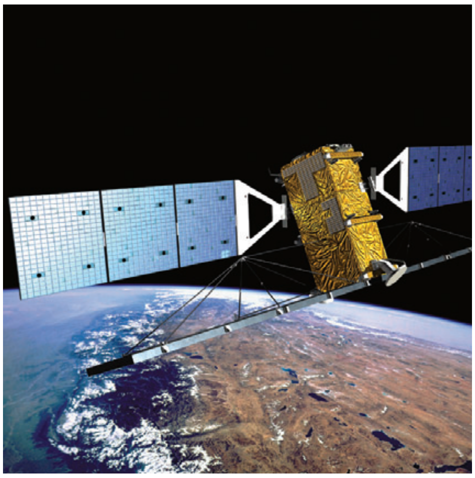
Oil spill preparedness and response: An introduction

Guidance document for the oil and gas industry



Oil spill preparedness

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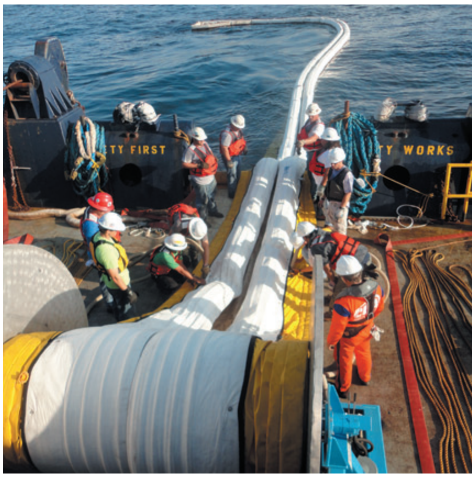

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IOGP Report 520

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Oil spill preparedness and response: An introduction

Guidance document for the oil and gas industry

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Introduction

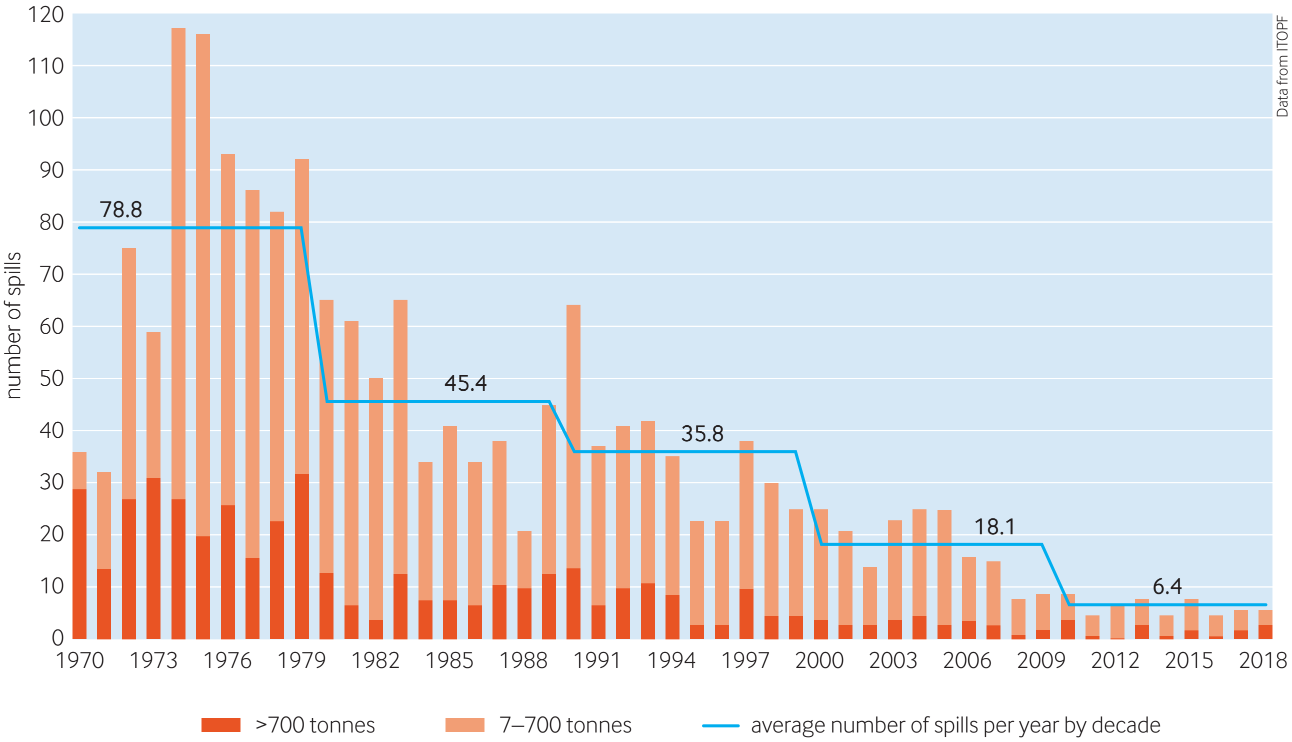
BACKGROUND

The oil and gas industry recognizes that oil spills may have serious ecological and socio-economic consequences, and are potentially hazardous to workers and the wider community. Significant effort and priority is dedicated to designing operations and employing procedures that prevent spills from occurring in the first instance, and improving the efficacy and speed of clean-up operations should an incident occur. The industry constantly incorporates new research, understanding and lessons learned to improve spill prevention. A focus on prevention has led to the number of large spill incidents (commonly defined as oil spills greater than 700 tonnes or 5,000 bbls) from shipping and allied activities being reduced by more than ten-fold from the 1970s through to the present day (Figure 1).

In the unlikely event that an oil spill does occur, the industry's primary goal is to minimize the impact of the spill on people and the environment. This is achieved by ensuring a well-planned, rapid and effective response. While response objectives will vary depending on the specific circumstances of the spill, there are certain basic objectives that will guide any response:

- safeguarding the safety and health of people—both of responders and communities;
- stopping the source of the spill as quickly as possible;
- minimizing environmental and community impact;
- minimizing the risk of oil reaching the shore in offshore scenarios; and
- minimizing the risk of oil entering watercourses or groundwater in onshore scenarios.

Figure 1 The number of significant spills from oil tankers, 1970 to 2018



The IPIECA-IOGP series of good practice guides on oil spill preparedness and response summarizes consensus views on good practice for a range of oil spill preparedness and response topics. The series aims to help align industry practices and activities, inform stakeholders, and serve as a communication tool to promote awareness and education.

PURPOSE

This document provides a framework for effective oil spill preparedness, response and restoration. It describes the key elements used by the industry to underpin this framework and references the good practice guides on oil spill preparedness and response. Hyperlinks are provided throughout the document, highlighted in blue, which direct the reader to each respective guide, as well as to other relevant sources, for more detailed information. This material is freely available on the IPIECA and IOGP websites at www.ipieca.org and www.iogp.org, respectively.

ORGANIZATION

This document is organized into the four main sections summarized below, and concludes with an appendix that lists the IPIECA-IOGP good practice guides and relevant technical reports.

Section 1: Key elements for a successful response

Prior to discussing different preparedness, response and restoration strategies and activities, it is important to understand the elements that are critical for a successful response. These elements include having an effective incident management system (IMS) in place along with a robust stakeholder engagement programme, to ensure that relevant authorities and communities are supportive of the planned strategies and tactics should a spill occur. A good understanding by stakeholders of the tiered preparedness and response concept along with the spill impact mitigation assessment (SIMA, also known as net environmental benefit analysis, NEBA) process and the need for informed decision making are also key to a successful response.

