NOWPAP MERRAC

Northwest Pacific Action Plan
Marine Environmental Emergency Preparedness and Response
Regional Activity Centre

P.O.Box 23, Yuseong, Daejeon, 305-600 Republic of Korea
Tel: (+82-42) 868-7281, Fax: (+82-42) 868-7738
E-mail: nowpap@moeri.re.kr
Website: http://merrac.nowpap.org

UNEP IMO

Guideline for the Use of Dispersants

MERRAC Technical Report No. 3

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MERRAC Technical Report No. 3

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Foreword

MERRAC, the Marine Environmental Emergency Preparedness and Response Regional Activity Centre, is one of four Regional Activity Centres of the Northwest Pacific Action Plan (NOWPAP) which was adopted in 1994 as a Regional Seas Programme of the United Nations Environment Programme (UNEP) by the People's Republic of China, Japan, Republic of Korea, and Russian Federation. MERRAC is responsible for regional co-operation on marine pollution preparedness and response in the region.

With technical support from the International Maritime Organization (IMO), MERRAC is currently functioning as secretariat for the NOWPAP MERRAC Focal Points Meeting, Expert Meeting, Competent National Authorities Meeting for NOWPAP Regional Oil Spill Contingency Plan (CNA meeting). The Centre also carries out other special activities including the management of a regional information system, organization of training and exercise, capacity building, co-ordination of research and development on the technical aspects of oil spills.

As one of main outcomes of MERRAC activities, the NOWPAP Regional Oil Spill Contingency Plan (the Plan) and its relevant Memorandum of Understanding (MoU) have been developed and officially come into effect as being signed by all NOWPAP Members. The purpose of the Plan is to provide an operational mechanism for mutual assistance through which the Member States will co-operate during major marine oil pollution incidents in the region.

In order to provide practical and technical guidelines to promptly and effectively respond to major oil spill accidents within the framework of the Plan, the 5th MERRAC Focal Points Meeting (MERRAC, Daejeon, 20-24 May 2002) especially agreed to carry out the series of MERRAC specific projects related to oil spill prediction model, sensitivity mapping, oil dispersant, shoreline cleanup, etc.

The documents have been prepared by the Experts Groups, whose members have been officially nominated by the NOWPAP Members and has a profound professionalism in the relevant fields. The 8th NOWPAP MERRAC Focal Points Meeting (MERRAC, Daejeon, 24-27 May 2005) finally reviewed the drafts and then approved to publish them as MERRAC Technical Report series. This technical reports are described the current situation of the relevant subjects and future actions of MERRAC related to relevant subjects. A series of the MERRAC Special Reports to be published in 2005 are as follows:

. Sensitivity Mapping
. Guideline for Shoreline Clean-up
. Guideline for the Use of Dispersants

As Director of MERRAC, I would like to thank the MERRAC Focal Points and all experts of the Expert Groups for their support and contributions to finalizing the MERRAC Technical Reports.

Chang-Gu Kang
Director of MERRAC, November 2005

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Chapter 1

Introduction

Over the past few years, the use of dispersants has become an increasingly common method to combat oil spills at seas. The reason for this is in part because new approach of their application and in part because current mechanical methods have definite limitations.

This has led to a change in attitudes both nationally and internationally. Several countries have expressed positive attitudes towards dispersants and have therefore softened their views on the use of such products.

This report aims to give an overview of the international usage of dispersants as a base for development of NOWPAP Guidelines on Oil Spill Dispersant that can be use during the joint response operation within the framework of NOWPAP Regional Oil Spill Contingency Plan.

Based on an analyse of NOWPAP member States' dispersants use polices and IMO Guidelines, the NOWPAP Guideline (Annex D) was prepared by experts from the People's Republic of China, Japan, Republic of Korea and the Russian Federation as a lead country (Annex A).

Chapter 2

Function and Chemical Composition of Oil Spill Dispersants

When oil is introduced into a water environment, the spill will spread horizontally on the water surface. Spreading varies with surface tension at the border between the oil and water. The higher the oil surface tension (and therefore the surface tension between the oil and water), the less the oil spreads. The function of an oil spill dispersant is to greatly reduce interfacial surface tension and enhance the rate of transfer of spilled oil from the water surface into the water column. Effective application of dispersant to oil that is dispersible will achieve this result. The main concerns about dispersant use are that the temporary increase in oil concentration and the potential for higher concentrations of toxic water-soluble oil components will cause environmental damage.

Dispersion is the conversion of spilled oil from a coherent slick floating on the surface of the sea into very small oil droplets, estimated as about 70 pm in diameter or less (Lunel, 1993), by the prevailing wave energy. These oil droplets are nearly neutrally buoyant due to their small size, and they remain dispersed into the water column until the majority of the oil is eventually biodegraded. The rate of dispersion depends on the oil's properties, principally viscosity, and the prevailing wave energy. Low viscosity oils disperse faster than higher viscosity oils and dispersion is faster in rough seas than in calm conditions.

Dispersion occurs naturally and can proceed at a rapid rate in rough conditions with some low viscosity oils, such as No. 2 heating oil (North Cape incident (OSIR, 1996)), or Gullfaks crude oil (Bruer incident (Harris, 1995)). The effective use of dispersants allows the responder to transfer the oil into the sea at a time and location that will cause less overall environmental damage than allowing the oil to drift toward more sensitive resources or eventually impact the shoreline.

Dispersants are comprised of three main components: surfactants, solvents and additives. Solvents must be used because the surfactants are often viscous or solid, and are either hydrocarbon-based or water-based. Surfactants are the active component that decrees the surface tension in the area between the oil and the water and speeds up emulsification of oil into water. Molecules (nonionic and anionic surfactants) are composed of a water soluble (hydrophilic) part and a hydrocarbon soluble (lipophilic) part and has the ability to orientate itself in the border area with the hydrocarbon soluble group in the oil and the water soluble group in the water. Another important component of dispersants is the additive, which stabilises and prevents the oil particles from breaking away from the border area between the oil and the water. The dispersion process also requires a certain amount of mixing energy and some dispersants require a specific wave movement or other form of energy. There has even been a development of products that can work well without the provision of additional mechanical energy.

Chapter 3

History

The history of dispersants, at least in the public's mind, begins with the wreck of the Torrey Canyon off the coast of Cornwall, UK in 1967, resulting in the loss of 95,000 tons of Kuwait crude oil (GESAMP, 1993; Advanced Technology, Inc. and Continental Shelf Associates, Inc., 1990). As part of the response, chemicals were used to remove oil from the shoreline. Although these chemicals are often referred to in the literature as dispersants, they bear little resemblance to modern chemicals developed for this use. Instead, they were degreasing agents containing 60 percent or more of aromatic solvents; their intended use was to clean oily residues from tanker compartments, not to respond to marine oil spills (Exxon, 1994). Their improper application, including direct shoreline application, resulted in extensive mortality of intertidal organisms (NRC, 1985; Exxon, 1994). According to Southward and Southward (1978), approximately 14,000 tons of weathered oil ultimately came ashore in Cornwall, and a total of 10,000 tons of chemicals were applied to remove it. The oil, most of which was at not particularly toxic by the time it reached the shore. The stranded oil was sprayed with chemicals and then removed by hosing down the area. In some locations multiple treatments were applied. While organisms were certainly killed by direct contact with the oil, almost all of the observed impacts were due to the chemical applications. Animal mortality near or in chemical-treated areas was nearly total and many algae were killed or damaged.

Despite its notoriety, this was not the first use of chemicals on a major spill. Just the year before (1966), the Norwegian tanker Anne Mildred Brovig collided with the British MV Pentlund in the vicinity of the Elbe Estuary in the North Sea. Approximately 450 bbls of a variety of dispersants were applied from workboats. Most was applied to oil escaping from the wreck or used to prevent the formation of large integrated oil slicks. In this case, no ecological damage was attributed to the use of the dispersants (Exxon, 1994). In the three years after the Torrey Canyon, dispersants were used seven times on major spills: three in 1968, one in 1969, and three in 1970. In none of these events was a significant ecological impact attributed to the use of dispersants observed. At one of the United States cases in 1969 dispersants were used during the Platform A blowout in the Santa Barbara Channel, Calif.

Opponents of dispersant use argue that it has proved unsuccessful in the past and that concrete, quantifiable proof of dispersant effectiveness is difficult to obtain. **Proponents** counter those objections by stating that, while the Torrey Canyon was a disaster, there is a long history subsequent to that of successful dispersant operations which opponents appear to ignore. Proponents suggest that dispersion can be a valid and effective response option and that objections to it are based on a narrow view of only a subset of relevant facts. The issue is synopsized simply as shown below.

Opponents argue:

It is better to remove spilled oil from the sea, rather than force it into the sea. The use of dispersants "hides" the problem of the spilled oil instead of "solving" the problem. They are an attempt by industry to avoid the expense of "better" response options.

- Addition of chemicals into the environment is undesirable. Dispersants are toxic, or their use causes the oil to have greater toxic effects.
- The oil will disperse naturally, given enough time. Dispersants are an unreliable response technique because they do not always work.

Proponents counter:

- Environmental damage, whether on the water surface, in the water column, or on the shoreline, is caused by exposure to spilled oil. Rapid and total removal of the oil by mechanical means is not feasible at a spill of any significant size. Dispersants can produce a net environmental benefit by rapidly removing oil from the sea surface and preventing or minimizing surface and shoreline impacts.
- Dispersion accelerates biodegradation and inhibits sedimentation of the oil.
- Modern dispersants have low toxicity and when combined with oil do not add measurably to the environmental effects caused by the oil alone.
- Natural dispersion is slowed or even stops altogether when oil emulsifies. Emulsified oil persists in and poses long-term hazard to the environment. Dispersant use speeds up the natural dispersion process and retards or prevents emulsification. Like every other response technique, dispersant use cannot be guaranteed to be effective in all circumstances.

Dispersants have been successfully used in a variety of situations, including several large incidents in recent times. Dispersants were a critical part of the response to the Sea Empress spill in February 1996 (Lunel. 1996). Through mid-1996, 80 documented uses of dispersants on spill events have been identified in the literature, and dispersants were used on many more small spills that did not receive international attention. Except for the Torry Canyon, dispersant use at spill events has never been reported to cause any additional environmental damages beyond that due to the oil. In many instances, dispersant use was credited with preventing shoreline damage or contamination of sensitive habitats.

Since the 1950's and 1960's, when oil transportation exploded and the number of accidents increased, dispersants have developed over what one usually divides into three generations. The first generation of dispersants that came out on the market were industrial water soluble and hydrocarbon-based cleaning agents which gave rise to toxic effects. The second generation of dispersants that were developed so-called “conventional dispersants” contained no aromatic hydrocarbons and are used today in seas where they are applied directly from vessels without dilution. This dispersants are usually used in the following relation to spilled oil: 1 part of dispersants to 5 or 10 parts of oil Conventional dispersants are starting to be replaced by the third generation of dispersants, the so-called ‘concentrated dispersants’ because these are easier to handle during clean-up operations. Third generation dispersants are usually divided into two types based on their solvent agent – water-based or hydrocarbon-based and can be applied in diluted by water or undiluted form. Water-based concentrated dispersants have a comparatively low toxicity, but require a longer time to disperse oil than ready-mixed products. Dispersant to oil relation for them is 1 part of dispersant to 10 or sometimes 250 parts of spilled oil.

The water-based dispersants solvent is made up of alcohol, glycols and glycol ethers (mostly ethanol, isopropane, ethylene glycol and propylene glycol) to increase its ability to mix with oil and lower the freezing point. Surfactants make up over 20% of these dispersants.

The development of concentrated hydrocarbon-based dispersants, also known as selfmixing dispersants, has made the dispersion of oil on the sea surface much faster and easier.

Chapter 4

The Role of NEBA

Selecting an appropriate response strategy requires a consideration of all the available response options, and how they can contribute to minimizing the impact of an oil spill on sensitive resources. Each response option has particular strengths and weaknesses that must be evaluated in light of the unique characteristics of each spill. In many cases, a combination of different options may be required. Net Environment Benefit Analyses (NEBA) is the process of deciding what options and response priorities are likely to result in the best outcome following an oil spill (IPIECA, 2000; Lunel and Baker, 1999 Lunel 2001). During a spill, decision makers are expected to reach rapid and defensible decisions about the protection of sensitive resources, often on the basis of limited information, and where conflict over priorities for protection exist. Effective preplanning can greatly increase the chance of a successful response through the discussion of response priorities and options when there is sufficient time to consider them thoroughly. For effective preplanning and contingency planning, sensitivity mapping should include not just a listing of the sensitive resources, but also a prioritization of the resources by the local stakeholders.

This should include an assessment of how viable it is to protect the given resource in the event of a spill. There are no right or wrong answers to which resources are the highest priority to protect.
However, without the local input to resolve conflicts in priorities at the contingency planning phase there will be delays to the decision making at the time of an incident that could have severe consequences to the local environment and economy. At the contingency planning stage, it is necessary to weight up the advantages and disadvantages of all available response options, including whether or not to use dispersants in specific coastal waters during a particular time of the year. This preplanning should define in advance of a spill whether dispersant use is likely to give the greatest overall benefit to the environment, or whether other response options are more suitable.

In general, endangered species, highly productive areas, sheltered habitats with poor flushing rates, and habitats that take a long time to recover should receive a high priority for protection. However, it is important that sensitive habitats and resources are not viewed in isolation from each other, since any response decision taken for a particular habitat or resource will affect adjacent ecosystems. For example, if oil is spilled above an area important for fishing and is moving rapidly towards a salt marsh, it may be advisable to disperse the oil within the fishery. This may increase oil exposure of the fishery, but will minimize oil from entering salt marsh sediments from where it will seep out over the years, forming a chronic source of pollution for both the salt marsh and the nearshore fishery ecosystems. It is particularly important to examine these possibilities in the contingency planning stage when there is enough time to give these complex interactions due consideration.

The 1995 edition of the International Maritime Organization/ United Nations Economic Programme **"Guidelines on Oil Spill Dispersant Application Including Environmental Considerations"** provides a good framework within which to take account of environmental considerations (IMO/UNEP, 1995). However, these need to be made specific to the environmental resources most relevant to the region. The adoption of this concept has been taken to its extreme in the new proposed Russian guidelines for dispersant use (Semanov, 1998). In this case, the proposed regulations stipulate that NEBA scenarios should be incorporated in any contingency plan that involves the use of dispersants. This approach would ensure that best practice is adopted. However, the proposed Russian guidelines go further and suggest that dispersant pre-approval can only be implemented if the actual spill scenario follows the NEBA scenarios in the contingency plan. Therefore, this approach, while having the merit of being based entirely around the NEBA concept, does present challenges on generating generic NEBA scenarios that will have a practical applicability to actual spill conditions.

