

Field Operations Guide for In-Situ Burning of On-Water Oil Spills

API TECHNICAL REPORT 1252
FIRST EDITION, JULY 2015



AMERICAN PETROLEUM INSTITUTE

Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

All rights reserved. No part of this work may be reproduced, translated, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 1220 L Street, NW, Washington, DC 20005.

Copyright © 2015 American Petroleum Institute

Foreword

American Petroleum Institute (API) publications necessarily address problems of a general nature, with respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

API is not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations under local, state, or federal laws.

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any federal, state, or municipal regulation with which this publication may conflict.

Contents

Purpose of this Field Operations Guide.....	vii
Priorities for Oil Spill Response	vii
Safety.....	vii
Intended Audience	vii
How to Use This Field Guide	vii
Introduction.....	1
Specific In-Situ Burning Considerations	1
ISB Decision-Making Components	4
ISB Field Operations Checklists	5
General Precautions and Preferred Conditions.....	5
Prerequisites.....	6
Logistical Considerations.....	7
Location Considerations	9
Monitoring, Notifications, and Documentation	11
ISB Plan Components of an Incident Action Plan	12
Habitat-Specific ISB Information.....	18
Open Sea and Large Lakes.....	18
Shallow and Near Shore Areas	18
Cold Climate Considerations	19
Ice Conditions on Water	20
Appendix A Appropriateness of ISB	21
Appendix B Personnel Safety	25
Appendix C Weather and Smoke Management.....	27
Appendix D Oil Containment & Fire Safety	31
Appendix E Ignition of ISB.....	40
Appendix F Efficiency and Burn Volume Estimation	44
Appendix G Air Quality Monitoring	47
Appendix H Unburned Oil & Post-Burn Residue Recovery	51
Appendix I Incident Command for ISB	53
Glossary	57
References	61

Purpose of this Field Operations Guide

This is a field operations guide. It is not an educational or decision-making tool. This Guide contains a set of operational checklists, tools, and references to assist in the conduct of in-situ burning (ISB) of spilled oil in the marine environment.

Priorities for Oil Spill Response

- People—safety of response personnel and the public.
- Environment—prevention of long-term health and welfare effects.
- Assets—minimizing damage to vessels, structures and equipment.

Safety

Responder safety and health must never be compromised for tactical considerations. Likewise ISB should be conducted to minimize smoke/particulate safety and health impacts to responders, the general public, users of sea lanes, etc.

Intended Audience

This Guide is intended for experienced operations personnel, having basic knowledge or expertise in ISB. Although widely applicable, this guide reflects research and experience in North American waters.

How to Use This Field Guide

A decision to use ISB with appropriate local, state, and/or federal approvals should already have occurred before field operations commence. The decision to pursue burn should be made early in an incident, taking into account its feasibility and appropriateness, with guidance from Incident Command/Unified Command to make best use of windows of opportunity.

Operations managers should then use this Guide to develop timely plans, brief personnel, and manage operations. Environmental staff

should ensure that the operational plans conform to any permission requirements or permit conditions.

- The included checklists provide guidance to develop operational arrangements to support ISB in marine and other open water locations.
- Verification of continued favorable burning conditions must occur throughout preparations and just prior to ignition. General and habitat-specific listings of such conditions are included.
- The scale of an ISB and its duration will significantly affect the potential hazards, permissions required, operational staffing, management structure, and intensity of any air quality monitoring. This Guide is intended to be incident scale-neutral.
- When encountering unfamiliar terms or acronyms, please refer to the Glossary.
- Appendices provide additional detail on specific operational considerations.

Field Operations Guide for In-Situ Burning of On-Water Oil Spills

Introduction

This Guide is intended to assist oil spill responders who are considering or executing controlled in-situ burning of a spill to marine, open waters. In-situ burning (ISB) is the combustion of hydrocarbon vapors from spilled oil, which are converted predominantly to carbon dioxide and water and released to the atmosphere. *In situ* means “in place” in Latin.

