PERSGA

Regional Organization for the Conservation of Environment of the Red Sea and Gulf of Aden

OIL SPILL RESPONSE GUIDELINES

October 2024

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Contents

(1) Introduction 8
(2) Tiered Response 8
(3) Spill Response Techniques 10
(4) Weathering 11
(5) Modelling 13
(6) Resources at Risk 13
(7) Spill Response Strategies 14
(8) Spill Impact Mitigation Assessment (SIMA) 18
(9) Spill Response Options 20
(9-1)Surveillance (FC 5 - Monitor Guidelines) 20
(9-2) Trajectory Modelling 21
(9-3) Monitor Natural Attenuation 21
(9-4) Assisted Natural Attenuation 22
(9-5) 9.5 Dispersant Application 23
(9-6) Mechanical Recovery 26
(9-7) In-situ Burning 35
(9-8) Sensitive Area Protection 37
(9-9) Shoreline Clean-up 39

Shaps

(Figure1) : Weathering Process Acting on Oil at Sea 12
(Figure2) : Behaviour of Spilled Chemicals 12
(Figure3) : PERSGA Region Sensitive Resources - UNEP..... 14
(Figure4) : Decision Flowchart for Appropriate Response..... 15
(Figure5) : Benefits & Drawbacks of Various Spill Response 17
(Figure6) : The SIMA Process 20
(Figure7) : Dispersant Effectiveness Test Process..... 25
(Figure8) : "U" Formation 32
(Figure9) : "J" Formation..... 32
(Figure10) : "V" Formation..... 32
(Figure11) : Single-ship side sweep 33
(Figure12) : Boom Formation: Exclusion Booming (L), ... 38
(Figure13) : Phases of Shoreline Cleanup Operations..... 40

Tables

(Table1) : Geographical Reach of Each Tier Capability..... 8
(Table2) : Roles and Responsibilities of Potential Key Players in case of an Oil Spill 10
(Table3) : Oleophilic Skimmer Summary 27
(Table4) : Non-Oleophilic Skimmer Summary 27
(Table5) : Potential Hazards for Oil Spill Responders 52
(Table6) : PPE Requirements for Specific Cleanup Techniques53

(1) Introduction

These guidance notes offer a summary of the spill response options.

Further reading is encouraged to gain a more in-depth knowledge of the subject. There are many useful documents that can be studied. A selection of useful reference works can be found at:

- International Maritime Organisation (www.imo.org)
- ITOPF Technical Information Papers (www.itopf.org/knowledge-resources/documents-guides/technical-information-papers/)
- IPIECA (www.ipieca.org/our-work/oil-spill-preparedness-and-response/oil-spill-response-resources/)
- CEDRE Clean-up Activities (www.cedre.fr/en/Resources/Practical-datasheets/Cleanup-activities)
- OSRL Technical Library (www.oilspillresponse.com/technical-library/)

PERSGA maintain a large electronic library of useful reference material.

Personnel with designated responsibilities for spill preparedness and response should undergo specific training, both theoretical and practical, in their roles.

(2) Tiered Response

Oil spill response preparedness is classified into the three levels, or 'tiers', representing the oil spill response capability (e.g., response personnel, equipment and additional support). The tiered approach is cumulative so that the elements of a Tier 1 response are supplemented by higher tier capability and not superseded or replaced by it.

Capability	Geographical Reach
Tier 1	Local
Tier 2	Regional or National
Tier 3	International

(Table1) : Geographical Reach of Each Tier Capability

In this context, multiple agencies and organizations can be involved in the management and response to a marine spill incident. Table 2 provides a summary of the roles and responsibilities for key player during a spill in the context of the PERSGA RSCP.

	Key Players	Roles and Responsibilities
National Level - Operational Authority	National Response Commander	Receive the oil pollution report and oil visual observation report. Share and disseminate the POLREP, SITREPS reports and the Oil visual observations reports to the member of national committee in his country and sending a copy to the EMARSGA. Overall responsibility for the coordination and implementation of onsite response operations, based on the incident management plans Responsible for preparing and documenting incident management plans, tracking resources assigned to the incident, maintaining incident documentation, and developing plans for the operational periods and demobilization Submit incident reports regularly to the members of national committee and a copy to the EMARSGA. Prepare an incident action plan (IAP) which provides details on the response, shores rehabilitation and protection actions Overall supervision of the full and effective implementation of the IAP within his country and coordinating efforts and communication between the parties involved in the response process.
	Sovereign Ministries and Government Agencies	Facilitating the transfer of experts, equipment and materials to/from the site of the spill/ incident and affected sites. Supervising and facilitating trans-boundary and cross borders movement/transfer of equipments and experts to/from the spill/incident and affected sites if needed, including immigration and customs procedures. Supervising and facilitating the issuance of flight permits and permits for the movement of marine vessels, if needed for the response process. Facilitate the communication process between the parties involved in the response process. Providing insurance cover the teams participating in the response process and ensuring the safety of personnel, equipment and materials. The armed forces, border guards and civil defense sectors can contribute voluntarily depending on the circumstances to support response teams by providing several workers, means of transportation - four-wheel drive cars or speedboats - or means of communication if needed. Monitor the impact of pollution and supervise all response efforts within its national borders (land and sea) Regular communication with relevant regional and international organizations and neighboring countries to coordinate response efforts Issuing the necessary instructions regarding any modifications to the navigation lines for ships transiting in the region Full supervision and coordination of consultations regarding all public health threats to the population, reaching the beach or banning fishing in certain areas Supervising and assisting in assessment and cleanup of the contaminated sites Supervising the management of oily waste and ensuring the proper disposal of the wastes Allocating dedicated sites for the deployment of response equipment and the establishment of technical personnel Issuing of the necessary permits and authorizations for the entry/exit and movement of personnel, equipment and materials, and the movement of aircraft and marine supply vessels Providing logistical support (accommodations, means of subsistence and accommodation, and facilitating access to supplies for response teams)
	Private Sector Involved	Supporting the teams participating in the implementation of the response plan by providing the means of communication and the available equipment which can help contain the incident and reduce its impacts Providing logistical support to the participating teams by providing and equipping the means of subsistence and accommodation

	Key Players	Roles and Responsibilities
Regional Level	PERSGA/ EMARSGA	Promptly circulate the oil spill to PERSGA, the national coordinators in the member states of the authority, and to the concerned international organizations and bodies such as the International Maritime Organization (IMO) and the United Nations Environment Program (UNEP). Make efforts to obtain more information about the accident, including identifying (the threatened area, the level of pollution, the type of accident), circulating this to the national coordinators in the member states, and following up on developments continuously. Run the oil spill trajectory model to predict the course and fate of the spill in the marine environment in a timely and continuous manner and circulate the results to the national response coordinators. Forming a crisis unit that works around the clock from PERSGA staff that continuously liaises with response officers at the regional level to provide support and technical advice and to keep them informed on an ongoing basis on the results of reports received from other countries or international organizations. Overall coordination of the regional and international response to the spill, to manage, co-ordinate and facilitate requests and offers of assistance from regional and international entities.
International Level	Neighboring Countries and relevant international agencies	If requested, provide additional resource to the response Carry out a response if the countries' waters or coastlines are affected as described in the national level.

(Table2) : Roles and Responsibilities of Potential Key Players in case of an Oil Spill

(3) Spill Response Techniques

The aims of any oil spill response are to minimise damage to environmental and socioeconomic resources, and to reduce the time for recovery of affected resources by achieving an acceptable standard of cleanliness. Once a pollutant has been spilled, urgent decisions need to be made about the options available for clean-up, so that environmental and socioeconomic impacts are kept to the minimum.

Getting the correct balance can be a difficult process, and conflicts inevitably arise which need to be resolved in the best practicable manner. The advantages and disadvantages of different responses need to be

considered and compared both with each other and with the advantages and disadvantages of natural clean-up, a process sometimes known as Spill Impact Mitigation Assessment or SIMA. This is considered further below in Section 8.

Regardless of the Tier into which a particular incident falls, the same response strategies would be equally applicable for similar types of incidents. Therefore, there is no requirement to identify the specific response strategies based on a specific Tier. For example, the basic strategy for booming and recovery in offshore environments for 3 tonnes or 3000 tonnes of oil is exactly the same; contain with a boom and recover with a skimmer.

The most important aspect of an escalating incident relates to the complexity of the response requirements. A Tier 1 spill is generally a straightforward incident that usually only requires a maximum two or three response strategies. A Tier 2/Tier 3 spill will likely require a broad variety of strategies at different stages of the response, or possibly simultaneously for an ongoing release.

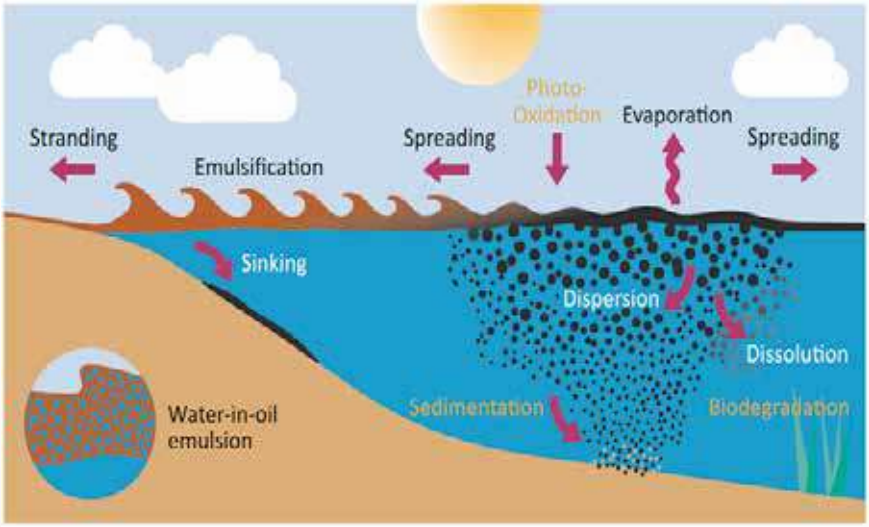
Spill response techniques would be selected, based on SIMA and the prevailing conditions, to enable successful implementation of the strategy. The equipment used to implement the response strategy may therefore differ (e.g., dispersant vs heavy duty offshore boom) and this would be identified at the time of the incident taking into account incident specific circumstances and conditions (e.g., weather, wind direction, sea state).

The National On-Scene Commander (NOSC), in consultation with others as required (e.g., Incident Command Team members), will identify the appropriate response strategies required for combating the release as soon as practicable using the available information (i.e., trajectory modelling for the specific incident, location of sensitive receptors etc). This will form the basis for the implementation of an Incident Action Plan (IAP) for combating the release. Once an IAP is implemented, the NOSC shall review the efficacy of the response strategies regularly and adjust the adopted methods as required to suit the evolving circumstances.

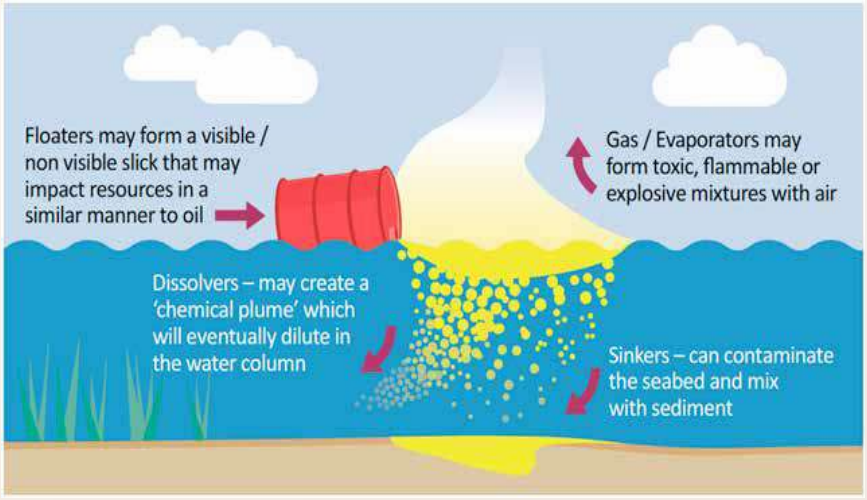
(4) Weathering

When oil or chemicals are spilled at sea, they undergo a number of

chemical and physical changes. These processes are called “weathering”. Figure 1 shows the weathering process acting on oil at sea whilst Figure 2 shows the behaviour of chemicals at sea.



(Figure1) : Weathering Process Acting on Oil at Sea



(Figure2) : Behaviour of Spilled Chemicals

(5) Modelling

Oil spill trajectory modelling provides information on potential movement of oil slicks. This information supports the decision-making process for identifying general resources at risk and mobilization of response resources. Computerised oil trajectory modelling provides oil movement predictions (2D and 3D) as well as detailed information about oil weathering such as evaporation, emulsification and natural dispersion.

Oil spill surveillance, whether through aircraft or remote sensing (e.g. satellites), collects images of the spill to visually assess the oil thickness, to estimate the oil weathering and to determine the extent and appearance of oil slicks. It also provides a validation of information obtained from oil spill modelling.

