICATION FOR ISB ........ 29

APPENDIX IV.D ECOLOGICAL CONSIDERATIONS FOR ISB ........ 31

IV.D.1 Open Water ISB ........ 31
IV.D.2 Direct Temperature Effects ........ 31
IV.D.3 Surface Microlayer ........ 31

IV.D.3.1 Role And Importance of the Surface Microlayer ........ 31
IV.D.3.2 Potential Effects of Burning on the Surface Microlayer ........ 32

IV.D.4 Environmental Toxicological Considerations ........ 32

APPENDIX IV.E SAFETY AND HEALTH CONSIDERATIONS AND BY-PRODUCTS OF ISB ........ 34

IV.E.1 Safety of Response Personnel ........ 34
IV.E.2 General Public Health Considerations ........ 35
IV.E.3 By-products ........ 36

APPENDIX IV.F OPERATIONAL CONSIDERATIONS FOR CONDUCTING ISB ........ 37

IV.F.1 Open Water Burning ........ 37
IV.F.2 Burning in Other Inland Environments ........ 37
IV.F.3 Burning in Ice/Winter Conditions ........ 37
IV.F.4 Fire Resistant Boom ........ 38
IV.F.5 Ignition ........ 38
IV.F.6 Oil Thickness ........ 38
IV.F.7 Effects of Weathering ........ 39
IV.F.8 Effects of Emulsification ........ 39
IV.F.9 Unburned Oil and Solid Burn Residues ........ 39

# 1.0 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 Subarea Contingency Plan (SACP) and Chemical & Bioremediation Countermeasures (CBC) policy. Subarea Planning Committees may develop specific policies for ISB (ISB) 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 CBCs, and ISB. All four states, local authorities, and federal agencies with jurisdiction in 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 allowed within the boundaries of authority by the Region 7 Regional Response Team (RRT).**

**Notes:** On December 11, 2023, the National Contingency Plan (NCP) Subpart J final rule, as amended, became effective. See 40 CFR §§ 300.900 through 300.970 regarding the use of CBCs.

## 1.1 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 CBCs and ISB (see 40 CFR § 300.910). 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 CBCs, 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.

### 1.1.1 CBC Procedure

For CBCs the approving authority is the FOSC when the FOSC has obtained the concurrence of both the RRT's EPA co-chair and the affected state's representative, and, to the maximum extent practicable, consulted with the Federal Natural Resource Trustees' representatives on the RRT (40 CFR 300.305(e)).

### 1.1.2 ISB Procedure

ISB, 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 CBC procedure approval because such agents are considered to be in the same category as CBCs. ISB can be performed on the open water and near or on shore.

The use of ISB 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 ISBs in 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) (with the appropriate state permit).

- If the proposed burn is on a local, state, tribal, or federally-owned or managed natural resource area, the concurrence of the landowner/manager must be obtained.
- 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, SOSCs, and FOSCs 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 ISB. It is the expectation of the members of the Region 7 RRT that, except in extraordinary cases, a local incident commander or state or FOSC 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 time permits, the views of the FOSC should be sought and considered.

Because the timeframe for making decisions regarding ISB is often very short, guidelines are included in Section 2.0 to assure that the most significant issues are considered. This decision-making methodology for burning has been approved by the Region 7 RRT.

## 1.2 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 in 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.

# 2.0 ISB

## 2.1 POTENTIAL EFFECTIVENESS OF ISB

Although ISB 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, ISB is most easily and effectively implemented during the early stages of a spill.

The efficiency of ISB 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 other methods. In comparison, mechanical removal (such as skimming) typically has an efficiency of 10 to 20 percent.

ISB 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) also has been demonstrated. Difficulties with establishing and maintaining necessary slick thicknesses (in the case of lighter oils) and ignition (for heavier oils) make ISB a slightly less viable alternative for those materials than for crude oils.

## 2.2 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.

### 2.2.1 Summary of 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.

### 2.2.2 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.
- ISB may prevent or significantly reduce the extent of shoreline impacts, including exposure of sensitive biological resources, and 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.

### 2.2.3 Disadvantages

- Large quantities of highly visible black smoke are generated that may adversely affect human and other exposed biological 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.
- ISB 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.

