SAMPLE SITE SAFETY PLAN FOR MARINE IN-SITU BURN OPERATIONS

Introductory Note: Response situations expose personnel, and sometimes the general public, to potentially hazardous situations. In-situ burn (ISB) operations add an additional element to safety considerations. The precautions necessary for the safety of personnel in an ISB response effort must include safety protocols for burning in addition to those for conventional cleanup.

The following site safety plan includes those elements unique to ISB; refer to the general site safety and health plan for spill response safety considerations not related directly to ISB. This plan is designed as an appendix to the umbrella site safety plan for the overall response. The sample is not a standard, but rather a suggested starting point.

The plan contains some operational aspects which may create redundancy with ISB operations plans. If a safety consideration is tied to the specific operation that makes it different due to the added hazard of ISB, then the operation is included in this plan. For regions and responders with comprehensive ISB operations plans, redundancy may be dropped from the sample.

TABLE OF CONTENTS

1 ISB SITE DESCRIPTION[1]

	NO	YES	
A. Geographic Location of Burn Site(s):	NA	NA	
B. Hazards:	G G G G	G G G G	Oil Type: (See General Site Safety Plan) Burn Promoters: (If yes, attach an MSDS) Combustion by-products: (See Section ----) Heat/Flame: (See Section ---)
C. Weather Conditions: (used to determine trajectory of boom sweep and smoke plume)	NA	NA	Wind velocity/direction: Current velocity/direction:
D. Population Centers: (Indicate demographic information -- e.g., urban or rural; residential or industrial)	G	G	1. 2. 3.
E. Sensitive Areas: (e.g., endangered species habitat, commercial fishing activity, vessel traffic lanes, cultural/historical resource)	G	G	1. 2. 3.
F. Secondary Fuels Sources: (e.g., nearby oil storage facility, pipeline, or vegetation)	G	G	1. 2. 3. Establish a safe zone and designate as off limits to burning operations
G. Secondary Sources of Ignition: (e.g., flares)	G	G	1. 2. 3. Establish a safe zone and designate as off limits to burning operations
H. Map: Attachment #___	G G G G G G G G	G G G G G G G G	Direction of response sweep Burn path/trajectory of smoke plume Population centers Sensitive areas Contamination zones Exclusion zones Hazardous zones Other:
I. Medical Emergencies: (ISB-Related)	First Aid :location Hospital Name: Phone: Has the hospital been contacted to verify whether burn and/or smoke inhalation victims can be handled? Doctor:		

[1] Refer to the general site safety plan for entire spill location.

2 BURN OBJECTIVES

All work shall be conducted in accordance with procedures established during pre-burn briefings and attached work plans. A work plan is provided as attachment: _____.

Entry Objectives: Recovery of oil/fuel spill, booming operations, and ISB operations.
Other activities/objectives: _____
_____
_____
_____
_____
_____

Detailed objectives will be developed daily as part of the overall burn plan described in Section 4.1 of this plan (or refer to the applicable burn operations plan). Daily objectives will be communicated to personnel during the pre-departure safety briefing

3 RESPONSE ORGANIZATION

3.1 **Contact List**: See Annex B.

3.2 **Personnel Responsibilities**: [Positions discussed below may vary depending upon the spill management, expertise of personnel, and limited availability of trained people. If necessary, one person may fulfill more than one role.] The following subsections describe personnel responsibilities for burn operations with respect to safety:

3.2.1 **Burn Coordinator** provides the coordination link between all burn operations and the FOSC and the Unified Command. This person may be the Operations Chief for smaller spills where ISB is not occurring concurrently with other response operations. In larger spills, the Operations Chief may designate the burn coordinator. Also, the burn coordinator and the safety officer positions could be fulfilled by one person, depending upon his/her training and expertise.

3.2.2 **Safety Officer.** [This person may be the Safety Officer for the overall spill management or the Safety Officer's designee for ISB operations. For purposes of this document this position will be referred to as the Burn Safety Officer.] The responsibilities of the Burn Safety Officer for ISB operations include (but are not limited to):

- Ensuring worker health and safety during burn operations;
- Conducting pre-burn safety briefing on operational procedures and goals;
- Identifying potential emergencies;
- Explaining emergency communication protocols and emergency burn-termination criteria;
- Coordinating implementation of this plan;
- Assigning and monitoring activities of Deputy Safety Officers onboard each vessel;
- Maintaining this plan and providing daily updates (as needed);
- Acting as liaison with Site Safety Officers from other organizations participating in the response effort; and
- Reporting to the FOSC via the Burn Coordinator.

3.2.3 **Deputy Safety Officers.** The Burn Safety Officer designates a deputy onboard each vessel to monitor and track the condition of the fire relative to that vessel. Since the Burn Safety Officer will

be onboard the ISB Command Vessel (' 3.4.1 below), an additional deputy safety officer is not required. Additionally, a deputy safety officer does not have to be an extra person on the vessel, necessarily. Other responsibilities include:

- Informing onboard personnel about safety measures specific to the particular vessels;
- Ensuring that vessel personnel understand emergency communications and procedures;
- Monitoring all safety aspects of the ISB response as it pertains to the particular vessel; and
- Reporting to Burn Safety Officer.

