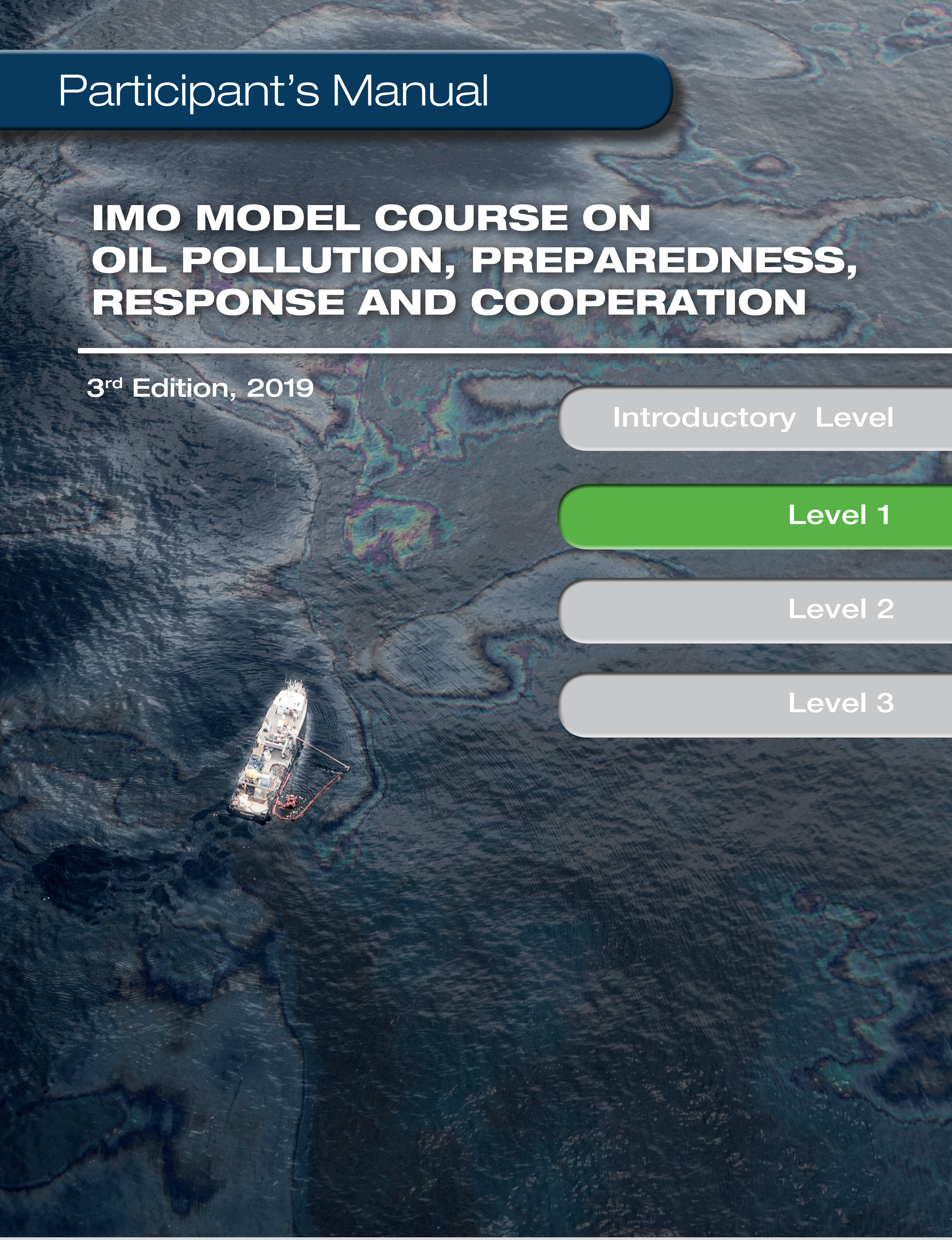
Participant's Manual



IMO MODEL COURSE ON OIL POLLUTION, PREPAREDNESS, RESPONSE AND COOPERATION

3rd Edition, 2019

Introductory Level

Level 1

Level 2

Level 3

INTERNATIONAL MARITIME ORGANIZATION

TABLE OF CONTENTS

INTRODUCTION

The purpose of the Participant's Manual is to provide you with guidance in the use of the course materials and hand-outs both during and after the seminar.

GENERAL

The International Convention on Oil Pollution Preparedness, Response and Cooperation, 1990 (OPRC) calls for the International Maritime Organization, along with relevant international and regional organizations, oil and shipping industries, to develop a comprehensive training programme in the field of oil pollution preparedness and response together with the necessary expertise to develop and implement. In this regard, four model training courses were developed aimed at the following:

Introductory Level:	Raising Awareness
Level 1:	First Responders (Operational)
Level 2:	Supervisors and On-Scene Commanders (Tactical)
Level 3:	Administrators and Senior Managers (Strategic)

These courses, when properly linked to a country's national contingency plan, can be used to train those who are responsible for the conduct and management of an effective response to a marine oil spill.

The Level 1 course was designed to be conducted as a four-day course and is aimed at Team Leaders, Supervisors, First Responders and all those working in the field in response to an oil pollution incident.

STRUCTURE OF THE COURSE

COURSE OBJECTIVES

All modules and the lessons contained therein have a clearly stated objective or set of objectives. These objectives establish what you are expected to achieve by the end of the lesson. It is important to note that these are guidelines for instructors of what is expected while facilitating the subject matter. It is the instructor's responsibility to ensure that you are able to achieve the stated objectives.

Due to time constraints for this course, it is only possible to provide an introduction to the subject matter. Further Reading is required and there are extensive reference works published by, amongst others, IMO, IPIECA[*]/IOGP[†], ITOPF[‡] and CEDRE[§]. Suggested further reading sources are given at the end of each lesson. You are encouraged to seek out and research topics that are applicable to you.

PARTICIPANTS' QUALIFICATIONS AND EXPERIENCE

The course is designed as an intensive learning experience. The course design assumes that you do not have extensive experience in oil spill response but do have a responsibility for ensuring that such capability exists in your company, department or country or in participating in a response to an oil spill incident. The emphasis of the training course content is on the development of an operational

[*] IPIECA: The global oil and gas industry association for environmental and social issues

[†] IOGP: The International Association of Oil & Gas Producers

[‡] ITOPF: The International Tanker Owners Pollution Federation Limited

[§] CEDRE: Centre of Documentation, Research and Experimentation on Accidental Water Pollution (original: Centre de documentation, de recherche et d'expérimentations sur les pollutions accidentelles des eaux) response to an oil spill incident. There are other IMO model courses which address the tactical (Level 2) and strategic (Level 3) aspects of oil spill responses.

This course addresses the operational aspects of the response in the field. It does so in the context of the application of the current best practices and thinking in the response to an oil spill.

During the course you are expected to:

- work hard;
- ask questions;
- complete assignments and exercises accurately and on time;
- cooperate with the course director and instructional staff;
- assist other participants during classroom and exercise discussions and assignments;
- participate fully in all discussions (classroom, exercises, assignments, briefings, etc.); and
- observe all HSE expectations and report any unsafe situations.

FURTHER READING

At the end of each lesson there is a list of suggested reading, specifying the publications and materials approved by IMO. The sources have been compiled from documents that are commonly used and readily available on line. This list in not exhaustive and you are encouraged to source and read any locally relevant material.

COURSE MATERIALS

The course material on the course CD or USB pen drive consists of the following components:

- a complete set of slide presentations; and
- the Participant's Manual.

ACKNOWLEDGEMENTS

The training material is based on the Model Courses developed by IMO and approved by the Sub-Committee on Pollution Prevention and Response (PPR) and by the Marine Environment Protection Committee (MEPC) at its Seventy-first session (3–7 July 2017).

Where known, the sources of images, graphics and information are gratefully acknowledged on the presentation slides.

DISCLAIMER

Although all possible efforts have been made to ensure the correctness and completeness of the information provided. The content and materials presented in this Model Course do not necessarily reflect the relevant national policy and procedures of all member states involved in its development.

MODULE 1.1: OVERVIEW OF OIL SPILL RESPONSE

MODULE OBJECTIVE

The overall objective of this module is to enable participants to understand the principles of oil spill response, including the management of field operations and the health and safety aspects of a response.

This module is composed of six lessons, one video and one exercise:

- L.1.1: Course introduction
- V.1.1: Video – Introduction to oil spills
- L.1.2: Fate and Behaviour of Oil in the Marine and Shoreline Environment
- L.1.3: Impacts of oil spills
- L.1.4: Principles of Incident Management – Field Perspective
- L.1.5: Health and Safety Aspects of Oil Spill Response
- Ex.1.1: Exercise – Health and Safety
- L.1.6: Overview of Oil Spill Response Techniques

The objectives for each lesson are described below.

LESSON 1.1: COURSE INTRODUCTION

Objective:

The objective of this lesson is for participants to understand the aims and objectives of the training course.

At the end of this lesson, participants will:

- understand the timetable and course content of the training course;
- understand the organizational and domestic arrangements for the training course;
- have received a full safety briefing; and
- have been introduced to your fellow participants and facilitators.

Lesson summary:

It is important that participants are briefed on the safety, domestic and organizational aspects of the course. This lesson plays a vital role in welcoming participants to the course, introducing the facilitators and fellow attendees, to ensure that participants are aware of the structure of the course and what will be required of you.

Further reading:

- IMO. *International Convention on Oil Pollution Preparedness, Response and Cooperation*, 1990 (OPRC), 1991 Edition, International Maritime Organization, London, 1991 **(Approved by IMO)**.

VIDEO 1.1: INTRODUCTION TO OIL SPILLS

Objective:

The objective of this video is to give participants an understanding of the size, scale and complexity of oil spills.

At the end of this video, participants will:

- understand the range and scale of oil spill incidents; and
- have an appreciation of the difficulties and complexities of oil spill response.

Lesson summary:

It is important that participants have an appreciation of the potential size, scale and complexity of an oil spill or potential oil spill incident. This lesson plays a vital role in setting the scene for the remainder of the course.

Not all oil spills or potential oil spills are the same. They vary from low-level operational spills of limited quantities to significant releases with the attendant degree of response difficulty and complexity. It is vital that participants are prepared in advance of any spill or potential spill.

Video link: http://www.itopf.org/knowledge-resources/library/video-library/video/1-introduction-to-oil-spills/

Further reading:

- IMO. *International Convention on Oil Pollution Preparedness, Response and Cooperation*, 1990 (OPRC), 1991 Edition, International Maritime Organization, London, 1991 **(Approved by IMO)**; and
- IMO. *Manual on Oil Pollution, Section II – Contingency Planning*, 2018 Edition, International Maritime Organization, London, 2018 **(Approved by IMO)**.

LESSON 1.2: FATE AND BEHAVIOUR OF OIL IN THE MARINE AND SHORELINE ENVIRONMENT

Objective:

The objective of this lesson is for participants to understand the fate and behaviour of oil when released into the marine and shoreline environment, as well as recognizing the importance of these processes on response techniques.

At the end of this lesson, participants will:

- understand the principal oil weathering processes for surface and sub-surface oil spills;
- understand the range of shoreline interactions according to shoreline types; and
- understand the impacts of these processes on response.

Lesson summary:

When oil is spilled into the marine environment, it becomes exposed to environmental conditions such as winds, waves and varying temperatures, which will change the oil properties over time. This process is referred to as "oil weathering". The principal weathering processes are as follows:

- **Spreading:** As soon as oil is spilled at sea, it will start spreading into a thin layer on the sea surface. Low viscosity oil will tend to spread faster than that of high viscosity. The oil will change colour according to its thickness. Thick oil will remain black or brown while thin oil will become rainbow-coloured with a silvery sheen.
- **Evaporation:** The lighter components of the oil will evaporate over time. High temperatures, rough seas and high winds will influence this process. Evaporation will generally result in higher oil density and viscosity, which will affect response strategies. Significant amounts of oil can be eliminated from the environment with this process.
- **Dispersion:** Oil droplets of various sizes will mix into the water column under the actions of breaking waves. This process is principally observed with low viscosity oil. While small oil droplets may remain in the water column and dilute, larger oil droplets will rise back to the sea surface to form new oil slicks.
- **Emulsification:** With the action of waves, some oil will take up water droplets, which will become incorporated into the oil matrix forming an emulsion. Oils with an asphaltene concentration above 0.5% or with a nickel/vanadium concentration above 15ppm are likely to form an emulsion. Emulsification will increase the volume of pollutant up to five times and will significantly increase oil viscosity, complicating clean-up and altering other weathering processes.
- **Stranding or shoreline interaction:** In almost all cases, oil eventually reaches the shoreline where it becomes stranded. The persistence of oil on shoreline will depend on shoreline type and exposure to sea energy.

As mentioned, the processes can significantly affect the effectiveness of response strategies by changing oil properties over time. This will have a direct impact on safety, operations and on the effectiveness of spill equipment and clean-up techniques.

Further reading:

- IMO. *Manual on Oil Pollution, Section IV – Combating oil spills*, 2005 Edition, International Maritime Organization, London, 2005 **(Approved by IMO)**;
- ITOPF. *Technical Information Paper (TIP) 2 – Fate of Marine Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-2-fate-of-marine-oil-spills/);
- ITOPF. *TIP 6 – Recognition of Oil on Shorelines,* 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-6-recognition-of-oil-on-shorelines/); and
- POSOW. *Oiled Shoreline Assessment Manual*, 2013 (www.shorelinescat.com/Documents/Manuals/POSOW%20Oiled%20Shoreline%20Assessment%20Manual%20webversion.pdf).

LESSON 1.3: IMPACTS OF OIL SPILLS

Objective:

The objective of this lesson is for participants to gain an understanding of the potential sources of oil spills, to recognize the potential impact of oil spills on social and economic activities, on the marine environment and fisheries.

At the end of this lesson, participants will:

- have a better appreciation of potential impacts from an oil spill; and
- be able to use this information to implement a tactical response to oil spills.

Lesson summary:

Shipping transports 90% of our global trade and is a very powerful and positive force, making a major contribution to global trade and prosperity. It has a relatively small negative impact on the global environment and, statistically, is the least environmentally damaging mode of transport, when its productive value is taken into consideration. However, the risk of pollution remains and the OPRC Convention seeks to address our preparedness and response capabilities.

It is important that to have an understanding of the potential impact of oil spills on social and economic activities, the marine environment and fisheries in order to be able to assist in implementing an operational response to any oil spill incident that you are called upon to respond to.

Oil spills interfere with coastal activities and can threaten sea-birds, marine life, fisheries, coastal installations and recreation areas. Therefore, the response to such pollution requires careful advance planning. From an environmental aspect, it is important to keep in mind that health of populations is more important than individuals. Recovery time is highly variable within populations and habitats. Prioritized areas to be protected should be pre-identified at the contingency planning stage.

Due to time constraints, it has only been possible to provide an introduction to these topics, and participants are urged to read the papers produced by IMO, ITOPF and IOGP/IPIECA and CEDRE on this subject, as listed below.

Further reading:

- IMO. *Manual on Oil Pollution, Section IV – Combating oil spills*, 2005 Edition, International Maritime Organization, London, 2005 **(Approved by IMO)**;
- IMO. *Contingency Planning, Manual on Oil Pollution, Section II,* 2018 Edition, International Maritime Organization, London, 2018 **(Approved by IMO)** ;
- IMO. *Guidelines for Sampling and Identification of Oil Spills, Manual on Oil Pollution, Section VI ,* 1998 Edition, International Maritime Organization, London, 1998 **(Approved by IMO)**;
- IMO/UNEP. *Guidance Manual on the Assessment and Restoration of Environmental Damage Following Marine Oil Spills,* 2009 Edition, IMO, London, 2009 **(Approved by IMO)**;
- CEDRE. *Surveying Sites Polluted by Oil,* 2006 (www.cedre.fr/en/Our-resources/Documentation/Operational-guides/Surveying-Sites - please send an email to documentation@cedre.fr to request full version);
- ITOPF. *TIP 2 Fate of Marine Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-2-fate-of-marine-oil-spills/);

- ITOPF. *TIP 6 Recognition of Oil on Shorelines*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-6-recognition-of-oil-on-shorelines);
- ITOPF. *TIP 11 Effects of Oil Pollution on Fisheries and Mariculture*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-11-effects-of-oil-pollution-on-fisheries-and-mariculture/);
- ITOPF. *TIP 12 Effects of Oil Pollution on Social and Economic Activities*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-12-effects-of-oil-pollution-on-social-and-economic-activities/); and
  ITOPF. *TIP 13 Effects of Oil Pollution on the Marine Environment*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-13-effects-of-oil-pollution-on-the-marine-environment/).

LESSON 1.4: PRINCIPLES OF INCIDENT MANAGEMENT – FIELD PERSPECTIVE

Objective:

The objective of this lesson is for participants to understand the principles of incident management from the field perspective, including operational organization and management, communications, reporting and dealing with the media.

At the end of this lesson, participants will understand:

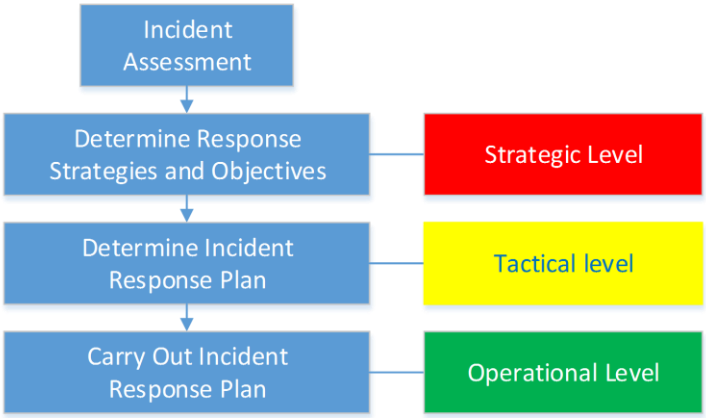
- the need for an Incident Management System (IMS);
- the response planning cycle;
- the Incident Action Plan (IAP); and
- the role of Operations within the response organization.