Section 2: Preparedness

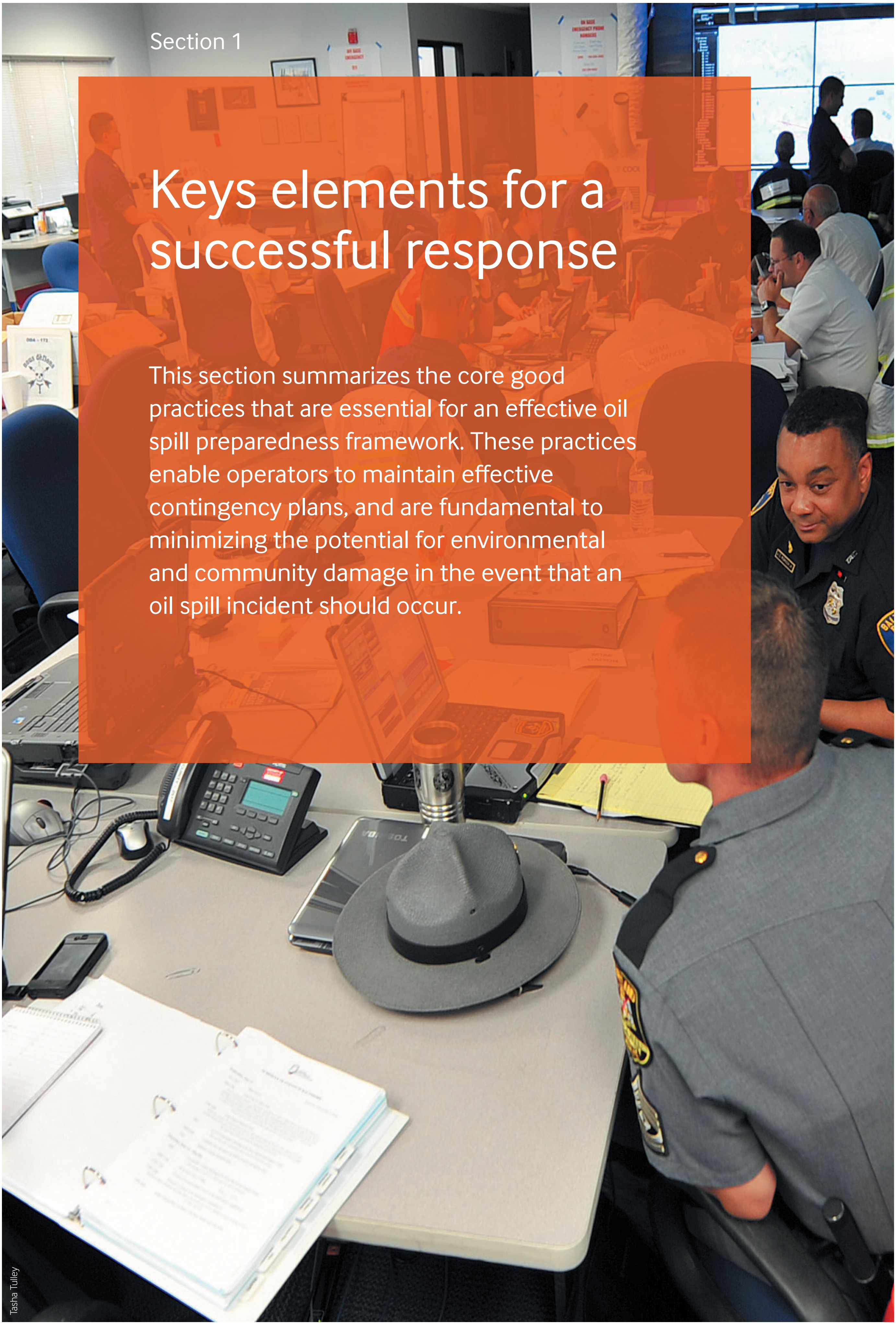
In addition to the elements mentioned above, an effective spill preparedness programme needs to be put in place to ensure that those extracting, storing and transporting oil are adequately prepared to respond to potential oil spill scenarios, including a worst credible case discharge. Preparedness programmes generally include, but are not limited to, a comprehensive oil spill contingency plan (OSCP) and a robust training and exercise programme, along with the implementation of the tiered response approach.

Section 3: Response

The next step in the framework is responding to an oil spill should one occur. First and foremost is the protection of the health and safety of responders and the public. This component also covers the various response options for assessing and combating oil spills on water and land as well as dealing with waste management, environmental protection, oiled wildlife and other operational issues.

Section 4: Restoration

Once the emergency phase of a spill response is completed, actions will generally be required to assess potential impacts on the environment and conduct the associated restoration activities or provide compensation for socio-economic disruption. Lessons learned through response and restoration are fed back into preparedness, to promote continuous improvement.



Keys elements for a successful response

This section summarizes the core good practices that are essential for an effective oil spill preparedness framework. These practices enable operators to maintain effective contingency plans, and are fundamental to minimizing the potential for environmental and community damage in the event that an oil spill incident should occur.

Tasha Tulley

Key elements for a successful response

A successful oil spill response has a set of core good practices at its heart. These are the elements of an effective oil spill preparedness framework; they are promoted by industry and are fundamental to minimizing the potential for environmental and community damage. These core good practices begin with the understanding that, even with a strong focus on prevention, there is still a possibility that oil spill incidents may occur. Operators therefore need to have effective, actionable contingency plans in place that are capable of mounting a response up to and including the worst credible case release or discharge.

INCIDENT MANAGEMENT SYSTEM

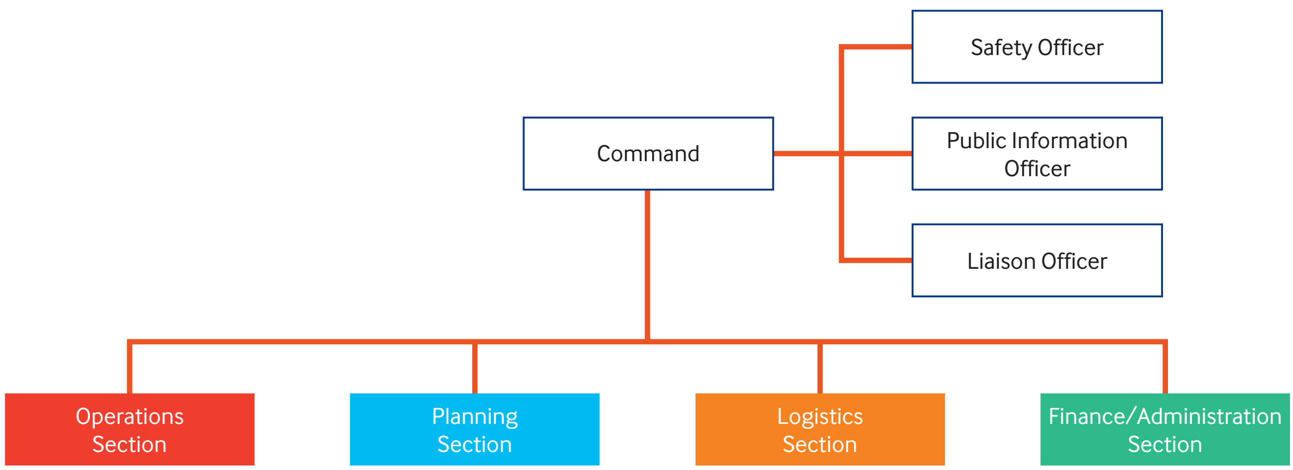
Effective incident management requires the ability to establish command and control of the response activities—i.e. to move the management of the response from the initial reactive phase to a proactive one, where the scope of the incident is understood, appropriate response actions are being taken in alignment with planned strategies, and where the outcome of the incident is being driven by a clear set of objectives to protect people and the environment.

The incident management system (IMS) defines and standardizes the management organizational structure and processes to enable seamless integration of various involved organizations while promoting successful incident command, control and coordination. The IPIECA good practice guide entitled *Incident management system for the oil and gas industry* introduces the common elements of an IMS to stakeholders who may be called upon to work together to provide specific expertise, assistance or response resources during an emergency incident.

Figure 2 illustrates a typical incident management structure and its functional sections. Variations may exist from country to country but these fundamental command and general staff positions should be addressed by any system to be effective.

Experience has shown the value of unifying and integrating incident response functions into a single organization, managed and supported by one command structure and supporting processes, and with clear 'line of sight' between command and field. The IMS can include the integration or coordination with other potential aspects of an incident, such as firefighting, search and rescue, or source control.

Figure 2 Typical incident management structure



The incident response organization is most successful when the following key principles are applied:

- use of a single, integrated organization to manage the response;
- a structured planning cycle and development of an incident action plan;
- establishment of clear, hierarchical reporting relationships; and
- keeping the organization modular, scalable and appropriately sized.

TIERED PREPAREDNESS AND RESPONSE

Tiered preparedness and response is recognized as the basis for a robust framework. It establishes capability that can be escalated and cascaded to the scene. This avoids the proliferation of impractical stockpiles of large quantities of response resources yet can still provide an appropriate and credible response through the integration of local, regional and international capabilities. The established three-tiered structure allows contingency planners to describe how an effective response to any oil spill will be provided, i.e. from small operational spillages to a worst credible case release at sea or on land.

The tier classifications are defined as the resources required to deal with potential spill scenarios and are broadly considered as follows:

Tier 1: Locally available capability (resources) necessary to handle relatively minor spills that can typically be resolved within a few hours or days and/or provide an initial response to larger spills.

Tier 2: Regional capability in the wider area or country necessary to supplement Tier 1 resources, including general equipment and specialized tools and services, for responses to more significant spills that may continue for several days or weeks.

Tier 3: National or international capability necessary for responses to major spills that require substantial additional resources due to incident scale, complexity and/or impact potential and which may continue for weeks or months.

Developed in the 1980s, the tiered preparedness and response approach categorizes response capabilities, and ensures that the appropriate resources are accessible to a facility or region in the event of a spill. This aligns with the requirements of the International Maritime Organization's (IMO's) International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (the OPRC Convention), which states that response capabilities shall be established, either individually or through bilateral or multilateral cooperation, commensurate with the risk involved. These principles enable responders to plan for the escalation of both regional and global response resources in the unlikely event of a major spill. The OPRC Convention is the key international agreement that commits a country to develop and implement an effective preparedness and response framework.

It is important to recognize that while the extent and size of the spill is relevant to the tier classification, other factors such as environmental resources at risk, seasonal accessibility and geographical remoteness also play a part. For this reason, the tiers should not be defined quantitatively as there are too many variables associated with a spill (e.g. oil type, location, environmental setting, weather, local governance, etc.) to calculate the amount and quantity of resources required to combat spillage of a given volume. A technical report, *Oil spill risk assessment and response planning for offshore installations*, is available to assist offshore operators with their contingency planning.