## 2.3 ISB DECISION PROCESS

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

### 2.3.1 Step 1: Site Conditions and Desirability

- Access routes to the scene?
- Locational information, including: river mile or latitude/longitude or other precise geographical description?
- Proximity to public, biological populations, transportation routes, and valuable property?
- Material, type, amount, area, 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 A.1 through A.7 for various considerations.

### 2.3.2 Step 2: Feasibility

- Can worker, public, and property safety be reasonably assured? Responders risk exposure to airborne toxic agents. See Appendix IV-E for more information.
- Can the fire be contained?
- Are environmental conditions favorable? Wind speeds less than 20 knots (23 miles per hour [mph], 34 feet per second [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 millimeters (mm) for fresh crude oil, 3 to 5 mm for diesel and weathered crude, and 5 to 10 mm for emulsions and bunker C fuel oil. Water in oil emulsions containing more than 30 to 50 percent water are difficult to ignite and support combustion. Most oils readily burn if the water content is less than 25 percent. Most crude oils require an evaporative loss of less than 30 percent 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 IV-F for additional information.
- Is the product ignitable without adding a burning agent? CBC 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 more environmentally hostile products such as gasoline or diesel. Also, if the latter materials are used, considerations must include the toxicity of additives such as methyl tert-butyl ether (MTBE), gasoline with ethanol, etc. and the adverse environmental impacts this will cause.
- Is the product gasoline or other light petroleum product? If so, both mechanical techniques and ISB are viable options. However, due to the greater 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 IV-A.
- Are 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?
- Is a source for extinguishing the fire available such as fire trucks, water pumps, etc.?

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

### 2.3.3 Step 3: Acceptability

- Distance between burn and human population?
- Will ambient levels of airborne particulate matter (PM) less than 10 microns in diameter (PM-10), averaged over 1 hour near humans, be above 150 micrograms per cubic meter ($\mu g/m^3$) or will ambient levels of PM with diameter less than 2.5 microns (PM-2.5), averaged over 24 hours, near humans, be above 35 $\mu g/m^3$? If so, evacuate or shield them, or do not conduct the burn.

- Are air monitoring capabilities available?

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 would likely object to it, and should be contacted.

  Note: Habitat fact sheets describing the impacts of various response methods (e.g., ISB, suction, vegetation removal, sorbents, etc.) are available at the Regional Response Team 5 website.

### 2.3.4 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.
- Are burn extinguishing measures available?
- Public notification. See Appendix IV-C for guidelines on Public Notification.
- A written description of the incident and burn plan should be provided to the FOSC and other pertinent players.
- Public Information Officer (PIO) involvement – for example, messaging press releases (PR), fact sheets (FS). See Appendix IV-C.

### 2.3.5 Step 5: Monitoring

The primary operational purpose in monitoring the burning of spilled oil is to determine if burning requirements and objectives are met. Because the current body of knowledge about burning is limited, the secondary purpose in monitoring is to provide an opportunity to gather further information. Operational monitoring should occur during a response involving the use of ISB 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;
- Effectiveness of residual material collection;
- Adverse effects to natural resources both pre- and post-burn (e.g., number of dead organisms);
- Effects on human health (see appendix IV-B for air monitoring guidelines).

In an effort to gather more data about ISB, research possibilities involving a broad range of physical, biological, and chemical issues, are encouraged. Research monitoring might involve:

- Collection of oil samples prior to burning for analysis;
- Observations of residual material's behavior and fate;
- Collection of residual material for analysis;
- Upwind and downwind air sampling;
- Documentation of number and location of sampling stations;
- Determination of contaminant compounds (e.g., polycyclic aromatic hydrocarbons [PAH] or particulates) to be monitored;
- Documentation of Species and numbers of biota (e.g., waterfowl, aquatic organisms, vegetation) in the area.

### 2.3.6 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 in Region 7.

- Post-burn monitoring of the site should be considered, including biota recovery, residual oil remaining, etc.