Lesson summary:

The early stages of any response incident are often confusing and stressful, with competing priorities, few resources and little information. Effective incident management requires turning this opening "crisis" phase into a structured response in the shortest possible time. This can best be achieved by utilizing an Incident Management System (IMS) that will be best suited for your needs, understood by the course participants, and exercised.

There are a range of response systems employed worldwide. In this lesson we will consider the principles of an IMS that can be applied to a range of response situations and organizational structures. You will consider which system best meets your needs.

The IMS promotes cohesion and provides direction to deliver a response strategy. During an incident response, the response objectives are established at the strategic level (see graphic below). At the tactical level, these objectives are turned into an incident (action) response plan. An IMS ensures a structured and flexible response organization to develop and manage a response plan.



The IMS defined in this lesson involved:

- The operations function
  - Aviation division
  - Marine division
  - Shoreline division
  - Wildlife division
  - Health and safety
  - Waste management
- The planning function
  - Situation intelligence
  - Environment
  - Resource deployment
  - Response planning
  - Technical support
- Logistics function
  - Supply
  - Communications support
  - Facilities support
  - Transport support
  - Subsistence
- Finance function
  - Accounts
  - Insurance/compensation
  - Cost recovery

An Incident Action Plan (IAP) pulls together the incident objectives, strategies and tactics. An IAP is developed for a specified period of time and describes the activities and logistical support required during that period. It is a "living document" and subject to amendment and updating as the latest information is received.

Effective management requires a systematic approach and is therefore a continual process of identifying and addressing the unique risks posed by a particular incident. In its simplest form, this process consists of the following four steps and is referred to as the Response Planning Cycle:

- Incident Assessment

- Planning and Decision Making
- Implementation
- Monitoring and Review

Within the "Operations Team" there will be a number of specific teams with differing responsibilities such as aerial operations, at-sea operations and shoreline operations. These identified sectors will be controlled by a Beach Supervisor/Manager who will be responsible for the operations within their sector and will be supported by response teams, headed by Team Leaders.

The systems described in this lesson can be expanded or contracted to meet the management needs of any type or size of incident. Response organizations generally fall into three main styles: single command, coordinated command and unified command.

Due to time constraints, it has only been possible to provide an introduction to these topics, and you are urged to read the papers produced by IMO, ITOPF and IOGP/IPIECA on this subject.

Further reading:

- IMO. *Implementation of an Incident Management System (IMS),* 2012 Edition, International Maritime Organization, London, 2012. **(IMO Approved)**;
- CEDRE. *Management of Volunteers in Coastal Pollution Response*, 2012 (www.cedre.fr/en/Our-resources/Documentation/Operational-guides/Volunteers, please send an email to documentation@cedre.fr to request full version);
- IPIECA/IOGP. *Mutual Aid Indemnification and Liability*, 2016 (http://www.ipieca.org/resources/awareness-briefing/mutual-aid-indemnification-and-liability-including-a-template-emergency-personnel-secondment-agreement/);
- ITOPF. *TIP 10 – Leadership, Command & Management of Marine Oil Spills*, 2012 (www.itopf.com/knowledge-resources/documents-guides/document/tip-10-leadership-command-management-of-oil-spills/); and
- POSOW. *Oil Spill Volunteer Management Manual*, 2013 (www.posow.org/documentation/manual/volunteersmanual.pdf).

Lesson 1.5: Health and Safety Aspects of Oil Spill Response

Objective:

The objective of this lesson is to give you an understanding of the importance of safety procedures when responding to a spill. This includes information on how to identify the type of potential hazard during a spill, recognize the potential dangerous impact on health and take the right precautions when facing this kind of situation.

At the end of this lesson, you will be able to:

- recognize the potential sources of danger of a spill;
- identify symptoms related to toxic exposure and select protective measures; and
- recognize the precautions to be taken during spill response operations.

Lesson summary:

Ensuring the health and safety of the public and response personnel should be the utmost priority during an oil spill response. It is essential that management and field personnel have the ability to identify potential hazards and implement associated corrective actions to ensure everyone's safety. Responders can be exposed to a wide range of potential hazards during an oil spill, the main ones being:

- physical hazards trip and fall;
- chemical hazards due to the toxic nature of some oil components;
- environmental hazards from weather conditions such as heat stress;
- wildlife hazards due to potential wildlife encounters during clean-up operations; and
- other hazards.

To ensure a safe working environment for all workers involved in the response, it is essential to develop an adapted safety plan. This specific safety plan will take into consideration all response activities (at-sea, aerial and ground activities), as well as specific work site considerations. This plan will identify hazards, requirements for safety training, equipment such as personal protection equipment (PPE) and site control measures. It will also include incident or near miss reporting protocols to ensure that the plan is updated according to new risks and/or potential incidents. Although the implementation of the safety plan is ultimately the responsibility of the incident manager, all responders must be responsible to ensure their own safety and the safety of those working around them.

Protection of the general public is another important consideration during an oil spill response. Generally, the public can be affected by hydrocarbon vapours or by direct contact with oil. The public can be protected by implementing preventive evacuations of areas potentially exposed to vapours and by enforcing strict access control of contaminated areas.

Further reading:

- IPIECA/IOGP. *Oil Spill Responder Health & Safety – Good Practice Guide Series,* 2013 (http://www.ipieca.org/resources/good-practice/oil-spill-responder-health-safety/);
- IPIECA/IOGP. *Mutual Aid Indemnification and Liability*, 2016 (http://www.ipieca.org/resources/awareness-briefing/mutual-aid-indemnification-and-liability-including-a-template-emergency-personnel-secondment-agreement/);
- ITOPF. *TIP 10 – Leadership, Command & Management of Marine Oil Spills*, 2012 (www.itopf.com/knowledge-resources/documents-guides/document/tip-10-leadership-command-management-of-oil-spills/);
- POSOW. *Oil Spill Volunteer Management Manual*, 2013, (www.posow.org/documentation/manual/volunteersmanual.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

Exercise 1.1: Exercise – Health and Safety

Objective:

The objective of this exercise is for you to understand the health and safety aspects of oil spill response, from a field perspective, including the identification of risk and the implementation of mitigation measures.

At the end of this exercise, you will be able to:

- understand the health and safety aspects of oil spill response;
- identify areas of risk; and
- enact mitigation measures.

LESSON 1.6: OVERVIEW OF OIL SPILL RESPONSE TECHNIQUES

Objective:

The objective of this lesson is to give participants an overview of oil spill response techniques.

At the end of this lesson, participants will:

- recognize the different response techniques available for oil spill response; and
- have an overview of different types of equipment and their limitations.

Lesson summary:

A limited number of response techniques are available when responding to an oil spill. Some response techniques are available for operations conducted at sea while others are available when dealing with shoreline clean-up. This presentation discusses the principal response techniques available.

The ITOPF Technical Information Paper (TIP) 10 – Leadership, Command and Management of Marine Oil Spills (part of the Further reading recommendations) provides a valuable summary of this subject:

> "As the scale and details of the incident become clearer, a number of key response decisions will be required, for example:
>
> - whether to mobilize aircraft for surveillance of the spill and for subsequent monitoring and control of the clean-up operations at sea and onshore;
> - which of the available response resources are likely to be most suitable, based on the oil type and environmental considerations;
> - where to deploy equipment and personnel taking into account observations of oil movement, the risk to sensitive resources and equipment availability;
> - the need for logistical support to enable activities such as transport and temporary storage of recovered oily waste and distribution of fuel for machinery, personal protective equipment (PPE) and food for the workforce; and
> - which treatment and disposal routes will be most suitable for the various waste streams, i.e. liquid oil, oiled shoreline substrate, used PPE and sorbent materials.
>
> Adverse weather conditions or excessive currents may mean that no immediate response at sea is feasible and, if coastal sites have already been affected, decisions may focus on the priorities for shoreline clean-up.
>
> In a major spill, it is most unlikely that all the economic and environmental resources at risk can be successfully defended, either because of a lack of suitable response equipment or insufficient time to deploy the equipment. As a consequence, decisions may be required as to which sensitive resources should be protected, or affected sites cleaned, in preference to others. For example, boom may be allocated to protect a mangrove stand rather than a sand beach despite the concerns of local hoteliers, as the mangroves will be more sensitive to oil and more difficult to clean. Alternatively, men and equipment may be tasked with recovering bulk oil on the shorelines to prevent remobilization to other areas in preference to cleaning lightly oiled shorelines, even if they are in amenity areas.
>
> When deciding the most appropriate response options, priority should be given to those techniques that are technically reasonable in the circumstances, that minimize the amount of waste generated, are cost effective and are permitted under national policy and regulations.

Consideration of the advantages and disadvantages of clean-up techniques can assist in minimizing the overall impact on the environment and on social and economic activities. Net Environmental Benefit Analysis (NEBA)* is a pragmatic scientific approach that can be used to determine which response techniques would allow recovery of the environment more quickly or would provide the greatest protection to sensitive resources in comparison with natural cleaning. By way of example, when considering the application of dispersant to floating oil, the potential impact of the oil on seabird populations might be evaluated against the potentially increased impact of dispersed oil on sub-surface biota. Alternatively, the decision to utilize heavy machinery to recover bulk oil and reduce the possibility of the oil remobilizing to affect other sensitive areas should be balanced against the potential for long term damage to the substrate.

To ensure the most effective use of response resources, it is important that conflicting and counterproductive response techniques are not undertaken concurrently in the same locality. For example, the use of dispersants (the aim of which is to place oil into the water column) will render booms and skimmers redundant, as they are intended to contain and recover floating oil. Furthermore, dispersants can adversely affect the ability of oil to adhere to sorbent materials and to oleophilic skimmers."

This lesson explains the equipment available for the response including:

- Containment and recovery
  - Boom
  - Skimmers
  - Pumps/vacuum systems
  - Sorbents
- Dispersants
- In situ burning
- Shoreline protection

Remember that recovery is very challenging and that various items of equipment each have their respective limitations and that, whilst response techniques may be counterproductive if undertaken concurrently, it is important to consider all response technologies in planning and preparing for a response. Preparedness and operational control are key for an efficient response.

Further reading:

- IMO. *Manual on Oil Pollution, Section IV – Combating oil spills*, 2005 Edition, International Maritime Organization, London, 2005 **(Approved by IMO)**;
- IMO. *Field Guide for Oil Spill Response in Tropical Waters*, 1997 Edition, International Maritime Organization, London, 1997 **(Approved by IMO)**;
- IMO. *Guideline for Oil Spill Response in Fast Currents*, 2013 Edition, International Maritime Organization, London, 2013 **(Approved by IMO)**;
- IMO. *Guidelines for the Use of Dispersants for Combating Oil Pollution at Sea* (to be published in 2019), International Maritime Organization, London **(Approved by IMO)**;
- IMO. *Contingency Planning, Section II, Manual on Oil Pollution,* 2018 Edition, International Maritime Organization, London, 2018 **(Approved by IMO)**;

* For information, the concept of Spill Impact Mitigation Assessment (SIMA) is currently under development by the oil and gas industry and is a further development of the NEBA concept. Note that at the time of publishing this Model Course, SIMA has not been considered or reviewed by IMO.

- CEDRE. *Custom Made Spill Response Barriers*, 2012 (www.cedre.fr/en/Our-resources/Documentation/Operational-guides/Custom-Made-Barriers, please send an email to documentation@cedre.fr to request full version);
- CEDRE. *Manufactured Spill Response Booms*, 2012 (www.cedre.fr/en/Our-resources/Documentation/Operational-guides/Manufactured-Booms, please send an email to documentation@cedre.fr to request full version) ;
- CEDRE. *Response to Small-Scale Pollution in Ports and Harbours*, 2007 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Pollution-in-Ports)
- CEDRE. *Surveying Sites Polluted by Oil*, 2006 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Surveying-Sites – please send an email to documentation@cedre.fr to request);
- CEDRE. *Use of Sorbents for Spill Response, Operational Guide,* 2009 (wwz.cedre.fr/en/content/download/1776/138719/file/extract-sorbents.pdf) ;
- CEDRE. *Using Dispersant to Treat Oil Slicks at Sea*, 2005 (wwz.cedre.fr/en/content/download/1779/138734/file/extract-using-dispersant.pdf);
- ITOPF. *TIP 1 – Aerial Observation of Marine Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-1-aerial-observation-of-marine-oil-spills/);
- ITOPF. *TIP 3 – Use of Booms in Oil Pollution Response*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-3-use-of-booms-in-oil-pollution-response/);
- ITOPF. *TIP 4 – Use of Dispersants to Treat Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-4-use-of-dispersants-to-treat-oil-spills/);
- ITOPF. *TIP 5 – Use of Skimmers in Oil Pollution Response*, 2012 (www.itopf.com/knowledge-resources/documents-guides/document/tip-5-use-of-skimmers-in-oil-pollution-response/);
- ITOPF. *TIP 7 – Clean-up of Oil from Shorelines*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-7-clean-up-of-oil-from-shorelines/);
- ITOPF. *TIP 8 – Use of Sorbent Materials in Oil Spill Response*, 2012 (www.itopf.com/knowledge-resources/documents-guides/document/tip-8-use-of-sorbent-materials-in-oil-spill-response/);
- OSRL. *Aerial Surveillance Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Aerial-Surveillance-Handbook.pdf);
- OSRL. *Containment and Recovery Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Containment-and-Recovery-Handbook.pdf);
- OSRL. *Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf);
- OSRL. *Offshore In-Situ Burn Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/In-Situ-Burn-Handbook.pdf);
- OSRL *Shoreline Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Shoreline-Operations-Handbook.pdf);
- OSRL *Vessel Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf);
- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013, (www.posow.org/documentation/manual/cleanupmanual.pdf);
- POSOW. *Oiled Wildlife Response Manual*, 2013 (www.oiledwildlife.eu/sites/default/files/POSOW%20oiled%20wildlife%20manual.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

MODULE 1.2: OIL SPILL RESPONSE TECHNIQUES – AT-SEA

MODULE OBJECTIVE

The overall objective of this module is to enable participants to understand in detail the existing at-sea response techniques and become aware of the advantages and disadvantages of each oil spill response technique as well as the logistical requirements for their deployment in the field.

This module is composed of six lessons (one of which is optional), one video and one exercise:

- V.1.2: Video – At-sea Response
- L.1.7: Dispersants
- L.1.8: Booms – Containment and Protection
- L.1.9: Skimmers
- L.1.10: Temporary Storage
- L.1.11: In Situ Burning (optional)
- L.1.12: Using Sorbents
- Ex.1.2: Exercise – At-sea Response Equipment

The objectives for each lesson are described below.

VIDEO 1.2: AT-SEA RESPONSE

Objective:

The objective of this video is to give an understanding of at-sea response operations.

At the end of this video, participants will:

- understand the principles of at-sea response operations;
- be aware of the advantages and limitations of at-sea response; and
- understand the equipment and methodologies employed during at-sea response operations.

Lesson summary:

When faced with an oil spill, responders have to select the most appropriate response options in order to minimize damages from oil on the environment and socio-economic activities. Containment and recovery and chemical dispersion of the lost pollutants are key tactical considerations. However, no magic option exists and these methodologies have operational limitations. Field personnel must have detailed knowledge about the available response techniques in order to ensure effective deployment of resources.

Video link: http://www.itopf.org/knowledge-resources/library/video-library/video/3-at-sea-response/

Further reading:

- IMO. *Manual on Oil Pollution, Section IV – Combating oil spills*, 2005 Edition, International Maritime Organization, London, 2005 **(Approved by IMO)**;

- IMO. *Field Guide for Oil Spill Response in Tropical Waters*, 1997 Edition, IMO, London, 1997 **(Approved by IMO);**
- IMO. *Guidelines for the Use of Dispersants for Combating Oil Pollution at Sea,* (to be published in 2019), IMO, London **(Approved by IMO);**
- CEDRE. *Custom Made Spill Response Barriers*, 2012 (www.cedre.fr/en/Our-resources/Documentation/Operational-guides/Custom-Made-Barriers);
- CEDRE. *Manufactured Spill Response Booms*, 2012 (www.cedre.fr/en/Our-resources/Documentation/Operational-guides/Manufactured-Booms, please send an email to documentation@cedre.fr to request full version);
- CEDRE. *Use of Sorbents for Spill Response, Operational Guide,* 2009 (wwz.cedre.fr/en/content/download/1776/138719/file/extract-sorbents.pdf) ;
- CEDRE. *Using Dispersant to Treat Oil Slicks at Sea*, 2005 (wwz.cedre.fr/en/content/download/1779/138734/file/extract-using-dispersant.pdf);
- IPIECA/IOGP. *Oil Spill Responder Health & Safety – Good Practice Guide Series,* 2013 (http://www.ipieca.org/resources/good-practice/oil-spill-responder-health-safety/);
- content/uploads/2017/01/Responder_health_and_safety_2016.pdf);
- IPIECA/IOGP. *The Use of Decanting during Offshore Oil Spill Recovery Operations*, 2016, (http://www.ipieca.org/resources/awareness-briefing/the-use-of-decanting-during-offshore-oil-spill-recovery-operations/);
- ITOPF. *TIP 1 – Aerial Observation of Marine Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-1-aerial-observation-of-marine-oil-spills/);
- ITOPF. *TIP 3 – Use of Booms in Oil Pollution Response*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-3-use-of-booms-in-oil-pollution-response/);
- ITOPF. *TIP 4 – Use of Dispersants to Treat Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-4-use-of-dispersants-to-treat-oil-spills/);
- ITOPF. *TIP 5 – Use of Skimmers in Oil Pollution Response*, ITOPF, 2012, (www.itopf.com/knowledge-resources/documents-guides/document/tip-5-use-of-skimmers-in-oil-pollution-response/);
- ITOPF. *TIP 8 – Use of Sorbent Materials in Oil Spill Response*, 2012 (www.itopf.com/knowledge-resources/documents-guides/document/tip-8-use-of-sorbent-materials-in-oil-spill-response/);
- OSRL. *Aerial Surveillance Field Guide*, 2011, (www.wcmrc.com/wp-content/uploads/2012/06/Aerial-Surveillance-Handbook.pdf);
- OSRL. *Containment and Recovery Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Containment-and-Recovery-Handbook.pdf);
- OSRL. *Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf);
- OSRL. *Offshore In-Situ Burn Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/In-Situ-Burn-Handbook.pdf);
- OSRL. *Vessel Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

LESSON 1.7: USE OF DISPERSANTS

Objective:

The objectives of this lesson are to understand the mechanism of dispersion*, the tactical advantages and disadvantages of using dispersants, and the logistical requirements for their deployment.