3.2.4 **Boom Commander.** Operations should ensure that one person controls boom logistics on the lead boom-towing vessel (see 3.3.3 below). For all boom-handling activities this person must work closely with the Burn Safety Officer to ensure efficient communication between the boom-towing vessels and other burn operations' vessels.

3.2.5 **Communications Unit Leader.** The communications unit leader, or designee, is onboard the command vessel. Responsibilities include:

- Ensuring effectiveness of overall communication of burn operations;
- Verifying communication links to each vessel and aircraft prior to ignition; and
- Reporting to the Burn Safety Officer.

3.2.6 **Air Operations.** Pilots of helicopters or fixed-wing aircraft used for aerial surveillance support for the burn and/or igniter deployment will brief the Burn Safety Officer on intended operations.

3.3 **Vessel Requirements**: The following vessels are required for safe burn operations (refer to the applicable burn operations plan for proper operational techniques.):

- ISB Command Vessel (1) to provide central command operations at the burn scene;
- Boom-Towing Vessels (2) to tow and control fire resistant boom;
- Fire-Control/Safety Vessel (1) to monitor burn and provide safety support;
- (Optional, as available) Helicopter or fixed-wing aircraft for aerial surveillance and/or possible igniter deployment.

If the burn operation consists of only one pair of boom-towing vessels, the command vessel and fire control/safety vessel could be combined.

[Please note that vessel requirements may differ from region to region depending on availability of vessels, location and remoteness of the spill, or the presence of ongoing extensive spill response operations.]

3.4 Responsibilities of Vessels

3.4.1 **ISB Command Vessel.** The Burn Safety Officer will be on the command vessel. The Burn Safety Officer reports to the FOSC, via the burn coordinator.. The command vessel controls all aspects of the burn, including the following:

- Ensuring overall safety, including adequacy of designated ISB location; absence of other sources of secondary ignition nearby; and safety of projected path of the sweep (while

burning) for operators as well as the public;

- Communicating with all personnel involved in the burn to ensure awareness of events taking place before, during, and after the burn;
- Delivering or delegating final command for ignition of the burn.
- Maintaining communication with the FOSC;

3.4.2 **Safety Boat.** The safety boat's responsiblities include:

- Cross-checking to verify that all safety requirements of the burn are addressed;
- Monitoring and maintaining pre-designated "fire-free" zones;
- Reporting all hazards to command vessel;
- Preparing firefighting equipment (optional) onboard for accessibility and use;
- Assisting command vessel with burn observations and effectivness monitoring;
- Sampling[2] and recording to determine oil volume calculations prior to burn;

3.4.3 **Boom-Towing Vessels** are responsible for the following:

- Maintaining consistent tow speeds, boom configurations, and oil collection rates; and
- Performing emergency termination procedures.

Note: Boom-towing vessels do not necessiarily need fire-protective equipment. It is up to the individual organization's discretion. For example, the U.S. Navy Supervisor of Salvage (SUPSALV) carries fire-protective clothing for each person onboard and small fire pumps for each vessel, as added safety measures. Also, protective equipment is advised when using an igniter. People with protective equipment, however, may tend to assume adequate protection, and thus, move too close-in to the fire. If people are close enough to the flames to need fire-protective equipment, the vessel is also in danger.

[2] Samples include a 1-liter sample of collected oil (prior to burn) which will help determine length of the burn.

4 BURN AREA CONTROL

4.1 **Burn Plan**: In order to maintain organization within the response effort, a site-specific burn plan, or in-situ burn application[3], will be drawn up prior to ignition of the burn. To burn safely, the plan must include the following important considerations:

- Burn Feasibility: verification that window of opportunity exists for loft of smoke plume;
- Operational checklists: a chronological checklist of all operations critical for completion before, during, and after ignition;[2]
- Action plan: To supplement the operational checklists, a plan that details vessel deployment, method of ignition, weather forecasts, and water conditions for the specific geographic area; and
- Burn termination criteria: Should worker or public heath be threatened.

4.2 **Site Control**: Anyone entering or departing a burn area, or associated control zones, reports to the Burn Safety Officer. All persons entering the burn area must subscribe to this portion of the approved Site Safety and Health Plan by signature. All personnel will have adequate training on in-situ burn operations, and on hazardous waste operations safety and health (see Section 12 for training requirements).

4.3 **Traffic Control**: Movement of non-response vessels and aircraft in the vicinity of the burn may be affected by ISB response vessel activity and smoke production. Prior to and during burn operations, the response activity must be coordinated with the local airports, the FAA for Notice to Aviators, and the USCG for Notice to Mariners. Exclusion zones and traffic control corridors must be identified prior to ignition.