## 2.4 ISB REFERENCE SOURCES

- *Field Operations Guide for In-Situ Burning of Inland Oil Spills*, American Petroleum Institute, Technical Report 1251, July 2015
- *Field Operations Guide for In-Situ Burning of On-Water Oil Spills*, American Petroleum Institute, Technical Report 1252, July 2015
- *Applicability of Clean Air Act Ambient Air Quality Regulations to the In Situ Burning of Oil Spills*, National Response Team (NRT), November 1995
- NOAA Office of Response and Restoration – ISB:
  - *Oil Spills in Marshes: Planning and Response Considerations*, September 2013
  - Special Monitoring of Applied Response Technologies (SMART) for ISB & CBC
  - Residues from ISB of Oil on Water
  - Health and Safety Aspects of ISB of Oil
  - ISB Emissions Comparisons, 2012
- Regional Response Team 6, *Guidelines for Inshore/Nearshore ISB*

# 3.0 CHEMICAL & BIOREMEDIATION COUNTERMEASURES (CBC)

## 3.1 WHAT A RESPONDER NEEDS TO KNOW TO CONSIDER USE OF A CBC

Except for specific circumstances (i.e., to prevent or substantially reduce a hazard to human life in accordance with 40 CFR 300.910 (d)) the use of CBCs will be considered on a case by case basis. CBCs include dispersants, surface washing agents, bioremediation agents, or miscellaneous oil spill control agents listed on the NCP Product Schedule. Descriptions and guidelines for each follows.

**In general, RRT policy does not allow the use of CBCs on navigable waters.**
There are no preapproved uses for CBCs within Region 7, excluding use on small roadway spills, as described below. In general, incident-specific conditions vary too widely on inland spills to allow for preapprovals.

Local/state/federal Incident Commanders are preauthorized the use of CBCs, listed on the NCP Product Schedule, to address small spills to roadways. This exemption has been developed for the protection of public safety and preservation of roadway surfaces. CBCs may be used for these incidents when no immediate threat to surface water or groundwater quality is evident. Additionally, measures to contain runoff from the spill cleanup action should be taken.

Consistent with the NCP, in situations when a human hazard is not present, the FOSC must receive the concurrence of EPA RRT representative(s), and the RRT representative(s) 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 FOSC 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 (d)). If a chemical or bioremediation product is used under these circumstances, the FOSC must notify the EPA 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 CBC showstoppers:

- Is the product on the NPC Product Schedule at NCP Subpart J Product Schedule (December 2023)? If not, then it should not be used except as noted in 40 CFR 300.910 (d).
- Will the CBC be used in accordance with product-specific recommended application procedures described in the NCP Product Schedule Technical Notebook at NCP Subpart J Technical Notebook (December 2023)? If not, then it should not be used except as noted in 40 CFR 300.910 (d).
- 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, SOSC, and the State and Federal Natural Resource Trustees.
- CBCs require RRT approval.

## 3.2 CBC DECISION PROCESS

### 3.2.1 Step 1: Site Conditions and Desirability

- Can worker safety be reasonably assured?
- Are environmental conditions favorable?
- Access routes to the scene?
- Locational information, including: river mile or latitude/longitude or other precise geographical description?
- Material type, amount, area, age, phases, condition of the spill?
- Proximity to public, biological populations, transportation routes, or valuable property?
- Will the use of CBCs prevent or reduce further damage by the spill?
- Are mechanical containment and recovery adequate? If so, explain why CBCs are being considered.
- Ecological factors such as environmentally sensitive areas?

### 3.2.2 Step 2: Feasibility

- Will the use of a CBC be effective and produce the desired result? The listing of a product on the NCP Product Schedule does NOT mean that EPA approves, recommends, licenses, certifies, or authorizes the use of the product on an oil discharge. The listing means only that data have been submitted to EPA as required by Subpart J of the NCP, Section 300.915.
- Has impact of floating oil been determined to be greater than impacts resulting from mixing of oil into the water column?

- Are recovered oil storage capacities very limited, or has the formation of emulsified oil resulted in skimmer inefficiencies?
- Does the efficiency of skimmers need to be further increased?
- Are sensitive resources such as wetlands at risk, and is equipment readily available early in the spill?
- Is immobilization of the oil necessary for the prevention of refloating, substrate penetration, or further spreading?
- Is the oil projected to impact shorelines which have high recreational or aesthetic value?
- Are medium weight or diesel-type oils resisting other removal methods?

# APPENDIX IV.A
# 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 on water using a fireproof boom.
- Impacts to marsh 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, however, little information is available regarding this effect.
- Burning of oiled woody wetland vegetation (compared to grasses and sedges) should not be conducted.
- 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 fuel 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, plants are dormant, and aboveground vegetation is also dormant.
- 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 its type, the species present, condition (optimal or marginal for species use), and 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 ISB may compact oil into sediments, where it persists longer. Therefore, the relative damages from different response options should be weighed carefully.