The use of dispersants in freshwater environments differs from its use in open sea and requires the consideration of a number of factors not covered in this lesson.

At the end of this lesson, participants will understand:

- the principles of dispersion;
- how dispersants can be applied;
- how they are deployed; and
- the health and safety considerations.

Lesson summary:

When facing an oil spill, responders have to select the most appropriate response options in order to minimize damages from oil on the environment or on socio-economic activities. The use of dispersants can, in the appropriate circumstances, help to minimize such damage and, as such, is a key tactical consideration. However, no magic option exists and these methodologies have operational limitations, as well as environmental and safety precautions to be considered in their use. It is important for field personnel to understand how these can be used and the logistical requirements for their deployment.

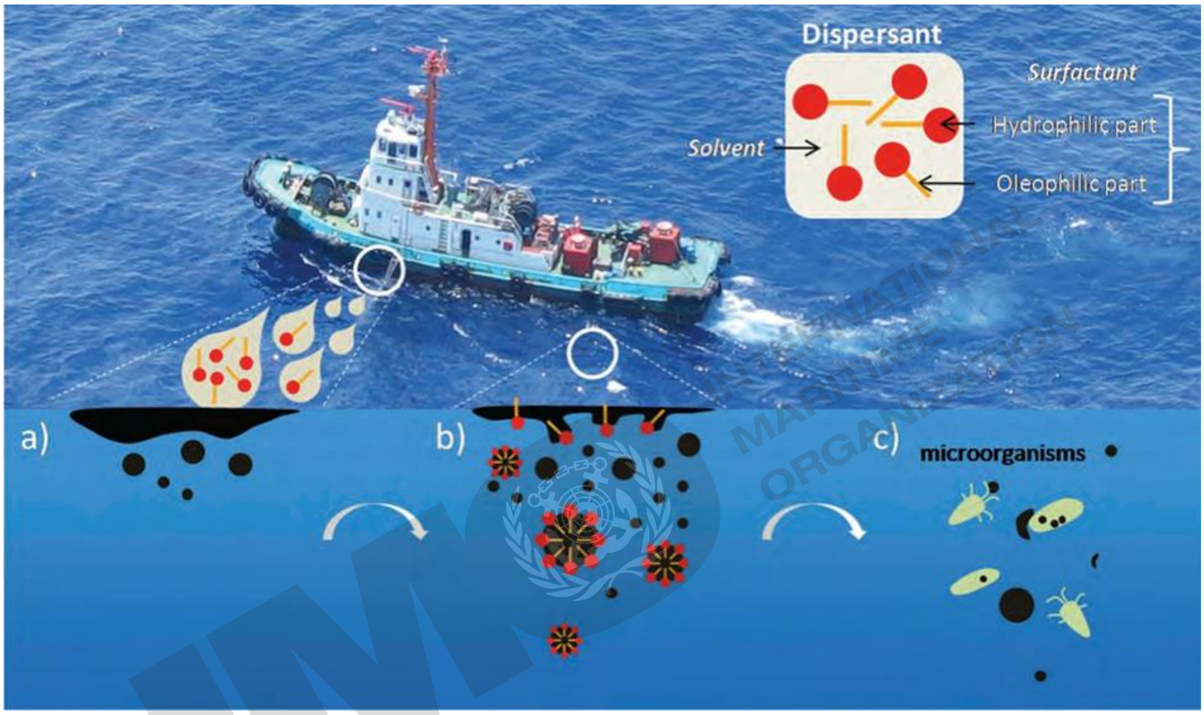
The following text has been extracted from the ITOPF Technical Information Paper (TIP) 4 – Use of Dispersants to Treat Oil Spills (part of the Further reading recommendations):

> "The principal aim of dispersant application is to break up an oil slick into numerous small droplets which become rapidly diluted into the water column and are subsequently degraded by naturally occurring micro-organisms. Used appropriately, dispersants can be an effective response to an oil spill and can minimise or prevent damage to important sensitive resources.
>
> In common with other response techniques, the use of dispersants must be considered carefully, to take into account oil characteristics, sea and weather conditions, environmental sensitivities and national regulations on dispersant use. In some cases, significant environmental and economic benefits can be achieved through the use of dispersants, particularly when other at-sea response techniques are limited by weather conditions or the availability of resources.
>
> Dispersants are designed to enhance natural dispersion by reducing the surface tension at the oil/water interface, making it easier for wave motion to create many more small oil droplets. Dispersants are a blend of surfactants (surface active agents) in a solvent. The solvent has two functions: to act as a 'thinner', reducing the viscosity of the surfactant, so that it can be sprayed, and to promote the penetration of the surfactant into the oil slick.
>
> To achieve an effective dispersion, oil droplet size must be in the range of 1pm to 70pm (pm = micrometres = 10-6 metres. 1 pm = 0.001mm), with the most stable size being less

* The information provided in this lesson is, unless otherwise specified, referring to surface application of dispersant rather than sub-sea application.

than 45pm. The speed with which droplets in this size range rise towards the surface is balanced by the turbulence of the sea so that they remain in suspension and the oil and dispersant mixture dilutes rapidly within the top few metres of the water column. The presence of the surfactant molecules at the droplet surface, and the reduced probability of oil droplets coming into contact as they dilute and move apart, minimises the possibility of re-coalescence and reformation of surface slicks.

Biodegradation by a range of marine micro-organisms can occur only at the droplet surface because the organisms are present in the water and not in the oil. The production of numerous smaller oil droplets increases the surface area of the oil and therefore the area available for biodegradation.



In the figure above: The chemical dispersion process: a) Dispersant containing surfactants and solvent is sprayed onto the oil with the solvent carrying the surfactant into the oil; b) The surfactant molecules migrate to the oil/water interface and reduce surface tension, allowing small oil droplets to break away from the slick; c) The droplets disperse by turbulent mixing and are ultimately degraded by naturally occurring micro-organisms, such as bacteria and fungi. This latter stage may require days or weeks to achieve.

Types of Dispersants

Dispersants are classed according to their generation and their type. The first generation of products, introduced in the 1960's, were similar to industrial cleaners and degreasers, with high aquatic toxicity. They are no longer used in oil spill response.

Second-generation dispersants, also called Type I dispersants, were designed specifically to treat oil spills at sea by spraying from vessels. They contain a hydrocarbon solvent with a low or no aromatic content and typically 15 to 25% surfactant. They are intended to be applied undiluted (neat), as pre-dilution with sea water renders them ineffective. They also require a high dose rate of between 1:1 and 1:3 (dispersant to oil). While having lower toxicity than the first-generation dispersants, they are less effective and may be more toxic than third-generation dispersants. In many countries, Type I dispersants are no longer used.

Third-generation dispersants contain a blend of two or three surfactants with glycol and light petroleum distillate solvents. The concentration of surfactant within the solvent lies between 25% and 65% and tends to be higher than with Type I products.

Third-generation dispersants can be divided into Type II and III dispersants. Both types are concentrate dispersants. However, Type II dispersants are generally diluted with sea water prior to use, typically at 10% dispersant, but require a high dosage of 2:1 to 1:5 (dispersant/water mix to oil) to be effective. This requirement for dilution limits their use to application from vessels. Type III dispersants are used neat and were developed primarily to allow efficient application from aircraft but may also be used *from vessels. Dosage rates range between 1:5 and 1:50 (neat dispersant to oil), with the ideal practical ratio determined as a result of trials during an incident. Third generation, Type III dispersants are now the most commonly available dispersants.*

Dispersant Spraying Operations

In a large incident, coordination of all response actions is necessary to ensure dispersant use does not overlap or conflict with other response techniques. For example, oil dispersed into the water column cannot be contained by booms or recovered by skimmers. In addition, oil adheres to many sorbent materials, such as polypropylene, as a result of the relative surface tension of the oil. As the surface tension of oil is modified by dispersants, the effectiveness of sorbent materials can be significantly reduced by the use of dispersants. Oleophilic skimmers will be similarly affected when used alongside dispersants.

Dispersants can be applied from vessels or aircraft to oil spilt on open water. Large multi-engine aircraft offer advantages of payload for application to major off-shore spills but, along with vessels, helicopters and light aircraft, may be suitable for treating smaller spills closer to the shore.

It is important that spray systems deliver dispersant droplets of the correct size. Droplets need to be large enough to overcome the effects of wind drift and evaporative loss but not so large that they punch through the oil rather than migrate to the oil/water interface. The optimum dispersant droplet size is between 600 and 800pm in diameter.

Dispersant sprayed onto water or sheen will be ineffective and a waste of costly resources. Consequently, the thickest part of the oil slick should be rapidly targeted, before weathering of the oil or changes in the sea conditions render dispersants ineffective.

Dispersants sprayed from vessels are usually applied through a set of nozzles mounted on spray arms. Diesel or electric pumps transfer the dispersant from a storage tank to the spray arm, fitted with a set of nozzles calibrated to produce a uniform spray pattern of droplets along the length of the arm. Spray units can be portable or permanently installed on a vessel and systems are available to deliver the dispersant either undiluted or diluted with sea water.

Spray arms operate more effectively if mounted as far forward on the vessel as possible, to avoid the bow wave pushing the oil beyond the width of the spray pattern, or the spray swath. Mounting the spray arms on the bow allows the vessel to travel faster and, because freeboard is often greater at the bow, also allows the spray arms to be made longer. This optimises the encounter rate, i.e. the amount of oil that can be treated, with a limited dispersant payload. However, if the arms are too long they risk damage when the vessel rolls in swell.

Fire hoses or fire monitors are sometimes used to apply concentrate dispersants diluted in the water stream. However, optimum dilution of the dispersant is difficult to achieve because of the very high flow rates and it is difficult to apply the dispersant as a uniform spray of droplets. The high pressure of the water jet also risks forcing the dispersant through the oil. Thus, fire monitors are likely to lead to wastage of dispersant and ineffective application unless specially modified for the purpose.

Vessels offer advantages for dispersant spraying because they are usually readily available, easy to load and can apply dispersant fairly accurately to specific areas of a slick. They have cost advantages over aircraft and may be able to carry larger payloads. Nevertheless, they also have severe limitations, particularly for larger spills, because of the low treatment rate and the difficulty of locating the heaviest concentrations of oil from the bridge of a vessel, although this latter problem can be partially overcome by directing the operation from a spotter aircraft.

Logistics

Dispersant application is a specialised operation that requires trained operators and thorough preparation to ensure that all the logistics are in place. For operations to be most effective, it is desirable to use spotter aircraft to guide and co-ordinate spraying vessels and aircraft. The crew of the spotter aircraft should be able to identify the heavier concentrations of oil or the slicks posing the greatest threat. They will need to have good communication with the crews of spraying aircraft or vessels in order to guide them to the target, and with spraying aircraft, to identify the points at which spraying should start and stop in order to minimise overspray and wastage of dispersant. During the spraying operation itself, spotter aircraft can also be used to judge the accuracy of the application and the effectiveness of the treatment. These functions are particularly important when directing large multi-engine spraying aircraft that can rapidly apply large volumes of dispersant. At the low altitude necessary for effective application, the crew will experience difficulties in distinguishing between oil, sheen and water, especially if the slick is fragmented.

To ensure safety, aircraft exclusion zones need to be in force during aerial spraying operations. Relief crews may be necessary, as flying over the sea at low altitude can be extremely demanding. Periodic checks of the aircraft are also recommended to ensure that the dispersant does not contaminate lubricants, particularly in the tail rotor of helicopters, or attack any exposed rubber components of aircraft flight control systems. It is advisable to wash down the aircraft frequently with fresh water to remove both dispersant and salt water spray.

Good organisation on the ground is needed to enable spraying operations to continue for the maximum available time during daylight hours. This may require routine maintenance of aircraft and spraying equipment to be carried out during hours of darkness. It is unlikely that a single payload will be sufficient to treat a slick, especially if the release is continuous, and additional supplies of dispersant need to be sourced and conveniently located in order to re-supply vessels or aircraft with minimum delay. Similarly, thought should be given to the provision of fuel, particularly for aircraft, and to the equipment necessary to load vessels or aircraft, such as high capacity pumps and road tankers.

For long-term storage of dispersants, plastic drums, tanks or 1m3 Intermediate Bulk Containers (IBCs) are preferable. Provided that they are not exposed to direct sunlight, dispersants stored unopened should last for many years. However, once opened, the dispersant should be tested periodically for its effectiveness. Dispersants of different types, ages or brands should not be mixed in the same tank or storage container as this may alter the viscosity of the dispersant or cause some components to precipitate or coagulate. Dispersants should not be stored after they have been diluted with sea water. A temperature between -15°C and 30°C is optimum for storage of most dispersants and manufacturers recommend that temperature fluctuations are minimised during storage. In very cold air temperatures, some dispersants may become too viscous to pass through the spray nozzles."

Safety

If operated correctly, following good operational procedures and using the proper PPE, dispersants should pose no risk to health. However, there are exposure pathways that could present risks to observers and these should be understood and mitigated before beginning loading, spraying or monitoring operations.

Whilst conducting loading, spraying or monitoring operations it is very important that all personnel wear the correct level of PPE. The level of PPE will depend on the type of operation being undertaken, the location of monitoring and the application platform. If there is a risk of contact with dispersant, ensure full dispersant PPE is worn. If monitoring from an aerial platform, hearing protection, eye protection and an aviation life jacket is required.

Summary

The principal aim of dispersant application is to break up an oil slick for subsequent degradation by naturally occurring micro-organisms. Used appropriately, dispersants can be an effective response to an oil spill and minimize or prevent damage to important sensitive resources, however, as with other response techniques, its use must be considered carefully.

Further reading:

- IMO. *Guidelines for the Use of Dispersants for Combating Oil Pollution at sea*, *Parts I, II & III,* 2017 Edition *(to be published),* International Maritime Organization, London 2017 **(Approved by IMO)[*];**
- CEDRE. *Using Dispersant to Treat Oil Slicks at Sea*, 2005 (wwz.cedre.fr/en/content/download/1779/138734/file/extract-using-dispersant.pdf);
- IPIECA/IOGP. *Dispersant Logistics and Supply Planning*, 2013 (http://www.ipieca.org/resources/good-practice/dispersant-logistics-and-supply-planning/);
- ITOPF. *TIP 4 – Use of Dispersants to Treat Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-4-use-of-dispersants-to-treat-oil-spills/);
- OSRL. *Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf);
- OSRL. *Dispersant Application Monitoring Field Guide Tier I*, 2015 (www.oilspillresponse.com/technical-library/dispersant-application-monitoring-field-guide---tier-i-visual-observation/);

[*] Please note that Part IV of the IMO *Guidelines for the Use of Dispersants for Combating Oil Pollution at Sea* is currently under development.

- OSRL. *Vessel Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

Lesson 1.8: Booms – Containment and Protection

Objective:

The objective of this lesson is to understand the principles of boom deployment and recovery and standard boom configurations.

At the end of this lesson, participants will:

- know the various boom types and their limitations;
- know the most common boom deployment configuration using vessels or from the shoreline; and
- understand the logistical and ancillary requirements for the deployment of booms.

Lesson summary:

One of the most common response techniques is the use of booms for oil containment or for the protection of sensitive resources. They will almost always be used to some degree during an oil spill response. There are multiple boom types available, all with their respective limitations. It is therefore very important for field personnel to have a good understanding of the various boom types and to know in which circumstances they can be deployed and how.

This presentation will provide field personnel with the necessary knowledge to ensure the efficient use of booms during an oil spill situation either at sea, near or on the shore.

A boom is a floating physical barrier used to control the movement of oil. Booms are typically the first mechanical response equipment taken to a spill site.

Booms are routinely used to surround and contain oil spilled at sea and to deflect its passage away from sensitive resources or towards a recovery point. The success of booming operations can be limited by the rapid spread of floating oil and the effects of currents, tides, wind and waves. Effective boom design and a well-planned and coordinated response can reduce these problems, although in some circumstances booms might not be the appropriate response option.

Booming is subdivided into different categories, including:

- **Containment Booming** is used in little or no current to isolate a spill, control spreading, concentrate the oil, and facilitate its recovery by skimmers.
- **Deflection Booming** is deployed at an angle to a drifting slick to divert oil away from sensitive areas or to a collection point. One or more booms can be used to direct a slick to an advancing skimmer for recovery.
- **Protection Booming** is used to exclude slicks from sensitive shorelines and/or amenities.

With the addition of sorbent material, booms can also be used to ensnare and collect oil.

The type of boom selected will depend on how quickly it is needed, how easily it can be deployed and how rugged or durable it is. The speed and ease of deployment usually depends on the equipment and number of people required. For example, self-inflating booms can be deployed very rapidly, either from reels or bundles; however, if extended deployment is required, a more rugged boom that is slower to deploy (e.g. pressure inflatable) will perform better. Generally, ease and speed of deployment are trade-offs with ruggedness and durability.

