

MANUAL ON

Oil Spill Risk Evaluation and Assessment of Response Preparedness

2010 EDITION

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2010 Edition
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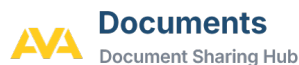
MANUAL ON

OIL SPILL RISK EVALUATION AND ASSESSMENT OF RESPONSE PREPAREDNESS

2010 Edition



London, 2010



Provided by IHS

First published in 2010 by the
INTERNATIONAL MARITIME ORGANIZATION
4 Albert Embankment, London SE1 7SR
www.imo.org

Printed in the United Kingdom by CPI Books Limited, Reading RG1 8EX

ISBN 978-92-801-1512-3

IMO PUBLICATION
Sales number: I579E

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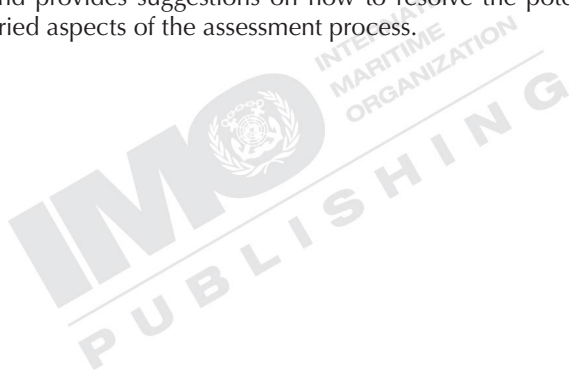
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Purpose of this Manual

Authorities and operators will from time to time, and particularly in connection with the approval of new operations at sea or on shore, need to assess whether the oil spill preparedness arrangements that are in place are appropriate to protect the surrounding environment. It is acknowledged that any effort should, in the first instance, be focused on prevention of spills. However, it is essential to have the capability in place to deal with incidents, should they arise.

This Manual provides guidance on issues that might be considered when undertaking a preparedness assessment, answers key questions that may arise and provides suggestions on how to resolve the potentially complex and varied aspects of the assessment process.





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Preface

This *Manual on Oil Spill Risk Evaluation and Assessment of Response Preparedness* draws on the experience and lessons learned during the past thirty years, by Governments and industry, in connection with marine oil spill contingency planning and response. It provides a clear and concise overview of the present level of knowledge, expertise and understanding in the field. It covers the assessment of oil spills, their volume, causes and the likely consequences and impact on the marine environment. It also considers the type and size of oil spill response capabilities.

It is recognized that each spill presents its own particular challenges for Government and industry, depending on weather conditions, type of oil, location and socio-economic and environmental resources at risk. However, the assessment of risks and the level of preparedness to be established nationally, or at a specific location, should use consistent approaches that are based on past experiences.

In 1990, the International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC 1990) was adopted and entered into force in 2005. This Convention calls on Contracting Parties to establish a national system for responding promptly and effectively to oil pollution incidents and, as appropriate, to establish a minimum level of pre-positioned oil spill response equipment commensurate with the risk involved. This will usually be done in co-operation with the oil and shipping industries, port authorities and other relevant parties.

This Manual provides information on the assessment of the risk, as a basis for consideration and development of the preparedness and response capacity within the context of national or local contingency plans. The Manual also provides guidance that may be useful to Governments in the assessment of the adequacy of a contingency plan established as a requirement under the provisions of national rules and regulations. The information is intended for Governments, particularly those of developing countries, and industry on the most appropriate issues to be considered when assessing risk and when preparing the basis for the development of a national, regional or local contingency plan.

The development of this *Manual on Oil Spill Risk Evaluation and Assessment of Response Preparedness* was undertaken by the OPRC-HNS Technical Group and approved by the Marine Environment Protection Committee (MEPC) of IMO at its fifty-eighth session. The MEPC wishes to express its appreciation to the many experts who assisted in the preparation of the Manual and who contributed photographs, illustrations and reference data.



IMO I579E 2010

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.

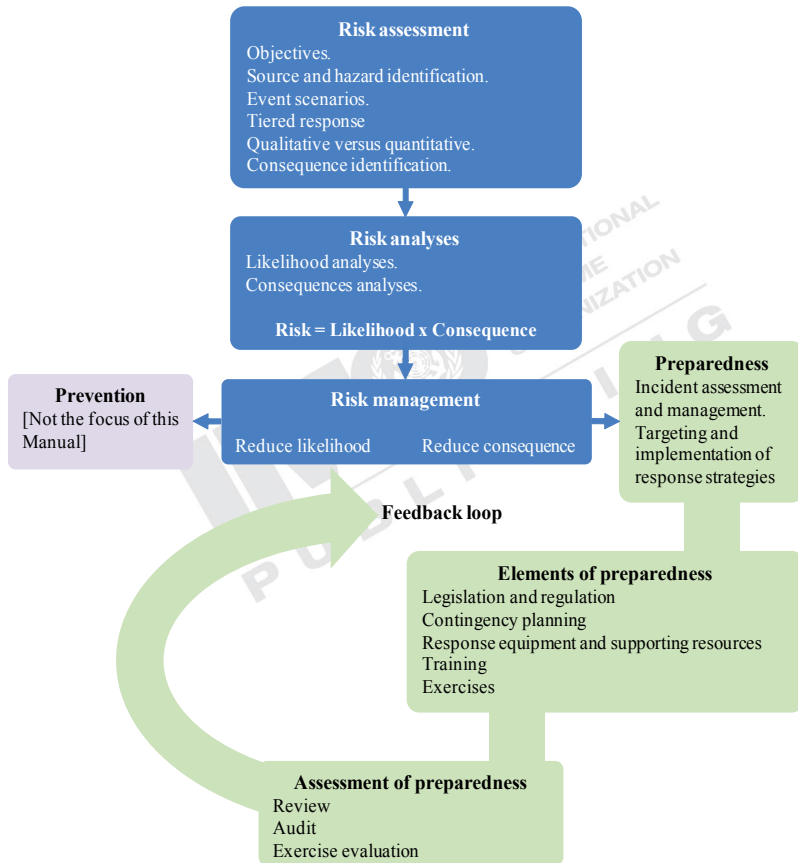


Figure 1 – Overview of risk assessment and management, preparedness development and assessment processes

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
- transshipment 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.*