The IPIECA good practice guide on *Tiered preparedness and response* presents an updated view of the tiered approach, describing the evolution from a simple scale-based (resource requirement) model to a more detailed approach where expertise and specific tools are accessed and utilized where beneficial. The capabilities that may be required for oil spill response are grouped into 15 discrete categories, to enable a much more specific and tailored representation of the available tiered response capabilities matched to each operation's risk. Thus the tiered response capability required is unique to an operation and location, with each situation being shaped by both setting and operational factors. This directly links the risk profile to how resources will be provided and escalated in proportion to an incident's needs.

Each capability can be considered independently and can take account of at least the following four determining factors:

- inherent operational-specific risks (e.g. the oil type, inventory and related release scenarios);
- location-specific risk (e.g. the proximity of oil-sensitive ecological, socio-economic and cultural receptors and exacerbating metocean conditions such as ice, darkness or harsh climate);
- relative proximity and access to supporting resources and their logistical requirements; and
- applicable legislative requirements or stipulated regulatory conditions.

Petronia Consulting

STAKEHOLDER ENGAGEMENT—ALIGNMENT, INTEGRATION AND DECISION MAKING

Preparedness efforts rely on ensuring, to the extent feasible, that the concerns, expectations and priorities of all stakeholders are understood and considered when developing oil spill contingency plans. This encourages all parties to work together effectively, towards a common goal. Stakeholders may be varied and include oil companies, rig or vessel owners/operators, government agencies, international organizations, fishing associations, environmental groups and local communities.

The priorities for spill response will inevitably vary according to the individual circumstances of the spill but, in general, will follow the hierarchy below:

- People: protect the health, safety and property of responders and the public.
- Environment: prevent damage to sensitive ecological, socio-economic and cultural resources.
- Assets: maintain the vitality and sustainability of tourism and other key business and community industries, such as transportation and fishing.
- Reputation: conduct the response in an ethical and transparent manner.

Speed is a key element in an effective response as oil spills are often rapidly evolving events and pollution can spread quickly on the water's surface. Delays early in the response can lead to significant consequences including greater spill impacts later in the process.

For this reason, it is in everybody's interests to promote a fast, safe and efficient response through effective cooperation between government, industry and stakeholders. This translates into practical actions which may include:

- a clear response organizational structure with unified command, a common set of objectives and integrated procedures;
- a communications plan ensuring the flow of factual and consistent information to stakeholders;
- availability of pre-authorized techniques in the response toolkit; and
- the ability to mobilize and deploy response capabilities without unnecessary barriers.

The involvement of stakeholders in the contingency planning process provides the foundation for successful decision-making. A SIMA-driven response strategy identifies suitable response tools, the use of which will preferably have been pre-approved by regulators and supported by stakeholders.

The IMO's OPRC Convention establishes a commitment to work cooperatively with other countries, and with the oil, shipping and ports industries, in ensuring a suitable national oil spill response system. It also stipulates reporting and planning requirements and the development of both bilateral and multilateral agreements to encourage and facilitate transboundary cooperation. The requirements set by the OPRC Convention are aligned with the key elements of response described in this document.

SPILL IMPACT MITIGATION ASSESSMENT

Spill impact mitigation assessment (SIMA, also known as net environmental benefit analysis, NEBA) is a methodology used to ensure that the impacts of oil spills on people and the environment are minimized. It involves consideration and judgement to compare the likely outcomes of using different oil spill response techniques. The process may be led by experienced planners but encourages inputs from government, industry and local communities. SIMA provides a solid scientific basis for understanding the primary trade-offs between response options, while incorporating value judgements concerning differing ecological and socio-economic resources. The benefits and drawbacks of different response techniques need to be compared with no intervention, to determine which approach will result in the least overall harm to the environment and local community. It typically involves the following steps and should ideally be carried out prior to an oil spill as a fundamental part of contingency planning:

1. Compile and evaluate data for relevant oil spill scenarios including fate and trajectory modelling, identification of resources and sensitive receptors at risk, and determination of feasible response options.
2. Predict outcomes/impacts for the 'no intervention' (or 'natural attenuation') option as well as the effectiveness (i.e. relative impact mitigation potential) of the feasible and safe response options for each scenario.
3. Balance trade-offs by weighing and comparing the range of benefits and drawbacks associated with each feasible response option, including no intervention, for each scenario.
4. Select the best response option(s) to form the strategy for each scenario, based on which options or combination of options will minimize the overall ecological, socio-economic and cultural impacts, and promote rapid recovery.

SIMA can also be expedited during an incident to facilitate or refine urgent decisions on how to minimize environmental and socio-economic impacts. The good practice guide on NEBA explains the principles underlying the net environmental benefit approach, while 'how to' guidelines on the implementation of SIMA have also been produced.

SITUATIONAL AWARENESS, ALIGNED OBJECTIVES AND RESPONSE STRATEGY

A clear communication plan is critical to a successful response and includes the development of pre-established points of stakeholder contacts within industry, government and the community as part of the preparedness process. A shared view of the situation ('situational awareness') using surveillance, modelling and visualization tools as inputs to a 'common operating picture' (COP) will ensure that all stakeholders are operating from the same perspective. This, coupled with a good understanding of each stakeholder's primary concerns, will assist a unified command in developing a response strategy that achieves appropriate response objectives and priorities. Although a good practice guide has not been prepared specifically to describe this aspect of spill response, situational awareness is largely addressed in the good practice guides on satellite remote sensing and aerial observation discussed in the *Response* section on page 18.

A technical report is available which provides guidance on creating a COP for use during a response to an oil spill. The report, entitled *Recommended practice for Common Operating Picture architecture for oil spill response*, also provides guidance on the implementation of the requisite data management by the response community.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Preparedness

The concept of oil spill contingency planning is introduced in this section, along with the key activities necessary to ensure adequate preparedness for an oil spill incident, namely:

- sensitivity mapping;
- incident management training; and
- oil spill response exercises.

OSRL

Preparedness

CONTINGENCY PLANNING

Oil spill contingency planning is the process of developing a suitable spill response capability in compliance with the local regulatory framework and commensurate with the oil spill risks of a facility or activity. The oil spill risk assessment and response planning processes allow the identification of, and adequate planning and provisioning for, spill scenarios of all scales and complexities. Incorporated within these processes are the principles of tiered preparedness and response discussed on pages 7–8 of this document.

The IPIECA-IOGP good practice guide on *Contingency planning for oil spills on water* provides a detailed explanation of the contingency planning and preparedness processes. In summary, the following critical elements should be considered:

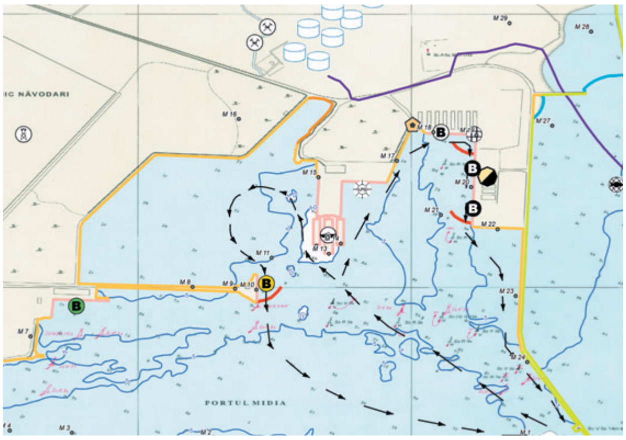
- The basis of response preparedness is the capability to respond; this is not measured solely by equipment stockpiles, but also encompasses personnel, organization, procedures, logistics, training and exercising.
- Understanding the level of risk, including identifying oil fate and trajectory and the key ecological and socio-economic sensitivities which may be threatened under realistic planning scenarios, is vital.
- Developing robust response procedures for spill scenarios up to and including the worst credible case, with the ability to cascade identified capability through the tiers as needed and without barriers.
- Working with regulators and the community to secure pre-authorizations for the preferred response techniques, based on SIMA or similar approaches.
- Ensuring that communications strategies are in place, and that key community, regulatory and other stakeholder contacts are identified and are consulted in the contingency planning process.
- Conducting training and exercises to test the plan and validate response capability.

SENSITIVITY MAPPING FOR OIL SPILL RESPONSE

The mapping of areas that are particularly sensitive to accidental oil pollution is an important step in the oil pollution preparedness process. These are typically areas with particular ecological, socio-economic, or cultural importance, such as biodiverse or sensitive ecosystems, endangered species or other critical habitats, key natural resources, recreational or commercial activities etc., which are at risk of encountering spilled oil. They may also be referred to as resources at risk.

Sensitivity maps should be included in contingency plans as they are often critical for informing key response decisions and developing an appropriate response strategy, tactics and operations. Sensitivity maps are typically used in conjunction with spill trajectories to identify the most sensitive sites or resources within the potential impact area, thus providing a basis for defining protection and clean-up priorities as part of the overall response strategy. During a response, maps may also be used by on-site responders for site-specific protection and clean-up operations. The good practice guide entitled *Sensitivity mapping for oil spill response* provides a structured approach to successfully manage the development of oil spill sensitivity maps. It indicates the key elements to be included in different types of maps at strategic, tactical and operational levels.