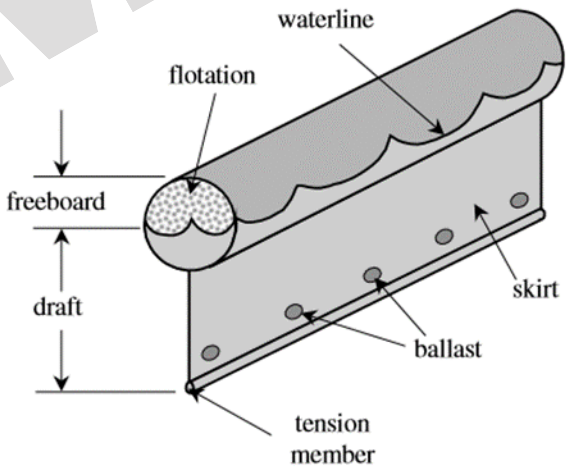
Personnel responsible for selection and use of boom should:

- understand the function of basic components and ancillary fittings common to most booms;
- identify the appropriate boom to use, taking into account its expected location of use, sea conditions, and spill response operation;
- consider the listed design factors that affect a boom's performance, including its durability, storage, deployment, and oil containment potential. Manpower requirements also need to be evaluated;
- select an appropriate size of boom according to environmental conditions and expected performance; and
- consider which boom types can be most effectively used on a spill. Refer to data for each boom type, which includes a description, recommended uses, and operational considerations.

Boom Design

Booms are manufactured in a wide variety of designs, sizes and materials for different applications. Booms generally have four basic components:

- Flotation
- Skirt
- Tension member(s)
- Ballast



(Source: Oil spill response field manual, Exxon Mobil, 2014)

Freeboard and draft are the portions of a boom's flotation and skirt above and below the waterline, respectively.

Most commercially available booms can be categorized into one of four basic design types:

- Internal foam flotation
- Self-inflating
- Pressure-inflatable
- Fence

Specialty booms are available, including those manufactured with sorbent and fire-resistant materials, shore-sealing barriers, and netting to trap high viscosity or solidified oil.

Boom Failure

Ensure that participants are aware of the five basic types of operation boom failure:

- Entrainment
- Drainage
- Splash over
- Submergence
- Planing

Boom Application

Before booms are deployed, the approximate length of required boom should be assembled as completely as possible, either on land or on the deck of a boat. Suggested lengths of booms for various applications are:

Application	Type of Boom	Quantity
Circle a stricken vessel	Offshore or harbor, depending on sea conditions	3 x ship's length
Contain leakage from terminal operations	Calm water or harbor, depending on sea conditions	1.5 x ship's length
Use with an ocean skimmer	Offshore	500–1,500 ft (460-610 m) per skimmer
Protect entrance to estuary, stream, river, etc.	Calm water	3 to 4 x width of a water body
Bays, harbors, marshland	Calm water or harbor, depending on sea conditions	(1.5 + current in kts) x width of a water body

(Source: Oil spill response field manual, Exxon Mobil, 2014)

Boom Deployment

It is important to ensure that all boom connectors are compatible, especially when booms from multiple manufacturers are used. This will ensure that all booms can be connected to each other, even if they are from different manufacturers.

Once the boom is ready, it can be launched and towed into position by boat. To ease the problems for a towing boat, a long boom can be doubled back on itself and towed out from the centre point. Once that is anchored, the ends can be towed into place and anchored. The final configuration can be arranged by setting suitable anchors or securing to permanent anchor points.

Where a boom is being used to collect oil at a shore location or protect a sensitive area, care should be taken to seal the shore end of a boom so that no oil can escape. This is particularly difficult in tidal waters and at sites where the shore is rocky or strewn with boulders and crevices.

Boom length may have to be modified after the boom has been deployed. This can be difficult to do from a vessel, particularly in strong currents, high winds, or low temperatures, as loose shackles, bolts, and tools can be lost over the side. Often, boom length cannot be changed once the boom is in the water, and to do so the boom must be retrieved, reconfigured, and re-deployed.

Boom lengths of 500 to 1,500 ft. (150 to 460 m) are typically used when towing boom in a U, V, or J configuration to maximize the oil encounter rate. Lengths as high as 2,000 ft. (600 m) have been used, but manoeuvrability is improved with shorter boom lengths.

The use of proper towing bridles or paravanes will minimize damage during towing by efficiently transferring the point load tension from the line to the connector. Towing devices prevent a boom from twisting when being towed at high speeds. Lines between boom ends and vessels should be of sufficient length to avoid sharp stress or snatching on a towed boom. Approximately 200 ft. (60m) for a 1,500 ft (460m) length of boom is typical. When feasible, an odd number of boom sections should be used to avoid having a connector at an apex from which oil more readily escapes.

Oil concentration by towed booms can be slow in thin slicks. Boom performance can be judged visually at the apex of the U or J. Oil lost under a boom will appear as globules or droplets rising from behind it. Eddies behind a boom are also an indication that towing is too fast; however, sheens are usually present behind a boom, even when it is functioning well.

Note that the apex of a boom often cannot be seen from the wheel-houses of towing vessels. Aircraft equipped with suitable air-to-sea communications can assist in directing the movements and activities of vessels to ensure that they are operating in the heaviest concentrations of floating oil. Oil slicks can be more easily located from the air than from the water surface. The thickness and volume of a slick can also be estimated from an aircraft.

Maintaining proper station of the two towing vessels relative to one another requires good communication and is improved with practice. Towing in a J configuration is difficult with untrained crews. For maximum manoeuvrability at low speeds, the ideal towing point aboard the vessel must be determined by trial and error, and may need to be altered according to wind and course direction. A towing point well forward of the stern is best.

Boom Anchoring

Anchoring a boom requires specific knowledge of the equipment, accessories, and techniques involved. Tide tables, local knowledge and weather forecasts should be consulted before a boom is deployed, especially when it must remain overnight.

Anchoring a boom requires anchors (e.g. Danforth, Fisherman's), release lines, chains, floats, bridles, lights, and other accessories. If feasible, permanent anchors should be placed at strategic sites in advance of a spill.

Local mariners can also provide guidance and practice drills to help determine the type and weight of anchors most effective at specific sites.

There are a number of safety concerns in booming operations that should be addressed by risk assessment. These include the type of oil and associated hazards, working near water, working on decks covered with oil, the weather conditions and movement of the vessel. An operational plan must be provided for each vessel detailing their specific operations, including risk assessments.

Responder guides, such as the ExxonMobil Oil Spill Response Field Manual and the OSRL Containment and Recovery Field Guide and Shoreline Operations Field Guide, provide a more detailed introduction to this subject.

Further reading:

- IMO. *Manual on Oil Pollution, Section IV – Combating oil spills*, 2005 Edition, International Maritime Organization, London, 2005 **(Approved by IMO);**
- IMO. *Field Guide for Oil Spill Response in Tropical Waters,* 1997 Edition, IMO, London, 1997 **(Approved by IMO);**
- IMO. *Guideline for Oil Spill Response in Fast Currents*, 2013 Edition, IMO, London, 2013 **(Approved by IMO);**
- CEDRE. *Custom Made Spill Response Barriers*, 2012 (www.cedre.fr/en/Our-resources/Documentation/Operational-guides/Custom-Made-Barriers);
- CEDRE. *Manufactured Spill Response Booms*, 2012 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Manufactured-Booms, please send an email to documentation@cedre.fr to request full version);
- CEDRE. *Response to Small-Scale Pollution in Ports and Harbours*, 2007 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Pollution-in-Ports);
- ITOPF. *TIP 3 – Use of Booms in Oil Pollution Response*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-3-use-of-booms-in-oil-pollution-response/);
- ITOPF. *TIP 7 – Clean-up of Oil from Shorelines*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-7-clean-up-of-oil-from-shorelines/);
- ITOPF. *TIP 8 – Use of Sorbent Materials in Oil Spill Response*, 2012, (www.itopf.com/knowledge-resources/documents-guides/document/tip-8-use-of-sorbent-materials-in-oil-spill-response/);
- OSRL. *Containment and Recovery Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Containment-and-Recovery-Handbook.pdf);
- OSRL. *Shoreline Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Shoreline-Operations-Handbook.pdf);
- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013, (www.posow.org/documentation/manual/cleanupmanual.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

LESSON 1.9: SKIMMERS

Objective:

The objective of this lesson is for participants to understand the principles of using skimmers to recover oil, as well as the common types of skimmers available and their advantages and disadvantages. It is also important to understand the common types of pumps, how they operate and their advantages and disadvantages.

At the end of this lesson, participants will understand:

- the various types of skimmers and how they work;
- the advantages and disadvantages of different types of skimmers;
- the various types of pumps and how they work; and

- the advantages and disadvantages of different types of pumps.

Lesson summary:

When facing an oil spill, responders have to select the most appropriate response options in order to minimize damage from oil to the environment or on socio-economic activities. At-sea or near-shore oil recoveries are usually done with skimmers.

The ultimate aim of any recovery operation is to collect as much oil as is reasonably and economically possible. A successful recovery system must overcome the challenges of encountering significant quantities of oil and its subsequent containment, concentration, recovery, pumping and storage. The recovery and pumping elements of the overall operation are frequently combined in a skimmer. All skimmers are designed to recover oil in preference to water, but designs vary considerably according to the intended use, for example, at sea, in sheltered waters or onshore. Skimmers for use on water include some form of flotation or support arrangement while more complicated designs may be self-propelled and may have several recovery elements, integral storage tanks and oil/water separation facilities

Skimmers are mechanical devices that physically remove the free or contained oil from the surface of the water. There are many different types of skimmers, but they can be grouped into four categories based on oil recovery principles: weir skimmer, oleophilic skimmer, vacuum skimmer and mechanical skimmer. Each type of skimmer has operational advantages and disadvantages. The table below, from Chapter 9 of the ExxonMobil Oil Spill Response Field Guide provides guidance on skimmer selection.

		Skimmer Type																
		Weir Skimmers					Oleophilic Skimmers								Hydro-dynamic Skimmers			*
		Simple Weir	Self-Leveling Weir	Weir with Integral Screw Auger	Advancing Weir	Weir Boom	Drum	Disc	Grooved Drum/Disc	Fabric-Coated Drum/Disc	Rope Mop	Zero Relative Velocity Rope Mop	Sorbent Lifting Belt	Brush	Water Jet	Submersion Plane/Belt	Rotating Vane	Paddle Belt
Operating Environment	Open Water	●	●	●	◑	◑	◑	◑	◑	◑	○	○	○	◑	●	●	◑	●
	Protected Water	◑	●	●	○	○	○	○	○	○	○	○	○	○	◑	◑	○	○
	Calm Water	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	High Current >1 knot (> 0.5 m/s)	●	●	◑	○	◑	●	●	●	●	◑	●	◑	◑	◑	◑	◑	●
	Shallow Water <1 foot (< 0.3 m)	○	◑	●	●	●	◑	◑	◑	◑	○	●	●	◑	●	◑	◑	○
	Debris (Including ice)	●	●	○	◑	●	◑	◑	◑	◑	○	○	○	○	◑	◑	◑	○
Oil Viscosity	High Viscosity	●	●	◑	●	●	◑	●	◑	◑	●	●	○	○	○	◑	◑	○
	Medium Viscosity	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Low Viscosity	○	○	◑	○	○	◑	◑	○	○	◑	◑	●	●	○	◑	○	◑
Skimmer Characteristics	Oil/Water Pickup % **	●	◑	◑	◑	◑	○	○	○	○	○	○	◑	◑	◑	◑	◑	○
	Recovery Rate	◑	●	●	◑	○	◑	◑	○	○	●	◑	◑	◑	●	◑	◑	◑
	Ease of Deployment	○	○	◑	◑	●	○	○	○	○	◑	○	○	○	◑	●	◑	◑
Available as VOSS (Vessel of Opportunity Skimming System)		✔	✔	✔		✔	✔	✔	✔	✔	✔		✔	✔			✔	✔
Available as Advancing Skimmer					✔	✔			✔			✔	✔	✔	✔	✔		✔
Available with Storage					✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔		✔

Legend ○ Good ◑ Fair ● Poor ✔ = Yes

(Source: Oil spill response field manual, Exxon Mobil, 2014)

In summary, weir skimmers are generally used in open sea or nearshore operations, oleophilic skimmers have many advantages in nearshore or onshore operations, vacuum skimmers are uncomplicated, small and lightweight and mechanical skimmers are normally used for heavy viscous oils and debris.

The performance of a skimmer can be measured by different indicators such as the recovery rate, recovery efficiency or throughput efficiency. It is very important for field personnel to have a good understanding of the various skimmer types and to know in which circumstances they can be deployed and how.

Pumps are an integral part of the recovery process. Pumps are used to transfer recovered product from:

- skimmer to interim storage;
- interim storage to transportation vessel/vehicle; and
- transportation vessel/vehicle to final storage/disposal facility.

The pumping phase often determines the overall performance of a skimmer because all pumps lose efficiency, albeit at different rates, as oil viscosity increases. In general, positive displacement pumps are more suitable for handling recovered oil. Centrifugal pumps are both limited in the viscosity of the oil they can handle and tend to promote the formation of water-in-oil emulsions. Some specialized pumps, including those designed to pump concrete or slurry and those based on an Archimedes screw principle, have a very high viscosity tolerance but the internal resistances of discharge hoses may then become a limiting factor. The lesson will also provide an introduction to the different types of pumps and their uses as they are a key component of the recovery process. The table below, from Chapter 11 (Transfer) of the ExxonMobil Oil Spill Response Field Guide, provides guidance on pump selection.

	Characteristics of Transfer System															
	Fluid Type			Debris Tolerance			Other Criteria									Notes
	High Viscosity	Medium Viscosity	Low Viscosity	Silt/sand	Gravel/particulate	Seaweed. stringy material	Transfer rate	Low emulsification tendency	Ability to run dry	Ability to operate continuously	Self-priming	Suction head	Back pressure/head	Portability	Ease of repair	
Centrifugal	●	◑	○	○	○	●	○	●	○	○	●	●	●	○	○	5 8
Lobe	○	○	●	◑	◑	◑	◑	◑	◑	◑	◑	◑	○	◑	◑	2
Gear	○	○	●	●	●	◑	●	◑	◑	◑	◑	◑	○	◑	●	2
Intermeshing Screw	○	○	●	●	●	◑	●	◑	●	◑	◑	◑	○	◑	◑	2
Rotary Vane	◑	◑	◑	●	●	●	◑	◑	●	◑	◑	◑	◑	◑	◑	-
Flexible Impeller	◑	◑	◑	◑	◑	◑	◑	◑	●	◑	○	◑	◑	◑	◑	6
Screw/auger	○	○	●	○	○	●	●	○	◑	◑	●	●	◑	◑	◑	1
Progressive Cavity	○	○	◑	○	◑	◑	◑	○	●	◑	○	○	○	◑	◑	2
Reciprocating	○	○	◑	◑	◑	◑	◑	◑	○	◑	◑	○	○	◑	◑	2 4
Diaphragm	◑	◑	◑	○	◑	◑	◑	◑	○	◑	◑	◑	◑	◑	○	1 3 7
Peristaltic	◑	○	○	○	○	◑	○	○	○	○	○	○	○	○	○	-
Annular Injection	○	○	○	○	○	●	○	○	N	●	N	N	N	○	○	-
Vacuum Truck	○	○	○	○	○	○	◑	○	○	◑	○	○	N	◑	◑	-
Air Conveyor	○	○	○	○	○	○	◑	○	○	◑	○	○	N	◑	◑	-

Legend ○ Good ◑ Fair ● Poor N = Not Applicable

(Source: Oil spill response field manual, Exxon Mobil, 2014)

Generally, the amount of water recovered with the oil should be kept to a minimum, in order to optimise storage and reduce subsequent processing costs. However, with high viscosity oils, recovery of free or entrained water may provide the initial benefit of reducing the back pressure encountered from the resistance of the oil while pumping and the power required to pump over a specified distance. This will reduce wear and tear on components. Skimmers that recover large amounts of water by virtue of their design may be advantageous in such situations, provided that sufficient storage is available, or the water can subsequently be decanted. Steam heating to reduce blockages of pumps and hoses may also assist flow. Significant drops in pump inlet pressure have been demonstrated through the use of an annular water injection ring, where the injected water acts as a lubricating medium between the oil and hose wall. Where available, the use of shorter and/or larger diameter discharge hoses may also serve to improve pumping efficiency.

Transfer hoses and hydraulic hoses should be fitted with flotation devices to prevent drag on the skimmer that may cause the skimmer to float at an incorrect attitude. Floats also ensure that the hoses are more readily visible to minimize fouling and the risk of entanglement with the vessel's propeller. All hoses, including hydraulic hoses, can prove troublesome to handle when oily and should be fitted with simple but effective couplings. A selection of adapters can prove useful for matching hoses of different diameters and joining different connectors.

Many skimmers are designed with a dedicated power pack for the pumping and, where necessary, for the recovery components of the system. Diesel power packs, for example, can be used directly or to drive electric, hydraulic or pneumatic systems. All but petrol engines can be built to comply with safety regulations imposed in refineries, tank farms and other restricted areas where there may be a risk of fire and explosion. In pumping high viscosity oils, power packs may need to operate at full capacity and so it is important that power supplies are chosen to match the full range of pump capabilities.

Safety

Some key safety messages that must always be remembered are:

- keep hands/clothing away from moving parts;
- wear gloves, be aware of hot surfaces, especially exhausts;
- do not attempt to clear debris from a working skimmer;
- be aware of oil-covered surfaces;
- use caution around hydraulic hoses – safety glasses, hoses, whip checks; and
- inspect equipment before and during use.