## IV.A.1 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, ISB in wetlands can be effective, because 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 to rejuvenate wetlands that have accumulated high litter loads, generate green vegetation or open spaces to attract wildlife, release nutrients for recycling, and 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 energy content (measured in British thermal units [BTU]) of the oil may increase the temperature and heat penetration of the burn, and there is often an oil residue which can be toxic to the environment. The experiences of fire ecologists and practitioners can greatly contribute to the development of guidelines for burning wetlands as a spill response strategy. Guidance has been 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 burning were developed:

## IV.A.2 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.

### IV.A.3 CONS

- Burning can cause substantial initial plant damage, because the aboveground vegetation is removed.
- Burning can cause long-term impacts to vegetation, especially if the fire is so hot that the submerged 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 IV.B
# AIR MONITORING GUIDELINES FOR HUMAN HEALTH IMPACTS OF ISB

ISB 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.[1]

## IV.B.1 MONITORING FOR RESPONDERS

The responders, i.e., the workers assigned to conduct the ISB, 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 potentially exposed to volatile organic compounds (VOC). 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 ($CO_2$), carbon monoxide (CO), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), particulates, and other combustion products. Air concentrations of those substances depend on many variables, and substantial variability can be expected. 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 (PPE) 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.

[1] See also the National Response Team's "Guidance On Burning Spilled Oil In Situ", 1995 (https://www.nrt.org/sites/2/files/airregs.pdf) for a discussion on the recommended limits for short-term human exposure to PM-10 during ISB.

#### IV.B.1.1 Sampling Purpose

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

- Characterize exposures and hazards associated with the operation to provide better protection;
- Ensure compliance with Occupational Safety and Health Administration (OSHA) requirements, per 29 CFR 1910.134 b.(8)1 and 29 CFR 1910.120.q.3.(ii)2;
- Provide data collection for scientific purposes;
- Enable decisions regarding appropriate PPE (e.g., respirators or protective coveralls).

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

#### IV.B.1.2 Exposure Limits

Exposure limits for responding personnel should be based on occupational exposure guidelines (see Table IV-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 IV-1

## OCCUPATIONAL EXPOSURE LIMITS AND NATIONAL AMBIENT AIR QUALITY STANDARDS FOR THE MOST SIGNIFICANT PRODUCTS OF IN SITU BURNING

| COMPOUND | OSHA PEL | ACGIH TLV | NAAQS |
|---|---|---|---|
| Benzene (in volatile organic compounds)) | 1 ppm (5 ppm) | 0.5 ppm (2.5 ppm) | N/A |
| Nitrogen dioxide | (5 ppm) | 3 ppm (5 ppm) | 0.053 ppm annual average (0.1 ppm 1-hour average) |
| Sulfur dioxide | 5 ppm | (0.25 ppm) | 0.5 ppm 3-hour average (0.075 ppm 1-hour average) |
| Carbon monoxide | 50 ppm | 25 ppm | 9 ppm 8-hour average (35 ppm 1-hour average) |
| Polycyclic aromatic hydrocarbons (PAH) | Not applicable | Not applicable | Not applicable |
| Particulate matter, 2.5-micron (PM-2.5) | Not applicable | Not applicable | 0.015 mg/m$^3$ annual average (0.035 mg/m$^3$ 24-hour average) |
| Particulate matter, 10-micron (PM-10) | 5 mg/m$^3$ | 3 mg/m$^3$ | 0.15 mg/m$^3$ 24 hour average |

Notes:

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

| | |
|---|---|
| ACGIH TLV | American Conference of Industrial Hygienists Threshold Limit Values (1993. Threshold Limit Values for Chemical Substances and Physical Agents, 1993-1994. Cincinnati, OH). |
| mg/m$^3$ | milligrams per cubic meter |
| NAAQS | National Ambient Air Quality Standards (U.S. GPO, 1993. 40 CFR 50.4 to 50.11). |
| OSHA PEL | Occupational Safety and Health Administration Permissible Exposure Limits (U.S. GPO, 1993. 29 CFR 1910.1000, Table 2). |
| ppm | Parts per million |

### IV.B.1.3 When To Sample

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

### IV.B.1.4 Sampling Methods

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.;
- Include a combination of area sampling (e.g., instruments placed on boom-towing boats) and personal sampling on the workers themselves;
- Include both short-term peak exposure and time-weighted averages, for the total duration 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 or fuel vapors).