Assistance with trajectory modelling and spill surveillance can be requested from EMARSGA

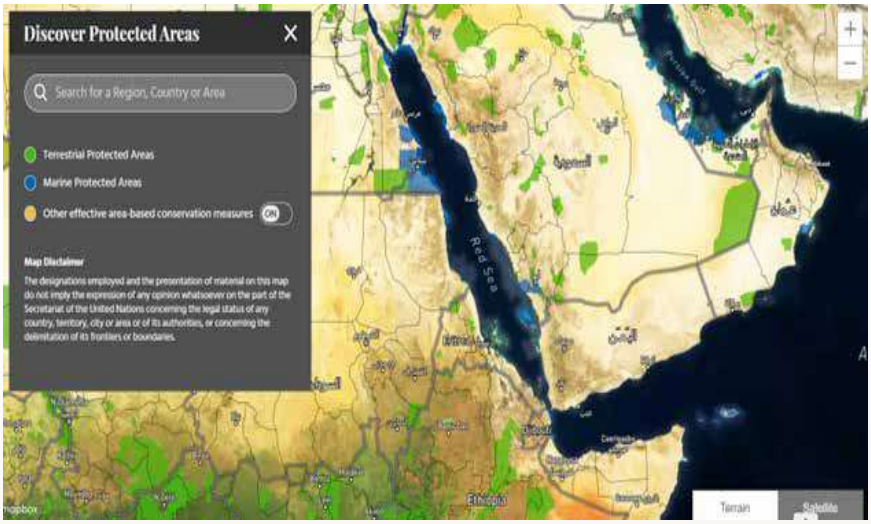
Phone: (+ 2) 065 3544159 | Fax: (+2) 065 3544174 | E-mail: emarsga@persga.org

Complete and submit Spill Trajectory Modelling Request Form (PERSGA RF 2) to EMARSGA

(6) Resources at Risk

The National Contingency Plan of each PERSGA member States should include the identification of the sensitive local resources that may be at risk form an oil spill. Sensitive resources should be identified in collaboration with various stakeholders include economic, environmental and cultural areas of importance.

The World Database on Protected Areas administered by the UNEP World Conservation Monitoring Centre holds a vast amount of information on protected areas (www.protectedplanet.net). An interactive map can be found to identify marine protected areas and terrestrial protected areas in the PERSGA Region as shown below.



(Figure3) : PERSGA Region Sensitive Resources - UNEP

(7) Spill Response Strategies

The overall response objective is to minimise the oil spill impacts on the communities, the environmental and socio-economic activities such as fishing. All response decisions, especially the selection of response strategies, should be guided by the principles of the Net Environmental Benefits Analysis (NEBA) methodology. The protection priorities for the response will likely be as follows:

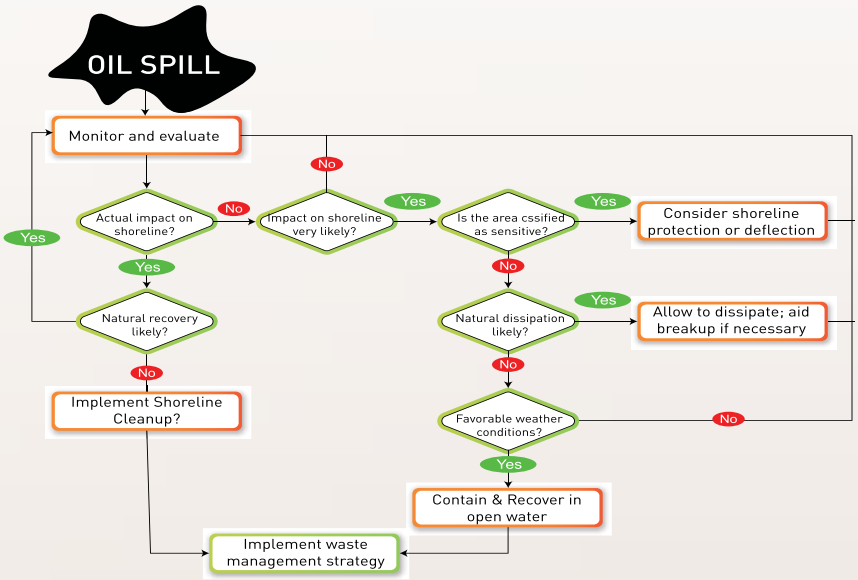
- People and communities – people and communities living at or near the coast that can be severely impacted by oil
- Environmentally sensitive areas and wildlife – areas that are important local ecological sites, protected under local and/or national laws and those that support endangered endemic or internationally protected species
- Assets and infrastructure – assets and infrastructure at or near the shoreline such as power station intakes, ports, and the like.

It will be critical early in the response to identify cleanup endpoints for at sea response and for shoreline cleanup. The determination of endpoints is to provide clear instructions to responders on when to stop oil recovery operations. Generally, it takes into consideration multiple factors such as

the safety of responders, the sensitivity of the environment or operational factors. Endpoint criteria should aim at promoting natural attenuation and avoid causing additional damages.

It is also important that endpoint criteria be agreed and understood by all parties involved in the response. A detailed guidance on endpoint determination can be found at https://www.ipieca.org/resources/good-practice/a-guide-to-oiled-shoreline-clean-up-techniques/.

Responders will have to determine applicable response strategies based on the specific situation at the time of a spill. The identification of response strategies must be based on the NEBA principles, current available resources and consider logistical constraints. A decision flowchart (figure 4) can help in this process.



(Figure4) : Decision Flowchart for Appropriate Response Strategies

Response Strategies	Benefits	Drawbacks and Limitations
At-sea containment and recovery	• 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	• 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
Controlled in-situ burning	• 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	• 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

Response Strategies	Benefits	Drawbacks and Limitations
Surface dispersant application	• 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 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	• May not work on high viscosity fuel oils in calm, cold seas • May have a limited 'window of opportunity' for use as oil weathers • 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 (shortlived 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
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

(Figure5) : Benefits and Drawbacks of Various Spill Response Techniques

The original version of this table can be found at https://www.ipieca.org/resources/good-practice/oil-spill-preparedness-and-response-an-introduction-2019/

The following sections provide an overview of the main response strategies that could be employed during an oil spill incident in coastal and marine environment and their associated operational limitations. It is important to remember that irrespective of the response strategies selected, a waste management program must be implemented.

(8) Spill Impact Mitigation Assessment (SIMA)

SIMA is a fundamental principle underpinning oil spill response preparedness and response. Originally known as NEBA (Net Environmental Benefit Analysis (NEBA), SIMA has been further developed to expand on the principles of NEBA and now include:

- In terms of the process, follow a four-step action process which can be applied before, during and after a spill
- Focus on impact mitigation rather than "environmental benefit"
- Embraces a wider interpretation of "environment" that includes other resources such as socio-economic and culturally significant receptors
- More correctly describes a value-based "assessment" which draws upon sound science and experience, rather than a quantifiable or statistical output which the term "analysis" may imply.

The SIMA process is described below and then summarised in Figure 4.

SIMA Step 1: Evaluate Data

- Undertake oil fate and trajectory modelling for the pollutant and current conditions
- Determine resources (ecological, socio-environmental & cultural) at risk

SIMA Step 2: Predict Outcomes

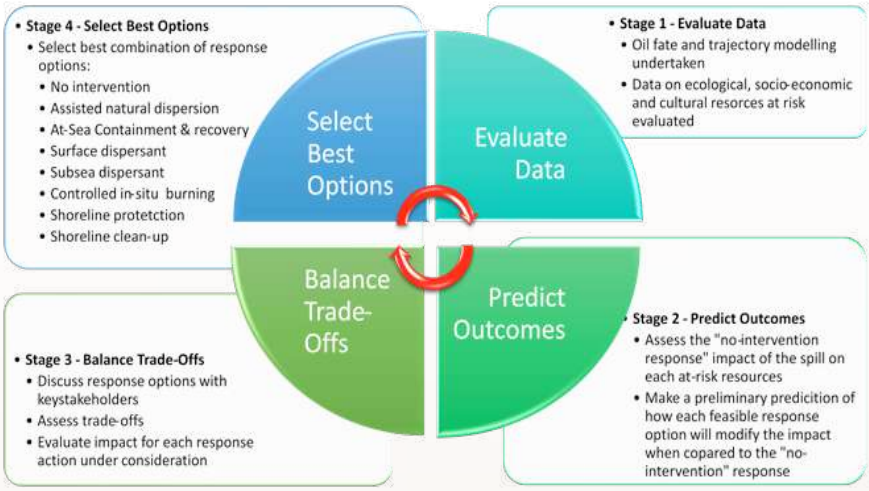
- Assess the impact of a “no intervention” response on each of the resources at risk
- Make a preliminary prediction of how each feasible response will modify the impact on the resources at risk, compared to the “no intervention” response

SIMA Step 3: Balance Trade-Offs

- Discuss response options with key stakeholders
- Assess trade-offs for each feasible response option being considered
- Evaluate impact for each response action under consideration

SIMA Step 4: Select Best Options

- Select best combination of response options to create an appropriate response strategy
- Consider complete response toolkit:
  - o No intervention
  - o Assisted natural dispersion
  - o At-sea containment & recovery
  - o Surface dispersant
  - o Subsea dispersant
  - o Controlled in-site burning
  - o Shoreline protection
  - o Shoreline clean-up



(Figure6) : The SIMA Process

(9) Spill Response Options

When considering the initial spill response options see Flow Chart 1 (FC 1) Spill Response Guidelines and the directions to other guidelines contained there.

In particular, Flow Chart 11 contains guidance on the selection of spill response tactics whilst Flow Chart 12 provides guidance on spill response options.

(9-1) Surveillance (FC 5 - Monitor Guidelines)

Surveillance of the spill location provides an initial assessment of the area affected and the direction or trajectory of the pollutant's movement. This enables the Incident Command Team (ICT) to determine the resources at risk, potential beaching locations and time, potential crossing into and affecting neighbouring country's waters.

Initial assessments and reports can come from those on-scene whilst specialised assets may be tasked to carry out aerial, surface or shoreline assessment. There are a number of Flow Charts and Response Forms that can assist in this process:

- Flow Charts
  - o Monitor Guidelines - FC 5
- Response Forms
  - o Vessel POLREP - RF 1
  - o Surveillance Tasking Form - RF 7
  - o Aerial Surveillance Form - RF 8
  - o Vessel Surveillance Form - RF 9
  - o Shoreline Surveillance Form - RF 10

(9-2) Trajectory Modelling

Using the data from the initial report (Vessel POLREP (RF 1) and the environmental data contained within the Incident Report Form (RF 2) an estimation can be made of the trajectory of the pollutant.

The rate and direction of the pollutant's trajectory will be governed by the physical properties of the pollutant, the volume and rate of loss and the environmental conditions (wind, tide/current/wind-driven current). Guidance Note 3 (Spill Assessment) provides further explanation and guidance.

Computer modelling may assist the ICT when the spill is offshore but models are less accurate and effective in near-shore locations.

The Planning Section of the ICT can access to computer models via EMARSGA. EMARSGA can provide both oil and chemical spill modelling. Requests for modelling can be initiated by submitting a Spill Trajectory Modelling Request Form (PERSGA RF 2) to EMARSGA.

Forecasted trajectories can be verified through surveillance.

(9-3) Monitor Natural Attenuation

Natural attenuation can be described as "a variety of physical, chemical, or biological processes that, under favourable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of spilled pollutants". In other words, the natural decay of the spilled product.

The speed of natural attenuation is dictated by the physical properties of the pollutant, the volume of the pollutant spilled and the environmental conditions. A small quantity of a light refined product, such as gasoline, will decay quickly in hot, breezy weather with a moderate or rough sea whereas a heavy concentration of heavy fuel oil in cold, calm conditions will persist.

Very often, if the circumstances allow, natural attenuation is the most practical response option. It should be considered if:

- A limited quantity of the pollutant has been lost;
- The pollutant's properties allow natural attenuation to occur quickly ;
- No sensitive resources are threatened by the movement of the pollutant whilst undergoing natural attenuation;
- The environmental conditions are assisting or accelerating natural attenuation; or
- If the environmental conditions preclude responding safely, such as at-sea recovery.

In all cases, monitoring of the natural attenuation must be carried out, forecasting should be undertaken and the anticipated trajectory of the pollutant modelled. Any modelling needs to be verified by surveillance. Once the pollutant is no longer a threat then surveillance and monitoring may be discontinued.

(9-4) Assisted Natural Attenuation

The natural attenuation process may be assisted or accelerated by the introduction of external energy. This could include the agitation of the slick by propellor or thruster wash or the use of fire horses or monitors on the affected area.

The external energy should be concentrated, initially, on the leading edge of the polluted area or where the slick is thickest.

In all cases, monitoring of the assisted natural attenuation must be carried out. Once the pollutant is no longer a threat then surveillance and monitoring may be discontinued.

(9-5) 9.5 Dispersant Application

Chemical dispersants, typically a surfactant carried in a solvent, can assist in spill response operations. However, the use of chemical dispersants is highly regulated and, even if allowed, are often used in controlled quantities and within a restricted area.

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.

Typically, the use of dispersants will only be considered if:

- There is a demonstrable benefit to the use of dispersants over other response options.
    - o Spill Impact Mitigation Assessment process
- The dispersant type is approved by the authorities.
- The dispersant to be used has been tested and remains effective and approved.
- The planned usage location is more than one nautical mile from 20m depth (i.e., not in shallow water)
- The oil is amendable to the dispersant.
    - o See Dispersant Effectiveness test below in Section 9.5.1
- If permission is given this mate include:

o Maximum quantities to be used daily.

o A restriction on areas to be sprayed.

o The requirement to monitor and sample the operations.