Figure 3 Example of an operational sensitivity map



OIL SPILL RESPONSE AND INCIDENT MANAGEMENT TRAINING

Effective oil spill preparedness requires personnel who understand, and can perform, a variety of emergency response and incident management functions. The purpose of oil spill training is to ensure that these personnel are identified and given appropriate opportunities to learn and maintain relevant knowledge and skills. For most personnel, their role in oil spill response will be an additional duty to their normal or daily jobs. Some of a person's day-to-day skills may be directly relevant to his/her allocated role during an emergency, for example:

- managerial or supervisory capabilities;
- general logistical, procurement or administrative knowledge; and
- specialist knowledge on safety, legal or government and public affairs.

However, in all cases the unique and varied challenges posed by an oil spill response will require an understanding that extends beyond the normal experiences of a person's job. All incident management team personnel will therefore require some level of training in their team role, in addition to oil spill basics, to enable them to perform safely and effectively in the case of an emergency.

A training programme has its roots in the oil spill contingency planning process and its related oil spill risk assessment. Programmes should be matched to the needs determined within contingency plans and be fit for purpose in both their content and delivery methods. The good practice guide on *Oil spill training* presents a stepwise process, referred to as the 'training cycle', to assist organizations and individuals in achieving this aim (Figure 4).

Figure 4 Elements of the oil spill training cycle


OSRL


OSRL

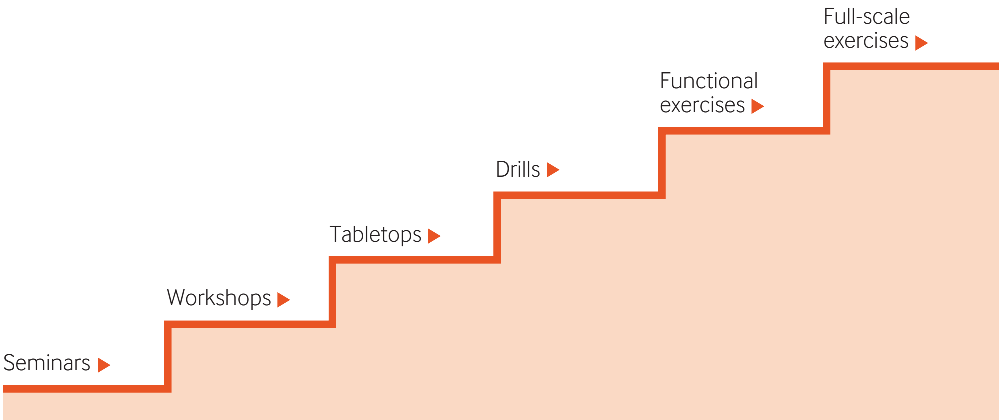
OIL SPILL RESPONSE EXERCISES

Oil spill exercises encompass the activities through which personnel can develop competence through practice, and test the effectiveness of oil spill contingency plans and procedures for continual improvement. The importance of oil spill exercises is emphasized by the OPRC Convention, whereby it is required that governments shall work with the oil and shipping industries, port authorities and other relevant entities to establish '... a programme of exercises for oil pollution response organizations and training of relevant personnel.' It is instructive to note the linkage between exercises and training.

The good practice guide on *Oil spill exercises* provides information on constructing an exercise programme. A well-designed and implemented exercise programme will enable response personnel to undertake simulated emergency response actions in a controlled, low-risk setting, and provide the opportunity to:

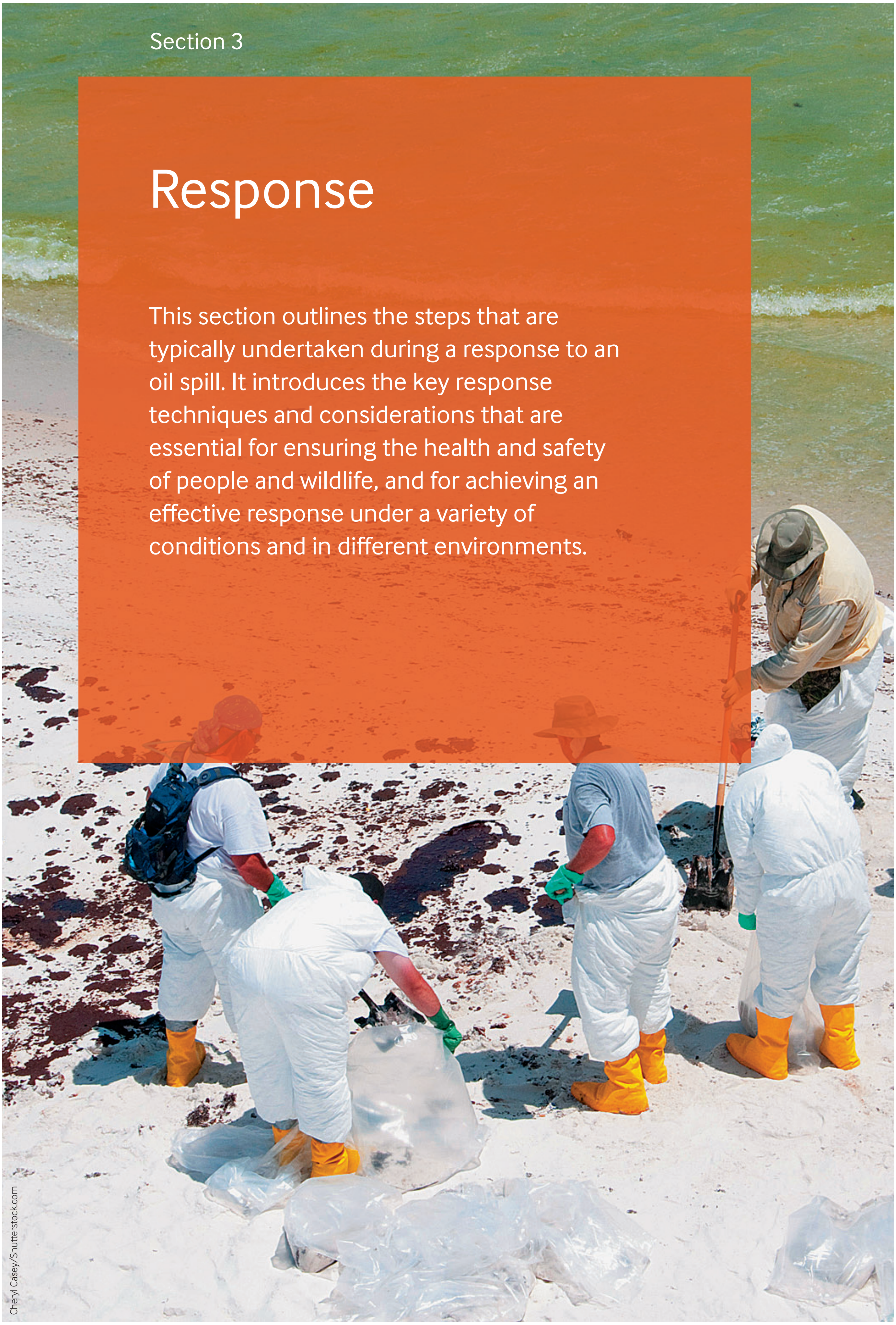
- assess and validate oil spill contingency plans, procedures, training, equipment and logistics;
- clarify the roles and responsibilities of emergency response and incident management teams;
- improve response coordination, integration and communication within and between the varied organizations and stakeholders;
- identify gaps in response resources or capability;
- build individual and team confidence and competence;
- measure response team performance; and
- identify opportunities for improvements in preparedness and response.

Figure 5 The progressive development of an exercise programme



Response

This section outlines the steps that are typically undertaken during a response to an oil spill. It introduces the key response techniques and considerations that are essential for ensuring the health and safety of people and wildlife, and for achieving an effective response under a variety of conditions and in different environments.



Cheryl Casey/Shutterstock.com

Response

The response to an oil spill incident typically proceeds through the following steps:

- **Initial deployment:** following verification of a spill, completion of the required notifications and initial safety assessment, responders immediately mobilize and deploy all necessary local capability, and develop situational awareness concerning the event's scale and impact potential.
- **Confirm response techniques:** responders verify that planned response techniques are appropriate, or modify them as necessary.
- **Organize the response:** an incident management team is activated, at a scale commensurate with the incident's needs, to establish clear objectives, strategy and tactics, and mobilize the appropriate resources, taking into consideration the possibility of escalation.
- **Cascade resources:** capability is deployed as required to effectively manage the response, which may include cascading resources from the appropriate pre-identified tiered sources, as the spill evolves and responders understand what is required.
- **Adjust for realities:** effectiveness of techniques and incident conditions are assessed and adjusted throughout the response.
- **Ongoing response:** the response will continue until an agreed-upon end point is reached, at which time restoration will commence.

Note that, after the initial deployment, when the response evolves from a reactive to a proactive phase, the process becomes cyclical. Based on an operational period (typically 24 hours), there may be a repeating process of 'plan, do, re-evaluate and adapt'.

