Introduction

The purpose of this *Manual on Oil Spill Risk Evaluation and Assessment of Response Preparedness* is to provide guidance on how to assess whether the preparedness arrangements that are in place are appropriate, in light of the potential for an oil spill incident and its consequences.

The *Manual on Oil Spill Risk Evaluation and Assessment of Response Preparedness* is for guidance only. It does not recommend or advocate prescriptive approaches to assessment. While assessment of risk and preparedness are closely linked to the contingency planning process, this Manual should not be seen as a continuation of the IMO Manual on Oil Pollution series, nor as an exhaustive report on marine oil spill response.

The key element in the ability to respond to a marine oil spill is the existence of an exercised and tested contingency plan that links the risk of a spill with the ability to respond, while taking into consideration the threat to the environment. The plan should include scenarios which are matched to an appropriate response strategy and capability, and establish procedures to trigger external assistance through the tiered preparedness and response approach. Examples of different types of contingency plans are given in the IMO *Manual on Oil Pollution–Section II, Contingency Planning* and the subject of tiered response is described in detail in IPIECA's *IPIECA Guide to Tiered Preparedness and Response.*

Effective oil spill response requires appropriate systems and trained personnel for safe and efficient implementation. However, it must be recognized that there is also a need for support functions to deal with the non-technical aspects of an oil spill, such as the ability to engage with the media, legal and other stakeholders' concerns that will arise during an incident. Necessary organization and control structures must be in place, in order to support all these efforts and their associated activities.

A systematic approach is required which, incorporates prevention and preparedness activities as part of the risk reduction process. This Manual focuses on preparedness, which ensures that in the event of a spill, there is a managed and controlled response, thereby reducing the consequences to the environment.

This Manual describes a number of different tools, models and formulae that may be used to measure spill preparedness. However, every measure has some limitations and may not be suited to all circumstances. Flexibility and judgement should therefore be used in applying these measures to a particular case and in the interpretation of the results.

Figure 1 provides an overview of how the sections of the Manual interrelate to cover the steps and links in the risk assessment and management, preparedness development and assessment processes.

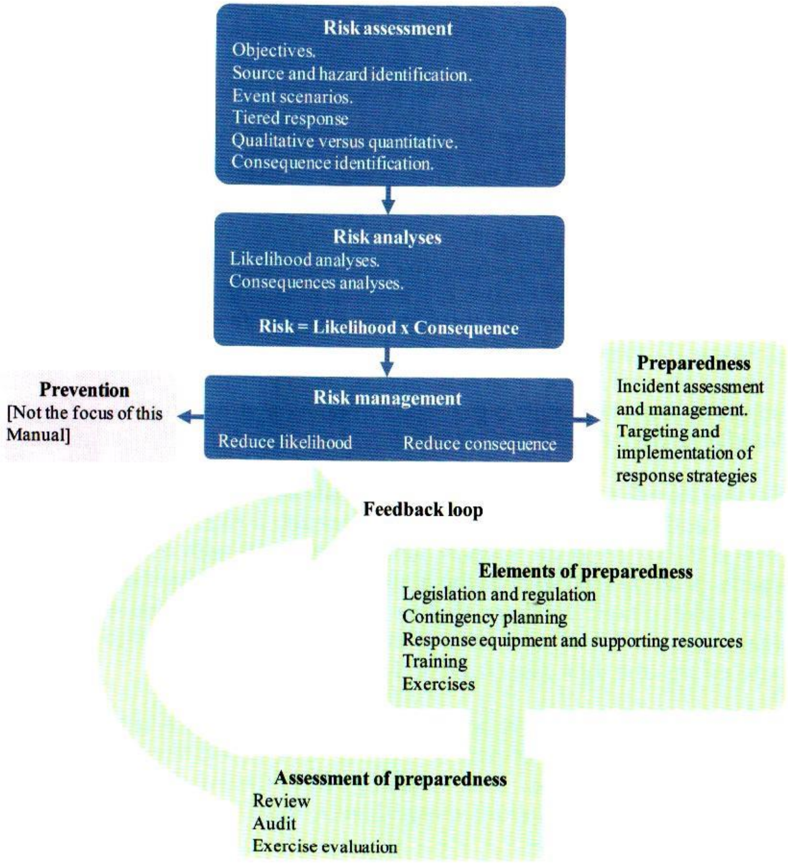

Figure 1 – *Overview of risk assessment and management, preparedness development and assessment processes*

1 Risk assessment

Overview

1.1 Before embarking on the assessment of preparedness, the following question must be addressed: "Prepared to respond to what?" That is, understanding the risk or possibility of a maritime incident resulting in a discharge of oil and the factors that need to be considered when developing or reviewing a response capability.

1.2 Risk assessment can be a complicated affair but, in simple terms, it is the determination of what can go wrong at a defined interval and what the consequences will be if it does. It is therefore important to determine the possible events that could lead to an oil spill, together with the possible resulting impacts. Note that a risk assessment does not, in itself, remove the risk, but provides a systematic approach which allows for the identification, management and reduction of the risk. In combination with other aspects (i.e. economics), it defines the minimum level of preparedness required.

1.3 Risk can be an emotive subject, driven by perceptions of threat and fear of consequences. For example, it is well known that society has an aversion to accidents that are catastrophic. Many people view an aeroplane crash with 100 fatalities with greater concern than 100 separate car accidents leading to the same result. This can manifest itself as an irrational fear of flying compared to driving, despite the fact that the risk of driving may be demonstrably higher than that of flying. It has also been shown that society is usually much less accepting of human-induced risks, as compared to natural ones. These types of perceptions can influence the underlying views about oil spills, with a tendency for some stakeholders to focus on very rare major spills as the main risk which may not be the case. This may result in expectations for large response capabilities at many locations. If such perceptions are not properly addressed, some stakeholders may become alienated and cause friction in preparedness and response activities.

1.4 Prior to describing aspects of the process, it is useful to introduce and define a variety of terms often used in oil spill risk assessment:

Source The facility or operation from which an accidental release of oil may occur (e.g. a pipeline, storage tank, oil tanker, non-tank vessel, offshore installation, etc.).

Hazard A potential danger which can cause a release of oil (e.g. uncharted rocks, congested waters, poorly maintained equipment).

Event Refers to an accidental release of oil (i.e. a hazard interacts with a source to produce an incident).

Frequency The statistical number of times an event will occur within a defined sample size over a specific period (e.g. the frequency of an oil spill greater than X tonnes in a port is Y times per Z years).

Probability Refers to a single event and is expressed as a number between 0 (zero chance) and 1 (certain).

Likelihood A generic term covering either frequency or probability, depending on the analyses used.

Consequence The socio-economic or environmental costs/damage which may result from an incident.

Risk A measure of both the likelihood and consequence, if a hazard manifests itself. This is usually expressed by factoring likelihood and consequence together.

Events

1.5 The first step in the risk assessment process is to identify the source and hazard, followed by consideration of how these may interact to produce potential events and scenarios. Both sources and hazards may be identified through a range of methods:

Historical data This process uses historical accident data appropriate to the operation or area that is being assessed. At the national level, international spill statistics may be useful in some cases, whilst individual operations may be better suited to more specific data sets in others. The data may provide an indication of spill causes, volumes and oil types – all useful elements in scenario development.

Expert review The use of experts to examine and discuss an operation in a structured framework. The experts would typically undertake facilitated sessions, asking the question "what if?" in relation to the operation under consideration. Based on their experience and knowledge, the output would be a list of potential situations that might lead to an oil spill.

Event trees An event tree is a time-based logic diagram, usually based on success/failure modelling (i.e. 'hazard sequencing'). The tree starts with an initiating event and proceeds through a chain of protective features, which may fail, to identify possible outcomes. They are often utilized in accident analyses and can be useful when choosing between alternative designs to mitigate risk.

Comparison Review of the risk assessment work undertaken by operations or countries in analogous situations, perhaps sharing a similar geographic setting, climate, industry activity, or other. Such an approach, may be useful and prevent duplication.

Site visits Structured site visits can allow experienced professionals to visualize potential hazards in their specific context and may allow interviews with relevant personnel who can contribute to the process.

Sensitivity maps Indication of the vulnerability of a specific area. This could be ecological but may also include socio-economic aspects.

1.6 There are a wide range of potential spill sources (vessels, offshore installations, pipelines and storage facilities) and a variety of causes, which may lead to an accidental release of oil. The location of an event will also have a strong bearing on its possible impacts and consequences.

1.7 Some typical causes of incidents identified in oil spill risk assessments are:

- ship collisions
- ship groundings
- failures during loading or discharge operations
- failure of system integrity
- fires/explosions
- hull failures
- offshore well blow-outs
- offshore installation process failures
- transhipment of oil or other cargo

1.8 Whatever method, or combination of methods, is used for source and hazard identification, the output can be used to generate event scenarios, which then need to be analysed and profiled. The key profile information required is:

- general scenario description
- likelihood of occurrence
- potential consequences (spatial and temporal)

1.9 In essence, the target outputs from the profiling will include the type and volume of spilled oil, predicted weathering, forecasted location and trajectories of resulting slicks, frequency or probability of the event, and potential socio-economic and environmental resources. It is possible to devise convenient statistical descriptions for scenarios which may include concepts such as the 'maximum most probable discharge' or the 'average most probable discharge' (as in the United States, see table 2). In attempting to develop an idea of the extremes, the use of the term 'worst case scenario' is common, though this is open to interpretation. In basic volumetric terms the 'worst case' may be considered as the total loss of all oil from the largest tanker entering an area. However, it can be argued that 5,000 tonnes of heavy fuel oil from a cargo vessel can be worse than 100,000 tonnes of very light crude oil from a tanker. Planning for extreme scenarios, which are invariably very rare events, requires a pragmatic approach and should not become mired in unproductive arguments about exactly which situation is worst. The tiered preparedness and response approach provides a pragmatic mechanism to ensure equipment and personnel capacity can be mobilized for extreme scenarios, through national and international cooperative efforts. This emphasises the need to focus time and effort on developing such cooperation.