Chapter 5

Developing List of Approved Dispersants

The aim of developing a list of approved dispersants is to ensure that the most effective low toxicity dispersants are available at the time of a spill. The requirement to test many different dispersant products means that the testing procedure must be based on laboratory tests. Given that laboratory tests cannot recreate the exact conditions of mixing energy and dilution that will be experienced at sea, it is important that the laboratory testing does not introduce arbitrary restrictions that relate to effects in laboratory tests rather than performance in the operational field situation (Lunel 2001). The best example of an arbitrary restriction introduced by a laboratory-testing regime is given in the United Kingdom. Following the *Braer* incident off the coast of Shetland in 1993, the U.K. government reviewed the approval and use of dispersants in the United Kingdom (the conclusions are summarized in MAFF, 1997). One of the tests introduced at the time was to subject all dispersants to the "rocky shore test" whether or not they are intended for use as shoreline cleaning agents. In this test, dispersant is applied directly onto the common limpet, *Patella vulgata*, in levels that would be associated with use of the dispersant as a shoreline cleaner. The trigger for this change was the fact that when dispersants were applied in high winds at the *Braer* incident some of the dispersant drifted onto the shoreline at very low concentrations (orders of magnitude lower than levels associated with use as a shoreline cleaner). As a result of this change, some of the most effective dispersants on viscous and heavily emulsified oil have now been removed from the United Kingdom's approved list. It has now been well established that the toxicity arising from the use of modern dispersants arises not from the dispersant but the dispersed oil (IMO/UNEP, 1995). That being the case, the U.S. approach of testing for the efficiency of the dispersant product rather than its toxicity for approval purposes has significant merit. The toxicity of the dispersant is measured and reported to ensure that there is no return to the high toxicity products used in the days of the *Torrey Canyon*. However, bearing in mind that for modern dispersants the toxicity arises from the dispersed oil rather than the dispersant (IMO/UNEP, 1995), the efficiency of the product is justifiably the primary consideration in whether a dispersant appears on the dispersant list.

Chapter 6

Policy of Dispersant Application by NOWPAP Countries

6.1 Laws, Regulations and Guidelines Applied to Use of Dispersants in NOWPAP Countries

The policy of dispersant application is govern in NOWPAP member states by national appropriate laws and regulations (Table 6-1)

Table 6-1

Country	Institution responsible for approval of dispersants	Law	Regulations	Guidelines
China	MSA of China	Marine Environment Protection law of the People's Republic of China	Prevention of pollution of areas by vessels	GB 18188.2-2000
Japan	Ministry of Land, Infrastructure and Transport	Prevention of marine pollution and maritime Disaster	Cabinet Order H 201 of 1971 amended No 22 of 1993	no
Korea	Korea Coast Guard	Prevention of ocean pollution	Enforcement regulation on prevention of ocean pollution	Yes, based on IMO Guidelines
Russia	Ministry of Nature Resources	Protection of Environment	Oil spill dispersants application rules	See regulation on application of oil spill dispersants

6.2 Specific of Dispersant Application by NOWPAP Member States

6.2.1 The People's Republic of China

China currently has restrictions on the use of dispersants for combating or cleaning up an oil spill. According to Chinese regulations dispersants may be used in open waters over one nautical mile from the shoreline at low tide if this method is deemed necessary, effective and environmentally preferable to other methods.

In China, the main law and regulation concerning dispersant application is the marine environmental protection law of the People's Republic of China and the regulations concerning the prevention of areas by vessels of the People's Republic of China. The main regulation is: It is strictly limited to use dispersants in China. Any dispersant used in any case should be approved by the organization authorized by the People's Republic of China. Application dispersant mast be approved by MSA of China.

Guide of application dispersant (excerpt from GB 18188.2-2000)

1. The principle of usage dispersant

At the following condition can consider usage dispersants handling the surface afloat oil or incidents spill oil:

a) Surface afloat oil or incidents spill oil may move to coast, marine products farming water and other sensitive areas, will threaten business, environment or comfort benefits, and can't be dispersed by itself through the nature evaporation or the function of wind, wave and flow, nor control or recovered with the physics method before arriving above sensitive areas;

b) The spill oil is difficult to handle with the physical and mechanical method, but the total damage handling spill oil usage dispersants is smaller than leaving the oil on the surface without handling;

c) The surface afloat oil or incident spill oil type and water temperatures, the weather, sea condition and other environment conditions is suitable for using dispersants;

d) Under the situation of having taken place or being possible occurrence oil fire, exploding, etc. shall endanger the safe of human life or facilities.

2. The principle of the limit usage dispersant

The following conditions are not proper usage dispersant, but taking place or possible occurrence endangering human life or facilities safety is excepted.

a) Spill oil is the light quality oil that vaporize easily as gasoline, kerosene... etc. or is thin oil film that present the rainbow characteristic;

b) Spill oil is the high content wax oil, or the high pour point oil is difficult to scatter with chemistry method;

c) The spill oil can't flow under the environment water temperature, or becomes thick fragment that have clear edge and emulsify becomes the oil-water thing through aeolian erosion in a couple of days;

d) The spill oil takes place in closing and shallow water area or quiet water area;

e) The spill oil takes place in the fresh water source or the area of the important influence to the marine products resources.

3. Application method

Using the appropriate tool to spray the dispersant on the surface spill oil film, the diameter of jet drips are about 400 ~ 700 μm.

3.1 The dosage

3.1.1 The dosage of using dispersant to deal with spill oil, is decided by the spill oil characteristic, the dispersant emulsifies function and work condition etc. The normal type dispersant dosage is general for 30% ~ 100% that deal with the spill oil quantity; The concentrated type dispersant dosage is general for 10% ~ 20% that deal with spill oil quantity.

3.1.2 Using the concentrated type dispersant diluted by water, the concentrated dispersant in its dilution liquid should above 10%. The every type dispersant are all proper to use its original liquid directly.

3.1.3 Handling a water top oil fire, can jet the burning oil with water nozzle siphon 3% ~10% the dispersant.

3.2 Spray the method

3.2.1 According to estimate with the area and thickness of the oil film, should adjust appropriately the speed of work ship and the dosage of spring dispersant, so that insure the proper proportion of dispersant dosage to spill oil quantity.

3.2.2 The speed of spray work ship is about 2 to 7 n miles/h in general, the length of spraying arm should be not over 15 Ms generally. Make the spray nozzle closed to the wave crest surface as soon as possible, by adjusting its high degree.

3.2.3 The spray work ship should go along wind axis and against the wind, and go along the oil film edge towards the middle of the thick oil. Can adopt single ship consecution operating or many ships are parallel or operating in front and back, each ship sprays boundary to hand over mutually but not layer after layer.

3.2.4 Working in quiet sea condition, must mix with the machine at the same time, for example, the adoption drags along broken up plank, waste chain etc. that take after spraying the arm. The upper limit wind velocity suitable for operation is 25 to 28 n miles/h.

3.2.5 For handling the dirty oil on the bank rocks or the facilities, spray dispersant first, then wipe the oil with hard brush after softening, jet with the nozzle finally. Collect the waste liquid after handling, and treat them according the relevant provisions.

3.3 Safety

Spray dispersant personnel should wear personal protection equipment, for example, waterproof smock, gloves or mask etc.

4. Application management

4.1 The dispersant application should obey *the marine environmental protection law* and *the regulations concerning the prevention of areas by vessels of the People's Republic of China*.

4.2 Any dispersant used in any case should be approved by the organization authorized by the People's Republic of China.

4.3 A report should be hand in the MSA after application dispersant, its main contents includes:

a) Name of the dispersant application organization;

b) Spill oil time, location, process (include an other handling the spill oil measure and the result), scale of the oil incident and the spill oil characteristic;

c) The weather, sea condition, water temperature, shore line type etc. and other environment term when the dispersants are used;

d) The spilling oil handling method, start and end time, handling result evaluated;

e) The dispersant name, dosage and produced time, the pattern approved certificate serial number;

f) Problem and suggestion.

Standard of Dispersants

Item		Specifications
Appearance		Clear, without layers
Flash point in open cup (℃)		> 70
Viscosity at 30℃ (mm^2/s)		< 50
Effectiveness (%)	10 min	> 20
	30 s	> 60
Biodegradable BOD_5/COD (%)		> 30
Acute Toxicity fish Gobiidae		3000 ppm MLC > 24h

6.2.2 Japan

Technical standard of oil dispersant is regulated under Article 43-4 of the Law Relating to the Prevention of Marine Pollution and Maritime Disaster, Article 33-2(2) of Regulations for the Enforcement of the Law Relating to the Prevention of Marine Pollution and Maritime Disaster and the Ministerial Ordinance regulating Technical Standards for Chemicals which are used for the prevention of marine pollution due to oil or hazardous liquid substances

(Chemicals for prevention of marine pollution due to oil or hazardous liquid substances)

Article 43-4 of the Law

1. Chemicals which are used for the prevention of marine pollution due to oil or hazardous liquid substances and which are regulated under ordinances of the Ministry of Land, Infrastructure and Transport and ordinances of the Ministry of the Environment must not be used, unless such chemicals meet the technical standards regulated under ordinances of the Ministry of Land, Infrastructure and Transport and ordinances of the Ministry of Environment.

2. The chemicals mentioned in the previous Clause must be adequately used in accordance with the situation of marine pollution and situation of such sea areas, subject to the use thereof.

Article 33-2 of Regulations

(2) Oil dispersant

a. The oil dispersants shall conform to the standards provided by the Ministerial Ordinance regulating Technical Standards for Chemicals which are used for the prevention of marine pollution due to oil or hazardous liquid substances

b. The viscosity shall be 50 centi-stokes or less at the temperature of 30 degrees centigrade.

c. The rate of emulsion shall be 60% or more in 30 seconds and 20% or more in ten minutes after the start of settling test.

Article 2 of the Ministerial Ordinance

(1) As for oil dispersants,

a. The flash point shall he higher than 61 degrees centigrade.

b. The biodegradability of the surface active agent shall be 90% or mote on the average of the results of the seventh and eighth days from the beginning date of test.

c. The harmfulness to life shall be indiscernible to such an extent that skeletonema costatums do not perish when cultivated for a week in a solution holding 100 ppm or more of the oil dispersant and that 50% or more of the killifish (oryzias lapipes) do not perish when cultivated for 24 hours in a solution holding 3.000 ppm or more of the oil dispersant.

d. The disposed specific oil shall be dispersed in particles in the sea and shall not be precipitated on the sea bottom.

Requirements to oil dispersants

Item		Approval criterions
Flash point ℃		More than 61
Viscosity (cSt) 30 ℃		50 or less
Emulsification rate	After 30 secs.	60 or more
	After 10 secs.	20 or more
Biodegradability (%)		90 or more
Biological toxicity	Skeltonema costatum (ppm)	100 or more
	Himedaka (LD50< ppm)	3000 or more

Regarding a direction for the use of dispersant, it is described in the Japanese National Contingency Plan for Oil Pollution Preparedness and Response in the following:

Japanese National Contingency Plan for Oil Pollution Preparedness and Response

Chapter III Basic matters on response for oil pollution

Section 5 – Operation for cleaning spilled oil
3.5.2

(3) Recovery of Spilled Oil

Measures such as mechanical recovery by using an oil recovery boat, an oil skimmer, and others, and manual recovery by using oil absorbent or gelling agents, and temporary and supplementary measures by using ladles, buckets, and others. The best measure among these should be used as appropriate.

(4) Chemical treatment

Chemical treatment by using oil dispersant for decomposition. This measure should be used only when it is difficult to collect the spilled oil by the measure mentioned in paragraph (3), taking into account the situation to conduct the collection, the weather and sea condition, the natural environment, and the area of fishing grounds or aquaculture grounds.

6.2.3 Republic of Korea

Korea has laws and several regulations on existing policies and guidelines regarding the use of prevention materials and agents of ocean pollution comprised dispersants. There are two laws and six enforcement regulations.

Article 49 of the law on prevention of ocean pollution

The Korea Maritime and Port Authority, ship's owner or a person who establish sea equipment has to possess the prevention materials and agents of ocean pollution that approved by certificate laboratory to prevent discharged oil or pollution.

Article 64 of the law on prevention of ocean pollution

Clause 1
A manufacturer and importer of the prevention materials and agents of ocean pollution has to obtain type approval by a commissioner of Korea Coast Guard with the Ministry of Maritime Affairs and Fisheries Ordinance.

Clause 2
Materials and agents which fixed by the Ministry of Maritime Affairs and Fisheries Ordinance follow other special regulation.

Clause 3
A person who obtains type approval, has to receive performance test for the materials and agents by a commissioner of Korea Coast Guard or a minister of Ministry of Maritime Affairs and Fisheries in advance.

Clause 4
When a person who obtained type approval manufacture or import the materials or agents, he has to receive verification for the materials and agents by a commissioner of Korea Coast Guard or a minister of Ministry of Maritime Affairs and Fisheries.

Clause 5
A person who laded the materials or agents on a ship in a party to an agreement, has to obtain approval by a commissioner of Korea Coast Guard or a minister of Ministry of Maritime Affairs and Fisheries with the Ministry of Maritime Affairs and Fisheries Ordinance.

Clause 6
A Minister of Ministry of Maritime Affairs and Fisheries or a commissioner of

Korea Coast Guard can specify an agency that carry out performance test, verification and approval.

Article 104 of the enforcement regulations on prevention of ocean pollution

Clause 1
A kinds of materials and agents which has to obtain type approval are follow.
1. Oil fence
2. Oil dispersant
3. Oil absorbent
4. Oil gelation agent

Article 105 of the enforcement regulations on prevention of ocean pollution

Clause 3
A person who obtains type approval for the materials and agents, has to submit a written application of performance test to a commissioner of Korea Coast Guard with the materials or agents and their explanations.

Article 106 of the enforcement regulations on prevention of ocean pollution

Clause 1
In case of the materials or agents are pass to the performance test , a Minister of Ministry of Maritime Affairs and Fisheries or a commissioner of Korea Coast Guard has to is sue a certificate of type approval for the materials or agents to applicant.

Article 111 of the enforcement regulations on prevention of ocean pollution

Clause 1
A person who obtains official approval for the materials and agents, has to submit a written application of verification to a commissioner of Korea Coast Guard.