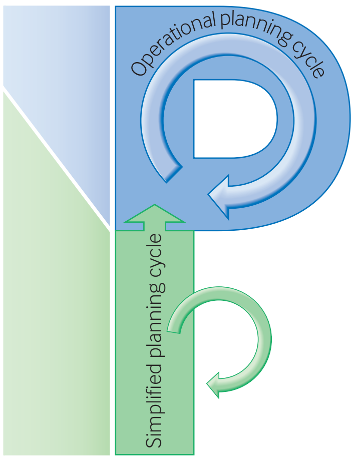
OIL SPILL RESPONDER HEALTH AND SAFETY

When an oil spill occurs, the issue of health and safety, both for the public and oil spill responders, is the highest priority consideration. It is recognized that health and safety are managed in different ways around the world, with some countries having highly regulated and prescriptive regimes, while others use a risk-based system.

Figure 6 Application of an IMS to the response organization and planning cycle for both major and smaller incidents

Incident size/ complexity	IMS organization	IMS planning process
Major	Full IMS structure	
Medium	Partial IMS structure	Simplified planning cycle
to		
Small	Simplified IMS structure (tactical response)	

IMS planning cycle



The good practice guide on *Oil spill responder health and safety* focuses on identifying the main hazards when an oil spill occurs, their degree of severity, and the practical steps that can be taken to minimize the impact of the spill on the health and safety of those involved in responding to it. Although this document is primarily intended to address oil spills on water, it may also be of use in the event of an inland spill.

VOLUNTEERS

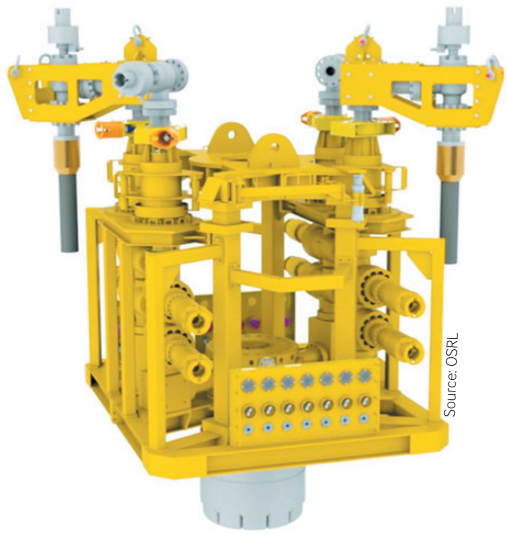
In some cases, consideration may be given to the use of volunteers to support the response effort. Such assistance can be a useful resource and provide quick access to people who may possess valuable local knowledge. However, there are several challenges that should be addressed when deciding whether to use volunteers. These are discussed in the IPIECA-IOGP technical report on *Volunteer management*.

SOURCE CONTROL

An important part of any response to an oil spill incident is to safely control the source of the spill and stop further flow as soon as possible. While source control is featured in plans for vessel operations, pipelines, terminals, etc., it is important to recognize the substantial investment by industry in the development and global provision of source control capability for capping offshore subsea wells.

Offshore well source control methods include blowout preventer (BOP) activation, capping, containment and relief well drilling. Secondary BOP activation involves trying to close the BOP using a remotely operated underwater vehicle (ROV) with the help of a subsea intervention skid. Subsea capping involves installing a capping stack (Figure 7) onto the incident well and then closing it to shut off the flow.

Figure 7 Example of a subsea capping stack



Subsea containment involves installing a capping stack onto a well and then hooking up subsea production equipment to divert flowing hydrocarbons back to the surface for capture through one of several means. This 'cap-and-flow' approach may be an interim phase or tactical response when well integrity concerns prohibit the safe shut-in of a flowing well.[1] For all intents and purposes, the capping stack portion of both concepts is the same.

While source control is outside the scope of the good practice guide series, more information on this subject can be obtained from the IOGP/IPIECA report, *Source Control Emergency Response Planning Guide for Subsea Wells*. The oil spill contingency plan should consider span of control, technical complexity and how to effectively integrate the Source Control Branch with pollution response activities. It is recognized that establishing subsea well control may take significant time, and oil spill contingency plans should reflect this.

[1] Note: within the context of source control, there are some differences in language used in the US and internationally. Some examples of language differences include the US term 'cap and contain', which internationally means 'capping' and the US term 'cap and flow', which internationally means 'containment'. This document follows international language conventions.

SURVEILLANCE AND MODELLING

It is important for responders, government agencies and communities to have a clear understanding of the pollution situation, response actions under way, and progress being made to prevent or mitigate potential impacts. This 'situational awareness' is provided by a combination of surveillance operations, predictive modelling and the depiction and reporting of a variety of response data, for example through a Common Operating Picture (COP).

The good practice guide entitled *Aerial observation of oil spills at sea* explains the principles of aerial surveillance, as well as developing a mission profile, and recording oil appearance and estimating quantities from the air.

Michel Starr, Fisheries and Oceans Canada

Guidance is provided on calculating slick drift and preparing pollution reports, as well as guiding response vessels from an observing aircraft. It is also recognized that unmanned aerial vehicles (UAVs) and autonomous underwater vehicles (AUVs) are likely to have an increasing role in oil spill surveillance, monitoring and response. Moreover, the tools and technologies used for subsurface surveillance and monitoring of the water column are detailed in the good practice guide entitled *In-water surveillance of oil spills at sea*.

Satellite remote sensing is one of several capabilities that form the surveillance strategy required for an effective oil spill response. The technology has been developed significantly to the point where it is now meeting needs in terms of spatial and temporal sampling and timely response. Satellites may operate with fewer constraints compared to other aerial surveillance techniques with respect to weather, logistics and ground or airspace restrictions, and can be particularly useful and cost-effective for wide-area synoptic coverage. The good practice guide entitled *Satellite remote sensing of oil spills at sea* provides guidance on the strategic and operational roles of satellites in the context of an oil spill response. The guide covers how to set up a satellite remote sensing response team, the technology involved, the process of taking a satellite image request through to providing decision-making information, and the challenges and future opportunities for satellite remote sensing within the oil spill response framework.

Oil spill modelling tools are widely utilized to predict the surface and subsea movement and fate of spilled oil, in contingency planning, exercise development and incident response. While these tools can provide useful support to a response, they should be verified with ground observations during real incidents.

RESPONSE TECHNIQUES

The techniques that are considered and identified in the scenario planning stage are drawn from the response toolkit. These tools include natural processes (i.e. biodegradation), the use of at-sea containment and recovery, chemical dispersants and controlled in-situ burning, as well as shoreline protection and clean-up. These tools are described in the following text, and Table 1 on pages 19–20 summarizes the benefits and potential drawbacks of each technique.

Table 1 The benefits and potential drawbacks of the various oil spill response techniques

<table>
<tr><th>RESPONSE TECHNIQUE</th><th colspan="2">BENEFITS</th><th colspan="2">DRAWBACKS AND LIMITATIONS</th></tr>
<tr><td>At-sea containment and recovery</td><td colspan="2">• Removes oil with minimal environmental impact
• Effective for recovering a wide range of spilled products
• Large 'window of opportunity'
• Minimal collateral impacts
• Greatest availability of equipment and expertise
• Recovered product may be reprocessed</td><td colspan="2">• Inherently inefficient and often very slow
• Difficult to recover a significant percentage of the oil in larger spill cases
• Inefficient and impractical on thin slicks
• Decreased effectiveness in inclement weather or higher seas
• May recover a high proportion of water
• Requires storage capability and subsequent treatment/disposal for recovered material
• Labour and equipment intensive</td></tr>
<tr><td>Controlled in-situ burning</td><td colspan="2">• Rapid removal of large amounts of oil
• Much less oil left for disposal
• High efficiency rates (up to 98–99%)
• Less equipment and labour required; specialized equipment (boom) is transportable by air
• No recovered oil storage or disposal requirements (except possibly for burn residue)
• Effective over a wide range of oil types and conditions
• Reduced vapours at the water surface through oil removal improves responder safety</td><td colspan="2">• Black smoke perceived as a significant impact on people and the atmosphere
• Limited 'window of opportunity' for spills on open water
• Need to capture and contain sufficient volume of oil and increase slick thickness for in-situ burning to be effective
• Effectiveness diminishes for heavier oils and as oil weathers
• Presents a potential risk to offshore wildlife
• Burn residue can be difficult to recover (may sink from burns of very heavy oils)
• Localized reduction of air quality
• Potential for secondary fires during inland use
• Ineffective in inclement weather or high seas</td></tr>
<tr><td>Surface dispersant application</td><td>• Lower manpower and logistical requirements than other response options
• Can be applied over a broad range of weather conditions
• Higher encounter rate compared to other surface options</td><td rowspan="2">• Reaches and treats significantly more oil than other response options
• Speeds up oil removal from the water column by enhancing natural biodegradation
• Removes or reduces surface oil slicks
• Reduces the amount of oil that spreads to the shoreline
• No recovered oil storage or disposal requirements
• Reduced vapours at the water surface</td><td>• May not work on high viscosity fuel oils in calm, cold seas
• May have a limited 'window of opportunity' for use as oil weathers</td><td rowspan="2">• Does not directly collect the oil from the environment but instead disperses it into the water column where it can be biodegraded
• Potential effects of dispersed oil on marine life dwelling in the water column (short-lived and localized exposures are anticipated)
• Potential market confidence-based economic impact on fishing industries if the public misunderstands the potential effects of dispersant on seafood</td></tr>
<tr><td>Subsea dispersant application</td><td>• Continuous operations, day and night, are possible
• Can be applied in all but very severe weather conditions
• High encounter rate</td><td>• Slower mobilization time compared to surface application</td></tr>
</table>

continued ...