1.10 In a risk analysis, the two fundamental components of risk, i.e. the likelihood and consequence, need to be measured in a manner that allows comparison between each identified scenario. There are many ways in which these components are determined. These can generally be divided into two types of analyses known as 'quantitative' or 'qualitative'. Quantitative methods use mathematical data to produce numeric outputs, whilst qualitative methods use descriptions or defined terms.

Quantitative measurements

1.11 Quantitative analysis provides specific data points for each parameter. For the identification of likelihood, this may be expressed as frequency or a probability. Frequency would be expressed as the number of times a hazard is expected to result in an actual event over a chosen time frame; two times per three years, once a decade, three times every 100 years etc. Probability uses the same data but is expressed as a decimal number between 0 and 1 (or as a percentage between 0 and 100%). The preceding examples would have annual probabilities of 0.66 (66%), 0.1 (10%) and 0.03 (3%).

1.12 Quantitative measurements of consequence are very difficult to perform, as placing a value on some parameters is extremely difficult. For example, the economic damage of an oil spill may be estimated in financial terms, but using the same approach for the ecological damages is much

more challenging, as this would require placing a monetary value on natural systems. This is a controversial area and this manual does not recommend such valuations. This means that measurements of consequence are far more likely to be expressed in qualitative terms.

Qualitative measurements

1.13 Qualitative measurements use defined terms to bracket a range of possible likelihoods or consequences. Table 1 gives an example of qualitative terms for describing likelihood. This is just one example of any number that could be devised. The actual range of terms or values used is not necessarily important, as long as all hazards are assessed against the same scale. The process is for measuring relative likelihood or consequence, which enables prioritization during the risk management process.

Descriptive term	Likelihood ranges	
	Chance of occurring in a given year	Frequency of occurrence
Certain	>99%	Annually (at least)
Likely	50 to 99%	1–2 years
Possible	5 to 50%	2–20 years
Unlikely	2 to 5%	20–50 years
Rare	1 to 2%	50–100 years
Extremely rare	<1%	>100 years

Table 1 – *Example of qualitative likelihoods*

1.14 Qualitative approaches are very useful, because they accommodate the absence of exact data and are easy to use. However, it should be noted that the descriptive terms must be based upon quantitative ranges or very clear definitions. This removes subjectivity from the process. Without these definitions one person may consider once every ten years as 'rare', whereas another might consider once every hundred years is 'rare'.

1.15 Sometimes a degree of mathematical data is used (e.g. a probability or frequency from historical data, coupled with descriptions of consequences) in determining risk. This is referred to as a semi-quantitative approach. Section 2.3 provides an example of qualitative assessments of consequence.

Tiered response

1.16 The scenarios should be categorized in a way that will assist and feed into the contingency planning process. The widespread and conventional approach in planning is to use the tiered response approach for this categorization. There are usually three tiers defined:*

Tier 1 Those operational-type spills that may occur as upsets to routine activities at, or near an operator's own facilities or within a port, as a consequence of routine activities. The individual operator or port authority is expected to respond adequately to such incidents with their own resources.

Tier 2 These are most likely to extend outside the remit of the tier 1 response area and possibly larger in size, where additional resources are needed from a variety of potential sources and a broader range of stakeholders may be involved in the response.

Tier 3 These are spills that, due to their scale and potential to cause major impacts, call for substantial further resources from a range of national and potentially international sources.

1.17 The tiered response approach provides an extremely useful tool for categorization of scenarios. It may be expected that the most likely scenarios will fall within tier 1, whilst rare catastrophic scenarios will almost certainly be tier 3.

1.18 The actual derivation of the tiers from an operation or area relates to a variety of factors, which include spill volume, type of oil, climate, proximity to sensitive resources and availability of supporting logistics, etc. (see also table 8).

1.19 Although spill volume is only one of the influencing factors, it has been widely used as a backbone to planning frameworks. Some countries have adopted specific guidance for defining release volumes in scenarios for their contingency planning. This can provide a useful starting point for the development of an operation's response capability. Two illustrations are given in table 2 to demonstrate the variety of ways this approach can be implemented.

* IPIECA, 2007. *IPIECA Guide to Tiered Preparedness and Response* - Volume 14. London: International Petroleum Industry Environmental Conservation Association. http://www.ipieca.org/publications/publications_home.php

United States		
Average Most Probable Discharge (AMPD)	**Maximum Most Probable Discharge (MMPD)**	**Worst case scenario**
For a vessel, AMPD means "the lesser of 7.3 tonnes of oil or 1 per cent of the cargo from the vessel during cargo transfer operations to or from the vessel." For a facility, AMPD means "a discharge of the lesser of 7.3 tonnes or 1 per cent of the volume of the worst case discharge."	For a vessel, MMPD means, "a discharge of 365 tonnes of oil for vessels with a cargo capacity equal to or greater than 3,650 tonnes or 10 per cent of the cargo capacity. For facilities, MMPD means, "a discharge of the lesser of 175.2 tonnes or 10 per cent of the volume of a worst case discharge".	"a discharge in adverse weather conditions of a vessel's entire oil cargo or the largest foreseeable discharge of a facility in adverse weather conditions".

United Kingdom (Offshore operations only)		
Quantity (tonnes)	**Response capability**	
	Areas of very high seabird vulnerability	**Other areas**
0 to 25	Within 1 hour @ 10 tonnes/hour	No 1 hour requirement
25 to 100	Within 2 hours @ 10 tonnes/hour	
100 to 500	Within 6 hours @ 50 tonnes/hour	
500 to 10,000	Within 18 hours @ 50 tonnes/hour	
Note that for smaller quantities of light oils, monitor and natural dispersion is accepted. This represents guidance for offshore operations at least 25 miles from the coast. Variations may be required or accepted on a case-by-case basis.		

Table 2 – *Examples of release volumes for contingency planning scenarios*

Consequences/impacts

1.20 The potential environmental and socio-economic damage of oil spills is reasonably well studied and understood.* Table 3 gives examples of this understanding, with respect to the main resources that may be damaged by an oil spill. This type of information is needed to make an assessment of consequences during the risk assessment process. It is therefore important to ensure that people with a good knowledge of this subject are included in the contingency planning process.

* *Manual on Oil Pollution, Section IV* – Chapter 4, IMO.

Receptor	Potential damage
Mammals	It has been rare for whales, dolphins, seals and sea lions to be affected following a spill. Sea otters are more vulnerable due to their way of life and their fur structure.
Birds	Birds using the water/air interface are at risk, particularly auks and divers. Oiled birds usually die. Treatment requires specialized expertise and appropriate facilities, both of which must be integrated with the overall response.* Recovery of local populations depends either on the existence of a reservoir of young non-breeding adults from which breeding colonies can be replenished (e.g. guillemots) or a high reproductive rate (e.g. ducks). There is no evidence to date that any oil spill has permanently damaged a seabird population, but the populations of species with very local distributions could be at risk, in exceptional circumstances.
Fish	Eggs and larvae in shallow bays may suffer heavy mortalities under slicks, particularly if dispersants are used. It is believed that adult fish tend to swim away from oil. There is no evidence so far that any oil spill has significantly affected adult fish populations in the open sea.† Even when many larvae have been killed, this has not been subsequently detected in adult populations, possibly because the survivors had a competitive advantage (more food, and less vulnerable to predators). Adult fish in aquaculture cages may be killed, or at least made unmarketable because of tainting.
Invertebrates	Invertebrates include shellfish (both molluscs and crustaceans), worms of various kinds, sea urchins and corals. All these groups may suffer heavy casualties if directly exposed to fresh oil. In contrast, it is quite common to see barnacles, winkles and limpets living on rocks in the presence of residual weathered oil.
Endangered species	Rare animals or plants, or those with limited geographic distribution may be particularly vulnerable to oil impacts and raise specific concerns.

* IPIECA, 2004. *A Guide to Oiled Wildlife Response Planning* – Volume 13. London: International Petroleum Industry Environmental Conservation Association. (IPIECA). http://www.ipieca.org/publications/publications_home.php

† IPIECA, 1997. *Biological Impacts of Oil Pollution: Fisheries* – Volume 8. London: International Petroleum Industry Environmental Conservation Association. (IPIECA). http://www.ipieca.org/publications/publications_home.php

Receptor	Potential damage (cont.)
Planktonic organisms	Serious effects on plankton have not been observed in the open sea. This is probably because high reproductive rates and immigration from outside the affected area counteract short-term reductions in numbers caused by the oil.
Larger algae	Oil does not always stick to the larger algae because of their mucilaginous coating. Intertidal areas denuded of algae are usually readily re-populated once the oil has been substantially removed. Many algae are of economic importance either directly as food or for products such as agar. Algae cultured for this purpose lose their commercial value if tainted.
Marsh plants	Some species of plants are more susceptible to oil than others. Perennials with robust underground stems and root-stocks tend to be more resistant than annuals and shallow rooted plants. If, however, perennials such as the grass Spartina are killed, the first plants to recolonize the area are likely to be annuals such as the glasswort (*Salicornia*). This is because such annuals produce large numbers of tidally dispersed seeds.*
Mangroves	The term "mangrove" applies to several species of trees and bushes. They have a form of aerial 'breathing root' which enables them to live in fine, poorly oxygenated mud. They are very sensitive to oil, partly because oil films on the breathing roots inhibit the supply of oxygen to the underground root systems.†
Harbours and marinas	The functioning of commercial ports and harbours can be disrupted by oil slicks or clean-up activities. Boats in marinas may be at risk of oiling and subsequently need to be cleaned.
Industrial seawater intakes	Seawater intakes may be at risk from floating and/or dispersed oil, leading to a need for protection or for shutting down operations.
Fishing industry	Fishing may not be feasible due to oil slicks or the imposition of fishing bans. Aquaculture facilities may be severely affected by direct oiling or loss of market confidence.
Recreational and tourism	Use of beaches and the coast for amenity and water sport purposes can be severely curtailed or disrupted by shoreline oiling.