- The requirement to record dispersant usage, quantities, times and location (RF 13).

The use of dispersant under controlled conditions may prevent large quantities of oil impacting on sensitive areas with consequent risk of damage from the oi, emulsified oil or response methods.

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9-5-1 : Dispersant Effectiveness Test

The effectiveness of the dispersant on the spilt product can be quickly tested. It is recommended that a test is carried out prior to mobilising dispersant spraying resources.

The equipment required to carry out the test is as follows:

- 2 x clear glass containers with lids
- Sample of dispersant
- Sample of sea water
- Sample of spilt pollutant

The test process is as follows:

1. A container is ¾ filled with sea water. This will act as the control container.
2. 20 drops of the spilt product are added to the container contents.

3. Shake the container vigorously, at least 10 times.
4. Place control container down and observe.
5. Time how long it takes for the oil and water to separate.
6. Take the second container and ¾ fill with sea water. This will act as the test container.
7. Add 20 drops of the spilt pollutant to the container contents.
8. Add 1 drop of the dispersant. It is important not to overdose the test container. Use a 20:1 ratio Oil: Dispersant.
9. Shake the test container vigorously, at least 10 times.
10. Place test container down and observe.
11. If the oil is suspended within the water column and does not separate and return to the surface then the dispersant can be considered effective.

The test procedure is shown in Figure 5.



(Figure7) : Dispersant Effectiveness Test Process

Any dispersant application should be closely monitored and controlled. This may mean the use of helicopters or other aerial assets to guide spray vessels, aircraft and helicopters into the optimal response locations. The spraying of dispersant onto non-affected areas must be avoided.

Pollutants that are initially amendable to dispersants mat not remain amenable over time. Some pollutants disperse easily, some will be more resistant, some will not be amenable under any circumstances. Dispersants have been found to be most successful on low to medium viscosity oils (generally < 5,000 CSt). This means that as the oil “weathers” and the viscosity increases, then the effectiveness of the dispersant option becomes limited. This results in a window of opportunity when considering any dispersant spraying operations. The rate of “weathering” is determined by the oil type, source of release and the environmental conditions.

(9-6) Mechanical Recovery

The primary technique adopted by many government authorities is the mechanical recovery of oil from the sea surface. This is usually achieved by use of booms to concentrate spilt oil, allowing a skimmer to selectively recover and pump the oil to storage. Many different types of skimmer exist with designs optimised to deal with different scales of operation, oil types and environmental conditions.

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 interrelated problems 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.

A number of factors should be considered when selecting skimmers, the most important of which are the viscosity and adhesive properties of the spilt oil (including any change in these properties due to 'weathering' over time), together with the sea state and levels of debris.

In relatively predictable situations, such as at fixed facilities, for example, marine terminals and refineries, the type of oil handled may be known and a specific skimmer can be selected. Conversely, a versatile skimmer, that may be required to address a variety of situations and oils. However, no single skimmer can cope with every situation that may be encountered as a result of an oil spill and a selection of skimmers may be required, particularly as the oil weathers .

9-6-1 : 9.6.1 Skimmer Selection

The selection of skimmers may be limited by those immediately available. In Tier 3 response operations a number of different types of skimmers may be provided to the response operations so it useful to

have a knowledge of all types of skimmers, not only those routinely available in-country.

0The recovery element of a skimmer diverts or skims the oil from the sea surface, where it flows to the inlet side of a pumping system for transfer to storage. The mechanisms through which oil is removed from the water surface include oleophilic (oil loving) systems relying on adhesion of oil to a moving surface, suction systems, weir systems relying on gravity, and systems that physically lift the oil with mechanical scoops, belts or grabs.

0Tables 4 and 5 below show a summary of both Oleophilic and Non-Oleophilic Skimmers.

	Skimmer	Recovery rate	Oils	Sea state	Debris	Ancillaries
Oleophilic	Disc	Dependent on number and size of discs. Tests show grooved discs can be highly effective.	Most effective in medium viscosity oils.	In low waves and current can be highly selective with little entrained water. However, can be swamped in choppy waters.	Can be clogged by debris.	Separate power pack, hydraulic and discharge hoses, pump and suitable storage required.
	Rope mop	Dependent on number and velocity of ropes. Generally low throughput.	Most effective in medium oils although can be effective in heavy oil.	Very little or no entrained water. Can operate in choppy waters.	Able to tolerate significant debris, ice and other obstructions.	Small units have built in power supply and storage. Larger units require separate ancillaries.
	Drum	Dependent on number and size of drums. Tests show grooved drums are more effective.	Most effective in medium viscosity oils.	In low waves and current can be highly selective with little entrained water. However, can be swamped in choppy waters.	Can be clogged by debris.	Separate power pack, hydraulic and discharge hoses, pump and suitable storage required.
	Brush	Throughput dependent on number and velocity of brushes. Generally mid-range.	Different brush sizes for light, medium and heavy oils.	Relatively little free or entrained water collected. Some designs can operate in choppy waters, others would be swamped in waves.	Effective in small debris but can be clogged by large debris.	Separate power pack, hydraulic and discharge hoses, pump and suitable storage required.
	Belt	Low to mid-range.	Most effective in medium to heavy oils.	Can be highly selective with little entrained water. Can operate in choppy waters.	Effective in small debris but can be clogged by large debris.	Can deliver oil directly to storage at the top of the belt. Ancillaries required to discharge from a vessel to shore.

(Table3) : Oleophilic Skimmer Summary

Non-Oleophilic	Vacuum/ suction	Dependent upon vacuum pump. Generally low to mid range.	Most effective in light to medium oils.	Used in calm waters. Small waves will result in collection of excessive water. Addition of a weir more selective.	Can be clogged by debris.	Vacuum trucks and trailers are generally self-contained with necessary power supply, pump and storage.
	Weir	Dependent upon pump capacity, oil type etc. Can be significant.	Effective in light to heavy oils. Very heavy oils may not flow to the weir.	Can be highly selective in calm water with little entrained oil. Can be easily swamped with increase in entrained water.	Can be clogged by debris although some pumps can cope with small debris.	Separate power pack, hydraulic and discharge hoses, pump and storage. Some skimmers have built in pumps.
	Belt	Low to medium.	Most effective in heavy oils.	Can be highly selective with little entrained water. Can operate in choppy waters.	Effective in small debris. Clogged by large debris.	As for oleophilic belt skimmer.
	Drum	Mid range.	Effective with heavy oils.	Can be highly selective in calm water with little entrained oil. However, can be swamped in waves.	As for weir skimmer.	As for weir skimmer.

(Table4) : Non-Oleophilic Skimmer Summary

9-6-2 : Pumps, hoses and power supplies

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 specialised 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.

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 an initial benefit in that the back pressure encountered from the resistance of the oil while pumping and the power required to pump over a specified distance can be reduced. 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 be decanted subsequently. 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 minimise 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.

9-6-3 : Storage

Storage of recovered oil and oily water is often a significant limiting factor of the overall operation. For many vessels, on-board storage will be limited, especially for many vessels of opportunity and may be rapidly overwhelmed or any system where large volumes of oil are encountered. When the storage capacity is full then the recovery operations must pause until sufficient storage space is available.

An oil/water separator can be used to concentrate recovered oil and maximise the use of limited space. Simple gravity separation in settling tanks is usually adequate, whilst heating coils can be effective in speeding up the separation process. However, the ability to discharge separated water may be limited by local regulations (see 9.6.4 Government Actions below). Vessels with large internal storage capabilities, or with suitable oil/water separation facilities, are able to spend more time at sea recovering oil but, by necessity, are larger and consequently may not be sufficiently manoeuvrable in many situations encountered, particularly close to shore. The logistics of a recovery operation may be enhanced by providing dedicated storage barges or tankers to receive recovered oil at sea.

Alternatively, purpose-built floating temporary storage, for example, inflatable barges, may be employed. However, the potential for such craft to be overwhelmed in rough sea conditions when loaded should be considered. Dracones, bladders or other enclosed storage should be used with caution due to the potential difficulties with subsequent emptying and cleaning.

Ultimately, recovered oil will require discharge to shore and suitable tank or other storage units close to available jetties with appropriate offloading equipment should be identified. Where vessels are not equipped with heated storage tanks, the use of portable heating coils may facilitate subsequent flow through pipe work and hoses to shore, thereby minimising the turnaround time for vessels to return to sea and resume recovery operations.

Similarly, the local storage of oil recovered on or near the shore may be a limiting factor and transfer directly to road tankers for onward transport is often preferable. As noted, industrial or farm vacuum tankers are useful in combining many of the individual elements of the oil recovery operation. Alternatively, portable storage tanks, skips or lined pits, placed above the high-water mark, can provide intermediate solutions. For the latter, local permits may be required prior to construction. The ability to decant separated water should be included in the site plan.

9-6-4 : Government Actions

The design of vessels, their operations and the carriage of cargoes is regulated by international conventions arising the work of the International Maritime Organization (IMO) and ratified by member states.

The purpose of these regulations is to ensure the safety of vessel's crew and passengers, the safe design of vessels, the safe operation of vessels including the restriction of the types and quantitates of cargoes they may carry.

In this regard, certain classes of vessels (tankers, etc) are designed to work in explosive or flammable atmospheres that may typically be encountered during spill response operations. Administrations can allow an exemption for other vessel types to be used in spill response operations but need to be conscious of the safety aspects and to approve, before commencement of the response, the use of such vessels. This will include a survey of the intended vessel and the requirement for the vessel to have an operational response plan, to have the ability to monitor any explosive or flammable atmosphere, the ability to shut down ventilation and intakes and an understanding of potential sources of ignition.

Equally, the operational discharge of oil and oily water is strictly controlled by the MARPOL Regulations. Administrations can make an exception to these regulations and approve discharges into the sea during oil spill response combatting operations in order to minimise the damage from pollution .

9-6-5 : Recovery at sea

When planning a response, consideration should be given to the entire suite of logistic requirements necessary to support a recovery operation at sea. Surveillance aircraft are required to locate areas of thickest oil and direct recovery vessels for optimum effectiveness. Suitable vessels from which to deploy booms and skimmers need to be made available as rapidly as possible, before the oil has spread and slicks become too fragmented for recovery to be feasible.

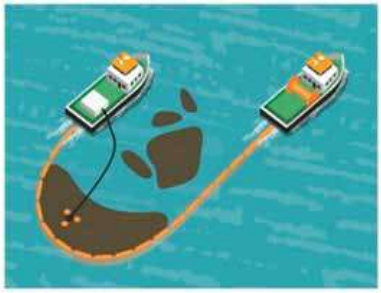
Coordination from the air calls for aircraft equipped with air-to-sea communications for direct contact with recovery vessels, allowing a rapid response to shifting conditions. Sufficient storage capacity at sea is necessary to match the anticipated rate of recovery and, as discussed above, arrangements need to be in place ashore to receive recovered oil. The difficulties of ensuring that all these components are in place quickly enough means that only very rarely is more than ten percent of spilt oil recovered at sea and much lower percentages are the norm, despite the involvement of significant numbers of response vessels in many incidents.

To concentrate floating oil at sea, booms can be towed in U, V or J configurations (Figures 6, 7 and 8) typically using two or three vessels. The recovery device is either deployed from one vessel or towed as part of the boom array .The skimmer should be kept in the maximum thickness of oil but contact between the skimmer and the boom should be avoided to protect the boom from abrasion and other mechanical damage. Wave reflection against large skimmers can interfere with the oil flow to the recovery element. Skilful handling of the equipment is called for, along with continuous adjustments as conditions change. The expertise necessary to tow booms at the slow speeds required is gained through spill experience and regular exercises. In practice, maintaining the required configuration of multi-vessel recovery systems can be problematic, primarily due

to difficulties in coordination between the vessels involved.



(Figure8) : "U" Formation



(Figure9) : "J" Formation



(Figure10) : "V" Formation

An alternative solution is to combine oil concentration, recovery and storage functions in a single-ship system using a flexible or rigid sweeping arrangement (Figure 9). Flexible systems employ a boom attached to an outrigger. However, if the swath is too wide, the set-up can become prone to damage in rough weather or large swell and manoeuvrability can be restricted, severely affecting vessel handling. In such systems, the skimmer is positioned at the apex of the boom where oil is highly concentrated and may be free floating or built into the side of a vessel with a suitable opening to allow the ingress of oil. Rigid systems comprise a solid floating barrier or sweeping arm deployed from a vessel by crane or hydraulic arms. The skimmer, usually a weir or brush depending on the oil to be recovered, is built into the arm, close to the vessel to facilitate recovery. The comparative ease of deployment and straightforward design are strong factors contributing to the success of rigid sweeping systems.



(Figure11) : Single-ship side sweep

Flexible or rigid systems can be used from specially designed vessels or from vessels of opportunity with suitable fittings. Ideally, the vessel used as a working platform should have suitable handling gear and sufficient manoeuvrability to quickly assume and maintain a selected position against winds and currents. The large open decks of Anchor Handling Tug Supply (AHTS) vessels or Platform Supply Vessels (PSV) are convenient for the storage, handling, deployment, maintenance and cleaning of equipment. However, experience has shown that the exposed decks of such vessels are hazardous for crew in heavy seas. Other vessel types with low freeboard can experience similar problems with large amounts of water and oil washing on-board in heavy swell conditions.

