UNEP-PNUE

MEDITERRANEAN ACTION PLAN (MAP)
REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

10th Meeting of the Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC)

REMPEC/WG.32/9/1
Date: 15 April 2011

Malta, 3-5 May 2011

Original: English Only

Agenda Item 9

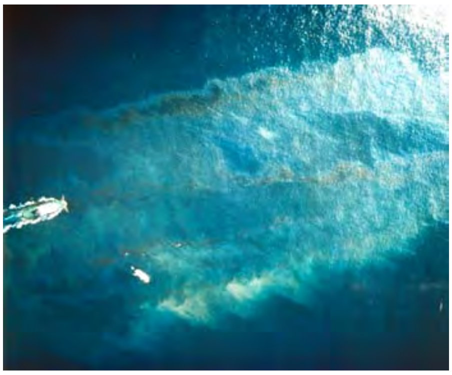
PROGRESS REPORT OF THE MEDITERRANEAN TECHNICAL WORKING GROUP (MTWG)

ANNEX II

GUIDELINES FOR THE USE OF DISPERSANTS FOR COMBATING OIL POLLLUTION AT SEA IN THE MEDITERRANEAN REGION

Part I:	Regional approval.
Part II:	Basic information on dispersants and their application.
Part III:	Outline and template for a national policy on the use of dispersants.
Part IV:	Operational and technical sheets.





Guidelines for the use of dispersants

for combating oil pollution at sea in the Mediterranean region

Part I: Regional approval

MEDITERRANEAN ACTION PLAN (MAP)
REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)


REGIONAL MARINE POLLUTION EMERGENCY

RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

MEDITERRANEAN ACTION PLAN

Guidelines for the use of dispersants for combating oil pollution at sea in the Mediterranean region

Part I: Regional approval

Regional Information System – Part D, Section 2 (RIS/D/2)

www.rempec.org

April 2011 Edition

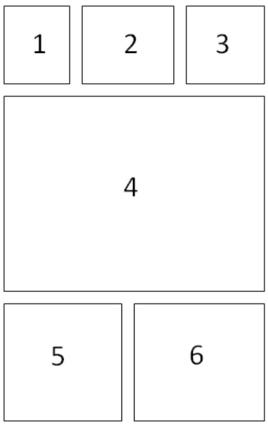
Note

This document is aimed at facilitating the implementation of the “Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency” of the Barcelona Convention (Emergency Protocol, 1976) and the “Protocol concerning Co-operation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea” (Prevention and Emergency Protocol, 2002) by the Contracting Parties of the Barcelona Convention.

These "Guidelines", which are advisory, do not affect in any way already existing or planned national laws and regulations related to matters covered by it. REMPEC assumes no liability whatsoever for any potentially damaging consequences which could result from the interpretation and use of information presented in this document.

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of IMO, UNEP, MAP and REMPEC concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries.

Cover photos: © Cedre



Helicopter mounted spraying system

Airborne treatment

Aerial monitoring operation

Ship mounted spraying system

Airborne treatment

Shipborne treatment

The Guidelines are downloadable from REMPEC’s website (www.rempec.org) in the section “Information resources/Regional Guidelines/Preparedness & Response”.

For bibliographic purposes this document should be cited as follows:

IMO/UNEP: Regional Information System; Part D – Operational Guidelines and Technical Documents, Section 2, Guidelines for the use of dispersants for combating oil pollution at sea in the Mediterranean region, REMPEC, April 2011 edition.

Foreword

In a large part of the Mediterranean coastal States, the use of dispersants as a response method for combating accidental oil spills at sea has not as yet been covered by specific national regulations.

Controlled and appropriate use of selected dispersants on types of oil amenable to chemical dispersion, is widely recognized as one of the useful methods for combating accidental oil spills, and in particular the massive ones. Moreover, under certain sea and weather conditions the use of dispersants might be the only applicable response method for protecting sensitive natural resources, coastal installations or amenities.

However, the opportunistic attitude regarding the use of dispersants is hardly acceptable. Selection of products which might be used, definition of zones in which their use is either allowed or prohibited and their place in the general strategy of pollution response need to be adequately regulated if the use of dispersants is expected to produce desired results without creating additional risks for the environment.

Considering the developments in the field of dispersants since the October 1998 edition of the "Guidelines for the Use of Dispersants for Combating Oil Pollution at Sea in the Mediterranean Region", the Ninth Meeting of the Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta, 21-24 April 2009, tasked the Mediterranean Technical Working Group (MTWG) to review their content.

This new edition of the Guidelines [endorsed by the Tenth Meeting of the Focal Points of REMPEC, Malta, 3-5 Mai 2011] has been prepared with the technical support of the 'Centre of Documentation, Research and Experimentation on Accidental Water Pollution' (CEDRE) and reviewed by the Centre in collaboration with the MTWG.

They aim at assisting the Mediterranean coastal States in developing and harmonizing national laws and regulations regarding the use of dispersants in response to oil spills at sea. It does not refer to the use of dispersants on shore.

The Guidelines are divided into four independent parts addressing different issues. Each part has been developed with a specific objective and is aimed at different end-users:

PART I REGIONAL APPROVAL

Part I which remains unchanged when compared to the version adopted by the Eighth Ordinary Meeting of the Contracting Parties to the Barcelona Convention (UNEP (OCA)/MED IG.3/5, Appendix I, Antalya, Turkey 15 October 1993), provides regionally approved guidance for the development of national laws and regulation on the use of dispersants.

PART II BASIC INFORMATION ON DISPERSANTS AND THEIR APPLICATION

Part II provides theoretical information on dispersants and their application. It is aimed at providing background information on the matter to any person interested in the subject.

PART III OUTLINE AND TEMPLATE FOR A NATIONAL POLICY ON THE USE OF DISPERSANTS

Part III has been prepared with a view to assisting coastal States in the development of their national policy on the use of dispersants. It has been developed as a template which can be followed and adapted by the authorities in charge of the development/maintenance of the national policy on the use of dispersants and can also be used for the implementation of national or local contingency plan for dispersants.

PART IV OPERATIONAL AND TECHNICAL SHEETS

Part IV is based on the publication entitled “Using dispersant to treat oil slicks at sea. Airborne and shipborne treatment. Response manual” (CEDRE 2005). It provides a set of practical technical sheets which point out the different operational issues when using dispersants. It has been developed for operational users with a view to providing them with the required knowledge for efficient dispersant application.

In order to keep the coastal States regularly informed of the current situation regarding the use of dispersants, REMPEC shall update this document to include any new and significant developments in the research field.

GUIDELINES FOR THE USE OF DISPERSANTS FOR COMBATING OIL POLLUTION AT SEA IN THE MEDITERRANEAN REGION

P A R T I

REGIONAL APPROVAL

TABLE OF CONTENTS

P A R T I

REGIONAL APPROVAL

INTRODUCTION

With a view to implementing the Protocol Concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency (Barcelona, 16 February 1976),

The Contracting Parties to the Barcelona Convention,

have approved the following Guidelines in order to guide the Mediterranean coastal States in developing and harmonizing their national laws and regulations regarding the use of dispersants in combating accidental marine oil pollution.

1. SCOPE

1.1 These Guidelines apply to the conditions and limits of the use of dispersants in combating accidental marine oil pollution.

They rely on the state-of-the-art in the field of the use of dispersants, as presented in Part 1 prepared by REMPEC on the basis of currently available technical literature.

1.2 These Guidelines which are advisory guidelines, do not affect in any way existing and future national laws and regulations related to matters covered by them and compatible with their objectives.

2. DEFINITIONS

For the purpose of these Guidelines:

"Dispersant" means a mixture of surface active agents in one or more organic solvents, specifically formulated to enhance the dispersion of oil into the sea water column by reducing the interfacial tension between oil and water.

"Regional Information System" (hereinafter referred to as "RIS") means a set of written documents and computerized databanks, models and a decision-support system which REMPEC compiles, prepares, keeps up-to-date, publishes and regularly disseminates to the Mediterranean coastal States, comprising necessary information on various aspects of preparedness for and response to accidental marine pollution by oil and other harmful substances.

3. GENERAL PRINCIPLES

3.1 Each Mediterranean coastal State shall endeavour to take the necessary measures to ensure that when dispersants are used for combating accidental marine oil pollution within its territorial waters or during combating operations conducted under its authority outside its territorial waters according to international law, these are used in an appropriate way with a view to reducing the negative effects of such pollution and, in particular, with a view to minimizing its overall effect on the marine environment.

3.2 Each Mediterranean coastal State shall endeavour to take the appropriate steps necessary to define its policy regarding the use of dispersants in combating accidental oil pollution, applying the principle of prior authorization for the use of dispersants.

3.3 Each Mediterranean coastal State shall endeavour to take the necessary measures to ensure that national regulations regarding the use of dispersants, including any limitations for their use, are clearly reflected in the national contingency plan for accidental oil pollution combating, as well as in any bilateral or multilateral operational agreement concerning co-operation and mutual assistance in response to accidental marine oil spills.

3.4 With a view to facilitating international co-operation in combating massive oil spills which may threaten the interests of one or more coastal States, each Mediterranean coastal State should make available to the other Mediterranean coastal States, information concerning its policy regarding the use of dispersants. Such information should be made available through the RIS.

3.5 If necessary, each State shall make all necessary arrangements, in liaison with other States, in order to eliminate dispersants which have reached their expiry date.

4. USE OF DISPERSANTS IN COMBATING ACCIDENTAL MARINE OIL POLLUTION

4.1 It is the sovereign right of each Mediterranean coastal State to prohibit within its territorial sea the use of dispersants for combating accidental marine oil pollution.

4.2 Each Mediterranean coastal State which considers the use of dispersants as one of the possible methods for combating accidental marine oil pollution and which incorporates this method in its oil pollution response strategy shall adopt rules and regulations regarding:

- requirements for the use of dispersants;
- restrictions on the use of dispersants;
- conditions for the use of dispersants.

4.2.1 Requirements for the use of dispersants

(i) Within the powers given to the On-Scene Commander by the competent national authorities, he shall take the decision to use dispersants, taking into account the applicable national rules and specific circumstances of the accident and shall rely on the advice given by specialized organizations.

(ii) Only dispersants which have been approved for use in the territorial waters of a respective coastal State shall be eligible for such an authorization, taking into account the reservations mentioned in (b) below.

a) Approval for use may be granted by the competent national authorities to products satisfying certain established and defined criteria, concerning at least the product efficiency, toxicity and possibly biodegradability.

b) Coastal States which have no defined testing and approval procedures or do not possess the necessary means to carry out the tests, may approve for use in its territorial waters products approved for use by another State, taking into consideration the compatibility of standards adopted by each State concerned.

c) When granting approvals for use of particular products in its territorial waters, competent national authorities shall take into consideration the changes in original properties of dispersants which may occur with aging and the lack of sufficient scientific knowledge of these processes. Accordingly, they may grant such approvals for only a limited period of time or stipulate periodical checking of original properties of approved products.

d) Competent national authorities shall prohibit the use of products whose properties have changed beyond acceptable standards due to aging. According to circumstances, all such products shall be either recuperated or destroyed, disposed of and/or used for other purposes.

4.2.2 <u>Restrictions on the use of dispersants</u>

(i) Each coastal State shall endeavour to designate zones, precisely defining their geographical boundaries, where the use of dispersants is either allowed (subject to prior authorization), limited or prohibited.

(ii) Such zones shall be designated with a view to protecting particularly sensitive marine ecosystems and/or preventing negative effects of dispersed oil on industrial or other installations in zones not considered as environmentally sensitive.

(iii) In designating such zones, competent national authorities shall take into consideration, at least:

- the environmental sensitivity of the area (specific habitats, fish spawning areas, shellfish breeding areas, seasonal changes in the environment, etc.);

- the oceanographic features of the area (sea depths, currents, wave energy, etc.);

- the distance from the shore and the type of adjacent coastal formations.

(iv) Once such zones have been designated, the competent national authorities responsible for the preparation of national contingency plans, shall endeavour to prepare maps showing the geographical limits of these zones and to include these maps in their respective contingency plans.

(v) When updating contingency plans and in particular as regards the zones where dispersants can be used, the competent national authorities may take into consideration assessment studies on the impact of the use of dispersants during previous pollution events.

4.2.3 <u>Conditions for the use of dispersants</u>

With a view to achieving the maximum effectiveness of dispersants' treatment and to minimizing any possible deleterious effects of such treatment, each Mediterranean coastal State shall include in the operational part of its contingency plan, precise technical conditions for the use of dispersants, regarding *inter alia*:

- types and characteristic of oil which might be chemically dispersable;

- recommended application techniques;

- recommended dosages of dispersants;

- limits of weather/sea state conditions in which the use of dispersants could be envisaged.

4.3 All such requirements, restrictions and conditions for the use of dispersants, established by each Mediterranean coastal State individually, should be reflected in their respective national contingency plans and taken into consideration in any bilateral or multilateral operational agreements concerning response to accidental marine oil pollution which the coastal States may wish to enter into.

5. REGIONAL CO-OPERATION

5.1 Mediterranean coastal States shall exchange the information concerning their respective national policies regarding the use of dispersants, including *inter alia* information on products approved for use, criteria for approval of products, laboratories authorized to perform testing of products, restrictions and conditions for use of dispersants. Such information will be disseminated through RIS.

5.2 Mediterranean coastal States agree to mutually accept, in joint response operations in case of emergency, the policy regarding the use of dispersants of the coastal State in whose territorial waters the response operations are carried out.

5.3 In all such cases, the competent national authorities of the affected coastal State agree to consider authorization for use in their territorial waters of dispersants approved by the assisting coastal State, providing that such approval was granted in conformity with the principles on which these Guidelines are based.

5.4 Mediterranean coastal States shall endeavour to co-operate in developing compatible testing procedures for approval for use of products commercially available with a view to eventually harmonizing such testing procedures.

5.5 Mediterranean coastal States shall endeavour to facilitate the transfer of technology among themselves with regard to the use of dispersants, in particular through REMPEC.

5.6 If a State, affected by pollution, does not possess the pre-established national regulations for the use of dispersants, it shall seek the most qualified advice and endeavour to take into account the regulations of the neighbouring States.

6. ROLE OF REMPEC

6.1 REMPEC shall continue to collect and disseminate, through RIS, information concerning:

a) the state-of-the-art in the field of using dispersants in marine oil pollution response;

b) new products and application techniques;

c) research on the process of aging of stored dispersants and related developments;

d) policy, including rules and regulations of the Mediterranean coastal States regarding the use of dispersants;

e) products approved for use in the Mediterranean coastal States;

f) delineation of zones for the use of dispersants established by the coastal States;

g) testing procedures adopted by the Mediterranean coastal States;

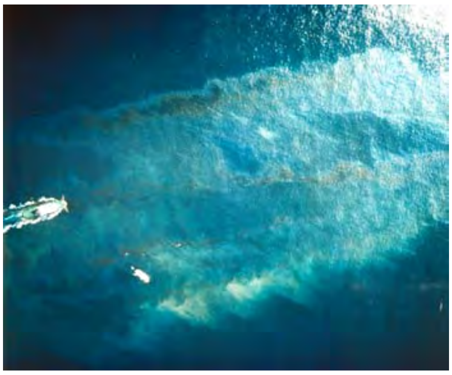
h) laboratories authorized to test dispersants on behalf of the competent national authorities in their respective countries.

6.2 At the request of the competent national authorities of the Mediterranean coastal States, REMPEC shall provide advice and technical assistance concerning all aspects of developing national policies regarding the use of dispersants.

6.3 REMPEC shall organize training activities on the use of dispersants aimed at personnel involved in planning and response, either by including these activities in general training courses or by organizing specialized courses.

6.4 REMPEC shall maintain updated versions to the Parts of these Guidelines taking into consideration acquired experience and technology developments on the one hand and information provided by the member States on the other hand. It shall submit to the Contracting Parties for approval the modifications to be introduced in these Guidelines themselves.

REMPEC
MARITIME HOUSE, LASCARIS WHARF, VALLETTA VLT 1921, MALTA
rempec@rempec.org - www.rempec.org



Guidelines for the use of dispersants

for combating oil pollution at sea in the Mediterranean region

Part II: Basic information on dispersants and their application

MEDITERRANEAN ACTION PLAN (MAP)
REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

REGIONAL MARINE POLLUTION EMERGENCY

RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

MEDITERRANEAN ACTION PLAN

Guidelines for the use of dispersants for combating oil pollution at sea in the Mediterranean region

Part II: Basic information on dispersants and their application

Regional Information System – Part D, Section 2 (RIS/D/2)

www.rempec.org

April 2011 Edition

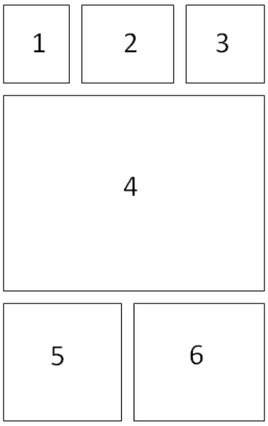
Note

This document is aimed at facilitating the implementation of the "Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency" of the Barcelona Convention (Emergency Protocol, 1976) and the "Protocol concerning Co-operation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea" (Prevention and Emergency Protocol, 2002) by the Contracting Parties of the Barcelona Convention.

These "Guidelines", which are advisory, do not affect in any way already existing or planned national laws and regulations related to matters covered by it. REMPEC assumes no liability whatsoever for any potentially damaging consequences which could result from the interpretation and use of information presented in this document.

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of IMO, UNEP, MAP and REMPEC concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries.

Cover photos: © Cedre



Helicopter mounted spraying system

Airborne treatment

Aerial monitoring operation

Ship mounted spraying system

Airborne treatment

Shipborne treatment

The Guidelines are downloadable from REMPEC's website (www.rempec.org) in the section "Information resources/Regional Guidelines/Preparedness & Response".

For bibliographic purposes this document should be cited as follows:

IMO/UNEP: Regional Information System; Part D – Operational Guidelines and Technical Documents, Section 2, Guidelines for the use of dispersants for combating oil pollution at sea in the Mediterranean region, REMPEC, April 2011 edition.

Foreword

In a large part of the Mediterranean coastal States, the use of dispersants as a response method for combating accidental oil spills at sea has not as yet been covered by specific national regulations.

Controlled and appropriate use of selected dispersants on types of oil amenable to chemical dispersion, is widely recognized as one of the useful methods for combating accidental oil spills, and in particular the massive ones. Moreover, under certain sea and weather conditions the use of dispersants might be the only applicable response method for protecting sensitive natural resources, coastal installations or amenities.

However, the opportunistic attitude regarding the use of dispersants is hardly acceptable. Selection of products which might be used, definition of zones in which their use is either allowed or prohibited and their place in the general strategy of pollution response need to be adequately regulated if the use of dispersants is expected to produce desired results without creating additional risks for the environment.

Considering the developments in the field of dispersants since the October 1998 edition of the "Guidelines for the Use of Dispersants for Combating Oil Pollution at Sea in the Mediterranean Region", the Ninth Meeting of the Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta, 21-24 April 2009, tasked the Mediterranean Technical Working Group (MTWG) to review their content.

This new edition of the Guidelines [endorsed by the Tenth Meeting of the Focal Points of REMPEC, Malta, 3-5 May 2011] has been prepared with the technical support of the 'Centre of Documentation, Research and Experimentation on Accidental Water Pollution' (CEDRE) and reviewed by the Centre in collaboration with the MTWG.

They aim at assisting the Mediterranean coastal States in developing and harmonizing national laws and regulations regarding the use of dispersants in response to oil spills at sea. It does not refer to the use of dispersants on shore.

The Guidelines are divided into four independent parts addressing different issues. Each part has been developed with a specific objective and is aimed at different end-users:

PART I REGIONAL APPROVAL

Part I which remains unchanged when compared to the version adopted by the Eighth Ordinary Meeting of the Contracting Parties to the Barcelona Convention (UNEP (OCA)/MED IG.3/5, Appendix I, Antalya, Turkey 15 October 1993), provides regionally approved guidance for the development of national laws and regulation on the use of dispersants.

PART II BASIC INFORMATION ON DISPERSANTS AND THEIR APPLICATION

Part II provides theoretical information on dispersants and their application. It is aimed at providing background information on the matter to any person interested in the subject.

<u>PART III</u> <u>OUTLINE AND TEMPLATE FOR A NATIONAL POLICY ON THE USE OF DISPERSANTS</u>

Part III has been prepared with a view to assisting coastal States in the development of their national policy on the use of dispersants. It has been developed as a template which can be followed and adapted by the authorities in charge of the development/maintenance of the national policy on the use of dispersants and can also be used for the implementation of national or local contingency plan for dispersants.

<u>PART IV</u> <u>OPERATIONAL AND TECHNICAL SHEETS</u>

Part IV is based on the publication entitled "Using dispersant to treat oil slicks at sea. Airborne and shipborne treatment. Response manual" (CEDRE 2005). It provides a set of practical technical sheets which point out the different operational issues when using dispersants. It has been developed for operational users with a view to providing them with the required knowledge for efficient dispersant application.

In order to keep the coastal States regularly informed of the current situation regarding the use of dispersants, REMPEC shall update this document to include any new and significant developments in the research field.

GUIDELINES FOR THE USE OF DISPERSANTS
FOR COMBATING OIL POLLUTION AT SEA
IN THE MEDITERRANEAN REGION

P A R T II

BASIC INFORMATION ON DISPERSANTS AND THEIR APPLICATION

TABLE OF CONTENTS

PART II

BASIC INFORMATION ON DISPERSANTS AND THEIR APPLICATION

1. INTRODUCTION

Since their first application on a large scale (in the aftermath of the "Torrey Canyon" oil spill in 1967), the use of dispersants as a response method for combating accidental oil spills has remained a controversial issue. Although often recognized by clean-up specialists as one of the most effective methods for dealing with oil spills, chemical dispersion of spilled oil has numerous setback. The controversy partly stems from lack of information, prejudice and misunderstanding of the action of dispersants. The opposition to using dispersants is often also inspired by the results of their insufficiently planned or improper application. The use of dispersants, especially the decision making process as well as the application process, need to be planned carefully at national level and supported by an appropriate rational stated in a policy.

A relatively small number of countries in the Mediterranean region have a clearly defined policy regarding the use of dispersants. The current status on the policy of use of dispersant in Mediterranean Coastal States can be consulted on REMPEC's Country Profile (http://www.rempec.org/country.asp) available on REMPEC's website (www.rempec.org). The lack of a clear policy regarding dispersants and their use inevitably results in heated discussions at the time of the spill.

The objective of this document is to provide relevant, up to date information on dispersants and their place in oil spill response strategy, which may help the Mediterranean coastal States in creating their policy regarding the use of these products in combating accidental oil pollution. In this respect the document proposes, in Part III, a standard policy for the use of dispersants to be used as a model and adapted by States which would set their National Policy on the Use of Dispersant.

Generally speaking a policy for the use of dispersants should be based on a full understanding of the action of dispersants and currently utilized application methods and operational practices, as well as on adopting compatible and, if possible, standardized procedures for testing and assessing efficiency, toxicity and biodegradability of dispersants and oil/dispersants mixtures.

2. THE MEDITERRANEAN SEA: BASIC CONSIDERATIONS

Despite the fact that the Mediterranean sea is an almost closed sea, with limited exchange of water with the open Atlantic ocean, generally speaking the volume of the surface sea water concerned by the dispersion process remains quasi infinite regarding the size of a possible major oil spill, and would allow a full dilution of a dispersed oil plume and a return to the background level in such a case.

However, close to the shore and/or in shallow waters the dilution process can meet locally some limitations which should be taken into consideration in the decision to use dispersants.

Considering the use of dispersants, the Mediterranean surface water is salty water (between 37 and 39.50 g/L from the West to the East) except in the very North of the Aegean Sea due to the Black sea water supply (18g/L) and close to some large river estuaries or delta.

The surface water temperature is generally comprised between 18 and 24 °C. Close to the coast the surface water temperature can exceed 24 °C while during winter in northern parts it can drop (e.g. Adriatic Sea, 14 °C…)[1].

Surface area (total) 2000 - 3000 m depth contour less than 200 m depth contour	2.5×10^6 km^2 30% 20%
Volume- less than 200 m depth contour	55.5 10^3 Km^3
Salinity of surface water	36 to 39.5
Temperature of surface seawater (average)	18 to 24 °C

Tides in the Mediterranean are generally regarded as weak, i.e. tidal amplitudes are much lower than in the oceans.