Table 3 – *Examples of coastal resources and potential issues*

* IPIECA, 1996. *Biological Impacts of Oil Pollution: Saltmarshes* – Volume 6. London: International Petroleum Industry Environmental Conservation Association. http://www.ipieca.org/publications/publications_home.php

† IPIECA, 1994. *Biological Impacts of Oil Pollution: Mangroves* – Volume 4. London: International Petroleum Industry Environmental Conservation Association. http://www.ipieca.org/publications/publications_home.php

1.21 In practice, it is difficult to accurately predict the consequences of an oil spill due to complex variables such as oil type, volume, weather, location, season and the variability of ecosystems. An oil spill at any given location can have very different consequences depending on the specific circumstances present at the time of the incident (e.g. onshore versus offshore wind; light oil versus heavy oil; summer tourism versus wintering bird populations). In reality each spill is unique, and risk assessment can only incorporate broad principles in determining consequence.

1.22 It is important to note that placing even qualitative values on environmental resources can be difficult and that different stakeholders or interest groups may have varying views on how they should be ranked. Some stakeholders may have little or no technical knowledge and lack awareness of the potential consequences. High profile species or certain geographical areas may receive particular attention or concern from the public and this may place a societal value on a resource, irrespective of any scientific analyses or viewpoints.

1.23 It can therefore, be, challenging to undertake consequence analyses because of the need for information on sensitive resources, the variability of natural systems and the issue of achieving consensus on perceived value and priorities. This is particularly the case if quantitative studies are being attempted. For this reason there may be a tendency to focus efforts on the likelihood element of event analyses. However, there needs to be a balance in the assessment of risk. Qualitative measurement often provides the best practical tool for determining consequences.

1.24 Table 4 illustrates the categories used to determine a consequence level for segments of coastline. Numerical values are assigned to the identified consequence levels (very low is 0, low is 1, etc.). These can be used in risk calculations.

Resource category		Consequence level description				
		Very low (0)	**Low (1)**	**Moderate (5)**	**Unknown or high (20)**	**Extreme (50)**
Environment	**Shoreline character**	Negligible sensitivity	Low sensitivity (e.g. exposed rocky headlands, eroding wavecut platforms)	Moderate sensitivity (e.g. fine grained sand beaches, exposed compacted tidal flats, mudstone, coarse grained beaches)	High sensitivity (e.g. mixed sand and gravel beaches, gravel beaches, shelter rocky coasts, scoria)	Extremely high sensitivity (e.g. sheltered tidal flats, salt marshes, mangroves)
	Plants and animals	None or very few vulnerable species	Minor short-term impacts	Vulnerable species are generally of local value only	Limited but medium term effects	Vulnerable species are of local and regional importance
	Protected sites	No protected sites present	Scenic or wildlife management reserve	Scenic/nature reserve, wildlife refuge	Marine park, marine reserve, wildlife/marine mammal sanctuary	International protected sites (e.g. RAMSAR)
Human	**Economic**	No resources or activities of economic significance	Low economic significance for the region and nation	Some economic significance of the region, none nationally	High regional economic significance, some national significance	High national economic significance
	Cultural	No cultural importance	Some importance for local community, low regional significance	Important to local and regional community but low national significance	Important to local and regional community, some national significance	High national cultural significance
	Social, amenity and recreation	No community significance	Low community significance for the region and nation	Some community significance for the region, none nationally	High regional community significance, some national significance	High national community significance

Table 4 – *Example of categories to determine qualitative consequence level*

*Source: New Zealand Marine Oil Spill Risk Assessment 2004**

*Maritime New Zealand. 2004. *New Zealand Marine Oil Spill Risk Assessment 2004.*

1.25 Table 5 gives an example, using the data contained in table 4, for assessing data for a particular coastal area

		Very low (0)	Low (1)	Moderate (5)	Unknown or high (20)	Extreme (50)
Environment	Shoreline Character		X			
	Plants and Animals		X			
	Protected Sites	X				
Human	Economic			X		
	Cultural			X		
	Social, Amenity and Recreation				X	

Table 5 – *Example of the determination of consequence levels*
*Source: New Zealand Marine Oil Spill Risk Assessment 2004**

1.26 Table 6 shows how these scores are converted into the area's overall qualitative vulnerability ratings for the two factors. In this example, environmental scores 2 and is ranked low, whilst human scores 30 and is ranked high.

Sum of combined scores	Vulnerability rating
0	Very low
1–3	Low
4–18	Moderate
19–79	High/Unknown
80 +	Extreme

Table 6 – *Conversion of consequence score into qualitative vulnerability ratings*
*Source: New Zealand Marine Oil Spill Risk Assessment 2004**

*Maritime New Zealand. 2004. New Zealand Marine Oil Spill Risk Assessment 2004.

Risk and risk assessment

1.27 Risk is clearly an unavoidable part of everyone's lives and something that underpins many choices that individuals and communities make, sometimes unconsciously. The majority of oil spills fall into a category of human-induced risks and are therefore subject to particular scrutiny, expectations and perceptions, by people and society at large. Major oil spills have the potential to cause widespread and dramatic damage and disruption to the environment and people's livelihoods, which gives them greatly heightened significance in the public's eye compared to less visible or newsworthy risks such as, for example, chronic oil pollution from used engine oil dumped into waterways (possibly causing greater environmental degradation in the long term).

1.28 This means that the risk assessment process must incorporate various stakeholders' expectations if communities at risk and the wider society are to accept the presence, scale and operational procedures associated with the development and transportation of oil and its refined products. This issue should not be underestimated in risk analyses as it strongly justifies and encourages a need for inclusive contingency planning, where risk management is implemented (e.g. by the establishment of suitable preparedness).

1.29 The word risk can mean different things depending on context (from 'danger' to 'thrill'), which means stakeholders could view a 'risk' assessment with very different mindsets. In order to ensure clarity and generate a shared perspective for risk assessment in relation to emergency preparedness, risk is defined as the interaction of hazard and sources to produce consequences with a given likelihood. This leads to a very common and widely accepted definition of risk in the oil spill preparedness context, which is stated by the equation:

Risk = likelihood x consequence

1.30 Risk assessment is the process whereby likelihood and consequence are combined to allow balanced and reasoned judgements concerning what oil spill prevention and preparedness measures may be appropriate or needed in risk management. It is common to represent the above equation in a risk matrix (likelihood on one axis and consequence on the other) to generate risk ratings. This allows event scenarios to be plotted on the matrix and a clear picture of relative risk to appear. The matrix will also identify the relative risk within the tiered response and thereby help focus the need for improved preparedness measures at local, regional or national levels.

1.31 Gathering suitable data during the risk assessment provides a framework within which risk management decisions can be made. The following sections address this issue and highlight the complexities involved. It is noted that the risk assessment itself does not provide an immediate or direct indication concerning what measures should be implemented to manage the identified risks. Rather, this framework enables options on risk mitigation (i.e. oil spill prevention and preparedness) to be considered and logical choices to be made.

2 RISK MANAGEMENT

2.1 Risk management is a process that evaluates the outputs from the risk assessment and puts in place measures to ensure that identified risks are acceptable or require mitigation. The mitigation measures are chosen from options available to reduce the likelihood (preventive measures) and/or consequences (preparedness measures) of oil spills. The risk management process will most likely result in the final design of preparedness capacity required for each tier. Contingency plans and response plans will then define what arrangements are to be in place to mitigate large oil spills (worst case scenario). It should be recognized that if one accepts the societal and political reality that oil is going to be produced and transported on a global scale, then all oil spill risks cannot be eliminated. Most of these risks can be reduced by some amount and the risk managers must work within the political, social and economic framework to target risk reduction measures, often using a risk matrix (see table 7).

2.2 Engaging stakeholders is an important element in the risk management process. Clear presentation of the underlying risk analyses, perhaps including initial proposals for prevention and preparedness measures, should be the basis of this engagement. It is noted that accepting risks does not necessarily mean that all stakeholders will be 'happy' with the risk. Rather, it means that all viable alternatives to reduce risk have been examined and the best possible combination of measures chosen.

2.3 The criteria for 'acceptable' risk cannot be defined in absolute terms, as they are specific to a particular location, the expectations of stakeholders and may also have been established at a national level. It is noteworthy that risk acceptability can differ between communities and nations and over time. For example, the legislated use of seat belts has become widespread as a risk reduction measure as understanding has improved and attitudes have changed.

2.4 One principle that provides a consistent approach is that risks should be "As Low As Reasonably Practical" (ALARP). This means that risks falling within the ALARP zone on the risk matrix (see table 7), require that risk reduction measures be implemented that have the ability to make a meaningful reduction in likelihood or consequences, whilst taking into account practicalities. This is generally interpreted as meaning that risk reduction measures must be technically feasible and cost effective (i.e. the associated

costs should not be disproportionate to the benefits gained). It is recognized that this raises important issues about cost-benefit in relation to environmental resources. Although some theoretical models have been developed that place a notional monetary value on ecological resources, these are controversial and are not widely accepted. Ultimately, this aspect of the risk assessment process will involve value judgements and attempts to reach consensus amongst key stakeholders, using the risk matrix and assigned consequence values as the basis for discussion.