### IV.B.1.5 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 safety equipment.

## IV.B.2 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 posed to 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 6 miles when the wind blows toward shore. However, burns may be conducted closer than 6 miles if conditions permit. Similarly, a burn may be inappropriate at 6 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 of 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 total particulates in the center of the plume 3 miles downwind of the burn is expected to be around 150 milligrams per meter ($mg/m^3$) (McGrattan et al. 1993). If the burning is conducted according to the operational guidelines suggested above, PM-10 levels 6 miles away from the burn should be significantly lower than 150 $mg/m^3$ 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.

### IV.B.2.1 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.

### IV.B.2.2 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 ISB, it is advisable to collect information concerning concentrations PM-10 or smaller PM in smoke or PM-2.5 or finer particles in smoke. 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 monitoring and sampling.

### IV.B.2.3 Exposure Limits

Exposure limits for the general public should be based on the National Ambient Air Quality Standards, which are used by EPA for air quality control. The standards for PM-10 and PM-2.5 are shown in Table IV-1. To err on the side of safety, this Region 7 policy adopts an action level of 150 $mg/m^3$, averaged over 1 hour. Concentrations above this level should result in operational measures to control the rate of burn/smoke formation.

### IV.B.2.4 Sampling Limitations

In general, air sampling should not be regarded as a requirement for conducting ISB 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 FOSC, 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 ISB. Trends are more important than a single number. The readings of a real-time particulate monitor may fluctuate widely, depending on nearby activities such as passing cars or smoke from fireplaces in nearby houses. Therefore, a single reading may be misleading. Averaging the readings over a period of time (e.g., 15 minutes) should provide an indication of the trend, that is, whether the concentration goes up or remains steady. Visual observations, coupled with real-time data that 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 concentrations should be presented with the associated uncertainty and possible interferences and inaccuracies. Otherwise, the values may not mean much, or worse yet, be misleading.

### IV.B.2.5 Sampling Rationale

Sampling may be conducted for several reasons:

- To assess exposure levels at different points, in order to provide immediate feedback to the FOSC, and to verify visual observations of plume behavior;
- To validate air dispersion models;
- To satisfy other scientific or historical data collection needs.

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

### IV.B.2.6 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 contaminant levels are expected to be below exposure limits). 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 ISB 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.

### IV.B.2.7 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 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 with attached filter cassettes may be deployed at various locations for laboratory analysis. Their data, which are not real-time, may be used for exposure assessment, model validation, and to provide information for future ISB.

### IV.B.2.8 Recommended Air Monitoring Equipment for ISB

The primary health concern for ISB 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 VOCs and PAHs could be additional health and safety concerns in the immediate area. Air monitoring is an important tool in communicating risks to the public during 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.
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 burn effectiveness and to address any public health concerns.

The EPA Region 7 Emergency Response Program and its contractors, along with the U.S. EPA Environmental Response Teams (ERT) and U.S. Coast Guard (USCG) Strike Teams, are often called in emergencies to conduct perimeter and on-scene 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 or EPA satellite office. For a spill on the upper Mississippi River this would translate to 3 to 10 hours. The FOSC can mobilize additional air monitoring resources from 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 ERTs in Edison, New Jersey and in Las Vegas, Nevada, are on call 24 hours per day and are equipped and specialized to support FOSCs in conducting air monitoring. The ERT can mobilize to the site within 12 to 24 hours after being requested by a FOSC to support air monitoring activities. The USCG Strike Teams also are equipped and trained to provide air monitoring, safety monitoring, and other assistance to the FOSC as needed. The Strike Teams can mobilize to a site in 12 to 24 hours to provide air monitoring assistance.