Table 1 The benefits and potential drawbacks of the various oil spill response techniques (continued)

RESPONSE TECHNIQUE	BENEFITS	DRAWBACKS AND LIMITATIONS
Shoreline protection	• Can protect targeted shoreline sites when other options are not feasible or totally effective • Equipment is often readily available and easily deployed where conditions are favourable • More effective in sheltered waters • Possible to develop, test and verify boom deployment configurations and equipment requirements at priority sites during contingency plan development and implementation	• Difficult to deploy and anchor booms in strong currents • Breaking waves reduce boom function • Booms require regular maintenance due to tides and wind changes • Practical limitations to length of boom that can be deployed—cannot protect large areas of coastline • Deflects or diverts oil to other areas, if no recovery systems deployed

DISPERSANTS: SURFACE APPLICATION

Dispersant use can be an effective way of minimizing the overall ecological and socio-economic damage by removing oil from the sea's surface as small droplets, thereby preventing oil from reaching coastal habitats and shorelines, and enhancing the natural biodegradation processes that ultimately assimilate oil into the environment. What dispersants are, and how they work when applied to oil slicks on the sea's surface, are described in the good practice guide entitled *Dispersants: surface application*. Details on the capabilities and limitations of dispersants are presented, together with highlights on the need for regulation, the advantages of planning and advance authorization, operational procedures and monitoring during their use. Specific guidance on monitoring the effectiveness of dispersant application is provided in the technical report entitled *At-sea monitoring of surface dispersant effectiveness*.

Further guidance is provided on the development of suitable regulations through a technical report on *Regulatory approval of dispersant products and authorization for their use*. The proper care of dispersant stockpiles has also been addressed in the technical report, *Dispersant storage, maintenance, transport and testing*.

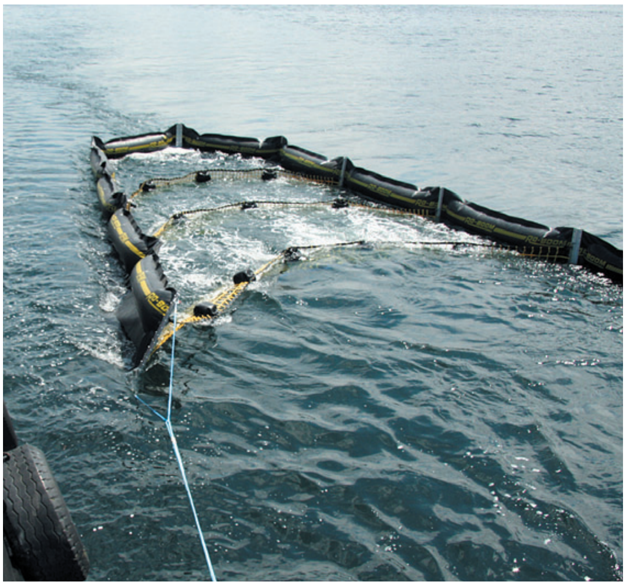
OSRL

DISPERSANTS: SUBSEA APPLICATION

The recent evolution of sub-sea dispersant injection (SSDI) as a response tool for possible deeper water well releases is described in the good practice guide entitled *Dispersants: subsea application*. This includes the operational capabilities that have been developed, and how the decision to plan for SSDI may be justified by SIMA approaches. Features described include the ability to mount continuous operations in a wide range of sea conditions, as well as approaches to monitoring the effectiveness and effects of its application.

AT-SEA CONTAINMENT AND RECOVERY

At-sea containment and recovery is the controlled encounter and collection of oil from the water's surface. Equipment is used to corral and concentrate the spilled oil (using floating barriers or booms) on the sea surface into a suitable surface thickness, allowing for mechanical removal. The good practice guide on *At-sea containment and recovery* explains how effective containment and recovery can reduce: the impact on on-water sensitivities such as seabirds, fish and mammals; the impact on shoreline sensitivities by removing floating oil at sea; the complexity and duration of a shoreline response; and the volume of waste generated by a response by preventing or minimizing shoreline impacts. It explores the reasons why at-sea containment and recovery may have limited effectiveness in offshore scenarios, and the circumstances under which it should, and should not, be considered.



Desmi

MPCA

CONTROLLED IN-SITU BURNING

In-situ burning (ISB) is the controlled ignition and burning of spilled oil at, or close to, the spill site. ISB is recognized as a viable response tool for cleaning up oil spills on water, land and ice. ISB can rapidly reduce the volume of spilled oil, thereby greatly reducing the need to collect, store, transport and dispose of recovered oil. ISB can also shorten the overall response time, thus aiding in environmental protection. The good practice guide on the *Controlled in-situ burning of spilled oil* contains information on the scientific aspects of the burning process and its effects, and presents practical information about the procedures to be followed and equipment required for carrying out an in-situ burn. A technical report entitled *Guidelines for the selection of in-situ burning equipment* has also been produced.

SHORELINE ASSESSMENT (SCAT)

Despite the best intentions of an on-water response to an oil spill at sea or in a river, at least some of the spilled oil may reach the shoreline or the bank. When a shoreline impact occurs, or is likely to occur, shoreline assessment is a critical component of the response programme, and provides essential information for setting objectives, priorities, constraints and end points for an effective shoreline response. The good practice guide entitled *Guide to oiled shoreline assessment (SCAT) surveys* explains how an effective shoreline assessment programme supports the planning, decision making and implementation process for a shoreline response, and how the key components of shoreline surveys are integrated into the data generation, decision making and implementation/ closure stages of a shoreline response programme.

SHORELINE CLEAN-UP

The good practice guide entitled *A guide to oiled shoreline clean-up techniques* sets out the important factors to be considered when contemplating the clean-up of an oiled shoreline, including the steps to be taken in managing shoreline clean-up operations. The document discusses the advantages and disadvantages of some of the most frequently used clean-up methods, and identifies the stages in the overall operation during which the various methods are likely to be most useful. In addition, the document examines the interaction between stranded oil and different shoreline types, and suggests some possible approaches to addressing the challenges that this interaction can present.

INLAND RESPONSES

The good practice guide entitled *Oil spills: inland response* presents an overview of inland oil spill response in aquatic environments (freshwater rivers and streams, lakes and ponds, wetlands and estuarine water bodies and their associated shores and banksides), identifying similarities to marine response and highlighting unique issues pertinent to inland spills. The document addresses the response phase of inland incidents, where actions are undertaken to ensure safety, minimize the immediate spread and threat of a spill, and deploy techniques to clean up spilled oil in aquatic environments. It does not address spills to terrestrial environments and the possible remediation actions which may be considered where oil has contaminated the underlying soil or groundwater.

WASTE MANAGEMENT

The response to an oil spill often results in the rapid generation and accumulation of large quantities of oily waste. Emulsified oil and oiled sand, gravel, ice and entrained debris, as well as oiled personal protective equipment (PPE) and consumables, can increase the volume of waste to many times the volume of the oil originally spilt. This waste often exceeds the capacity of the locally available waste management infrastructure which can slow or temporarily discontinue oil recovery and clean-up operations. As a result, the management of response-related wastes can become the most time-demanding and costly aspect of an oil spill. The good practice guide entitled *Oil spill waste minimization and management* sets out the principles for identifying and managing the various waste streams listed above and from a variety of sources (offshore and onshore spills, and upstream and downstream operations from oil exploration and production, processing, refining, transport and storage activities).

OILED WILDLIFE

The good practice guide on *Wildlife response preparedness* provides an overview of the key concepts and practices in oiled wildlife response preparedness, and explains how a higher level of integrated preparedness can be achieved. This document provides guidance for managing the capture, triage, cleaning, rehabilitation and release of oiled wildlife. A technical support document entitled *Key principles for the protection, care and rehabilitation of oiled wildlife* has been developed as a reference to illustrate what should be considered as international 'standards of practice' for animal protection and care during an oiled wildlife response.


USCG


OWCN, UC Davis

ARCTIC CONDITIONS

While there may be particular features of a response in Arctic climatic conditions and associated remote locations, these do not alter the underlying key elements of effective preparedness. The choice of optimal oil spill response options in the Arctic can vary greatly depending on many factors, for example the location, timing, ice conditions, ice season duration, environmental sensitivities and oil properties. While ice is a prominent feature of many Arctic areas, it should be noted that large parts of the Norwegian Arctic, including almost all of the area opened for petroleum activities, remain ice-free all year round. In these areas, a conventional oil spill response is applicable—potentially in combination with other specialized Arctic oil spill response systems.

To ensure that the key elements of a response can be properly addressed in Arctic conditions, significant effort has been put into researching and refining response techniques and their implementation in cold seas and ice cover. The Arctic Oil Spill Response Technology Joint Industry Programme (JIP) ran from 2012 to 2017 and undertook research projects to further improve Arctic spill response capabilities (www.arcticresponsetechnology.org).