The basic objectives of an on-water ISB operation are to:

1. Safely and efficiently remove as much oil as possible from a water surface to reduce environmental impacts;
2. Reduce the movement of spilled oil by wind, wave, tide, or current and subsequent exposure of into more sensitive and/or economically important environments.

This Guide is intended primarily as a field guide for experienced personnel, as opposed to an educational or decision-making tool. It is assumed that users have basic knowledge or expertise in ISB, so the Guide functions primarily as a set of checklists, tools, and references to assist in conduct of ISB.

- The environments addressed in this Guide include open ocean, other large water bodies or inland seas, and near shore locations, with and without ice.
- This Guide is intended for all sizes of incidents, since even small localized incident responses should follow the same basic procedures as a large incident.

Specific In-Situ Burning Considerations

Tactical decisions as well as the nature and amount of resources needed to conduct a safe and effective burn depend upon the size of the expected burn(s); the volume and condition of the oil spilled; the type of release (i.e. limited event vs. continuing spill); the proximity of

the intended burns to the source; and whether the spill source is already ignited, or could be ignited accidentally.

The safety of personnel will always be of paramount importance. Sometimes safety considerations will drive use of specific procedures for ignition and sustained combustion of highly volatile fluids.

Oil Types

It is assumed that the type of oil to be burned is crude oil, diesel, or other petroleum product that floats on water, and which can be burned safely. Lighter petroleum products such as gasoline are typically considered too volatile for a safe burn. The condition of the oil, its weathering state and ability to ignite and burn, is key.

Location Considerations

ISB should be conducted at locations sufficiently removed from an unignited spill source for fire control purposes. Open water or near shore locations are typically far from populated areas. Many open water locations may be conducive to a safe and efficient ISB, and in some situations, burning may be the only means of both quickly and safely removing large amounts of oil.

Requirements to Ignite and Sustain an ISB

ISB requires fuel, oxygen, and an ignition source. Fuel for a burn is provided by the vaporization of oil, which is increased by the heat from a fire. To sustain a burn, there needs to be adequate oil for continued vapor generation to yield steady-state burning. In addition, it is necessary to have a sufficient thickness of oil to provide insulation against the loss of heat from the oil into the water below. At oil thicknesses of only a millimeter or two, most fairly fresh petroleum products can cool to temperatures below their fire points, releasing insufficient vapors to sustain combustion.

The thicknesses required to ignite and sustain combustion depend upon the volatility of an oil, its emulsification (or water content), and wind and sea state conditions. Ignition of spilled oil is especially dependent upon these conditions because of the limited size and intensity of most ignition devices.

- For a burn to be ignited and sustained on water, the spilled oil must be at least 1/10 in., or 2–3 mm, in thickness. For heavier and emulsified oils up to 10 mm thickness may be necessary to generate burnable vapor concentrations.
- Volatile fractions can quickly evaporate from spilled oil and render it too heavy for a sustained burn. An oil spill over approximately four or five days old may be impossible to ignite or a burn impossible to sustain without use of an accelerant or fire promoter.
- Once ignited, spilled oil will tend to burn down to a thickness of about 1 mm on water.

Containment

Containment of some form is usually necessary to limit spreading of an oil slick and maintain necessary thickness for ignition and sustained burning. Oil slicks can spread quickly on open water to thicknesses of 1/10 mm or less within minutes to hours, depending upon the nature and amount of oil spilled and the wind and sea conditions. Therefore, fire-resistant booms are predominately used to capture and contain oil to thicknesses of at least 5 to 10 mm. Slick thicknesses of 10–20 cm or more, help burn efficiency.

- Other types of physical containment (e.g. ice, debris, shorelines) can provide barriers against spreading of oil to support ISB.
- Ambient winds and chemical herders can also help drive slicks against natural or manmade barriers to thicken oil and support combustion.
- The size of a burn may be sufficient (typically 10s of meters in diameter) to create thermally induced winds moving radially inward toward the center of a burn as hot air rises above the fire. Such winds can transport surrounding surface slicks toward and into the fire, thereby helping sustain and prolong the fire.