Figure 1: Map of the Mediterranean Sea

3. GENERAL NOTIONS ON DISPERSANTS

3.1 Definition

Oil spill dispersants are mixtures of surface active agents in one or more organic solvents, specifically formulated to enhance the dispersion of oil into the sea-water column by reducing the interfacial tension between oil and water. Natural or induced movement of water causes a rapid distribution within the water mass of very fine oil droplets formed by the dispersant action, thus enhancing the biodegradation processes. At the same time, oil that

[1] 1969-Pr P Tchernia-Cours d'Océanographie Régionale- Service Hydrographique et Océanographique de la Marine.

is dispersed is no longer subject to the action of wind which makes it drift towards the coast or other sensitive areas. Moreover, dispersants prevent coalescence of oil droplets and reforming of the oil slick.

3.2 History of dispersants

The idea of applying the well known principle of removing a greasy substance by mixing it with a dispersing agent (soap, detergent) and washing it with water was first proposed in the early sixties.

The first extensive use of mixtures of industrial detergents and hydrocarbon aromatics solvents used as dispersants (first generation), in response to the "Torrey Canyon" oil spill in March 1967, unfortunately demonstrated that their toxicity was much too high and that devastating impact on marine life outweighed their efficiency as pollution clean-up agents.

Very soon after, new formulations environmentally acceptable made of less toxic surfactants much less toxic low-aromatic or non-aromatic hydrocarbons (e.g. low aromatic kerosene or high boiling solvents containing branched saturated hydrocarbons) appeared on the market. These new products became known as "second generation" dispersants or referred to as “conventionals” and are less and less in use nowadays.

Dispersants of "the third generation" often referred to as "concentrates" appeared by the mid seventies. These mixtures of emulsifiers, wetting agents and oxygenated solvents which have an higher content of active components (surfactants) and less solvents are more efficient than "the second generation" dispersants and therefore can be used at lower [dispersant – oil] dosage than the conventionals .They can be applied from boat neat or pre-diluted into seawater, or by aircrafts (always neat). Most of the products marketed today belong to this category.

Since their appearance, dispersants have been used during numerous oil spills of various sizes all over the world and they became an important tool in responding to oil spills. Development of new products was followed by the development of application techniques and by significant scientific research in the field of environmental effects of dispersants and dispersed oil.

Figure 2: Slicks being dispersed by a helicopter

3.3 Nomenclature of dispersants

The following table summarizes the nomenclature of current dispersants. Dispersants are classified basically into 2 classes: second and third “generations”, commonly called conventionals and concentrates. Aside this classification, the U.K. authorities classified dispersants according to the generation and to the application method for which the product has been approved in the U.K.: type 1, conventional dispersant; type 2 concentrates approved to be applied pre-diluted into sea water (from boats); type 3, concentrates approved to be applied neat (from boats or aircrafts).

The table below gives a comparative presentation of these systems:

GENERATION	STANDARD NAME	DISPERSANT-OIL DOSAGE	TYPE OF SOLVENT	TYPE	APPROVED TO BE APPLIED (U.K.)
2nd	Conventional dispersants	High dispersant dosage: 30 – 50% of the oil quantity	Non-aromatic hydrocarbons	1	Undiluted (neat), from vessels
3rd	Concentrate dispersants	Low dispersant dosage: 5 –10% of the oil quantity	Oxygenates (e.g. glycol ethers) and non-aromatic hydrocarbons	2	Diluted, from vessels
				3	Undiluted (neat), from vessels and/or aircraft

Figure 3: Plume of dispersed oil at sea

3.4 <u>Composition of dispersants</u>

Oil spill dispersants are composed of two main groups of components:

- surface active agents (surfactants)
- solvents

Surfactants (or surface active agents) are chemical compounds with molecules composed of two dissimilar parts; a “water-loving” (hydrophilic) part and an “oil-loving” (oleophilic) part. Surfactants act as a ’chemical bridge’ between oily materials and water and enable these two phases to mix with each other more easily (in other word the surfactant molecules when migrating to the oil – water interface, contribute to reduce the interfacial tension between oil and water). Therefore, the natural agitation (e.g. waves) can break the oil into myriads of tiny droplets which disseminate as a plume into the top layers of the water column.

In order to improve the performance of the dispersant, several surfactants are often combined but only nonionic and anionic surfactants are used in modern formulations:

⇨ <u>nonionic surfactants</u>: sorbitan esters of oleic or lauric acid, ethoxylated sorbitan esters of oleic or lauric acid, polyethylene glycol esters of oleic acid, ethoxylated and propoxylated fatty alcohols, ethoxylated octylphenol.

- ⇨ anionic surfactants: sodium dioctyl sulfosuccinate, sodium ditridecanoyl sulfosuccinate.

Solvents are liquid chemicals or their mixtures added to dispersants in order to dissolve solid surfactants, to reduce the viscosity of the product thus enabling uniform application, to enhance the solubility of the surfactant in the oil and/or to depress the freezing point of the dispersant. Solvents may be divided in 3 main groups: (a) water, (b) water miscible hydroxy compounds and (c) hydrocarbons. Hydroxy compounds used in dispersant formulations include ethylene glycol monobutyl ether, diethylene glycol monomethyl ether and diethylene glycol monobutyl ether. Hydrocarbon solvents used in modern dispersants include odourless, low aromatic kerosene and high boiling solvents containing branched saturated hydrocarbons.

The two groups of modern dispersants have approximately the following composition:

Conventional (2nd generation) dispersants	Concentrate (3rd generation) dispersants
10 to 25% surfactant	25 to 60% surfactant
Hydrocarbon solvent	Polar organic solvent or mixed with hydrocarbon solvent

Figure 4: Dispersant stockpile in drums

Table: Typical compounds used in dispersant formulations

<table>
<tr><th>Generation</th><th>Description</th><th>UK Type</th><th>Surfactants</th><th>Solvents</th></tr>
<tr><td>Second</td><td>Hydrocarbon-base, Conventional</td><td>Type 1</td><td>(i) Fatty acid esters
(ii) Ethoxylated fatty acid esters</td><td>Light petroleum distillates:
Odourless or de-aromatised kerosene
Low aromatics (less than 3% wt.) kerosene
CAS No. 64742-47-8
EC No. 265-149-8</td></tr>
<tr><td rowspan="2">Third</td><td>Water-dilutable concentrate</td><td>Type 2</td><td rowspan="2">(i) Fatty acid esters or sorbitan esters such as Span™ series
CAS No.1338-43-8
(ii) Ethoxylated fatty acid esters (PEG esters) or ethoxylated sorbitan esters such as Tween™ series
CAS No. 103991-30-6
(iii) Sodium di-iso-octyl sulphosuccinate
EC No. 209-406-4
CAS No. 577-11-7</td><td rowspan="2">Glycol ethers such as:
Ethylene glycol
Dipropylene glycol
2-butoxyethanol (Butyl Cellosolve™)
CAS No. 111-76-2
Di-propylene glycol monomethyl ether
CAS No. 34590-94-8
EC No. 252-104-2
Light petroleum distillates:
Hydrotreated light distillates
CAS No 64742-47-8
EC No. 265-149-8</td></tr>
<tr><td>Concentrate</td><td>Type 3</td></tr>
</table>

4. USE OF DISPERSANTS IN THE OIL SPILL RESPONSE STRATEGY

Chemical dispersion is one of the response options at sea, with “mechanical recovery associated with containment”, and “do nothing and monitor the spill”, and (for general reference) “in situ burning”.

The use of dispersants in oil spill response has a number of advantages:

- By removing the oil from the surface it helps to stop the wind effect on the oil slick’s movement that may otherwise push the surface slick towards sensitive areas (often the shoreline).
- In contrast to containment and recovery, dispersants can be used in stronger currents and greater sea states.
- It is often the quickest response option.
- It reduces the possibility of contamination of some resources sensitive to the floating oil (surface slick) such as sea birds and mammals.
- It inhibits the formation of "chocolate mousse".
- It enhances the natural degradation of oil.
- Dispersion does not produce wastes to be disposed.

The use of dispersants has also its disadvantages:

- By dislocating the floating oil into the water column, it may adversely affect certain parts of biota which otherwise would not be reached by surface oil otherwise.
- If dispersion of oil is not achieved, effectiveness of other response methods on oil treated by dispersants decreases.
- Dispersant are not efficient towards all oil pollutants, especially those which present a high viscosity.
- When initially efficient, chemical dispersion is applicable only for the first hours/days of the operation, before the oil becomes non dispersible.
- On significant pollution, chemical dispersion is not applicable in a too calm sea state (sea state 0, 1 possibly 2 according to the situation).
- If used near the shore and in shallow waters, it may increase the penetration of oil into the sediments; similarly, if suspended sediments are present, dispersants facilitate the adhesion of oil to the particles.
- It introduces an additional quantity of extraneous substances into the marine environment.

Figure 5: Aerial dispersant application with a DC3 aircraft from the UK authorities (source MPCU)

The possibility of balancing properly these advantages and disadvantages decreases in an emergency situation, and accordingly the use of dispersants and its place in a general response strategy for oil spills needs to be defined in advance. Where and under which circumstances the use of dispersants will be given priority over other available combating methods needs to be analysed and decided during the preparation of the contingency plan. By evaluating different interests for each particular zone, geographical boundaries may be defined within which dispersants may or may not be used. As a general rule, dispersants should not be used in the areas with poor water circulation, near fish spawning areas, coral reefs, shellfish beds, wetland areas, and industrial water intakes (Refer to Part III of these Guidelines).

Massive oil spills also often necessitate international co-operation. Application of dispersants may be a part of the assistance offered to a country confronted with such a spill. In order to facilitate inclusion of offered assistance in the national response activities, some countries or groups of countries (Bonn Agreement countries) have agreed to mutually accept the application of products approved for use by each country, in case of emergency. Part I ("Regional Appoval") of these Guidelines provides guidance on regional cooperation.

When such a general policy has been adopted in advance, a final decision on the use of dispersants in a spill situation will have to be taken only on the basis of given circumstances (type of oil, conditions, availability of material and personnel, etc.). The preparation of decision trees to help responsible officers greatly facilitates this process (Refer to the Annex of Part III of these Guidelines).

Taking a decision on the use of dispersants is one of the priorities in each spill situation since relatively shortly after the spillage most oils will no longer be amenable to chemical dispersion.

Once the decision to use dispersants has been taken, the strategy of their use becomes decisive for the positive outcome of the operation. From a strategic viewpoint some basic principles in this regard can be defined:

- dispersants should be applied to the spill as early as possible;
- dispersant spraying operation should be terminated when the oil reaches the state of weathering (viscosity, mousse formation) in which it is not readily dispersed anymore;
- if the oil is approaching a sensitive area, dispersants should be applied to the part of the slick nearest to it.

In case of a massive oil pollution affecting an extensive area, it is possible and often necessary to use a combination of spill response methods. In such situations dispersants can be used on one part of the slick at the same time when oil is mechanically recovered on the other end of it.

On location dispersant should be applied according to specific operational rules such as:

- dispersants should be applied to thick and medium thick parts of the slick and not to the low thickness areas (sheen);
- treatment should be methodical, in parallel and contiguous or slightly overlapping runs;
- it is important to treat the slick against the wind;
- vessels are suitable for treatment of smaller spills near the shore, but aircrafts permit a rapid response (less than 24 hours after the spillage), in particular when large offshore spills are concerned;
- regardless of whether dispersants are sprayed from vessels or aircraft, spotter aircraft should be used for guiding them and assessing the results.

Figure 6: Spotter aircraft of the British Maritime Coastguard

Visual aerial observation, complemented with photography, video recording or using one of the available remote sensing techniques should be used for evaluating the results of the application of dispersants. Such reports and records can be also used for record keeping purposes.

Finally, from a practical viewpoint, countries which decide to consider the use of the chemical dispersion in the response strategy need to pay particular attention to:

a) storage of sufficient quantities of selected and approved products;

b) procurement and maintenance of adequate spraying equipment;

c) training of personnel on all aspects of dispersants use, including organizing practical exercises at regular intervals.

5. FACTORS AFFECTING THE ACTION OF DISPERSANTS

Regardless of the application **technique** (Chapter 10) and **dosage** used (Chapter 9), dispersant action will primarily be determined by:

- type of oil to be treated;
- contact dispersant/oil;
- mixing;
- weather conditions.

5.1 Type of oil

Characteristics determining the **type of oil** which can be chemically dispersed are basically:

a) Viscosity:

Only oils with **viscosity at seawater (ambient) temperature** of not more than 5 000 cSt (most fresh crudes, medium fuel oils) are considered to be chemically dispersible by presently existing products. Chemical dispersion of oils with viscosity between 5 000 and 10 000 cSt may be uncertain (reduced); chemical dispersion above 10 000 cSt and (heavy, weathered and emulsified crudes, heavy fuels) is very little or non effective.

Even oils with low initial viscosity are likely to reach quickly the limits proposed above (often 24 hours from the moment of spillage) due to the weathering process. The time during which oil remains dispersible is called “the window of opportunity for dispersion”. It would vary according to the type of oil and the meteorological and oceanographic conditions (mainly temperature, agitation / wind).

The more viscous the oil is the more agitation (waves) is required for its chemical dispersion.

b) Pour point:

Oils with a high paraffin (wax) content i.e. with a high **pour point** can cease to be dispersable if ambient temperature is significantly lower than their pour point.

c) Oil emulsification:

With the emulsification process, the oil viscosity increases, and dispersant are generally not effective on water-in-oil emulsions ("chocolate mousse"). However, when the emulsion is very fresh, (not entirely stabilized) research studies showed that dispersants may be effective; in such a case, the dispersant application can be undertaken in two stages : a first application to break the emulsion and therefore to reduce the oil viscosity, followed with a second application to carry out the dispersion itself.

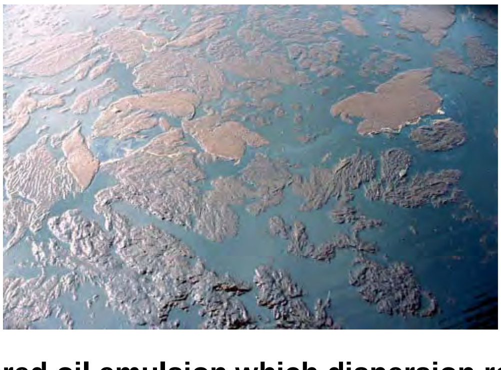


Figure 7: Weathered oil emulsion which dispersion remains uncertain

5.2 Contact dispersant/oil

In order to achieve a good dispersant/oil contact, a dispersant needs to be sprayed onto the floating oil in such a way as **to reach the surface** of oil and **not to penetrate** through the oil layer. These goals are achieved by combining appropriate spraying technique (Chapter 10) and appropriate droplet size. Optimal droplet size is considered to be in the range of 350 and 1000 µm, or approximately 700 µm. Smaller droplets will be carried away by wind and may never reach the oil, while the bigger ones penetrate through the oil layer and enter directly in contact with the water without having sufficient time to bind themselves to the oil. Application spraying system should be chosen to reach such requirements.

5.3 Mixing

Once the dispersant has come in contact with oil and the oleophilic end of its molecule has been attached to oil, the dispersant/oil mixture needs to be agitated in order to be broken down in droplets and dispersed in the sea-water mass.

Natural agitation of the sea surface (waves) is required for completing this process (e.g. sea state 2, Beaufort 3).

In some cases, if the wave energy is insufficient (very calm sea), on limited pollution, the mixing of dispersant/oil system and water can be supplied locally:

- by sailing through the oil slick and stirring it with bow wave and propeller action;
- by mixing oil and water with fire hoses.

Figure 8: Ship applying dispersant
(a part of mixing energy is generated by the bow wave)

5.4 Weather conditions

Chemical dispersion of oil is less affected by adverse **weather conditions** than other spill response methods (e.g. containment and recovery). In addition, weather conditions do not directly affect the physicochemical process of dispersion, but rather the application of dispersants.

Winds may blow the sprayed dispersants away from the target area and consequently cause significant loss of product. In case of the aerial spraying of dispersants, high winds may also affect the safety of spraying aircraft.

Waves: Whilst waves provide the required mixing energy to enable the dispersion process (the more energy the better is the dispersion); large waves or breaking waves can also be an obstacle and render spraying operation difficult for boats. Interaction between dispersant and oil slicks broken by the wave effect can also be reduced since part of the dispersant would be sprayed directly on the water surface rather than on the oil.

Poor **visibility** affects dispersants' action only indirectly through impeding spraying operations.

6. PHYSICAL CHARACTERISTICS OF DISPERSANTS

Some physical properties of dispersants may have practical consequences on the use of these products (application, fire hazard, conservation). For this reason some countries include in their approval procedure some requirements concerning the viscosity and/or pour point, flash point, and stability/shelf life.

6.1 Viscosity

The viscosity of a liquid is defined as its resistance to flow. The unit most commonly used in the Mediterranean region for quantifying viscosity can be the dynamic viscosity in "centipoise" – (cP) or the kinematic viscosity in "centistoke" – (cSt).

Note: in this context, as dispersant density is not far from 1, especially for the concentrates, the units centipoise and centistoke are roughly equivalent.

The viscosity of dispersants depends of the temperature. Typical viscosity range are indicated in the table below:

Dispersant typical viscosity ranges cP/ temperature °C	0 °C	20 °C
Conventionals	10–50	5-25
Concentrates	60–250	30–100

Viscosity has an effect on the dispersant droplets size. In this respect, some countries may require some limitations in the dispersant viscosity (e.g. France dispersant viscosity must be below 80 cP at 20 °C).

6.2 Specific gravity

The ratio of the weight of a solid or a liquid to the weight of an equal volume of water, at some specified temperature.

Conventional dispersants have generally lower specific gravities (0.80 - 0.90) than concentrates (0.90 - 1.05).

6.3 Pour point

The temperature below which this liquid will not flow.

Pour point of most dispersants is well below 0 °C (-40 to -10 °C) and in the conditions prevailing in the Mediterranean these should never solidify.

6.4 Flash point

The lowest temperature at which vapours above the volatile substance will ignite in air when exposed to a flame.
Most dispersants have flash point above 60 °C and should be considered as non-flammable. For practical safety reasons some countries may limit the flash point (e.g. in France dispersant flash point must be higher than 60 °C).

6.5 Stability / Shelf-life

During the period declared by the manufacturer as the shelf-life of the product, its properties should not change. Most manufacturers claim a shelf-life of 5 years or more for their product.

6.6 Others

Certain components of some dispersants may cause the corrosion of the packages (drums or containers) in which the product is stored over the prolonged periods. Accordingly, regulations concerning dispersants in some countries require that the product does not contain such components.

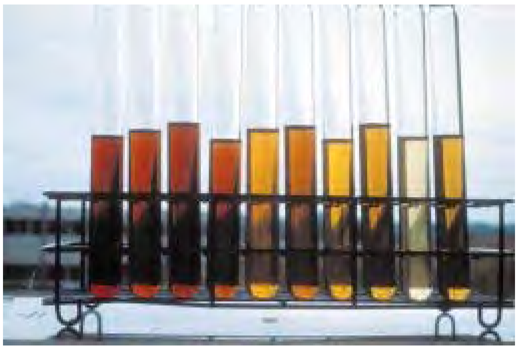


Figure 9: Samples of dispersant during quality control in the laboratory

7. ENVIRONMENTAL EFFECTS

Environmental effects of dispersants' use are mainly related to: (a) the toxicity of dispersants or oil/dispersant mixtures; (b) their influence on microbial degradation of spilled oil; and (c) their effects on seabirds and marine mammals populations.

7.1 Toxicity

Toxicity can be defined as the negative effects on organisms caused by exposure to a chemical or substance.

These negative effects may be lethal (cause death) or sub-lethal (cause negative effects that damage the organism in some way, but do not cause death). Exposure depends on the concentration of the substance and the period of time for which the organism is exposed to.

Toxicity is usually expressed as an effect concentration at a specific time, or as an effect time at a specific concentration. Most often, effect concentrations are expressed as parts per million (ppm) or parts per billion (ppb) and these units are used interchangeably with mg/litre and µg/litre, respectively, minor differences in exact concentrations notwithstanding.

Toxicity of dispersants should be ideally tested *in situ* and on actually present organisms. However, the impracticability of such field tests has led to the development of numerous laboratory testing procedures. Results of such tests should be interpreted very cautiously since the tests are not intended to be ecologically realistic or to predict effects of using dispersants in the field. Most tests use concentrations and exposure duration which substantially exceed expected field exposures. In addition, animals are exposed to more or less constant concentrations for several days, while in the sea initial concentrations of dispersant and/or dispersed oil would be diluted progressively and generally rapidly. Moreover, major errors in interpreting laboratory test results may also originate from the fact that thresholds are most often reported as nominal concentrations (total amount of dispersant or oil divided by the total volume of water in the experimental chamber) rather than measured concentrations of materials to which organisms are actually exposed. Last but not the least, testing conditions may lead to overestimate the oil toxicity. Indeed oil toxicity tests are often performed on fresh oil while, in real situations, the oil would have been partly weathered, for few hours, losing its more toxic compounds (see paragraph below “Toxicity of oil”).

Figure 10: Toxicity tests with shrimps conducted on dispersed oil in UK

Intrinsic toxicity of dispersant

Lethal concentrations of dispersants have been the main concern and most toxicity tests aim at determining these. However, certain sub lethal effects including changes in reproduction, behaviour, growth, metabolism and respiration may also occur when organisms are exposed to levels well below lethal thresholds.

It is to be emphasized that these responses have been noted in laboratory experiments where the duration of exposure is 1 to 4 days, much longer than those expected in most dispersant use situations in open water, and exposure concentrations of reported sub lethal effects normally are 1 or 2 orders of magnitude above highest anticipated concentrations in field use.

Few reports exist of measurements of concentrations following the use of dispersants in the field, however, these suggest that even initial concentrations in the water column are typically below estimated lethal and sub lethal concentrations derived from experiments.

In conclusion, results of studies investigating the effects of dispersants suggest that major effects should not occur in the near-surface waters due to a dispersant alone, provided properly screened dispersants are used at recommended application rates.

Toxicity of oil

Oils of different types contain a small proportion of chemical compounds that are toxic to many marine organisms. Some of the more acutely toxic lower molecular weight compounds (benzene, toluene, ethyl benzene and xylenes, often referred to as BTEX compounds) are also volatile and water-soluble to some degree. Freshly spilled crude oils are much more acutely toxic than modern oil spill dispersants.

Higher molecular weight compounds that are present in low concentrations in many oils that often cause concern over toxicity are the PAHs (Polycyclic Aromatic Hydrocarbons). PAHs are known to be carcinogenic and can cause other effects by chronic exposure.

Toxicity of oil affected by the use of dispersants

Dispersing spilled oil converts the oil from a surface slick to a plume or 'cloud' of very small oil droplets dispersed in the water column. These oil droplets might be ingested by filter feeding organisms, such as copepods, oysters, scallops and clams.

The increase in the oil surface area increases the rate at which partially water-soluble chemical compounds in the oil are transferred into the sea. The localised concentration of these potentially toxic Water Accommodated Fraction (WAF) compounds will rise before they are diluted. This is the justification for the argument that dispersants can never be a valid oil spill response because the use of dispersants, if they are effective, will inevitably cause an increase in the dispersed oil concentration in the water column and leading to toxic effects on marine life. However, it is important to distinguish between:

(i) the increased potential for toxic effects to occur; and,
(ii) the possibility of toxic effects actually occurring.

Dispersed oil concentrations will certainly be higher if dispersants are used, than if they are not. This does not mean that the dispersed oil concentrations will be high enough, or persist for long enough, to cause actual toxic effects. Most spilled oils will naturally disperse to some degree in the initial stages of an oil spill, before the oil becomes emulsified. The successful use of dispersants will obviously increase the concentration of dispersed oil in the sea. However, this is a matter of degree rather than an absolute difference; some spilled oil is likely to naturally dissolve and/or disperse even if dispersants are not used.

By dispersing the oil in the water column the exposure of the organisms living in the upper layer of the water column increases. If the dilution of the plume of dispersed oil in the water column is rapid the exposure will be low: experience from both experimental field trials and dispersant offshore operations at real spills have shown that dispersed oil will quickly be diluted into the sea. The concentration of oil in water rapidly drops from a maximum of 30-50 ppm just below the spill short time after treatment, to concentrations under 1-10 ppm of oil in the top 10-20 meters after a few hours.

Because oil will disseminate in the environment by natural dispersion which is a process that proceeds quite rapidly in rough seas with low viscosity oils, exposure of some marine organisms to dispersed oil at some concentration will occur even when dispersants are not used.