Certain types of vessels have been shown to be particularly effective for the recovery of large volumes of floating oil. In particular, the large storage capacities of dredgers, coastal tankers and bunker barges allow for longer periods at sea before discharge is required. The relatively high freeboard of these and other types of vessels can assist in allowing recovery on the lee side, although deploying equipment from a height can introduce problems of windage. Handling of recovered oil will be assisted by the high-capacity pumps with which such vessels are typically equipped and the fact that storage tanks are often fitted with heating coils. For dredgers, the use of dredge pipes or buckets directly in the oil may be feasible in limited circumstances and the non-selective nature and large pipe diameters of these systems reduce the potential for debris and highly emulsified oil to cause blockages.

9-6-6 : Recovery nearshore and onshore

Self-propelled skimmers can be used to good effect in the calmer waters of ports, harbours and sheltered areas, where they may also serve some secondary function, for example as debris collectors.

These vessels are often an integral part of response arrangements for oil terminals and refineries where the pollution risk and oil type may be appreciated and understood and planning a response may be relatively straightforward. Purpose-built, self-propelled skimmers are comparatively expensive but are effective in confined areas, particularly where access from the shore is impractical.

For portable skimmers, the use of shallow-draught vessels may provide optimal work platforms close to shore. In such cases portable storage tanks or Intermediate Bulk Containers (IBCs) may be placed on-board to receive the oil. However, care should be taken to ensure that the volumes of oil stored, together with the presence of power packs and other equipment, do not affect vessel stability.

In common with other floating materials, oil accumulates in certain places along the shore under the influence of wind and water movement. Typically, areas where debris collects naturally will be where the oil will also collect. Such natural collection points can assist recovery operations, provided the skimmers are capable of dealing with the debris that is usually present, often in large amounts, in these areas. Oleophilic rope-mop skimmers, which are less constrained by debris than other types of skimmer, may be most effective. Recovery can be enhanced with the aid of booms to further concentrate the oil and to reduce the possibility of remobilisation on changing wind or currents. Rope-mop skimmers can also be deployed effectively inside a boom to collect small quantities of oil along its length.

Where possible, it is usually easier to operate skimmers from the shore, particularly if road access, hard standing or a flat working area is available close to the point where the oil is to be recovered. Skimmers can be operated from cranes on dock walls and jetties or, if the oil is sufficiently thick, some types of pump can even be placed directly into the oil.

Once the working site has been identified, a simple site plan can streamline the handling of recovered oil and reduce working hazards. Careful thought must be given to providing operators with the necessary logistical support, including fuel, provisions, shelter and communication

with the incident command centre.

Where oil has stranded on mud or sand shores, conditions may allow the oil to be concentrated in trenches for recovery, most commonly by vacuum devices. Oil pooled between rocks or in crevices may be similarly recovered. On hard-packed sand beaches, recovery may be accelerated by tractor-mounted oleophilic drums or other devices to collect tar balls. Other specialised skimmers may be effective in specific situations onshore. However, in the majority of instances, other techniques, including manual recovery, will be more appropriate.

9-6-7 : 9.6.7 Management of Operations

The successful management of recovery operations requires a knowledge of the current operational picture (who is working where, doing what and with what), good coordination and logistical support.

Response Forms RF 14 (At-Sea Recovery Operations Report Form) and 15 (Shoreline Operations Report Form) in combination with RF 16 (Overall Operations Progress Report and RF 17 (Asset / Site Personnel Report Form) allow field supervisors to keep the Incident Command Centre briefed on progress, summarise the oil and waste recovered and track the usage of consumables. This not only allows the Incident Command to track progress but also to review and update the Initial Action Plan (RF 5).

(9-7) In-situ Burning

In-situ burning (ISB) is the controlled combustion or burning of spilled oil's hydrocarbon vapours in place.

ISB is a non-mechanical response option as, for example, is the application of oil spill dispersants. However, rather than using chemicals to remove spilled oil, the oil is removed by combustion of its hydrocarbon vapours. The best spill clean-up strategy will likely involve a combination of all available response options.

When combining different clean-up techniques, the objective should be to find the optimal mix of equipment, personnel and techniques that affords environmental protection and mitigates potential impacts.

- ISB can be used to remove oil spilled on hard surfaces, soils, ice and snow on land, snow and ice on water, on sea ice and on water.
- During an on-water spill, ISB can be used in open waters (whether inland or offshore).
- Burning can be repeated in cases where sufficient oil remains.
- ISB can be used in conjunction with other techniques to clean up different areas of a slick.

9-7-1 : ISB Parameters

Ignition of volatile oils is achieved easily, while heavier oils often require the use of an accelerant or promoter, such as diesel fuel, to ignite the hydrocarbon vapours.

If not enough vapours are produced, the fire will either not start or will be quickly extinguished. The amount of vapours produced is dependent on the amount of heat radiated back to the oil, which encourages further vaporization.

If the oil slick is too thin, some of this heat is conducted through the slick and lost to the water layer below. Insufficient heating of a slick reduces vaporization rates and lowers vapour concentrations, until eventually, concentrations are too low to sustain combustion.

Oil that is heavily emulsified with water can be ignited if sufficient heat is supplied to remove water and release hydrocarbon vapours. Containment of the oil on water may be necessary when carrying out ISB as the oil slick needs to be thick enough to ignite and sustain a burn.

Once burning, the heat radiated back to the slick is usually sufficient to allow combustion down to an oil thickness of around 0.5–1 mm. The oil burn rate is largely a function of oil type and its degree of weathering.

In general, most oils on water will burn if slicks are more than 2–4 mm thick. On land or wetlands, the situation is similar, although oil with a thickness of 1 mm or less can be burned in a sustained manner on grassland because of heat from the burning of vegetative fuels.

Heavy oils will require a small amount of primer (promoter or accelerant), such as diesel fuel, to start ignition. A promoter or accelerant would

be applied to just a few spots on a slick which are judged to be near or on the thickest portion. Easy ignition of the promoter or accelerant can heat the underlying oil and increase its vaporization rate and its potential for ignition. Once burning, heavy oils will burn well, and even emulsified oil can break down and burn.

9-7-2 : ISB Approval

Most countries have not yet established approval processes for conducting ISB but as more countries seek to use ISB in oil spill response operations, it is anticipated that an approval process will be developed, similar to the dispersant use approval process, which would entail government and stakeholder engagement.

In general, regulatory agencies are most concerned with operational safety (i.e. fire control and responder safety) and public safety (i.e. fire control and the potential for effects from smoke plumes on air quality and health) during response operations. Some jurisdictions may waive air quality limits for special cases, such as during an emergency, if ISB operations are considered to be a beneficial and viable response option under SIMA.

(9-8) Sensitive Area Protection

Some shorelines can be considered more sensitive due to its ecological, economic or cultural importance. These shorelines will be prioritised for protection against a shoreline impact.

Following a spill, monitoring and surveillance will be implemented, backed-up by trajectory modelling and verification (GN 3 Spill Assessment Guidelines). This will provide information on where and when the spilled pollutant may impact sensitive resources.

Sensitivity mapping will provide the type of shoreline and a relative environmental sensitivity index (ESI). This ESI ranking, coupled with the results of the Shoreline Surveillance Form (RF 10) will assist the Incident Command when establishing the Initial Action Plan (RF 5) and determining the response options.

It is most unlikely that all the spilled oil from a particular incident will be recovered or dispersed at sea and some oil is likely to come ashore.

Damage to particularly oil-sensitive resources, such as salt-marsh or mud-flat habitats, may be avoided by preventing the oil from contaminating them with the use of booms.

Booms deployed at sea and along the shoreline will prevent the spilled oil from coming into contact with the resource and the oil may be deflected to another less sensitive part of the shoreline, or may be collected with skimmers or vacuum devices. Booms cannot be used to protect very long sections of shoreline; they are best used to protect particularly sensitive sites such as estuaries. Booms used in this way are 'current-limited' in the same way as booms used at sea; oil will pass under the boom if the current exceeds more than 0.7 knot.

One response option is the protection of sensitive shorelines (Figure 10)



(Figure12) : Boom Formation: Exclusion Booming (L), Chevron Booming (M), Cascade Booming

Booming of sensitive sites requires:

- Equipment
- Deployment Vessel
- Training personnel
- Anchoring or retention equipment
- Appreciation of tides, currents and weather conditions
- Monitoring

It is recommended that sensitive sites that are routinely at risk are identified in advance and have a site-specific tactical plan developed that describes where booms can be laid, how they are to be anchored or fixed in position, what lengths of boom and equipment would be required.

Once a spill occurs, a SCAT team should survey the area, check that the Site Tactical Plan is still appropriate and confirm recommendations to the Incident Command.

(9-9) Shoreline Clean-up

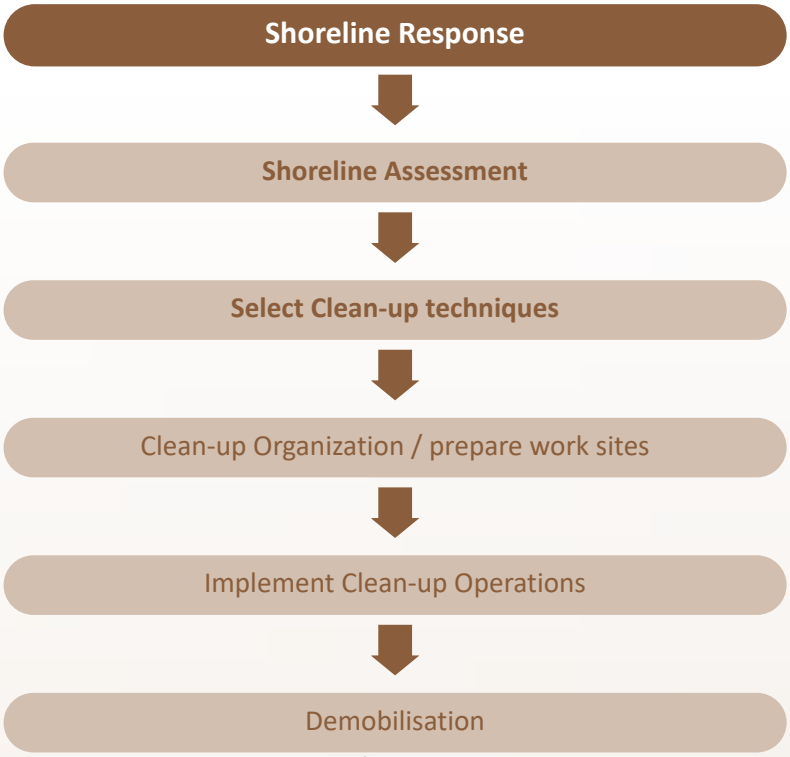
The selection of the most appropriate clean-up techniques requires a rapid evaluation of the degree and type of contamination, together with the length, nature and accessibility of the affected coastline.

Where possible it is important to start removing oil from affected shorelines as quickly as possible to minimise its remobilisation and potential to affect other areas. As time passes and the oil weathers, it may adhere to rocks, sea walls or become mixed or buried in sediments.

Clean-up operations are often considered in three stages:

- Stage 1 - Emergency Phase:
  - o Collection of oil floating close to the shoreline and pooled, bulk oil ashore
- Stage 2 - Project Phase:
  - o Removal of stranded oil and oiled shoreline material
- tage 3 - Polishing Phase
  - o Final clean-up of light contamination and removal of oil stains, if required

Figure 11 presents the general sequence of phases in typical shoreline response operations.



(Figure13) : Phases of Shoreline Cleanup Operations

9-9-1 : General Principles

Given the difficulties of cleaning up oil at sea, many oil spills result in contamination of shorelines. The oil which reaches the coast generally has the greatest environmental and economic impact. It also determines to a large extent the political and public perception of the scale of the incident, as well as the costs.

The principal aim of the shoreline clean-up operation is to reduce the pollution to a tolerable level. The difficulty in achieving this simple aim and the level of remaining pollution that could be described as 'tolerable' will depend on the type of shoreline and other local factors. However, it should be borne in mind that in any clean-up operation, a point will be reached where little will be gained from further expenditure of resources and the residual traces of oil are best left to degrade naturally.

A second aim is therefore to restore the coastline with the least impact on the environment. It is essential that the local authority contingency plan has been prepared in collaboration with the relevant statutory conservation bodies, fisheries departments and other organisations concerned, in order that the limitations of shoreline clean-up have been appreciated. The plan should indicate areas for special consideration such as Sites of Special Scientific Interest (SSSI), where some clean-up methods might be deemed to be unacceptable. Indeed, there may be areas where any clean-up action will be detrimental to the environment and any stranded oil will have to be left to degrade naturally. The rate of natural degradation will depend on the ambient temperature and the sea state to which the stranded oil is subjected. In cold climatic conditions and areas with low energy surf, the degradation could take several years.

Where it is decided that a clean-up operation is necessary, the main option is to recover the oil from the water or the shoreline and temporarily store the recovered oil and oily waste near the site, pending subsequent transport to intermediate storage sites and final disposal. The most appropriate technique for shoreline clean-up will depend on the location, type and amount of oil and the facilities available to deal with it.