NOAA

The key outcomes of this JIP were:

- State-of-knowledge reports on key oil-in-ice response topics such as remote sensing, dispersants, ISB and environmental effects, synthesizing critical information gained over more than 40 years.
- An environmental effects database and literature navigator to facilitate the use of NEBA/SIMA.
- Better-defined windows of opportunity and new data on expected response effectiveness for strategies involving dispersants, herders and ISB, helping to improve contingency planning and enable more realistic training and exercises to maintain and develop responder skills.
- Results of the dispersant research show the relative benefits of subsea dispersant injection (SSDI) in a range of water depths and wind speeds.
- More effective remote sensing supported by trajectory modelling to help responders better detect, track and map the extent and movements of the oiled area.
- A practical field operations guide to remote sensing of oil in ice to help responders identify the most effective mix of sensors and platforms to suit an Arctic spill scenario.
- New response tools such as aerial herder/burn systems enable rapid response to remote spill locations without being dependent on marine support.

The JIP results can inform decision-making and the public concerning many important topics involved in any discussion of an Arctic oil spill response. This transfer of information is supported by the free availability of reports and online access to all the material produced by the JIP, including state-of-the-art technology reviews, technical reports, peer-reviewed papers, videos and graphics.

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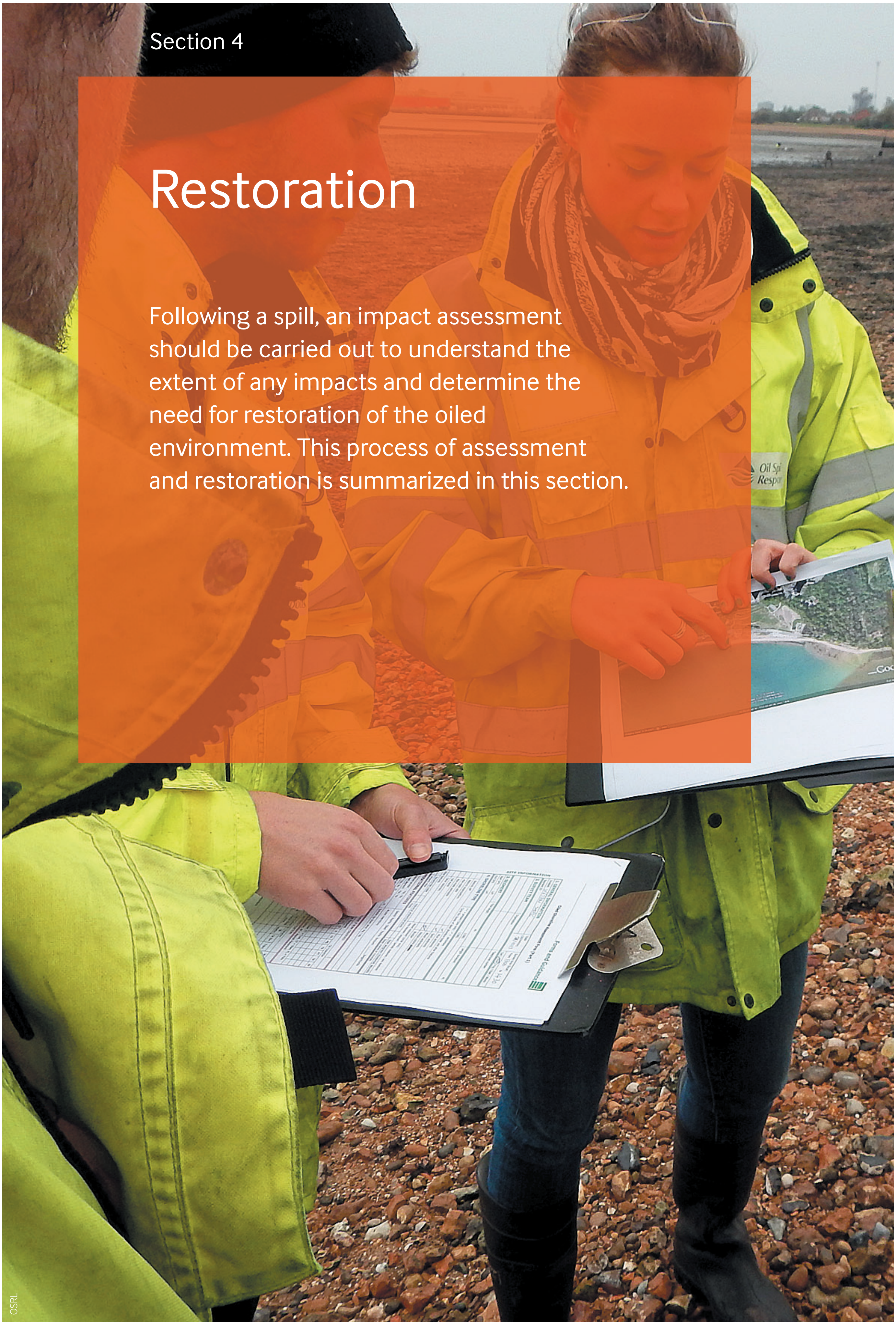
Section 4

Restoration

Following a spill, an impact assessment should be carried out to understand the extent of any impacts and determine the need for restoration of the oiled environment. This process of assessment and restoration is summarized in this section.

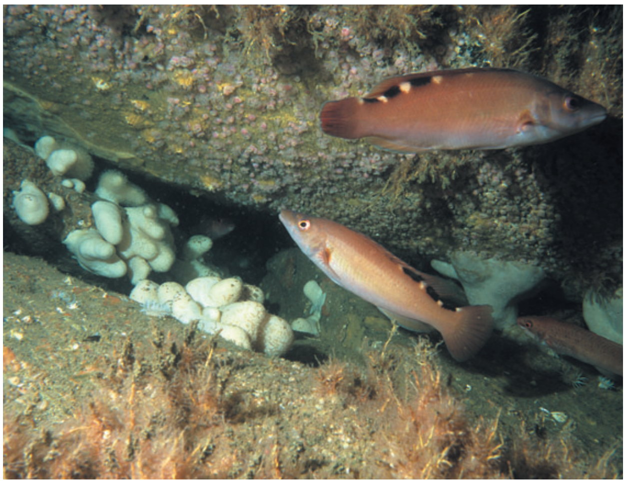


OSRL

Restoration

While distinct and separate from the preparedness and response processes, and inevitably taking place over longer timescales, impact assessment and restoration play key roles following a spill. In many cases, an impact assessment should be initiated immediately following discovery of a spill to collect ephemeral data, and will often continue well after the emergency response phase is complete. Components of assessment and restoration may include:

- Environmental impacts: oil spill impacts on marine ecology and on shorelines can be significant, particularly in the early stages of a spill. It is therefore important to understand what the potential impacts are, so that adequate pre-planning can be conducted to quickly initiate an impact assessment programme.
- Remediation: the remediation of oil spills typically involves the removal or treatment of residual oil on shorelines or terrestrial areas after the emergency response phase has been completed and transitions to the project phase. Typically, remediation is only required if there are ongoing environmental impacts from the residual oil.
- Environmental restoration: the goal of environmental restoration is to restore the environment to pre-spill conditions through natural recovery or restoration activities such as marsh vegetation planting, sediment replacement, habitat enhancement, etc.
- Community restoration: compensation of financial impacts is one form of community restoration, along with advertising campaigns to promote local businesses, tourism and recreation, and enhanced access to recreational shorelines.


Jon Moore

MARINE ENVIRONMENTAL IMPACTS

The good practice guide entitled *Impacts of oil spills on marine ecology* provides an overview of how oil spills can impact marine ecological resources and functions, and how quickly those resources and functions can take to recover. It describes the properties of mineral oils and physical processes that spilled oils go through that are relevant to marine ecological impacts, provides a general description of the mechanisms and factors that typically affect the impacts of oil spills on marine resources and their rates of recovery, and describes some of the more common impacts that oil spills have had on different ecosystems, with reference to particular case studies. The document summarizes current good practice in spill response and how it is designed to minimize spill impacts.

Owens Coastal Consultants

Jenifer Baker

SHORELINE ENVIRONMENTAL IMPACTS

The good practice guide entitled *Impacts of oil spills on shorelines* provides an overview of how oil spills can impact marine and estuarine shorelines and how quickly they can recover. The document describes the fate of oil on different shorelines and the characteristics that are relevant to impacts and recovery, together with the ecological impacts of oil on shorelines. It outlines current best practice in shoreline clean-up, and summarizes some of the fundamental approaches and requirements of impact assessment.

ECONOMIC ASSESSMENT AND COMPENSATION

Despite the best efforts of those involved in a response, a release of oil has the potential to affect property and impair commercial activity, resulting in economic loss. The good practice guide entitled *Economic assessment and compensation for marine oil releases* considers the effects of oil on the fisheries and tourism sectors, as well as on other commercial activities and local communities who may be dependent on subsistence or artisanal economies, and identifies the sources of money that may be available to compensate for such damages. The legislation and compensation schemes that enable payments are explained, and the methods by which the various types of economic damage can be quantified and calculated under the schemes and the procedures necessary for submitting claims for losses are outlined, including claims for the costs of a response, as well as for property damage and for economic loss.