Article 112 of the enforcement regulations on prevention of ocean pollution

Clause 1
In case of the materials or agents are pass to the official approval, a Minister of Ministry of Maritime Affairs and Fisheries or a commissioner of Korea Coast Guard has to issue a certificate of success in official approval to applicant and

seal for the materials or agents.

Article 113 of the enforcement regulations on prevention of ocean pollution

Clause 1
A Minister of Ministry Affairs and Fisheries or a commissioner of Korea Coast Guard can approve in follow case.

1. In case of the materials or agents which approved by a party to an agreement laded on a ship which manufactured or repaired in a party to an agreement.

2. In case of the materials or agents which approved by a party to an agreement and do not produce in Korea and notify by a Minister of Ministry Affairs and Fisheries or a commissioner of Korea Coast Guard laded on a ship.

Requirements to oil spill dispersants.
Flash Point ℃ : more than 61
Biodegradability % : more than 90
Toxicity : Sceletomena costatums - 1 week at concentration 100 ppm,
Orizias latipes $LC_{24}50 > 4000$ ppm
Brine Shrimp Artemia $LC_{24}50 > 4000$ ppm
Rock Fish $LC_{24}50 > 2000$ ppm
Viscosity, set at 40 ℃ : Less 30 cSt

Application of dispersants are carried out according to IMO/UNEP Guidelines

6.2.4 The Russian Federation

The Russian policy of using oil spill dispersants is determinated by federal laws “Protection of environment”, “Protection of population and territory in case of emergency situation”, Government order “About urgent measures for prevention and combating oil and oil products spills” and “Oil spill dispersants applying rules”

Oil spill response policies is be based on the following principles:

- As much oil as possible should be recovered at sea before it reaches shore in order to cut costs and reduce environmental damage.

- Mechanical recovery systems should preferably be used to clean up Tier 1 oil spills if the whether conditions allow to do it.

- All oil spill cleanup resources (dispersants and mechanical equipment) should be given equal consideration for cleaning up Tier 2 and Tier 3 spills, because experience has shown that on average mechanical equipment is only capable of recovering not more than 20 to 30 percent of the spilled oil.

- The chosen oil spill response techniques should be applied concurrently. That part of the slick that poses the greatest threat should be treated with dispersants, while the rest should be cleaned up mechanically.

- A decision to use dispersants should be made solely on the basis of a Net Environmental Benefit Analysis (NEBA) of pre-approved dispersants for the polluted area or the area threatened by pollution.

Requirements to oil spill dispersants

Item		Ministry of Nature resources approval criterions
Flash point ℃		> 61
Viscosity (cSt) 30 ℃		< 50
Emulsification rate	After 30 secs.	> 60
	After 10 secs.	> 20
Biodegradability (%)		> 90
Toxicity, limit allowed concentration (LAC) mg/l		< 0,005

LIST OF OIL SPILL DISPERSANTS APPROVED BY NOWPAP MEMBER STATES is given in ANNEX B.

Chapter 7

Dispersant Application Techniques

7.1 General Recommendations

The effectiveness of dispersants is largely determined by the time that has elapsed since the spill and intelligent application of the chemicals. Because of evaporation of the oil's light fractions, the "window of opportunity", i.e. the time in which dispersants may be applied most effectively, ranges from 24 hours to several days (in the case of an ongoing spill).

In order to treat a slick effectively, dispersants should be sprayed in a sufficient amount and as evenly as possible on the slick. This can be accomplished only by means of equipment that can generate dispersant droplets of an optimal size (Semanov, 1998). If the droplets are more than 1 mm in diameter, they will penetrate the oil slick and get lost in the water, while very small droplets less than 0.1 mm in diameter are easily carried off by the wind and fail to reach the slick, which also results in chemical losses. Thus dispersant droplets should be kept within a size range of 0.1-1.0 mm (normally 400 to 700 μ. Third-generation dispersants may be applied as an aqueous solution or in pure undiluted form. If possible, dispersants should be applied to the oil slick in undiluted form in order to make treatment more effective.

7.2 Dispersant-oil Ratio

The amount of dispersant needed to treat an oil slick depends on the following factors:

- the type and amount of oil on the water's surface;
- the dispersant application technique;
- the need to achieve an instant effect and the possibility of achieving a long-term effect.

Less dispersant is needed to treat newly spilled light low-viscosity crude and light petroleum products (diesel fuel, light fuel oils with a viscosity of less than 100 cSt) than high-viscosity heavy petroleum products and watery oils (1000-2000 cSt) that have been on the water for a long time. In the first case a dispersant-oil ratio of 1 to 5% may be required, while in the second case this ratio may be 10 to 30%. The use of dispersants to treat oil with a viscosity of more than 2,000 cSt is usually ineffective. In practice, the term dispersant-oil ratio is usually used and is expressed as a proportion, such as 1:10, meaning that one part dispersant is needed to treat 10 parts oil.

The dispersant-oil ratio is also determined by the type of dispersant. This ratio is 3 to 5 times higher for second-generation dispersants than for concentrated third-generation dispersants.

The capacity of the dispersant pumps and dispersant consumption per unit of treated oil slick area should be calculated by the following formulas:

$$F = S \bullet u \bullet d \bullet D, \; l/s$$

where:

- V is pump capacity, l/s;
- S is the width of the treated swath in meters;
- U is boat (aircraft) speed in m/s;
- D is the thickness of the oil slick in mm;
- D is the dispersant-oil ratio.

$$P = 10^4 \bullet d \bullet D, \; \text{liters per hectare}$$

where:

- P is dispersant consumption in liters per hectare.

In practice it is very hard to determine the amount of spilled oil and thus the required amount of dispersant with the naked eye. Colour is recommended as the basis for estimating the thickness of an oil slick: a 0.1-mm slick will be black, while a silvery or rainbow slick will be 0.01 to 0.001 mm thick.

The amount of dispersant required to treat an oil slick will also depend on the required effectiveness of treatment. If a slick is far enough from an environmentally or economically valuable area (estimated travel time of more than 24 hours), there is no need to try to destroy the slick right away and one may reduce the dispersant-oil ratio by a factor of 3 to 5 (to 20 to 50 liters per hectare). Even with this low dispersant-oil ratio, a treated slick will disperse before it gets close to a threatened area.

7.3 Safety Precautions in Dispersant Application

It should be avoided prolonged contact with the skin and use personal respiratory organ protective gear and protective eyewear when handling dispersants. When dispersants get onto the skin or into the eyes, they should be flushed out with plenty of fresh water.

Dispersants are classified as flammable materials, that is why it must be not handled them near an open flame.

Detailed safety requirements for oil spill response operations involving the use of dispersants are given in the dispersant application instructions.

7.4 Techniques for Applying Dispersants to an Oil Slick

Special workboat equipment, crop duster helicopters and planes, transport planes with special dispersant tanks and sprayers, transport helicopters with special outboard dispersant tanks and sprayers, and boat fire systems and monitors may be used to apply dispersants to an oil slick.

Detailed equipment specifications and use procedures are provided by equipment manufacturers and are also given in the instructions. Below it is evaluated application systems and their advantages and disadvantages, which must be taken into consideration in an NEBA.

7.4.1 Boat Treatment

a. Treatment with Diluted Dispersants

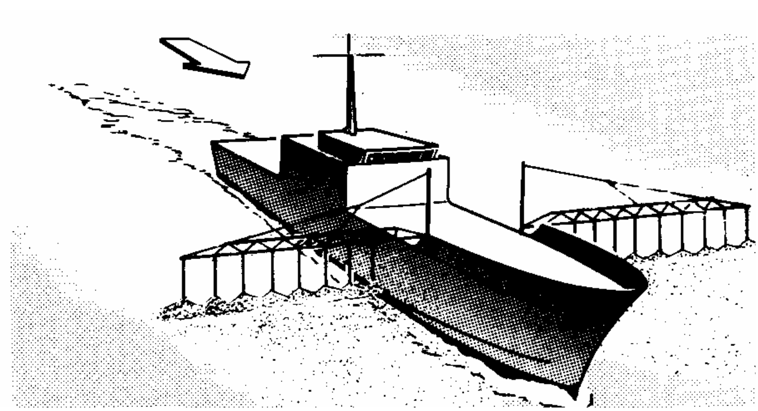

Figure 7-1. Dispersant application from ship
Source: CEDRE/IFP

Even though it is recommended that dispersants, including concentrated third-generation chemicals, be applied in undiluted form, sometimes in practice solutions of dispersants (usually in concentrations of 10 to 30%) are used, especially for treating thin slicks and low-viscosity oils with a viscosity of less than 500 cSt. In this case one may use the boat's firefighting system and inject the dispersant into the boat's fire main. The angle of the monitor (tip) of the fire hose should be adjusted by the operator on the basis of the boat's speed and the wind so that the stream of dispersant will cover as wide a swath as possible. One disadvantage of this system is that it is impossible to adjust dispersant concentration. Special dispersant sprayer rigs (Fig. 7-1), consisting of two pumps (for the water and the dispersant), a mixer, and outboard booms with spray nozzles set as close as possible to the bow of the boat to counter the effect of breakers may also be used to apply a solution of dispersant in seawater. These rigs make it possible to adjust dispersant concentration during application.

b. Treatment with Undiluted Dispersants

Treatment involves the use of a rig similar to that described above, but without the water pump or with air replacing water. The wind has a considerable effect on the effectiveness of undiluted dispersants, which is why treatment should be carried out when the boat is traveling against the wind in order to counter wind effects. Boat speed is generally kept in the 4~8 knot (2~4 m/s) range, while the width of the treated swath does not exceed 30 meters (Fig. 7-2 and 7-3).

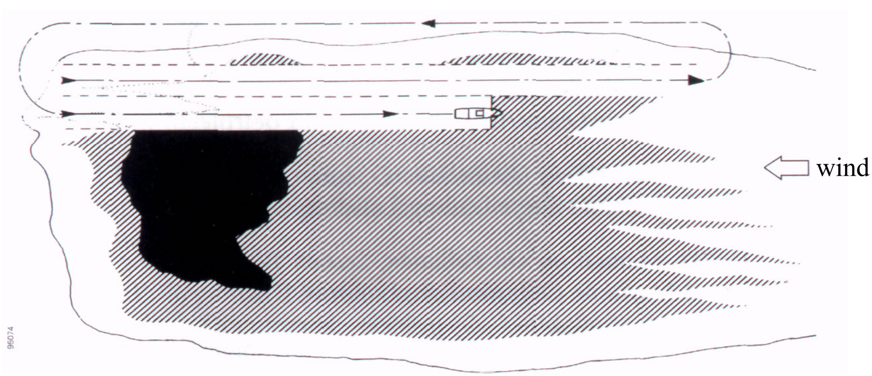

Figure 7-2

Source: Bocard, C. and F. Merlin (1987)

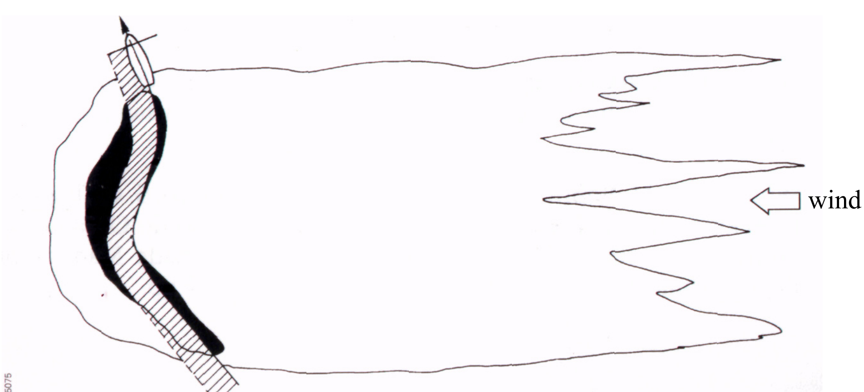

Figure 7-3

Source: Bocard, C. and F. Merlin (1987)

The advantage of boat application is the continuity of the process, because a boat can hold a one-day or more supply of dispersant, and moreover, the quality of treatment can be easily adjusted on board a boat. Usually less dispersant is consumed in boat treatment than in aerial treatment.

SPECIFIC CASE: Case where the oil has gathered in narrow crosswind strips: treat following the strips, but only with the downwind spraying equipment. See figure 7-3.

7.4.2 Aerial Treatment

Aircraft are mainly used to apply dispersants in undiluted form, and crop duster equipment may be used for this purpose (Fig. 7-4). This equipment consists of a pump and calibrated nozzles. Treatment quality is highly dependent on flying conditions during the process. Treatment should be carried out with the wind at a minimal altitude and at speeds no greater than 300 km/hr. At higher speeds, the dispersant droplets are atomized very finely by the oncoming stream of air, and it is difficult to control their deposition on the surface of the slick because of the wash.

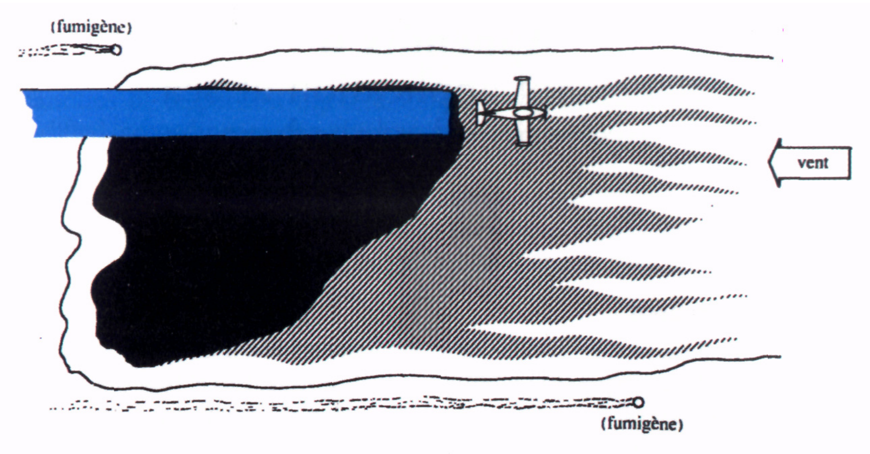

Figure 7-4
Source: Merlin, F. and C. Bocard (1989)

SPECIFIC CASE: If the oil is concentrated in a narrow strip across the wind: treat by small successive runs in the axis of the wind or, if applicable, treat cross-wind, taking into account the transverse drift of the dispersing agent. See figure 7-5.