During the "Sea Empress" incident, (Wales 1996), which led to the largest dispersant treatment operation (440 tons of dispersant where applied on fresh crude at sea), oil concentrations were monitored in the upper water column as follows:

Time after dispersant application	Oil concentration in the upper water column (ppm)
Just after treatment	10
2 day s after treatment	1
1 week after treatment	0.5
1 month after treatment	0.2
3 months after treatment	Background level

Figure 11: The Sea Empress incident (UK)

Various studies have been carried out to devise toxicity test methods which expose test organisms in conditions closer to the real environment. Toxicity tests performed with more realistic "spike-exposure" regimes show that the use of dispersants does not cause significant effects at dispersed oil concentrations of lower than 5-10 ppm with embryos and larvae. A level of 10 -40 ppm -hours (concentration in ppm multiplied by exposure in hours) was found to produce no significant effects on higher marine life, such as older larvae, fish and shellfish.

However, recent studies (e.g. Discobiol), show that:

- Lethal concentration on adults and juveniles are much higher than the concentration observed in real incidents.
- Sub lethal effects can be observed after the exposure time (bio-accumulation, metabolites in leaver, stress indicators…); however most of these observed effects are reversible in a relatively short delay: after 2 weeks of recovery the observed effects disappeared or reduced close to the background level.

Figure 12: Assessment of the impact of dispersed oil on fish – (Discobiol program)

Provided that dispersants are used to disperse oil in water where there is adequate depth and water exchange to cause adequate dilution, there is little risk of dispersed oil concentrations reaching levels for prolonged periods that could cause significant effects to most marine creatures.

Generally speaking, after incidents where large quantities of oil were dispersed at sea (e.g. "Sea Empress"), the environmental impact, when observed, has been much lower than expected, and the overall advantages resulting from the use of dispersants confirmed.

7.2 Microbial Degradation

Dispersion of oil, either mechanically or chemically, renders oil more available to microorganisms present in the sea water. The influence of dispersants on microbial degradation of oil is hence of prime importance.

Microorganisms capable to grow on petroleum hydrocarbons are present in all sea waters, and the rate of microbial degradation is directly related to the degree of oil dispersion. Paraffinic and high and medium aromatic fractions of oil are biodegradable, while for polyaromatic hydrocarbons (4, 5 cycles), asphaltenes it has not been proven beyond doubt. There is no evidence of biodegradation of polar fractions, nitrogen-, sulphur- and oxygen-containing compounds.

Dispersants increase the rate of oil biodegradation through:

- increasing surface to volume ratio of oil;
- increasing oil bioavailability, (reduce the tendency of oil to form tar balls or mousse; stabilization of oil droplets in the water column instead of beaching or sedimenting).

However, dispersants may also reduce the rate of biodegradation by adding new bacterial substrate (the dispersant) that may be more attractive to microorganisms than oil or possibly increasing dispersed oil concentrations in the water column, which may have temporary toxic or inhibitory effects on the natural microbial populations.

As for toxicity, most of the knowledge of dispersed oil degradation is limited to results of laboratory or other small scale studies. Some laboratory studies and all mesocosm studies have shown an increase in rates of oil biodegradation when dispersants are used. Temporary inhibition of biodegradation with dispersed oil was also recorded in laboratory tests. However, it appears to occur at dispersed oil concentrations higher than expected in the field. Data from pond and mesocosm studies strongly indicate that effective use of dispersants would increase the biodegradation rate of spilled oil. The question whether dispersants enhance the extent of biodegradation needs to be further studied, although available information suggests that refractory compounds would not be degraded despite the addition of dispersants.

7.3 Effects on Seabirds and Marine Mammals

Oil affects seabirds and marine mammals due to:

1. Toxic effects of either direct ingestion of oil from the sea surface or indirect ingestion through grooming or preening.
2. Effects on the water-repellency of feathers or fur needed for thermal insulation.

Reduction of these effects by use of dispersant has not been studied extensively.

Review of available studies did not indicate differences of the toxicity to seabirds of oil components in chemically and mechanically dispersed oil. However, there is an obvious need to reduce surface oiling for bird protection. Exposure to dispersants and dispersed oil seems to be a greater problem than enhanced toxicity of oil.

It is known that marine mammals are affected by exposure to oil. The effects reported include the dysfunction of physiological processes such as thermoregulation, balancing and swimming ability as well as impairment of biochemical processes such as enzyme activity. Other overt effects such as eye irritation and lesions have also been reported. Exposure of marine mammals to oil can lead to changes in the ability of animals to deal with the uptake, storage and depuration of hydrocarbons whilst acute exposures can result in mortality in particular with young mammals which are more susceptible to the toxicological effects of oil.

Oiling causes reduction in fur insulating capacity and dispersants have been experimentally used for the removal of crude oil attached to fur. These experiments resulted in the removal of natural skin oils together with crude thus destroying the fur's water-repellency. Surfactants can increase the wettability of fur or feathers, allowing cold water penetration and subsequent increase of the thermal conductance. This is particularly dangerous to animals that are buoyed or insulated by their fur or feathers. Records of animal deaths due to direct ingestion of oil during grooming also exist. Extremely limited information on the influence of dispersants or dispersed oil on marine mammals exists, nevertheless the use of dispersants may not reduce the physical threat of spilled oil to some fur-insulated sea mammals.

7.4 The use of dispersant on underwater oil releases (e.g. blow out)

Dispersant can be used to disperse under water releases such as blow out coming from sub sea well head.

This technique has been used recently during the “Deep Water Horizon” incident, in the Gulf of Mexico in 2010, where large quantities of oil were released at sea (high pressure / high shear rate). Large quantities of dispersants have been injected directly at the source of the spillage at the sea bottom (1300 m depth) into the damaged riser to disperse the oil just released (fresh), in order to:

- reduce the quantity of oil resurfacing from the damaged well;
- reduce the amount of volatile in the atmosphere close to the damaged well (for security reason);
- reduce the amount of oil liable to be drifted to the sensitive Louisiana shoreline (environmental issue).

The formation of a large plume of dispersed oil between 1100 and 1300 m, with low oil concentrations has been observed. At the time this text has written there was still debate on the effects (efficiency and impact) of this peculiar dispersant application.

In terms of efficiency, uncertainties remain on the real effect of dispersants (e.g. what was really dispersed by the dispersant and what would have been naturally dispersed).

Waiting for further investigations, the preliminary feeling of the scientists community is “that the use of dispersants and the effects of dispersing oil into the water column has generally been less environmentally harmful than allowing the oil to migrate on the surface into the sensitive wetlands and near shore coastal habitats” (“Deep Water Horizon” Dispersant Use Meeting Report – May 26-27, 2010 CRRC).

It should be highlighted that the usual recommendations for regular dispersant application on surface slicks may not be applicable to the sub-sea application of dispersant on a sub-sea blowout plume. In sub-sea application the oil is fresh with its light ends, (the most toxic fractions) while surface slicks are usually partly weathered. However, considering ultra-deep environment the environmental conditions are so different (temperature, ecological sensitivity and diversity, temperature… etc.) in comparison with surface water (photic zone) that the usual way to assess the possible impact of chemical dispersion (as described in Part II and Part III of these Guidelines) is not applicable as they are (e.g. regular NEBA process as described in the next chapter 8).

If required, this chapter on sub-sea dispersant application could be further expended in a future edition of the Guidelines when the results of the ongoing studies on the Deep Water Horizon incident and its consequences will be made available.

Figure 13: Under water blowout in ultradeep environment during Deep Water Horizon incident (source SINTEF)

8. NET ENVIRONMENTAL BENEFIT ANALYSIS (NEBA)

As the aim of the spill response is to minimise the overall environmental impacts on natural and economic resources, the decision on the use of dispersants should be based on the following comparison: "***What would be the impact of the pollution when treated with dispersant and when non treated with dispersant*?**".

This comparison is named: the NEBA[2] (the Net Environmental Benefit Analysis).

The NEBA should:

- Consider the behaviour (drift and ageing) of the treated oil (drift according to the stream, speed of dilution of the plume) and of the non treated oil (drift according to the stream and the wind).

- Assess consequently the different resources which will be concerned either by the treated oil or by the surface oil.

- Assess the sensibility of the different resources at concern towards the dispersed oil and toward the surface oil (non dispersed).

- Consider also the time frame of the restoration of the items which may be impacted.

These analyses assist decision makers when considering whether or not the use of dispersants is appropriate or not, to minimize the environmental/economic damage.

Often, the NEBA can lead to compare the damage of the oil dispersed at sea with the damage of the slick drifted on the shoreline.

In most cases, the damages at sea caused by the dispersed oil are generally less than those generated by the oil weathered (often persistent) and stranded on the shoreline. However,

[2] The concept of NEBA can be found in the literature under different names : NEEBA (Net Environmental & Economic Benefit Analysis, or NEDRA (Net Environmental Damage Risk Assessment), etc.…

coming closer and closer to the shoreline the NEBA becomes more and more difficult as depending on the response strategy, the dispersed oil and the non-dispersed oil may affect different sensitive areas and therefore may require prioritisation of resources to be preserved.

Habitats/resources should be considered as a whole and not independently, as the decision of applying dispersant may benefit to particular habitat/resource and at the same time affect adjacent ecosystems. For example, if an oil spill occurs in shallow water above submerged coral reef with current and wind conditions leading the slick toward mangrove swamp, it is advisable to disperse the oil above the reef (even though it may increase oil exposure of the corals) in order to avoid oil from becoming incorporated into the mangrove sediments from where it will seep out over the years thereby forming a chronic pollution source for both the mangrove and coral reef ecosystems.

Figure 14: Field experiment conducted on mangrove with dispersed oil in order to assess the impact of the dispersion in TROPIC experiment (source: Clean Caribbean)

The NEBA process takes time and should be planned in advance. In order to conduct a NEBA it is essential to list resources present in an area by order of the protection priority. Such list should take into account factors such as possible seasonal variations which may affect priorities. When drawing up such a list, both natural and economic resources should be considered. In general it can be said that endangered species, highly productive areas, sheltered habitats with poor flushing rates, habitats which take a long time to recover should receive top protection priority.

In Part III of these Guidelines, the reader will find elements of practical guidance for conducting a NEBA process.

9. TESTING, ASSESSMENT AND SELECTION OF DISPERSANTS

Indiscriminate use of dispersants in combating oil spills may have deleterious effects on the marine environment and therefore most of the countries, which consider the use of dispersants as part of their oil spill response strategy, have developed certain criteria or specifications with which dispersants should comply.

These specifications may be used for the selection of the most adequate products on an informal basis, while some countries have established formal approval criteria.

For the moment, there are no real agreements at international level on these criteria, despite the efforts made by intergovernmental bodies such as European Maritime Safety Agency (EMSA) or Bonn Agreement while trying to harmonise the use of dispersant in their respective region. However, on a case by case basis, instead of setting their own approval procedure, some countries would simply approve dispersants approved in other countries. For instance, Croatia accepts certain products approved in other countries such as Cyprus, France, and United Kingdom. Another example is Israel, which accepts products approved by CEDRE.

Most often the specifications are based only on the effectiveness and toxicity testing of products. In addition, some countries have set standards on the biodegradability of the product and/or dispersed oil. There are also countries which specify required physical characteristics of dispersants which may be used.

On the basis of screening tests for any of these characteristics, individual competent national authorities develop their lists of approved products, which might be used in conformity with the approved response strategy.

There is also no agreement on testing procedures between different national administrations. However, regardless of the tests chosen, these should allow for ranking of products with regard to their relative effectiveness, toxicity or biodegradability.

All known testing procedures are based on laboratory tests. Such tests are not aimed at simulating real field situations and are accordingly designed to give relative values of tested properties. Field experience shows that there are no significant discrepancies between relative values obtained in laboratory tests and behaviour of tested products in the field, although differences sometimes appear. The same applies to the comparison between results of different tests: although absolute values can largely differ for a specific characteristic of a tested dispersant, depending on the testing procedure used, products which show better results according to a certain procedure, normally also appear superior when tested in accordance with another procedure.

The main concern in the early years of the use of dispersants was their toxicity. With the development of new, much less toxic formulations, more and more attention has been paid to the efficiency of dispersants. **At present, the effectiveness of dispersants is the most important selection criteria**. It is considered that toxicity, as well as biodegradability, of an ineffective product are irrelevant. The objective is to select a product with the best possible combination of relatively high effectiveness and relatively low toxicity.

Regardless of specific test procedures, a generally accepted testing pattern follows several common steps. The effectiveness of the product is tested first. Products which pass this criterion are then tested on toxicity and biodegradability. Results of toxicity and biodegradability tests are compared, and the products which pass defined criteria are approved for possible use.

9.1 Effectiveness tests

Most of these tests measure the degree and/or the stability of dispersion (droplet size distribution) either by visual observation or by some kind of analytical technique, after mixing oil and dispersants under standard conditions.

The measurement of the lowering of interfacial tension between oil and water following the addition of a dispersant or the speed of resurfacing of dispersed oil after mixing can also be used for the assessment of the dispersant's efficiency.

The differences in results and rankings often originate from differences in the parameters of the tests (type of oil, temperature, oil and water volumes, dose rates, contact between the dispersant and the oil – application or premixed level and type of mixing energy, close test tank of continuous dilution, test duration, etc. Refer to table in the next page).

Test ID	Energy source	Energy level	Water volume	Oil/water ratio	Dispersant application method	Dispersant/oil ratio	Settling time
IFP	Oscillating hoop	1-2	4-5	1:1000	Dropwise	variable	1
Labofina rotating flask	Rotating vessel	3	0.25	1:50	Dropwise	1:25	1
Swirling flask	Shaker table	1-2	0.12	1:1200	Premix/dropwise	1:10 to 1:25	10

Among the main effectiveness laboratory test procedures:

- The LABOFINA test (or WSL test) procedure used in UK which is ran in a separating funnel in rotation to provide strong energy to promote the dispersion process. (ref to WSL Report LR448. appendix A).

- The IFP test (flow through test) procedure used in France which is ran in a test tank in which the water is renewed in order to reproduce the dilution which would occur at sea; in this test the mixing energy brought by a wave generator remains gentle. (ref: French standard AFNOR NFT 90-345).

- The Swirling test, used in North America, carried out on oil samples premixed which dispersant in a very small funnel which rotate gently to promote the dispersion process (ref . ASTM F2059 - 06 Standard Test Method).

- The MNS is a very high energy test used in Norway .

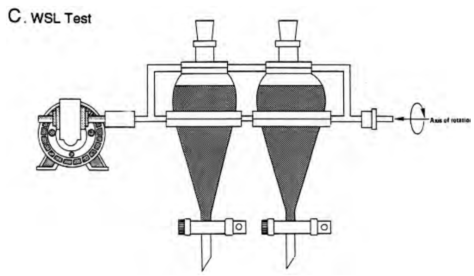


Figure 15: the Labofina / WSL test apparatus

Figure 16: The IFP / flow through test apparatus (source SINTEF)

Figure 17: The swirling flask test method (source: www.marinemanagement.org.uk/protecting/pollution/documents/approval_lr448.pdf)

Figure 18: The MNS test apparatus

At last, when a vessel is on site, it is possible to assess the oil dispersibility by collecting a sample in a glass jar directly from the slick and by testing it in the field. The field test procedure consist in comparing the dispersion of a sample containing dispersant and oil and one containing only oil following manual agitation (hand checking). (e.g. National Plan Oil Spill Dispersant Effectiveness Field Test Kit - Nat-DET). Such tests can be useful to oil spill responders to decide on the opportunity of applying dispersant on oil which degree of weathering is unknown.

9.2 Toxicity tests

Test materials are usually dispersants, dispersed oil (oil/dispersant mixture) and sometimes oil alone. Test species could be fish, arthropods (usually decapod crustaceans), molluscs (pelecypods), annalids (polychaetes) and algae. Ideally, test species should be selected among locally significant populations. Tests may be acute (short term) single species, lethal or sublethal.

The main goals of these tests are to determine the relative toxicity of a certain dispersant versus other previously tested products.

Due to the increase of toxicity with the increase of temperature, toxicity tests should take into consideration expected changes in seawater temperature.

Measure of the Lethal Concentration 50 (LC_{50}) in a determined period (usually 24 or 48 hours) is a common criteria used in toxicity tests.

Toxicity testing issue can be considered from two different approaches:

(i) either, checking the intrinsic toxicity of the dispersant in order to reject the most toxic ones, in that case only the dispersant is tested;

(ii) or, checking that the dispersant does not increase the oil toxicity; in that case the tests are performed on the oil alone and on the oil and dispersant mixture.

Due to the fact that dispersing the oil in the water column lead to increase the oil toxicity of oil towards the animals living in the water column, the toxicity of the mixture oil and dispersant should be higher than the one of the oil alone. The more efficient the dispersant, the more toxic the mixture of oil and dispersant may appear as the oil will be better dispersed. Therefore, such approach can be more restrictive and eventually reject the most efficient dispersant. This is in contradiction with the goal of an approval procedure which should be designed to select the more efficient and less toxic ones.

Considering the objectives of the approval procedure (selection of the best products, i.e. the less toxic ones), the control of the intrinsic toxicity of the dispersant is sufficient. However the issue of the toxicity of the dispersed oil remains a concern when considering the policy for the use of dispersants. The toxicity of the dispersed oil (toxicity of the “oil and dispersant” mixture) is required when defining scenarios (environmental conditions) for which the use of dispersant will remain environmentally acceptable (e.g. part of the NEBA process).

Among the main toxicity tests procedure:

- The test procedures in force in United Kingdom :
  - the sea test -comparison on brown shrimp of the toxicity of the oil with and without dispersant-
  - the rocky shore test –effect of the dispersant on the common limpet- ref : MAFF Fisheries Research Technical Report Number 102.

- The test procedure used in France: comparison of the CL_{50}(6h) of the dispersant alone with the one of a reference toxicant on white shrimp. (ref French standard NF T90-349).

- The standard toxicity test used in United States involves exposing silversides mysid shrimp to concentrations of the test product and No. 2 fuel oil alone and in a 1:10 mixture of product to oil (ref http://www.epa.gov/osweroe1/docs/oil/cfr/appendix c.pdf)

Figure 19: The British testing equipment for assessing the toxicity

9.3 Biodegradability tests

Dispersants and dispersant/oil mixtures are often tested for biodegradability. There is no consensus on a standard method for testing biodegradability of dispersants and various adapted standard tests on organic material are in use (e.g. the method used in France – Standard NF 90 346).

9.4 Other tests

Standard analytical methods are used for testing other properties (density, viscosity, etc.) if so required by the competent authorities.

10. DOSAGES OF DISPERSANTS AND APPLICATION RATES

The amount of dispersants which needs to be applied to a certain quantity of oil, in order to achieve a desired level of dispersion, depends on the oil type, its weathering degree, its thickness, the environmental conditions (e.g. waves), and the dispersant itself.

In certain cases as during the "Sea Empress" incident in 1995, the oil is easily dispersible and therefore a low dosage (oil/dispersant ratio) may be sufficient, whilst in other incident less favorable (low dispersibility of the oil), it may be suitable to increase the dosage.

Practically, it is advisable to refer to the dose recommended by the manufacturer (often 5% for "concentrates"), dosage which can be adjusted during the operations on the basis of certain average figures.

In general terms **conventional dispersants or 2nd generation** (hydrocarbon based dispersant) are usually applied in doses of approximately 30 - 50 % of estimated oil quantity for low viscosity oil (up to 1000 cSt) and 100% for oils in the viscosity range of 1000 - 2000 cSt.

Figures for **concentrate dispersants or 3rd generation,** are in the range of 5 % for oils of up to 5 000 cSt, and 5 - 10% for treatment of oil between 5 000 and 10 000 cSt. Treatment of oils with viscosities of more than 10 000 cSt is considered ineffective. For fresh light oils easily dispersible viscosity less than 500 cSt a dosage lower than 5% may be sufficient.

Considering the application rate versus the oil thickness required **application rates** can be calculated on the basis of generally accepted rules for the assessment of oil thickness (dark patches of oil are assumed to be approximately 0.1 mm thick and areas covered by a thin oil sheen are estimated to be between 0.001 and 0.01 mm).

Regardless of the spraying device used, application rate is determined by the discharge rate of dispersant pump, speed of the vessel or aircraft and the width of the area covered by the spray (swath). The relation between these variables is the following:

Application rate = Discharge rate / Speed x Swath

Consequently, given the constant swath of the available spraying equipment, the required application rate for each particular slick area can be achieved by:

a) either selecting the appropriate discharge rate of the dispersant pump;

b) or selecting the appropriate speed of the vessel or aircraft.

Very often an average treatment rate of 100 litres of concentrate dispersant per hectare, corresponding to oil thickness of 0.1 mm and a dose of 1: 10 is used in approximate calculations for the use of dispersants.

Figure 20: Ship mounted modern application spraying equipment (source SINTEF)

11 SYSTEMS FOR THE APPLICATION OF DISPERSANTS

Selection of the dispersants' application technique basically depends on:

- the type of dispersant available;
- the type of spraying device available;

although the size and location of the spill must also be taken into consideration.

Several dispersant spraying systems exist and they can be grouped in accordance with the carrier for which they were designed:

- aircraft mounted spraying systems;
- boat mounted spraying systems;
- portable units for individual use.

11.1 Aircraft mounted spraying systems

As a result of advantages offered by the aerial spraying of dispersants (good control and assessment of results, rapid response, high treatment rates, optimum use of the product, regardless of the sea state), a number of spraying systems have been developed for use with both fixed and rotating wing aircraft (helicopters). Existing units are either of a type which can be used by the aircraft of convenience or of the permanently installed type. Standard built-in spraying systems of crop spraying aircraft, widely used in agriculture, can be adapted for the spraying of dispersants.

Only neat concentrate dispersants are suitable for use with airborne spraying systems.

11.1.1 Airplanes

Crop spraying airplanes are readily available. However, it is advisable to modify the spraying nozzles because the application rate of dispersants is much higher than that of agrochemical products. They could not be used far from the shore due to limited tank capacity and insufficient safety offered by a single engine.

Figure 21: Crop spraying aircraft

Fixed systems for converted **multi-engine aircraft** comprise storage for dispersants, a pump including powerpack spray arms with nozzles and a remote control system.

As an alternative, some independent system (with tank, pump and spray booms), have being developed which can be clamped under the fuselage as a detachable pod (i.e. instead the luggage chest); these systems allow to convert quickly regular planes into spraying aircrafts.

Figure 22: Spraying multi-engine aircraft during Deep Water Incident (source US Coast Guard)

POD spraying systems for small aircraft; self container spraying system which can be rigged under a small plane as a POD (luggage trunk). It is quick and easy to convert regular plane usually devoted to good or passenger transportation into a spraying aircraft. The capacity of these systems is around 1.5 t of dispersant.

Figure 23: POD spraying aircraft (source French Customs)

Self-contained airborne spraying systems are built to suit large transport airplanes which have rear cargo doors able to remain open during the flight. Containerized units comprise tank, power pack, pump and retractable spray arms and can be easily loaded into the cargo hold.

Figure 24: Large Self Contained spraying system (20t capacity) on C130 Hercules

11.1.2 Helicopters

Fixed spraying systems for helicopters are mounted under the fuselage and are made up of the same parts as the units built-in fixed wing aircraft.

Figure 25: Fixed spraying systems for helicopter

Helicopter **spray buckets** can be used with any helicopter having a cargo hook for under slung loads. Units are self contained (tank, pump, power pack, spraying arms) and can be remotely controlled from the cockpit.

Figure 26: Helicopter equipped with independent spraying bucket (source SINTEF)

Aerial application of dispersants depends on the visibility over the slick area and relies on wave energy for mixing dispersant with spilled oil.

Aircraft permanently equipped for dispersant spraying are rare due to high costs involved and the use of under slung helicopter buckets seems to be the most readily available solution. In addition, the use of helicopters has the advantage of extremely good manoeuvrability but their carrying capacity decreases very quickly when the distance to be covered increases. The selection of fixed wing aircraft is limited by the lowest speed at which the aircraft can operate and which should not exceed 150 knots.

11.2 Boat mounted spraying systems:

Several types of this equipment exist including units fixed on the vessel as well as removable ones.

11.2.1 Systems for spraying conventional dispersants

Systems for spraying **conventional / 2nd generation** (hydrocarbon based dispersants) are rarely used nowadays since these dispersants are sprayed undiluted and due to the 1:1 or maximum 1:3 dispersant/oil rate, a large amount of dispersant needs to be carried on board. They comprise a fixed flow rate pump and 2 spraying arms usually with 3 nozzles each; these units were often stern mounted.