2.5 Note that when using this approach, any risks in the "Negligible zone" are regarded as broadly acceptable and therefore do not require risk management measures. Any risks in the "Intolerable zone" must have been reduced, irrespective of cost, to bring them into the ALARP zone, as a minimum. It is also noteworthy that preparedness measures established to reduce the consequences of higher risk scenarios may reduce the risk rating of all scenarios.

2.6 The consequence categories in the example below of the risk matrix can be defined as C1 being "insignificant" to C5 being "catastrophic" and the intervening categories being minor, moderate and major. The likelihood categories can be defined as L1 being "rare" to L5 being "extremely likely" with the intervening categories being unlikely, possible and likely.

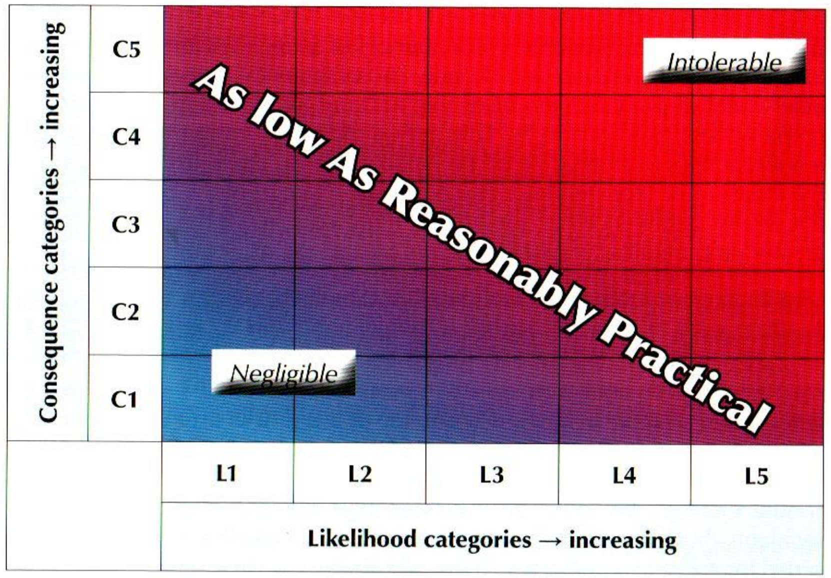

Table 7 – *Example of how a risk matrix is structured*

Reducing likelihood (Prevention measures)

2.7 There are many areas where the likelihood of an incident can be influenced. These are generally part of prevention measures and can include a wide range of actions, for example:

- Improvements to facility design
- Locating facilities in areas of lower incident probability
- Robust maintenance and inspection procedures
- Training programmes in standard operating procedures
- Use of highest quality shipping, operating to highest standards
- Anti-terrorist measures/improved security

2.8 The focus of this Manual is on preparedness, therefore these prevention measures are not considered in detail, although it is recognized that they play a key role in risk management.

Reducing consequence (Preparedness measures)

2.9 Measures to reduce the consequences of an incident are linked directly to oil spill preparedness and, hence, to contingency planning. A rational assessment of preparedness takes into account all the different elements of preparedness (see section 5). This moves the focus away from the natural tendency to over-emphasize oil pollution response equipment stockpiles as the measure of preparedness. These are just one part of the picture, but not the whole. Experience has shown that more equipment does not equate to greater preparedness, if other elements are lacking or weak.

2.10 Identifying options to improve preparedness requires discussion and cooperation between the contingency planners and various stakeholders. A number of improvements to preparedness are likely to focus on tiered response options and measures to ensure escalation of the tiers can be achieved in a timely manner, without any political or logistical barriers. This approach also emphasizes the synergies of co-operation in oil spill preparedness, especially for tier 2 and tier 3 events. The risk management outcomes should highlight the benefits of co-operative mechanisms for larger scale incidents, both between Governments and in partnership with industry. In order for these risk reduction measures to be effective there needs to be open dialogue and political support.

3 MITIGATING THE EFFECTS OF OIL POLLUTION

3.1 There are a number of complex interacting variables influencing and sometimes limiting the options available in an oil spill response. The outcomes of a risk assessment cannot predict with certainty the precise requirements of a real incident, or that the response will unfold in a 'text book' fashion. Rather, the assessment's outcomes should assist contingency planners in developing an appropriate, adaptable and credible response capability as part of the risk management process.

3.2 The practical realities of an oil spill incident invariably require responders to be flexible during the response operations. For example, strong winds or bad weather may prevent the preferred use of a planned offshore response, therefore, shoreline protection and clean-up will become the main response operation. Conversely, exceptionally calm weather may provide unexpected opportunities for on-water operations, including the mobilization of additional resources from tier 2 or tier 3 capacities.

3.3 The oil spill preparedness outcomes of the risk management process will be specific to the assessed operation and can be quite detailed. However, care needs to be taken so that they do not result in overly prescriptive or formulaic approaches that do not take into consideration the real-world practicalities of oil spill response. The main focus of risk assessments is to provide broad indications of suitable response strategies, levels of tiered response capability and prioritization of sensitive resources.

Incident assessment

3.4 If an oil spill incident does occur, it is unlikely that all its features will exactly match an event scenario identified during the risk assessment. Therefore, the contingency plan must incorporate robust operational assessment procedures as part of the response. These procedures should ensure that the actual response is based on relevant, real information about the incident, avoiding 'blind' or automatic responses, which may be inappropriate. The actual response strategy used will be dependent on incident-specific details, for example: a risk assessment may justify the potential use of dispersants at a particular location as bringing net environmental benefit. However, only through suitable field assessment procedures can an operational decision be made on whether dispersant use in a real incident is likely to be effective (i.e. oil type and its actual weathering state under the prevailing conditions). The decision on the use of dispersants could be based on results of a Net Environmental Benefit Analysis (NEBA) of which the risk assessment is a part.

3.5 With a proper operational assessment of a real incident, the appropriate resources can be mobilized from the tiered response capability. The assessment procedures can be encouraged and facilitated by a variety of standard forms and checklists within the contingency plans. Structured training and exercises can be used to embed and reinforce the application of such tools. The forms, frequently included in plans to allow structured assessments, are:

- a safety assessment checklist
- an oil spill reporting form
- an aerial assessment and oil spill quantification form

Mobilization of resources

3.6 Whether resources are immediately available (tier 1), come from within the area (tier 2) or from national and international locations (tier 3), it is imperative that alert and mobilization procedures and associated logistics are considered, exercised and incorporated within contingency plans.

3.7 Oil spill operations can utilize both specialized equipment, such as booms, skimmers, pumps, dispersant spraying systems, etc., and non-specialized items such as hand tools, and earth moving machinery. Furthermore, it is highly likely that large oil pollution incidents will also need significant logistical support from aircraft, vessels and vehicles. Transportation requires fuelling and coordination, whilst personnel need safety equipment, lodging and various welfare facilities. Communication networks and documentation are also an essential part of any response. In short, a response to a large oil pollution incident can be a challenging undertaking for which contingency plans must provide a suitable management and coordination framework.

3.8 A vital aspect of a successful tiered response is the need to encourage the escalation of a response from one tier-level to the next, as soon as there are any indications that this may be needed. Denying the need for mobilization of additional support, or waiting until the existing response capability is completely overwhelmed does not lead to an effective response. Contingency plans should include procedures to alert, or place on standby, higher tier resources to rapidly initiate their mobilization, if and when needed.

3.9 The derivation of capability at the three tiers is best done through an inclusive contingency planning process, based on the risk assessment, but taking into account inputs from a wide range of involved parties (see also section 2.4) and practical factors. Examples of factors influencing the response capability needed and where the boundaries between tiers are set are summarized in table 8.*

* IPIECA, 2007. *IPIECA Guide to Tiered Preparedness and Response* – Volume 14. London: International Petroleum Industry Environmental Conservation Association. (IPIECA). http://www.ipieca.org/publications/publications_home.php

3.10 The use of individual key factors, such as spill volumes or proximity to sensitive socio-economic and environmental resources, can play a useful role in this process. However, it can also be very misleading to use single factors as the sole determinant of response capability. Two simple examples demonstrate this: (1) a spill of 50 tonnes of a light refined product will require a very different response capability compared to the same volume of a heavy fuel oil; (2) a local marina or sensitive marine inlet will require a fixed length and type of boom in order to protect it from floating oil, irrespective of the volume spilled. These are the kinds of considerations that should inform the development of a response capability. In the case of a marina or inlet, there could be further consideration of its distance from potential sources and whether protection boom may be accessed from tier 1 or tier 2 stockpiles.

Type	Factors
Operational	• Probability and frequency of an oil spill occurring • Spill volume • Oil type • Impact of the spill on business operations • Feasibility to mount a safe, efficient response
Setting	• Proximity of the spill to operations • Climate, weather or operating conditions altering fate and behaviour of oil or impeding response operations • Proximity to sensitive environments • Proximity to socio-economic resources
Response capability	• Tier 1 resources influenced by budgetary commitments, provision of personnel and logistics • Availability and capability of regional tier 2 options • access to tier 3 support
Legislative	• Political stability and culture of host country or multiple countries • Governmental requirements for specific response actions or performance criteria • Influences of national, provincial or local government authorities • Stipulated subscription to designated tier 2 or tier 3 support

Table 8 – *Factors influencing a tiered response*

Incident management

3.11 In order to mitigate the consequences of an incident and effectively utilize oil pollution combating resources, it is essential to establish a structured incident management system.