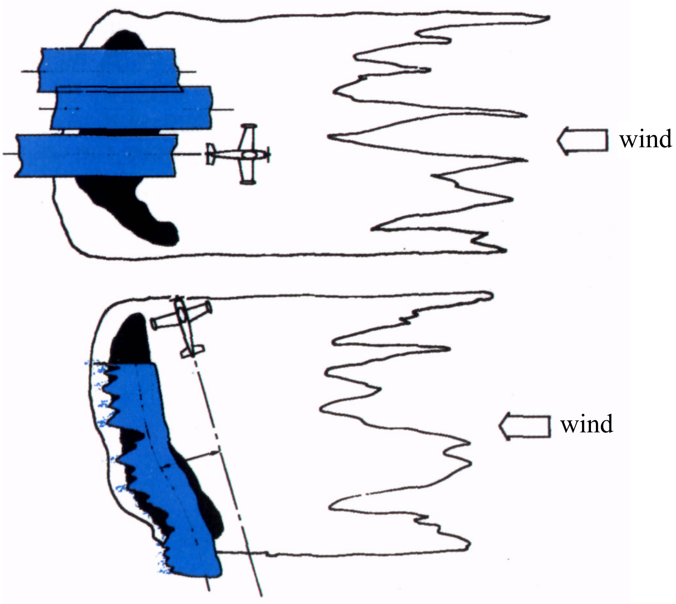

Figure 7-5

Source: Merlin, F. and C. Bocard (1989)

a. Helicopter application

Crop duster helicopters have attached chemical sprayer equipment that may be used to apply dispersants without any adjustment. The use of these helicopters is limited by distance to shore and payload capacity (300 to 860 kg), which is why helicopters can only be used in coastal areas near landing pads. Fuel and chemicals must be delivered to the landing pad in order to ensure adequate treatment capacity.

Helicopter capabilities may be expanded by using outboard sprayer rigs. These include a tank, nozzles, and a pump. In this case one may use transport helicopters with no restrictions in terms of distance from shore to the open sea and with a much greater payload (3 to 8 tons).

b. Treatment with Fixed- Wing Aircraft

Single-prop crop dusters may be used to spray dispersants without any equipment modifications. These aircraft do not require improved airfields and are highly maneuverable, but have a limited payload (1 ton) and range from shore. They may be used only in the littoral zone.

Dispersants may also be applied from specially equipped heavy transport planes. These aircraft can treat large polluted areas but require improved airfields.

Planes and helicopters can apply the calculated amount of dispersant (50 to 100 liters per hectare) over a 15 to 20 meter wide swath (helicopters and single-engine aircraft) and a 20~50 meter swath (transport planes).

One disadvantage of using aircraft in relation to boats is the impossibility of adjusting the dispersant dosage during the application process, which may lead to excessive dispersant consumption.

List of oil spill dispersants application technique used by NOWPAP member states is given in Annex C.

7.5 Strategic Recommendations for Dispersant Application

Usually an oil slick on water is of a variable thickness, and the dispersant dosage should be adjusted on this basis during the application process. When using boats to apply the dispersant, dispersant flow may be adjusted by adjusting the output of the proportioning pump, changing nozzles, or changing boat speed. When aircraft are used, dispersant dosages may only be adjusted by changing nozzles on the ground. It should be pointed out that using dispersants to treat thin rainbow-colored oil sheens, which do not pose a significant environmental threat, is not recommended. In order to achieve the maximum treatment effect, one should:

- start treatment from the edge of the slick and move towards the middle;
- apply the dispersant in parallel and continuous runs;
- spray dispersants from aircraft with the wind and from boats against the wind;
- when using aircraft, factor in the time it takes to prepare the aircraft and dispersant transport caused by wind action. Smoke canisters may be used to determine wind direction.

During treatment one must try to:

- avoid breaking up the slick into several smaller slicks, i.e. avoid applying the dispersant at the middle of the slick.

7.6 Tactic Recommendations for Dispersant Application

Dispersant treatment should be discontinued when black oil slicks disappear from the surface and/or instrumental monitoring indicates that additional treatment is not having any effect on the oil's concentration in water. In treating floating watery slicks spraying should not be discontinued abruptly, because more time and a bigger dispersant dose are needed to break up these emulsions.

For both aircraft and ships, a wind speed of up to 25 to 30 knots is probably an upper limit. Above these speeds the application becomes less efficient, as sprayed dispersant is blown away by the wind and because dispersant is applied onto vigorously breaking waves. Dispersant application operations must be targeted:

- dispersant should not be applied to oil sheen, and
- dispersant should be applied to the thick parts of the slick (dull gray to dark brown appearance).

A methodical procedure must be adopted. Dispersants should be applied with parallel and continuous runs to be certain that the entire slick has been treated. Both aircraft and ships need to be guided towards the thickest areas of the slick by a dedicated spotter aircraft-flying overhead.

In case of extensive pollution and the simultaneous use of several methods of dispersant application, the different operations must be coordinated:

- the target allocated to each application method should be determined in a way to optimize its use (e.g. helicopters, which have limited range, would be directed towards the near-shore area while large fixed-wing aircraft would logically be used for offshore operations);
- the spill area should be divided into zones, and each zone should be allocated to the different methods or group of methods of applying dispersants;
- if several methods are used for treating the same area, it is essential to have a spotter aircraft at the location.

It is important to treat the different parts of the slick in the correct chronological order:

- if sufficient dispersant and application methods are available to treat the entire quantity of oil, then the thickest parts of the slicks should be treated first;
- if dispersant and/or application means are inadequate, only part of the slick can be completely treated. If mechanical recovery is possible, the thinnest parts of the slick (which can represent large areas) should be treated with dispersants and the thickest parts handled by mechanical recovery. Sheen, however, should not be treated.

When managing the operations, it must be kept in mind that dispersant should not be used simultaneously with other techniques (e.g. booming, recovery) on the same part of the slick.

In case of a continuous oil release the dispersant must be applied as close to the source as possible.

Before an extensive treatment operation, a test must be done to ensure that the treatment is effective.

Logistics for large spills

The quantity of dispersant to have at hand is 5 to 10% of the amount of oil to be treated (e.g. for a 10,000 t oil spill the amount of dispersant required is between 500 and 1,000 t). Supplying an adequate quantity of dispersant in a very short time to deal with a large spill can be a problem that must be included in the contingency plan.

Similarly, it is often difficult to get enough spraying platforms (aircraft, helicopters or vessels) to fully treat the spill at relatively short notice. Other general logistical requirements have to be considered, such as a spotter plane to direct the aircraft or x'essels towards the parts of the pollution to be treated. Large spray aircraft have specific logistical requirements, such as airfields with adequate runways and refueling facilities, which must be considered.

If the operation is subject to logistical limitations it is important to optimize the use of what is available.

7.7 Water and Weather Considerations in Dispersant Application

One should not use dispersants in confined areas of the sea with slow water exchange (bays, lagoons), in shallow waters less than 10 meters deed, or at ambient temperatures below +5°C. Some dispersants may emulsify spilled oil in an ice environment, but because oil degradation almost stops in the winter, dispersants should be applied in ice environments only after a painstaking NEBA. In the process one must keep the following considerations in mind:

- oil degrades very little;
- water emulsification in an oil slick, especially because of snow, is quite significant and dispersants may impede this process;
- the effectiveness of oil dispersal in water is much lower in an ice environment than in other seasons;
- dispersant-treated oil is very difficult to clean up with mechanical recovery equipment;
- the mixture of oil and dispersant sticks to marine mammal fur and bird feathers in much smaller amounts and can be easily rinsed off with water.

7.8 Monitoring the Effectiveness of Dispersant Application

The results of oil slick treatment and the effectiveness of dispersant action may be monitored both visually and instrumentally. Visual surveillance is effective during the daylight hours in treating oil slicks from aircraft, because easily spotted traces of dispersed oil in the form of brown or orange clouds form on the water's surface. But in certain cases, especially in boat treatment, visual surveillance may be difficult, and moreover certain oils, depending on the condition of the sea, will start to disperse in a few minutes or even tens of minutes after the dispersant is applied. That is why it is recommended constant instrumental monitoring of oil concentrations in the water column. These oil-in-water concentrations should be determined before and after dispersant treatment. Treatment results should be considered satisfactory if:

- orange or brown clouds of dispersed oil appear in the water;
- oil concentrations in the subsurface layer of water rise dramatically.

7.9 Monitoring Environmental Effects

Monitoring environmental effects is an important part of oil spill response. When dispersants are used, no monitoring is required additional to that needed for other oil spill response techniques.

Fish and mobile organisms will try to move away from the oil spill. Surface plankton may experience some additional mortality due to dispersant use but this is not significant since rapid recolonization occurs.

Following a spill, it may be necessary to prohibit fishing and collection of shellfish for consumption, regardless of whether dispersant was used or not. To determine when the fisheries should be re-opened after such a ban, the fish and shellfish should be monitored. The monitoring can be carried out by having people on "taste panels" and/or by conducting chemical analyses.

Chapter 8

Discussions of the Future Works on Dispersant Application Issues

8.1 Results of 7th NOWPAP MERRAC Focal Points Meeting

May 2004 FPM 7 meeting has considered the report prepared by the expert group (UNEP/IMO/NOWPAP/MERRAC/FPM 7/13). It was noted in the report that NOWPAP countries have quite similar policies on oil spill dispersants application. However the main difference was in different national methods of testing and approving the various products that can be included in the list of pre-approved dispersants. This means that a certain dispersant which is approved in one NOWPAP member, is not necessarily allowed to be used in the other NOWPAP countries during joint response operations within the framework of NOWPAP Regional Oil Spill Contingency Plan. It was concluded, that it is necessary to harmonize tests procedures and lists of pre-approved dispersants or to develop an other approach which would allow for mutual assistance in dispersants application during oil spill emergencies.

In a discussion following the presentation of the report, the meeting participants expressed various views related to the regional guidelines on oil dispersants. The meeting agreed that there was a need to continue the activities of the expert group especially in order to answer the questions on the necessity, feasibility and applicability of: a) a common regional policy on oil dispersant; b) common tests and approval methods and/or list of dispersant to be used by all NOWPAP members by sharing the results of toxicity/efficiency tests according to national procedures to all NOWPAP members; c) alternatively, to propose other operational methods under which joint dispersants application operations in case of emergencies would be practical, quick and efficient. The meeting agreed that the experts group on dispersants will discuss and review these questions during the coming Experts Meeting and will make the necessary recommendations to the next MERRAC FPM. The meeting asked the NOWPAP members to prepare their proposals for discussion by the end of September 2004. These proposals for discussion are given below.

8.1.1 Japan proposals

We can understand the necessity of common criteria for the approval of dispersant and for the use of dispersant; however it seems to be impossible to develop common criteria, because each country has set its own criteria or standards based on geographic factor, the environment, technology, agreement with fishery etc. Taking into account the fact that there is no international criterion for the procedure of the approval of dispersant, it would be premature to tackle this issue in the NOWPAP MERRAC activities.

8.1.2 Russian Federation proposals

At MERRAC FPM 7 no Members NOWPAP had comments on the Manual. The main discussion was on the issues of policies on oil spill dispersants application because each Member has their own list of approval dispersants that not coincide with the list of other NOWPAP Members. Besides, the procedures of approval of dispersants in other NOWPAP Members don't coincide. The above make impossible the application the dispersants of one NOWPAP Member in the territorial water of another Member.

It seems expediently to make the analysis of the following approach:

1. The decision making of request of assistance accordingly the Regional OSR Plan each NOWPAP Member to send requested Member measures for use oil dispersants. Adequate quantity of dispersants allowed for application in the territorial water of the requesting Member should be provided by the requesting Member;

2. To choose some more or less commonly used dispersants by the Members and to test them accordingly by national method. The aim could be the development of list of dispersants approved by all NOWPAP Members. This approach needs significant finance;

3. To develop unified method of evaluation of toxics dispersants and test existing dispersants. This approach is the least acceptable due to necessity of more time and significant finance.

All the above approaches should be considered at the autumn 2004 Expert Meeting in China.

8.2 Results of 2004 NOWPAP MERRAC Expert Meeting and 8th NOWPAP MERRAC Focal Points Meeting

1. Taking into account article 4.5 of the NOWPAP Regional Oil Spill Contingency Plan, the autumn 2004 Expert Meeting has reviewed the results of activities and agreed on the following:

   - NOWPAP members have rather similar policy and technique on oil spill dispersant application based on IMO/UNEP Guideline

- NOWPAP members have different own national methods of testing of dispersants and different list of approved dispersants.

- Now it seems to be premature to develop common test methods, approved procedure and common list of approved dispersants.

- the use of dispersant within a NOWPAP Members jurisdiction during join response operations (JROs) should be in accordance with the provisions of the national contingency plan and/or policy of the NOWPAP Member concerned. In the case of JROs, NOWPAP members requested assistance should have stock of prior approved dispersant and assisting NOWPAP Members may provide appropriate spraying equipment first of all aircraft based.

2. Based upon the discussion, the Expert Meeting agreed to recommend following conclusion to the next 8th MERRAC Focal Points Meeting:

   - Add to the final report on NOWPAP Guideline list of oil spill dispersant application equipment first of all aircraft based and publish it as MERRAC Technical Report.

   - Invite NOWPAP members to submit appropriate relevant information to the project leading country (Russia) as soon as possible (tentative deadline-by January 2005).

   - Periodically consider and discuss information concerning oil spill dispersant policy and application technique.

Chapter 9

Conclusions and Recommendations

1. According to the Memorandum of understanding between MERRAC and CNIIMF a NOWPAP regional guidelines on use of oil spill dispersants has been prepared by an Expert Group. The Expert Group included nominated national experts from China, Japan, Korea and Russia with the leading role of the Russian expert from CNIIMF. The Expert Group has collected information on existing relevant guidelines and policies in the NOWPAP and other regions, analyzed and compared it with technical viewpoint.

2. The developed Guidelines based both on appropriate IMO/UNEP Guidelines on oil spill dispersants application and national NOWPAP countries policies on using dispersants. The main philosophy of the Guidelines is the following: oil spill dispersants are very effective oil spill combating mean but must be used only based on results of Net Environment Benefit Analyses (NEBA) applying of available oil spill response technique.