Figure 27: Conventional dispersant spraying system for boat

11.2.2 Systems for spraying concentrate pre-diluted into sea water

The application of dispersant pre-diluted into sea water was invented to apply the concentrate dispersant (low dispersant/oil dosage) using the equipment originally developed for applying conventional dispersants (high dispersant/oil dosage). Indeed, the dilution enables an increase of the flow rate to be sprayed and therefore allow spraying with the same equipment (large nozzles). These systems are designed to pre-dilute the dispersant generally around 10% dispersant into sea water.

This goal can be achieved by:

Eductor systems are designed to work with the ship's built-in fire-fighting system. The eductor connected to the discharge side of the pump, causes a negative pressure at the point of dispersant intake, thus sucking it in into a discharge line. The diluted dispersant is applied by a fire monitor or through nozzles mounted on spraying arms attached to the vessel's side.

These systems tends to waste the dispersant and has limited encounter rate, although it is found on most vessels, it should be used only if no other equipment is available.

Injection systems consist of two pumps: one for water and the other, similar to chemical feeder pumps with variable flow rate, for the dispersant. The dispersant is applied through nozzles mounted on spraying arms attached to the vessel's side. Fixed and portable designs exist, and are preferably installed on the vessel's bow in order to benefit from the mixing energy provided by the bow wave

It should be emphasized that pre-dilution into sea water can reduce the efficiency of dispersant especially when the oil is a bit viscous, i. e. weathered (>700 cSt). For this reason, the neat dispersant application (developed below) is strongly recommended.

Figure 28: Application of dispersant pre-diluted into sea water

11.2.3 Systems for spraying neat dispersants

Systems for spraying **neat concentrates** are specifically designed for the application of undiluted concentrate dispersants.

These units are usually bow mounted, have a pump with a variable flow rate and the dispersant is discharged also through nozzles mounted on spraying arms. These are usually longer as compared to stern mounted arms, having a greater oil encounter rate. Mixing energy is provided by bow wave.

In order to increase the dispersant flow rate range some units are equipped with multiple spraying assembly. By operating one or several spraying assembly the flow rate can be adjusted to cope with different situations encountered (ship speed, oil thickness and type…).

Different types of vessels may be used for spraying dispersants and, in addition to specially built anti-pollution vessels; these include tug boats, supply vessels, trawlers or small fishing vessels. The necessity to operate at low speeds at the same time retaining the necessary maneuverability may be a limiting factor in the selection of vessels. Suitable vessels should also have sufficient storage space for dispersant.

Figure 29: Neat Concentrate dispersant spraying system for boat

11.3 Portable units for individual use

Light weight, cheap and easily available **back pack units**, normally used in agriculture, and mainly designed for shoreline rock cleaning, may also be used for application of dispersants to small spills near the shore. The application rates are limited.

There are designs where the tank and the pump are **trailer mounted** and connected to the portable spraying gun by a flexible hose.

Both hydrocarbon based and concentrate dispersants can be used with this group of devices.

12. LOGISTIC REQUIREMENTS FOR THE EFFICIENT USE OF DISPERSANTS

Regardless of the scale on which dispersants are applied, their use calls for well organized logistic support. As oil is liable to chemical dispersion only during the first hours or days after being spill at sea (window of opportunity for dispersion), at the time of the spill, the responder should be able to implement the dispersion application without loss of time. Therefore, all the logistics should be pre-planned. This aspect may appear particularly important when dispersants are used for the treatment of massive spills relatively far offshore. Since mechanical recovery of oil also requires significant logistic support, logistical constraints may be a decisive factor in deciding whether to use one method or the other. The availability of the necessary equipment, products and personnel will play a key role in taking decisions. However, other factors such as the size of the spill and its location, time required for mobilizing equipment and personnel and prevailing sea and weather conditions, will also strongly influence the decision on which method to choose.

To ensure maximum efficiency of the dispersant treatment operation, particular attention needs to be given to its logistic aspects:

- Treatment of oil with dispersants requires the use of significant quantities of the product. The dispersant quantity can be estimated at approximately 5 % of the volume of oil which is planned to be treated when concentrate dispersants are used. If conventional, hydrocarbon-based products are used it can be up to almost the same volume of oil (100%) to be dispersed. This explains why nowadays conventional products are almost no longer used for the treatment.

- Stockpiles of dispersants existing in most of the countries are usually planned to be sufficient only for initial response. Pre-arrangements with manufacturers and/or distributors are therefore recommended to provide additional quantities of the product at an extremely short notice. International, regional, sub-regional and bilateral agreements with neighbouring countries should be considered in advance in view of mutualising national stockpiles available in the region or in remote countries. Particular attention should be given to custom pre-arrangement to ensure smooth transboundary movement. Countries affected by a spill requesting additional stockpiles and equipment can, in the framework of the Protocol Concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea, request the assistance of REMPEC to facilitate the coordination of the regional assistance.

- Transportation of dispersant from the sites of storage, production or from the airport of arrival (only airlifting the supplies from one country to another is fast enough to bring dispersants to affected country in time) to the spill site or base of operations, needs to be properly planned and precisely executed.

- If large quantities of dispersants are utilised, their transportation from the stores to the operations' base in road tankers or liquid containers is more efficient as compared to transportation in drums. High capacity pumps should be used for reloading of spraying units.

- Maintenance of spraying equipment as well as vessels or aircraft included in the operation should be planned. Supplies of the most important spare parts need to be available at the base.

- Fuel for vessels and aircraft needs to be available at the base and refueling operations executed promptly in order not to delay spraying operations. Problems are often encountered when aerial spraying is used, since in most places the fuel for piston-engined aircraft is in short supply. If local aircrafts are used, necessary arrangements for fuel supply are made in advance through the contingency planning process.

Figure 30: Dropping zone, arranged on the coast to operate a helicopter equipped with a spraying bucket

- Generally speaking, helicopters can land or change the spraying systems, even without landing, almost anywhere. Landing sites for small aircraft can be improvised if proper airfields are not available. However, larger aircrafts need long runways and only appropriate airports can be considered as bases for the refueling and reloading of dispersants.

- Accommodation for crews needs to be provided near the base. When larger vessels are used for spraying, this problem is eliminated since the crews is accommodated on board.

- Appropriate communication links, in particular those between spotter aircraft and spraying units, are essential. VHF appears to have advantages over other systems.
- Permanent contact needs to be established with national aviation authorities to obtain clearance for planned operations without delay.

- If requesting aircraft through international assistance is considered, flight authorizations, compatibility of the infrastructure (e.g. runway specification), availability of specified fuel needs to be checked in advance, preferably when preparing the contingency plan

13. <u>STORAGE OF DISPERSANTS</u>

13.1 <u>Storage</u>

Quantity of dispersants to be stored for emergency response needs to be assessed during the preparation of contingency plans. **It will be calculated on the basis of the quantity needed to respond to the most likely size of spill during the period necessary to bring in replacement stocks.** The time needed for stock replenishment (either by the manufacturers or from other sources) has also to be negotiated and determined in advance (cf. Chapter 12). Except for continuous release, arrival of new quantities of dispersants more than 48 hours after the start of spillage will be useless in most cases.

Dispersants are most often stored in 200-litre steel drums, usually in open space or preferably in sheds. Although the possibility that the drums will corrode from the inside should not be neglected, it is more likely that the corrosion will start from the outside.

Accordingly, regular control of stored drums is strongly recommended. Alternatively, dispersants may be sold and stored in plastic drums, which are corrosion resistant, however these should be protected from direct sunlight in order to avoid their deterioration.

Delivery and storage of dispersants in bulk containers is also possible. From the operational point of view, taking into account the need for quick response and hence the need for transporting large quantities of the product, this option is preferred to storage in drums. Storage in road tank trailers is even more practical.

Countries that make use of specialized anti-pollution vessels may opt for storage in vessels' integral tanks. For spraying from other vessels, when the need arises, dispersants can be transferred from storage containers to flexible pillow tanks, which can be placed on board practically any vessel.

Relatively high capacity portable pumps, made out of materials resistant to the components of dispersants, need to be available for the transfer of products from storage containers to spraying units.

13.2 <u>Ageing</u>

Dispersants are a complex mixture of various components, and with ageing their properties may be subject to changes, i.e. their stability is not necessarily good. During the prolonged storage, certain components may separate from the solution in layers or even crystallize. Usually dispersant deterioration results from bad storage conditions dispersant quality may be altered (e.g. dispersant stock polluted by an external product or dispersant tank overheated under the sun for long periods…). Most often, deteriorations are reflected as a loss of effectiveness of the product. Therefore, it is advisable to check periodically the quality of the products (e.g. laboratory controls every 2 years).

Countries which have established approval or acceptance procedures regularly require the information on shelf-life from the manufacturer of the product (cf. Chapter 6, paragraph 6.5). Regardless of the manufacturer's declaration, the most reliable method for discovering changes in the original quality of the stored dispersant is to periodically test its effectiveness and to compare the results with the results obtained, using the same method and the same product when it was fresh. Such tests can be easily carried out and do not necessitate expensive laboratory equipment.

BIBLIOGRAPHY

1. ITOPF (1986), Response to marine oil spills, ITOPF, London, U.K.

2. CONCAWE (1986), Oil spill dispersants efficiency testing: review and practical experience, Report No. 86/52, CONCAWE, The Hague, The Netherlands.

3. Bocard, C. (1987), Basic considerations on the use of dispersants / Selection of dispersants (Technical paper for MEDEXPOL 87 training course), Marseille, France.

4. Bonn Agreement (1988), Position paper on dispersants, Bonn Agreement, London, U.K.

5. IMO (1988), Manual on oil pollution, Section IV: Combating oil spills, IMO, London, U.K.

6. CONCAWE (1988), A field guide to the application of dispersants to oil spills, Report no. 2/88, CONCAWE, The Hague, The Netherlands.

7. Bonn Agreement (1991), Amended Chapter 20 of the Bonn Agreement Counter Pollution Manual (working paper), Bonn Agreement, Paris, France.

8. Merlin, F. (1991), Selecting dispersants and periodic checking of their quality, CEDRE, Brest, France.

9. IMO / UNEP (1995), IMO / UNEP guidelines on oil spill dispersant application and environmental considerations, IMO, London, U.K.

10. IPIECA, 2001. Dispersants and their role in oil spill response – Technical report series volume 5.

11. Maritime Safety Authority of New Zealand, 2001. Oil spill dispersants. Guidelines for use in New Zealand. Maritime Safety Authority of New Zealand.

12. GAOCMAO, 2002. Guidelines for the use of oil spill dispersants in the Gulf.area. GAOCMAO.

13. Energy Institute, 2004. Operational guidelines on the use of oil spill dispersants at sea. Energy Institute.

14. CEDRE, 2005. Using dispersants to treat oil slicks at sea. Airborne and ship borne treatment. Response manual. CEDRE.

15. NOWPAP MERRAC, 2005. Guideline for the use of dispersant.

16. National Research Council, 2005. Oil spill dispersant. Efficacy and effects. National Academic Press.

17. ITOPF, 2005. Technical Information Paper - The use of chemical dispersants to treat oil spills. ITOPF, London.

18. Lewis, A, Merlin, F, Darling, P, Reed, M, 2006. Applicability of oil spill dispersants. Part 1 – Overview. EMSA.

19. EMSA, 2007. Inventory of national policies regarding the use of oil spill dispersants in the EU member states. EMSA.

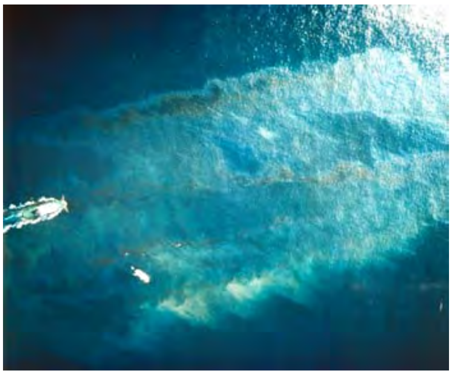
20. 2007: Merlin F.X., The use of dispersant – State of art – WP2. Oil Spill Response at Sea – SPREEX program.

21. MERRAC Technical Report No. 3. MERRAC

____

REMPEC
MARITIME HOUSE, LASCARIS WHARF, VALLETTA VLT 1921, MALTA
rempec@rempec.org - www.rempec.org





Guidelines for the use of dispersants

for combating oil pollution at sea in the Mediterranean region

Part III: Outline and template for a national policy on the use of dispersants

MEDITERRANEAN ACTION PLAN (MAP)
REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)


REGIONAL MARINE POLLUTION EMERGENCY

RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

MEDITERRANEAN ACTION PLAN

Guidelines for the use of dispersants for combating oil pollution at sea in the Mediterranean region

Part III: Outline and proposed template for a national policy for the use of dispersants

Regional Information System – Part D, Section 2 (RIS/D/2)

www.rempec.org

April 2011 Edition

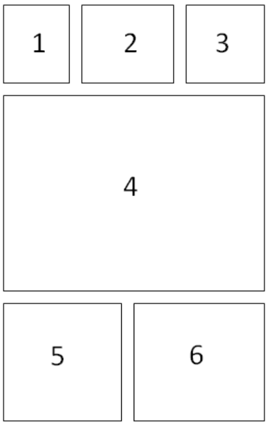
Note

This document is aimed at facilitating the implementation of the "Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency" of the Barcelona Convention (Emergency Protocol, 1976) and the "Protocol concerning Co-operation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea" (Prevention and Emergency Protocol, 2002) by the Contracting Parties of the Barcelona Convention.

These "Guidelines", which are advisory, do not affect in any way already existing or planned national laws and regulations related to matters covered by it. REMPEC assumes no liability whatsoever for any potentially damaging consequences which could result from the interpretation and use of information presented in this document.

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of IMO, UNEP, MAP and REMPEC concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries.

Cover photos: © Cedre



Helicopter mounted spraying system

Airborne treatment

Aerial monitoring operation

Ship mounted spraying system

Airborne treatment

Shipborne treatment

The Guidelines are downloadable from REMPEC's website (www.rempec.org) in the section "Information resources/Regional Guidelines/Preparedness & Response".

For bibliographic purposes this document should be cited as follows:

IMO/UNEP: Regional Information System; Part D – Operational Guidelines and Technical Documents, Section 2, Guidelines for the use of dispersants for combating oil pollution at sea in the Mediterranean region, REMPEC, April 2011 edition.

Foreword

In a large part of the Mediterranean coastal States, the use of dispersants as a response method for combating accidental oil spills at sea has not as yet been covered by specific national regulations.

Controlled and appropriate use of selected dispersants on types of oil amenable to chemical dispersion, is widely recognized as one of the useful methods for combating accidental oil spills, and in particular the massive ones. Moreover, under certain sea and weather conditions the use of dispersants might be the only applicable response method for protecting sensitive natural resources, coastal installations or amenities.

However, the opportunistic attitude regarding the use of dispersants is hardly acceptable. Selection of products which might be used, definition of zones in which their use is either allowed or prohibited and their place in the general strategy of pollution response need to be adequately regulated if the use of dispersants is expected to produce desired results without creating additional risks for the environment.

Considering the developments in the field of dispersants since the October 1998 edition of the "Guidelines for the Use of Dispersants for Combating Oil Pollution at Sea in the Mediterranean Region", the Ninth Meeting of the Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta, 21-24 April 2009, tasked the Mediterranean Technical Working Group (MTWG) to review their content.

This new edition of the Guidelines [endorsed by the Tenth Meeting of the Focal Points of REMPEC, Malta, 3-5 May 2011] has been prepared with the technical support of the 'Centre of Documentation, Research and Experimentation on Accidental Water Pollution' (CEDRE) and reviewed by the Centre in collaboration with the MTWG.

They aim at assisting the Mediterranean coastal States in developing and harmonizing national laws and regulations regarding the use of dispersants in response to oil spills at sea. It does not refer to the use of dispersants on shore.

The Guidelines are divided into four independent parts addressing different issues. Each part has been developed with a specific objective and is aimed at different end-users:

PART I REGIONAL APPROVAL

Part I which remains unchanged when compared to the version adopted by the Eighth Ordinary Meeting of the Contracting Parties to the Barcelona Convention (UNEP (OCA)/MED IG.3/5, Appendix I, Antalya, Turkey 15 October 1993), provides regionally approved guidance for the development of national laws and regulation on the use of dispersants.

PART II BASIC INFORMATION ON DISPERSANTS AND THEIR APPLICATION

Part II provides theoretical information on dispersants and their application. It is aimed at providing background information on the matter to any person interested in the subject.

PART III OUTLINE AND TEMPLATE FOR A NATIONAL POLICY ON THE USE OF DISPERSANTS

Part III has been prepared with a view to assisting coastal States in the development of their national policy on the use of dispersants. It has been developed as a template which can be followed and adapted by the authorities in charge of the development/maintenance of the national policy on the use of dispersants and can also be used for the implementation of national or local contingency plan for dispersants.

PART IV OPERATIONAL AND TECHNICAL SHEETS

Part IV is based on the publication entitled "Using dispersant to treat oil slicks at sea. Airborne and shipborne treatment. Response manual" (CEDRE 2005). It provides a set of practical technical sheets which point out the different operational issues when using dispersants. It has been developed for operational users with a view to providing them with the required knowledge for efficient dispersant application.

In order to keep the coastal States regularly informed of the current situation regarding the use of dispersants, REMPEC shall update this document to include any new and significant developments in the research field.

GUIDELINES FOR THE USE OF DISPERSANTS FOR COMBATING OIL POLLUTION AT SEA IN THE MEDITERRANEAN REGION

P A R T III

OUTLINE AND TEMPLATE FOR A NATIONAL POLICY ON THE USE OF DISPERSANTS

TABLE OF CONTENTS

9. Precautions and operational recommendations.

    9.1 Drills.
    9.2 Training.
    9.3 Protection of persons and equipment.

10. Use of oil spill dispersants in inland waters (rivers and lakes).

P A R T III

OUTLINE AND TEMPLATE FOR A NATIONAL POLICY ON THE USE OF DISPERSANTS

Template for National Policy for the Use of Dispersants In "*Country* Name" Marine Waters

1. Preamble

Chemical dispersion is one of the response options to combat oil spillages. This technique is designed for offshore and not for shoreline situations.

This technique has clear operational advantages, however it requests some precautions. These points are developed in this document which is to be used in conjunction with the National Oil Spill Contingency Plan (NOSCP).

Note: Concerning the use of oil spill dispersant in inland waters (e.g. lakes or rivers), refer to Chapter 10.

2. Objectives of chemical dispersion

Chemical dispersion aims at minimizing the impact of oil pollution.

The use of dispersants at sea aims at reducing the amount of oil which would reach the coast, or environmentally or economically sensitive areas.

The use of dispersants generates the scattering of the oil in a dispersed form into the marine environment which is favourable to degradation processes (particularly biodegradation).

3. The chemical dispersion process

Applied onto oil slicks, dispersants tend to reduce the interfacial tension between the water and the oil and allow the natural mixing generated by the waves to split the oil into a myriad of tiny droplets suspended in the water column: the oil is dispersed. Then turbulences and streams disseminate this dispersed oil into the marine environment.

By removing the oil from the surface it helps to stop the wind effect on the oil slick's movement that may otherwise push the surface slick towards sensitive areas (often the shoreline).

Dispersants also prevent coalescence of oil droplets and reformation of oil slick.

4. Role of the dispersant response option in the at sea combating strategy

At sea there are different response options: Recovery possibly associated with Confining, Chemical Dispersion, In Situ Burning, Monitor and Wait for action – refer to IMO manual).

In the decision making process, each of these options considered alone and/or combined should be examined in a comparative way.

Chemical dispersion is generally not compatible with the other response options (especially the confining and recovery). However, in the same case of pollution, the use of chemical dispersion simultaneously with other response options can be considered on different locations.

Note: Concerning the use of oil spill dispersant on the use of oil spill dispersants in inland waters (e.g. lakes or rivers), refer to Chapter 10.

5. Dispersant formulations and types

Oil spill dispersants are composed of two main groups of components:

- Surface-active agents (surfactants);
- Solvents.

For efficiency prospective only concentrate dispersants are recommended for use in *«COUNTRY NAME»* marine waters.

Note: For fresh water use refer to Chapter 10.

6. Advantages and disadvantages

6.1 Advantages:

- Dispersant can be generally used in more difficult situations (wind and sea state) than the other active response options, especially containment and recovery).

- Dispersion does not produce wastes to be disposed.

- When dispersed the pollutant is no longer drifted by the wind, and then follows the stream; therefore, when carried out upwind sensitive areas, dispersion contributes to reduce the amount of pollutant which would drift towards these locations.

- Dispersants help in reducing the contamination (oiling) of some resources sensitive to the floating oil (surface slick), e.g. mammals and birds.

- Chemical dispersion enhances the (bio) degradation of the oil in the marine environment.

6.2 Disadvantages:

- Dispersants are not efficient towards all oil pollutants especially those which present a high viscosity (Refer to chapter. 7.1.1).

- Dispersion increases temporary and locally the toxicity of the oil, as the dispersed oil is more bioavailable for organisms living in the water column.

- Dispersion is not appropriate everywhere, particularly where the possibility of dilution and dissemination is reduced (Refer to chapter. 7.1.2).

- When initially efficient, chemical dispersion is applicable only for the first hours/days of the operation, before the oil becomes non dispersible.

- On significant pollution, chemical dispersion is not applicable in too calm sea state (sea state 0, 1 possibly 2 according to the situation)[1].
- Pollutant is not removed but only dispersed.

7. Recommendations for the use of dispersants.

7.1 Recommendation for the decision making on the use of dispersants.

Taking into account that dispersants can be efficient only during the beginning of the oil release, it is of utmost importance that the decision to use or not to use dispersant is made quickly, without loss of time in assessments and discussions.

The speed of decision depends on a close preparation in which decision criteria will have been first studied from the physico-chemical, environmental and logistic viewpoints.

7.1.1 Oil dispersible and not dispersible

The effectiveness of chemical dispersion depends on the nature of the pollutant; the viscosity of the pollutant at ambient temperature constitutes one of the most important factors.

Chemical dispersion is usually possible for the pollutants not exceeding a viscosity of 5 000 cSt; (with some exceptions, for example, in the case of hydrocarbons containing strong paraffin contents).

Beyond 5000 cSt the chances of success decrease quickly; dispersion often is not adapted for the pollutants having a viscosity of 10.000 cSt and more.

The viscosity of an oil pollutant increases with the time spent in the environment (since the release), under the effect of ageing (evaporation, emulsification), its dispersibility decreases with time: in general, an oil pollutant is dispersible only during a certain time - we speak about “window opportunity for dispersion”.

To have an idea of the viscosity of an oil pollutant, and/or its “window opportunity for dispersion”, certain data-processing models designed to estimate the evolution of a pollutant according to its nature and the environmental conditions can be used (model of ageing: ADIOS freeware from US NOAA[2]).

When the pollutant has a significant viscosity, the more agitated the environment is (state of sea), the higher are the chances for dispersion.

On the other hand, in terms of environmental concerns, non persistent oils - refined products, (e.g. petrol, diesel oil, kerosene.) do not require the application of dispersant as they are expected to evaporate and self disperse when released at sea. Moreover, these light products contain toxic light ends which would generate a greater impact if dispersed in the water column.

---

[1] In some situations, the application of dispersant can carried out in very calm situation, 1) when the size of the spill is small enough to be able to bring artificially the mixing energy (e.g. with water hoses); this may be the case of small Tier 1 incident; 2) when the weather forecast announces a rapid deterioration of the prevailing meteorological conditions.

[2] National Oceanographic & Atmospheric Administration.

On these products the chemical dispersion could be considered only for safety reasons (reduction of the fire or explosion hazard).

Generally accepted viscosity limits	
Light refined product (petrol, kerosene, diesel oil…)	No chemical dispersion.
Pollutant viscosity < 500 cSt	Dispersion is generally easy with a concentrated dispersant, applied neat or prediluted in seawater.
500 cSt < Pollutant viscosity < 5 000 cSt	Dispersion is usually possible with a concentrated dispersant applied neat.
5 000 cSt < Pollutant viscosity < 10 000 cSt	Uncertainty as to the result: dispersion is sometimes possible with a concentrate applied neat but in that case it is better to check on part of the slick whether the dispersant is effective before extending the treatment to all of the slick.
Viscosity > 10 000 cSt	Dispersion is generally impossible.

Reminder in order to prepare the dispersion response option: for oils frequently transported inside or in the vicinity of *"COUNTRY NAME"* waters / regularly imported in *"COUNTRY NAME harbours"*, specific studies should be conducted on these oils in order to assess the windows of opportunity for dispersion (time delay during which the oil remains dispersible):

i) weathering study using modelling (ADIOS);
ii) completion of lab tests to assess oil dispersibility.