4.4 **Vessel Location**: An important consideration in maintaining the safety of response personnel is the location and placement of response vessels in relation to the burning slick. Location and movement of all vessels throughout the response effort will be planned prior to ignition of the burn. All vessels will remain out of the downwind quadrant. Ancillary vessels and aircraft non-essential to the burn must remain in pre-designated safe zones, traveling upwind and up current from the burning slick. To avoid exposure to excessive heat and to emissions, all vessels and personnel will remain at least five fire diameters away and upwind from the burn.

During the burn, towing vessels should be positioned so that there is an absolute minimal chance of being surrounded by, or coming into contact with, concentrations of oil that could pose a threat due to deliberate or accidental ignition.

4.5 Igniters

Ignition Safety: Ignition of the oil slick should receive careful consideration. Aircraft operations to ignite oil with gel or other aerial ignition methods must be well-coordinated. Weather and water conditions should be kept in mind, and proper safety distances adhered to at all times. Given the range of igniter types and ignition methods, manufacturer specifications for proper deployment will be followed.

4.5.1 Helitorch or Other Air-Deployable Igniter Systems:

IMPORTANT NOTE: The helicopter or fixed-winged aircraft deploying a Helitorch ignition or

[3] In-situ burn applications and operational checklists are region-specific.

other air-deployable igniter will maintain flight paths perpendicular to the boats and boom to eliminate flying over any vessels.

Type of Igniter:_____
Additives:_____
Manufacturer:_____
Point of Contact:_____
Attach an MSDS for additives and igniter contents.

4.5.2 **Hand-held Igniter Systems**: The person deploying the hand-held igniter will be trained in the use of the igniter. Follow safety recommendations of manufacturer.

Type of Igniter:_____
Additives:_____
Manufacturer:_____
Point of Contact:_____
Attach an MSDS for additives and igniter contents.

4.6 **Premature and Secondary Ignition Sources**: As with conventional oil containment measures, premature or accidental ignition of the slick must be avoided at all costs. Proper consideration must be given to the proximity of potential ignition sources to any combustible slicks up until the time of deliberate ignition. Also, before deliberate ignition, the wind and direction of tow will be considered to ensure that no one is within or near any potential large concentrations of vapors which might flash upon ignition. If atmospheric conditions are very still, considerable concentrations of ignitable vapors may collect in the atmosphere above the slick; ignition should commence from an appropriately safe distance. Monitoring should be considered to rule out unintentional ignition.

4.7 **"Go/No Go" Policy:** The organization must ensure delegation of authority of veto power, prior to ignition. Each deputy safety officer can veto the commencement or continuation of the burn based upon safety concerns within each area of responsibility. Each commander must ensure that all personnel are in the correct and safe place and that all equipment is in proper working order before ignition of the burn. **If an emergency situation arises after ignition of the burn, any deputy safety officer can terminate the burn by following emergency communication procedures (see Section 8.3.1.2).**

4.8 **Termination of Burn**: In most circumstances, the FOSC should plan to allow an oil slick to burn to completion once it has ignited. However, premature termination of a burn may be necessary if worker and public health is threatened due to a wind or weather shift, or a secondary ignition of another slick is a possibility. The fire may be extinguished prematurely by releasing the tow line from one of the towing vessels while the other moves ahead at several knots. This allows the oil to spread out quickly to a thinness that cannot support combustion. A second alternative is to move both towing vessels ahead at several knots, forcing the oil beneath the boom and removing it from the combustion zone. Refer to the applicable burn operations plan for more detail on terminating a burn.

4.9 **Pre-Ignition Checks**

Note: All radio frequencies and radio protocols should have been finalized prior to transit to the spill site.

1. Communications Officer performs a radio check and ensures that each vessel involved is aware of how much time is left before the ignition to burn. Also, the communications officer verifies that each vessel is aware of the designated burn trajectory.
2. Command vessel communicates with FOSC to obtain final approval to burn.
3. Command vessel communicates with helicopter and obtains verification of a clear burn path ahead

(assuming helicopter is available).
4. Burn safety officer ensures that boats and boom are pointed upwind (into the wind).
5. Burn safety officer reiterates the locations ofoil-free safe areas where vessels can retreat and regroup, should an emergency arise.

Contained oil should be ignited only after all pre-burn checks and requirements, as outlined in the FOSC approval applications and operational checklists, are met and confirmed via radio link with all vessel commanders and key participants.

(Refer to Annex C or the burn operations plan for detailed burn operations.)

5 HAZARD EVALUATION

5.1 **Airborne Particulates:** Considered by most experts to be the main airborne health hazard associated with in-situ burn emissions, particulates are small pieces of solid carbon or liquid hydrocarbon suspended in the air. Particulate matter is a by-product of incomplete combustion.