During an incident when ISB is being evaluated, and humans could be exposed to the smoke plume, it is recommended that the Incident Commander plan to have air monitoring set up prior to and during the burn event. EPA and its contractors could immediately mobilize staff and equipment to monitor for particulates using Real-time Aerosol Monitors (RAM). In addition, carbon monoxide, carbon dioxide, and VOCs could be monitored directly at the burn location. EPA Region 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. RAMs, Mini RAMs, or equivalent, can serve as valuable tools to assess the levels of particulates in a plume that could impact humans during an ISB. These instruments can be fitted with size-selection attachments to obtain readings for PM-10 or PM-2.5, if desired. The current guidelines for safe levels of particulates are a PM-10 or PM-2.5 concentration of less than 150 $\mu g/m^3$. Further Clean Air Act amendments may change the particulate matter (PM-10 and PM-2.5) standards. The RAM and Mini RAM instruments directly read a measure of the airborne particulates. The instruments can be used to screen residential and work areas during an ISB, so that 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, EPA also could mobilize photoionization detectors, flame ionization detectors, multi-gas meters, colorimetric tubes, fixed sampling pumps, and portable gas chromatographs to monitor contaminants, including VOCs, PAHs, particulates, carbon monoxide, and carbon dioxide during an ISB.

The air monitoring equipment described in the following table can be mobilized to an emergency by calling the 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 |

* Staffed by USCG, and can tie into EPA Regional Office or USCG Office

The State Emergency Response Program 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 National Oceanic and Atmospheric Administration (NOAA) Scientific Support Team can also provide air monitoring resources from its field office at Louisiana State University. District 8 Scientific Support Coordinators (SSC) are located at:

NOAA SSC and NOAA Regional Response Officer
Prevention, USCG 8th District (DP-SSC)
500 Poydras Street, Suite 1341
New Orleans, Louisiana 70130
Office Phone: (504) 376-3213

NOAA SSC, USCG Sector Houston-Galveston
13411 Hillard Street
Houston, Texas 77034
Office Phone: (206) 549-7819

NOAA SSC, NOAA Disaster Response Center
7344 Zeigler Blvd
Mobile, Alabama 36608
Office Phone: (206) 549-7759

Table IV-2 shows EPA's current inventory of air monitoring capabilities for ISB in Region 7.

### TABLE IV-2

### EPA REGION 7 AIR-MONITORING CAPABILITIES FOR ISB

| Item Description / Manufacturer / Model | Type | Target Compound(s) | EPA TLC | Fenton FO |
|---|---|---|---|---|
| AreaRae / Rae Systems / PGM-6560D | Multi-Gas Detector w/ PID | VOCs, LEL, CO, $H_2S$, and $O_2$ | 8 | 4 |
| AreaRae / Rae Systems / PGM-5020 | Multi-Gas Detector w/ PID | VOCs, LEL, CO, $NH_3$, and $O_2$; gamma radiation | 4 | 0 |
| UltraRae 3000 / Rae Systems / PGM-7360 | PID | VOCs, Benzene, Butadiene | 5 | 1 |
| Single Gas Monitor- Hydrogen Sulfide / Rae Systems / ToxiRae 2 PGM-1120 | Single-Gas Detector | $H_2S$ | 6 | 0 |
| ToxiRae Pro / Rae Systems / PGM-1860 | Single-Gas Detector | CO | 5 | 0 |
| Hydrochloric Acid Monitor / Draeger Safety / X-AM 5100 | Single-Gas Detector | HCl (gas) | 2 | 0 |
| Single Gas Monitor - Phosphine / Rae Systems / ToxiRae 2 PGM-1192 | Single-Gas Detector | Phosphine | 2 | 0 |
| Single Gas Monitor- Sulfur Dioxide / Rae Systems / ToxiRae 2 PGM-1130 | Single-Gas Detector | $SO_2$ | 1 | 0 |
| Chip Measurement System / Draeger Safety | Gas-Specific Monitor | $H_2S$, CO, $CO_2$, TPH, $SO_2$, HCN, $Cl_2$, benzene, toluene, xylenes, and other analytes | 2 | 1 |
| Portable Chemcassette Tape Gas Detector / Honeywell / SPMF-P1US SPM Flex | Gas-Specific Detectors | Organic and Inorganic Gases | 1 | 1 |
| MultiRae Pro / Rae Systems / PGM-6248 | Multi-Gas Detector w/ PID | VOC (ppb), LEL, CO, $H_2S$, and $O_2$; gamma radiation | 4 | 2 |
| Multi-gas PID / Draeger Safety / X-AM-7000 | Multi-Gas Detector w/ PID | VOCs, LEL, CO, $H_2S$, and $O_2$ | 2 | 0 |
| Multi-gas Detector/ Rae Systems / PGM-50-5P | Multi-Gas Detector w/ PID | VOCs, LEL, CO, $H_2S$, and $O_2$ | 2 | 2 |
| Photoionization Detector ppbRae / Rae Systems / PGM-7240 | PID | VOCs (ppb) | 1 | 1 |
| Analyzer, Toxic Vapor / Thermo Environmental Instruments / TVA 2020 | PID and FID | Organic and Inorganic Gases | 2 | 1 |
| Handheld Dusttrak / TSI Inc. / 8534 | Air Sampling | PM1, PM2.5, PM10 and Total PM Fractions | 2 | 1 |
| Dusttrak DRX / TSI Inc. / 8533 EP | Air Sampling | PM1, PM2.5, PM10 and Total PM Fractions | 3 | 3 |