There are a number of general considerations that are common to all clean-up operations:

- Access points
  - o The contingency plan should identify suitable access points for equipment and vehicles. The relevant statutory nature conservation body should be consulted beforehand where this might involve damage to the beach environment, e.g. cutting through dunes.
- Temporary storage of waste

o Before commencing recovery operations, it is important to make suitable provision for the temporary storage of oily wastes. Possible sites for temporary storage should be included in the contingency plan, as should final disposal routes for wastes arising from clean-up operations.

- Removal of pollution
  - o It is desirable to remove the gross pollution from surfaces

while the tide is still ebbing. As much as possible of the oil or emulsion should be removed as quickly as possible before the next tide deposits more oil at the same location. In a large oil spill incident, it is possible that the coastline could be subjected to prolonged recontamination over several tides. It is advisable to remove stranded oil after each tide because subsequent tides may wash all or part of the oil to shores in the vicinity that would otherwise have escaped pollution.

The success of recovery operations will depend on:

- The type of beach material;
- The type of equipment used; and
- Supervision of the operation.

Care taken in choosing the right technique, together with careful supervision, will ensure that the amount of oiled beach material requiring final disposal is kept to a minimum.

9-9-2 : Types of Shoreline

To avoid unacceptable damage to the environment through clean-up operations it may sometimes be necessary to leave oil to degrade naturally. The rate of natural degradation of oil on the coastline will depend on the ambient temperature and sea state.

It is possible in a large oil spill incident that beaches could be subjected to prolonged re-contamination over several tides. It may therefore be necessary to carry out beach clearance operations during ebb tides and slack water for several days. It is advisable to remove stranded oil after each tide, as subsequent tides may remove all or part of the oil and pollute other beaches or other sensitive shoreline sites in the vicinity which would otherwise have escaped pollution. This is a general recommendation only as many other local factors will influence the situation, and local knowledge and conditions prevailing at the time of an incident will obviously affect the action necessary.

When removing oil from beach substrates, care must be taken not to collect excess beach material as this will lead to an unnecessary and expensive increase in waste material for which a disposal site will eventually have to be found.

Once thick layers of oil have been removed from the beach surface, and it is certain that no further floating oil is likely to come ashore, 'final polishing' techniques may then be considered. If after bulk removal of beached oil, the remaining oil layer is less than 6 mm, then shoreline chemicals, subject as always to approval from the authorities, may be used as a final polishing technique.

9-9-3 : Sensitivity of shoreline types and habitats to oil pollution

Shorelines can be classified on a relative scale of vulnerability or sensitivity to oil pollution on the basis of shoreline type. The classification is only approximate, but combines the probability of the oil being cleaned away by natural processes with the likelihood of the habitats present being occupied by typical populations. The classification is also a rough guide to the difficulty of shoreline clean-up.

The selection of the appropriate shoreline cleanup tactic is largely based on the shoreline type and should always aim at maximising efficient oil recovery whilst minimising the potential impacts of cleanup activities. Responders and especially those responsible for identifying tactics should keep in mind the principles of SIMA and always ensure that cleanup will not cause more damages than leaving the oil naturally degrade. Table 6 below provides an overview of shoreline types in PERSGA region and associated shoreline tactics. This information will guide local responders with the selection of appropriate tactics to minimise impacts.

The appendices contain Tactical Response Sheets for different response techniques.

	Tactic	Fine-Grained Sand Beaches	Pebble Cobble Gravel Beaches	Exposed Riprap	Exposed Tidal Flats	Sheltered Tidal Flats	Sheltered Rocky Shores and Coastal Structures	Mangroves	Coral Reefs	Seagrasses
Bulk oil removal	Manual recovery of oil	■	■	■	■	■	■	■	■	
	Mechanical recovery of oil	■	■							
	Manual and Passive Recovery in mangrove areas							■		
	Manual recovery in seagrass areas									■
Removal of stranded oil	Passive recovery with sorbents	■	■		■	■				
	Manual and Passive Recovery in tidal flats				■	■				
	Low-pressure and High-pressure wash and Recovery in .Man-made area			■			■			

9-9-4 : Shoreline Assessment

Oiled shore assessment surveys—also known as Shoreline Clean-up Assessment Technique (SCAT) surveys—are a critical component of a response operation. The information gathered by the survey teams is used by the response managers to set objectives, priorities, constraints and end points, all of which are essential in supporting the planning, decision making and implementation of an effective shore response programme.

Oiled shore assessment surveys of inland aquatic environments are carried out to:

- define and document the scale and character of shoreline oiling;
- identify and document the shoreline type and riverine or lacustrine character within the affected area;

- develop recommendations for treatment end points and treatment techniques which provide a net environmental benefit based on sound science;
- provide support throughout the treatment programme so that shore clean-up operations personnel understand the expectations and concerns of the response managers;
- provide a process for closure once treatment has been completed; and
- involve appropriate representatives to ensure consensus throughout the shoreline response programme.

In order to facilitate standardization or a systematic approach to assessment and capturing field data Use Response Form 10 (Shoreline Surveillance Form).

For successful implementation of SCAT, a team of dedicated personnel is needed who are familiar with its aims and terminology. This team should be fully integrated within the incident management team to ensure that their data are utilised to support the decision-making process.

SCAT teams should be mobilised quickly at the commencement of the incident and carryout follow-up and repeat surveys at regular intervals to ascertain and track the clean-up progress.

9-9-5 : Main Clean-Up Methods

Examples of the main clean-up methods used, their benefits and potential impacts on ecological resources are described below:

- • Leave alone for natural weathering: no clean-up activity—usually chosen because it is considered that the impacts of clean-up would outweigh the benefits of removal. This approach is most often applied to lightly oiled shorelines. The natural removal of the oil should be monitored to ensure that it does not have a greater impact than expected. The primary benefit is that it causes no further impact associated with clean-up, but the potential disadvantages are that the oil may contaminate other resources (e.g. birds) and that it may persist and inhibit recovery of the natural community.

- Shoreline protective booming: booms may be used to deflect oil away from sensitive shoreline habitats or to contain oil on a shore for subsequent recovery. There are a number of practical and operational issues that can limit the effectiveness of these techniques and even cause some impacts. Strong tides and wave action make booming particularly difficult, but in some situations the techniques can result in reduced contamination of sections of shoreline.
- Use of barriers and berms: physical barriers, including dams, fences and earthen berms, may be built onshore or offshore to prevent oiling of a sensitive resource (e.g. the entrance to a lagoon) or to trap oil for subsequent removal. It is inevitable that this option will cause disturbance to the shore habitats being built upon, and may potentially lead to impacts on habitats that depend on their exposure to normal tidal movements. When blocking narrow channels, it may be possible to include a system to allow water to flow underneath while capturing oil floating on the surface. It is good practice to monitor the conditions in the areas above the barrier, and to re-establish water flow before conditions deteriorate beyond acceptable limits.
- Non-invasive removal of oil and unattached oiled debris: removal of bulk oil, without removing or notably disturbing the primary substrata or biota that characterize the habitat, is the primary objective of most shoreline responses. In its simplest form it may require no more than someone with a plastic bag and suitable clothing manually picking up tar balls and oiled debris; however, a number of manually and mechanically operated products, tools and machines have been developed, including various forms of sorbents, rakes, scrapers, suction (vacuum) devices and beach-cleaning machines. Removing bulk oil reduces the risk of oil remobilization and contamination of other resources, and may enhance recovery of the oiled habitat. In many situations these advantages greatly outweigh the disadvantages. However, in other situations there are potentially significant impacts associated with access to the shoreline and the disturbance of wildlife. The use of sorbents also increases the amount of waste material that needs to be disposed of.
- Sediment reworking and relocation: these methods enhance

the natural cleaning of the sediment due to wave and current action, by tilling, breaking up or relocating contaminated sand, pebbles or cobbles. The latter may involve digging out and moving oiled sediments from the upper shore to further down the shore where there is more wave energy (surf washing). Wave action subsequently remobilizes the sediment and reforms the beach, removing oil in the process. While most of the oil is not recovered, it is typically dispersed or flocculated into the sea and is unlikely to persist. Some oil may refloat and contaminate other resources. If carried out appropriately the potential impacts from habitat disturbance, burial of organisms and temporary increases in siltation are limited, but this will depend on the community present.

- Physical removal of contaminated substrata or attached biota: this can include invasive methods that dig or scrape away oiled sediment, or cut/pull up oiled algae or plants. While removal of the oil reduces the risk of oil remobilization and contamination of other resources, removal of the substrata or vegetation has the potential for significant impacts on the habitat and may slow down the recovery of the natural community. Removal of sediment could, in some situations, initiate backshore erosion. If it is decided to reduce contamination in a shorter time than would occur by natural processes, the method employed should remove the minimum amount of sediment or vegetation necessary. Re-nourishment (sometimes termed re-charging) of beach sediments by importing them from elsewhere, usually dredged from offshore, is carried out routinely for some popular amenity beaches, but is not appropriate for all beaches.
- Flushing and deluge: these clean-up methods involve pumping and spraying water onto oiled shoreline habitats to remove oil. There are numerous approaches, varying primarily in the volume and pressure of water pumped, and sometimes in the temperature and type of water. A variety of methods may be used to recover the oil that is remobilized by these cleaning methods, but most involve flushing the oil back into the water where it can be more easily contained and recovered. In many situations these methods can be used to mobilize and recover large amounts of oil without having significant impacts on the habitat. However, high pressure or large volumes of water are

relatively aggressive and can cause loss of sediment, changes in sediment character through loss of fine particles, burial of organisms, erosion of soft rock surfaces, removal of attached plants and animals, and temporary increases in siltation. Use of hot water to aid mobilization of more viscous oil and use of fresh water rather than seawater may cause additional mortality. Creating trenches, berms or barriers to concentrate oil can also have additional impacts.

- Controlled in-situ burning of oiled vegetation: in some oiled marsh situations a 'controlled' burn can remove large amounts of oil and allow recovery of the vegetation more quickly than it might have done by natural processes alone. However, the effectiveness of the burn and the potential impacts on the marsh communities can depend on a number of factors, including time of year (winter is best), plant species, soil type (peaty soils are prone to severe damage), water level (>10 cm over the sediment is best) and oil type. Some burns have resulted in rapid recovery, but in other cases the habitats have taken many years to recover. In addition, it can be difficult to control a burn and many have extended far beyond the oiled areas. Controlled burning will also cause mortality of any animals present in the marsh that are not protected by sufficient water or sediment, and it creates large volumes of black smoke that can affect other local resources.
- High-pressure washing, steam cleaning and sand blasting: these are often termed 'polishing' techniques because they are typically used to remove relatively small amounts of weathered oil that is firmly attached to hard substrata, primarily in amenity areas. However, they may also remove biota (e.g. algae, barnacles, lichens) that are attached to the treated area and can sometimes erode the surface of soft or friable substrata. It is good practice to use sorbents or other methods of recovering the remobilized oil. The ecological benefits are fairly limited except where potentially persistent tar residues cover areas of dry wave-sheltered upper shore rock that could inhibit colonization by biota.
- Treatment with chemical agents: a number of chemical agents are designed for use in shoreline clean-up, including surface washing agents, formulations of dispersants and solidifiers.

These are also 'polishing' techniques that are mainly used to remove relatively small amounts of weathered oil from hard substrata in amenity areas. They can have similar benefits in wave-sheltered upper shore areas of rock. The remobilized oil may disperse or refloat, depending on the agent. Dispersed oil can create elevated concentrations of oil in nearshore waters and increase penetration of oil into beach sediments, though these are likely to be transitory effects. Surface washing agents, which lift and float oil residues, are generally preferred.

- Bioremediation: The main approach to bioremediation is bio-stimulation where nutrients (fertilizers, typically including formulations of nitrates and phosphates) are applied to accelerate the natural microbial degradation processes. If nutrient addition is excessive for the affected area there is the potential for eutrophication (overstimulation of plant growth). Toxicity testing of the bioremediation product may also be appropriate. Bioaugmentation involves the addition of oil-degrading microorganisms to an oiled area if the natural populations are considered insufficient. It is used routinely in some contaminated land situations, but has not been effective in shoreline habitats.
- From an ecological perspective the best response to enhance recovery is usually the one that removes as much bulk oil as possible without causing any major physical disturbance to the habitat, and then leave it to be cleaned through natural processes. This approach may, however, need to be modified if the SIMA determines that other issues have a higher priority.

9-9-6 : Management of Operations

The successful management of recovery operations requires a knowledge of the current operational picture (who is working where, doing what and with what), good coordination and logistical support.

In addition to Response Form 10 (Shoreline Surveillance Form) there are other response forms that allow field supervisors to keep the Incident Command Centre briefed on progress, summarise the oil and waste recovered and track the usage of consumables. This not only allows the Incident Command to track progress but also to review and update the

Initial Action Plan (RF 5).

These forms include:

- Site Specific Health and Safety Assessment Form - RF 11
- Site Safety Briefing Form - RF 12
- Shoreline Operations Recovery Report Form - RF 15
- Overall Operations Progress Report Form - RF 16
- Asset / Site Personnel Report Form - RF 17

9-9-7 : 9.9.7 Health, Safety and Security

There are several priorities during oil spill response in terms of health, safety and security. The main objective is to ensure the overall well-being of the public and all oil spill response personnel deployed for the response.