3. The analyse shows that NOWPAP countries have rather similar policies on oil spill dispersants application but different own national methods testing of them and different list of allowed to use pre approved oil spill dispersants. But NOWPAP member states have different methods of testing of dispersants and list of approved chemicals. It will be followed by some problems during real oil spill response situations: ***an oil spill dispersant approved in a NOWPAP country is not always usable in the other NOWPAP countries as they have different types of approved dispersants and test methods. As a result* in *case of a real oil spill and during a joint response operation within the framework of NOWPAP Regional Oil Spill Contingency Plan NOWPAP countries will be able only to assist each other by supplying dispersant application technique.***

Chapter 10

Summary

According to the Memorandum of Understanding between MERRAC and Russian Central Marine Research and Design Institute, Ltd (CNIIMF) an Expert Group has prepared a draft of NOWPAP regional guidelines on use of oil spill dispersants. The Expert Group included nominated national experts from China, Korea, Japan and Russia with the leading role of the Russian expert from CNIIMF.

NOWPAP Guidelines contains the following information:

- Purpose, scope and general principles usage of oil spill dispersants,
- behaviour of spilled oil on the surface of water,
- preliminary approval procedures of dispersants,
- dispersants application techniques and planning,
- decision-making in oil spill response,
- list of dispersants approved in NOWPAP countries,
- list of NOWPAP countries laws and regulations concerned using of dispersants.

All NOWPAP countries have rather similar policy on using of dispersants. According it dispersants can be allowed to use if they passed preapproval procedures including toxicity and efficiency tests and also based on results of Net Environment Benefit Analysis (NEBA) - an analysis of the pros and cons to using dispersants or other techniques against oil spills on water. The technical limitations in today's dispersants are sensitivity for low salinity, for low water temperatures, as well as for the oil's density and viscosity. Usage of dispersants are effective usually not more than two days after spill (window of opportunity) during this time oil will have undergone major weathering processes that followed by increasing of oil's viscosity and density.

Analyse of NOWPAP member states dispersants application policy and list of approved dispersants shows that in case of real oil spills ***NOWPAP countries will be able to assist each other during a joint response operation within the framework of NOWPAP Regional Oil Spill Contingency Plan only by supplying dispersant application technique as they have different type of approved dispersants.***

This version of the report was updated based on results of Meetings of Working Groups of Nominated National Experts Regarding MERRAC Specific Projects, Qingdao, People's Republic of China, 15-16 November 2004 and the 8th MERRAC FPM & 1st CNA, Daejeon 24-27 May 2005.

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Annex A

List of National Experts of the Expert Group for NOWPAP Regional Guidelines on Use of Oil Spill Dispersants

People's Republic of China

Mr. HUA Wenfeng
Division Chief
Marine Pollution and Dangerous Goods Control Division
Rizhao Maritime Safety Administration of the People's Republic of China
Middle Section of Beijing Road,
Rizhao City, Sandong Province, CHINA
Tel: +86-633-8385409
Fax: +86-633-8331954
E-mail: RZMSAWGFWC@Yahoo.com

Japan

Mr. Suguru OGURA
Director
Research & Study Office
Maritime Disaster Prevention Center
Takadanobaba Center Bldg. 6F
31-18, Takadanobaba 1-chome,
Shinjuku-ku, Tokyo, 169-0075, JAPAN
Tel: +81-3-3204-6394
Fax: +81-3-3204-8125
E-mail: ogura@mdpc.or.jp

Osamura Takeda osamu-takeda@kaiho.mlit.go.jp

Republic of Korea

Dr. Kou-Sul Yeum
Director
ENVI CLEAN Chemical Technique Institute
429-450, 2Ba-516, Shihwa Industrial Area, Jungwang-Dong, Shiheung-City,
Gyunggi-Do, Korea
Tel: 82-31-319-7540
Fax: 82-31-319-7543
E-mail: ssyusung@chollian.net

Russian Federation: Leading Country

Dr. Gennady Semanov, Head of Laboratory "Environmental safety of maritime transport"
Central Marine Research & Design Institute (CNIIMF).
6, Kavalergardskaya Str., St.Petersburg, 191015, Russia.
Tel: +7-812-271 10 15
Fax: +7-812-274 38 64
E-mail: semanov@cniimf.ru

Annex B

List of Oil Spill Dispersants Approved by NOWPAP Member States

1. List of Dispersant Approved by China MSA

Production	manufacture
GM—2 Oil Dispersant	Qingdao Guangming Environment Protection Ltd.
M H Oil Dispersant	Wenzhou Marine Environment Protection Factory
Haihuan No.1 Sea surface Oil Dispersant	Marine Environment Protection Institute of SOA
Y D 9705 Oil Dispersant	Yongda Fine Chemical(Zhuhai) Ltd.
Ocean Oil Dispersant	Xiamen Weite Trade Ltd.
B H X	Jiangsutaicang Blue Marine Environmental ProtectionEquipment Ltd.
Double elephant Oil Dispersant	Dalian No.2 Organic Chemical Factory
GFS Oil Dispersant	Dalianshuangxing Industry Co.
CLEANSTAR Oil Dispersant	Zhuhai Jiexing Washing TechnologyLtd.
ZY——F1 Oil Dispersant	Zhuoyue TechnicalLtd. Of Oil and Gas University
Fulaide Dispersant	Dalian Fulaide Environment Friendly Reagent Production Ltd.
OLLERASER	Hangzhouzheda Huagao Industry Technology Development Ltd.
High-speed Dispersant	Shanghaishengzhong technical development Ltd.

2. List of dispersants approved in Japan (At the instant of 1 /1 /2005)

type approval		maker's type	maker's name
date	No.		
25 / 2 /1977	P-331 P-332	D・ K-SOL 1 D・ K-SOL NEW 2	DAIICHI KASEI SANGYO CO., LTD
7 / 8 /1981	P-428	D・ K-SOL SP	
15 /10 /1976	P-319	SUPEREMULSION OX-20	KURE KYODO KIKO K. K.
	P-320	SUPEREMULSION OX-20B	
10 /12 /1976	P-323	PAKEM DLT-10	NIHON PAKARAIZINGU K. K.
	P-324	PAKEM DLT	
15 /10 /1976	P-317	SHINYOSTEC OB-50T	SHINTOYO KAGAKU KOGYO K. K.
1 /12 /1976	P-325	S・ O・ R	DOWA KAGAKU K. K.
5 /12 /1977	P-374 P-375	HAITORON #3A OILCREANER H	SANYO KASEI KOGYO K. K.
26 /12 /1977	P-376	RINDA OSD-300	YOKOHAMA YUSHI KOGYO K. K.
15 / 8 /1980	P-423	RINDA OSD-300L	
10 /12 /1975	P-264	YUNISOL FL (70)	NIPPON YUKA KOGYO
17 / 1 /1983	P-435	YUNISOL FL (100)	
29 / 7 1987	P-458	YUNISOL FL (800)	
18 /11 /1998	P-559	YUNISOL D-1128	
31 /10 /2000	P-570	YUNISOL SELF MIXING S-7	
10 /12 /1975 4 / 7 /1997	P-257 P-258	NEOS AB2000 NEOS AB3000	NEOSU CO., LTD
3 / 9 /1984	P-443	NEOS AB-H	
18. 9 /1998	P-553	NEOS D-1128	
16. 2 /2001	P-573	SEAGREEN SELF・MIXING S-7	

type approval		maker's type	maker's name
date	No.		
10 /12 /1975	P-256	SEAGREEN 805	MATUMOTO YUSHI SEIYAKU K. K.
6 / 2 /1985	P-444	SEAGREEN DC-6	
8 / 4 /1999	P-561	SEAGREEN D-1128	
16 / 2 /2001	P-572	SEAGREEN SELF･ MIXING S-7	
10 /12 /1975	P-266	NISSAN METALREX CL-600	NIHON YUSHI K. K.
10 /12 /1975	P-269	MERUCLEAN 505	TAIHO KOGYO K. K.
20 /11 /1987	P-464	MERUCLEAN 707	
24 / 2 /1997	P-536	D1128	
3 / 7 /1997	P-545	MERUCLEAN 200	
19 /11 /1999	P-564	TAIHO SELF MIXING S-7	
10 /12 /1975	P-259	MIRACLE KS-3000S	KATAYAMA KAGAKU KOGYO K. K.
	P-260	MIRACLE KS-5000	
28 / 7 /1978	P-395	MIRACLE KS-3000	
10 /12 /1975	P-261	TOHO CACTUSCLEAN L-1	TOHO TITANIUM K. K.
15 / 8 /1980	P-424	TOHO CACTUSCLEAN L-10	
10 /12 /1975	P-265	MERUCLEAN 101A	TOHO CHIBA KAGAKU KOGYO K. K.
29 / 6 /1982	P-432	MERUCLEAN 201A	
21 / 5 /1990	P-492	FOSAITO SEACLEAN EM-3116	
10 /12 /1975	P-262	MARINESTAR	YAMASA KAGAKU K. K.
7 / 4 /1976	P-294	YUKAI A	
10 /12 /1975	P-267	COASTGUARD S-101	MARUZEN YUKA KOGYO K. K.

type approval		maker's type	maker's name
date	No.		
10 /12 /1975	P-255	NICHIACE 1500L	NICHIEI KOGYO K. K.
10 /12 /1975	P-268	PORTCLEAN A	MIZUHO KAGAKU KOGYO K. K.
17 / 2 /1976	P-282	SHIKURU N-800	DAIICHI KOGYO SEIYAKU K. K.
	P-283	YAMATOCLEAN S-480	
15 / 8 /1977	P-369	SHELL DISPERSAL CHEMICAL LT	
24 / 4 / 1991	P-497	YCC-BLUE CLEAN	
18 /11 /1998	P-558	BLUE CLEAN D-1128	DAIICHI KOGYO SEIYAKU K. K.
10 / 6 /1976	P-296	ON-100	NAKANO YUSHI KENKYUSHO K. K.
15 /10 /1976	P-318	SNOW RAPPU E-12000	NISSAN KAGAKU KOGYO K. K.
14 / 8 /1979	P-417	NIKKA SANCLEAN E-700	NIKKA KAGAKU KOGYO K. K.
19 / 3 /1978	P-436	TOHO CACTUSCLEAN L-10A	TOKYO FINE CHEMICAL K. K.
11 / 6 /1987	P-453	TOHO CACTUSCLEAN H-2	
24 / 1 /1998	P-560	TOHO CACTUSCLEAN D-1128	
31 /10 /2000	P-569	TOHO・SELF・MIXING S-7	
11 / 6 /1987	P-454	GAMOZORU・LT-A	FUJI KAGAKU KOGYO K. K.
	P-455	GAMOZORU・KONKU・C-100	
21 / 6 /2002	P-576	WAKO' S BIOCLEAN	WAKO CHEMICAL CO., LTD

3. List of Dispersant Approved by Korea Coast Guard

Production	Manufacture
World-Clean, World-Clean 90	Hae-Ryong Ltd (Ulsan, Kyungnam)
Hi-Clean (Condensed), Arino Conc, Hi-Clean2 (General)	Dae-Il Chemical Ltd (Busan)
MEioil Dispersant (Condensed), Mei-A	Duk-San Intex Ltd (Seoul)
Environ OD-22	ICI Woobang Ltd. (Yangsan, Kyungnam)
Gamma-Sol LT-**α**	Sung-A Chemical Ltd (Pyung-Taek, KyungGi-Do)
Bio Clean, High Con (Condensed)	Green-Cjem Ltd (Kimpo, KyungGi-Do)
MJ-Sea100	Man-Jang Ltd. (Busan)
SG-1000	Kwangwoo Parker (Pohang, KyungBook)
SX-100 (Condensed)	SeoiL Hwasung Ltd (Masan, Kyungnam)
JD-101	Jungho Tongsang Ltd (Anyang, Kyung-Ki)
Exxon Correxit 9529	Honam Oil (Yeochun Branch, Chunnam)
Neos (A-3000)	Daebok Haewoon (Busan)
OWR-S (Water Soluble)	Semikwang Ltd (Kimpo, KyungKi)
Simple Green (Condensed)	DongGu Bupum Ltd (Seoul)
AL-2001	AeJeo Land Ltd (Seoul)
JD-500	Jinweon Industry Ltd (Anyang, KyungGi)
BY·FAR·Z-M	Sam-O NK (Seoul)
Bioversal HC-S (Condensed)	BVE Korea Ltd (Seoul)
NH-M10, Ultra-Conc (Condensed)	O-Sung NH Ltd (Busan)
Clean-1000 (General)	YiDeuk Ltd (Kyungsan, Kyungbook)

4. List of dispersants approved by the Russian Federation

No	Dispersant Model	Efficiency		LAC, mg/l
		30 sec	10 min	
1	OM-6	60	30	0,005
2	OM-84	80	45	0,25
3	Corexit 9527	80	51	0,05

Annex C

List of Oil Spill Dispersants Application Technique of NOWPAP Member States

1. China

Dispersant stocks (including spray system)

Name	Amount	Place of Stock	Owner	Type	Capacity	Other Note (Available Equip.)
	500	Area of Storage	Chenshan Dock			
	200	Jiantiao Oil Store	Sanmen County Petroleum Co., 86-576-3333353			
	200	Kanmenwai Huangmen Oil Store	Shengli Petrol Chemical Co. Ltd, Yuhuan County			
	200	Yingdong Oil Store	Yuhuan County Petroleum Co.			
	200	Maanshan Oil Store	Yuhuan County Petroleum Co.			
	200	Dock of Yingdong Oil Saling	Yuhuan County Petroleum Co.			
	200	Shitang Cheguan Oil Store	Taizhou Petroleum Co.			
	200	Shitang Oil Store	Wenling Petroleum Co.			
	200	Shitang Meihuayu Oil Store	Wenling Petroleum Co.			
	300	Liushuikeng Oil Store	Wenling Petroleum Sales Co.			
	200	Diaobang Hongshan Oil Store	Wenling East Port Quatic Products Co.			