Hazard Description: Particulates less than 10 microns (millionths of a meter) in diameter can reach the deep portion of the lungs (the critical gas exchange area) and become a burden on the respiratory system. Thus the air quality standards are expressed as a fraction of particulates smaller than 10 microns in diameter (annotated as PM-10). The median size of particulates in the smoke from oil fires is 0.5 microns, posing a definite hazard to respiration. Studies show that the ground level concentrations of PM-10 nearby in-situ burn events usually remain below safety levels (except for the area directly in the smoke plume). For most people, exposure to inert particulates becomes a problem only at high concentrations. However, sensitive individuals may develop problems at levels much lower than that.

Permissible Exposure Limits (PEL) for PM-10: For **response personnel**, the following exposure limits apply:

OSHA PEL: 15 milligrams per cubic meter (mg/m^3) total particulate 8 hour mean
5 mg/m^3 respirable particulates (PM-10) 8 hour mean

Symptoms of Overexposure: Excessive PM-10 will burden the respiratory tract and cause breathing difficulties.

Basic Precautions: Using respirators and eye protection suitable for protection from particulate matter will reduce exposure. The best precaution, however, is to avoid overexposure altogether. Keep vessels and personnel out of the smoke plume.

For hazards associated with other burn emissions constituents, refer to Annex D.

5.2 **Environmental Monitoring for Chemical Hazards**:

To ensure the health and safety of responders, the site safety plan must restrict all responders and response vessels from entering the smoke plume or from approaching the fire perimeter. Data analyzed from the Newfoundland Offshore Burn Experiment (NOBE) demonstrated that PM-10 levels were low upwind and outside of the smokeplume. Until further experience is gained, however, it is strongly recommended that PM-10 levels be monitored for worker's health and safety.[4]

[4] Guidance on monitoring is forthcoming from the NRT Science & Technology Committee. This document will be updated after such guidance is released.

Even though data on other ISB gaseous emissions suggest that concentrations do not seem to pose a risk if responders and vessels remain safe distances and upwind from the burn, concentrations of carbon dioxide are high at ground levels close to the burn. If for some reason, a responder must move close-in to the burn, proper personal protection equipment and monitoring must be administered. Additionally, a multiple burn scenario has not been tested. Should multiple burns be proposed, sampling for other hazards such as carbon monoxide, carbon dioxide, and polynuclear aromatic hydrocarbons, in addition to PM-10, is highly advised.

The following monitoring may be conducted; if used, monitoring equipment will be calibrated and maintained in accordance with the manufacturer's instructions (electronic equipment will be calibrated before each day's use):

INSTRUMENT	FREQUENCY
__ Combustible gas	___continuous, ___hourly, ___ daily, Other:
__ WBGT/heat stress	___continuous, ___hourly, ___ daily, Other:
__ Noise	___continuous, ___hourly, ___ daily, Other:
__ other chemical specific monitors (colorimetric/electronic):	
__ Particulate Monitors	___continuous, ___hourly, ___ daily, Other:
__ other	___continuous, ___hourly, ___ daily, Other:
__ other	___continuous, ___hourly, ___ daily, Other:

Zones of potentially hazardous substances may be encountered based upon wind and weather patterns. Projected extent and direction of plume of oil vapors prior to burn and smoke plume during the burn (along with any other applicable hazards found during the site survey) will be marked on the attached site maps.

5.3 **Burn Hazards**

Although safe practices should eliminate the possibility of a responder getting burned during an ISB, contingencies for such a scenario must be identified. Depending on the severity of the burn, damage inflicted will vary from superficial reddening of the skin to extensive surface blistering and death of underlying tissues. However serious, the correct first aid treatment is to cover the burnt surface with loosely applied, dry, sterile dressings. To reduce the dangers of infection, handling the burnt area must be reduced to a minimum and any temptation to clean its surface resisted. All burns of more than a trivial nature should be referred to the hospital.

5.4 **Other Hazards**:

Heat Proximity: Exposure of personnel to uncomfortable or dangerous levels of heat can be minimized or eliminated with proper considerations for vessel placement during a burn. Vessels should come no closer than five fire diameters for any extended length of time.

Heat Stress: In an in-situ burn event, the combination of hot weather and flame radiation can pose potentially dangerous situations for response personnel. Certain safety problems are common to hot environments. Heat tends to promote accidents due to slippery palms, dizziness, lower mental alertness, or fogging of safety glasses. If the victim is conscious and able to drink fluids, provide caffeine-free, cold liquids, preferably water.

Heat stroke is a serious condition which occurs when the body's temperature regulatory system fails and sweating becomes inadequate. A heat stroke victim's skin is hot, usually dry, red, or spotted. Body temperature is usually 105 degrees or higher, and the victim may be mentally confused, delirious, or unconscious. Unless the victim receives quick and appropriate treatment, brain damage and/or death can occur. Any person with signs or symptoms of heat stroke requires immediate hospitalization; however, first aid should be administered immediately with the intent to lower the body temperature. Move the victim to a cool area, thoroughly soak the clothing with cold water, and vigorously fan the victim.