A Health and Safety Officer will be appointed as part of the Incident Management Teams. He will then develop more detailed Site-Specific Health and Safety Plans (SSHP) for each operated site prior to operations in accordance with local and national plans and regulations. The SSHP should, ideally, address the following elements:

- Site information;
- Risk and hazards assessment;
- Meteorological and marine conditions;
- Comprehensive operations work plan;
- First Aid/Medical Aid stations/contact numbers;
- Personal protective equipment (PPE) selection criteria;
- individual and area air monitoring;
- site control measures;
- confined space entry procedures, if needed;
- pre-entry briefings (initial/daily/pre-shift);
- pre-operations health and safety conference for all incident participants;

- decontamination; and
- Management of data relating to all of the above.

Site layout plans may help with making people aware of the risks and the location of key safety elements. These should be prepared and displayed at the site command post. A copy should be retained at the incident command centre and should be revised as conditions at the site change.

Onsite Health and Safety Considerations

Several potential hazards pose a risk for response personnel (table 7) on the field while carrying out the response. Authorities responsible for coordinating oil spill response must ensure that procedures are in place to eliminate or diminish potential hazards present during an oil spill.

All responders must be trained to examine their work site carefully to find and identify hazards and the actions, conditions and possibilities that could lead to an accident. Once hazards are clearly identified, responders can decide what actions or procedures are necessary to either eliminate or reduce the hazards that could lead to an accident, injury, or occupational illness. Potential actions are:

- Eliminate the hazard
- Substitute the hazard with a lesser risk
- Engineering control
- Isolating the hazard by temporarily containing the work environment or work process
- Administrative controls
- Personal protective equipment (PPE)

Chemical Hazards	Physical Hazards	Environmental Hazards	Security Hazards
Oxygen deficiency Total Hydrocarbon Content (THC) Toxic gases Vapors Mists Fumes Dusts	Noise Slips, trips and falls Heavy equipment Hydraulic and pneumatic On-water operations Pressure washers Steam cleaning Fire/explosion hazards Flammable gas generation	Heat stress COVID infection	Combat zones Mine fields (land and sea) Unexploded ordinance

(Table5) : Potential Hazards for Oil Spill Responders

Cleanup Technique	Description & Requirements	Hard Hat	Safety Glasses	Rubber Boots	Tyvek	PFD	Hearing Protection	Gloves	Respirator
Manual Scraping (Beach Clean Up)	Oil is scraped from substrate manually using hand tools. Foot or light vehicular access.	A			D	B	NA	D	NA
Sump and pump/ vacuum	Oil collects in sump as it moves down the beach and is removed by pump or vacuum truck. Requires recovery equipment.				NA	B		D	NA
Manual removal of oiled materials	Oiled sediments and debris are removed by hand, shovels, rakes,	A			D	B	NA	D	NA
Low pressure flushing (Decon Operations)	Low pressure water spray flushes oil from substrate, it is channeled to recovery points. Light vehicular traffic, recovery equipment.				NA	B		D	NA
Manual sorbent application (Beach Clean Up)	Sorbents are applied manually to contaminated areas to soak up oil. Disposal containers for sorbents, foot or boat access.	A			NA	B	NA		NA
Manual cutting	Oiled vegetation is cut by hand, collected and stuffed into bags or containers for disposal. Deploy plywood sheets for foot traffic.	A	D	E	NA	B	NA		NA
Vacuum trucks, pumps or portable skimmers	Oil collects in sumps behind booms or natural depressions and is removed by vacuum trucks, vacuum pumps or portable skimmers.				NA	B		(4)	NA
Recovery of oil from ground	Contaminated oil is pumped out. Heavy equipment access.	D			NA	NA	NA		NA
Skimming Operations (water)	Use of on water skimming resources to remove oil from the water.	A			D				
High Pressure Cleaning (Decon Operations)	High Pressure Cleaning Man-made subtracts and (Decon Operations)				D	B			
LEGEND	**X** Required **NA** - Not Applicable a) Required only when overhead hazards are present. b) Portable floating device (PFD) is required when working on water, docks, barges, boats, piers. c) Optional if it's raining or liquid saturation is likely. d) Based on risk e) Steel-toed boots required based on worksite conditions								

(Table6) : PPE Requirements for Specific Cleanup Techniques

Tactical Response Sheets

TACTICAL RESPONSE SHEET: SURVEILLANCE, MONITORING AND EVALUATION

Response Objective (refer to annex 1)

The response objectives of this technique are to:

- Continuously monitor the location and the trajectory of released oil through surveillance
- Provide regular updates on the physical appearance of the oil i.e. fragmentation, colour, according to the BONN agreement
- Identify sensitive resources that are in the predicted trajectory of the oil
- Assist with C&R operations through guidance of vessels to the leading edge of the slick
- Closely monitor the physical appearance of the slick to assess the oil or conditions and the perceived impact
- Assist preparing response resources for mobilisation
- Ensure health and safety of responders



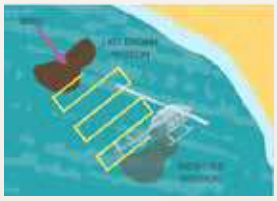
Tactic description (IPIECA, 2016a)

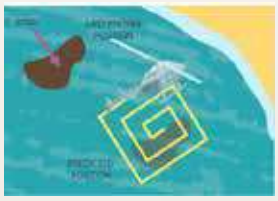
Observe and quantify the release using a dedicated surveillance aircraft or vessels. The use of an aircraft allows for monitoring of a significant area in most weather conditions. Vessels can be used but there are limitations with regards to the area of coverage and quantification is rarely possible. Follow the process below:

1. Implement a surveillance and monitoring plan as soon as possible and continue until no oil at sea is confirmed.
2. Locate the most significant slicks and monitor changes in physical appearance i.e. fragmentation/ colour changes/dispersion.
3. Determine and report trajectory of the identified slicks. Report movement of oil towards sensitive environmental resources.eg. rafting birds or industry inlets.
4. Provide operational support to vessels involved in containment and recovery operations, directing the vessels to the largest slicks and orientating to intercept the leading edge of the slick.

Deployment Configuration (Refer to Annex 1)







Deployment Considerations and Limitations

- Communication between all response personnel (including ground, aerial and vessel personnel). Ensure radio channels, satellite communication is possible. Different types of aircraft will have different limitations. For example fixed wing aircraft will a longer endurance on scene than a helicopter. Alternatively, the view would be unobstructed in a helicopter, but in a fixed wing can often be obstructed due to small windows and their position over the wing.
- Quantification of oil relies upon the availability of suitably trained personnel conducting the surveillance.
- Prioritization of resources as per NEBA (Net Environmental Benefit Analysis).
- Liaise with local authorities.

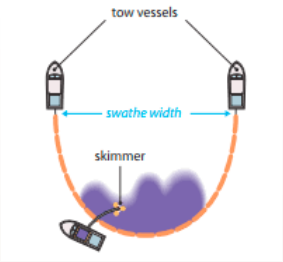
TACTICAL RESPONSE SHEET : CONTAINMENT AND OIL RECOVERY ON WATER BY J or U-BOOM CONFIGURATION

Response Objective

The response objectives of this technique are to:

- Contain and recover released oil at sea
- Contain and recover released oil nearshore
- Minimise shoreline impact
- Ensure health and safety of responders
- Consider ecological sensitivities

The feasibility and effectiveness of vessel containment and recovery is subject to resources being available, sea state and waste storage. It may be possible in sheltered water bodies to use make-shift/custom made barriers, although recovery systems (skimmers) and temporary storage for recovered oil will need to be considered.



Tactic Description

1. **Determine if the conditions are suitable** – In high waves or current speeds, boom failure can occur. The range of conditions that boom can be used depends on boom type.
2. **Deploy the boom and move into towing formation** - Conventional booms are not designed to be towed at speed. Typical speeds of 0.5 – 1 knot is preferred.
3. **Recover oil from apex of boom** – Recovery using an offshore recovery device (skimmer). If unavailable, manual recovery is a possibility.
4. **Store oil on vessel or in inflatable offshore storage –** An independent vessel can shuttle supplies and transfer oil to shore. This will ensure recovery can continue.

Deployment Configurations

The U-Boom System 	2 vessels towing boom in a "U" configuration, providing a wide swathe and large encounter rate and concentrating oil into the apex of the boom. When temporary storage is full, the recovery vessel leaves to transfer the oil – the U formation can continue to collect. Requires a third vessel for recovery. This can be circumvented using a boom vane on one side of the boom but requires deployment by experienced personnel.
The J Formation 	2 vessels towing boom in a "J" configuration, providing a narrower swathe and concentrating spilled oil into the apex of the boom. Once oil has been contained in the apex of the boom, a 'J' configuration can then be adopted in order to recover the product using one of the two towing vessels. It is possible to continue skimming while towing is in motion. The primary vessel should direct the speed and course of the recovery vessel. Once the oil is collected in the boom, transfer it to temporary storage using the skimmer on board the recovery vessel.
Side Sweep 	One vessel is required, using a boom arm from the side of the vessel and concentrating oil into the apex formed within the boom for simultaneous containment and recovery. Quick to deploy if immediately available and easy to maintain configuration when manoeuvring.

Deployment Consideration and Limitations

- Ensure the selection of the correct boom and skimmer for the conditions and the type of oil.
- Conduct continuous gas testing as you approach the slick from upwind. Should the alarm sound exit the plume perpendicular to the wind direction until normal readings are obtained.
- Consider vessel stability and when loading equipment onboard. All equipment should be suitably fastened to the deck for offshore transit.
- Daily weather evaluation is recommended and including distance to a safe harbor and transit times.

- Vessels setting and tending the skimmers and storage devices should be able to safely transit seas which exceed the operating limitations of the equipment.
- A communications schedule should be established and followed, between vessels in transit and the Operations Section.

Recommended environmental conditions

Wind	Waves	Current	Boom Performance
0 – 10 kts (0 – 20 km/hr)	Calm, swells	0 – 0.5 kts (0.25 m/s)	Good
> 20 kts	> 4 ft	> 1 kt (0.5 m/s)	Poor

Make-shift/custom-made Boom Towed by Boats (Cedre, 2012)

Note that this technique requires good experience of using boats and containment devices. Even in optimal conditions, the technique may not be as effective as using specialised equipment (for images refer to page 79/88 in Cedre, 2012).

1. Build the boom designed to be towed.
2. Build the beam and attach to the boat.
3. Attach the boom to the beam and to the boat.
4. Adjust the boom's position and conduct a trial on the water
5. Recovery, storage and disposal of the oil and boom must be planned before starting the operations.

Drive at low speed (0.5knots max) or remain stationary facing into the current and wait for the oil to drift towards the boom.
It will be difficult to manoeuvre when the boom is at the side of the boat. Floating debris can damage the boom. The sea conditions will need to be optimal for this to be attempted (i.e., calm < 10 knots).

Deployment Examples (ITOPF, 2011)



Side sweep vessel, with recovery system onboard



U-boom formation, note some oil is undercutting at the apex

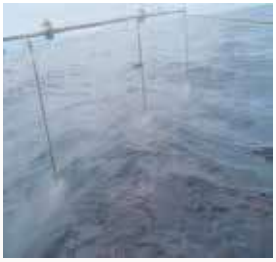
TACTICAL RESPONSE SHEET: DISPERSANT SPRAYING

Response Objective

The response objectives of this technique are to:

- Decrease the persistence of oil in the environment
- Minimise the likelihood of a shoreline impact
- Reduce the volume of waste created
- Reduce the potential vapours released from the oil
- Ensure health and safety of responders

Dispersant use should only be considered in areas where the direction of oil is travelling away from the shore or sensitivities such as coral reefs, fishing grounds and mangroves/mudflats and any others sensitive habitats (seagrass, sheltered areas, etc)

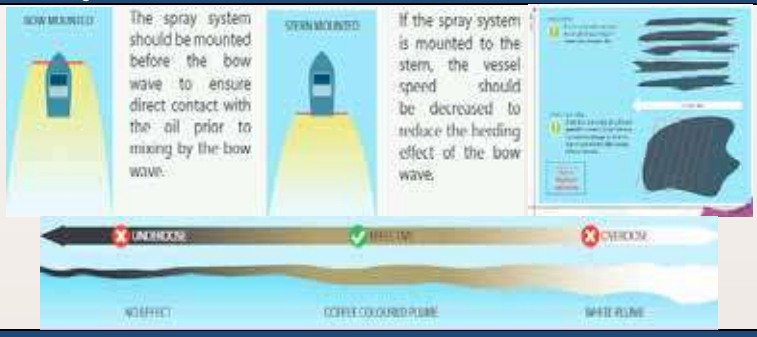


Tactic description

How to spray from onboard a vessel with specialised spray arms or fire hoses/monitors:

1. Droplet size should be about that of an average raindrop.
2. No more than 20% of the dispersant (and considerably less if possible) should fall off-target.
3. Where possible, use a spotter plane to control larger spraying operations or ones where the surface oil has become fragmented.
4. Begin at the leading edge posing the greatest threat and only spray thick patches of oil rather than films or sheen.
5. If a large, thick patch is identified, it may be advantageous to spray right round the outer edge first in order to restrict the spread of oil. Otherwise use parallel and continuous runs.
6. Where practicable, and if wave action is not considered sufficiently strong to aid chemical dispersion, use mechanical means (surface breaker boards or propeller agitation to increase water agitation.
7. Monitoring (and recording) of the volumes and location of dispersant application is essential, and spraying should be terminated as soon as it is no longer effective.