	200	Yongan Dock	Wenling Fuel Co.			
	200	Jianmen Port Oil Store	Huayuan Petro&Chemical Co.,Taizhou			
		Shuixianao, Beishan County	Taizhou Petroleum Co.			
	200	Shitang Shatou Oil Store	Southern Fishing Industry Petroleum Co. Ltd, Taizhou			
	200	Jiaoshan Port Oil Store	Fareast Petroleum Co., Wenling			
	250	Daomimen Oil Store	Wenling Petroleum Co.			
	200	Shuiyuntang Oil Store	Linhai Petroleum Co.			
	200	Matou Hill	Yongquan Supply & Sale Co., Linhai			
	200	Taishi Dock	Taizhou Petroleum Co.			
	200	Dock of Refrigeratory	Jiaojiang Refrigerating Equipment Factory			
		Oil Barge 1	Taizhou Marine Shipping Co.			
	305	Oil Containing No1, Suanshan Dock Warehouse	87353111-3104,87350880			
	80	Oil Containing No2, Finished Products Dock	Dock of finished Products			
	60	Oil Containing No5,Daxie Dock	Dock of Daxie			
	2000	On board of Yonggang Huanyou No.1	Port Environment Protection Fleet,			
	1t	Shiku Port Area	Shiku Warehouse	GM-2		
	0.2t	Houzhu Port Area	Houzhu Warehouse	GM-2		
	0.2	Meilin Port Area	Meilin Warehouse	GM-2		

	2t	Houzhu Port Area	Shijing Warehouse	GM-2		
	1t	Xiaocuo Port Area	Fujian Oil Refinery	GM-2		
	2t	warehouse	Fuzhou Haijie Co., 86-591-3758077	MN		
	500kg	Dock Warehouse	Dahua Oil Store,Petrol China, 86-593-6897883	MN		
	2600kg	Docks of Xiamen Haicang, Xianglu Dock, Botan Dock	Haitong Shiping Service Co. Ltd, Xianmen, 86-592-2390192, 2390152(F)	BH-X		
	500kg	Airfield Terminal	Airfield Terminal, 86-755-27777497			
	2000kg	Shayuchong	Guanghui Dock, 86-755-84231555	JD86 Concentrated		
	1000kg	Shayuchong	Zhongpeng Dock, 86-755-84230318	JD86 Concentrated		
	2000kg	Shekou	Hailong Co., 86-755-26895788	JD86 Concentrated		
	2000kg	Yantian	Hailong Co., 86-755-26895788	JD86 Concentrated		
	4000kg	Shekou	Hangpeng Co., 86-755-26691382	GM-2		
	500kg	Shekou	Merchant Attraction Co., 86-755-26692521	GM-2		
	500kg	Airfield Terminal	Airfield Terminal, 86-755-27776209	GM-2		
	500kg	Chiwan Oil Store	Guangjv Energy, 86-755-26682128	GM-2		
	500kg	Shekou	Leyi Co., 86-755-26390292	GM-2		
	500kg	Shekou	Chiwan Port Navigation Co., 86-75526817658	GM-2		
	500kg	Shekou	Moon Bay Dock	GM-2		

	200000kg	Base of Longshan Co.	Longshan Co., 86-755-26392618	Common		
	1100	Shekou	Yashilin Co.	SZ-A		
	200	In Shiwan	Huayuan Oil Store, 13929905727			
	20	In Shiwan	Shakou Power Plant, 13902412625			
	100	In Shiwan	Shitan Oil Store			
	500	In Shiwan	Feshan Power Plant, 13078188183			
	240	In Shiwan	Chanyun Hongsan, 13902419752	GM-2		
	300	In Shunde	Changli Cleaning Co., 13802640740			
	500	In Nanhai	Pingdong Oils Factory, 6776786			
	340	In Gaoming	Dock of Nanhai Power Plant A, 68218988830			
	100kg	Dock	Jintaifeng Fuel Co. Ltd, Zengcheng			
	100kg	Dock of warehouse	Electricity Fuel Co., Dongguan			
	100kg	Dock of Yongxing Chemical Industry	Yongxing Petrol&Chemical Co. Ltd, Dongguan			
	400kg	Dock of Donghua Power Plant Oil Store	Dongguan Electricity & Chemistry Group Co., 2487663(F)			
	200kg	Dock of Guohong Power Plant Oil Store,	Dock of Guohong Power Plant Oil store, 2428306, 13902697896,			
	300kg	Dock of Zhangcun Oil Store	Dongguan Petroleum Co., Guangdong, 2264938, 2203469			
	200kg	Dock of Hongcheng Wanjiang Oil Store, Petrol China	Hongcheng Petroleum Supply Co., Petrol China, Guangzhou, 2187262, 2187386(F), 13332678042			

	100kg	Dock of Jintian Oil Store	Jintian Fuel Co., Ltd, Dongguan			
	400kg	Chaojie Dock	Chaojie Co. Ltd, Dongguan, 13829767611, 13829767176			
	600kg	New Energy Dock	Dongguan New Energy Fuel Co. Ltd, 8825612, 8223038(F), 13662751725			
	0.2t	Dock Warehouse of Yangpu Port Power Plant	28822354, 13907655191	Concentrated		
	0.2t	Dock Warehouse of Qinglan Port	Qinglan Port Service Co., 63329349, 13807613259	GFS		
	340kg	Dock Warehouse of Basuo Port	Basuo Port Service Co., 25523345	GM-2		
	4.25t	Dock Warehouse of San Nanshan Terminal	BP China Co. Ltd, 8883000, 13500063240			
	2400kg	Dock Warehouse of Ssanya Hongtang	Hainan Petroleum Pacific Co. Ltd, 88913113, 13807505263	GM		
	340kg	Dock Warehouse of Sanya Marine Police	Sanya Petroleum, SINOPEC	GM-2		
	400kg	Warehouse of Sanya Nanshan Dock of Nanhang Army	Sanya International Energy Co. Ltd, 88830251, 13876190055	GM-2		
	500kg	Macun Guosheng Dock Warehouse	Hainan Guosheng Petroleum Co. Ltd, 67440038, MT13907539629	Concentrated		
	500kg	Macun SINOPEC Dock Warehouse	Hainan Gas Co., SINOPEC, 67428085	GM-2		
	520kg	Dock Warehouse of Macun Army	Army 75563, 67428131, 13807590003	GM-2		

	100kg	Macun New Dock Warehouse	67428745	GM-2		
	500kg	Dock Warehouse of Macun Power Plant	Dock of Hainan Fire Power Co. Ltd 67428761	PP-2		
	250kg	Warehouse of Haikou Oil Dock	Hainan Petroleum Co., SINOPEC	GM-2		
	120kg	Guantouling Dock of Beihai Petroleum Co.	Beihai Petroleum Co. SINOPEC	GM-2		
	6400l	Dock of Weizhou Terminal Handling Factory	86-759-3900367	GM-2		
	300kg	Dock of Guigang Petroleum Branch Co.	Guigang Petroleum Branch Co., 86-775-4281029	GM-2		
	2t	SINIPEC Dock of Qinzhou Yingling	Qinzhou Liquefied Gas Co. Ltd, Guangxi, 86-777-3888811, 13087772799	GM-2		
	400kg	Qinzhou Yingling Guangming Dock		GM-2		
	120kg	Pollution Cleanup Boat	OilSpill Stricking Team of Working Staff Association, Beihai MSA	GM-2		
	400kg	Dock Warehouse of Beihai Salvage&Rescue Station	Beihai Tianxiang Oils Supply Co., 86-779-3909961, 13707795856	GM-2		
	200kg	Dock of Guigang Petroleum Pingnan Branch Co.	Guigang Petroleum Pingnan Branch Co., 86-775-4281029, 13978585765	GM-2		
	160kg	Guantouling Dock of Beihai Petroleum Service Department	Beihai Petroleum Service Department, Zhenqian Petroleum Administration, 86-779-3915158, 13517793245	GM-2		

2. Japan

Helicopter Dispersant spray system

Name	Amount	Place of Stock	Owner	Type	Capacity	Other Note (Available Equip.)
Rotortech TC-3 MK-Ⅱ	1	Hakodate	Japan Coast Guard (JCG) Phone & Fax : +81-3-3591-9819	Helicopter Spray System	910 L	
Rotortech TC-3 MK-Ⅱ	1	Yokohama	JCG	Helicopter Spray System	910 L	
Rotortech TC-3 MK-Ⅱ	1	Miho	JCG	Helicopter Spray System	910 L	
Rotortech TC-3 MK-Ⅱ	1	Naha	JCG	Helicopter Spray System	910 L	
Oil Spill Fighter Spray System	1	Yokohama (PLH YASHIMA)	JCG	Helicopter Spray System	420 L	
Oil Spill Fighter Spray System	1	NAGOYA (PLH MIZUHO)	JCG	Helicopter Spray System	420 L	
Oil Spill Fighter Spray System	1	Niigata	JCG	Helicopter Spray System	420 L	
Oil Spill Fighter Spray System	1	Fukuoka	JCG	Helicopter Spray System	420 L	

Helicopter Dispersant Spray Systems

The TC-3 Oil dispersant sprayer

1. Outline
    - This sprayer is used from the air, mounted beneath a helicopter.
    - An internal engine forces the dispersant through the booms and out the nozzles, 16 on the short boom and 21 on the long boom.
    - It is controlled with a control box from the helicopter cockpit. The engine can be turned on or off, the rate of spraying can be controlled, and the long or short boom can be chosen.
    - It can spray the dispersant maximum 455l/m.
      When a Bell 212 is used, the amount of dispersant that can be carried is approximately 400 liters.

2. Particular

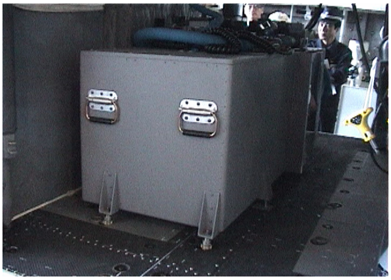
• Tank capacity	910	l
• Weights (dry)	156	kg
• Height	1.38	m
• Width	1.85	m
• Length	1.65	m
• Length (boom)	9.15	m
• Power (Gasoline engine)	7	kw

The Oil dispersant sprayer "Oil spill fighter"

1. Outline
   - This sprayer is used from the air, mounted beneath a helicopter (Bell 212).
   - An internal motor forces the dispersant through the booms and out the nozzles, 12 on the spray boom.
   - It is controlled with a control box from the helicopter cockpit. The motor can be turned on or off, the rate of spraying can be controlled.
   - It can spray the dispersant maximum 136l/m.

2. Particular

• Tank capacity	386	l
• Weights	74	kg
• Power	28	vdc



3. Helicopter Dispersant Spray Systems Equipped by Korean Coast Guard

Name	Amount	Place of Stock	Owner	Type	Capacity
Simplex 10900-004 (U.S.A)	1 set	Busan	Korea Coast Guard	Helicopter Spray System	1.5 kl/h
Simplex 10900-004 (U.S.A)	1 set	Mokpo		Helicopter Spray System	1.5 kl/h
TC-3 (VIKOMA, Great Britain)	1 set	Incheon		Helicopter Spray System	910 l.

1. TC-3

- ○ Spray System: Helicopter Spray System
- ○ Capable Quantities of Spray: Max. 418ℓ/min
- ○ Weight: 250kg
- ○ Tank Capacity: 910ℓ
- ○ Mobile Source: DC(Battery), Manual
- ○ Fuel: Diesel Oil
- ○ Manufacture: England VIKOMA
- ○ Time of Purchasing: April 3rd 2000
- ○ Unit Price: Korean Currency: 71,097,300 (equivalent to ~US$70,000)
- ○ Quantity KCG holds: 1

2. SIMPLEX

- ○ Spray Tank Assembly with Support Installation: 205kg
- ○ Spray Boom Assembly with Nozzles Installation: 26kg
- ○ Spray Tank Contents: 1400ℓ
- ○ Hydraulic Power Unit Installation: 87kg
- ○ Quantity KCG holds: 2

4. The Russian Federation

Dispersant spray systems

Name	Amount	Place of Stock	Owner	Type	Capacity	Other Note (Available Equip.)
R-1	1	Okha	Rosneft – Sakhalinvjrneftegas	Air spray	70	
R-2	1	〃		Air spray	225	
R-1	1	〃		Air spray	70	
R-2	1	〃		Air spray	225	
R-1	1	〃		Air spray	70	
R-2	1	〃		Air spray	225	
R-1	1	〃		Air spray	70	
R-2	1	〃		Air spray	225	
	1	Nogliky	SEIC	Helicopter Dispersant Spray System		

Annex D

NOWPAP Guidelines on Oil Spill Dispersant Application

PREFACE

The NOWPAP *Guidelines on Oil Spill Dispersant Application* provides information on the use of oil spill dispersants. It is intended primarily for use by Member Governments of NOWPAP and other oil spill responders and which can be applicable during the joint response operation within the framework of NOWPAP Regional Oil Spill Contingency Plan.

The text is based on the IMO/UNEP *Guidelines on Oil Spill Dispersant Application* approved by Marine Environment Protection Committee of IMO on 4 September 1994 and NOWPAP member states polices and national manuals on use of dispersants.

All statements and procedures are given in it shall be considered as recommendations. In case of a contradiction of them with national regulations the last shall prevail.

CONTENT

Acronyms and Definitions

Chocolate mousse — a highly stable weathered emulsion of water in oil. It may remain in the environment for a long time and turn into "tar balls".

Dispersant — A blend of surfactants in one or more solvents designed to emulsify oil in the sea.

Dispersal — The process of emulsification. For liquids the terms dispersal and emulsification are theoretically synonyms. They are used for the formation of emulsions of oil in water, and for the formation of emulsion of water in oil.

Emulsion — A mixture of fine drops of one liquid in another. For oil spill response purposes, this means a suspension of fine drops of oil in water or water in oil. Milk, which is a suspension of drops of fat in water, is a clear example of a natural emulsion.

IMO — International Maritime Organization.

IPECA — International Association of Petroleum Industry Representatives.

MEPC — Marine Environment Protection Committee of the International Maritime Organization.

Oil — Oil in any form, including crude, liquid hydrocarbon fuel, and treated petroleum products.

Oil spill Oil spill — Any unintentional discharge or spillage of oil. The following arbitrary hierarchical system is used to characterize the magnitude of oil spills:

Tier 1 - a minor oil spill that can be cleaned up by means of the manpower and resources of the site at which the spill occurred. A Tier 1 spill is difficult to quantify, because this depends on the area where the spill occurred. Spills of less than 500 tons may be considered minor spills.

Tier 2 - a medium oil spill whose cleanup requires the use of the available manpower and resources in a particular region. In quantitative terms, a spill of no more than 500 tons and less than 5000 tons

	may theoretically be considered a medium oil spill. Tier 3 - a major oil spill whose cleanup requires the employment of manpower and resources at the federal or international levels.
OSCP(Oil spill contingency plan)	A document governing the organization and conduct of oil spill response operations.
OSR	Oil spill response.
OSRMB	Oil Spill Response Management body.
UNEP	United Nations Environmental Program.