Heat exhaustion is caused by the loss of large amounts of body fluid and salt through sweating. A victim suffering heat exhaustion usually still sweats, but experiences weakness or fatigue, giddiness, nausea, or headaches. Severe cases may exhibit vomiting or unconsciousness. The skin is clammy and moist, the complexion is pale or flushed, and the body temperature is normal. Treatment requires rest in a cool place and intake of liquids (caffeine-free).

Other hazards not ISB-specific: For other hazards refer to the general oil spill site safety plan for the incident.

6 PERSONAL PROTECTIVE EQUIPMENT (PPE) Refer to Annex A.

7 DECONTAMINATION PROCEDURES

Contaminated personnel, and personnel entering contaminated areas, will be decontaminated in accordance with the current work plan or attached decontamination layout.

8 EMERGENCY PROCEDURES

8.1 Emergency Medical Procedures

Refer to applicable section of the general site safety plan for the incident. IF an ISB-specific injury occurs:

- Contact the appropriate hospital or first aid station identified in ' 1, as appropriate.
- Dispatch medical aid from shoreside, as required.
- The Burn Coordinator will enlist assistance of crew from any vessel capable of rendering additional assistance.
- Medical evacuation by helicopter to the pre-identified hospital will be decided by the Burn Coordinator in conjunction with the Burn Safety Officer.

8.2 Emergency Fire Procedures:

- DO NOT attempt to fight fires other than small fires. A small fire is generally considered to be a fire in the early stages of development, which can readily be extinguished with personnel and equipment in the immediate area in a few minutes time.
- DO NOT take extraordinary measures to fight fires.
- You MUST sound the appropriate fire signal (three blasts with an air or foghorn) if fire cannot be put out quickly.
- Alert nearby personnel to call for assistance.
- Notify supervisor.
- The Burn Safety Officer will ensure that the fire is extinguished before restarting work.

8.3 Emergency Termination of Burn: Refer to Section 4.8 for burn termination procedures.

8.3 Communications

8.3.1 **Radio Communcation:** Dedicated radio links with specific frequencies will be established for vessel-to-vessel, vessel-to command, vessel-to-air, and air-to-air communications. Repeater

stations will be arranged for as appropriate for distant or blocked communication paths.

Assignment of Frequencies:

Primary Command Channel (for general command communications):
Freq:_____ Channel:_____ (VHF__ UHF__ CB__ Other_____)

Boom-Towing Vessel Channel (dedicated for boom-towing vessels):
Freq:_____ Channel:_____ (VHF__ UHF__ CB__ Other_____)

Safety Vessel Channel (dedicated for routine communication):
Freq:_____ Channel:_____ (VHF__ UHF__ CB__ Other_____)

Aircraft Channel (dedicated for aircraft):
Freq:_____ Channel:_____ (VHF__ UHF__ CB__ Other_____)

Emergency Channel (dedicated for emergency communications):
Freq:_____ Channel:_____ (VHF__ UHF__ CB__ Other_____)

Other: _____
Freq:_____ Channel:_____ (VHF__ UHF__ CB__ Other_____)

8.3.2 **Emergency Communications:** An emergency can be communicated or declared using any of the above frequencies. All working frequencies will be monitored throughout the ISB effort by the command vessel and safety vessel. Once an emergency situation has been declared and identified, all response vessels will monitor the dedicated emergency radio channel for emergency instructions. The command vessel will request any further changes in radio channel selection as appropriate.

As part of the "go/no-go" policy, each deputy safety officer may stop the response effort by declaring an emergency. In declaring an emergency, the party must identify its vessel or operating unit and must provide a description of the problem.

In the event of radio equipment failure on any vessel, instructions to switch to other frequencies will be given by the communications officer on the command vessel.

8.3.3 **Emergency Phone Numbers**

On-Scene Coordinator:
(_____) _____ (__voice __fax __cellular __pager __home)
(_____) _____ (__voice __fax __cellular __pager __home)

Site Safety and Health Officer:
(_____) _____ (__voice __fax __cellular __pager __home)
(_____) _____ (__voice __fax __cellular __pager __home)

Burn Safety Officer:
(_____) _____ (__voice __fax __cellular __pager __home)
(_____) _____ (__voice __fax __cellular __pager __home)

Hospital:
(_____) _____ (__voice __fax __cellular __pager __home)
(_____) _____ (__voice __fax __cellular __pager __home)

If a victim is in route, alert the hospital for incoming patient with burn-related injuries.

9 TRAINING AND SITE SAFETY MEETINGS

9.1 **Training**: Prior to any response effort, all personnel must be OSHA and HAZWOPER training certified, as per 29 CFR 1910.120. Thereafter, classroom and/or hands-on refresher training must be completed by all personnel annually, emphasizing the particular hazards of a burn event to response personnel, equipment, and the general public. Training must also include experience with equipment and general response techniques, such as vessel operation, fire resistant boom deployment and towing, oil and residue recovery, ignition techniques, etc., to ensure safe operations.