Results from these studies are given in the document *"to be specified"* in form of tables giving the [oil viscosity / the window of opportunity] of each studied oil according to different environmental conditions (temperature, wind). Studies are to be done by *"administration or institute in charge"* in collaboration with *"list of administration, institutes, etc involved"*.

7.1.2 Locations where the chemical dispersion can be undertaken

The toxicity of the dispersed oil can affect marine fauna and flora, hence chemical dispersion is not applicable everywhere.

Chemical dispersion is not generally adapted on or in the immediate vicinity of the ecologically vulnerable or sensitive areas and in areas where the possibilities of renewal and mixing of water do not offer conditions for rapid dilution of the dispersed oil.

The definition of the areas where chemical dispersion can be reasonably undertaken is a relatively complex and long process since it must take into account different local environmental parameters and data (current, biological diversity…). Such a task would be hardly carried out during an incident. Areas where chemical dispersion can be reasonably undertaken from an environment point of view should be pre-established and geo-localised: geographical limits for the use of the dispersants.

The choice of these areas should be based on studies of scenarios which aim at comparing the evolutions and the environmental and socio-economic impacts of the pollutant of dispersed and non-dispersed oil (reference to the concept of "NEBA" Net environmental benefit analysis – IMO/UNEP Guidelines). These studies of scenarios would take into account all local characteristics: type of ecological and socio-economic resources – marine protected areas and the fisheries related resources, currents, seasons – climate variations and migrations of the marine species of interest, etc (a summary of these issues is given in the table below).

The geographical limits must be defined for increasing spill scenarios, corresponding to pollution situation of Tiers 1, Tiers 2 *[up to 200 t of oil]* and Tiers 3 *[larger than 200 tons of oil].*

As a general regulation, dispersion operations can be achieved in the following limits:

- Off the *[proposed depth: 20 m]* isobath depth and *[proposed distance: 1 Km]* distance to the shore for dispersing Tier 3 pollution.

- Off the *[proposed depth: 10 m]* isobath depth and *[proposed distance: 0.5 Km]* distance to the shore for dispersing Tier 1 and Tier 2 pollution.

However, a technical committee,

- led by *“name of the administrative body in charge”,*
- and composed of: *“list of the administrations, laboratories, institutes, harbour authority, private bodies... involved”*
- with consultation of : *“list of the administrations, laboratories, institutes, harbour authority, private bodies…. involved”*
- The technical secretary of the technical committee is carried out by *“name of the administrative body in charge”*,

will examine and study, when necessary *“on areas of special interest such as harbour entrance (risky area), marine protected areas (high environmental interest: fisheries and marine critical habitats)“*, modifications of these general limits at local scale to take into account local characteristics (environmental and socio-economic).

This technical committee can take advantage of consulting Non Governmental Organisations dealing with marine conservation, scientific experts in marine environment.

Considering harbour areas *“list of the concerned harbours”*, the possibility of using dispersant should be examined on realistic scenarios in terms of quantity of oil to be involved in expected spill incidents, the main locations where the risk for incident is the most important, the prevailing weather conditions, the tidal stream and the surface agitation. These scenario studies will aim at comparing realistically (according to the available equipment) the possibilities for containment and recovery, chemical dispersion and letting oil to come ashore for shoreline cleanup. For each of these options the environmental damage and the associated cost will be considered and compared in order to determine the most appropriate option.

“Name of the administration” is in charge of conducting these investigations.

The charts of the limits are integrated in the contingency plan to assist persons in charge of the response to decide without delay to disperse or not (to decide quickly as long as the pollutant is still dispersible).

The local specific regulations related to the use of dispersants decided by the commission are presented (or described) as charts in the Annex *"to be specified".*

These charts are regularly updated by *"name of the administration in charge"* under the supervision of the technical committee designed above.

Note on the use of oil spill dispersants in inland waters: *in inland waters the rationale can be different and the environmental considerations may differ. This document deals only with the marine application and not with the use in inland waters. See Chapter 10.*

Basic principles to set environmental considerations to the use of dispersant particularly in coastal waters

As a first approach, the following basic principles can be considered:

1) Consider the use of dispersant in open sea / offshore / ahead sensitive resources, to avoid oil to reach the shoreline or possibly sensitive items (where water quality need to be preserved).

2) Generally speaking, no use of dispersant on or in the immediate vicinity of sensitive items.

3) On coastal areas where several sensitive items are of concern, NEBA based on realistic scenarios is needed.

4) When NEBA is needed:
   a. Local sensitive items should be listed and their possible vulnerabilities assessed;

   b. Consider NEBA approach in terms of vulnerability rather than sensibility (vulnerability=sensitivity and restoration time);

   c. If conflicting conclusions:
      - Preserved the habitat before the species;
      - Preserved the reproduction possibilities rather the young stages;

5) Warning: special concerns for the application of dispersants when the wind is blowing in the direction of flocks of birds (contact between dispersants and feathers of seabirds should be avoided).

Note 1: The use of dispersants should be a response to incidental pollution; in sheltered area, a chronic-usage on repeated incidents can lead to chronic contamination.

7.1.3 Logistics for dispersant application

Logistics required for the application of dispersant include the spraying systems, the products, and other related items.

These products and means required are listed in the contingency plan (location, quantities, characteristics, compatibility, availability, operational limit conditions and mobilisation and deployment timeframe) such as:

- operational stocks of dispersant;
- shipboard spraying systems;
- vessel on which spraying equipment can be used;
- vessels equipped with spraying systems;
- aerial spraying aircrafts;
- facilities from where means would be deployed (airports, ports…).

and eventually:

- aerial surveillance aircrafts aiming at following, and guiding the operations;
- communication means;
- transport means...

The plan must include information (characteristic, performances, requirements, and conditions of availability ...) related to the equipments which are likely to be mobilized:

- at national level public and private equipment;
- at regional level equipment available through bilateral or regional agreement(s) with neighbour countries;
- at international level equipment available through international, regional, sub-regional or bilateral agreements or through contracts with international cooperative companies.

The plan provides details on the persons in charge of the equipment (contact person).

"Name of the administration in charge" in cooperation with the stakeholders *(private companies, ports….)* is in charge of keeping the listing of equipment and related logistics up to date.

7.2 The decision making process

The decision at the time of the incident is led through 3 questions:

- Q1) Is dispersion *a priori* possible or not from a physicochemical point of view? Is the viscosity of the pollutant compatible with dispersion? This question refers to the recommendations put forth in § 7.1.1.

- Q2) Is dispersion acceptable from an environmental point of view? Is the pollution located in an area where *a priori* dispersion is possible? This question refers to the recommendation mentioned in § 7.1.2.

- Q3) Is dispersion feasible from a logistic point of view? Are the logistics available (products and spraying equipment) *a priori* available and sufficiently mobile to conduct the operation within the time limit (period when chemical dispersion remains effective "window of opportunity for dispersion")? This question refers to the recommendation mentioned in § 7.1.3.

At the time of the incident, the decision of using dispersant is taken by *"name of the administration in charge"*. For this decision, *"name of the administration in charge"* can request the assistance of other relevant institutions: *"name of other institutions"*.

Decision trees for decision making process are reproduced in **Annex.**

7.3 Selection of dispersant products

The dispersants used in the *"COUNTRY NAME"* controlled waters must be approved for pollution countermeasure use by the authorities.

Note: such acceptation (or approval) do not prevent a dispersant to comply with the general regulation on chemicals.

For efficiency prospective only concentrate dispersants are recommended for use in *"COUNTRY NAME"* controlled waters.

For safety reasons dispersant products flash point should be above *60 °C*.

The product should be documented through manufacturer's recommendations.

Dispersant should be guarantee by its producer to be stable and to keep its properties for 5 years minimum when stored in proper conditions.

The products approved are registered on a list of approved products constantly revised.

In the event of pollution concerning neighbouring countries, the decisions related to the use and to the application of dispersant must take into account the existence of bilateral (or regional) agreements with the neighbouring country(ies), *"Name of the Agreement(s) and Country(ies) part of the agreement(s)"*. These agreements refer to: the dispersants approved by the related country(ies), the application equipment which can be pooled, and the integration in the *"COUNTRY NAME"* response capacities brought from the related country(ies).

As a principle, in case of joint operation at the regional level, dispersants approved in the partner countries will be accepted if they have been tested for effectiveness and toxicity.

In the event of major pollution, requiring international assistance (Tier 3), dispersants can then be products which will have been examined at least from the point of view of their effectiveness and their toxicity and which are acceptable.

The approval procedure and its possible revision are under the responsibility of a technical committee:

- led by *"name of the administrative body in charge";*
- and composed of: *"list of the administrations, laboratories, institutes, harbour authority, private bodies... involved".*
- with the consultation of: *"list of the administrations, laboratories, institutes, harbour authority, private bodies… involved".*
- The technical secretary of the technical committee is carried out by *"name of the administrative body in charge".*

Note ***on the use of oil spill dispersants in inland waters:*** *the choice of the dispersant product is different (products efficient at sea are often not efficient in fresh water). See Chapter 10.*

7.4 Choice of application equipment

The equipment used for the application of the dispersants is specialised materials or materials converted for this purpose (e.g. agricultural plane equipped with proper nozzles or mobile spraying equipment to be set in (under) transports planes).

The equipment ensures a regular spraying and distribution of the dispersant (diameter of the dispersant droplets, rate of application).

The equipment is regularly maintained (individually checked once a year at the warehouse) and is tested periodically through exercises (Refer to chapter. 9.1).

The choice of the application equipment of the national stockpiles should be approved by *"name of the administrative body in charge"* with technical advice of *"list of the administrations, institutes and/or private bodies involved".*

7.5 Logistics related to the application of dispersants

The application of dispersants requires a complete logistics; in addition to the spraying equipment, it is necessary to envisage the logistics to carry this equipment (ships, helicopters and planes), the required consumable (in particular fuel), adapted facilities (port, airport and runways) as well as other related provisions (e.g. means of transport of the material or products).

Aircrafts can be in *"COUNTRY NAME"* or coming from external countries; they can belong to public sector or to private companies.

In case of aircrafts owned by external private or public bodies, contracts should be set to ensure the availability of the equipment at the time of the incident (e.g. availability within 6 hours after call for mobilization.).

Reciprocal compatibilities of the equipment and materials deployed must be checked in order to guarantee the reliability of the whole logistic chain (e.g. compatibility of the spraying systems with the ships, compatibility of planes or helicopters with the local facilities…).

Moreover, for these aircrafts, the different authorisations linked to the Civil Aviation regulations should be prepared in advance in order to allow a fast deployment of the aircrafts at the time of the incident.

Operational stocks of dispersant: In order to ensure prompt dispersion application, dispersant stockpiles must be set up. These stockpiles should be quickly deployed or localised near the spraying systems. They must be also dimensioned to enable a day of dispersion with the spraying system available at the location. Regarding the vessel-mounted spraying systems, stockpiles should be located preferentially in the ports where the vessels are located. Concerning the aerial spraying aircrafts, stockpiles should preferably be available at the airport.

The date of manufacture of the product must be given by the supplier.

The dispersant must be stored according to the manufacturer's instructions and their material safety data sheet (MSDS).

The batches of dispersant of the operational stockpiles are checked periodically (physicochemical parameters – aspect, viscosity, density –; effectiveness….) to check their good conservation. *(Suggestion: periodic checking plan: 5 years after purchase if the product has been kept in its original tank/drum, and further every 2 years)*.

Disposal of unusable dispersants is the responsibility of the dispersant owner The dispersant must be disposed off in environmentally acceptable norms akin to any chemical substances which are disposed in accordance to the environment regulation that are in force (tractability).

An inventory of stockpiles of dispersant and spraying systems should be kept up-to-date. This inventory must take into account stockpiles of the countries or entities with which bilateral agreements or agreements of assistance exist as well as the industry capacities.

The public stockpiles of dispersant are under the responsibility of *"name of the administrative body in charge".*

Considering the aerial application equipment, *"name of the administrative body in charge"* makes an inventory of the possible available resources at a regional level (e.g. existing spraying aircrafts)

Considering application equipment taking into account that private resources will be needed contracts must be set with bodies owning this equipment.

"Name of the administrative body in charge" is in charge of establishing contracts with private/external bodies owning application equipment which are planned to be mobilised in the contingency plan.

"Name of the administrative body in charge", keeps updated the inventory of equipment and products available from public and private sector.

8. Application procedures

8.1 On location dispersion efficiency test and dispersion monitoring

The weathering degree of the oil is generally unknown; therefore the dispersibility of the pollutant remains uncertain when the treatment starts and further.

For this reason, any treatment operation should begin with careful observation of the treatment effect (e.g. visual observation to look for brown plume under the sea surface corresponding to dispersed oil). It is necessary to carry out when starting the treatment with a test spraying run in order to decide whether to continue or to stop the dispersant application. Such tests should be repeated along the operations to check periodically the dispersant keeps efficient.

When available, remote aerial remote sensing techniques such as Infra Red (IR) can be used to confirm the disappearance of the surface oil resulting from the dispersion process.

At last, when a vessel is on site, it is possible to assess the oil dispersibility by collecting a sample in a glass jar in the slick and by testing it in the field. The field test procedure consist in comparing, following manual agitation (hand checking), the dispersion of a sample containing dispersant and oil and one containing only oil (e.g. National Plan Oil Spill Dispersant Effectiveness Field Test Kit - Nat-DET).

"Name of the administrative body in charge" must designate the person on location who will complete these controls in order to be informed on the efficiency of the application.

"Name of the administrative body in charge" in consultation with the *Ministry Responsible for the Environment* will decide to continue or to stop the treatment.

8.2 Dispersion application procedure

Success of an operation is based on the respect of treatment procedures. The treatment should be conducted:

- on the thick parts of the slick (colour brown to black) without taking into consideration the thinnest parts (iridescence, shine…);
- in a systematic way, taking into account the wind;
- (Reference Appendix 6 – Operational procedures from IMO / UNEP recommendations on dispersant application) and Part IV of these Guidelines.

As often as possible, treatment equipment (especially ships) are guided during the spraying operation by a spotter aircraft which indicates the slick zones where the dispersant application must be targeted. When necessary, these parts to be treated can be marked out (with buoys or smoke canisters).

As often as possible, the treatment is monitored in order to assess its efficiency; such a monitoring can be carried out by taking waters samples on the treated slick before and after treatment for further oil concentrations measurements, or by aerial photography or remote sensing technique (e.g. IR) to assess the amount of oil remaining on sea surface (reduction of the slicks due to the dispersion process). This monitoring can be useful to justify the decision to use dispersant and to claim for compensation afterward.

"Name of the administrative body in charge" with, if necessary, the help of *other institutions*, is responsible for organising the monitoring of the efficiency of the dispersion.

8.3 Assistance to foreign experts / operators

In case of large incident (Tier 3) involving foreign experts / operators (from neighbouring countries, international service companies...), and according to the decision taken by the Contracting Parties to the Barcelona Convention, it is necessary to plan national contact persons in charge of welcoming these external teams and facilitating their involvement in the national context (example, a contact person at the airport to take care of a foreign team in charge of running a spraying aircraft, for accommodations, jet-fuel supply, customs clearance, various authorisations…).

8.4 Involvements on fisheries activities

The dispersion of significant amount of oil can impact some environmental resources as fisheries (e.g. tainting of sea food following contact with oil droplets). For sanitary reasons and to justify afterwards claims for compensation, it is useful to monitor the water column quality which may have been in contact with oil as well as the quality of the sea food, and possibly to take appropriate measures such as banning fishing temporarily.

The monitoring of the effects of the use of dispersants as well as the appropriate decisions (e.g. fishing ban) is under the responsibility of the *"name of the administrative body in charge"* in consultation with the *"list of the administrations, institutes and/or private bodies involved".*

9. Precautions and operational recommendations

9.1 Drills

Drills are organized periodically to validate the combating procedures, to train the operators and to check the capability of the contingency plan (through table top exercises to check the availability of persons to be mobilized – level 1 exercise) and through practical field exercise to check the capability of the combating equipment to respond to a pollution situation (through real simulations, mobilizing people and equipment on site – level 2 exercise).

One level 1 exercise (table top) per year should be organised in each riparian district, and one level 2 exercise per year should be organised at the national level, in a different riparian district each year.

Level 2 exercise could be organised in the frame of the NOSCP (National Oil Spill Contingency Plan) (involving other techniques than dispersion).

Corrective actions will be taken according to the observations made during the exercises.

Drills are coordinated by the *"name of the administrative body in charge"* with the *concerned organisations*.

9.2 Training

Personnel in charge of operating the dispersant application equipment are specifically trained. This training can be integrated in the general training plan scheduled in the NOSCP (National Oil Spill Contingency Plan).

The *"name of the administrative body in charge"* coordinates and supervises the training.

9.3 Protection of persons and equipment

Personnel in charge of the spraying operations are protected against mist of dispersant (Individual Protective Equipment; e.g. mask, protective impermeable clothes, gloves…).

Solid surfaces (especially ship decks) which may receive spray of dispersant are flushed with water to avoid being slippery (safety concerns).

Materials and equipment in contact with dispersant are flushed with water to avoid any deterioration (of paint, rubber seals…).

Spraying equipment is rinsed with fresh clear water after use.

10. Use of oil spill dispersants in inland waters (rivers and lakes)

The use of dispersants in inland waters differs from the open sea use:

Generally speaking, chemical dispersion is not appropriate to oil pollutions in inland waters as:

- The volume of water is often limited and does not allow the same dilution-dissemination conditions as those prevailing in the open sea.
- The agitation is often too weak to promote the dispersion process.
- The lack of agitation is favourable to the choice of the containment and recovery response option.
- In inland waters, the oil spill incidents involve more often light refined products which do not require chemical dispersion.
- There are uncertainties on the environmental and socio-economic impact; the environmental considerations may differ from those prevailing in marine environment, in terms of sensibility and vulnerability; these should need to be studied in advance in order to check that dispersion would bring more advantages than disadvantages. In particular, chemical dispersion is not suitable in the vicinity or upstream of water intakes (which would be polluted in such a case), of fish farms etc…

According to these considerations, generally speaking the use of dispersant in fresh water environment should be avoided; the situations for which the dispersion process could be applied in fresh water would be only:

- on oil products dispersible, (viscosity less than 5 000-10 000 cSt), and also persistent (which excludes the light refined products – petrol – diesel oil – kerosene – which naturally evaporate and self-disperse);
- possibly, on rivers presenting a strong stream preventing any possibility to choose the recovery/containment option, or in great lakes when the agitation resulting of bad weather conditions (wind) is strong enough to prevent any containment/recovery operation;
- far away from environmentally sensitive resources or waters intakes;
- on very limited quantities of pollutant, in order not to pollute the local environment.

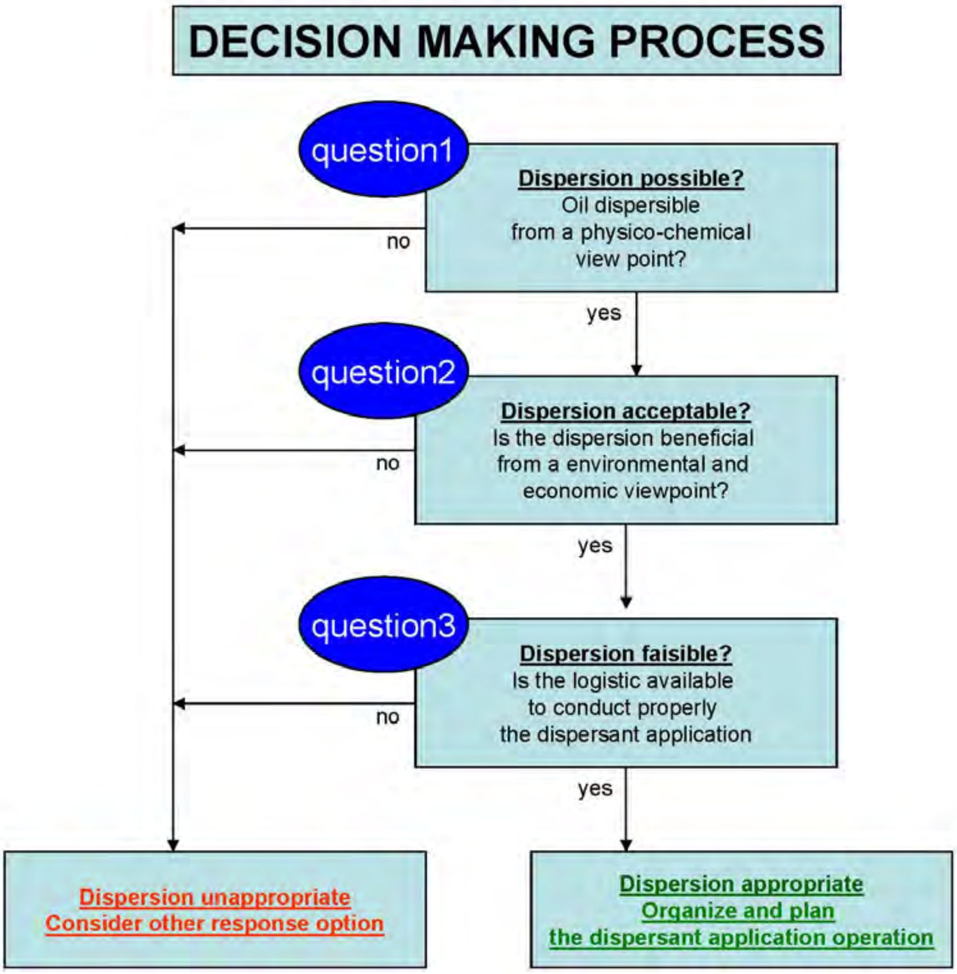
In such a case, it would be necessary to:

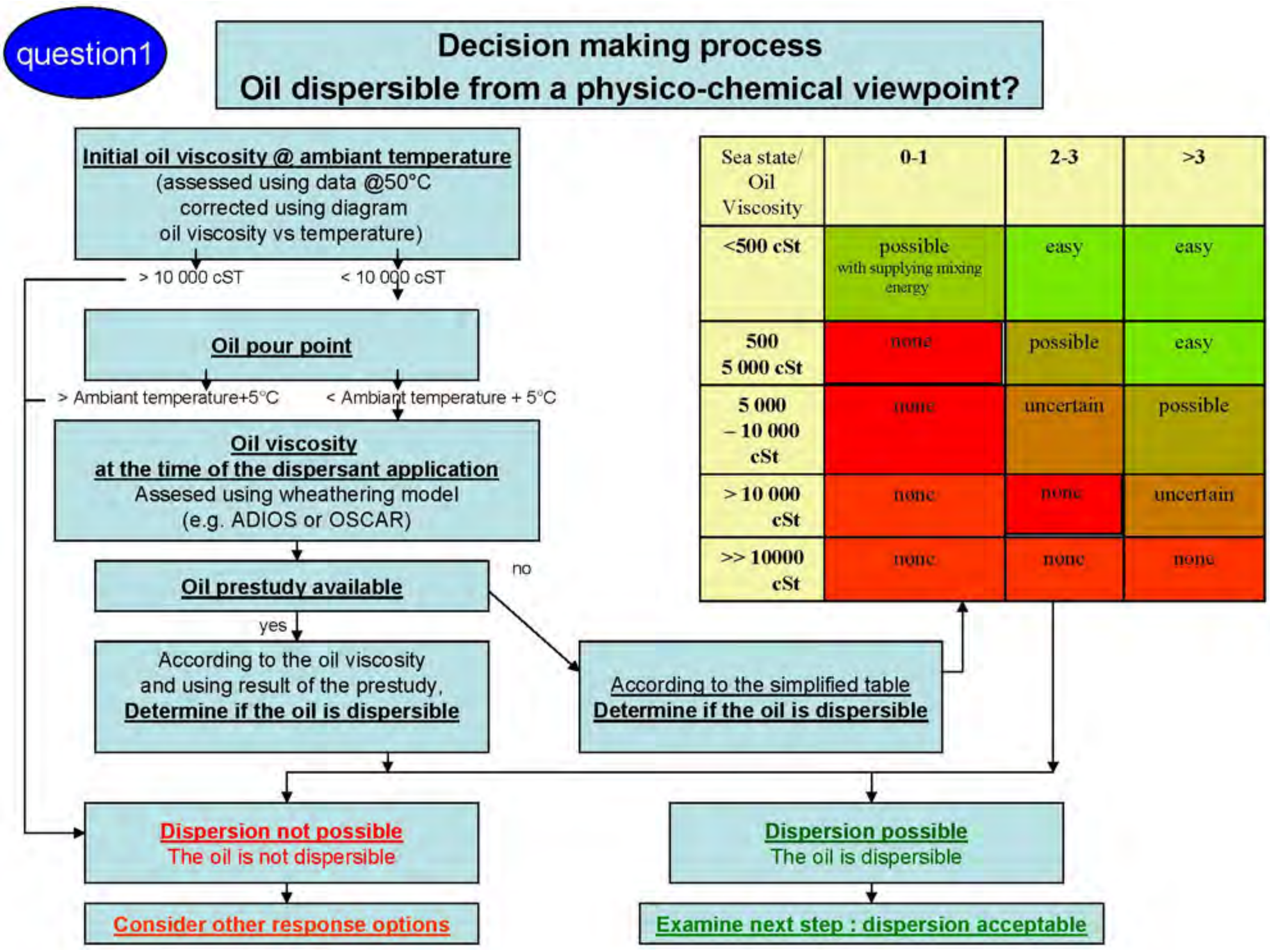
- use a specific dispersant designed for fresh water use (as marine oil spill dispersants are not efficient in fresh water). Refer to the French list of fresh water dispersants at: http://www.cedre.fr/en/response/dispersants_ed_gb.pdf;
- if necessary, promote the dispersion process by mixing the slick with water jets after application;