ISB Decision-Making Components

ISB quickly and significantly reduces the amount of spilled oil on water or shoreline, thereby preventing longer environment exposure times or being moved by wind or current with the result of exposing additional natural resources and habitats. ISB can also reduce ground-level volatile air concentrations of oil components thereby making the post-burn work environment safer for response crews.

The decision to pursue and conduct an on-water burn should take into account the feasibility and appropriateness of ISB. Checklists are provided in this Guide to help address issues involving:

- nature and distribution of spilled oil;
- size and condition of the spill source (a batch or continuous release);
- potential for accidental ignition of the source or other facilities nearby;
- environmental conditions which might preclude a successful ignition and sustained burning; etc.

Once it is determined that a safe and effective burn can be conducted, such information can be used by planners to secure appropriate approvals and resources to carry out the burn(s). Once approved, operations managers should share site-specific burn plans, mobilize resources, brief personnel, and coordinate all offshore, shoreline, and air operations.

The focus of this Guide is upon the operational plans and implementation of the ISB, not the decision-making process. The Guide should serve as a field reference and summary of key factors in executing safe and effective controlled burns at sea once the decision to burn has been made and approved.

ISB Field Operations Checklists

Including Confirming Planning Considerations

General Precautions and Preferred Conditions

- **Winds**—<18 knots (21 mph or 34 km/hr) for ignition; sustained burning possible with higher wind conditions.
- **Wave Height**—less than 3-m swells or 1-m wind waves (may be higher with fresh and un-emulsified oil).
- **Oil**—at least 2 to 3 mm thick (2 to 3 times thicker for highly weathered/emulsified oil).
- **Emulsification**—typically less than 25% water content (can vary for different types of oil).
- **Current**—typically < 0.75 to 1 knot relative velocity between the fire boom and the surface oil/water to avoid entrainment of oil.
- **Ice**—ice cakes and floes with < 10% to 20% coverage. Greater concentrations can interfere with booming operations, filling the collection area and/or damaging booms. Ice can, however, provide natural containment for ISB depending upon the nature and concentration of the ice.

Prerequisites

- ☐ On scene conditions continue to justify, and satisfy requirements for, ISB (Appendix A).
- ☐ Human populations are at a safe distance from anticipated fire and smoke (Appendix A).
- ☐ The ISB can be conducted safely (Appendix B). A Site Safety Plan specific to the intended burn has been developed, approved, and communicated.
- ☐ Weather forecast indicates suitable conditions will persist over the estimated burn-time window (Appendix C).
- ☐ Oil on water, ice or shoreline is contained by natural barriers (ice, wind, and geography), or by booms; resulting in oil thicknesses of 2–3 mm or more for successful ignition.
- ☐ Wind and open water conditions are favorable for successful containment of oil (minimizing chances of boom failure) (Appendix D).
- ☐ Oil is fresh enough and has enough volatile hydrocarbons to allow ignition and there is sufficient oil and vapors for sustained combustion (Appendix E). A test ignition is suggested and may be required.
- ☐ Vessels for boom deployment, fire oversight, ignition, rescue, and monitoring are available and adequate in number, type, size, and power (Appendix D, E, and G).
- ☐ Federal, state, and local approvals have been obtained; consultations have been made.
- ☐ All necessary permits have been obtained and are available on site.
- ☐ The Responsible Party/Parties for the spill and incident management have given written consent to conduct of a burn.

Logistical Considerations

Personnel

- ☐ Personnel have been identified and assigned for:
 - ☐ Command and Communications.
 - ☐ Safety.
 - ☐ Oil Containment.
 - ☐ Ignition Operations.
 - ☐ Surveillance and Spotting.
 - ☐ Rescue and Emergency Medical Services.
 - ☐ Environmental Protection/Pollution Monitoring.
 - ☐ Wildlife Monitoring.
 - ☐ Post-Burn Activities (including residue recovery, burn volume estimation, equipment decontamination, etc.).
- ☐ Emergency Medical/Rescue and Fire Control Teams have been established.
- ☐ ALL personnel are appropriately trained and/or experienced for their roles.
- ☐ Appropriate personal protective equipment (PPE) and safety gear are available, distributed, and personnel are trained on its use.
- ☐ Hydration, toilets, shelter, and food supplies are available on participating vessels. Plans are in place to provide additional food, fuel, and supplies as necessary.