9.2 **Burn Safety Meetings**: Prior to the commencement of the ISB response effort, a safety orientation for all personnel should be conducted. Burn safety meetings will then be held aboard each vessel prior to the ignition of the burn. At a minimum, these meetings will describe the work to be accomplished, safety procedure changes, and site-specific safety considerations.

Burn Safety Officer: _____

9.3 **Sign Up Sheet**

Team Member (Print Name)	Contact Number (Phone, Pager)	Signature	Date

Annex A: Personal Protective Equipment

A.1 **General Policy**: Employers are responsible for supplying personal protective equipment (PPE), as required by OSHA [29 CFR 1910.120 (g)]. Level of PPE should be evaluated based upon the threats identified in the site characterization and hazard evaluation. If an employer is providing equipment, including respirators [29 CFR 1910.134], OSHA regulations for training, selection, maintenance, and medical examination and monitoring must be followed.

According to safe in-situ burn practices, workers should be kept out of the smoke plume and at a safe distance from the fire, thus higher level PPE requirements may be unnecessary. People with fire protective equipment may feel overconfident in their protection and move too closely to the fire. If personnel are close enough to the flames to need this type of equipment, the vessel will also be in danger.

The recommended PPE ensemble is Level D for the entire burn response operation. During pre-ignition and the burn phase, personnel should have access to respirators and goggles. As a precautionary measure, flame and fire-resistant coveralls may be necessary for personnel on the safety vessel. (Refer below to specific ensemble configurations.)

Other issues to keep in mind include:

- Vessel of opportunity systems (VOSS) personnel must be properly fitted and trained prior to commencing operation.
- People handling burn residue need protective clothing.
- People handling igniters should use flame-resistant coveralls.

A.1.1 **Coverall Specification**: Coveralls will be of flame and fire resistant type, and lightweight to prevent overheating. Coveralls will be worn at all times by response personnel potentially at risk to exposure. During pre-burn, burn, and post-burn operations, fire-resistant coveralls should not be worn when directly handling spilled oil, because any oil that gets on the suit becomes potentially flammable.

A.1.2 **Respirator Specification**: Per 29 CFR 1910.134, a respirator will be provided for all personnel involved in the response effort. Those personnel required to wear a respirator must remove facial hair to enable a proper seal of the respirator against the face. During fit testing of respirators, responders will be given the option to select the most comfortable respirator.

A-2 PPE Ensembles

Level D Ensemble:

- Oil-resistant coveralls
  OPTION: Street clothing may be worn by supervisory personnel, technicians, specialist, etc., that will not be exposed to oil or the immediate flame proximity.
- Rubber steel toe/shank safety boots with textured bottoms
  OPTION: deck shoes with textured soles (for boat operations)
- Rubber/latex or leather work gloves
- Rubber rain pants, jacket, and hood (as needed)
- Rubber apron (as needed)
- Personal Flotation Device (PFD)
- Quart bottle to carry fluids (during heat stress alert)

- Hearing protection (ear plugs)
- Insect repellent (if necessary)
- Hard hat (not required on vessel decks unless overhead equipment is operating)
- Safety goggles
- Sunscreen

Level C Ensemble:

- Fire-resistant coveralls
- NFPA rated fire-resistant gloves
- Half or full mask cartridge respirator
- Fire-resistant hood
- Face shield, as required
- Dust, fume, mist cartridge
- Organic vapor cartridge (on-hand for oil vapors prior to burn)
- Goggles

Annex B: Contact List

Function and Name	Phone Number	Radio Contact
Federal On-Scene Coordinator:		
Site Safety and Health Officer:		
Burn Safety Officer:		
Command Vessel:		
Boom-Tow Vessel #1:		
Boom-Tow Vessel #2:		
Safety Vessel:		
Communications Unit Leader:		
Air Operations Leader:		
Scientific Support Coordinator:		
Other:		

Annex C: Burn Operations

C.1 **Boom Deployment**: Boom deployment will be consistent with the boom instruction manual. Deployment of the boom in an ISB response situation will be made easier and safer with planning and training of personnel well in advance of any response effort. Preparations for the following considerations should be completed in advance:

- Ensure that the boom is properly stored in the tray or storage container as specified so deployment is feasible without snagging or twisting. A single twist of the boom can render it nearly useless for oil containment at or near the twist. Attempting to untwist the boom by hand after deployment presents a hazard to personnel.
- During deployment, anticipate drag forces induced by vessel movement and natural currents. Avoid standing on or holding down boom during adjustments. Use proper tie-downs and anchor points to eliminate tension in the portion of the boom on which work is being done.
- Ensure that all tie-downs, tow lines, tow posts, etc., are strong enough to withstand the average and peak drag forces that may be experienced by the fire resistant boom in tow.
- Provide adequate communications between the boom-towing vessels and the personnel tending the boom out of its container or tray. Dedicated radio links and hand signals should be pre-designated in case of an emergency.