Further reading:

- IMO. *Manual on Oil Pollution, Section IV – Combating oil spills*, 2005 Edition, International Maritime Organization, London, 2005 **(Approved by IMO);**
- IMO. *Field Guide for Oil Spill Response in Tropical Waters*, 1997 Edition, International Maritime Organization, London, 1997 **(Approved by IMO);**
- IMO. *Guideline for Oil Spill Response in Fast Currents*, 2013 Edition, International Maritime Organization, London, 2013 **(Approved by IMO);**
- CEDRE. *Response to Small-Scale Pollution in Ports and Harbours*, 2007 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Pollution-in-Ports);
- IPIECA/IOGP. *The Use of Decanting during Offshore Oil Spill Recovery Operations*, 2016, (http://www.ipieca.org/resources/awareness-briefing/the-use-of-decanting-during-offshore-oil-spill-recovery-operations/);
- ITOPF. *TIP 5 Use of Skimmers in Oil Pollution Response*, 2012, (www.itopf.com/knowledge-resources/documents-guides/document/tip-5-use-of-skimmers-in-oil-pollution-response/);
- ITOPF. *TIP 7 Clean-up of Oil from Shorelines*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-7-clean-up-of-oil-from-shorelines/);
- OSRL. *Containment and Recovery Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Containment-and-Recovery-Handbook.pdf);
- OSRL. *Shoreline Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Shoreline-Operations-Handbook.pdf);
- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013, (www.posow.org/documentation/manual/cleanupmanual.pdf); and

- Exxon Mobil *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

Lesson 1.10: Temporary Storage

Objective:

The objective of this lesson is for you to understand the operational aspects of temporary storage. This includes support equipment and accessories required in order to ensure that adequate and sufficient temporary storage is available during recovery and clean-up operations and to optimize the waste management and disposal during an oil spill response.

At the end of this lesson, you will understand:

- the operational aspects of temporary storage including support equipment and accessories required.

Lesson summary:

Waste management is a key aspect of oil spill response. If not managed properly, waste generation can halt recovery operations and jeopardize the entire response.

Many types of waste can be generated following an oil spill. Liquid wastes will include oil, oily water or emulsion, while solid wastes will mainly consist of oil mixed with shoreline material, debris or absorbents. Furthermore, large amounts of waste can be generated during an oil spill. It is not impossible to have 30,000 m^3 of waste generated by a spill of 1,000 m^3.

Temporary storage is key in a response because if no storage is available recovery operations will have to stop. It is important to think about the waste stream before beginning an oil recovery operation. It is also important for field personnel to understand the principles of waste management during an oil spill response, particularly the importance of setting up appropriate temporary storage sites.

Temporary storage could be located at sea (barges, vessel tanks, floating tanks) or onshore (skips, portable tanks, drums, lined excavated pits, plastic bags). Temporary storage at sea requires a suitable location to offload floating storage so that replacement units ensure that on-water recovery can continue. Temporary storage onshore needs to be carried out in accordance with local regulation, using barriers to prevent secondary contamination, ensuring all temporary storage units are above the high water/tide mark and are not on fragile vegetation such as dune grasses and if open containers are used they should have covers to exclude precipitation.

Waste management can affect response effectiveness. When establishing temporary storage think about the secondary contamination, transfer and transport for final disposal.

Refer to ITOPF's Technical Information Paper 9 (Disposal of Oil and Debris) for a summary of the main options typically available for the separation and disposal of oil and debris. The following extract is taken from that paper:

> "As a general rule, spills of persistent oils, such as crude oils, heavier grades of fuel oil and some lubricating oils, are likely to generate considerable quantities of waste. Once spilt, the oil will start to weather with an associated increase in water content and viscosity. Oil collected with minimal delay is more likely to be fluid and relatively free of contamination.

Over time, the oil may accumulate debris, either as a result of the break-up of the ship, from lost cargo or debris originating from the shore.

Even if the oil is free from solid debris, recovery at sea may involve collection of significant amounts of water due to the recovery methods used, or the formation of a water-in-oil emulsion. Alternatively, oils with a pour point above sea temperature may quickly become semi-solid, necessitating recovery by scoops or grabs that also tend to recover significant amounts of water. Spills of non-persistent oils tend to evaporate and disperse naturally within a short period of time and are therefore less frequently associated with waste generation issues.

Oil recovered from the shoreline will usually be mixed with substantial amounts of other material, such as sand, pebbles, wood, plastics and seaweed; each material may require a different method of treatment or disposal and separation can be difficult. For example, oily wood may be burnt under controlled conditions, possibly in situ, whereas burning oily seaweed is impractical. Oiled materials from response operations, such as adsorbent materials, protective clothing (PPE), damaged containment boom, storage sacks and other types of waste receptacles can also contribute significantly to the volume of waste produced following an oil spill, particularly if large numbers of inexperienced workers or volunteers are used. Considerable amounts of waste can also be generated if fishing gear and mariculture facilities are contaminated and cannot be cleaned satisfactorily, or if stock is condemned.

Temporary Storage

The large volumes of waste requiring disposal following clean-up can often present major logistical problems during handling and transportation. In order to allow clean-up operations to continue unhindered, it is usually necessary to store the material temporarily to provide a buffer between collection and final treatment and/or disposal. This also allows authorities time to select the appropriate method for dealing with the waste, if not already identified. In the case of waste resulting from shore clean-up, storage at the back of the beach above the high-water mark enables the transportation to be undertaken in two stages: from primary storage on the beach to intermediate storage and eventually to final treatment and/or disposal as necessary. This reduces the risk of contamination of roads by restricting the number of vehicles involved in the first stage transfer from the beach.

Oily waste must be transported, stored and disposed of in accordance with local regulations. In some countries, licences will be required for temporary disposal sites and by the contractors engaged for the various disposal tasks. Consultation with regulatory and licensing authorities, from the outset of the incident, will assist with this important administrative component of the disposal process.

As far as possible, and provided more than one disposal route is available, the different waste streams should be segregated at the point of collection and stored separately. The loss of control and discipline at any stage of the disposal route can lead to later complications and unnecessary additional costs. For example, bulk oil, oily debris and non-oiled materials should be stored in separate areas so that different methods of treatment and disposal can be followed for each category. Provided the bulk oil can be pumped at ambient temperatures, it can be stored in enclosed tanks. However, care should be exercised during the bulk storage of more viscous materials, particularly if the tanks are not fitted with heating coils, as emptying the tanks may be difficult without heating. Large volumes of recovered oil may be stored in tanker vessels, if available, although this may be an expensive option.

Highly viscous oils should be stored in open containers such as barges, skips or drums to facilitate treatment and transfer operations. If waste oil is to be stored for a significant length of time, covered containment is essential to prevent rainwater ingress, which may cause the oil to float and overspill. If purpose-built containers are not available, bulk oil from shorelines can be held within compacted earth walls or in simple storage pits lined with heavy gauge polyethylene (or other suitable oil-proof material). Long narrow storage pits approximately 2 metres wide and 1.5 metres deep are preferable to maintain ready access to all parts of the pit. However, the size and number of pits should reflect the volume of waste expected. If there is a possibility of heavy rainfall, allowance should be made for this when filling the pits. Where temporary storage of bulk oil is required in sensitive areas, such as sand dunes, it is important to avoid disturbance of the stabilising vegetation as this could lead to erosion. Wherever dug, pits should be filled in after complete removal of the oil and, as far as possible, the area restored to its original state.

Plastic sacks should be regarded as a means of transporting oily material rather than for storage as they tend to deteriorate and degrade in sunlight, releasing their contents If the contents are to be treated in some way prior to disposal, it will usually be necessary to empty the bags and dispose of them separately. Irrespective of whether waste is stored in containers, in heaps or piles or by other means, the storage area should be lined and provisions made to catch and treat leachate to prevent secondary contamination of the surrounding area and groundwater. Odours resulting from decomposing oiled vegetation, flies and vermin can be a nuisance if temporary sites are located close to populated areas.

Security of temporary waste storage areas should be proportionate to the risks associated with unauthorised access and might range from signage and cordoned—off areas to more impenetrable fencing and 24-hour surveillance. Without adequate security, especially close to urban centres, there is the additional risk of domestic or commercial waste being dumped at temporary storage sites. The time taken to transfer waste to designated final disposal sites should be minimised so as to avoid problems caused by waste being dumped and from secondary contamination.

Where final disposal methods have been identified and capacity allows, transport of waste from the shoreline directly to the site of final disposal negates the need for temporary storage. This avoids double-handling, minimises the build-up of waste and allows the overall response to be completed more quickly and cost effectively."

Refer to Chapter 14 (Waste Management) of the ExxonMobil Oil Spill Response Field Guide for further information on storage types.

Further reading:

- CEDRE. *Guidance on Waste Management during a Shoreline Pollution Incident*, 2011 (wwz.cedre.fr/en/content/download/1780/138739/file/extract-waste-management.pdf);
- CEDRE. *Oil Spill Waste Management*, 2004 (www.wcmrc.com/wp-content/uploads/2012/06/Waste-Management-at-Oil-Spills.pdf);
- CEDRE. *Response to Small-Scale Pollution in Ports and Harbours*, 2007 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Pollution-in-Ports);

- IPIECA/IOGP. *Oil Spill Waste Minimization and Management – Good Practice Guide Series*, 2016 (http://www.ipieca.org/resources/good-practice/oil-spill-waste-minimization-and-management/);
- IPIECA/IOGP. *The Use of Decanting during Offshore Oil Spill Recovery Operations*, 2016, (http://www.ipieca.org/resources/awareness-briefing/the-use-of-decanting-during-offshore-oil-spill-recovery-operations/);
- ITOPF. *TIP 5 – Use of Skimmers in Oil Pollution Response*, 2012 (www.itopf.com/knowledge-resources/documents-guides/document/tip-5-use-of-skimmers-in-oil-pollution-response/);
- ITOPF. *TIP 9 – Disposal of Oil and Debris*, 2011 (www.itopf.com/fileadmin/data/Documents/TIPS%20TAPS/TIP9DisposalofOilandDebris.pdf);
- OSRL. *Containment and Recovery Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Containment-and-Recovery-Handbook.pdf);
- OSRL. *Shoreline Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Shoreline-Operations-Handbook.pdf);
- OSRL. *Waste Management Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Waste-Management-Handbook.pdf);
- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013, (www.posow.org/documentation/manual/cleanupmanual.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

LESSON 1.11: IN SITU BURNING (OPTIONAL)

Objective:

The objectives of this lesson are to understand the operational aspects of In Situ Burning (ISB) as a possible spill response technique, including the support equipment and accessories that may be required.

At the end of this lesson, participants will understand:

- the principles of ISB;
- how ISB can be undertaken including the need for monitoring;
- the equipment and the logistical needs to use ISB; and
- the advantages and disadvantages of undertaking ISB operations.

Lesson summary:

When facing an oil spill, responders have to select the most appropriate response options in order to minimize damage from oil on the environment and socio-economic activities. The use of in situ burning may, in the appropriate circumstances, be a potential technique. In order to consider this, you need to be aware of how to conduct ISB operations, the potential effectiveness and the logistical considerations. This methodology has operational limitations and it is important for field personnel to be aware of this response option to ensure a safe and efficient use of this response technique

ISB operations can be conducted on land, ice or other hard surfaces, or on water. As with any response technique the effectiveness, efficiency and success rates are dependent on the type and properties of the oil, the amount of weathering that has occurred, the amount of oil and area covered, the response time and equipment availability and the current and forecasted weather and sea state.

All ISB operations require sufficient fuel to generate an ignitable concentration of vapours (the vapour burns rather than the liquid), an ignition source to instigate the burn, sufficient quantities of fuel (i.e. greater than 1-2 mm) to sustain a burn, specialist training and a means of monitoring the air and water quality.

ISB (burning oil in place) can quickly eliminate large quantities of spilled oil. There are various situations where controlled ISB can be conducted safely and efficiently. In the United States, many coastal areas have been preapproved for in situ burning as a response option under certain conditions.

ISB of spilled oil is not a substitute for dispersant application or containment and mechanical removal. However, there are often situations where burning may provide, if allowed, the only means of quickly and safely eliminating large amounts of oil. The objective is to select the optimal equipment and application techniques that will result in the least overall environmental impact.

Basic Requirements of ISB:

- oil layer thickness must be approximately 2 to 3 mm (0.08–0.12 inches) or more to sustain combustion;
- oil must be relatively fresh and not contain too much water;
- a fire-resistant boom is generally used in open water to hold the oil in place to maintain the burn;
- mouth openings of 0.3 total boom length (0.3 x *L*) and 0.6 total boom length (0.6 x *L*) are shown. The 0.3 x *L* configuration is recommended since it requires lower boom tension and is more easily controlled.

The overall efficiency of a burn depends on the original oil thickness, and, in a continuously fed oil fire, the way in which burn areas are maintained throughout the burn process. Thick oil layers (13 mm or more) normally burn with a thickness reduction rate of 2.54 mm/minute (i.e. about 2.5 litres per minute per square metre of burn area or 0.7 gallons/minute per 10 ft^2). With combustion normally taking place until the final thickness is approximately 1 mm, burn efficiencies in excess of 90% can be achieved.

Oil slicks thicker than 2 to 3 mm (0.08–0.12 inches) on water can be ignited easily under calm wind and wave conditions. Ignition of floating oil may still be possible in winds of up to around 27 knots (50 km/hr) and/or in waves as high as 1–1.5 m (3–5 ft.).

Ignition and sustained combustion may occur under far more severe conditions if the spilled oil is fresh and unemulsified. Ignition of floating oil is affected by evaporative losses, dispersion (chemical or natural), and water-in-oil emulsions. Water content of 15 to 25% makes ignition difficult for some oils. For most oils, a 50 to 70% water content makes ignition almost impossible unless very large ignition areas, igniters, and/or other fire promoters are used.

Unburned oil residue may reach a thickness of several centimetres and be sufficiently viscous to be picked up with equipment such as boat hooks, screened rakes, or pitch forks. Fishing nets with relatively small openings (2.5 cm [1 in] or smaller) would be adequate to corral and recover the residue. The residue, and most likely the fishing nets, could then be placed in plastic-lined containers or in drums for disposal.

If this tactic is to be considered, air quality monitoring needs to be into place and on-site monitoring is required for hazardous and flammable/explosion conditions. Downwind monitoring is required for public health concerns. In addition, you should have available constant weather monitoring and forecasting.

Further reading:

- IMO. *In-Situ Burning Guidelines*, 2017 Edition, International Maritime Organization, London, 2017 **(Approved by IMO);**
- IPIECA/IOGP. *Guidelines for the Selection of In-Situ Burning Equipment*, 2016 (http://www.ipieca.org/resources/awareness-briefing/guidelines-for-the-selection-of-in-situ-burning-equipment/);
- IPIECA/IOGP. *Oil Spill Responder Health & Safety – Good Practice Guide Series,* 2013 (http://www.ipieca.org/resources/good-practice/oil-spill-responder-health-safety/);
- OSRL. *Offshore In-Situ Burn Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/In-Situ-Burn-Handbook.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

LESSON 1.12: USING SORBENTS

Objective:

The objectives of this lesson are to understand what sorbents are, as well as their related advantages and disadvantages to ensure their safe and efficient use during a response.

At the end of this lesson, participants will understand:

- the principles of sorbents (uses, types, forms);
- the difference between natural organic, natural inorganic and synthetic sorbents; and
- the advantages and disadvantages of each type of sorbent material.

Lesson summary:

Oil sorbents comprise a wide range of organic, inorganic and synthetic products designed to recover oil in preference to water. Their composition and configuration are dependent upon the material used and their intended application in the response.

While widely used in spill response, sorbents should be employed with caution in order to minimize inappropriate and excessive use that can present major logistical difficulties associated with secondary contamination, retrieval, storage and disposal. These all contribute significantly to the overall costs of clean-up operations. In particular, synthetic sorbent material should be used in moderation and care taken to ensure it is used to its full capacity to minimize subsequent waste disposal problems.

Sorbents are used to recover small amounts of oil through absorption, adsorption, the penetration of oil into the sorbent material, and/or the adherence of oil onto the surface of sorbent material. To enhance recovery, most sorbents are both oleophilic (attract oil) and hydrophobic (repel water).

Use of sorbent materials on large spills on water is generally limited by five factors:

- Logistics of applying and retrieving sorbents on wide-spread slicks

- Labour-intensive nature of the operation
- Relative high cost (compared to small skimmers)
- Relative low recovery rates
- Large amount of solid waste generated

In general, use of sorbents is only appropriate during the final stages of a clean-up or to aid in the removal of thin films of oil. Sorbents can also be used to clean up secondary spills, and protect and/or clean environmentally sensitive areas, such as turtle egg-laying areas or marshes, where the use of other cleaning methods is restricted because of the damage they could cause.

All sorbents are effective to some extent. To optimize selection of a particular sorbent product, the properties of a sorbent must be tailored to fit the spill conditions. Sorbents that may be useful in one situation may be less desirable in another. In an emergency situation, whichever sorbent is handy should be used until a preferable one can be obtained.

Composition of sorbents can be grouped into three main types:

- Synthetic
- Organic
- Inorganic

Synthetic materials such as polyethylene and polypropylene generally offer superior oil recovery efficiency compared to organic and inorganic materials, such as peat moss or vermiculite.

Refer to Chapter 10 (Sorbents) of the Exxon Mobil Oil Spill Response Field Guide for a more detailed description of sorbent selection criteria and the most commonly found types of sorbent.

Refer to ITOPF's Technical Information Paper (TIP) 8 (Use of Sorbent Materials in Oil Spill Response) for a summary of the benefits and disadvantages of commonly available types of adsorbent material.

Safety

- always use proper PPE when deploying or recovering sorbents and try to minimize or avoid any contamination contact;
- use proper lifting procedures; and
- be aware of the weight when recovering – saturated sorbents can become heavy.