Deployment Configuration



Deployment Considerations and Limitations

- Limited window of opportunity and a test spray is required to determine effectiveness.
- Oil properties and amenability to dispersant (if oil is too viscous or emulsified, dispersant will be ineffective).
- State of the sea (wave height and temperature) in terms of agitation potential.
- Weather conditions and remaining daylight.
- Assessment of the net environmental and economic benefits of using dispersants (in each identified area) will be necessary in consultation with national authorities, prior to application (refer to NEBA).
- Note that a very high flow rate will make it difficult to achieve optimum dilution of the dispersant and uniform application of the dispersant.
- Vessel application is limited for large offshore spills, so aerial spraying should be considered if resources are available. Aircraft allow a rapid response, good visibility, high treatment rates and optimum dispersant use.
- Dispersant use should only be considered in areas where the direction of oil is travelling away from the shore or sensitivities such as coral reefs, fishing grounds and mangroves/mudflats.

TACTICAL RESPONSE SHEET: SHORELINE CLEAN-UP ASSESSMENT TECHNIQUE (SCAT)

Response Objective

The response objectives of this technique are to:

- Minimise waste by pre-cleaning prioritised areas at risk from oiling
- Record pre-oiling conditions on the shoreline
- Develop shoreline treatment recommendations
- Develop clean-up standards or criteria
- Assist Spill Impact Mitigation Assessment (SIMA)
- Inspect and evaluate post treatment areas
- Provide long-term monitoring
- Establish endpoints
- Ensure health and safety of responders



Tactic description

Pre- impact debris removal – Consider the removal of appropriate debris from identified/prioritised shorelines, to above the high-water mark to reduce overall waste. If debris accumulates in an area, this may indicate where oil will strand.

SCAT – Segment selected priority shorelines. For each of the identified sites, segments have been predetermined through a desk-based study. Boundaries may need to be refined once shoreline surveys are undertaken. Segment lengths are typically 0.2 - 2.0 km. If there is long uniform coast, segment boundaries may be based on operational features, such as access. For each segment follow the process below:

1. Define the shoreline: Shoreline type, sediment type and wave exposure.
2. Define the surface oil: Length and width of cover, distribution, thickness and characteristic.
3. Define subsurface oil: Define depth surveyed, position and character of oil.
4. Sketch and photograph: Provide detail on oil location, samples taken, pits dug potentially sensitive resources, access points, possible laydown areas and the shoreline layout. Georeferenced photographs for data accuracy as possible.
5. Record and report: Combine survey data to determine spill priorities and plan clean-up. Use survey data to create recommendations for clean-up techniques (shoreline treatment recommendations) which maximise recovery and enhance natural clean-up, whilst minimising effect on habitats.

Deployment Considerations and Limitations

- Pre-entry protocol ensuring entry downwind of spill source.
- Health and safety considerations working with collecting waste and debris.
- Segregate all recovered waste into appropriate types.
- Implement waste hierarchy where possible.
- Pre cleaning sites determined by SIMA.
- Determine waste streams.

TACTICAL RESPONSE SHEET: SHORELINE BOOMING

Response Objective

The response objectives of this technique are to:

- Protect an area of coastline and recover collected oil
- Deflect away from sensitive areas and direct oil to an area for recovery
- Protection of sensitive harbours and inlets
- Identify and prioritise sensitivities for protection
- Ensure health and safety of responders

Protection priorities need to be determined as different shorelines will have different substrates, wildlife and uses.



Tactic Description

1. Consider type of boom suitable for conditions or make-shift options if boom unavailable. Custom booms can be constructed locally from cost effective materials; however their effectiveness cannot be guaranteed.
2. Select booming formation that considers currents and area for protection. The aim will be to either deflect or protect sensitive areas and/or recover the oil.
3. A whole shoreline cannot be boomed due to the forces exerted on each boom by wind, tides and currents.
4. Ensure that the boom is securely staked, anchored or attached to a secure point on the shoreline.
5. Design the boom formation to have a low angle across the prevailing current direction. Boom failure increases with current speed and boom angle. Monitoring of tidal and current movements are necessary and require changing as and when tidal conditions change.

Deployment Configuration



Running Mooring – used to create a boom seal against a solid structure such as harbour wall



Exclusion booming – protects sensitive sites including small bays and inlets. Contains oil for recovery.



Cascade booming – deflects oil away from sensitive shorelines to a point of enhanced natural collection for recovery

Boom Types

Solid floatation 'fence' boom	Best suited to sheltered water environments such as harbours. Ballast chain helps keep skirt vertical. Easy to handle and deploy due to permanent foam buoyancy chambers removing inflation time. Requires less maintenance than inflation boom due to not being at risk from puncturing, Limited wave following characteristics makes it not suitable for offshore/high wave height environments.
Air inflatable curtain boom	Air buoyancy chambers inflated via non-return valves. Available in 10 and 20 metre sections joined by profiled aluminium connectors. Good wave following characteristic suited to nearshore environments. Care needed to avoid punctures when deploying on the shoreline and from floating debris.
Intertidal shore sealing boom	Three separate chambers, the top air filled, lower pair water filled. At low water the boom sinks and forms a seal with the shoreline. At other times behaviour is like conventional curtain boom. Excellent sealing qualities suitable for the intertidal range. Care needed to avoid punctures when deploying on the shoreline and from floating debris.
Sorbent boom	Lengths of adsorbent material contained in outer mesh or netting to form a boom. The material absorbs oil whilst repelling water. Good for lighter oils that cannot be collected using other methods. It is often used as secondary protection boom to catch small amounts of oil that may pass the primary containment boom in channels and inlets. Can however, create a lot of waste as the oiled boom must be disposed of appropriately as contaminated waste.

Deployment Considerations and Limitations

- Booms should be checked regularly.
- Long stretches of boom should not be deployed as they will not be effective.
- Utilise intermediate anchors to secure boom where the force from the current/tide may overcome existing anchoring points.
- Make-shift/custom-made barriers are difficult to make in an emergency and there is risk of entrainment of the oil under the barrier.

TACTICAL RESPONSE SHEET:PROTECTION OF WATER INTAKES BY FILTRATION (Make-shift/custom-made)

Response Objective

The response objectives of this technique are to:

- Prevent or limit oil entering a water intake, using make-shift/custom-made filters (Guena, Cedre 2012).



Tactic Description

1. Measure the water intake and cut wooden planks to size.
2. Assemble wooden planks to make a frame of required dimensions and reinforce with wooden struts.
3. Fill frame with chicken wire and loose sorbent fibres, such as oleophilic sorbents, (straw is not effective with fluid pollutants).
4. Attach the filter frame at the entrance of the water intake.
5. Monitor filter's efficiency an replace when saturated.

Deployment Configuration

- A series of different types of devices will improve the effectiveness of filtration.
- Water intakes can be fitted with tracks into which made-to-measure metal filters can be inserted in advance.
- Straw will not be effective for oil filtration so oleophilic sorbents should be used.
- A desalination plant will require an effective system so resources should be prioritised to those areas, taking into consideration current speeds, width and depth of the inlet.

Deployment Considerations and Limitations

On water intakes fitted with locks, valves and gates, where possible, completely close off the water intake then partially/gradually reopen to check filters holds and efficiency.

Advantages – requires a limited quantity and small range of widely available equipment and materials. Low coast if natural materials are used.

Drawbacks – difficult to find the right density of filter materials to ensure efficiency without leading to excessive head loss. Need for constant monitoring and regular maintenance. If the filter material is not very hydrophobic, it can slump down in the mesh and become heavy to handle. Only prevents visible contamination of installations without guaranteeing the water quality.

After use: sort and reuse structural and mooring elements, compost or incinerate vegetation.

Equipment Needed (for a 3 m wide water intake)		**Personnel Needed**	
Quantity	**Descriptions**	**Quantity**	**Position**
4 x 3m long	Frame: Wooden planks (battens or beams) 20cm wide	4	Water intakes
2 x 3m long	Frame: Wooden struts 3 to 5 cm wide		
20m^2 with 20mm mesh max	Frame: Metal or plastic mesh/netting (chicken wire, debris netting, anti-hail netting, windbreak or eel net), agricultural or oyster nets made of synthetic or natural fibres (vegetable nets, oyster bags)		
1m^2	Filtration materials: loose sorbent fibres or vegetation (straw)		
According to conditions	Attachment/anchoring: Piles (wood, iron), ropes, concrete wall plugs and screws, wood screws, ratchet straps		
Tools	Sledgehammer, wire cutters, locking pliers, wood or metal saw		

TACTICAL RESPONSE SHEET - MANUAL RECOVERY OF OIL FROM IMPACTED SHORELINES

Objective & Strategy

To remove oil or oiled materials, including oiled sediments, are removed using manual labour and hand tools (e.g. rakes, shovels).

Tactic description

- Shoreline teams pick up oil, oiled sediments, or oily material with rakes, forks, trowels, shovels, sorbent materials, or buckets.
- This may include scraping or wiping with sorbent materials or sieving if the oil has come ashore as tar balls.
- Collected material is placed directly in plastic bags, drums, or other containers for transfer – if the containers are to be carried to a temporary storage area, they should not weigh more than one person can easily and safely carry.
- To avoid spilling, containers should not be overfilled or dragged along the ground – collected material can be placed directly into the bucket of a front-end loader.
- This technique can be used practically and effectively in any location, for small amounts of oil on most types of shoreline

Deployment Configuration



Timing Phase:

The technique is used to recover stranded oil and contaminated sediments through the response and is sometimes even used to recover floating oil. As the predetermined end point is approached, further treatment such as sieving or harrowing may be necessary for high amenity beaches, but in many cases manual clean-up can achieve a satisfactory end point.

Deployment Consideration and limitation

- Walking in the oiled zone will carry oil into areas that have already been treated and trample oil into subsurface sediments.
- Tactic is labour-intensive and personnel may be exposed to a variety of weather conditions, such as heat, cold, and rain, and must have the appropriate PPE.

Equipment Needed		Personnel Needed	
Quantity	**Descriptions**	**Quantity**	**Position**
5	Shovels	1	Supervisor
5	Rakes	10	Crew
10	Buckets		
2	Roll of waste bags		
2	Bags absorbent pads		
1	Waste Bins (container)		

TACTICAL RESPONSE SHEET - OIL CONTAINMENT BY BERMS AND TRENCHES

Objective & Strategy

Berms and trenches are used to contain oil on a shoreline for recovery:

- As oil strands on the shoreline
- To limit remobilization of stranded oil
- To limit waves or rising water levels from over-washing a beach or bank

Tactic description

Berms can be constructed on a sandy or gravel beach parallel to the waterline to contain oil in the trench and to collect oil as it is washed ashore.

- Dig a trench along the shoreline in the intertidal zone during low tide time
- Build a sand wall at the top of the trench using sand extracted from the trench.
- Put plastic linings in the trench and on the sand wall to prevent corrosion and avoid mixing of clean
- sand with oil
- Pump the assembled oil in trench to vacuum truck or dump trucks
- Clean the trenches and remove the plastic linings after cleaning operations
- Tidal range in the area is appropriate for the implementation of this technique (estimated tidal range >1.5m)

Deployment Configuration



Timing Phase:

The technique is used to recover fluid stranded oil in the first phase of the response.

Deployment Consideration and limitation

- The feasibility and effectiveness of berms are limited by the size of the area to be protected; the time available to deploy equipment to construct berm
- Do not excavate materials if activities will cause more damage than the spill.

Equipment Needed		Personnel Needed	
Quantity	**Descriptions**	**Quantity**	**Position**
2	Excavator	1	Supervisor
3	Dump Truck with liner	2	Operator
1	Vacuum truck	2	Spotter (safety)
6	Roll Polyethylene Heavy Duty Plastic		

GENERIC TACTICAL RESPONSE SHEET MANUAL AND PASSIVE RECOVERY IN MANGROVE AREAS

Objective & Strategy

The objective of manual recovery and passive recovery is to remove oil by collecting it in a sorbent material, wrack and debris. The sorbent material and associated oil are then removed from the mangroves and disposed of according to the approved Waste Management Plan.

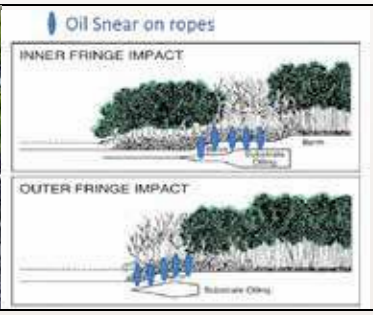
Tactic description

Manual recovery and passive recovery is performed through a process of absorption by sorbent materials, Sorbent pom-poms or "oil snares" are made from substances like polypropylene, a synthetic material that is oleophilic (oil-attracting) and hydrophobic (water-repelling). Sorbent materials must be placed and removed carefully to minimize disturbance of sediments and injury to the mangroves. Likewise, sorbent materials must be closely monitored and maintained to ensure they do not move, become stranded on the shoreline, tangled in the vegetation, or buried in sediments, causing damage to the mangroves or associated resources. Sorbents must be removed when they become saturated or are no longer effective or needed.