# TABLE IV-2

## EPA REGION 7 AIR-MONITORING CAPABILITIES FOR ISB

| Item Description / Manufacturer / Model | Type | Target Compound(s) | EPA TLC | Fenton FO |
|---|---|---|---|---|
| Air Sampler / RADECO / H-810 | Air Sampling | Total suspended PM | 4 | 0 |
| Air Sampler, High Volume (polyurethane foam [PUF]) / General Metal Works / Ps1-Hi-Vol | Air Sampling | PM, SVOCs, PAHs, dioxins, furans | 13 | 0 |
| Air Sampling, Pump / Environmental Monitoring Systems / Mega-lite High Vol Pump | Air Sampling | PM, metals, SVOCs/PAHs, and other analytes | 9 | 0 |
| Air Sampler, High Volume, Mass Flow (total suspended particulates [TSP]) / Thermo Scientific / GS2313-105 TSP | Air Sampling | Total suspended PM | 6 | 0 |
| Air Sampler, High Volume—Volumetric (TSP) Thermo Scientific / TSP Vari-Flo-GV2360-70-105 | Air Sampling | Total suspended PM | 6 | 0 |
| Air Sampling Pump / Sensidyne / Gil Air 5 | Air Sampling | PM, SVOCs, PAHs, dioxins, furans | 10 | 0 |
| Air Sampling Pump – Gillian (set of 5) Sensidyne / 800-884.111.1205 | Air Sampling | PM, metals, SVOCs, PAHs, and other analytes | 2 Sets | 0 |
| Radiation Air Monitor / Canberra / 00-6828 | Radioactive Particles | Alpha and Beta Radiation | 1 | 0 |
| Thermal Imaging Camera / MSA Systems, Inc. / EVO 5000 | Thermal Screening | N/A | 1 | 0 |
| Weather Station, Wireless / WeatherHawk / WXT520 | Weather | N/A | 1 | 1 |

**Notes:**

| | |
|---|---|
| $Cl_2$ | Chlorine |
| CO | Carbon monoxide |
| $CO_2$ | Carbon dioxide |
| EPA | U.S. Environmental Protection Agency |
| FID | Flame ionization detector |
| FO | Field Office |
| HCl | Hydrochloric Acid |
| HCN | Hydrogen cyanide |
| $H_2S$ | Hydrogen sulfide |
| LEL | Lower explosive limit |
| N/A | Not applicable |
| $NH_3$ | Ammonia |
| $O_2$ | Oxygen |
| PAH | Polycyclic aromatic hydrocarbon |
| PID | Photoionization detector |
| PM | Particulate matter |
| PM1 | PM less than 1 micron in diameter |
| PM2.5 | PM less than 2.5 microns in diameter |
| PM10 | PM less than 10 microns in diameter |
| ppb | Parts per billion |
| $SO_2$ | Sulfur dioxide |
| SVOC | Semi-volatile organic compound |
| TPH | Total petroleum hydrocarbons |
| TLC | Training and Logistics Center |
| VOC | Volatile organic compound |

### IV.B.2.9 Sampling Locations

Sampling locations should be based on priority concerns, with the first priority given to population centers downwind of the burn. For scientific data collection, for example, model validation, it is recommended that samplers be placed at different distances from the burn to collect particulate concentration data at ground level. These data would be extremely valuable for future burns.

If it is determined that sampling is needed, real-time particulate samplers (PM-10) should be positioned as follows:

- On the shoreline, at the expected centerline of the plume;
- At the population center of concern;
- In several locations in the vicinity of the population downwind of the burn.