Further reading:

- IMO. *Use of Sorbents for spill response – An operational guide*, 2016 Edition, International Maritime Organization, London, 2016 **(Approved by IMO);**
- CEDRE. *Custom Made Spill Response Barriers*, 2012 (www.cedre.fr/en/Our-resources/Documentation/Operational-guides/Custom-Made-Barriers);
- CEDRE. *Manufactured Spill Response Booms*, 2012 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Manufactured-Booms, please send an email to documentation@cedre.fr to request full version);
- CEDRE. *Response to Small-Scale Pollution in Ports and Harbours*, 2007 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Pollution-in-Ports);
- CEDRE. *Use of Sorbents for Spill Response*, Operational Guide, 2009 (wwz.cedre.fr/en/content/download/1776/138719/file/extract-sorbents.pdf) ;

- ITOPF. *TIP 8 – Use of Sorbent Materials in Oil Spill Response*, 2012 (www.itopf.com/knowledge-resources/documents-guides/document/tip-8-use-of-sorbent-materials-in-oil-spill-response/);
- OSRL. *Shoreline Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Shoreline-Operations-Handbook.pdf);
- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013, (http://www.posow.org/documentation/manual/cleanupmanual.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

EXERCISE 1.2: EXERCISE AND DEMONSTRATION OF AT-SEA RESPONSE EQUIPMENT

Objective:

The objective of this exercise is to consolidate the lessons in the previous modules by considering typical at-sea response equipment and their logistical requirements.

At the end of this exercise, you will:

- have consolidated the lessons from the previous operational modules;
- understand the various at-sea response techniques available and their limitations;
- understand the equipment and resources required to implement these techniques; and
- understand the logistics and response management implications around deploying these techniques.

Lesson summary:

The class will be divided in small groups and each group will nominate a representative for a plenary discussion following the exercise. You will be presented with a number of oil spill scenarios and each group will have to analyse the information and develop appropriate answers. You will then have to present your results to the other groups during a plenary session.

Further reading:

- IMO. *Manual on Oil Pollution, Section IV – Combating oil spills*, 2005 Edition, International Maritime Organization, London, 2005 **(Approved by IMO);**
- CEDRE. *Using Dispersant to Treat Oil Slicks at Sea*, 2005 (wwz.cedre.fr/en/content/download/1779/138734/file/extract-using-dispersant.pdf);
- ITOPF. *TIP 3 – Use of Booms in Oil Pollution Response*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-3-use-of-booms-in-oil-pollution-response/);
- ITOPF, *TIP 4 – Use of Dispersants to Treat Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-4-use-of-dispersants-to-treat-oil-spills/);
- ITOPF. *TIP 5 – Use of Skimmers in Oil Pollution Response*, 2012, (www.itopf.com/knowledge-resources/documents-guides/document/tip-5-use-of-skimmers-in-oil-pollution-response/);
- ITOPF. *TIP 8 – Use of Sorbent Materials in Oil Spill Response*, 2012, (www.itopf.com/knowledge-resources/documents-guides/document/tip-8-use-of-sorbent-materials-in-oil-spill-response/);

- OSRL. *Containment and Recovery Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Containment-and-Recovery-Handbook.pdf);
- OSRL. *Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf);
- OSRL. *Dispersant Application Monitoring Field Guide Tier I,* 2015 (www.oilspillresponse.com/technical-library/dispersant-application-monitoring-field-guide---tier-i-visual-observation/);
- OSRL. *Offshore In-Situ Burn Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/In-Situ-Burn-Handbook.pdf);
- OSRL. *Vessel Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

MODULE 1.3: OIL SPILL RESPONSE TECHNIQUES – SHORELINE ASSESSMENT AND CLEAN-UP

MODULE OBJECTIVE

The overall objective of this module is to understand in detail the operational aspects related to shoreline assessment and clean-up.

This module is composed of three lessons, one video and four exercises:

- L.1.13: Shoreline Assessment and Evaluation
- Ex.1.3 Shoreline Assessment and Evaluation – Exercise
- L.1.14: Shoreline Assessment Clean-up Techniques
- L.1.15: Shoreline Assessment Site Set-up, logistical and de-contamination issues
- V.1.3: Shoreline Clean-up
- Ex.1.4: Shoreline Types and Techniques
- Ex.1.5: Demonstration of shoreline equipment
- Ex.1.6: Stockpile Visit

The objectives for each lesson are described below.

LESSON 1.13: SHORELINE ASSESSMENT AND EVALUATION

Objective:

The objective of this lesson is to understand the importance of shoreline assessment and also understand the logistical requirements to conduct shoreline assessment.

At the end of this lesson, participants will understand:

- the phases and principles of shoreline assessment;
- the role of Operations within shoreline assessment; and
- the logistical requirements to conduct shoreline assessment.

Lesson summary:

Shoreline assessment can be done in either the pre-spill phase, in order to collect data for response preparedness or during the reactive response phase, to help guide decisions regarding shoreline treatment and response operations. Shoreline assessments, based on the Shoreline Clean-up Assessment Technique (SCAT), provide a standard methodology. This presentation provides field personnel with the necessary information to assist with this process as well as the required logistical arrangements for this work to be completed. It explains the role that Operations have in the SCAT process and how they can support the field work.

This lesson outlines the principles of shoreline assessment which provides incident management with real-time data on oiling conditions, as well as the steps to be taken to conduct shoreline assessment including systematic aerial/ground surveys, shoreline segmentation, oiling condition descriptions and operational support through to completion.

The principles of shoreline assessment are described as follows:

- Identify oiled and non-oiled areas
- Identify location, amount and character of oil
- Evaluate operational and logistical factors
- Establish shoreline treatment priorities
- Establish treatment standards
- Propose treatment methods

Shoreline assessment teams or SCAT teams are the "eyes" of incident management, providing real-time data on oiling conditions. Shoreline treatment recommendations are made considering the net environmental benefit as well as shoreline type and logistical, operational and safety constraints. The role of Operations within the SCAT teams is to provide clean-up expertise and to guide and agree on recommendations for technically feasible clean-up strategies.

Survey Preparation

A survey assignment has great strategic importance, which is why it is essential that it is well prepared. Before going on site, the observer has certain procedures and recommendations to follow:

1. Definition of the survey area. The coastline should be divided up, ensuring sufficient resource availability (manpower, vehicles, etc.) for the amount of time needed to conduct a survey of the entire area. Such limits will have to be defined if possible with existing geographic entities or areas with consistent substrates or the extent to which the coastline has been polluted by the spill. The smallest administrative division (commune, district, etc.) can be used as a basic framework in so far as it covers the same administrative framework as the one that applies to potential observers. In a set-up like this, each observer will be responsible for an area of the coastline.
2. Definition of the itinerary. The coastline should be inspected systematically. This may not always be possible for a number of reasons (not enough observers for a section of the coastline that is too vast or too steep, unsuitable tidal ranges or daylight times, etc.). In such cases, priority should be given to visiting the most appropriate sites.

There are a few rules to abide by before setting out on the survey:

- Find out the results of the most recent survey, especially the last flight over the area the previous day or on the morning of the same day: an aerial observation from a helicopter will tell you if and how seriously the coastline has been oiled, including places that are hard to reach on foot. This will also help you to decide where to conduct a survey on the very first day of a spill and thereafter, and identify arrivals of oil on sites that have not been inspected or that are no longer being inspected on a daily basis or because the site in question is in an area that has not been oiled.
- Study the configuration of the coastline on a map (including weather reports from the previous day or same day, prevailing currents, etc.) and identify sites that are more likely to trap floating debris and oil (such as creeks, bays, coves and spurs). Following this, compile a list of all sites likely to accumulate debris or macro waste (wrecks of all sorts, seaweed beds, etc.).
- Factor in response operations that have already been conducted, are underway or soon to be conducted.

Before departure:

- Make sure you have the equipment you need (in the appropriate quantity) and that it is in correct working order (batteries, both heavy and light duty).
- Make sure permission has been granted to visit certain sites (such as from defence or restricted facilities, private property, etc.).
- Ensure compatibility between the time of visit and tidal data.
- If you have to inspect a site or an area that may include an element of risk (such as islets, cliffs or marshes, where there are quick incoming tides or risks of being hemmed in by the sea), always give an indication of when you expect to return. Take a cell phone with you, and if coverage is likely to be inadequate, a VHF handset as well.

Each site must be reported on in a standard manner. The best way to achieve this is by adopting a standard form for all parties to use. The selected form should cover:

- Identification of the:
  - incident;
  - site;
  - survey; and
  - observer.
- Environmental characteristics of the site (unusual or well known), including:
  - physical;
  - ecological; and
  - socio-economic.
- General characteristics of the beach, including:
  - types of substrates; and
  - sizes.
- Characteristics of the pollutant and the spill, including:
  - colour, appearance, viscosity;
  - types of oil arrivals and location on the beach;
  - size, distribution and volume; and
  - expected trend (viscosity, washed back out to sea, etc.)
- Operational characteristics of the site, including:
  - accessibility;
  - ease in which work can be carried out there; and
  - availability of storage facilities for recovered waste.

The survey forms should mention the spill, including drawings of the site (profile and a map with a scale) and photos if possible that could be used for reference purposes afterwards.

Once the observer has inspected all the relevant sites, survey forms should be submitted along with a summary of the surveys conducted. The summary should ideally consist of a single map summing up all the information collected for the area, including estimated quantities of beached oil, the nature of the pollution (such as heavy emulsions, buried oil, arrivals of polluted seaweed, etc.). The submission may also include samples and supporting photographs.

In some instances, the information collected by observers can be entered into a Geographic Information System (GIS). Once the environmental and operational details of all the sites have been entered, simplified survey forms can be used to facilitate data entry.

Further reading:

- IMO. *Guidelines for Sampling and Identification of Oil Spills, Section VI – Manual on Oil Pollution,* 1998 Edition, International Maritime Organization, London, 1998 **(Approved by IMO);**
- IMO/UNEP. *Guidance Manual on the Assessment and Restoration of Environmental Damage Following Marine Oil Spills, 2009 Edition,* International Maritime Organization, London, 2009 **(Approved by IMO);**
- CEDRE. *Response to Small-Scale Pollution in Ports and Harbours*, 2007 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Pollution-in-Ports);
- CEDRE. *Surveying Sites Polluted by Oil*, 2006 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Surveying-Sites – please send an email to documentation@cedre.fr to request);
- ITOPF. *TIP 1 – Aerial Observation of Marine Oil Spills*, 2011 (http://www.itopf.com/knowledge-resources/documents-guides/document/tip-1-aerial-observation-of-marine-oil-spills/);
- ITOPF. *TIP 2 – Fate of Marine Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-2-fate-of-marine-oil-spills/);
- ITOPF. *TIP 6 – Recognition of Oil on Shorelines*, 2011 (http://www.itopf.com/knowledge-resources/documents-guides/document/tip-6-recognition-of-oil-on-shorelines);
- OSRL. *Aerial Surveillance Field Guide*, 2011, (http://www.wcmrc.com/wp-content/uploads/2012/06/Aerial-Surveillance-Handbook.pdf);
- POSOW. *Oiled Shoreline Assessment Manual*, 2013 (www.shorelinescat.com/Documents/Manuals/POSOW%20Oiled%20Shoreline%20Assessment%20Manual%20webversion.pdf) ; and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

EXERCISE 1.3: EXERCISE – SHORELINE ASSESSMENT EVALUATION

Objective:

The objective of this exercise is to consolidate the lessons from the Shoreline Assessment and Clean-up Evaluation module and to consider how to carry out and support shoreline assessment evaluation, who would be involved, the equipment they would use and the logistical resources they would employ, from an operational perspective.

At the end of this exercise, participants will have considered:

- what is required to initiate a shoreline assessment and evaluation;
- how your operational expertise could enhance the SCAT team; and
- how the operations team could support the SCAT team and what logistical resources could be employed.

Lesson summary:

The class will be divided in small groups and each group will nominate a representative for a plenary discussion following the exercise. Participants will be presented with a number of questions and each group will have to develop appropriate answers. Participants will then have to present their results to the other groups during a plenary session.

LESSON 1.14: SHORELINE CLEAN-UP TECHNIQUES

Objective:

The objective of this lesson is to understand the various clean-up techniques in order to reduce environmental damage, as well as the practicalities of oiled wildlife response.

At the end of this lesson, participants will:

- understand the overall objectives of shoreline clean-up;
- understand the factors that can affect shoreline clean-up;
- consider the three stages of shoreline clean-up;
- consider the aims of Net Environmental Benefit Analysis (NEBA);
- understand the basic shoreline treatment recommendations; and
- understand the different stages of shoreline clean-up for different shoreline types.

Lesson summary:

Once the shoreline assessment is complete, the shoreline assessment team or SCAT (Shoreline Assessment Clean-up Technique) Team makes shoreline treatment recommendations based on a variety of factors such as shoreline type, oil type and behaviour, endpoint criteria, net environmental benefit.

The objectives of shoreline clean-up are to remove the bulk oil, accelerate natural recovery and to avoid causing more damage to the environment through clean-up activities. This is conducted in stages of shoreline clean-up including the removal of gross pollution and bulk oil, the removal of oil and the final cosmetic treatment.

The shoreline clean-up methods that may be recommended are also reviewed in this lesson, including:

- Natural recovery
- Physical methods
  - Washing
  - Removal and disposal
  - In situ Treatment
- Chemical and biological Methods

Remember that safety is always the first priority and shoreline workers must understand their role and task and work together safely.

Since activities to combat floating oil at sea are typically limited by time, weather or other constraints, actions taken to prevent oil reaching shorelines may only be partially successful. When oil does reach the shoreline, considerable effort may be required to clean affected areas. It is therefore essential that comprehensive and well-rehearsed arrangements for shoreline clean-up are included in contingency plans.

The techniques available for shoreline clean-up are relatively straightforward and do not normally require specialised equipment. However, inappropriate techniques and inadequate organisation can aggravate the damage caused by the oil itself.

If oil reaches the shoreline the impact can become much more significant, both economically and with respect to environmental damage. The goal of shoreline treatment is to remove the oil and/or accelerate natural recovery of the shoreline while ensuring that any clean-up operations will not cause additional damage. In order to achieve this goal, it is important to know the treatment options as well as where and when they are most effective.

Refer to ITOPF's Technical Information Paper 7 (Clean-up of Oil from Shorelines) for a description of the most commonly used shoreline clean-up techniques and advice on which are best suited to each stage of operations for a range of different shoreline types. The following extract is taken from that paper:

> "The selection of the most appropriate clean-up techniques requires a rapid evaluation of the degree and type of contamination, together with the length, nature and accessibility of the affected coastline. In deciding priority actions, the competing demands on the marine environment need to be considered. For example, amenity use may demand quick and effective methods for the removal of the oil but these may not be compatible with environmental considerations that may call for less aggressive, slower techniques. In such situations, a balance has to be struck between these potentially conflicting interests, for the response as a whole and on a site-by-site basis.
>
> Clean-up operations are often considered in three stages:
>
> - Stage 1 — Emergency phase: Collection of oil floating close to the shoreline and pooled, bulk oil ashore.
> - Stage 2 — Project phase: Removal of stranded oil and oiled shoreline material.
> - Stage 3 — Polishing phase: Final clean-up of light contamination and removal of oil stains, if required.
>
> During the initial stage, resources will be mobilised with little notice in order to respond as rapidly as possible, for example to minimise the ability of the oil to move along the shoreline and cause additional damage or to affect wildlife. Moving to the second stage may allow resources to be contracted with greater deliberation and possibly placing work out to tender. While termed the project phase and often the most protracted part of shoreline clean-up, Stage 2 should be viewed as one component of the overall response to the emergency generated by the spill of oil and should not be perceived as longer term project management.
>
> Depending upon the situation encountered, progression through each of these stages may not be required. In some instances, the entire operation may be completed in one stage, whilst in others, Stages 1 and 2 may be combined. In many situations, once Stage 2 has been completed, any remaining oil may be best left to weather and degrade naturally.
>
> In every case, the first priority is to recover oil floating against the shore as quickly as possible, to prevent it moving to previously uncontaminated or cleaned areas. The same is true for heavy accumulations of stranded oil that may remobilise on subsequent tides. It may be possible to use booms to hold the oil against the shore while recovery is in progress. However, this strategy may not be applicable on environmentally sensitive shorelines, where it may be preferable to allow the oil to migrate to a less sensitive area or to where it is more easily accessible.

Once potentially mobile oil has been collected, it may then be necessary to compromise between waiting until all the oil remaining at sea has come ashore, to avoid cleaning the same area more than once, or to commence the second stage of operations immediately, although oil can become buried by successive tides, particularly on sand beaches. Often, a solution is to focus on removal of the thickest areas of oil in the most readily accessible areas without attempting to complete this stage of the work immediately.

Experience from many incidents has shown the costliest and most time-consuming component of the overall response to a spill of oil is the treatment or disposal of collected waste. As a consequence, unless other overriding factors are present, the clean-up technique chosen should be one that results in the minimum amount of waste collected for removal. This has the added benefit of minimising the quantity of material for subsequent storage, transport and final treatment/disposal, as well as reducing the possibility of shoreline erosion.

For many shoreline types, removal of all traces of oil will be difficult or inadvisable. As a consequence, it is not always obvious when a shoreline, or a particular work site, is sufficiently clean to allow work to terminate. One important factor is the 'use' of the affected area in terms of the relative importance of environmental, social and economic concerns. Seasonal variations in the significance and sensitivity of the location, as well as the degree to which it may be exposed to natural cleaning, are further important considerations, as is the question of cost. As the amount of oil remaining on the shore decreases, so cost becomes more important, because the effort and expenditure required to achieve further cleaning rise disproportionately in relation to the amount of oil removed. An exhaustive final clean-up stage, whereby traces of oil and oil stains are removed is, therefore, usually required only for low-energy, high-amenity areas during, or just prior to, the tourist season.