- ☐ Burn area maps and communications call lists have been prepared, verified, and distributed to ALL operations personnel.
- ☐ All operations personnel have been briefed on:
 - Safety (including health signs and symptoms of exposure and what to do about it).
 - Ignition and sustained burn plan.
 - Fire control and suppression.
 - Wildlife and environmental protection.
 - Emergency response tactics.

Staging

- ☐ Staging areas have been identified. Ports and docks have adequate material handling and resupply capabilities for fire boom, igniters, etc.
- ☐ If needed, local heliports or helispots have been identified and marked for:
 - Medical evacuation/Air ambulance procedures.
 - Crew changes and additional personnel needs.
 - Aerial surveillance and spotter support base.
 - Aerial ignition support base (if used).
 - Fuel storage and supply for offshore marine and air operations.
- ☐ Radios and cell phone coverage in all parts of the operational area are verified.
- ☐ Radio channels are established for:

- ☐ Command and Control.
 - ☐ Ignition Team.
 - ☐ Operational Surveillance & Spotting Teams.
 - ☐ Air Quality Monitoring Team.
 - ☐ Burn Residue Recovery Team (if used).
 - ☐ Other teams, as deemed appropriate and necessary.
- ☐ Ignition equipment is in place (Appendix E). In cold conditions, these must be able to provide high-temperature and sustained heat needed to ignite cold oils.

Location Considerations

Open Water Conditions

- ☐ ISB fire-resistant boom of sufficient durability and length is available (Appendix D), a typical length is 500 ft per burn team towing unit.
- ☐ Conventional containment boom is available for diverting or deflecting oil to the burn containment operation.
- ☐ Towlines, 200 to 300 ft at each end of the towed U-boom configuration, are available, along with suitable lighting if left deployed overnight.
- ☐ Boat or shore access is available for:
 - ☐ Boom deployment maintenance & supply.
 - ☐ Operational surveillance and spotting.
 - ☐ Vessel and/or aerial ignition.
 - ☐ Air quality and wildlife monitoring.
 - ☐ Rescue teams & backup fire control.

- Recovery and transport of unburned residues.
- Decontamination/cleaning for boats and boom.

Ice Conditions

☐ For ISB on solid ice:

- Thickness and integrity of ice has been verified for all operations that require any personnel or equipment on the ice.
- Chain saws and ice augers are available in the needed sizes.
- Lifting equipment is available to remove ice blocks from trenches or slots.
- Storage/containment areas for the ice have been established, if not used as containment or safety barriers on/in the ice.
- Front-end loaders, ditch-witches, and other heavy equipment for ice & snow modifications on thick stable ice.
- Underwater lights for locating oil trapped in ice.

☐ For ISB in broken ice:

- Adequate ice-strengthened vessels for offshore operations, with skimming systems designed for operations with ice could be needed to recover unburned oil or burn residue.
- Tracking beacons to monitor any movement of oil and/or oiled ice.
- Ignition systems (hand-held, terra-torch, helitorch or fixed-wing), depending upon the nature and distribution of the oil and ice.
- Aerial support to monitor oil/ice conditions, provide spotting for surface operations, and to document all burn operations.

Monitoring, Notifications, and Documentation

Monitoring

- ☐ Air monitoring equipment for particulates, lower explosive limit levels, volatiles, and poly aromatic hydrocarbons are functional, calibrated and deployed (Appendix G).
- ☐ Equipment for unburned oil and residue sampling and recovery is identified and in place (e.g. sorbent materials, nets, over-the-side excavators or scoops, viscous oil skimming systems, storage containers, etc.).
- ☐ Equipment for recording pre- and post-burn status (cameras, water- and beach-sampling materials as appropriate). Documentation of fire size, location, and duration of burn for oil removal volume estimates. Recording of multiple burns, amount of burn residue produced and collected, etc.