3.12 Effective incident management must also address the important issue of stakeholder and media pressure. These can be intense factors during a major incident and, if not handled effectively, they can begin to drive the response effort in directions other than those identified in the risk assessment and contingency plans. In the worst case, this can lead to situations where sound technical advice is overruled in favour of populist measures, such as aggressive or invasive clean-up of shorelines. This can mean the overall environmental damage is exacerbated rather than reduced by response – a most unsatisfactory result.

3.13 There are various ways to organize the necessary functions for effective coordination and management. There are no strict rules for the organizational and management structures that will need to be adapted to the local and national contexts. However, there are generally accepted principles and functions that need to be covered during a response. The high level principles are:

- the organization must be clearly defined and understood by all those involved, and with a clear definition and understanding of respective roles and responsibilities
- the decision-making processes should be streamlined
- there must be effective communication procedures between the parties involved
- the management team should establish clear objectives and priorities for the response effort and ensure that these are transmitted to the response teams

3.14 The five necessary functional components of a management organization are as follows:

Command This function provides for the overall command of the response activities and the determination of priorities. This function is also responsible for dealing with the related activities, such as media interest, legal implications, stakeholder concerns, etc. To effectively contribute to this function, it is recommended that this team has some experience in responding to oil spills, as well as having formal training in being an 'On-scene' or 'Incident commander'.

Planning Develops the overall response plan for approval by command and also the day-to-day action plans for the response teams. The key ability of this group is to take many inputs and create a logical planned output to ensure an effective response.

Operations The 'sharp end' of the response, this group has the responsibility for implementing the daily actions or missions, in accordance with the accepted action plan. This function also deploys and uses the necessary systems and personnel to mitigate the impact of the oil spill.

Logistics Ensures that necessary personnel, response equipment, transportation, approved disposal sites, food, personal protection equipment and cleaning facilities are available and operational at all times. This function maintains contact with, and control of, all sub-contractors necessary for running the clean-up operation

Finance This function tracks and records all the costs associated with the response and prepares any claims.

Strategy and techniques

3.15 Mitigating the consequences of oil spills largely comes down to effective targeting and implementation of pollution response strategies and techniques. The IMO *Manual on Oil Pollution, Section IV Combating Oil Spills*, details the various methods for dealing with oil spills. Each of the main strategies and their features is briefly described. One or more may be used subject to national environmental legislation and prevailing operational conditions at the time of selection.

Containment and recovery

3.16 Containment and recovery refers to the collection and removal of spilled oil from the surface of the water, thereby reducing the environmental threat. This involves the use of floating barriers ('booms') to concentrate the oil slicks, coupled with recovery devices ('skimmers') to pick up the oil and temporary storage for the recovered oil. It can involve the use of specialized response vessels equipped with a number of different systems, or vessels of opportunity converted for this purpose.

3.17 Unfortunately, the effectiveness of offshore containment and recovery can be severely limited by a variety of factors, including heavy seas, spreading and fragmenting of oil slicks, low 'encounter rates', limits on storage for recovered oil/water mixes and the difficulties of recovering highly weathered and viscous oils. These factors conspire to mean that during major incidents, particularly in the case of shipping incidents, a large proportion of spilled oil will be unrecoverable, even in the most organized and well-resourced operations, under favourable conditions.

Dispersants

3.18 Another option for combating offshore oil slicks is to disperse the oil into the water column by means of specially developed chemicals known as dispersants. The function of the dispersant is to accelerate the natural dispersion of the oil into the top few metres of the water column, where natural degradation can take place. Dispersants can be sprayed from a range of platforms including boats, aeroplanes and helicopters. With sufficient operational support, oil spread over a large area can be removed from the sea's surface relatively quickly and successfully, using dispersants.

3.19 However, dispersants have limitations in effectiveness and appropriateness. Weathered and viscous oils may not be amenable to chemical dispersant and the impacts of localized and temporary concentrations of dispersed oil on some environmental resources (i.e. shallow waters habitats, coral reef, fish spawning areas) may be higher than those posed by the floating oil. This means that the use of dispersants requires significant pre-planning and a clear policy and approval process from the relevant authorities. The underlying principle, when considering whether to use dispersants, should be net environmental benefit.

In-situ burning

3.20 Although not widely accepted as a mitigating technique for combating oil spills, *in-situ* burning may be an option to consider under certain conditions. In some spill situations, burning the oil in place may be considered as a viable alternative or addition to mechanical techniques. The main advantage of *in-situ* burning is the ability to quickly remove large amounts of oil from the marine environment. One drawback to *in-situ* burning is the fire and the large smoke plume generated which, in itself, creates air pollution. The burn or no-burn option is essentially a trade-off and the environmental risks should be carefully assessed before applying this technique.

Monitor and evaluate

3.21 Under certain circumstances, predictions may suggest that the spilled oil will disperse and dissipate naturally (i.e. a non-persistent light oil or with offshore winds), without contaminating coastlines or causing impacts to wildlife. This can justify a 'monitor and evaluate' approach. This does not mean

that no action will be taken. Instead, it means that no active intervention is required, but that the situation will be monitored for any changes. There are various surveillance, modelling and evaluation activities that should be carried out when implementing this approach and, possibly, the need to alert or mobilize combating resources on standby, in case conditions change and an active response is required.

Shoreline protection and clean-up

3.22 With most marine spills and, in particular, with large-scale incidents in coastal areas, there is invariably a shoreline clean-up aspect to the response. There are a range of techniques which are normally used in combination to mitigate the impact of oil on coastal resources. These techniques include manual and mechanical removal and flushing or washing with water at high or low temperatures and pressures. All of these, however, have their advantages and limitations.

3.23 Selection of the most appropriate technique will be dependent on the shoreline type and the level of pollution present, as the use of inappropriate techniques can result in increased damage to the environment. Within this framework, there are complex issues as to the most appropriate point to terminate the clean-up operations. It is for this reason that, in some cases, the least damaging strategy would be to allow natural recovery to take its course. In some cases, it may be advisable to remove bulk oil but leave smaller accumulations. This can be perceived as unsatisfactory to some stakeholders, casual observers and the media, who often equate 'clean-up' with removal of all visible oil to a 'pristine' condition. This issue can require significant education and awareness to diffuse pressures towards using aggressive and invasive techniques.

3.24 Once oil has reached the coastline, response efforts should first focus on areas which have the heaviest concentrations of mobile oil, which may re-mobilize and lead to further pollution of surrounding areas. Experience around the world has shown that sensitive areas such as marshes and mangroves often recover more quickly and completely if invasive clean-up techniques and physical disturbance are minimized or avoided. Natural cleaning can also be very effective on rocky shores that are exposed to strong wave action.

Waste management issues

3.25 At sea, oil recovery and in particular shoreline clean-up, can generate substantial amounts of oil and oily wastes. In this regard, the oil and emulsions recovered at sea, apart from limiting the coastline impact, are 'purer' than waste materials collected during shoreline clean-up operations. Consequently, it is significantly easier and less costly to dispose of liquid wastes because they can be reprocessed at refineries which are frequently located near ports. Acceptance of collected oil/water mixture for reprocessing will be dependent upon the composition of the mixture. Incineration may be the only viable option.

3.26 With respect to material recovered during shoreline clean-up operations, lack of waste segregation is often a major issue for final waste disposal. Waste material should be separated into various waste streams to facilitate disposal. Unfortunately, this is often not the case and consequently shoreline waste material can be a mix of a wide range of substances including sand, beach debris, personal protective equipment and other oiled material. This type of waste needs to be transported, stored and disposed of in an environmentally acceptable manner. More traditional disposal routes include recycling, incineration and landfill. However, many countries have strict regulations under which these options can be utilized. Waste disposal can continue long after the clean-up phase is over, often due to a lack of waste segregation.

Post-spill assessment

3.27 No matter how successful a response operation may be, oil pollution combating activities are unlikely to prevent all potential damage to marine and coastal resources. The underlying philosophy is to minimize the environmental and socio-economic impacts and to bring net benefit from the response and clean-up activities.

3.28 In order to identify any possible restoration or remediation actions and study their appropriateness and feasibility, it may be useful to undertake post-spill monitoring studies or damage assessments.* These studies can also provide sound scientific support and justification for chosen strategies and thereby inform future decision-making. The results from such studies may have value beyond a specific incident, as lessons can be shared with the wider oil spill preparedness and response community. This can lead to adjustments or refinements in risk assessments, due to greater understanding of the consequences. For example, during the initial response to several major oil spills, there were cases of extensive mechanical and manual clean-up of oiled wetlands. This was done in the belief that removing oil from the environment was a 'good and beneficial thing'. However scientific studies subsequently showed that such clean-up could disrupt the physical habitat,

* IMO, 2009. *IMO/UNEP Guidance Manual on the Assessment and Restoration of Environmental Damage following Marine Oil Spills* (2009). London: International Maritime Organization.

to the extent that recovery took significantly longer in the cleaned areas, compared to similar oiled areas left to recover naturally. Wetlands are now accorded the highest oil spill sensitivity status and priority because of this kind of increased understanding and insight. Furthermore, a more considered approach is now given to clean-up of wetlands, if they do become oiled.

3.29 Designing and implementing a post-spill monitoring programme requires planning and resources. It also must be understood that the natural environment is highly variable. Populations and species distribution are continuously changing in the absence of accidental pollution. Therefore, determining the effects of an incident on the environment can be difficult and rarely can absolute conclusions be drawn. However, the outputs do provide a weight of evidence and such studies have built up a credible body of literature that is now used to inform decision-making. This includes issues such as the likely recovery times from oiling for various shorelines types and the potential impacts of aggressive clean-up techniques.