The criteria for termination of the clean-up are usually discussed jointly and agreed following inspections conducted by a team comprising representatives of the various organisations involved in the response. To achieve the required consensus, it is important that the limitations of the shoreline clean-up techniques used are understood and that the objectives of the clean-up are pragmatic and agreed at an early stage, preferably even before the commencement of clean-up operations. Ideally, members of the SCAT inspection team would be involved throughout the incident so that the achievements of the cleaning operations can be appreciated in the context of the initial situation.

Management of Resources

The efficient management of resources engaged in shoreline clean-up is vital to the success of the operation. The responsibility for managing the response to the incident rest within the Incident Command but the proper organisation and management of the workforce on the shoreline is equally crucial. This can be achieved by division of the affected coastline into smaller areas, often relating to natural divisions in shoreline types. A supervisor or beach master should be assigned to take responsibility for the workforce within each area. If manual techniques are to be used, the workforce can be further divided into teams, each with a leader and allocated to clean a part of the shoreline. Tasks should be achievable within a realistic time period, perhaps half a day. The satisfaction of completing the task and observing the progress they have made can assist with motivating workers in what may be harsh conditions. At the same time, the shoreline is cleaned methodically, section by section. Each team would normally comprise 5-10 workers and each supervisor or beach master would be responsible for no more than about 100 people, i.e. approximately 10 teams, within the area. Workers should undergo basic training to ensure that the clean-up is ordered and effective and to raise awareness of any health and safety issues. Facilities to address the catering and sanitary needs of the teams should be established close to the work sites.

The potential performance of the workforce is difficult to judge until work has commenced and has been underway for some time. For this reason, deciding how many workers are required on a shoreline is best achieved by establishing a small-scale operation on a representative section of the shoreline and then replicating this approach with the appropriate level of manpower in other areas of the shoreline, once working practices have been optimised. The number of people required will be determined by the demands of the clean-up technique employed and the amount of material that can reasonably be handled within a day. However, the performance of the workforce will also be influenced by their training, motivation and supervision, as well as the shoreline type, accessibility, weather conditions and the levels of contamination. Ideally, the workforce should be drawn from a local organisation with an existing management structure, offering established lines of authority and working relationships. While military command structures meet these criteria, and might appear to lend themselves well to this type of operation, they can result in the teams being too large and some modification to the structure may be necessary.

The organization of equipment and vehicles working on the shoreline is no less important. Segregation of the work site into clean and dirty zones, limiting the number of vehicles within the dirty zone and restricting the movement of those vehicles to within that zone, helps to minimize secondary contamination. Larger capacity trucks, for example those used to transport the collected material to storage or disposal sites, should be kept off the beach, so that dirty and clean areas remain segregated. This also helps to reduce the amount of oil spread onto road surfaces. The types of vehicles selected should be appropriate to the waste transported, to ensure loads are secure and oil cannot leak out.

Road traffic in the vicinity of the work site should be controlled, so that the movement of trucks into and out of the work site is not hindered. The beach may also have to be closed in the interests of public safety, particularly where heavy vehicles are being used.

On tidal shores, the work has to be arranged around the tides, with rest periods and meal breaks preferably being taken at high water. While night time working may be appropriate within a port where adequate lighting can be provided, in other locations, such as open shorelines, it is usually found to be inefficient and potentially unsafe, even when lighting is available.

A record of the quantities of oil and oiled debris removed each day enables progress to be easily monitored, work site by work site, within the command centre. In addition to written reports, the status of each work site and the location of men and equipment can be conveniently recorded and monitored on large scale maps. Daily records of the men, equipment and materials used at each work site are also essential for the Incident Command to monitor the progress of operations and address any difficulties."

Reference should be made to the many useful papers and field guides produced by ITOPF, IPIECA, CEDRE, OSRL, POSOW and ExxonMobil, as detailed below.

Further reading:

- IMO. *Manual on Oil Pollution, Section IV – Combating oil spills*, 2005 Edition, International Maritime Organization, London, 2005 **(Approved by IMO);**

- IMO. *Field Guide for Oil Spill Response in Tropical Waters*, 1997 Edition, International Maritime Organization, London, 1997 **(Approved by IMO);**
- IMO. *Contingency Planning, Section II – Manual on Oil Pollution,* 2018 Edition, International Maritime Organization, London, 2017 **(Approved by IMO);**
- CEDRE. *Response to Small-Scale Pollution in Ports and Harbours*, 2007 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Pollution-in-Ports);
- ITOPF. *TIP 7 – Clean-up of Oil from Shorelines*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-7-clean-up-of-oil-from-shorelines/);
- OSRL. *Shoreline Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Shoreline-Operations-Handbook.pdf);
- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013, (www.posow.org/documentation/manual/cleanupmanual.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

LESSON 1.15: SHORELINE SITE SET-UP, LOGISTICAL AND DE-CONTAMINATION ISSUES

Objective:

The objective of this lesson is to understand the operational aspects of shoreline site set-up, including logistical and decontamination issues.

At the end of this lesson, participants will understand:

- what is included within the shoreline site set-up;
- the importance of logistical supply chain;
- the significance of an equipment staging area; and
- the importance and requirements of a de-contamination area.

Lesson summary:

A rapid response is essential for effective spill clean-up. Effective logistics ensure the expedient and efficient mobilization of resources and sustained resource availability throughout the response effort. Logistics are critical to the response effort and the supply chain must be maintained in order to avoid "bottlenecks" in the response operations. Even small breakdowns in the supply chain can cause delays. The establishment of staging and decontamination facilities is important early in the response and must be done in a timely manner since proper decontamination is required to allow personnel to safely leave the spill site for breaks, meals and shift changes.

The following table, taken from the ExxonMobil Oil Spill Response Field Guide explains some of the key logistical requirements:

Resources	Support	Services
• Contracts for goods and services • Procurement • Shipping/receiving • Warehouse/staging • Inventory management • Equipment tracking	• Transportation • Provisioning • Permits • Waste management • Assembly, fabrication and maintenance • Demobilization • Decontamination	• Security • Facilities • Administrative services

(Source: Oil spill response field manual, Exxon Mobil, 2014)

Provisioning can be divided into two categories: offshore and onshore. Personnel assigned to the field require various levels of provisioning, including fuel, food, housing, shelter whilst in the field, water, supplies, and sanitation facilities. Local commercial establishments may be available for some workers, but depending on the size of the response effort, temporary housing and canteen facilities may need to be brought into the area. This may be in the form of passenger ferries or accommodation vessels.

Staging Areas

Most equipment will require some level of assembly and testing to ensure its readiness for the field. This is often conducted in staging areas. Related activities may include attaching hoses and fittings, installing batteries, or matching power supplies/packs to equipment (e.g. skimmers). Other equipment and/or facilities may need to be set up on site. This may require the expertise of mechanics, technicians or other craftsmen. Systems should be in place for both preventative and remedial maintenance of response equipment. Maintenance activities may be carried out at the work site or at a pre-established central maintenance area. Fuel, lubricating oil, hydraulic oil and other fluids will be required to keep vessels, aircraft and vehicles operational.

Decontamination

Demobilization can occur very early in the response, and continue throughout as operational requirements change. Demobilization plans should be established for vessels, equipment, personnel, contractors and facilities.

Decontamination capability must be made available during all responses. Plans should be established early in the response to address personnel, vessels and equipment. Only approved cleaning chemicals should be used.

Personnel decontamination will be required throughout the response effort. Personnel decontamination units can be set up on site or commercial modular units may be leased or purchased.

Vessel decontamination will be essential as vessels/boats will accumulate oil on their hulls at and near the waterline. Soiled vessels should not be brought into uncontaminated harbours without first being cleaned. Vessel hulls may be manually washed from a low-freeboard pontoon float in a temporary slip constructed inside a protected, boomed-off area. Small skimmers may be pressure-washed while being suspended over a wash pit. Small boats may be lifted out of the water and clean in a decontamination zone.

If the location of the cleaning station does not have direct access to shore facilities, a barge may be needed to provide supplies, communications, shelter, and sanitary facilities.

Equipment decontamination will be necessary before equipment is moved to or through uncontaminated areas. This is especially evident as contaminated booms are moved from containment to protection or storage, or when clean-up equipment is moved from one area to another.

Further reading:

- IMO/UNEP. *Guidance Manual on the Assessment and Restoration of Environmental Damage following Marine Oil Spills,* 2009 Edition, International Maritime Organization, London, 2009 **(Approved by IMO);**
- IPIECA/IOGP. *Oil Spill Responder Health & Safety – Good Practice Guide Series,* 2013 (http://www.ipieca.org/resources/good-practice/oil-spill-responder-health-safety/);
- ITOPF. *TIP 7 – Clean-up of Oil from Shorelines*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-7-clean-up-of-oil-from-shorelines/);
- ITOPF. *TIP 9 – Disposal of Oil and Debris*, 2011 (www.itopf.com/fileadmin/data/Documents/TIPS%20TAPS/TIP9DisposalofOilandDebris.pdf);
- OSRL. *Containment and Recovery Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Containment-and-Recovery-Handbook.pdf);
- OSRL. *Shoreline Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Shoreline-Operations-Handbook.pdf);
- OSRL. *Waste Management Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Waste-Management-Handbook.pdf);
- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013, (www.posow.org/documentation/manual/cleanupmanual.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

VIDEO 1.3: SHORELINE CLEAN-UP

Objective:

The objective of this video is to illustrate issues related to shoreline clean-up such as planning, shoreline assessment and clean-up techniques.

At the end of this video, participants will understand:

- the importance of contingency planning with respect to shoreline clean-up;
- the various techniques used for shoreline clean-up ; and
- the importance of safety during these operations.

Lesson summary:

The impacts of when oil reaches the shoreline are generally much more significant than when oil is drifting at sea. This video depicts the assessment techniques employed during an oiled shoreline assessment, as well at the pros and cons of the various shoreline clean-up techniques. This provides responders with an overview of shoreline treatment options.

Video link: http://www.itopf.org/knowledge-resources/library/video-library/video/4shoreline-clean-up/

EXERCISE 1.4: EXERCISE – SHORELINE TYPES AND RESPONSE TECHNIQUES

Objective:

The objective of this exercise is for participants to consolidate the lessons from the previous module on shoreline assessment and clean-up. During the exercise, participants will be presented with various oil spill situations and asked to select the most appropriate response techniques for different shoreline types and scenarios.

At the end of this exercise, participants will:

- have consolidated the lessons from the previous operational modules;
- understand the importance of recognizing the different shoreline types and selecting the most appropriate response techniques for those types; and
- understand what may be required to implement the chosen response strategies.

Lesson summary:

The class will be divided into small groups and each group will nominate a representative for a plenary discussion following the exercise. Participants will be presented with a number of oil spill scenarios and each group will have to analyse the information and develop appropriate response strategies including proposed clean-up techniques, any access or logistical issues, identify the required equipment and identify and safety considerations. Participants will then have to present your results to the other groups during a plenary session.

EXERCISE 1.5: EXERCISE AND DEMONSTRATION OF SHORELINE EQUIPMENT

Objective:

The objective of this exercise is to consolidate the lessons from the previous module on shoreline assessment and clean-up, through demonstrations of different types of equipment as well as their component parts, methods of operations, capabilities and logistical requirements.

At the end of this exercise, participants will:

- have consolidated the lessons from the previous operational modules;
- understand how the response equipment works;
- understand where and when to use the response equipment; and
- understand the logistical requirements of the equipment.

Further reading:

- CEDRE. *Manufactured Spill Response Booms,* 2012 (wwz.cedre.fr/en/Our-resources/Documentation/Operational-guides/Manufactured-Booms, please send an email to documentation@cedre.fr to request full version);
- IPIECA/IOGP. *Guidelines for the Selection of In-Situ Burning Equipment*, 2016 (http://www.ipieca.org/resources/good-practice/oil-spill-responder-health-safety/);
- IPIECA/IOGP. *The Use of Decanting during Offshore Oil Spill Recovery Operations*, 2016, (http://www.ipieca.org/resources/awareness-briefing/the-use-of-decanting-during-offshore-oil-spill-recovery-operations/);
- ITOPF. *TIP 3 – Use of Booms in Oil Pollution Response*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-3-use-of-booms-in-oil-pollution-response/);
- ITOPF. *TIP 4 – Use of Dispersants to Treat Oil Spills*, 2011 (www.itopf.com/knowledge-resources/documents-guides/document/tip-4-use-of-dispersants-to-treat-oil-spills/);
- ITOPF. *TIP 5 – Use of Skimmers in Oil Pollution Response*, 2012, (www.itopf.com/knowledge-resources/documents-guides/document/tip-5-use-of-skimmers-in-oil-pollution-response/);
- ITOPF. *TIP 8 – Use of Sorbent Materials in Oil Spill Response*, 2012, (www.itopf.com/knowledge-resources/documents-guides/document/tip-8-use-of-sorbent-materials-in-oil-spill-response/);
- OSRL. *Containment and Recovery Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Containment-and-Recovery-Handbook.pdf);
- OSRL. *Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf);
- OSRL. *Shoreline Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Shoreline-Operations-Handbook.pdf);
- OSRL. *Dispersant Application Monitoring Field Guide Tier I*, 2015 (www.oilspillresponse.com/technical-library/dispersant-application-monitoring-field-guide---tier-i-visual-observation/);
- OSRL. *Vessel Dispersant Application Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Vessel-Dispersant-Application-Handbook.pdf);
- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013 (www.posow.org/documentation/manual/cleanupmanual.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

EXERCISE 1.6: STOCKPILE VISIT

Objective:

The objective of this exercise is to consolidate the lessons from the previous module discussed during this course. Participants will visit an equipment stockpile and understand, through demonstration, the response equipment, storage requirements and adopted maintenance regimes. Ideally, participants should take part in a hands-on deployment exercise.

At the end of this exercise, participants will:

- have consolidated the lessons from the previous operational modules;
- have seen the various equipment available for oil spill response; and

- understand the storage requirements, the mobilization procedures and the preventative maintenance and testing regimes that are in use in the stockpile.

Module 1.4: Oil Spill Response Support Issues

Module objective

The overall objective of this module is to enable participants to understand in detail the support issues including waste management and post-response operations.

This module is composed of two lessons and one video:

- L.1.16: Implementing Waste Management
- V.1.4: Video – Waste Management
- L.1.17: Post incident operations

The objectives for each lesson are described below.

Lesson 1.16: Implementing Waste Management

Objective:

The objective of this lesson is to understand the importance of waste management during an oil spill response and to identify best practices in order to minimize the amount of waste generated during an oil spill.

At the end of this lesson, participants will understand:

- the importance of planning for waste management prior to an oil spill;
- the types of waste generated during oil spill response;
- the transportation of waste; and
- options for final disposal of wastes.

Lesson summary:

Waste management is a key aspect of oil spill response. If not managed properly, waste generation can halt recovery operations and jeopardize the entire response. Many types of waste can be generated following an oil spill. Liquid wastes will include oil, oily water or emulsion while solid wastes will mainly consist of oil mixed with shoreline material, debris or sorbents. Furthermore, large amounts of waste can be generated during an oil spill. It is not impossible to have 30,000 m^3 of waste generated by a spill of $1{,}000 m^3$. This is why waste management planning should be carried out pre-spill and integrated into the contingency plan. This will ensure that every effort is taken to reduce, reuse, recycle or recover wastes while respecting local environmental regulations. Field personnel must be aware of good practice for waste management (such as separation of waste by type). Pre-planning for waste management will ensure a smooth and coordinated waste stream (storage-transfer-transport) that will contribute to an effective response.

Most oil spill clean-up operations, particularly those on shore, result in the collection of substantial quantities of oil and oily waste. The storage and disposal of waste is an important aspect of any response operation and adequate provisions for waste management should be clearly highlighted in all oil spill contingency plans. Arrangements made at the beginning of an incident must act to prevent waste issues from compromising the response effort and becoming a costly problem that continues long after the spill clean-up is complete.

Experience has shown that the most time-consuming and costly component of an oil spill response is often the treatment or disposal of collected waste. The amount of waste generated is dependent on many factors, such as the type and quantity of oil spilt, the extent to which the oil spreads and affects the shoreline and, most importantly, the methods employed to recover the spilt oil and oiled material from the sea surface and the shoreline.

During even relatively minor oil spills, the amount of waste collected can quickly overwhelm existing disposal facilities. To ensure this problem can be readily addressed, methods for dealing with waste should be a key component of any oil spill contingency plan. Decisions on response techniques should take account of the amount of waste likely to be generated, giving preference where possible to those techniques that minimize the amount of waste collected. In addition, especially in the case of shoreline clean-up, firm supervision of the workforce is essential. Nevertheless, even with the use of appropriate and reasonable response methods, the volume of waste generated can sometimes be as much as ten times greater than the volume of oil originally spilt.

Once collected, the effort and expense required to deal with the waste will depend on the storage, transport, treatment and disposal options available and on local regulatory requirements. Decisions on the treatment of waste should be made at the beginning of an incident, based on a realistic estimation of the amount and type of waste likely to be generated. Effective organization of all parts of the waste handling process is essential to avoid a major and costly problem. As global environmental awareness increases and regulatory requirements concerning waste disposal become stricter, innovative ways of using, recycling or disposing of waste are likely to be needed.