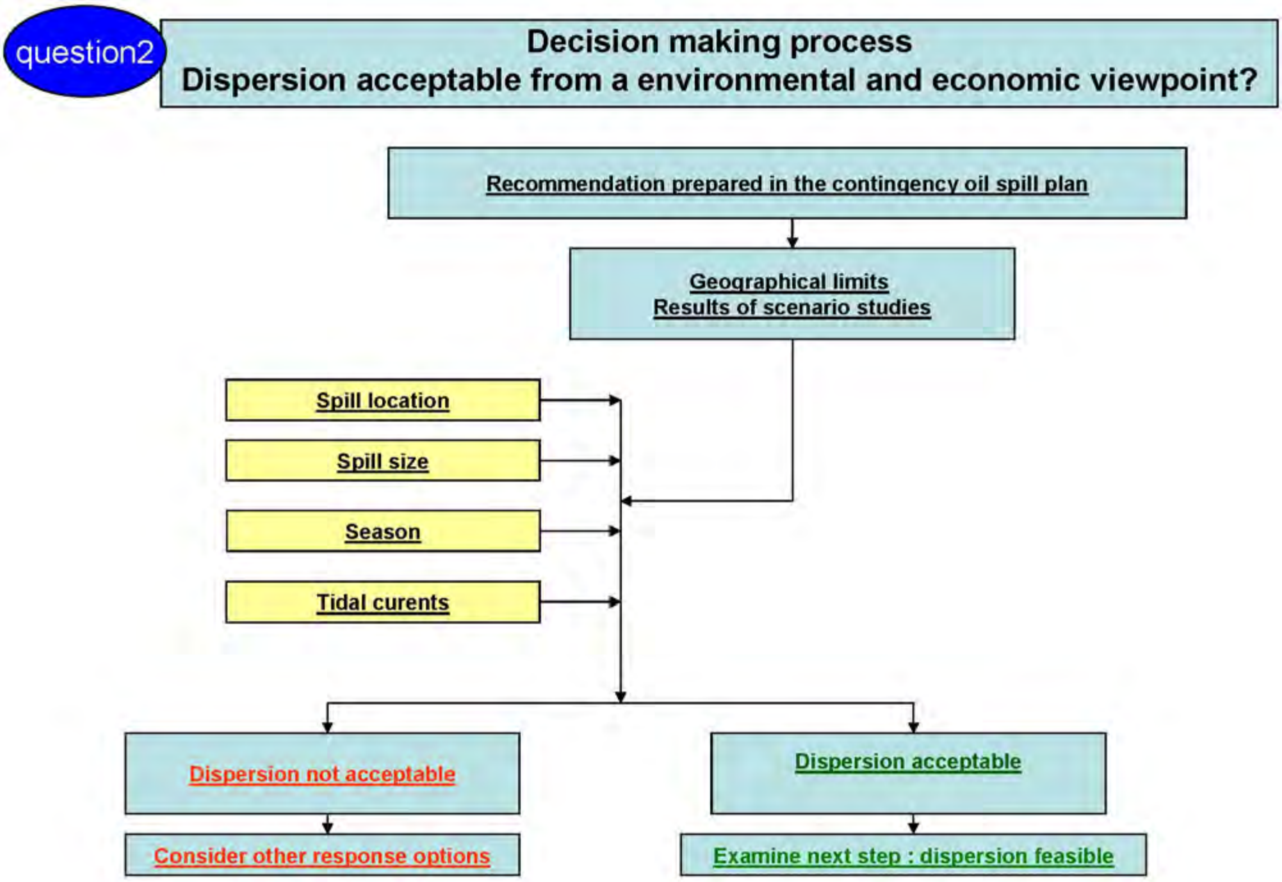
- on location where the depth is higher than 10 meters;
- with warning toward the populations which use the water (water uptakes, fishing…);
- with report of the incident to the authorities and monitoring of the environment.

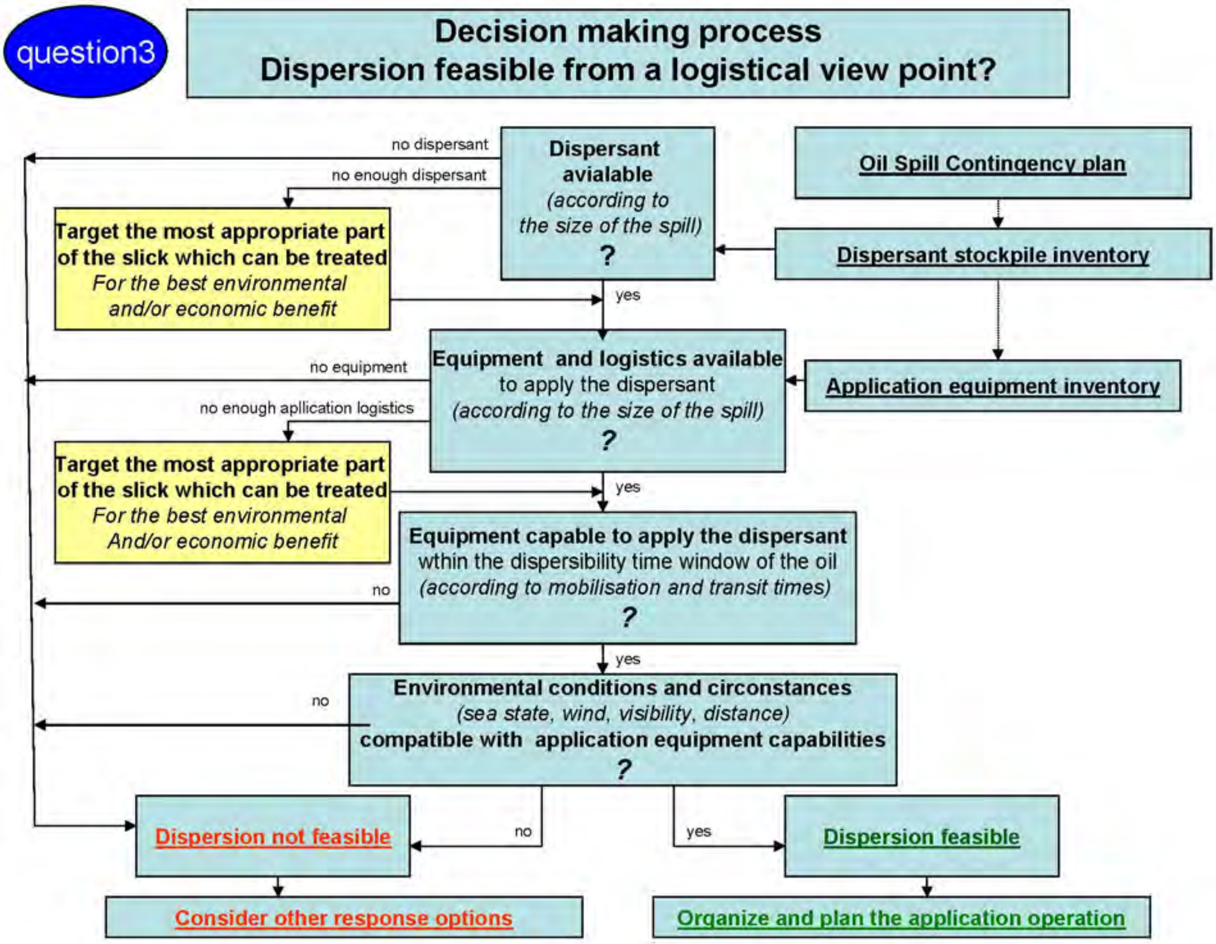
If some specific persistent oils (e.g. crude) would be frequently transported in known fresh water bodies, it is recommended that these oils are studied in terms of behaviour and toxicity in fresh water environment in order to determine the most appropriate response options and the best conditions for use, including the use of dispersant (determination of the weathering process of the oil dispersibility, dispersed oil toxicity…).

ANNEX


DECISION MAKING PROCESS
question1
Dispersion possible?
Oil dispersible from a physico-chemical view point?
no
yes
question2
Dispersion acceptable?
Is the dispersion beneficial from a environmental and economic viewpoint?
no
yes
question3
Dispersion faisible?
Is the logistic available to conduct properly the dispersant application
no
yes
Dispersion unappropriate
Consider other response option
Dispersion appropriate
Organize and plan
the dispersant application operation


question1
Decision making process
Oil dispersible from a physico-chemical viewpoint?
Initial oil viscosity @ ambiant temperature
(assessed using data @50°C
corrected using diagram
oil viscosity vs temperature)
> 10 000 cST
< 10 000 cST
Oil pour point
> Ambiant temperature+5°C
< Ambiant temperature + 5°C
Oil viscosity
at the time of the dispersant application
Assesed using wheathering model
(e.g. ADIOS or OSCAR)
Oil prestudy available
no
yes
According to the oil viscosity
and using result of the prestudy,
Determine if the oil is dispersible
According to the simplified table
Determine if the oil is dispersible
Sea state/ Oil Viscosity
0-1
2-3
>3
<500 cSt
possible
with supplying mixing energy
easy
easy
500 5 000 cSt
none
possible
easy
5 000 – 10 000 cSt
none
uncertain
possible
> 10 000 cSt
none
none
uncertain
>> 10000 cSt
none
none
none
Dispersion not possible
The oil is not dispersible
Consider other response options
Dispersion possible
The oil is dispersible
Examine next step : dispersion acceptable


question2
Decision making process
Dispersion acceptable from a environmental and economic viewpoint?
Recommendation prepared in the contingency oil spill plan
Geographical limits
Results of scenario studies
Spill location
Spill size
Season
Tidal curents
Dispersion not acceptable
Consider other response options
Dispersion acceptable
Examine next step : dispersion feasible


question3
Decision making process
Dispersion feasible from a logistical view point?
no dispersant
no enough dispersant
Dispersant avialable
(according to the size of the spill)
?
Oil Spill Contingency plan
Dispersant stockpile inventory
Target the most appropriate part of the slick which can be treated
For the best environmental and/or economic benefit
yes
Equipment and logistics available
to apply the dispersant
(according to the size of the spill)
?
no equipment
no enough apllication logistics
Application equipment inventory
Target the most appropriate part of the slick which can be treated
For the best environmental And/or economic benefit
yes
Equipment capable to apply the dispersant
wthin the dispersibility time window of the oil
(according to mobilisation and transit times)
?
no
yes
Environmental conditions and circonstances
(sea state, wind, visibility, distance)
compatible with application equipment capabilities
?
no
no
yes
Dispersion not feasible
Dispersion feasible
Consider other response options
Organize and plan the application operation

BIBLIOGRAPHY

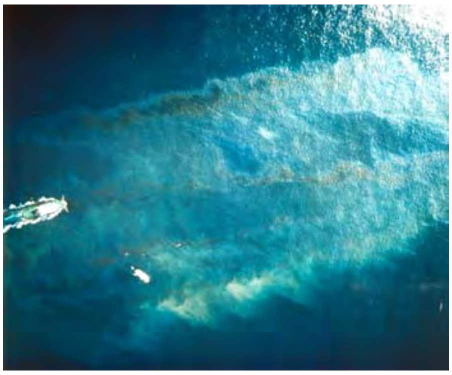
1. IMO (1988), Manual on oil pollution, Section IV: Combating oil spills, IMO, London, U.K.

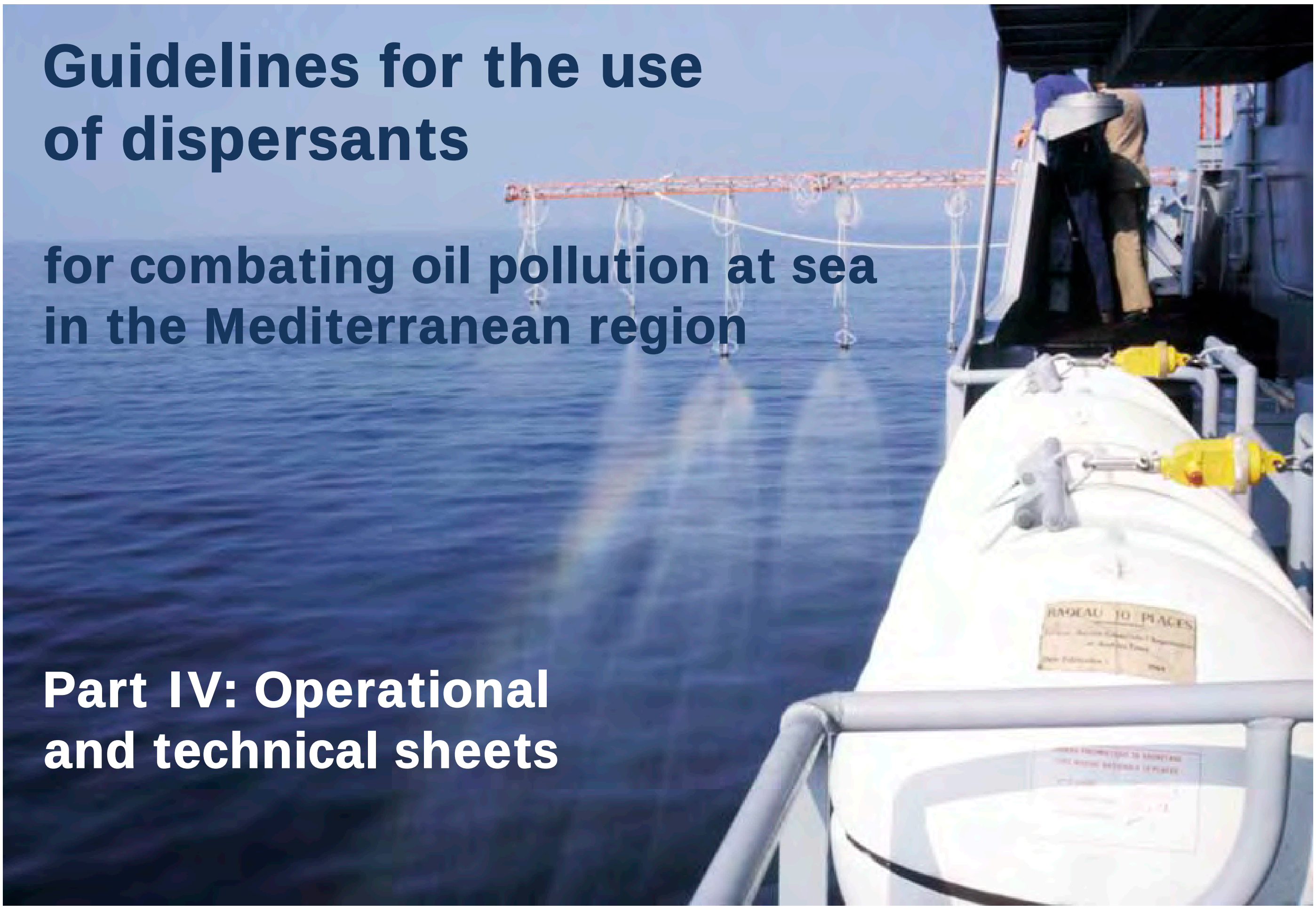
2. IMO / UNEP (1995), IMO / UNEP guidelines on oil spill dispersant application and environmental considerations, IMO, London, U.K.

3. IPIECA, 2001. Dispersants and their role in oil spill response – Technical report series volume 5.

REMPEC
MARITIME HOUSE, LASCARIS WHARF, VALLETTA VLT 1921, MALTA
rempec@rempec.org - www.rempec.org







Guidelines for the use of dispersants

for combating oil pollution at sea in the Mediterranean region

Part IV: Operational and technical sheets

MEDITERRANEAN ACTION PLAN (MAP)
REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)


REGIONAL MARINE POLLUTION EMERGENCY

RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

MEDITERRANEAN ACTION PLAN

Guidelines for the use of dispersants for combating oil pollution at sea in the Mediterranean region

Part IV: Operational and technical sheets

Regional Information System – Part D, Section 2 (RIS/D/2)

www.rempec.org

April 2011 Edition

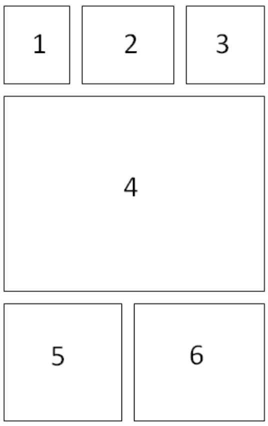
Note

This document is aimed at facilitating the implementation of the "Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency" of the Barcelona Convention (Emergency Protocol, 1976) and the "Protocol concerning Co-operation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea" (Prevention and Emergency Protocol, 2002) by the Contracting Parties of the Barcelona Convention.

These "Guidelines", which are advisory, do not affect in any way already existing or planned national laws and regulations related to matters covered by it. REMPEC assumes no liability whatsoever for any potentially damaging consequences which could result from the interpretation and use of information presented in this document.

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of IMO, UNEP, MAP and REMPEC concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries.

Cover photos: © Cedre



Helicopter mounted spraying system

Airborne treatment

Aerial monitoring operation

Ship mounted spraying system

Airborne treatment

Shipborne treatment

The Guidelines are downloadable from REMPEC's website (www.rempec.org) in the section "Information resources/Regional Guidelines/Preparedness & Response".

For bibliographic purposes this document should be cited as follows:

IMO/UNEP: Regional Information System; Part D – Operational Guidelines and Technical Documents, Section 2, Guidelines for the use of dispersants for combating oil pollution at sea in the Mediterranean region, REMPEC, April 2011 edition.

Foreword

In a large part of the Mediterranean coastal States, the use of dispersants as a response method for combating accidental oil spills at sea has not as yet been covered by specific national regulations.

Controlled and appropriate use of selected dispersants on types of oil amenable to chemical dispersion, is widely recognized as one of the useful methods for combating accidental oil spills, and in particular the massive ones. Moreover, under certain sea and weather conditions the use of dispersants might be the only applicable response method for protecting sensitive natural resources, coastal installations or amenities.

However, the opportunistic attitude regarding the use of dispersants is hardly acceptable. Selection of products which might be used, definition of zones in which their use is either allowed or prohibited and their place in the general strategy of pollution response need to be adequately regulated if the use of dispersants is expected to produce desired results without creating additional risks for the environment.

Considering the developments in the field of dispersants since the October 1998 edition of the "Guidelines for the Use of Dispersants for Combating Oil Pollution at Sea in the Mediterranean Region", the Ninth Meeting of the Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta, 21-24 April 2009, tasked the Mediterranean Technical Working Group (MTWG) to review their content.

This new edition of the Guidelines [endorsed by the Tenth Meeting of the Focal Points of REMPEC, Malta, 3-5 May 2011] has been prepared with the technical support of the 'Centre of Documentation, Research and Experimentation on Accidental Water Pollution' (CEDRE) and reviewed by the Centre in collaboration with the MTWG.

They aim at assisting the Mediterranean coastal States in developing and harmonizing national laws and regulations regarding the use of dispersants in response to oil spills at sea. It does not refer to the use of dispersants on shore.

The Guidelines are divided into four independent parts addressing different issues. Each part has been developed with a specific objective and is aimed at different end-users:

PART I REGIONAL APPROVAL

Part I which remains unchanged when compared to the version adopted by the Eighth Ordinary Meeting of the Contracting Parties to the Barcelona Convention (UNEP (OCA)/MED IG.3/5, Appendix I, Antalya, Turkey 15 October 1993), provides regionally approved guidance for the development of national laws and regulation on the use of dispersants.

PART II BASIC INFORMATION ON DISPERSANTS AND THEIR APPLICATION

Part II provides theoretical information on dispersants and their application. It is aimed at providing background information on the matter to any person interested in the subject.

PART III OUTLINE AND TEMPLATE FOR A NATIONAL POLICY ON THE USE OF DISPERSANTS

Part III has been prepared with a view to assisting coastal States in the development of their national policy on the use of dispersants. It has been developed as a template which can be followed and adapted by the authorities in charge of the development/maintenance of the national policy on the use of dispersants and can also be used for the implementation of national or local contingency plan for dispersants.

PART IV OPERATIONAL AND TECHNICAL SHEETS

Part IV is based on the publication entitled "Using dispersant to treat oil slicks at sea. Airborne and shipborne treatment. Response manual" (CEDRE 2005). It provides a set of practical technical sheets which point out the different operational issues when using dispersants. It has been developed for operational users with a view to providing them with the required knowledge for efficient dispersant application.

In order to keep the coastal States regularly informed of the current situation regarding the use of dispersants, REMPEC shall update this document to include any new and significant developments in the research field.

GUIDELINES FOR THE USE OF DISPERSANTS
FOR COMBATING OIL POLLUTION AT SEA
IN THE MEDITERRANEAN REGION

P A R T IV

OPERATIONAL AND TECHNICAL SHEETS

TABLE OF CONTENTS

PART IV

OPERATIONAL AND TECHNICAL SHEETS

1. HOW TO APPLY DISPERSANTS?

1.1 Possible vectors for applying dispersants

Dispersants can be used by ships, helicopters and planes (small, average or large size). These vectors all afford different operational options.

1-1-1 Aircraft

Aircraft always use neat dispersant.

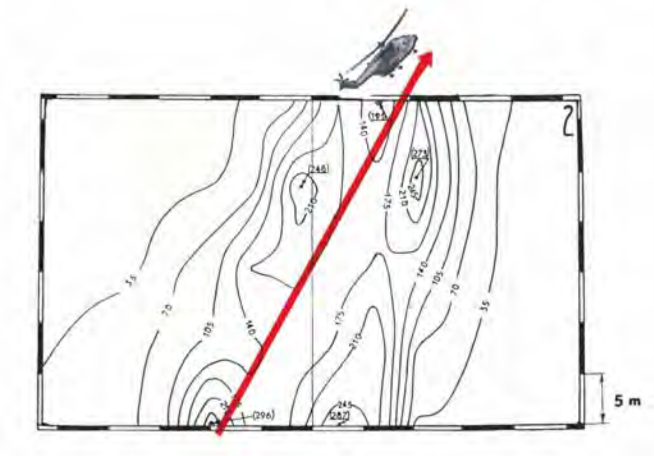
Features:

- Rapidity: they can get to the scene of operations very quickly and get the job done whilst the oil is still amenable to dispersion.

- High prospection rate: they can spray large areas quickly.

- They can spray even in bad weather.

- The need for aerial guidance may well be less: if the plane is flying too low over the sea to actually see the slick when spraying, it can, from time to time, climb higher and spot the slick in between two passes.



The litres per hectare iso-spraying curve for a SOKAF Bucket dispersant spraying system (mesh size of the map is 5 metres for a spraying rate in litres per hectare)

But:

- Uneven spraying (cf. figure above) and dispersant losses may well reach as high as 50 per cent: as dispersant is sprayed at a height of anywhere between 10 and 30 metres above the sea surface, part of the dispersant is more or less lost and does not reach the slick.

Situation with helicopters

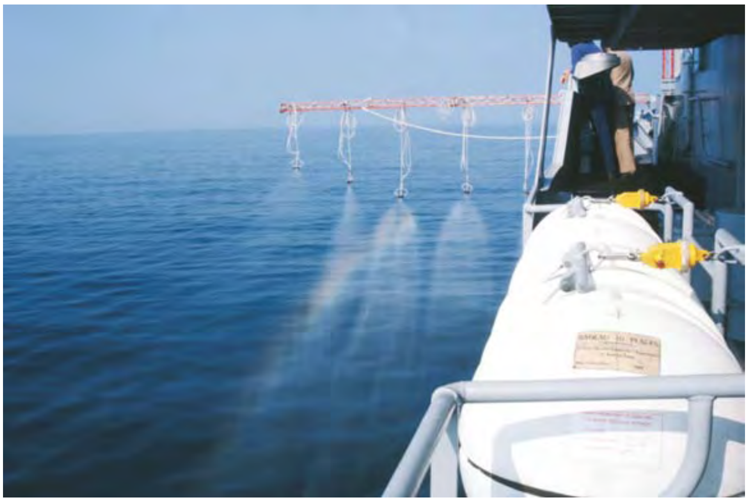
Helicopter payload capacities drop very quickly when transit distances increase.