Purpose and Scope

This NOWPAP "Oil Spill Dispersant Application Guidelines" (Guidelines) contains basic standards, guidelines, and requirements for the environmentally safe use of dispersants in cleaning up oil spills at sea, brief descriptions of dispersant application techniques and procedures.

This Guideline is considered as part of NOWPAP join oil spill contingency plan and intended for persons supervising oil spill response operations, for businesses and organizations involved in planning and conducting oil spill responses, developing and applying oil dispersants.

1. General Principles

Oil spilled on the surface of the sea spreads and forms an oil slick that is moved by wind and currents. Part of the oil slick goes down into the sea under the action of waves and currents and is decomposed by oxygen and bacteria. Oil floating on the sea surface always reaches shore causes damage to marine bioresources and economic. Shore cleanup operations may take years and cost lots of money. Oil spill response policies in the NOWPAP countries are based on the following principles:

- As much oil as possible should be recovered at sea before it reaches shore in order to cut costs and reduce environmental damage.
- Mechanical recovery systems should preferably be used to clean up Tier 1 oil spills if the whether conditions allow to do it.
- All oil spill cleanup resources (dispersants and mechanical equipment) should be given equal consideration for cleaning up Tier 2 and Tier 3 spills, because experience has shown that on average mechanical equipment is only capable of recovering not more than 20 to 30 percent of the spilled oil.
- The chosen oil spill response techniques should be applied concurrently. That part of the slick that poses the greatest threat should be treated with dispersants, while the rest should be cleaned up mechanically.
- A decision to use dispersants should be made solely on the basis of a Net Environmental Benefit Analysis (NEBA) of pre-approved dispersants for the polluted area or the area threatened by pollution.

2. The Behaviour of Oil on the Water Surface

It would be impossible to choose the most economically and environmentally sound oil spill cleanup technique without knowing how oil behaves on the sea surface. As soon as crude oil or petroleum products enter the sea, they almost instantly start to undergo physical and chemical changes, the most important of which are spreading and weathering (emulsification, dissolution, evaporation, photooxidation, and biodegradation).

The nature of these changes is determined by the spilled oil's properties (such as gravity, viscosity, surface tension, and fractional composition) and water and weather conditions at the site of the spill (wind speed, sea conditions and temperature). Below are examined the processes that take place with oil on water and must be taken into consideration in deciding whether to use dispersants.

2.1 Oil Spreading

The spreading rate of oil is primarily determined by its viscosity and gravity. Light low-viscosity oils such as diesel fuel and kerosene and most crude oil spread very quickly, while heavy fuel oils and waxy crudes spread quite slowly. Spreading generally ends a few hours or a few days after a spill. In the process the oil slick takes on different thickness and colors. Brightly colored sheens (less than 0.01 mm thick) account for about 90% of the oil slick's area, while black spots/thick films (more than 1 mm thick) usually account for about 10% of the slick's area. Thick black films usually become saturated with water a few days after a spill and turn into emulsion of water in oil, which later turns into so-called "chocolate mousse" and "tar balls."

2.2 The Movement of an Oil Slick

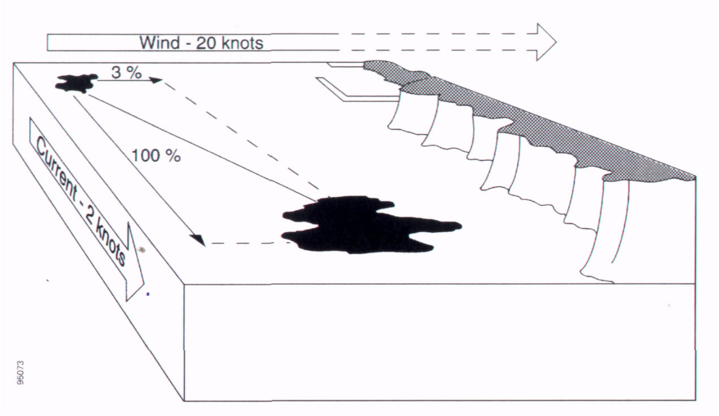


Figure 1. Effect of wind and current on oil slick movement
Source: CEDRE, Brest, France

The action of wind and currents transports an oil slick on the surface and alters its shape. The speed and direction of the slick's movement are primarily determined by the resultant vector of wind velocity and current (Fig. 1). Usually may be assumed that the slick's speed corresponds to 3% of wind speed. The effect of the wind is reduced to 1% under water at depths of up to 2 meters with a 30~40° change in course due to the Coriolis force (rotation of the Earth). As the slick moves, its contours change; giving it the shape of an oval with tails, and the slick may be broken up into smaller slicks by wind and wave action.

2.3 Evaporation

The emission of oil's light fractions into the atmosphere by evaporation is one of the primary natural factors by which oil is removed from the sea's surface. The rate of evaporation depends on the oil's vapour pressure and wind speed and to a lesser extent on ambient temperature. Oil's constituents with distillation points below 200°C (gasoline fraction) usually evaporate within hours, while oil fractions with boiling points of up to 270° take several days to get into the atmosphere. Evaporation raises the oil's viscosity, density and flash point.

2.4 Dissolution

Oil and petroleum products are relatively insoluble in water. It must be kept in mind that the light aromatic fractions, which are the most toxic, dissolve best in water.

2.5 Photo Oxidation and Biodegradation

The ultraviolet component of the sunlight spectrum causes the oxidation of oil's polar constituents. This makes the oil more soluble in water and helps stabilize the emulsion.

The sea always contains micro organisms capable of degrading oil by using it as a source of food and energy. Oil spills are accompanied by a rapid increase in the concentration of micro organisms in the water. Oil's paraffin (n-alkanes) are its most biodegradable constituents. The rate of biodegradation depends on temperature and the supply of oxygen and nutrients (nitrogen and phosphorus). It is rather slowly process.

2.6 The Settlement and Sinking of Oil

Oil can get to the seafloor in several ways:
- most crude oil residues after weathering are heavier than seawater;
- in shallow water oil sticks to grains of sand and suspended solids and settles on the bottom.

2.7 Dispersal

When oil gets on the water surface, it starts to emulsify under the action of waves and currents.

An emulsion into sea column is formed when waves break the oil slick into drops and carry them down into the sea. Wave action forms oil drops 1 μ. to 100 μ. in size. When wave action stops, big drops more than 100 μ in size float to the surface, coalesce, and form a new oil film. The small drops ascend more slowly and are dispersed by the action of currents under the surface, or when there is no current, are concentrated in the form of an emulsion at the water-oil slick interface, going back down into the sea when winds and currents resume. Because of the substantial increase in the area of contact with the environment, oil emulsified by this mechanism becomes very amenable to chemical and biological degradation and is usually degraded by natural factors within a few days. It may be generally assumed that in seas of up to 5 points on the scale, 0.5 to 2% (by volume) of the oil per hour will disappear into the sea in the form of emulsions in the first 10 hours after a spill, and then the process will slow down and stop in a few days.

An emulsion on the surface of water is formed by the penetration of water into a floating oil slick. The formation of that emulsions increases the oil's viscosity and gravity and results in a significant expansion of its volume. The process is promoted by the evaporation of light fractions from the oil and the oxidation of the residues. The emulsions will hinder and over time totally halt the natural degradation of oil and its dispersion in the water column. Over time that emulsions on the water's surface become even more stable and may turn into "chocolate mousse" and "tar balls", which may persist in nature for years. Weathering process is shown on the Fig. 2.

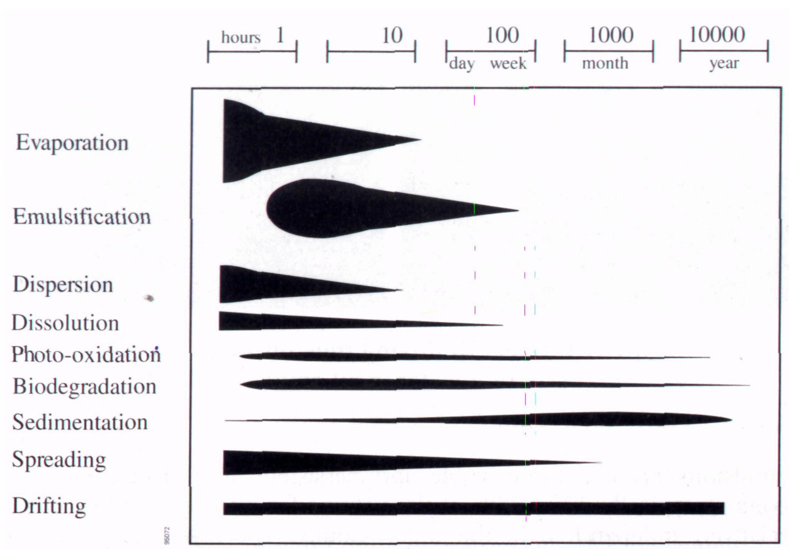


Figure 2. Relative importance of weathering processes with time
Source: Environment Canada

2.7.1 The Natural Dispersability of Oil

Oil's propensity to form emulsions and be dispersed into the sea column is controlled by its physical and chemical properties and natural factors (waves, wind, currents, temperature).

Oil's light fractions promote the formation of emulsions in water column. Evaporative losses of the light fractions will cause oil to lose its ability to form emulsions in water and promote formation of emulsion on the surface of water.

Light fraction evaporation time is the limiting factor for the most effective dispersion of an oil spill into sea and may be described by the term "window of opportunity." Heavy viscous oils with low light fraction contents are hard to disperse in water, while certain oils don't disperse in water at all and form highly stable emulsions on surface of water. Hence the persons preparing oil spill contingency plans are strongly advised to determine oil dispersability ahead of time.

2.7.2 The Use of Chemicals to Speed the Natural Oil Dispersion

Specialty chemicals known as dispersants are used to promote the formation of emulsions oil in water column, widen the "window of opportunity", promote the natural degradation of spilled oil, prevent the formation of "chocolate mousse", and keep the oil from reaching shore.

Oil spill dispersants are mixtures of surface-active agents in one or more organic solvents. They are specifically formulated to enhance the dispersion of oil into the seawater 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. Dispersants also prevent coalescence of oil droplets and reformation of the oil slick.

They help the oil slick spread on the water, help break it up into small drops (less than 100μ in size), and help carry them down into the sea. The dispersants ingredients surround each drop of oil, keeping them from coalescing and floating back to the surface. Rather than sinking the oil, the dispersants confine it to a layer of water no more than 10 meters thick forming a substance similar to milk. After dispersants are applied, at first the oil's, concentration in the sea becomes substantially higher and hazardous for plankton, fish eggs, and fry (the oil's concentration reaches 100 mg/1 at a depth of 0.1 meters, 10 mg/1 at a depth of 1.0 meters, and less than 1 mg/1 at a depth of 10 meters). But after a few hour (1 to 5 hours, depending on current speed), these concentrations decline dramatically to level of less than 1 mg/1. The examples of depth concentration profiles are presented on Fig. 3. Satisfactory dispersion of oil in water requires a dispersant-to-oil application ratio of 1% to 10%. Then sooner the dispersant is applied, the less is needed to achieve the desired effect.

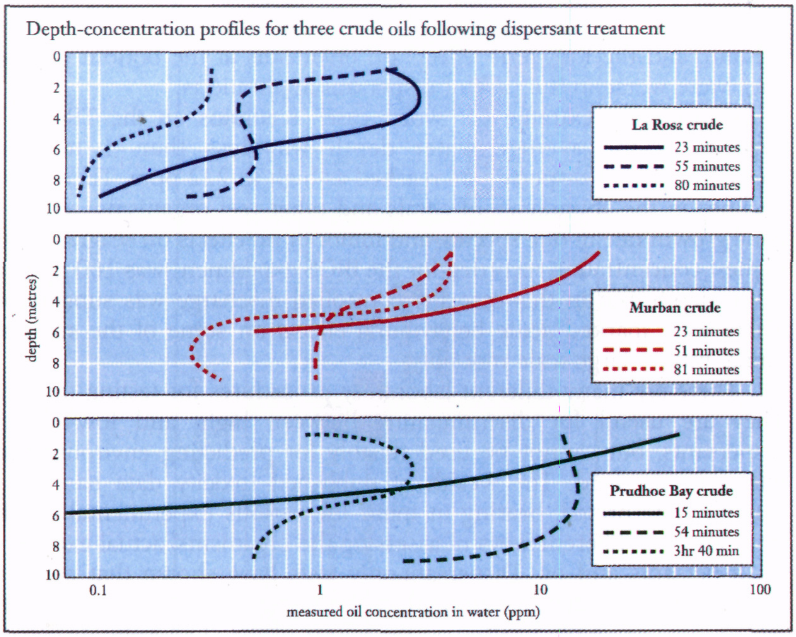


Figure 3. Depth concentration profiles

Graphs show depth-concentration profiles for three crude oils following dispersant treatment. The data were obtained from sea trials off the New Jersey and California coasts and show that dispersed oil concentrations diminish with time and depth, and at a depth approaching 10 m are typically less than I ppm at any time.
Source: IPIECA (1993)

Dispersants, like any other oil spill response technique, have their advantages and disadvantages:

The advantages of dispersants over other oil spill response techniques	The disadvantages of dispersants
1. They make oil less sticky for birds and marine mammals, thus protecting them from contamination and inevitable death in the oil slick.	1. Oil entering the water can harm aquatic life (plankton, fish, algae).
2. They mitigate adverse impact on the shoreline and onshore facilities.	2. An oil slick treated with a dispersant is difficult to recover with mechanical equipment.
3. They accelerate the natural biodegradation of spilled oil by a factor of hundreds.	3. Dispersants are not effective for all types of oil.
4. They prevent the formation of "chocolate mousse" (stable oil agglomerates).	4. When dispersants are applied to the shore, they may cause the oil to penetrate deeper into the soil.
5. They may be used in conditions that are unfavorable for other techniques (waves higher than 3 meters, strong currents).	5. Additional matter is put into the marine environment.
6. They can clean up oil pollution over large water areas. 7. They dramatically reduce the speed of a slick.	6. There are restrictions on the use of dispersants, based on the time that has relapsed since the spill (window of opportunity).

International experience in applying dispersants and research by international organizations (the International Maritime Organization and the UN Environmental Program) have shown that oil dispersion in places with adequate water exchange has never resulted in toxic effects on marine or benthic organisms. At the same time, oil-polluted rocky shores can recover in 0, 5 to 3 years, salt marshes can recover in 2 to 5 years, tidal shoals can recover in 5 to 10 years, and coral reefs may take 10 to 15 years to recover. The impact of oil on marine and benthic organisms is examined in Section 4.2.