C.2 **Boom Towing**: Boom towing will be consistent with the boom instruction manual. The following are safety considerations during towing operations:

- To avoid overexposure to the intense heat of the flames, all vessels must remain at least 5 fire diameters from the flame perimeter. Downwind of the burn, the minimum approach distance will be necessarily greater to avoid emission exposure to personnel. For operations using 660 feet or less of boom, use tow lines approximately equal to the length of the boom. For boom lengths greater than 660 feet, tow lines may be less than the length of the boom. This allows for adequate distance between the towing vessels and the burning oil contained in the bottom third of the boom in a "U" configuration. Also, ensure that strength of tow lines can withstand the maximum anticipated tension forces induced by the drag force of the boom.
- Ensure that qualified aerial support is prepared with established communication lines to inform all responders of the location of boom-towing vessels relative to the target oil slick; other oil slicks in the same general area; other vessels in the area; and the anticipated region of influence from combustion products.
- Prior to ignition, ensure that all personnel on-site are positioned upwind or crosswind from the target slick.
- If response operations commence at or near the spill source, personnel and equipment will be positioned at a safe distance from any potential explosion or premature ignition of oil at or within the source.
- **Contained oil should be ignited only after all pre-burn checks and requirements, as outlined in the FOSC approval applications and operational checklists, are met and confirmed via radio link with all vessel commanders and key participants.**

C.3 **Boom and Boat Handling**: Refer to the instruction manual for boom and boat handling instructions. The designated boom commander ensures effective communication between the boom-towing vessels and other vessels. Once the oil is ignited, the boom commander remains in contact with the burn watch personnel described in Section 3.2. Proper attention to the status of the burn, the speed and positions of the towing vessels, and the proximity of the burn to other vessels, slicks, etc., must be maintained for quick response to dangerous situations. The boom-towing vessels will have a pre-

determined plan of communication and action for defined situations, such as: modification of the rate of burn (by modifying the size); requests of and offers for assistance to the sister towing vessel; and termination of the burn.

C.4 **Ignition Safety**: Ignition of the oil slick should receive careful consideration. Aircraft operations to ignite oil with gel or other aerial ignition methods must be well-coordinated. Weather and water conditions should be kept in mind, and proper safety distances adhered to at all times. Given the range of igniter types and ignition methods, manufacturer specifications for proper deployment will be followed.

C.5 **Fire Control**: Depending upon response operation circumstances, the ISB command vessel may wish to manipulate the combustion rate of the oil slick. The rate of combustion is directly controlled by the forward velocity of fire resistant boom-towing vessels. A slower velocity will increase the burn rate by increasing the spread of the oil, thus increasing the fire diameter. On the other hand, a faster velocity will decrease the overall rate of combustion. Care must be taken when manipulating the burn rate. Too thin of a slick will cease to burn, while too fast of a tow will cause oil splash-over.

C.6 **Burn Effectiveness Monitoring**: The dedicated safety vessel assists the command vessel with monitoring the burn's effectiveness. The safety vessel crew monitors the status of the burn in relation to the proximity of the burn to towing vessels and other response vessels. It also monitors and maintains pre-designated "fire-free" zones as needed between response vessels or between the burn and specified sensitive areas. Also, this vessel can provide backup support for deployment and containment operations, and provide extra personnel and equipment, where needed.

C.7 **Aerial Surveillance**: Aerial surveillance should continue, as available, throughout the burn to enhance status updating capabilities. Aerial surveillance should also provide early warning for wind and weather shifts which may impact the direction of the smoke plume.

C.8 **Termination of Burn**: In most circumstances, the FOSC should plan to allow an oil slick to burn to completion once it has ignited. However, premature termination of a burn may be necessary if the wind or weather shifts unexpectedly, or if secondary ignition of another slick is a possibility. The fire may be extinguished prematurely by releasing the tow line from one of the towing vessels while the other moves ahead at several knots. This allows the oil to spread out quickly to a thinness that cannot support combustion. A second alternative is to move both towing vessels ahead at several knots, forcing the oil beneath the boom and removing it from the combustion zone.

C.9 **Residue Collection**: The safety boat is in charge of collection of left-over debris or residue.

C.10 **Routine Communications:** The command vessel will provide general command functions for burn operations, and it will serve as the primary communications post. All radio frequencies will be continuously monitored by command personnel aboard the command vessel, and safety command personnel aboard the safety vessel.

Instructions regarding general response procedures will be communcated as necessary by the command vessel. Direct communication between the boom-towing vessels is necessary to ensure coordination of boom-handling procedures; this communication will be continuously monitored by the command vessel. Coordination of aircraft activity will be done through the command vessel.

Annex D: ISB Emissions

In addition to particulate matter less than ten microns in diameter (PM-10), other substances are emitted durning an ISB event. For example, small amounts of toxic gases, including sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO), are produced. Carbon dioxide is produced in levels that need consideration. Also, small amounts of polynuclear aromatic hydrocarbons (PAHs) present in the unburned oil are emitted from the fire as a product of incomplete combustion.