Calibration trials on the ground for dispersant spraying PROTECMAR trials.

1-1-2 Vessels

Spraying equipment for vessels can use neat dispersant or, (with older equipment) spray dispersant once it has been pre-diluted in seawater. Using dispersant neat is preferred to pre-dilution as it is more effective on weathered and/or emulsified oil.

➔ *Cf. 5 " How much dispersant is to be used when spraying from a vessel?"*



Spray boom in full swing.

1-1-3 Items to note:

- Slow response: unless you have to treat a slick in the immediate vicinity, a vessel needs time to reach the scene of operations which means that the chances of being able to spray the slick during the requisite window of opportunity during which the oil will be amenable to dispersion will be slighter.

- Low prospection rate (in hectares treated per hour): simply because vessels cannot manage more than 4 to 6 knots (rarely 8) knots.

- Sensitivity to sea state: as soon as the sea state gets a little rough, vessel manoeuvres slow down. Furthermore, as dispersants produce a herding effect, vessels have to spray into the wind, which is not a very comfortable option especially when sea conditions are poor.

➔ *Cf. 3.4 "Dispersants can contract surface oil".*

But:

- The stirring effect produced by the bow wave can help to initiate dispersion if the sea is too calm.

- They can treat very fragmented slicks if they have aerial guidance to spot them.

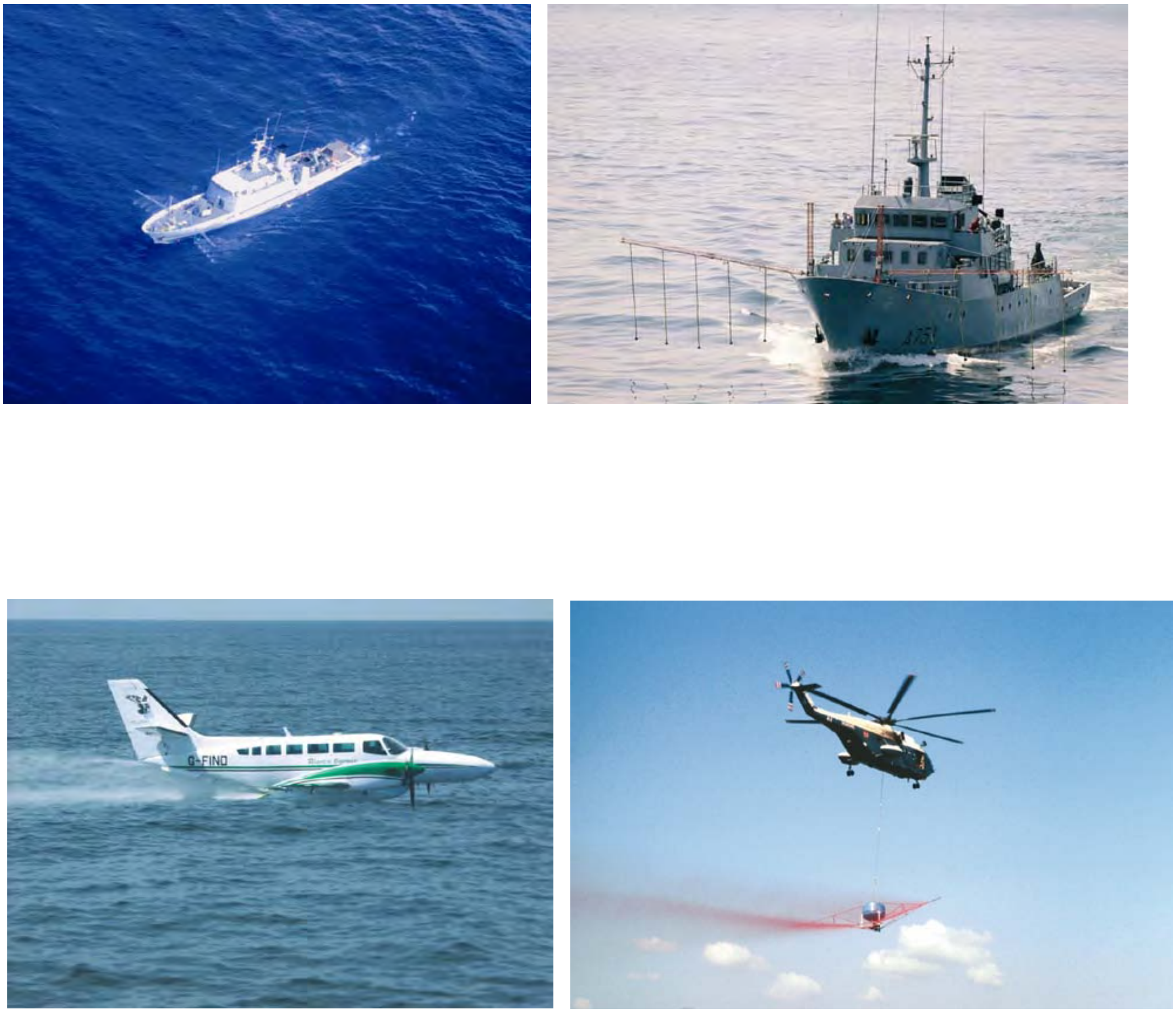
- They can help to calibrate dispersant spray rates (litres per hectare) either by changing vessel speed or better yet by using special spraying equipment (multiple boom spraying arrays).

- They can treat oil for long periods of time without needing to replenish.

1.2 <u>Dispersant must come into physical contact with oil and must be sprayed</u>

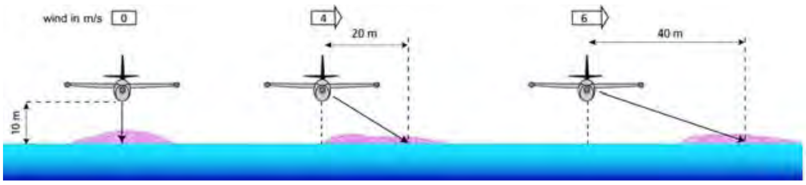
Dispersant spraying has to be geared so as to obtain an even application pattern and an optimum dispersant-oil contact.

- If the droplets of dispersant are too big they will simply traverse the slick and be wasted in the water column.
- If they are too small, the wind will cause them to drift away.



Dispersant spraying modes for vessels, planes and helicopters.

2. AIRBORNE TREATMENT



NB : the use of smoke bombs helps to materialise wind direction and comply with these instructions.

➔ *Cf. 6.5 “Start and stop cues”; Section “Prior reconnaissance, guidance and marking”.*

To avoid dispersant wastage (wind carries the dispersant away from the slick), the recommendation is generally to use droplet sizes of between 400 and 700 µm in diameter. This result can be achieved by the use of the right kind of spraying equipment.

➔ *Cf.box page 9 “Spraying equipment: nozzles and check valves”*

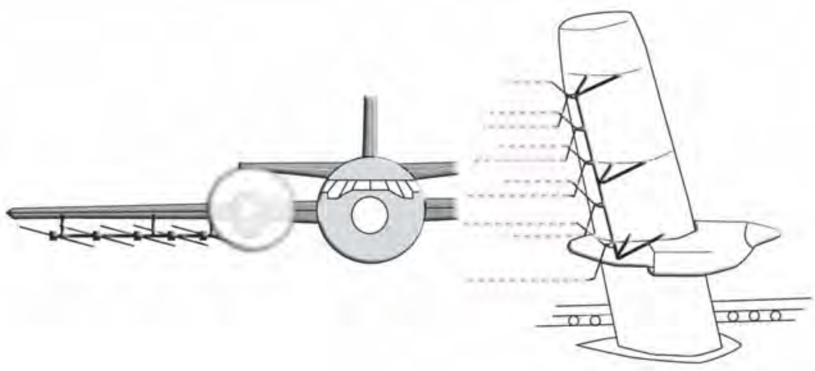
Note: Wind conditions can make spraying difficult and ineffective because dispersant droplets are blown by the wind as they are dropping onto the slick and a cross wind will push the dispersants away from the slick that is being targeted.

Instructions: During treatment operations, always fly upwind or downwind at the height recommended for the type of plane you are flying.

Spraying equipment: nozzles and check valves

Nozzles

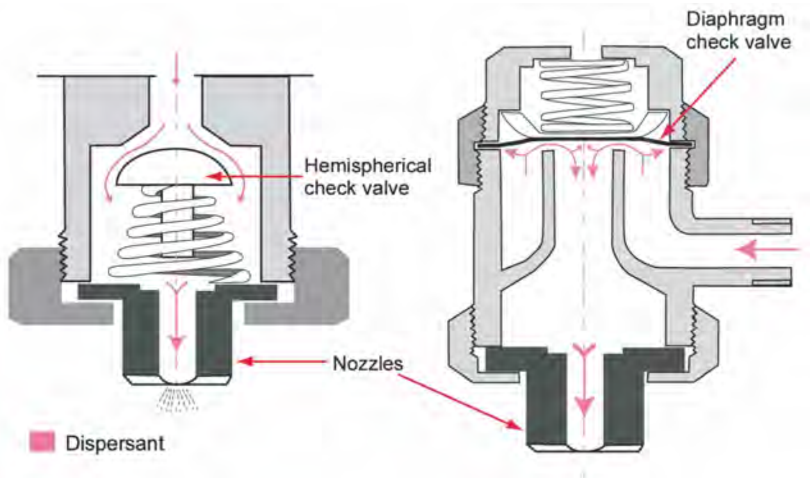
Dispersant spraying equipment generally involves the use of spraying booms fitted with calibrated nozzles that generally produce flat jets. In the case the nozzles must be placed at an angle of anywhere between 10° and 15° in relation to the spray boom in order to generate non crossing parallel jets.



No-drip check valves

Check valves are often mounted on the spray system upstream of the nozzles and close when the system pressure in the spray boom drops. This will avoid leaks and keep the spray system under pressure and full of dispersant when the spraying operation stops.

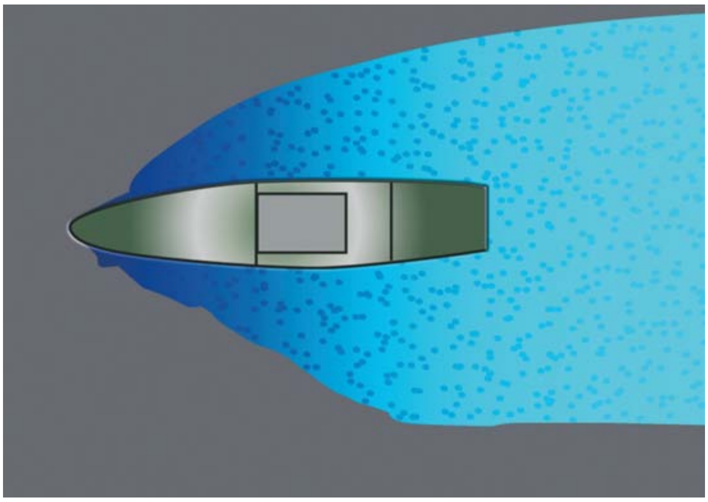
Note: clean check valves make for optimum spraying.



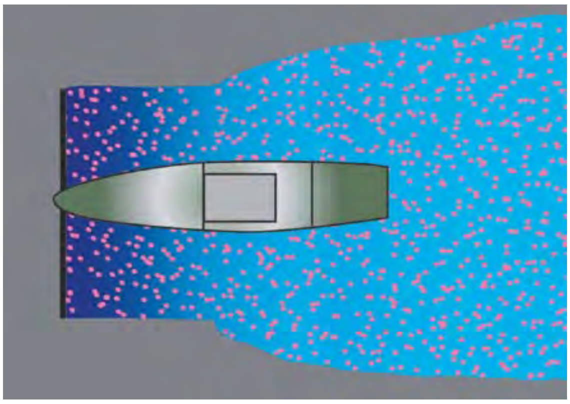
3. SHIPBORNE TREATMENT

3.1 Dispersants have to come into physical contact with oil

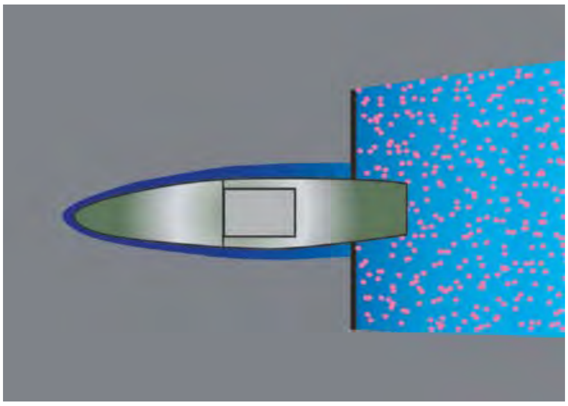
The bow wave pushes the oil away from the vessel



EITHER treat from the bow section in front of the bow wave



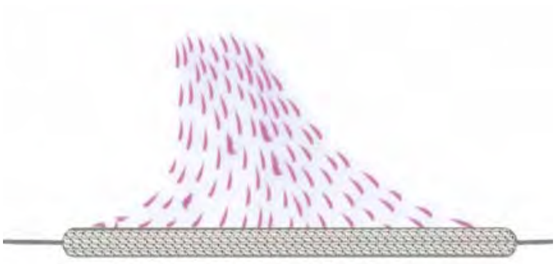
OR Slow down to reduce the bow wave

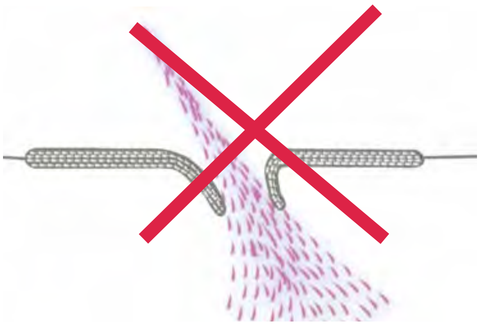


Bow wave as well as ship pitch push the oil away from the vessel and out of reach of the spray booms. Furthermore, the bow wave must not herd the dispersant before it has had a chance of penetrating the oil. The more viscous the oil is, the longer it takes the dispersant to penetrate the oil. In this case you will need to slow the vessel down.

3.2 Dispersants have to be sprayed on the oil

Dispersant droplets must not be too small or too big in order to settle gently onto the oil.

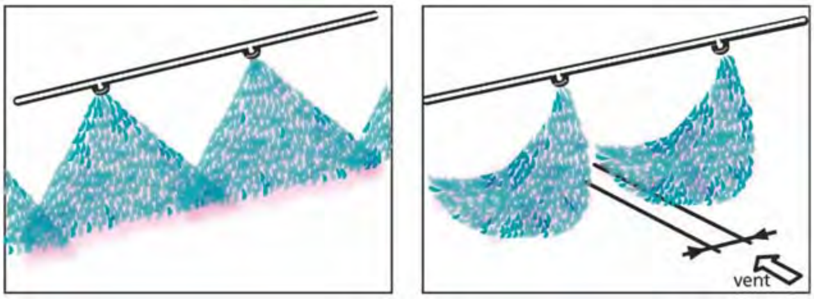




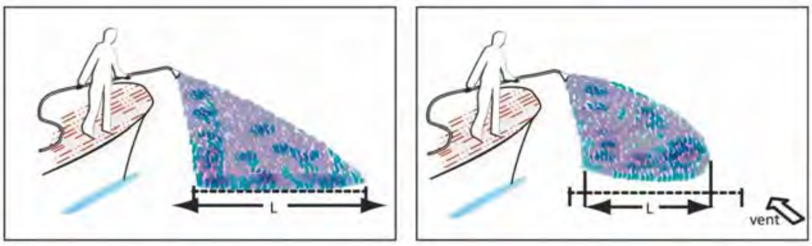
Use	Do not use
- Special equipment: spray booms, pipes… - or else, use fire hoses in fog stream mode.	Fire hoses in solid stream, and avoid pouring dispersant directly onto the slick.

3.3 Wind can prevent dispersants from being sprayed evenly over the slick

When using spray booms, strong wind can impair spraying quality by altering the shape of the spray and reducing spray width and even miss the oil altogether. This kind of effect will be all the more marked when dispersant is sprayed high over the slick.



Similarly, wind can considerably reduce the range of off centred flat spray nozzles (or systems such as fan air blower).

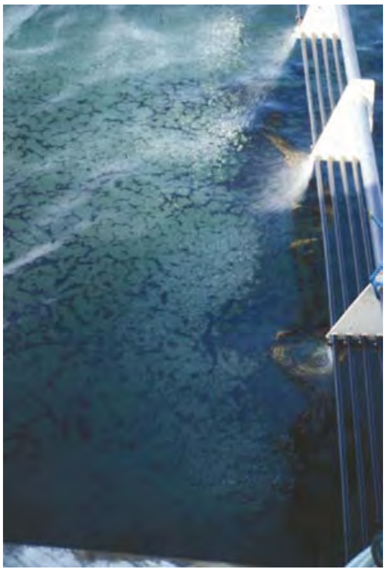


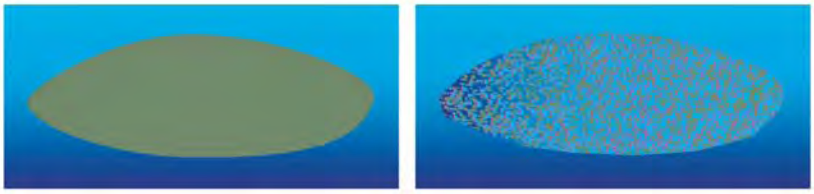
As a rule, the preferred spraying direction is into the wind. However, if the wind is really far too strong to the extent that it compromises spraying operations and adequate droplet dispersion, an attempt can be made to spray downwind but contraction may occur all the same. ➔ *Cf. 3.4 "Dispersants can contract surface oil".*

Important note: If you are crosswind only spray from the leeward side.

3.4 Dispersant can contract surface oil

In the event of adverse conditions, dispersants can concentrate oil into small patches or filaments that stay on the sea surface instead of dispersing oil into the water column.





Herding effect

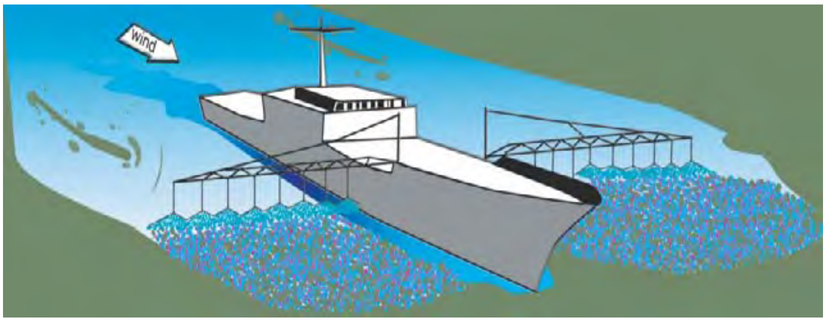
This effect will be observed when spraying dispersant downwind.

In this case, the slick is broken down into smaller patches by fine dispersant droplets that are blown forward in front of the vessel by the wind. When the spraying booms pass over the broken slick, most of the dispersant ends up on the water surface between the small oil patches. The preferred spraying mode is upwind (into the wind).

➔ *Cf. figure in 6.3 "Ship borne treatment"; Section "Standard approach".*

When this effect occurs, there is no point spraying dispersant a second time. It is always better to spray dispersant in one pass and adjust the dose accordingly.

This effect will not occur if oil is thick, emulsified and viscous.



Dispersant application completed downwind, leading to herder effect

3.5 Excessive dilution can cause a dispersant to be ineffective

If dispersant is used pre-diluted with seawater the percentage of dispersant in the mixture must be at least 10%.

4. HOW MUCH DISPERSANT IS TO BE USED WHEN SPRAYING FROM AN AIRCRAFT?

4.1 Required quantities

Required doses are of the order of 5 to 10% in relation to the amount of pollutant. In this case, treatment rates will depend on oil thickness. ➔ *cf. B1 - Slick characteristics.*

Viscosity (in cSt at sea temperature)	< 500	500 - 5 000	5 000 - 10 000	> 10 000
Amenability to dispersion	usually easy	usually possible	sometimes possible	usually impossible
Conventional 2nd generation - type 1	never sprayed by aircraft			
Concentrate 3rd generation - type 2 used diluted 10% in seawater				
Concentrate 3rd generation - type 3 sprayed neat % dispersant to pollutant	5%	5 - 10%	10% (possibly 15%)	ineffective

<u>Note 1</u> : fresh emulsion
It may be necessary to treat slicks by spraying dispersant twice at around one hour intervals. The first spraying operation will use low percentages of dispersant (1 to 2%) so as to break the emulsion and reduce viscosity. The subsequent spraying operation will effectively disperse the slick.

Except for special cases such as thick slicks (e.g. 250 litres / hectare for slicks that are 250 to 500 µm thick), the treatment rate can be adjusted by changing pump speeds or by changing the nozzles and to a lesser extent by changing aircraft ground speeds (for helicopters). The treatment rate (litres / hectare) can be worked out using the following equation:

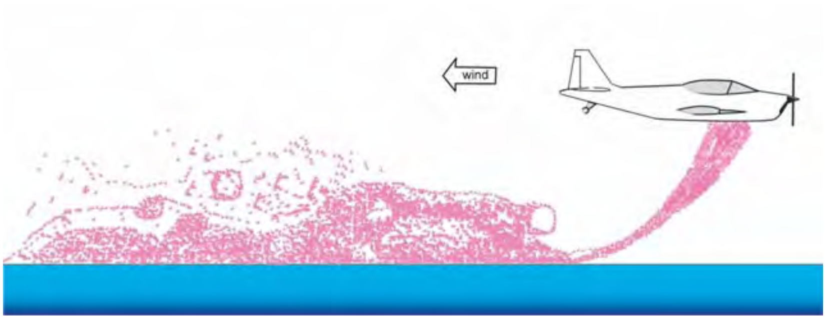
Rate ≈ $(10^3 / 3) \times (D / L \times v)$

D : dispersant flow rate (in liters/minute)
V : aircraft groundspeed during treatment (in knots)
L : effective with treated : 1.2 to twice the lenght of the spray boom depending on the aircraft and height (in meters)

Literal equation : $T_{(l/ha)} = 10^4 \times D / (L_{(m)} \times V_{(nds)} \times 1852) / 60$

In practice, slick thicknesses are unknown and the usual treatment rate is 50 to 100 litres / hectare meaning average slick thicknesses (50 to 200 µm, code 4).

Important note*:* the effective treatment rate is always less than the equation because some of the dispersant will be blown away by the wind. Bearing such losses in mind, and especially in the event of a small patchy slick, it may be advisable to increase dispersant quantities. For instance, step up quantities from 5 to 10%.



4.2 Adjusting dispersant quantities

ON THE GROUND	IN FLIGHT
• Mainly by choosing other nozzles*. • By changing pump speeds (rpm or by opening the «bypass»)*. ➔Cf. 8 *"Technical matters requiring attention prior to treatment".* ——— ** Once the spray system has been adjusted, note the delivery pressure. This will turn out to be very useful subsequently for ensuring effective spraying. Pressure variations can lead to system malfunction.*	• Change the flying speed (helicopter). • Some systems have several booms and the spray rates can be changed by feeding one of the booms **. ——— *** For instance a twin boom spraying system that can be operated independently.*

5. HOW MUCH DISPERSANT IS TO BE USED WHEN SPRAYING FROM A VESSEL?

5.1 Required quantities

They are of the order of 5 to 10% in relation to the pollutant. In this case, treatment rates are related to slick thickness.

Viscosity (in cSt at sea temperature)	< 500	500 - 5 000	5 000 - 10 000	> 10 000
Amenability to dispersion	usually easy	usually possible	sometimes possible	usually impossible
Conventional 2nd generation - type 1	30%	30 – 50%	up to 100% slightly effective	ineffective
Concentrate 3rd generation – type 2 used diluted 10% in seawater*	5 – 10%**	ineffective	ineffective	ineffective
Concentrate 3rd generation - type 3 sprayed neat % dispersant to pollutant	5%	5 - 10%	10% (possibly 15%)	ineffective

<u>Note 1</u> : fresh emulsion
It may be necessary to treat slicks by spraying dispersant twice at around one hour intervals. The first spraying operation will use low percentages of dispersant (1 to 2%) so as to break the emulsion and reduce viscosity. The subsequent spraying operation will effectively disperse the slick

* *The dispersant dilution rate must not be less than 10%.*
** *E.g., a 50 – 100% «dispersant + water» solution.*

In actual fact, it is very hard to know how thick the slick is owing to enormous slick thickness variations:

- thick patches: anywhere from 0.1 mm to a few millimetres;
- vast but very thin slicks: from 0.01 to 0.1mm.