3.30 The key to effective monitoring is the engagement of relevant expertise and integration with the overall oil spill response (i.e. addressing the issue in contingency planning). Whilst the specific detail of a monitoring programme will need to be addressed at the time, it is feasible to identify centres of expertise, which can be rapidly alerted and mobilized in the case of a spill. Knowledge of any existing environmental monitoring programmes, undertaken for reasons other than oil spills, should be investigated, as these can provide very useful pre-spill baseline data. Care should be taken that any monitoring studies are of relevance to the oil spill incident and provide useful and meaningful outputs.

4 ELEMENTS OF PREPAREDNESS

4.1 There are certain fundamental elements which together constitute oil spill preparedness. They are connected, but it is helpful to consider them individually, in order to understand the parts which constitute the whole. For the purpose of this Manual, the elements of preparedness are grouped as:

- legislation and regulation
- contingency planning
- response equipment and supporting resources
- training
- exercises

Legislation and regulation

4.2 States are encouraged by IMO to enact suitable legislation and regulations to provide a domestic framework for oil spill preparedness and response.

4.3 The primary international instrument of relevance is the OPRC Convention, which obliges States Parties to develop relevant national legislation to implement it. This legislation must ensure that:

- oil pollution emergency plans (i.e. oil spill contingency plans) are in place for those operations carrying oil spill risks (article 3)
- oil pollution reporting procedures and the ability to action reports are established (articles 4 and 5)
- national and regional systems for preparedness and response are established (article 6)
- the State will cooperate with other State Parties at the international level to facilitate a response (article 7)

4.4 Implementation of the OPRC Convention covers all elements of preparedness. This includes: the establishment of minimum levels of pre-positioned oil spill response equipment, commensurate with the risk; programmes for exercises and training of relevant personnel; and the facilitation of the movement of people and equipment across international boundaries when engaged in the oil pollution incident.

4.5 In addition, there are three international instruments, developed under the auspices of IMO, relating to the payment of compensation for spills from oil tankers, namely the International Convention on Civil Liability for Oil Pollution Damage, 1992 (1992 CLC), the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1992 (1992 Fund Convention) and the Protocol of 2003 to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1992 (Supplementary Fund Protocol). The regime established by these instruments makes compensation available to those who incur clean-up costs or suffer pollution damage as a result of an oil spill from a tanker.*

4.6 Recognition of the problems that can be caused by spills of heavy bunker fuel from non-tankers led to the adoption of the International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001 (Bunkers Convention). This convention imposes a limit of liability determined by an applicable national or international limitation regime, but in no case to exceed

* IPIECA, 2007. *IPIECA/ITOPF Briefing Paper Series – Oil Spill Compensation*. London: International Petroleum Industry Environmental Conservation Association. http://www.ipieca.org/publications/publications_home.php

the amount calculated in accordance with the Convention on Limitation of Liability for Maritime Claims, 1976. The Bunker Convention entered into force on 21 November 2008.

4.7 States are encouraged to enact national legislation to implement the above conventions. There are also technical aspects of oil spill response which require national regulation in order for preparedness to be robust. This includes issues such as safety of responders, policy and approvals for possible use of chemical dispersants and the storage, transfer and disposal of any waste materials generated during clean-up. Such regulations can clarify what is required to be addressed in contingency plans to ensure that there are no delays or any confusion in responding to oil spill incidents.

Contingency planning

4.8 As outlined in the IMO *Manual on Oil Pollution, Section II*, contingency planning is central to preparedness for an oil spill incident and is a process whereby information is gathered; risk assessments are undertaken; potentially threatened socio-economic and environmental resources are identified; appropriate response strategies are developed; and, procedures are established to ensure adequate tiers of capability can be mobilized, commensurate with the identified risk. A contingency plan needs to identify the organizational structure, with clear roles and responsibilities, and identify the means with which to manage and integrate the participation of a range of involved parties. Because these elements of a contingency plan may change frequently, timely review of contingency plans is suggested.

Response equipment and supporting resources

4.9 The strategy and techniques section has described the main strategies and techniques which can be employed during a response. This will usually entail the use of a variety of equipment and supporting resources, which must be deployed in a correct and safe manner. The equipment may be specialized, such as oil booms, recovery devices for skimming floating oil, dispersant spraying equipment or non-specialized machinery, such as pumps and hand tools.

4.10 Government and industry can provide specialized and non-specialized equipment, as a partnership. This approach provides scope for synergy and cooperation, as most oil spill incidents require a combination of both types of equipment. For example, a spill offshore may be combated with specialized containment booms and skimmers or dispersants, whilst oil stranded on the shoreline usually falls to manual labour using hand tools as the most effective method for clean-up.

4.11 The type, quantity and location of equipment stockpiles will be determined in the contingency planning process and the factors previously mentioned will have a direct bearing on these stockpiles (see table 8). It is very important to recognize that terms such as 'minimum level of pre-positioned oil spill response equipment' or 'tier 1, 2 or 3' stockpiles do NOT refer to standard or uniform lists that each operation or State should acquire. Equipment should be appropriate to, and commensurate with, the requirements identified in the risk assessment.

4.12 In practice, this means that it is legitimate for nominal 'equivalent' stockpiles to vary significantly between operations and geographic locations. A tier 1 capability for a busy oil port may involve a variety of boom and skimmer types, as well as dispersant spraying equipment, perhaps with dedicated oil pollution combating vessel(s). Conversely, a small marine terminal handling only refined products may require very little tier 1 equipment, for example sorbent material. Note that both may be correctly described as tier 1 stockpiles.

4.13 Training of personnel on the deployment of equipment is essential, but often lacking. If responders are not well trained, according to predefined response plans for specific areas, equipment could be damaged and unusable in the event of an incident.

Response performance criteria

4.14 It is useful to develop performance criteria for response capability. These criteria often focus on equipment capacity and the ability to mobilize it, but can also encompass management aspects of the incident. Such criteria provides a framework against which assessment can be carried out and, through exercises, capability can be proven and shown to be effective and credible. Table 9 provides some examples of useful performance factors which could be used by individual States to develop performance criteria.

Performance criteria	Comments
Equipment capacity matches potential scenarios at each tier	• Boom lengths suitable to proposed collection or protection deployments. • Recovery devices are rated capacity for likely oil types. However their effectiveness may be reduced due to operating conditions. • Storage capacity for recovered pollutant is suitable. • Dispersant stockpiles and application systems are matched.
Equipment packaged as 'response ready'	• Equipment stored in deployment packages, with all ancillaries, spares etc.
Logistical support	• Transportation (aircraft, vessels, vehicles) methods identified. • Proven during exercises.
Timely response	• Mobilization and deployment targets at each tier. May be set by reference to oil spill modelling studies. • Proven during exercises.
Effective deployment	• Teams are trained and exercised. • Booming plans are verified.
Equipment is functional	• Planned maintenance programmes in place and audited.
Escalation through the tiers	• Procedures for clearance and transfer of equipment and personnel across jurisdictions are tested.
Waste treatment	• Arrangements for temporary storage and segregation of collected waste

Table 9 – *Examples of equipment-related response performance criteria*

4.15 Globally, there are very few examples as to how the requirements of the OPRC Convention via regional agreements have been transferred into specific performance recommendations for establishing adequate emergency capacity and response capability at the national level. This is mainly due to the need for flexibility in establishing appropriate levels of preparedness. Anything too prescriptive invariably requires modification to suit a national risk profile and context.

4.16 One example, where guidance has been developed at the regional level, is the Convention on the Protection of the Marine Environment of the Baltic Sea (the Helsinki Convention), which in a recommendation* stated that:

"... Governments of Contracting Parties to the Helsinki Convention should, in establishing national contingency plans, aim at developing the ability of their combating services:

a) to deal with spillages of oil and other harmful substances at sea so as to enable them:

- to keep a readiness permitting the first response unit to start from its base within two hours after having been alerted;
- to reach within six hours from start any place of spillage that may occur in the response region of the respective country;

* HELCOM Recommendation 11/13, adopted on 14 February 1990, refers.

- to ensure well organized adequate and substantial response actions on the site of the spill as soon as possible, normally within a time not exceeding 12 hours.

b) to respond to major oil spillages:

- within a period of time normally not exceeding two days of combating the pollution with mechanical pick-up devices at sea; if dispersants are used it should be applied in accordance with HELCOM Recommendation 1/8, taking into account a time limit for efficient use of dispersants;
- to make available sufficient and suitable storage capacity for disposal of recovered or lightered oil within 24 hours after having received precise information on the outflow quantity".

4.17 It can be noted that the above recommendations set targets for response times, but do not stipulate specific response capacity. This was taken a step further with additional guidelines for minimum capability, which offer the following for Baltic countries:

"... **6** CAPACITIES TO RECOVER VARIOUS PERSISTENT OIL TYPES

The minimum requirements are as follows:

- 6.1 2,000 m high sea booms;
- 6.2 2.5 km^2 of sweeping performance. The calculated area is hereby based on a working speed of 1–2 knots of the sweeping or skimming vessels. A sweeping area of 2.5 km^2 has to be fulfilled by those countries which mainly use autonomous drive skimmer ships. The total boom length of 2,000 m can be diminished to 1,200 m if the sweeping capacity is considerably greater;
- 6.3 Six (6) high performance sea skimmers with full sets of auxiliary equipment;
- 6.4 Sufficient storage tank capacity should be available at sea for continuous operations. The land-based disposal arrangements of the recovered mixture close to the potential sea areas must also be ensured ...".