Refer to ITOPF's Technical Information Paper (TIP) 9 (Disposal of Oil and Debris) for a summary of the main options typically available for the separation and disposal of oil and debris. The following extractis taken from that paper:

> "As a general rule, spills of persistent oils, such as crude oils, heavier grades of fuel oil and some lubricating oils, are likely to generate considerable quantities of waste. Once spilt, the oil will start to weather with an associated increase in water content and viscosity. Oil collected with minimal delay is more likely to be fluid and relatively free of contamination. Over time, the oil may accumulate debris, either as a result of the break-up of the ship, from lost cargo or debris originating from the shore.
>
> Even if the oil is free from solid debris, recovery at sea may involve collection of significant amounts of water due to the recovery methods used, or the formation of a water-in-oil emulsion. Alternatively, oils with a pour point above sea temperature may quickly become semi-solid, necessitating recovery by scoops or grabs that also tend to recover significant amounts of water. Spills of non-persistent oils tend to evaporate and disperse naturally within a short period of time and are therefore less frequently associated with waste generation issues.
>
> Oil recovered from the shoreline will usually be mixed with substantial amounts of other material, such as sand, pebbles, wood, plastics and seaweed; each material may require a different method of treatment or disposal and separation can be difficult. For example, oily wood may be burnt under controlled conditions, possibly in situ, whereas burning oily seaweed is impractical. Oiled materials from response operations, such as adsorbent materials, protective clothing (PPE), damaged containment boom, storage sacks and other types of waste receptacles can also contribute significantly to the volume of waste produced following an oil spill, particularly if large numbers of inexperienced workers or volunteers are used. Considerable amounts of waste can also be generated if fishing gear and mariculture facilities are contaminated and cannot be cleaned satisfactorily, or if stock is condemned.

Handling and Transportation

The large volumes of waste requiring disposal following clean-up can often present major logistical problems during handling and transportation. Oily waste must be transported, stored and disposed of in accordance with local regulations. In some countries, licences will be required for temporary disposal sites and by the contractors engaged for the various disposal tasks. Consultation with regulatory and licensing authorities, from the outset of the incident, will assist with this important administrative component of the disposal process.

As far as possible, and provided more than one disposal route is available, the different waste streams should be segregated at the point of collection and stored separately. The loss of control and discipline at any stage of the disposal route can lead to later complications and unnecessary additional costs. For example, bulk oil, oily debris and non-oiled materials should be stored in separate areas so that different methods of treatment and disposal can be followed for each category.

Plastic sacks should be regarded as a means of transporting oily material rather than for storage as they tend to deteriorate and degrade in sunlight, releasing their contents If the contents are to be treated in some way prior to disposal, it will usually be necessary to empty the bags and dispose of them separately. Irrespective of whether waste is stored in containers, in heaps or piles or by other means, the storage area should be lined and provisions made to catch and treat leachate to prevent secondary contamination of the surrounding area and groundwater. Odours resulting from decomposing oiled vegetation, flies and vermin can be a nuisance if temporary sites are located close to populated areas.

Where final disposal methods have been identified and capacity allows, transport of waste from the shoreline directly to the site of final disposal negates the need for temporary storage. This avoids double-handling, minimises the build-up of waste and allows the overall response to be completed more quickly and cost effectively.

It is good practice to record the quantities and types of oily waste being collected to allow progress to be monitored within the command centre.

Waste Minimisation

The problems associated with disposal will be reduced if priority is given to minimising the amount of waste generated during the response. Unless other overriding factors are present, this should be an important factor when considering clean-up techniques.

Disposal is often complicated by the amount of debris recovered with the oil. Coastal surveys to identify where debris collects naturally will often indicate where oil is likely to come ashore. Debris can sometimes be removed from these shorelines before the arrival of oil, at nominal cost relative to the cost of its disposal once oiled. Alternatively, debris collection areas could be prioritised for protection with boom, to reduce the risk of clean debris becoming oiled.

In an effort to minimise the amount of waste water for final disposal, it may be possible to decant water that has separated from the oil/water mix recovered at sea or nearshore. After the oil has settled and separated in tanks onboard skimming vessels, vacuum trucks, or other devices, water may be run off from bottom valves into a boomed area. Concentrating the oil in this way serves to maximise the capacity of temporary storage, thereby reducing interruptions in the recovery operations while additional capacity is arranged. However, it should be noted that in some countries local legislation may prohibit *the discharge of any liquid to sea without specific dispensation from the relevant authorities.*

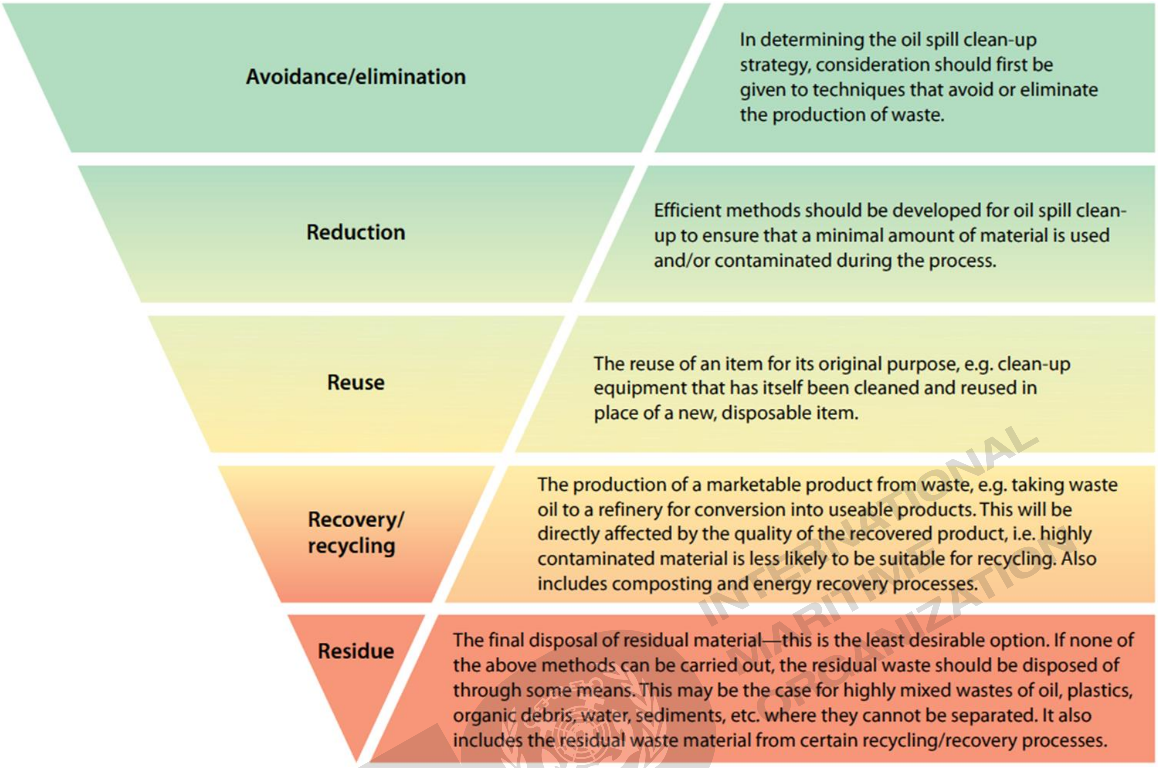
It may be possible to recover oil from contaminated beach material in situ. For example, oil seeping from collected beach material and debris can be contained within a ditch or bund surrounding the storage area. Oiled beach material may then be flushed with water, sometimes in conjunction with a suitable solvent, such as a citrus-based cleaner, to release the oil. Washing can be carried out using low pressure hoses to loosen and lift off oil from debris contained in a temporary storage pit. The resulting oil/water mixture can then be pumped to subsequent gravity separation. Another approach is to place contaminated material on a grill or wire mesh, with the oil draining into a skip or tank positioned beneath. This process can be assisted by washing the waste with water, although significant volumes of oily water can be generated. Separation can also be achieved in a closed system using water or a solvent. Devices have been developed based on a range of equipment, from standard cement mixers for small-scale batch operations to mineral processing equipment for large-scale continuous treatment. Although these large-scale systems have proved successful in specific circumstances, they are slow to achieve satisfactory levels of cleanliness and high levels of fines or tailings in the waste water can be difficult to separate. Consequently, they have not yet found widespread application at oil spill incidents.

The volume of waste can also be reduced by separating oil, in the form of tarballs, from clean sand by selective manual picking where a site might require a high standard of cleanliness, such as on tourist beaches. Sieving devices, both static and mechanical, are also sometimes used to remove oily sand residues and tarballs from lightly contaminated sand. While often labour intensive, the cost of cleaning large amounts of oiled beach material on-site could compare favourably with other methods that involve transporting the material some distance from the shoreline and subsequent disposal.

In many incidents, a large percentage of the waste generated is synthetic adsorbent material and a significant proportion of this material is often lightly oiled or not oiled at all. Waste problems will be subsequently reduced if adsorbent is used only when other techniques are unsuitable and if care is taken to ensure it is used to its full capacity.

Waste Disposal

The commonly accepted waste hierarchy* can be described as:

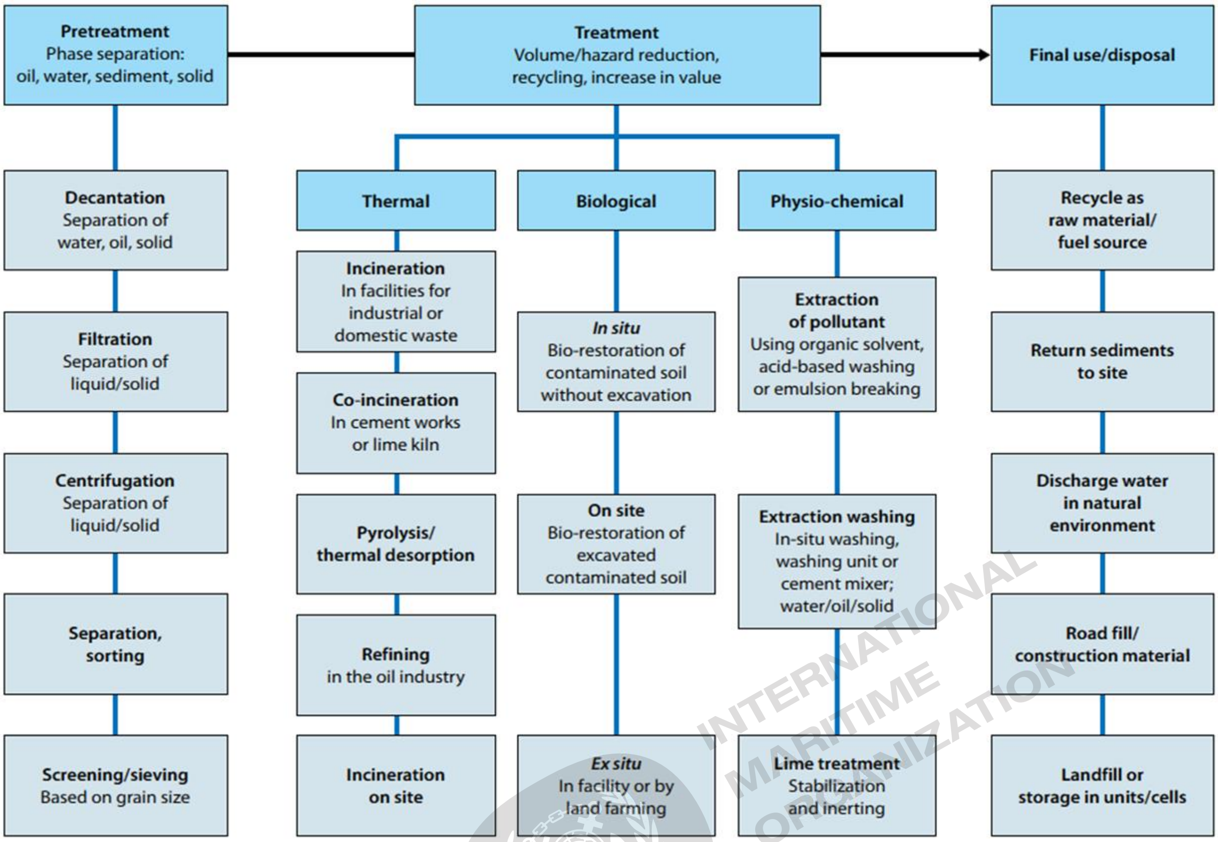


Waste Treatment and Disposal Methods

Waste type	Treatment/disposal method								
	Reprocessing	Oil-water separation	Emulsion breaking	Stabilization	Bioremediation	Sediment washing	Thermal treatment	Heavy fuel use	Landfill
Pure oil	✓	✗	✗	✗	✗	✗	✓	✓	✗
Oil and water	✓	✓	✓	✗	✗	✗	✗	✓	
Oil and sediment (fine or coarse)	✓	✗	✗	✓	✓	✓	✓	✗	✓
Oil and organic debris	✗	✗	✗	✓	✓	✗	✓	✗	✓
Oil and PPE/ equipment	✗	✗	✗	✗	✗	✗	✓	✗	✓

* IPIECA/IOGP: Guidelines for Oil Spill Waste Minimization and Management

Summary of Disposal Options[*]



Further Reading:

- CEDRE. *Guidance on Waste Management during a Shoreline Pollution Incident*, 2011 (wwz.cedre.fr/en/content/download/1780/138739/file/extract-waste-management.pdf)
- CEDRE. *Oil Spill Waste Management*, 2004 (www.wcmrc.com/wp-content/uploads/2012/06/Waste-Management-at-Oil-Spills.pdf);
- IPIECA/IOGP. *Oil Spill Waste Minimization and Management Good Practice Guide Series*, 2016 (http://www.ipieca.org/resources/good-practice/oil-spill-waste-minimization-and-management/);
- ITOPF. *TIP 9 – Disposal of Oil and Debris – Good Practice Guidelines*, 2011 (www.itopf.com/fileadmin/data/Documents/TIPS%20TAPS/TIP9DisposalofOilandDebris.pdf);
- OSRL. *Waste Management Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Waste-Management-Handbook.pdf);
- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013, (www.posow.org/documentation/manual/cleanupmanual.pdf); and
- Exxon Mobil. *Oil Spill Response Field Manual*, 2014 (http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/field-manual-for-spill-response).

[*] IPIECA/IOGP: Guidelines for Oil Spill Waste Minimization and Management

VIDEO 1.4: WASTE MANAGEMENT

Objective:

The objective of this lesson is for participants to gain a better understanding of the type of waste generated during an oil spill and the importance of pre-planning for waste management.

At the end of this video, participants will:

- have a better understanding of wastes types; and
- understand the importance of waste management to ensure a smooth response.

Lesson summary:

Waste management is a key aspect of an oil spill response. It is important to be fully aware of the types of waste that can be generated and how to manage these efficiently. Waste management pre-planning is very important in order to minimize waste generation, and ensure an efficient waste stream, as well as an environmentally sound solution for final disposal. This video will provide a great visual summary of important considerations related to waste management.

Video link: http://www.itopf.org/knowledge-resources/library/video-library/video/5waste-management/

LESSON 1.17: POST INCIDENT OPERATIONS

Objective:

The objective of this lesson is to understand the post-incident operations required after an oil spill, from a field perspective. These include the restoration of the response site, decontamination, overhaul and maintenance of response equipment, replacement of response equipment, post-incident assessment and wash-up.

At the end of this lesson, participants will understand:

- the tasks that must be completed at the end of a spill.

Lesson summary:

Once clean-up operations are terminated many tasks still remain before the response is completed. Generally, operational as well as administrative tasks need to be carried out.

Various operational and administrative tasks are necessary to return equipment to its pre-spill conditions and ensure that the incident is well documented and the lessons learned identified. Typically, post-spill studies initiated during a response will be ongoing for a period of time, depending on study objectives and goals.

Generally, four types of tasks are carried out during this stage:

- Operational tasks
- Administrative tasks
- Post-spill studies
- Restoration

Operational tasks include demobilizing all equipment used in the response and returning all equipment and stockpiles to their original state, with the equipment fully ready for the next operation. Typical operational tasks are:

- removal of equipment from the field;
- clean-up of equipment, waste area, ports, vessels, etc.;
- repairs and maintenance (planned maintenance system and/or manufacturer's recommendations); and
- restocking of consumables.

Operational tasks for field personnel include:

- ensure all equipment is removed from work sites;
- identify equipment to be repaired or replaced;
- ensure equipment is returned to the appropriate location;
- ensure equipment is cleaned up to the appropriate level so that if another spill happens, equipment can be used without problems; and
- ensure all waste is removed from worksite, including all oil, debris, PPE, food items, etc.

Typical administrative tasks at the operational level include:

- finalizing personnel and equipment usage timesheets;
- conducting incident debriefings with response personnel;
- participating in wider incident debriefs;
- identifying and implementing lessons learned;
- amending operational procedures, if appropriate; and
- contributing to incident reports.

Post-spill studies are also necessary to determine the nature and extent of the damage and to assess and monitor the recovery processes. Typically, post-spill studies will start during the response and continue after operations have concluded. Some activities related to post-spill studies may take place while workers are on site, in which case the role of Operations will be to:

- accommodate teams visiting sites (if safe);
- try not to interfere with sampling sites/material left on beaches; and
- provide logistical support as required.

Further reading:

- IMO. *Contingency Planning, Section II – Manual on Oil Pollution*, 2017 Edition, International Maritime Organization, London, 2017 **(Approved by IMO);**
- IMO. *Guidelines for Sampling and Identification of Oil Spills, Section VI – Manual on Oil Pollution*, 1998 Edition, International Maritime Organization, London, 1998 **(Approved by IMO);**
- IMO/UNEP. *Guidance Manual on the Assessment and Restoration of Environmental Damage following Marine Oil Spills*, 2009 Edition, International Maritime Organization, London, 2009 **(Approved by IMO);**
- OSRL. *Shoreline Operations Field Guide*, 2011 (www.wcmrc.com/wp-content/uploads/2012/06/Shoreline-Operations-Handbook.pdf);
- POSOW. *Oiled Shoreline Assessment Manual*, 2013 (www.shorelinescat.com/Documents/Manuals/POSOW%20Oiled%20Shoreline%20Assessment%20Manual%20webversion.pdf);

- POSOW. *Oiled Shoreline Clean-Up Manual*, 2013, (www.posow.org/documentation/manual/cleanupmanual.pdf); and
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