- Identify the trajectory of the spilled oil and select areas to be protected. Identify natural collection sites where floating debris is usually found.
- Evaluate access restrictions and select appropriate deployment vehicles
- Mobilize and deploy personnel with tools and materials.
- Secure sorbents.
- Monitor the sorbent on a regular basis for oil content and security of the anchor systems.
- Replace saturated sorbents as necessary.
- Store and dispose all recovered sorbents according to the waste management plan

Deployment Configuration





Timing Phase:

The technique is used to recover stranded oil and contaminated sediments through all phases of the response and is sometimes even used to recover floating oil.

Deployment Consideration and limitation

- Assessing the extent and distribution of stranded oil can be difficult
- the mangrove fringe sometimes is not accessible, due to its lower tidal height
- Heavily oiled wrack and debris should be removed if it can be done without significantly damaging prop roots, pneumatophores, and seedlings or trampling oil into the sediment.
- Passive recovery materials require periodic tending and replacement
- Logistics for solid waste transport and disposal need to be considered
- Temporary storage must be furnished or constructed near the site of the spill to ensure that
- Debris collection efforts can continue at maximum efficiency

Equipment Needed		Personnel Needed	
Quantity	**Descriptions**	**Quantity**	**Position**
10	Bags Sorbent Oil Snare on rope	2	Boat operator
1	Roll of utility ropes	2	Boat crews
1	Roll of clear waste bags	4	Shoreline works
3	Rakes		
3	Shovels		
10	Plastic pails		
2	Vessels		

TACTICAL RESPONSE SHEET - MANUAL RECOVERY IN SEAGRASS AREAS

Objective & Strategy

The objective of manual recovery of the seagrasses is to remove oil by collecting the seagrasses and debris. The vegetated material and associated oil are then removed from the substrate and disposed of according to the approved Waste Management Plan.

Tactic description

Where possible, oil should be prevented from entering shallow, sheltered areas where seagrass beds occur. Highest priority should be those beds which are known to provide nursery areas for commercially important species.
Manual recovery is performed by the shoreline workers working from a vessel and removing oily seagrasses carefully to minimize disturbance of sediments.

- Identify the trajectory of the spilled oil and select areas to be protected. Identify natural collection sites where floating debris is usually found.
- Mobilize and deploy personnel with tools and material
- Store and dispose all recovered seagrasses according to the waste management plan

Deployment Configuration





Timing Phase:
The technique is used to recover stranded oil and contaminated sediments through all three phases (emergency, project and polishing phases) of the response and is sometimes even used to recover floating oil.

Deployment Consideration and limitation

- Extreme care should be taken not to disturb the sediments during cleanup operations in the vicinity of seagrasses, which could result in total loss of the seagrass bed
- Logistics for solid waste transport and disposal need to be considered
- Temporary storage must be furnished or constructed near the site of the spill to ensure that seagrasses collection efforts can continue at maximum efficiency

Equipment Needed		Personnel Needed	
Quantity	**Descriptions**	**Quantity**	**Position**
2	Vessels	2	Boat operator
10	Bags Sorbent Oil Snare on rope	1	Boat crews
1	Roll of utility ropes	4	Shoreline works
1	Roll of clear waste bags		
3	Rakes		
3	Shovels		
10	Plastic pails		

TACTICAL RESPONSE SHEET - MANUAL AND PASSIVE RECOVERY IN TIDAL FLATS

Objective & Strategy

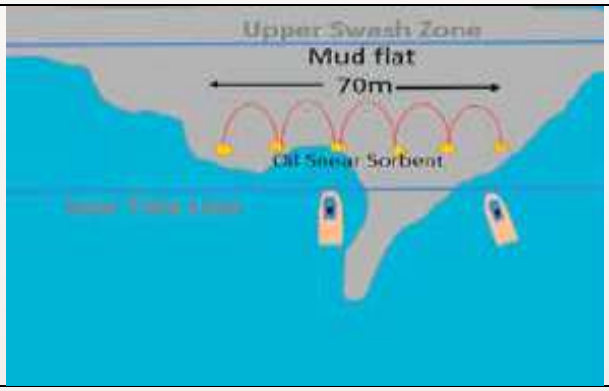
The objective of manual recovery and passive recovery is to remove oil by collecting it in a sorbent or oiled material by using manual labour and hand tools (e.g. rakes, shovels). The sorbent material and associated oil are then removed from the mud flat area and disposed of according to the approved Waste Management Plan.

Tactic description

Manual recovery and passive recovery in tidal flats is performed through a process of absorption by sorbent materials, Sorbent pom-poms or "oil snares" are made from substances like polypropylene, a synthetic material that is oleophilic (oil-attracting) and hydrophobic (water-repelling). Sorbent materials must be placed and removed carefully to minimize disturbance of sediments, this includes removal of surface soil contamination not gross digging.

- Identify the trajectory of the spilled oil and select areas to be protected. Identify natural collection sites where floating debris is usually found.
- Evaluate access restrictions and select appropriate deployment vehicles
- Mobilize and deploy personnel with tools and materials.
- Secure sorbents.
- Monitor the sorbent on a regular basis for oil content and security of the anchor systems.
- Replace saturated sorbents as necessary.
- Store and dispose all recovered sorbents according to the waste management plan

Deployment Configuration



Timing Phase:

The technique is used to recover relatively moderate volumes of mobile oil (clean-up phases two and three)

Deployment Consideration and limitation

- If the mud is soft, foot traffic should be controlled to minimize negative effects.
- Mixing of oil and disturbance of sediments may be reduced by controlling access routes or using
- boards placed on surface
- Used where persistent oil occurs in heavy amounts and where sensitive resources are likely to be oiled
- Raking may drive oil into lower levels of sediment.
- Passive recovery materials require periodic tending and replacement
- Logistics for solid waste transport and disposal need to be considered
- Temporary storage must be furnished or constructed near the site of the spill to ensure that debris collection efforts can continue at maximum efficiency

Equipment Needed		**Personnel Needed**	
Quantity	**Descriptions**	**Quantity**	**Position**
10	Bags Sorbent Oil Snare on rope	2	Boat operator
1	Roll of utility ropes	1	Boat crews
1	Roll of clear waste bags	4	Shoreline works
3	Rakes		
3	Shovels		
10	Plastic pails		
2	Vessels		

GENERIC TACTICAL RESPONSE SHEET - MECHANICAL RECOVERY IN OILED SHORELINES

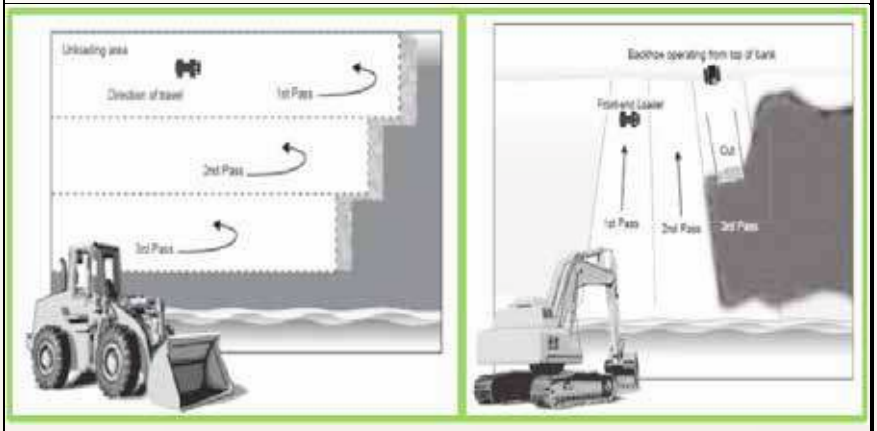
Objective & Strategy

To remove oil and oiled materials using mechanical equipment.

Tactic description

- Oil and oiled surface and subsurface materials are removed from shorelines using a range of mechanical devices – mechanical removal is faster than manual removal but generates more waste.
- The method of operation varies considerably depending on the type of equipment available and its ability to operate on a section of shoreline.
- Elevating scrapers, front-end loaders, backhoes, or vacuum trucks can remove and transfer material directly to a truck or temporary storage area in a single step – other equipment, such as graders, side cast material that must then be picked up by scrapers, loaders, or backhoes for transfer.
- The suitability of different types of machines for treating oil on shorelines is determined by the weight-bearing capacity of the sediments and the slope of the shore zone, as well as the performance characteristics of the individual equipment.

Deployment Configuration



Timing Phase:

Recovery of stranded oil and contaminated sediments is carried out from early in the response, through the end.

Deployment Consideration and limitation

- Traction of heavy equipment is typically reduced as sediment size increases.
- Avoid repeated handling or transfer of oiled sediments as much as possible as this increases the potential for spillage and decreases efficiency
- Do not pass machines through oily area to avoid the mixing of clean deposits with oil.

Equipment Needed		Personnel Needed	
Quantity	Descriptions	Quantity	Position
1	Front-end loaders	1	Supervisor
2	Dump Truck with liner	2	Operator
		2	Spotter (safety)

TACTICAL RESPONSE SHEET - PASSIVE RECOVERY WITH SORBENTS

Objective & Strategy

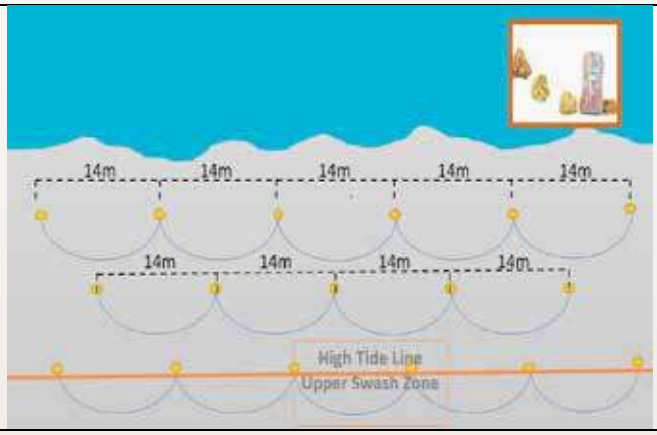
The objective of Passive Recovery is to remove oil by collecting it in a sorbent material. The sorbent material and associated oil are then removed from the environment and disposed of according to the approved Waste Management Plan. Passive recovery with sorbents are often used as a follow-up technique after bulk oil has been removed or in areas where access is difficult.

Tactic description

Passive Recovery is performed through a process of absorption by sorbent materials, Sorbent pom-poms or "oil snares" are made from substances like polypropylene, a synthetic material that is oleophilic (oil-attracting) and hydrophobic (water-repelling). Anchor the sorbent at low tide using T-post or makeshift mooring (wrapped around stones or using a big bag filled with sand)

- Identify the trajectory of the spilled oil and select areas to be protected. Identify natural collection sites where floating debris is usually found.
- Evaluate access restrictions and select appropriate deployment vehicles
- Mobilize and deploy personnel with tools and materials.
- Secure sorbents with stakes.
- Monitor the sorbent on a regular basis for oil content and security of the anchor systems.
- Replace saturated sorbents as necessary.
- Store and dispose all recovered sorbents according to the waste management plan

Deployment Configuration



Timing Phase:

The technique is used to recover relatively moderate volumes of mobile oil.

Deployment Consideration and limitation

- Shoreline access may influence deployment platform options
- Passive recovery materials require periodic tending and replacement
- Logistics for solid waste transport and disposal need to be considered
- Temporary storage must be furnished or constructed near the site of the spill to ensure that Debris collection efforts can continue at maximum efficiency

Equipment Needed		Personnel Needed	
Quantity	**Descriptions**	**Quantity**	**Position**
14	Bags Sorbent Oil Snare on rope	4	Shoreline works
17	Stakes "T-Posts"		
1	Roll of clear waste bags		
3	Rakes		
3	Shovels		

Further Reading

Recommended further reading and sources of information can be found at:

International Maritime Organisation (www.imo.org)

- International Convention on OPRC - 1991 Edition (K550E)
- Manual on Oil Pollution - Section I – Prevention - 2011 Edition (KA557E)
- Manual on Oil Pollution - Section II – Contingency Planning - 2018 Edition (IB560E)
- Manual on Oil Pollution - Section III – Salvage - 1997 Edition (KA566E)
- Manual on Oil Pollution - Section IV – Combating Oil Spills - 2005 Edition (KA569E)
- Manual on Oil Pollution - Section V – Administrative Aspects of Oil Pollution Response - 2009 Edition (KA572E)
- Manual on Oil Pollution - Section VI – IMO Guidelines on Sampling and Identification of Oil - 1998 Edition (K578E)
- Guidelines on the Use of Dispersants for Combating Oil pollution at Sea – 2024 Edition (Available to download at https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/OPRC%20&%20HNS/IMO%20Dispersants%20Guidelines%202024_Final.pdf)
- Oil Spill Response in Tropical Waters - 1997 Edition (I649E)
- Oil Spill Risk Evaluation Manual - 2010 Edition (E579E
- IMO In-Situ Burning Guidelines - 2017 Edition (I623E)
- Guidance document on the Implementation of an Incident Management System (IMS) - 2014 (I581E)

Copies of the IMO publications can be obtained from IMO Publishing (sales@imo.org)

ITOPF Technical Information Papers (www.itopf.org/knowledge-resources/documents-guides/technical-information-papers/)

IPIECA (www.ipieca.org/our-work/oil-spill-preparedness-and-response/oil-spill-response-resources/)

CEDRE Clean-up Activities (www.cedre.fr/en/Resources/Practical-datasheets/Cleanup-activities)

OSRL Technical Library (www.oilspillresponse.com/technical-library/)


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PERSGA