4.18 In addition, the Helsinki Convention has adopted a number of other recommendations relevant to oil spill contingency planning such as:

- Recommendation on minimum ability to respond to oil spillages in oil terminals
- Recommendation on ensuring adequate emergency capacity

4.19 The above recommendations were adopted several years ago, in order to ensure that adequate response capability was available within the Baltic Sea Area. These, however, were not based on a detailed risk assessment. However, since then, sub-regional and national risk assessments have been initiated in most areas of the Baltic. The Baltic is presented as an illustration, but has particular features of enclosed shallow waters and extensive oil transportation by sea. Other seas and regions will have different features, which would very likely lead to different capability or performance criteria recommendations.

4.20 In consideration of major incidents, it is recognized by the OPRC Convention that for a tiered response to be effective, it is necessary for rapid mobilization of equipment and personnel across international borders. This issue has been given particular emphasis through IMO resolution A.983(24).*

Training

4.21 It is evident that those responsible for an oil spill response operation must have a good understanding of their roles and responsibilities, as set out in the relevant contingency plans. A minimum number of competent trained people are needed to ensure that all the critical functions of spill management and operations can be fully implemented. The actual minimum number of trained persons for any particular operation is entirely dependent on the risk assessment and resulting preparedness that is established. A balance needs to be struck between available personnel, equipment capability and supporting logistics, as these need to be complementary. There is little value in acquiring extra equipment that goes beyond the realistic capacity for deployment unless additional personnel can be mobilised. If additional personnel are available and identified, they must be incorporated into the training programmes.

4.22 In order to assist the delivery of training programmes under the OPRC Convention, IMO has developed a series of model courses. These courses include training materials appropriate to the target groups, which are at three levels:

- Level 1 First Responders
- Level 2 Supervisors/On-scene Commanders
- Level 3 Administrators and Senior Managers Seminar

4.23 It is noted that in the case of non-specialized clean-up activities, usually on shorelines, relatively large numbers of unskilled manual labour may be required. It is neither feasible nor necessary to have a large pool of manual labour pre-trained for oil spill response. The recommended

* IMO. 2006. IMO Resolution A.983(24): Guidelines for facilitation of response to a pollution incident. London: International Maritime Organization.

approach is to have competent and trained supervisory personnel coupled with efficient induction programmes, particularly those focussed on safety during a response.

4.24 Turnover of staff and the subsequent loss of knowledge gained represent a major challenge to the sustainability of preparedness. This reinforces the need for on-going training, which incorporates both periodic refreshers, often on a three-year basis, and the induction of new personnel. It also emphasises the strong link between training and practice through a robust exercise programme.

Exercises

4.25 Oil spill simulation exercises are the critical test of whether preparedness is adequate and fit-for-purpose. A well-designed exercise programme will comprise different activities and can range from simple notification and communication tests, through to table-top simulations and to equipment deployment and full scale exercises in response to major incidents.*

4.26 Successful exercises require clear objectives and measures by which the activities can be assessed. Capturing the lessons learned from exercises is vital and every event should incorporate some form of evaluation process. Feedback from exercises should be constructive and include recommendations for addressing identified weaknesses. The most effective culture, to be adopted by all participants and evaluators, is one where 'problems' or 'mistakes' in exercises are viewed in a positive light of lessons learned, highlighting issues where improvement can be considered. The responsibility for implementing any agreed changes or amendments to plans and procedures, with associated deadlines, should be clear.

4.27 Exercise design requires significant thought, as it is relatively easy to hold events without a focus on specific objectives or can, conversely, be too complex, with a multitude of objectives none of which are properly addressed. There is also the threat that an exercise becomes a learning event, rather than a true test of procedures. This can be valuable within a wider training programme, but should not be mistaken for a rigorous assessment of preparedness.

4.28 Larger oil spill simulations can be major events, involving a variety of command aspects, strategic decision-making, operational control and equipment deployments, possibly at the national or regional level. There can be political forces influencing these events, which steer the activities

* IMO/IPIECA Oil Spill Report Series - Vol. 2: *Guide to Oil Spill Exercise Planning, 1996.* London: International Petroleum Industry Environmental Conservation Association. (IPIECA). http://www.ipieca.org/publications/publications_home.php

away from a practice or assessment of emergency preparedness towards a demonstration or show. The key to diffusing this situation, which undermines the benefits of the simulation, is to ensure a series of preparedness events to major exercises. This could be a combination of training courses, workshops, seminars and smaller-scale communication and table-top exercises. These should provide the reassurance to senior representatives that the major event will not lead to serious embarrassment or perceived 'failure', even if areas for improvement are identified during evaluation.

5 ASSESSMENT OF PREPAREDNESS

5.1 This section offers guidance and advice on how government agencies or facility operators can assess whether they are adequately prepared to respond to an oil spill. If a suitable process of risk assessment has been followed, it is a logical conclusion that appropriate preparedness will have been established. However, it may be necessary to subject an existing facility to an assessment or simply to check that preparedness remains current on a periodic basis.

5.2 The thoroughness and detail of the preparedness assessment will depend on the context. For example, a Government's national framework will have a policy focus, whilst an assessment of an oil handling facility will have a greater operational emphasis and will be significantly more specific in its detail. It should be noted that contingency plans at national and local levels should be integrated, so that preparedness at the national level has a bearing on preparedness at the facility level, especially for tier 2 and 3 response cases.

5.3 For each element of preparedness, it is possible to ask a series of questions, which commence at a high level and drill down to specifics, as appropriate. This can be viewed as a concept of addressing a hierarchy of strategy, tactics and operations. Table 10 provides two illustrations of these points on the use of dispersants and protective booming in oil spill response.

5.4 To illustrate how responsibilities for determining the answers to the questions raised in table 10 can be addressed or allocated, let us first consider dispersant use. The assessment of preparedness for dispersant use at the national level would focus on questions 1 to 4 and involve government departments, whilst a facility would concentrate on questions 5 to 7. This further emphasizes the relationship between preparedness at national and local levels. Without an adequate national policy, any dispersant use capability at the facility level is rendered largely ineffective. Note that for question 5 there would be a very specific link to the event scenarios in the risk assessment. The quantity of tier 1 dispersant stockpiles would be calculated in relation to indicative spill volumes, taking into consideration available support at tiers 2 and 3, and the expected weathering of likely oil types.

	Dispersant use	Protective booming
STRATEGY	1 Is there a clear national dispersant policy? 2 Is there a list of licensed dispersants, products?	1 Have coastlines been mapped for sensitive areas? 2 Has oil spill modelling been undertaken?
TACTICS	1 Are effective mechanisms for approving use during an incident in place? 2 Are pre-approval mechanisms in place?	3 Are protection priorities agreed? 4 Are stockpile locations agreed?
OPERATIONS	1 Are there suitable stockpiles of dispersant (size and location) and application methods (type and number of units)? 2 Are personnel trained in safe and appropriate application of dispersant? 3 Have dispersant use procedures been exercised?	4 Have booming plans been developed? 5 Is suitable booming equipment available? 6 Are personnel trained in safe and appropriate deployment of equipment? 7 Are supporting logistics available? 8 Are booming plans verified through deployment exercises?

Table 10 – *Illustrative hierarchy of questions for two equipment-related response elements*

5.6 Further examples of hierarchical questions are given in annex 1. These can be adapted or expanded to meet the specific needs of an assessment. Reference to potential spill scenarios from the risk assessment is a very useful step when considering the detail of these questions. The scenarios should outline 'what can happen' and determine what response capability is required. Reference to established performance criteria (see section 4) – or development of such criteria if they are not available – can also assist in providing an effective framework for the assessment of 'readiness to respond'. An illustration of how a planning scenario could be used to aid assessment of preparedness is given in annex 2.

5.7 Ultimately, these approaches enable assessors to answer the key overarching question 'how do we know we are prepared?' It is again emphasized that this provides a balanced approach and avoids a focus on one isolated element of preparedness. The comprehensive suite of questions also errs away from simplistic 'box-ticking', as there is frequent reference to whether items have been tested and exercised i.e. bringing assurance that preparedness is proven and credible.

6 SUMMARY AND CONCLUSIONS

6.1 It is important to understand the differences and links between risk assessment, contingency plans and actual response in the event of an incident:

Risk assessment The theoretical process that determines what can go wrong.

Contingency plan The procedures and response capability established to meet the identified risks.

Actual response The implementation of procedures and utilization of resources to deal with actual pollution.

6.2 The risk assessment should identify possible event scenarios with associated likelihoods and consequences, so that risk management is set within a meaningful framework. For the reduction of potential consequences, i.e. preparedness, appropriate response capability should be developed in the light of these scenarios, recognizing the practical limitations of the various response strategies. In turn, this should be used to engender realistic expectations of all the involved parties (Government, industry and other stakeholders) about what is achievable from response.

6.3 This publication has emphasized that preparedness is made up of various elements, each of which need to be addressed. Stockpiles of equipment are readily visible and do form part of the picture. However, large stockpiles do not automatically mean a better and more capable response. This is particularly the case if the response policy and contingency plans are not fully developed and exercised; if there is inadequate budget for maintenance; if competent personnel are not available for deployment and operations; if logistics cannot support the equipment; or if prevailing climatic conditions compromise the ability to utilize the stockpiled equipment.

6.4 For many countries, it is sufficient to establish a relatively modest minimum level of response equipment, as long as robust mechanisms for mobilization of cascading regional or international support, i.e. tiered response, are identified and exercised.

6.5 The results from the risk assessment should provide a solid basis for an inclusive contingency planning process, taking into account the views and expectation of the authorities, the operators, response service providers and other stakeholders. A partnership approach will lead to opportunities for education, awareness-building and generate understanding amongst these key parties concerning how preparedness can be developed to match the oil spill risks associated with an operation.