Public Safety Notifications

- ☐ Local emergency management and law enforcement agencies have been notified regarding any potential visibility impacts (aircraft, road and waterborne traffic, and spill response personnel).
- ☐ FAA has been notified of possible smoke impacts to air traffic, as appropriate.
- ☐ Marine safety zone established and Notice to Mariners requested of USCG, as appropriate.
- ☐ Potential road closures or detours due to smoke if burning near shore.
- ☐ Alerts and possible relocation of residents due to smoke.
- ☐ The local 911 public safety organizations have been briefed on the burn(s) and possible smoke concerns.
- ☐ A public relations contact has been identified and briefed.

ISB Plan Components of an Incident Action Plan

- ☐ ICS for this ISB has been established (Appendix I).
- ☐ Incident Command conditions and requirements for the ISB have been incorporated into plans as appropriate.
- ☐ Requirements of all federal, state and local permits have been communicated and incorporated into plans as necessary.
- ☐ **Site Safety Component** (Appendix B) including:
 - ☐ **Emergency Contingency Component** covering:
 - Monitoring (wind/sea conditions, visibility, temperature, etc.).
 - Waterborne Fire control (type, amount, and location of vessels/equipment/personnel).
 - Medical/Rescue Resources (air ambulances may not transport contaminated patients).
 - Emergency communications.
 - Rapid notification and evacuation of response personnel.
- ☐ **Oil Concentration Component** for surface water:
 - ☐ The concentration and thickening of oil with barriers or chemical herders to increase efficiency of burn.
 - ☐ Preparations for possible continuous burns of oil from large batch releases, continuous sources, the continuous feeding of weathered (low volatility) oil to towed U-boom configurations, and the deliberate ignition of spill sources.
 - ☐ The potential for use of icebreaking vessels to access oil beneath solid sea ice.
 - ☐ The use of ice penetration, trenching, and removal techniques for the exposure and capture/burning of oil.



Tow Boats Pulling Fire Boom in a U-Shaped (Catenary) Formation

Source: API.

- The use of chemical herding agents, wind or propeller wash to concentrate oil between ice floes, in leads, in or upstream of fire boom configurations, and along non-vulnerable (or lightly-impacted shorelines).
- The use of diversion boom to deflect oil in currents towards burn areas.
- The capture of oil with fire boom towed in a U-configuration (Appendix D).
- Use a two-boat configuration moving with current to capture oil in fire boom (boom to have relative velocity to stream flow of < 0.7 knots) for burning.
- In conjunction with the above tactic, two additional boats (more widely separated) can tow conventional deflection boom upstream in an open-apex (or “funnel”) configuration. Oil can then be concentrated over a broader swath, concentrating oil to the fire boom configuration.

- **Oil Collection** requirements with broken ice:
 - Use hand-held vessel-deployed and/or aerially-deployed igniters to ignite oil on ice or between floes.
- **Oil Collection** requirements under/in/on solid ice:
 - As ice concentrations increase beyond 20%–30% controlled ISB operations without boom can be done successfully when the ice confining the oil maintains the necessary oil thickness. Wind and chemical herding can assist in maintaining thickness. ISB, in particular, has significant potential for eliminating large quantities of spilled oil safely and effectively under extreme cold conditions, even in the presence of land-fast and offshore pack ice.
- **Ignition Plan Component** requirements:
 - Personnel identified.
 - Burn time estimated and ignition timing criteria established.
 - Ignition equipment readiness checked.
 - Ignition tactics identified (examples below).
 - Sequencing of ignition locations to give better control and speed of fire spread depending upon wind direction and safety considerations.
 - For open water, the sequencing and location of ISB actions might include: swath enhancements, towed boom orientation and speed, wind herding, and the use of propeller wash for herding.
 - Consider batch burning for better control of fire propagation. Usually, the use of two or more igniters and/or the use of hotter and longer-lasting igniters will suffice for any stubborn ignition.