PM-10 samplers should be operated for more than 8 hours:

- Before the burn commences to gather background data;
- During the actual burn to assess the burn effect;
- 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.

### IV.B.2.10 Other Sampling Considerations

- Area background readings should be taken before and after the burn to determine baseline levels.
- EPA and regional air monitoring stations may be able to assist by providing historical data, and by conducting air sampling during the burn itself (https://www.epa.gov/outdoor-air-quality-data and http://airnow.gov/)

# APPENDIX IV.C
# PUBLIC NOTIFICATION FOR ISB

Notification of the public of an impending burn is critical to the overall success of an ISB 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 burn 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, and tradeoffs with other countermeasures should be developed ahead of time and available for dissemination during the burn. This material should cover the trade-offs involved in choosing response countermeasures, and relate the risks of ISB 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.

A suggested public notice for ISB might look like:

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 burn 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 IV.D
# ECOLOGICAL CONSIDERATIONS FOR ISB

## IV.D.1 OPEN WATER ISB

Potential ecological impacts of open water ISB 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 ISB 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 ISB 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.

## IV.D.2 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 in the water during a 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.

## IV.D.3 SURFACE MICROLAYER

### IV.D.3.1 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.

### IV.D.3.2 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 ISB. 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.

## IV.D.4 ENVIRONMENTAL TOXICOLOGICAL CONSIDERATIONS

Although many studies to define the physical and chemical characteristics that result from ISB 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 ISB 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 ISB 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 dollars, oysters, 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 were subjected to aquatic toxicity testing.

Beyond the direct impacts caused by high temperatures, the by-products of ISB may be toxicologically significant. Although analysis of water samples collected from the upper 20 centimeters (cm) of the water column immediately following a burn of crude oil yielded relatively low concentrations of total petroleum hydrocarbons (1.5 parts per million [ppm]), compounds that have low water solubility or that associate with floatable particulate material tend to concentrate at the air-water interface (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 IV.E
# SAFETY AND HEALTH CONSIDERATIONS AND BY-PRODUCTS OF ISB

## IV.E.1 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 near sources such as tankers, barges, pipelines, or tank farms unless means are taken to ensure that the flames 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 ISB 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 PPE. Training for burn personnel should include proper use of use of PPE, which may be used to minimize inhalation of, and skin contact with, combustion by-products. Exposure limits such as OSHA's PELs 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 for 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.

## IV.E.2 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 may 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 ISB 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 ISB is inhalation of fine particulate material, which is a major constituent of smoke produced. An early assessment of health concerns attributable to the Kuwaiti oil fires identified PM-10 as representing the greatest health hazard in that situation. The extent to which these particles present a health risk during an ISB depends on the concentration and duration of exposure. It is important to remember that these particulates 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.

PAHs are a group of hydrocarbons produced during ISB. 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 PAHs that is the basis for concern. $SO_2$ and $NO_2$ 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 degree 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.

### IV.E.3 BY-PRODUCTS

By-products of ISB exist because no combustion process is completely efficient in oxidizing a given source material. Besides the normal results of burning, $CO_2$, water vapor, and an assortment of 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 IV.F
# OPERATIONAL CONSIDERATIONS FOR CONDUCTING ISB

## IV.F.1 OPEN WATER BURNING

An open water ISB 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 oil continuously spilling from a burning oil rig, or placing fire boom around a vessel or facility that caught fire.

## IV.F.2 BURNING IN OTHER INLAND ENVIRONMENTS

Although it is widely held that ISB 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.

## IV.F.3 BURNING IN ICE/WINTER CONDITIONS

Containment is almost always required to maintain the minimum 2 to 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 percent, 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 35ºC. It is important to note that an ISB in broken ice is not easily extinguished once ignited.

Burning oil in snow conditions is similar to burning oil on water, because 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 to 99 percent have been shown during field studies and actual spills. Oil/snow mixtures of up to 75 percent 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].

### IV.F.4 FIRE RESISTANT BOOM

The application of ISB 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 ISB may be denied.

### IV.F.5 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.

### IV.F.6 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.

## IV.F.7 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.

## IV.F.8 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 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.

## IV.F.9 UNBURNED OIL AND SOLID BURN RESIDUES

Although ISB 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 increase 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, heavier-than-seawater 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. Items to consider include:

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