Annex 1

Illustrative questions which could be used to support an assessment of preparedness

Legislation and regulation	1	Is the OPRC Convention ratified?
	2	Does national legislation exist and if so is it in place?
	3	Does it provide the 'authority to respond'?
	4	Is a clear mandate held by someone or group(s)?
	5	Are there associate policies to implement the legislation?
	6	Are there appropriate procedures?
	7	Are there appropriate standards?
	8	Are there appropriate work instructions?
The outcome would be that there is a legislative mandate to prepare and then to respond with all of the necessary policies, procedures and work instructions necessary to effect a positive outcome to an oil spill.		
Contingency planning (general)	1	Does the contingency plan exist and is it comprehensive and complete?
	2	Are the organization's roles/responsibilities clearly stated?
	3	Have sensitivity assessments of high risk areas been done and mapped?
	4	Is oiled wildlife response integrated with pollution response?
	5	Is the plan commensurate to the risk?
	6	Is the plan functional?
	7	Is the plan flexible to real incidents?
	8	Is the plan a controlled do?
Contingency planning (support functions)	1	Is legal support trained and available?
	2	Are communications specialists available and exercised?
	3	Are media relations in place and exercised?
	4	Are medical facilities available?
	5	Is there a health and safety policy process?

Contingency planning (waste management)	1	Is there a waste management plan?
	2	Are there procedures for waste minimization?
	3	Are there procedures for waste segregation?
	4	Is there an approved disposal plan?
	5	Are there accepted decontamination processes?
	6	Is there a reinstatement plan for clean-up sites?
Contingency planning (finance)	1	Is there a mandate in place to recover costs?
	2	Is there a contracting and procurement process in place?
	3	Is the claims process embedded in the management system?
	4	Is there a pre-approved authority for emergency contracting?
	5	Are robust documentation processes in place?
	6	Is the claims submission process understood?
The outcome would be a response, enacted through a sound planned approach that has been tested and accepted. This will ensure that decision makers are not distracted by support functions and can concentrate on managing the oil spill response. This will answer the question of how the waste is going to be handled and processed to meet the necessary environmental regulations etc. This will ensure the costs are captured from the start to solve the problem of trying to assess the costs after the fact.		
Response equipment	1	Is the equipment the correct type based upon the risk?
	2	Is there an appropriate amount of equipment, taking tiers into account?
	3	Is the equipment in the correct location, taking high risk areas into consideration?
	4	Is the equipment properly stored, maintained and documented?
	5	Is equipment packaged in functional units (e.g. matched booms, skimmer and temporary storage)?
	6	Are there adequate ancillaries, spares and procedures to support in case of breakdowns?
	7	Is additional equipment (from tiered resources) compatible?
	8	Is the equipment transportable?

Supporting resources (logistics)	1	Are required logistics identified?
	2	Are customs clearances in place for movement of equipment in or out of the country?
	3	Are standing offer contracts for catering, lodging etc. in place?
	4	Are sources of supply of protective clothing identified?
	5	Are there procedures to track equipment and personnel at each site?
This will ensure that equipment stockpiles exist that are commensurate with the risk, based on the tiered response approach. This will also ensure the necessary support mechanisms are available for the responders.		
Training	1	Is a training needs analysis part of the contingency planning?
	2	Is the correct number of personnel trained and competent according to standards?
	3	Is training current and tracked?
	4	Are trained persons available on a rota?
	5	Are trained persons based in the correct location?
	6	Are trained persons participating in exercises?
	7	Are trained persons medically fit?
	8	Is a source of untrained personnel available to augment under supervision, with induction training?
The outcome is a group of trained professional responders who understand their roles in the contingency plans, as well as having the identified group of untrained but available personnel to augment a response.		
Exercises	1	Is there an exercise programme?
	2	Does the programme incorporate a range of tests, from alert and notification through to table-top and deployment?
	3	Are lessons learned from exercises captured by evaluators?
	4	Are contingency plans reviewed in the light of exercises?
	5	Are exercises recorded?
Exercises are the fundamental mechanism for testing and verifying that plans and procedures are appropriate to the identified needs and commensurate with the risks.		

Annex 2

Possible assessment criteria based on a planning scenario

These criteria could be utilized in a paper review of assessment through interview with key players and examination of equipment resources, or through a series of exercises.

Scenario: Offshore installation, tier 2 scale incident

Spill location	ALPHA platform
Date and initial time	June 7 – early morning
Oil type	Medium crude oil
Quantity	~250 m^3 (1,750 barrels)
Initial wind velocity	2 m/s(<5 knots) south-easterly
Average air temperature	28°C (82°F)
Trajectory and oil fate	Oil initially rapidly spreads to cover approximately 2 km^2. Light winds and waves slowly fragment the slick into patches

Response activity

Response stage	Planned action	Performance and assessment criteria
Alert and identify Raise alarm Make safe	*June 7, 06:00:* The main control room is alerted to a problem with the import riser pressure. The Offshore Installation Manager (OIM) is called to the control room and orders immediate shutdown. A person is sent to the spider deck to check for surfacing oil. Standby vessel alerted to potential incident and ordered to investigate area.	Appropriate assessment of incident is undertaken immediately. Shutdown procedures enacted.

Response stage	Planned action	Performance and assessment criteria
Assess	*06:15 (15 minutes after spill):* Observer on platform reports to OIM that black oil is clearly visible surfacing around the risers; this is confirmed by the standby vessel. Oil is spreading away from the platform towards the north-west.	Assessment of oil spill undertaken. Standard reporting procedures used.
Initial reporting	*06:20 (20 minutes after spill):* OIM calls the Duty Incident Commander using the telephone number in the facility oil spill plan and describes the situation briefly. Mutual agreement to mobilize the Incident Management Team (IMT) is reached.	Correct reporting calls are made. Contact numbers in plans are current.
Initial strategy formation	*06:30 (30 minutes after spill):* Light winds and calm seas favour use of containment and recovery system(s). OIM requests: Standby vessel begins deployment of its single ship recovery system. Tier 2 response contractor mobilization to provide additional offshore recovery equipment. IMT carry out computer modelling to predict fate and trajectory of the oil slick. IMT organize helicopter overflight at earliest opportunity.	Appropriate strategy decision. Vessel recovery system operational and personnel competent in its deployment. Tier 2 contractor available within target mobilization times. Competent person able to run modelling. Aerial support for overflight available.
IMT established	*07:00 (1 hour after spill):* Duty team key positions are mobilized and staffed.	IMT is able to muster to control room.

Response stage	Planned action	Performance and assessment criteria
Notifications	*07:30 (90 minutes after spill):* IMT Liaison Officer notifies external organizations as prescribed in plans. Joint venture partners are notified.	All notifications are made and contact details are current.
Escalation preparedness	*08:00 (2 hours after spill):* Incident Commander directs IMT Operations Manager to put tier 3 contractor on 'alert' status.	Potential for incident to escalate identi-fied and supporting resources alerted.
Initial surveillance	*11:00 (5 hours after spill):* First overflight using helicopter services. Two persons from IMT planning section and a Government representative participate. Digital photographs and video are taken. Sketches of the extent and appearance of oil are made. Black oil slicks cover approximately 30% of 6 km^2. Estimated oil volume at sea is 200 m^3.	Trained aerial observers are available with ability to make systematic observations and quantification.
Containment and recovery operations	*08:00 (2 hours after spill):* Standby vessel has deployed recovery system and commencing operations. A sample of the recovered oil is taken and logged. Tier 2 contractor working with IMT logistics section to load and mobilize vessel 2 at quay. Modelling output indicates oil moving towards shoreline but gives a beaching time of more than one week under current wind conditions. Forecast is for stable weather with light winds. *10:00 (4 hours after spill):* Vessel 2 departs quay with offshore containment and recovery system (400 m offshore boom plus offshore boom plus offshore skimmer).	Sampling procedure is carried out correctly. Vessel logistics and operations are achieved.

Response stage	Planned action	Performance and assessment criteria
	13:00 (7 hours after spill): Vessel 2 on-site and deploying tier 2 contractor's offshore recovery system. *14:00 (8 hours after spill):* Standby vessel has been successful in recovery operations and filled its onboard storage tanks (330 m^3); heading to quay to discharge collected oily water. *19:00 (14 hours after spill):* Offshore operations cease due to failing light. Vessel 2 has collected 500 m^3 of oily water in onboard tanks; *en route* to quay to discharge.	
	Day 2: Standby vessel and vessel 2 have been preparing for first light operations. Helicopter directs vessels to areas of heaviest oil concentrations. Vessels report low success in concentrating oil in booms, as quantities on water diminish. Vessels return to quay to discharge oily water. Skippers estimate no more than 5% oil in recovered liquid.	
	Day 3: Standby vessel and vessel 2 are on site with equipment but not containing recoverable oil in booms.	
	Day 4: Vessels stood down and return to quay for decontamination.	

Response stage	Planned action	Performance and assessment criteria
Waste management	*Days 1 and 2:* Approximately 1,000 m^3 of oily water is discharged at quay. Road tankers supplied by approved contractors for transport and separation/disposal of oily water.	There is availability of suitable licensed road tanker to receive waste. Waste treatment and disposal options are addressed.
Stand-down resources	*Day 3:* Tier 3 contractor is officially stood-down by the Incident Commander. IMT staff numbers reduced.	Stand-down of alerted resources is carried out.
Debrief	*Day 5:* Incident hot-wash takes place. IMT and OIM construct a written report including log of events and lessons learned. Incident closed.	Lessons learned are captured and an action plan to implement any recommendations is developed with responsible persons and deadlines.

Mass balance estimate	Evaporated	100 m^3
	Dispersed/degraded	100 m^3
	Recovered at sea	50 m^3
	Beached	0 m^3
	TOTAL	**250 m^3**