The above substances were sampled and analyzed extensively in the multi-national, multi-agency 1993 Newfoundland Offshore Burn Experiment, commonly referred to as "NOBE." From experience gained, data suggest that emitted gases pose minimal threats to worker health and safety, if vessels and personnel remain safe distances from the fire, and upwind from the smoke plume. However, questions still remain and caution must be taken as initial burns are tested in an operational response setting until further data are gathered to repeat and validate NOBE's findings. Secondly, different ISB scenarios such as multiple burns have not been studied. Therefore, should a responder need to move close-in to the fire PPE and monitoring should be administered.

The following table summarizes the health hazards associated with an ISB event.

Table 1: Hazard Evaluation

Type of Gas	***Hazard Description***	***Exposure Limits***	***Symptoms of Overexposure***
Particulate Matter < 10 microns (PM-10): Particulates less than 10 microns (millionths of a meter) in diameter can reach the deep portion of the lungs (the critical gas exchange area) and become a burden on the respiratory system. Thus the air quality standards are expressed as a fraction of particulates smaller than 10 microns in diameter (annotated as PM-10).	The median size of particulates in the smoke from oil fires is 0.5 microns, posing a definite hazard to respiration. Studies show that the ground level concentrations of PM-10 nearby in-situ burn events usually remain below safety levels (except for the area directly in the smoke plume). For most people, exposure to inert particulates becomes a problem only at high concentrations. However, sensitive individuals may develop problems at levels much lower than that.	OSHA PEL: 15 milligrams per cubic meter (mg/m^3) total particulate 8 hour mean 5 mg/m^3 respirable particulates (PM-10) 8 hour mean	Symptoms of Overexposure: Excessive PM-10 will burden the respiratory tract and cause breathing difficulties.
Polynuclear Aromatic Hydrocarbons (PAH): a group of hydrocarbons found in both unburned oil and the smoke plume. PAHs have very low vapor pressures, and most are not very flammable. In ISB, PAHs adsorb to particulates. Studies show that concentrations in the smoke remain below 0.01 ppm, below exposure limits.	Some PAHs are suspected carcinogens over a long-term exposure; the target organs being the skin and lungs. The hazard is minimal in in-situ burn events. Because of the high temperatures, most PAHs are burned in the combustion process, and the concentration is usually higher in the oil than in the smoke.	OSHA PEL: 0.2 ppm for 8 hours (for volatile PAH)	None.

Carbon Dioxide (CO_2): Colorless, odorless gas produced by burning fossil fuels.	High levels of CO_2 were detected at ground levels near the fire. Although detection hits were high (500-750 ppm), the levels were well below the exposure limit. Until further data are obtained, consideration to these findings is prudent.	OSHA PEL: 5000 ppm for 8 hour mean	Headache, dizziness, restlessness; parasthesia; dysphea; sweating; malaise; increased heart rate, elevated blood pressure; coma; asphyxia; convulsions.
Sulfur dioxide (SO_2) **:** colorless nonflammable poisonous gas with a pungent odor. The concentration emitted in a burn is directly related to the sulfur content of the oil.	Toxic gas and a corrosive irritant to eyes, skin, and mucous membranes by forming sulfuric acid on these moist surfaces. The gas may reach the deep portion of the lung, but not as much as other, less soluble gases. The danger from in-situ burning is minimal; studies indicate that sulfur dioxide emissions remain significantly below the exposure limits.	- NAAQS: 0.14 ppm for 24 hours - OSHA PEL: 2 ppm for 8 hours	Irritation of eyes, skin, mucous membranes, and respiratory system.
Nitrogen dioxide (NO_2)**:** toxic gaseous by-product of oil combustion. It is normally a red-brown gas with an irritating odor.	Extremely toxic to humans by inhalation. It is less soluble than sulfur dioxide, so it can reach the deeper portions of the lungs (the critical gas exchange area). Small concentrations can cause pulmonary edema, which can be delayed. Nitrogen dioxide is also a strong irritant to eyes and respiratory tract. Studies of in-situ burn events have shown that concentrations of nitrogen dioxide in smoke emissions remain below 0.02 ppm; well below exposure limits.	- NAAQS: 0.053 ppm for 24 hours - OSHA PEL: 1 ppm for 8 hours	Irritation of eyes, skin, and mucous membranes.

***Carbon Monoxide (CO)*:** product of incomplete combustion of oils. It is a colorless, odorless gas that is toxic to humans.	The toxicity of carbon monoxide is acute: it has a high affinity to hemoglobin in the blood, displacing oxygen and ultimately causing oxygen deprivation in the body's cells. The hazard of carbon monoxide from burn emissions is minimal. Data so far suggest that concentrations in oil fire smoke remain below 5 ppm 150 meters downwind; well below exposure limits.	- NAAQS: 9 ppm - OSHA PEL: 35 ppm for 8 hours	Headache, nausea, dizziness, confusion; at high concentrations asphyxia and death may result.

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