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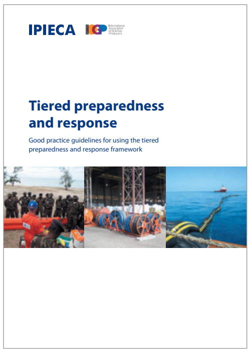
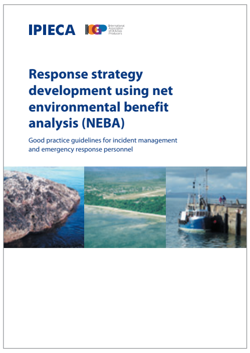
Appendix

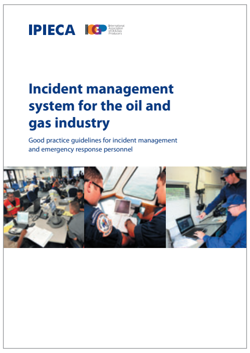
Good practice guides and key Joint Industry Project (JIP) technical reports

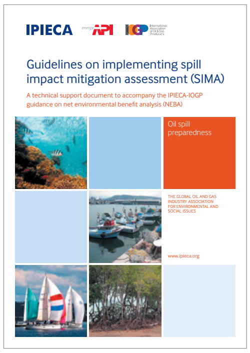
Appendix: Good practice guides and key Joint Industry Project (JIP) technical reports

STRATEGY

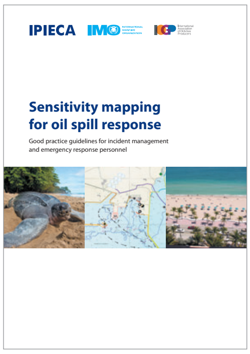


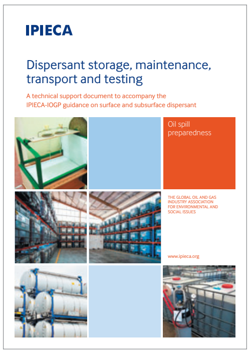


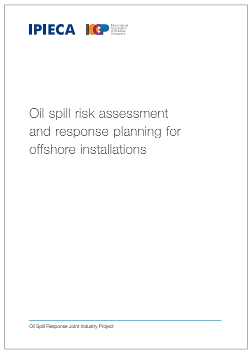


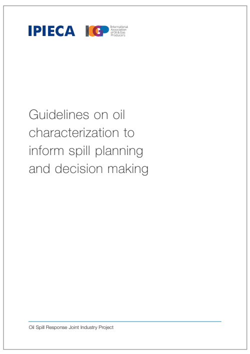


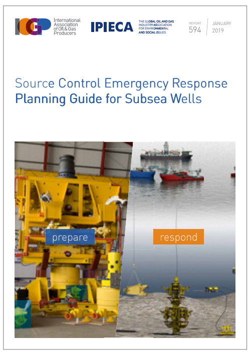
PLANNING



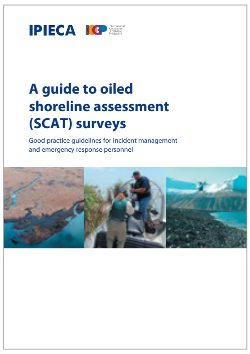


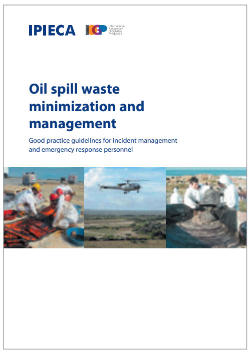






RESPONSE


IPIECA IOGP
A guide to oiled shoreline assessment (SCAT) surveys
Good practice guidelines for incident management and emergency response personnel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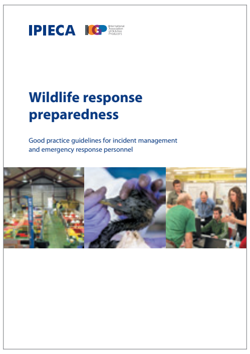
Oil spill waste minimization and management
Good practice guidelines for incident management and emergency response personnel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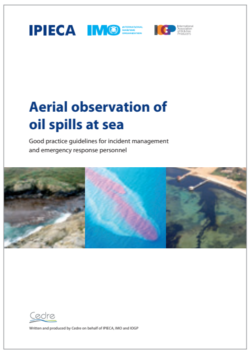
Wildlife response preparedness
Good practice guidelines for incident management and emergency response personnel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Aerial observation of oil spills at sea
Good practice guidelines for incident management and emergency response personnel
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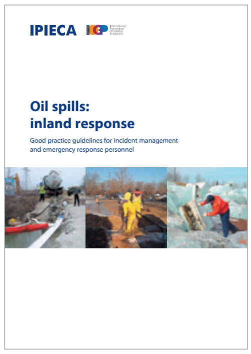
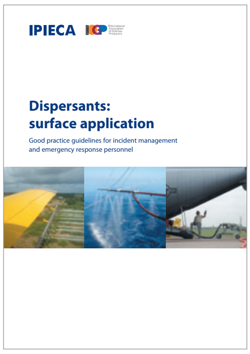
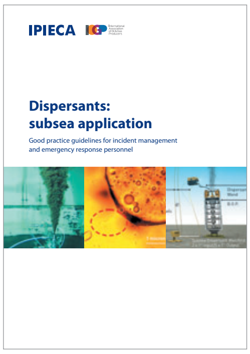

IPIECA IOGP
Oil spills: inland response
Good practice guidelines for incident management and emergency response personnel


IPIECA IOGP
Dispersants: surface application
Good practice guidelines for incident management and emergency response personnel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Dispersants: subsea application
Good practice guidelines for incident management and emergency response personnel


IPIECA IOGP
A guide to oiled shoreline clean-up techniques
Good practice guidelines for incident management and emergency response personnel


IPIECA IOGP
At-sea containment and recovery
Good practice guidelines for incident management and emergency response personnel


IPIECA IOGP
Controlled in-situ burning of spilled oil
Good practice guidelines for incident management and emergency response personnel

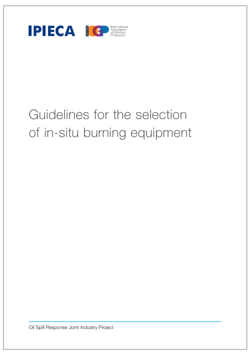

IPIECA IOGP
Satellite remote sensing of oil spills at sea
Good practice guidelines for the application of satellite remote sensing during oil spill response operations


IPIECA IOGP
In-water surveillance of oil spills at sea
Good practice guidelines for incident management and emergency response personnel


IPIECA IOGP
Key principles for the protection, care and rehabilitation of oiled wildlife
A technical support document to accompany the IPIECA-IOGP guidance on wildlife response preparedness
Oil spill preparedness


IPIECA IOGP
Dispersant logistics and supply planning
Oil Spill Response Joint Industry Project


IPIECA IOGP
At-sea monitoring of surface dispersant effectiveness
Oil Spill Response Joint Industry Project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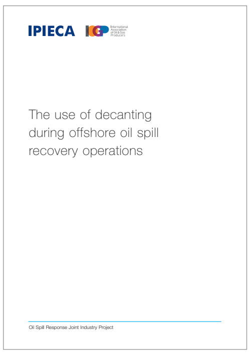
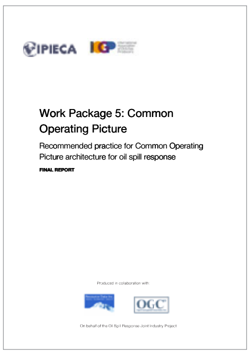
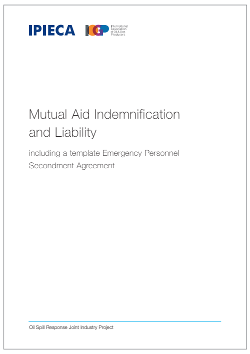
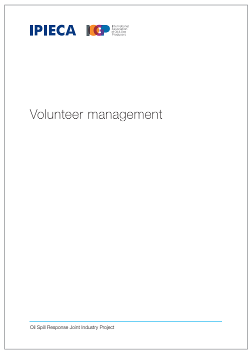
Guidelines for the selection of in-situ burning equipment
Oil Spill Response Joint Industry Project


IPIECA IOGP
The use of decanting during offshore oil spill recovery operations
Oil Spill Response Joint Industry Project


IPIECA IOGP
Work Package 5: Common Operating Picture
Recommended practice for Common Operating Picture architecture for oil spill response
FINAL REPORT
OGC

PEOPLE





IMPACTS

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ipieca

IPIECA is the global oil and gas industry association for advancing environmental and social performance. It develops, shares and promotes good practice and knowledge through industry collaboration. IPIECA convenes a large portion of the global oil and gas industry across the value chain and is the industry's principal channel of communication with the United Nations.

Through its member-led groups and executive leadership, IPIECA brings together the collective expertise of oil and gas companies and associations. Its unique position within the industry enables its members to contribute effectively to the sustainable development agenda.

IOGP International Association of Oil & Gas Producers

IOGP represents the upstream oil and gas industry before international organizations including the International Maritime Organization, the United Nations Environment Programme (UNEP) Regional Seas Conventions and other groups under the UN umbrella. At the regional level, IOGP is the industry representative to the European Commission and Parliament and the OSPAR Commission for the North East Atlantic. Equally important is IOGP's role in promulgating best practices, particularly in the areas of health, safety, the environment and social responsibility.

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