The chosen treatment rate will be about 50 to 100 litres / hectare, which would mean an average slick thickness of 0.1mm.

To optimise dispersant quantities, the treatment rate can be changed slightly depending on how thick the slick is.

5.2 Adjusting dispersant quantities

5-2-1 Standard approach

To achieve a treatment rate of 50 or 100 litres / hectare, vessel speeds will have to be adjusted to suit spray system requirements.

$V_{(50l/ha)} = D / (0.6 \times L)$

$V_{(100l/ha)} = D / (0.3 \times L)$

V = vessel speed (knots)

D = dispersant pumping rates (neat) delivered by the system (in liters / minute).

L = width (in meters) effectively treated by the system (distance from one boom tip to another including vessel width at spray boom location).

5-2-2 Special cases

- Non-adjustable spray system:

The thicker patches (oil thickness > 0.1 mm) will have to be sprayed at slower speeds or possibly several times to increase dispersant delivery quantities (> 100 litres / hectare).

- Adjustable spray system:

With a small adjustment range (1 to 4 times the flow rate), vessel speeds will have to be varied so as to deliver at least 100 litres / hectare.
v = D mini / 0.3 L
Adjustable systems can facilitate the treatment of thick patches (> 0.1 mm) as delivery rates can be increased to treat such patches with one pass.

With a big adjustment range (1 to 10 times the flow rate), your best bet will be to set vessel speed so as to deliver at least 50 litres / hectare.
v = D mini / 0.6 L

In this case, excess dispersant can be reduced over thin patches (10 to 100 µm) that can stretch for miles on end. Thick patches (> 100 µm) can be treated with a single pass as all you need do is increase delivery rates.

6. HOW TO TREAT A SLICK?

6.1 Areas to treat

Average to thick slick patches are treated by adjusting dispersant quantities sprayed.
Thin areas are not sprayed (codes 1 and 2: sheen, rainbow).

➔ *Cf. 4 "How much dispersant is to be uses when spraying from an aircraft?"*
➔ *Cf. 5 "How much dispersant is to be used when spraying from a vessel?"*

Important note: After weathering for a few days, the oil will be patchy and thick and will be called «chocolate mousse». By this stage, the oil will be so viscous as to render it impossible to disperse.

6.2 What to do

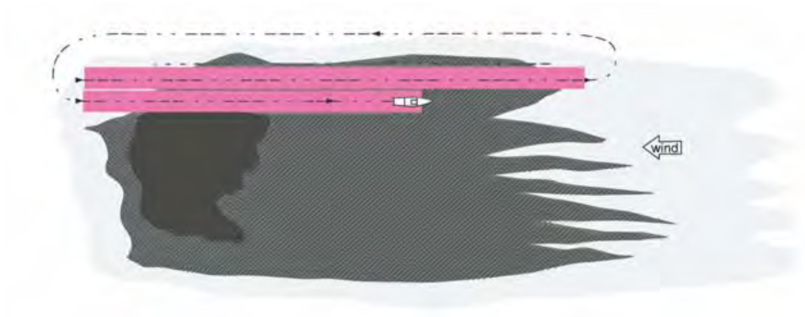
If you are on deck or flying low over the water you will have a hard time trying to identify the outlines of a slick not to mention slick thickness. You will have to be methodical.
You can always decide to «revisit» thick patches that have not been dispersed later on once the bulk of the oil has been treated.

DO	DO NOT
Begin treatment from the edges of a slick to the border of medium thickness areas. Treat the slick by parallel close passes (the only way to cover all the slick). Treat upwind or downwind (and for vessels, always upwind*) so as to guarantee spraying conditions and an optimum "dispersant-oil" contact. For aerial application, do not forget equipment response times and droplet drift caused by the wind when you need to start or stop spraying. ➔ *Cf. 6.5 "Start and stop cues".* ** Spray into the wind to avoid the herding effect. (➔ cf 3.4 "Dispersants can contract surface oil"); unless when the slicks are very thick and weathered and the herding effect does not occur.*	Cut up and fragment a slick. By ploughing through it in all directions, as you will soon find it impossible to spot the slick and treat it all properly. For vessels, treat downwind.

6.3 Ship borne treatment

6-3-1 Standard approach

The preferred approach is upwind.



6-3-2 Special case

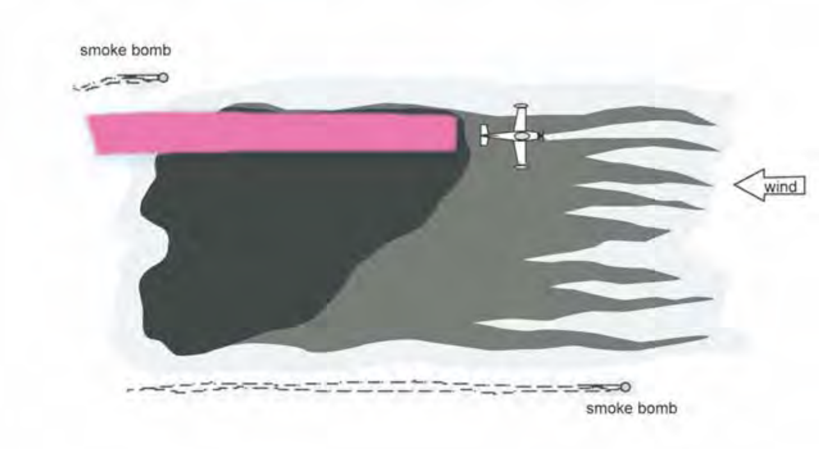
Slick is made up of a number of thin windrows placed abeam the wind: treat from the lee side of the vessel as the vessel sails lengthwise through the slick.

6.4 Airborne treatment

6-4-1 Standard approach

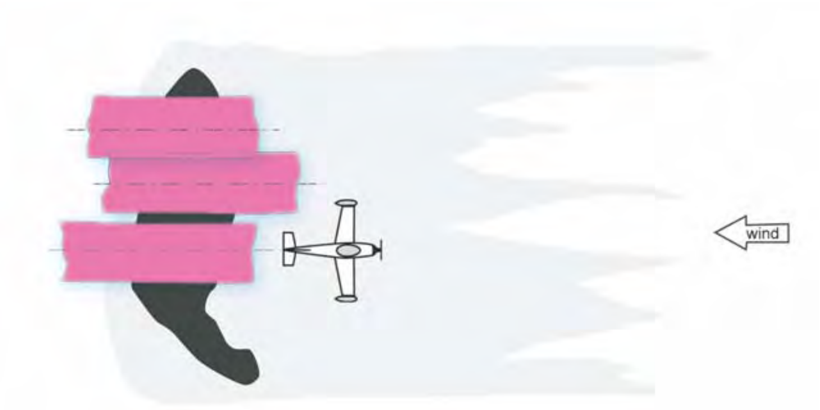
The preferred approach is either up or downwind.

Important note: Smoke bombs can be very helpful for marking a slick and showing wind direction. ➔ C*f. 7-2."* Using smoke bombs and buoys"

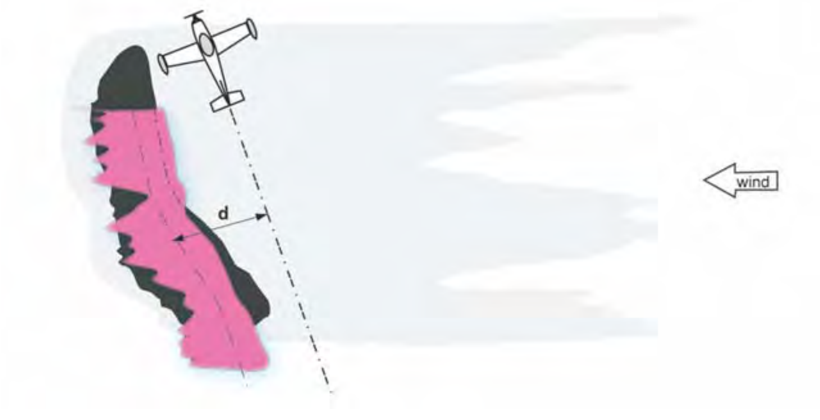


6-4-2 Special case

If the slick is a thin strip abeam the wind: the preferred treatment modality will be to fly several passes into the wind,



or possibly, treat abeam the wind not forgetting that the dispersant will tend to drift sideways with the wind (d).



Start and stop cues

The start and stop spraying cues have to include:

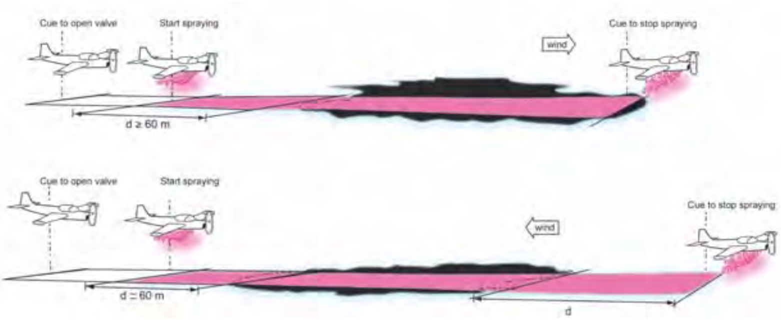
- equipment response times for spraying to start once the cue has been given (lead time is about a few seconds);
- wind effect: as dispersant droplets fall onto the slick, the wind will blow them away. Droplet drift (in metres) can be estimated as follows:

$$d = \frac{(v \times h)}{12}$$

(Where v: wind speed in knots; h: height at which aircraft is spraying).

Flying into the wind, the effect will occur once the slick has passed. Flying downwind, the effect will occur as soon as the aircraft reaches the edge of the slick.

Quite apart from response time considerations always start spraying 60 metres before reaching the edge of the slick, even if wind speed is low.



Spraying dispersant on the ground: spray downwind, spray upwind.

7. HOW TO GUIDE THE TREATMENT ON THE SLICK?

7-1 Prior reconnaissance, guidance and marking

At low altitude (recommended for treatment) it is not easy at all to identify the slick (edges, thickness). It is always advisable to have a second aircraft flying above to guide the sprayer aircraft onto the slick and to give the cues to start and stop spraying with each pass.

If no other aircraft is available, the sprayer aircraft will have to undertake at higher altitude its own reconnaissance of the areas requiring treatment prior to commencement. The pilot will need to take his bearings which will help him during the treatment (ships in the vicinity, platforms, shorelines, buoys, smoke bombs).

7-2 Using smoke bombs and buoys

The oil slick can be marked by:

- smoke bombs dropped by the sprayer aircraft when reconnoitring the slick to be sprayed. Smoke bombs will also be useful to indicate wind direction;
- smoke bombs and buoys launched from a vessel that is guided by an aircraft.

7-3 Aerial guidance procedure

Whenever di spersing or r ecovering oi l, v essels w ill nor mally r equire s ome form o f ae rial guidance: as crew on board vessels have great difficulty spotting oil on the water surface, response vessels need to be guided onto the slicks in order to be effective when spraying dispersant.

The preferred modality is to provide a det ailed description (with maps) of a s lick where the vessel or flotilla are going to start spraying. This will avoid having to tie up a spotter plane all day.

When this is not pos sible, bas ic guidance w ill be t aken t o m ean di recting a vessel t o the thickest parts of a slick by giving the helmsman a bearing and a distance.

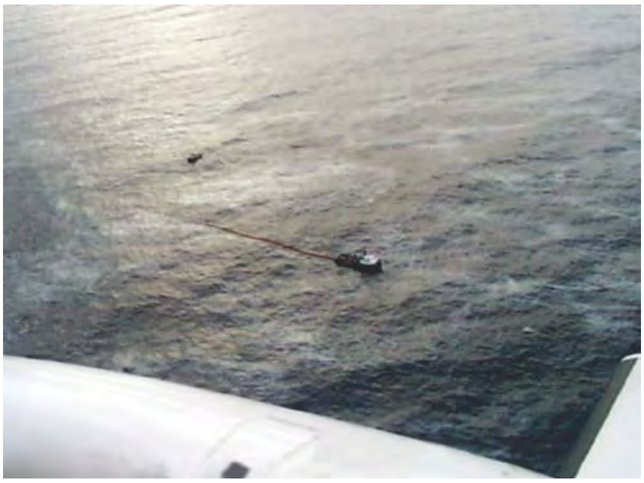
For instance: «the slick is 20 metres wide and 200 metres long bearing 30° and 300 metres from your current position».

The plane (or preferably a helicopter) has to indicate slick position and shape in addition to pointing out where the thickest arts of the slick are that will need spraying.

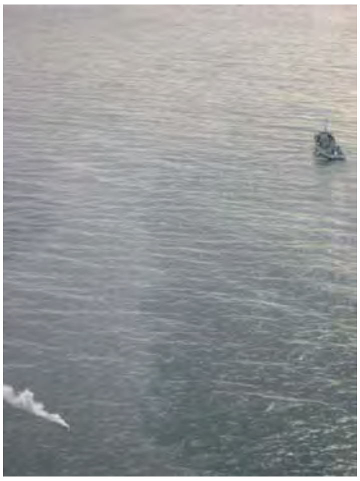
- Guidance can be given directly over the radio.

- When r esponse t ime i s l imited, i t i s al ways b est t o give t he c rew o n boar d t he response vessel an exact description of the slick(s) in addition to the GPS coordinates.

- Guidance to the slick can be improved if the vessel is told where to drop marker buo or smoke bombs.



Guidance provided by the French Customs aircraft to the French response vessel «Ailette» (Prestige spill, Galicia, 2002).



Using smoke bombs to mark slicks.

8. TECHNICAL MATTERS REQUIRING ATTENTION PRIOR TO TREATMENT

8.1 Treating slicks using aircraft

Before actually starting spraying operations, a ground test using water will show whether:

- the dispersant filter is clean;

- nozzles have been mounted correctly:

- choosing nozzle type (possibly),
- nozzle orientation,

- the nozzles are clogged or not;

- the check valves* (mounted just in front of the nozzles) work correctly or not;

➔ *cf. 2 "Airborne treatment".*

- dispersant flow rates and pressures are correct;

➔ *cf. 4 "How much dispersant is to be used when spraying from an aircraft?"*

- spraying controls (remote control) and solenoid valves are working correctly.

➔ *cf. box p 9 "Spraying equipment: nozzles and check valves".*

8.2 Shipborne treatment

Before turning the dispersant spray system on, care will be taken to:

- check that the main filter is clean;

- do a quick spray test (using water if need be) to ensure that the check valves and nozzles are clean and mounted correctly (orientation);

- check that the solenoid valves and control systems are working correctly;

- check that dispersant flow rates and pressures are correct.

➔ *cf. 5 "How much dispersant is to be used when spraying from a vessel?"*

Nozzles fitted with check valves.

9. PRECAUTIONARY MEASURES

9.1 Response crew

Dispersants can irritate eyes and mucosa, so avoid all contact with the eyes and the skin. Do not breathe aerosols.

When handling dispersants always wear protective clothing (e.g. oilskin) goggles, rubber coated gloves (recommended: rubber, nitrile; and always avoid: latex) and in the event of aerosols wear a mask that will protect the respiratory tract (at least wear a dustproof mask).

If dispersant comes into contact with your eyes or your skin, wash them immediately with a lot of clear water.

9.2 Equipment

Dispersants are natural solvents for products such as paints, elastomers, some plastics, tar, tarmac. Depending on the product in question, it will either soften, swell or detach (eg: coatings do this).

They also have a wetting effect:

- They can soak through the smallest cracks.
- They can make some surfaces slippery (deck) and make for dangerous working conditions.

If dispersant leaks and covers the hull or the deck, spray as much water as you can.

When spraying dispersant from a vessel, it is advisable to use some kind of permanent deck or keel cooling system (e.g. use fire fighting equipment or hawser hole washing systems) to prevent crew members from falling and being injured. You will also need to connect up a fire monitor to hose down the port and starboard sections of the deck all the time and especially to hose down the catwalks.

When spraying abeam the wind from a vessel, never spray from the windward side.

When spraying from an aircraft, check from time to time to ensure that the dispersant is not jeopardising the lubrification of moving parts (such as the rotors) or any part of the command and control system.

At the end of the day, rinse spraying equipment with fresh water in addition to the immediate surroundings (plane, runway or taxiway).

9.3 If a fire breaks out

Remember dispersants are flammable. Their flash point is usually over 60 °C.

If a fire breaks out, use powder extinguishers, CO_2, foam or water spray and cool the dispersant storage drums/tanks down.

10. HOW DO YOU ASSESS TREATMENT EFFICIENCY?

10.1 Visual observation

The dispersion operation is being effective if you can see a **brown-orange or even blackish cloud** (with some Heavy Fuel Oils) beneath the surface. This kind of cloud can usually be seen upwind of the area of the slick of medium to large thickness. The surface slick driven by the wind will drift slowly away and leave the dispersion cloud behind.

Note: The dispersion cloud will not always form immediately, particularly when the oil has weathered a bit and has emulsified a little and when wave energy is low. Moreover, the cloud will not always be easy to see and lasts for a long time. It may dilute and tend to disappear (once the oil has started to disperse). The dispersion cloud may form once dispersion has started but providing there is some form of wave action (crest of a wave). When spraying dispersant from an aircraft, the cloud may be harder to spot owing to the height you are flying at.

As time goes by (minutes or hours later), the slick will break up. **Surface areas covered by thick slicks will gradually shrink (gradual disappearance of average to very thick patches, very dark colours such as dark brown or black)**.

As thick slicks recede, much thinner zone appear (rainbow, codes 1, 2 or 3) which spread over large areas before declining and disappearing as time goes by (in the space of a few hours or a few days).

Note: Dispersion must not be mixed up with another visible and well known effect that occurs with fresh, thin oil slicks. Once the dispersant has been sprayed the oil disappears all of a sudden. In actual fact, the dispersant has pushed the oil sideways (herder effect) because it spreads very quickly. This is not real dispersion at all because after a little while the oil film reappears.

➔ *Cf. 3.4 "Dispersants can contract surface oil".*

10.2 Infra-red remote sensing

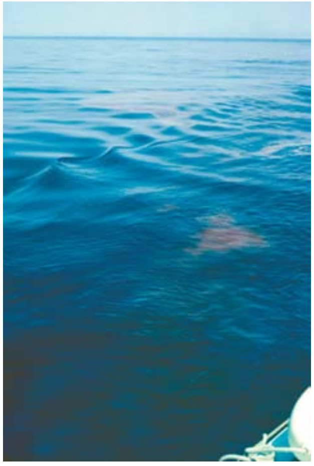
If the dispersion operation is effective, thick patches will gradually disappear from the sea surface and **on board the remote sensing aircraft the IR scans will show less and less white patches**.



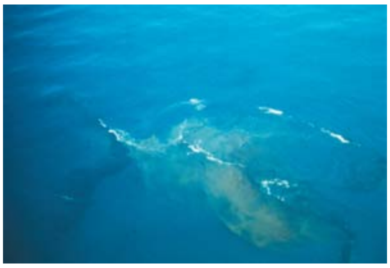
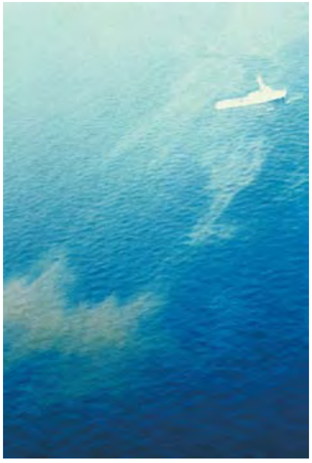
1., 2. Dispersion trial. See the beige colour of the slick just after spraying. This effect will last once a fire monitor has jetted the oil and dispersant.

3. Effect caused by the bow wave of a vessel passing through a treated slick. See the beige colour in the foam.

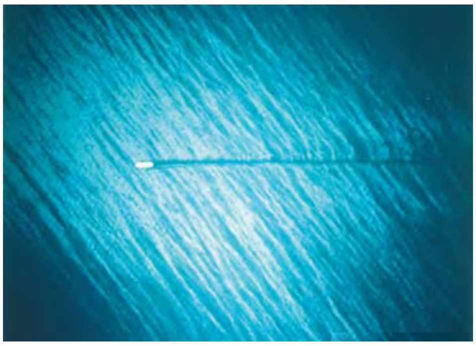
4. When the wave goes through the treated slick, oil is placed in suspension and the beige cloud forms.

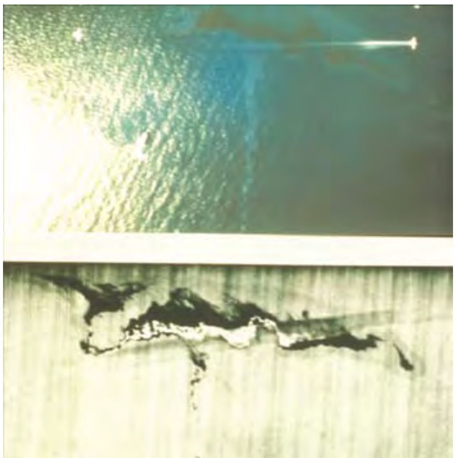
5., 6. Dispersed oil in the wake of a vessel engaged in dispersant spraying operations.

7., 8. What the pilot sees: clouds of dispersed oil (beige) are quite distinct from the appearance of surface oil (which is black or metallic). Note on photo number 7 the presence of white foam which shows that they sprayed too much dispersant.



9. Appearance of a slick treated a while ago. Thick patches have gradually subsided and only thin ones are left. (mainly sheen) and are breaking up naturally.



10. A Canadair starting to spray. The bottom picture shows the same slide in a thermal IR scene. Picture taken by the remote sensing aircraft (the thickest layers are in white).

11. Continuation of treatment. Note the appearance of a dispersion cloud (beige yellow) upwind of the thicker patches (black) and also below, temporary disappearance of thinner patches (the herder effect a dispersant can produce but this is not real dispersion in action at all).

12., 13., 14. Gradual disappearance of thicker patches that turn into dispersed oil patches (yellow brown cloud).

15. The same slick a day after being sprayed. The dispersion cloud has dissolved into the background. All that is left is sheen which is waning and disappearing.

11. MONITORING AND ASSESSMENT PROCEDURES

11.1 Testing prior to large scale spraying

As a response operation swings into action but before it really gathers operational momentum, tests should be conducted on part of the slick to check that the spraying operation is likely to succeed and be effective before ramping up to full scale operations.

You will need to do aerial spraying whilst being mindful of a number of operational limitations (such as available response time) to ensure a qualitative approach to efficacy testing by:

- the spotter aircraft, but remote sensing can also be used;
- a vessel in the vicinity; these observations have to confirm the presence of a brown coloured cloud or the gradual disappearance of thicker patches;
- otherwise, the sprayer aircraft will have to provide the input once it has finished spraying all the dispersant payload or possibly before it starts a second round.

When the response operation goes on for longer periods of time, the check will have to be done at least twice a day to ensure the oil is not weathering too much and is still amenable to dispersion.

If there is no indication that dispersion is really working, you might have to decide to stop spraying and ask yourself two questions:

- Dispersion is not producing the expected results. Is this due to the nature of the oil. Has it weathered too much and is it now too viscous to be dispersed? If the answer is yes then dispersion is no longer the option you need.

- Dispersion is not producing the expected results. Is this due to very low or no wave energy at all (sea is too calm)? If the answer to the question is yes, dispersion can only really be continued providing the (very) short term weather report can announce different weather conditions likely to remedy the problem and provide more wave energy.

11.2 Monitoring operations

If response operations are going to last for a few days, you will have to take seawater samples. The sampling will have to be done in areas that have just been treated by the sprayer aircraft. The labs will check the dispersed oil content of the samples which will give an indication as to whether treatment is effective and whether dispersion is justified.

The sampling (a few decilitres) will be conducted just below the water surface and if possible no lower than one metre. The sample must be kept in a glass bottle and when the sample is transferred to the glass bottle just after sampling, the supernatant oil (from the surface slick) will have to be removed if it has been picked up inadvertently with the rest of the sample.

REMPEC
MARITIME HOUSE, LASCARIS WHARF, VALLETTA VLT 1921, MALTA
rempec@rempec.org - www.rempec.org