3. Oil Dispersant Preliminary Approval Procedure

Dispersal is a specific oil spill response technique that requires caution in planning oil spill responses and in making decisions in a real-life situation.

Oil spill contingency plans may only include dispersants that have received the preliminary approval of appropriate national government agencies.
The preliminary approval process generally consists of the following phases:

1. Assessment of dispersant effectiveness by approved experimental procedures.

2. An assessment of the toxicity and biodegrability of dispersants.

3. Approval of use dispersants by appropriate national authority (ies).

Preliminary approval by the national agencies confirms that the dispersant in question has "in principle" been authorized for use in the inland seas, territorial waters, and exclusive economic zone and may be included in particular oil spill contingency plans.

The decision to apply preliminarily approved dispersants in a real-life situation is the prerogative of the Commander of the Oil Spill Response Management body in consultation with the concerned national authorities on the basis of a Net Environmental Benefit Analysis (Section 4.3.).

3.1 Assessment of Dispersant Effectiveness

For preliminary screening purposes, the <u>effectiveness</u> of dispersants must be assessed by national specialized organizations using appropriate experimental procedures. Only dispersants with an adequate effectiveness on a standard petroleum product may be authorized for use. In planning the use of dispersants at a site, one should make sure they are effective for the type of oil that would most probably get into the sea from the site. The results must be documented in a test report, and recommended application techniques, dispersant application ratios, and dispersant application conditions (water salinity, ambient temperature) must be appended to the report.

3.2 Assessment of Dispersant Toxicity

Only NOWPAP specialized national research organizations may assess the toxicity of dispersants.

4. Dispersant Application Planning

The use of dispersants as a possible oil spill cleanup technique must be planned and justified in the process of drafting appropriate oil spill contingency plans. The following factors must be taken into consideration:

- risk assessment of potential oil spill;
- factors that affect oil's behavior on water;
- the environmental and economic value of the area and its vulnerability to oil pollution;
- the dispersants' physical and chemical characteristics;
- the outcome of the dispersant net environmental benefit analysis (NEBA);
- preliminary approval of the application of specific dispersants.

4.1 Risk Assessment of Potential Oil Spill

The volume of a potential oil spill caused by the grounding or collision of a vessel can be estimated according to national risk assessment methods. The volume of a probable oil spill on oil terminal may be calculated on the basis of the volumes of handled oil and the number of ship calls. The volume of a spill resulting from a drilling platform accident may be calculated on the basis of accident statistics and oil storage tank capacity. In assessing risk, one must identify places with a high risk of accidents and determine whether there are any water areas that are highly vulnerable to pollution in the vicinity and the priorities for protecting these areas. The assessment must also consider the type of oil that could enter the sea in a particular area. A potential oil spill risk assessment is a mandatory component of any oil spill contingency plan and must be used as the basis for estimating the required supply of dispersants.

4.2 The Environmental Value of the Area and Its Vulnerability to Oil Pollution

The environmental value of an area and the vulnerability of ecosystem components to oil pollution recommended to be illustrated on environmental sensitivities maps (Fig. 4) produced by national specialized organizations.

Valuable ecosystem components (VEC) and their seasonal distribution must be plotted on the maps. The map legend must indicate their vulnerability to surface and three-dimensional oil pollution of the marine environment and oil pollution control priorities. VEC must include all rare species on the Rare and Endangered List bioresources and nature preserves (special protected areas). Sea areas where the use of dispersants is not recommended at any time of year (fish farms, water intakes), where dispersants may be applied in certain seasons, and where dispersants may be applied at any time (such as to prevent oil pollution of nature preserves and rare birds and mammals) also be recommended to shown on the map.

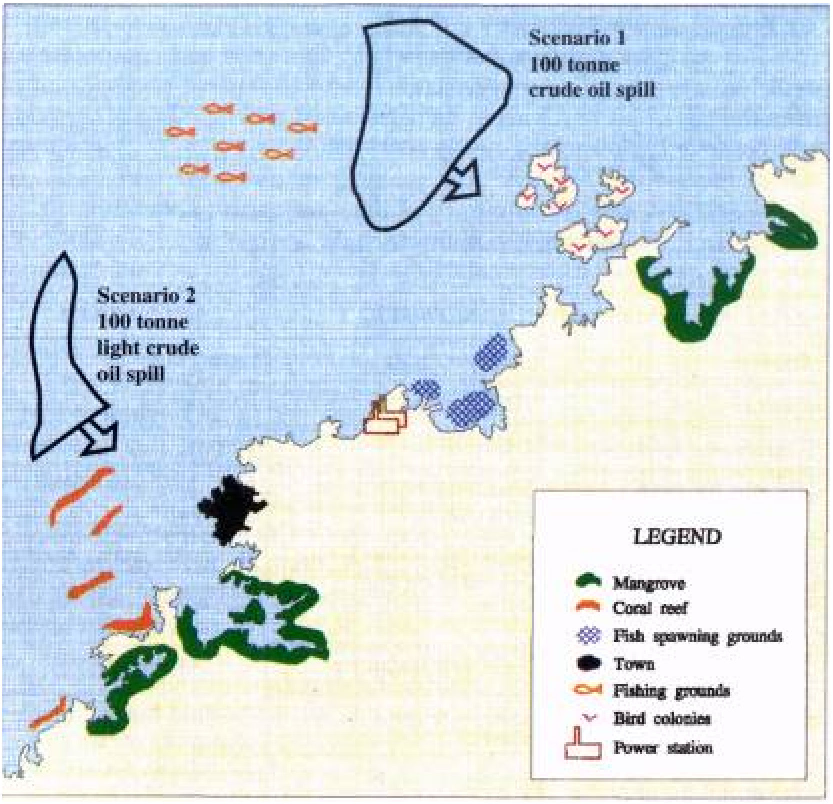


Figure 4. Sensitivity map of the area for the two scenarios (see 4.3)
Source: World Conservation Monitoring Center (WCMC), Cambridge, UK.

The NOWPAP Guidelines on sensitivity mapping or "The International Maritime Organization/International Association of Petroleum Industry Representatives Guide to Producing Environmental Vulnerability Maps" approved by the 37th Session of the Marine Pollution Control Committee of the International Maritime Organization on October 11, 1995 may be used as a reference for producing these maps.

Below are described several kinds of environmental components and their vulnerability to three-dimensional and surface oil pollution and thus to dispersed and undispersed oil as examples. These data should be used in the NEBA (Section 3.5) and in deciding which oil spill response techniques should be used.

Marine Mammals

Marine mammals that use fur as protection against freezing (otters, polar bears, fur seals, and so forth) are extremely vulnerable to surface oil films. They disrupt the heat insulation provided by the fur, causing the animals to die from freezing, and the animals are also poisoned when they swallow the oil. Protecting their habitat is a priority, and dispersants are preferred for this purpose. Dispersants should be applied as far away from their rookeries as possible, because the animals are sensitive to noise and groups of people and equipment, but if absolutely necessary dispersants may also be applied near their habitat.

Salty Tidal Zones

Usually these habitats are also feeding grounds for birds. When oil gets onto salty areas exposed at low tide, it will not get into the mud unless there is a sufficient number of holes and burrows dug by worms and crabs. But film oil sticks tight to these surfaces, poisoning the animals. Mechanical cleanup of these locations is very labor intensive and kills the animals that live there. Thus dispersants should be applied in the open sea before the oil reaches shore.

Marine Algae

Dispersed oil may cause more damage to marine algae than film oil, which is above the algae and thus has a less harmful effect on them. Hence dispersants are not recommended in shallow water areas with abundant algae.

Mollusks

They are more vulnerable to dispersed oil than film oil, which is why dispersant application is not recommended near areas where mollusks are harvested and cultivated.

Ponds Used for Aquaculture and Salt Extraction

These environmental components are vulnerable to both floating and dispersed oil, which is why precautions must be taken to prevent their pollution.

Salt Marshes

Marshes, which contain an abundance of animals and vegetation, actively absorb oil and retain it for a long time. Cleaning up marshes is very difficult, which is why precautions must be taken to keep oil from getting to them. Dispersants should preferably be applied in the open sea in order to reduce the concentration of the oil before it gets close to shore.

Rocky Coasts

Breakers clean oil quite quickly from rocky coasts. Rocky beaches have a quite high biological productivity and low self-cleansing capacity, which is why dispersants should be used in the open sea before the oil gets close to shore. At the same time applying oil to relatively unproductive pebble beaches is not recommended, because it could result in deeper penetration of the oil into the soil.

Sandy Beaches

These beaches have a relatively low biological productivity, quite easily cleanse themselves by means of wave action, and are relatively easy to clean up with mechanical equipment. Hence one may avoid using dispersants to protect them. But if these beaches contain large numbers of turtle eggs and are important as tourist areas, then dispersant application before the oil reaches shore may be justified.

Recreational Areas

These parts of the sea are quite important from an economic standpoint and at the same time have a low biological productivity. Hence even dispersant treatment of floating oil close to shore would be justified if there were no water intakes within a 3-km radius. If there are, steps must be taken to cover the intakes.

Industrial Facilities (Wharves, Power Lines, and So Forth)

Dispersant application is not recommended in the vicinity of industrial facility water intakes. If the oil is near docks and ports, dispersant application is not recommended, because in this case the oil can be recovered mechanically. At the same time, if the oil poses a major fire hazard (contains large amounts of light fractions), dispersant application will be justified for fire prevention purposes.

Birds

Oily birds normally freeze to death, and their survival rate is usually low after they are cleaned at special stations on shore. The damage becomes even greater if the oil reaches the birds' nesting and hatching areas. Dispersants may be the only way to save the birds' lives. If aircraft applies dispersants, it is recommended that the spraying be done as far away as possible from their habitats because of the danger of a collision with the birds. One must also consider seasonal variations in the geographical ranges of many bird species.

Fish

Film oil poses less of a danger to fish than emulsified oil, especially for fry. Adult fish can easily sense oil pollution and leave areas with high oil concentrations. But film oil may pose a significant danger to pelagic eggs and larvae and kill them. Dispersants are not recommended for application at fish spawning and feeding grounds, because they could harm fish stocks. This statement is especially applicable to shallow-water areas. At the same time dispersant application may be justified to protect these areas from an advancing oil slick.

Mariculture Areas

Oil in any form poses a great danger for such areas by killing or ruining fish and mollusks and thus rendering them unfit for human consumption. The application of dispersants in the open sea before the oil gets to these areas can mitigate the oil's harmful effects.

4.3 Net Environmental Benefit Analysis (NEBA)

NEBA is a weighing of the advantages and disadvantages of dispersants for the environment of the region depending on the time of year. The basis for a NEBA of dispersant application is constituted by the recommendations 4.2. to plot valuable ecosystem components on environmental sensitivities maps. An NEBA is performed in two phases, including a preliminary analysis at the time when oil spill contingency plans are prepared and a real analysis in the decision-making process during an actual oil spill.

In conducting a preliminary analysis for planning purposes, the following factors must be taken into consideration:

- The list of environmentally and economically valuable components that must be protected on the basis of their priority.
- Seasonal variations of environmentally valuable components.
- The effect of floating and emulsified oil on environmentally valuable components.
- The advantages and disadvantages of different oil spill response techniques.

The preliminary analysis may be used as the basis for plotting areas where dispersants should not be used at any time of year (Zone 1), areas where dispersants may be used under special conditions on the basis of a real NEBA (Zone 2), and areas where dispersants can be and should be applied at any time (Zone 3) on the environmental vulnerability maps appended to the oil spill response plan.

The NEBA team should be included:

- biologists with a good knowledge of the region or area in question;
- oil spill response specialists;
- dispersant application specialists;
- ecologists;

- experts on the behavior of oil at sea.

The author of the oil spill response plan must assemble these teams in the planning phase.

Below are given two NEBA scenarios as examples. They are plotted also on Fig. 4.

4.3.1 Scenario 1. Dispersant Application Not Recommended

100 tons of crude oil has been spilled and is moving towards a bird colony and a fish spawning ground. The bird colony is active and some of the fledglings are already in the water, there are abundant fry in the shallow water, and all of these animals are vulnerable to oil pollution. According to forecasts, the oil slick will reach the bird colony in 24 hours, littoral shoals with fry in 36 hours, and the shoreline in 48 hours.

Water and weather conditions permit the use of mechanical recovery equipment, and the equipment is near the scene of the spill. An analysis of oil spill response capabilities has indicated that oil may be dispersed or recovered mechanically before it gets to the shallow water area but not before it gets close to the bird colony. Because the bird colony covers a large area, it cannot be protected by booms.

Conclusions: The mechanical recovery equipment must be mobilized immediately. The use of dispersants is not recommended. Dispersant application would be good to protect the bird colony, but in this case the fry would be killed, resulting in harm to fish stocks. Because there are only a small number of fledglings in the water, the damage to the colony will not be significant and the colony can recover.

4.3.2 Scenario 2. Dispersant Application Recommended

The spill conditions are the same as in Scenario 1, but the spill occurred at the end of May, when there are a large number of fledglings in the water. In this case it would be better to use dispersants. In the process the young fish will die, but the fledglings will be saved. But fish stocks, in contrast to bird colonies, can recover relatively quickly (in one or two years).

Table 1. Summary of data and results of decision-making for two scenarios

SPILL INFORMATION	SCENARIO 1	SCENARIO 2
Oil type	Medium crude	Light crude
Quantity	100 tones	100 tones
Time since spill	1 hour	1 hour
Present location	5 nautical miles from bird colony	3 nautical miles from coral reef
Resources threatened	Spawning ground, bird colony shoreline	Mangrove stand, coral reef

RESPONSE OPTIONS	SCENARIO 1	SCENARIO 2
Mechanical clean-up	Yes, implement	Possible, but not rapid enough to reduce damage to mangroves
Dispersant use	Possible, but could cause serious damage to fish fry in spawning ground; this is a trade off for the birds	Possible; could save mangroves
In-situ burning	Too close to town	Too close to town
Boom sensitive areas	Possible, but could not be done in time to protect resources	Possible, but could not be done in time to protect resources
Surveillance	Will be done in all circumstances	Will be done in all circumstances

5. Decision-Making in Oil Spill Responses

In the event of an oil spill, decision-making policy should be based on the following principles:

- If possible, an oil spill should be cleaned up or destroyed before it gets close to the shore line, because shoreline response costs and environmental damage are many times greater than in the open sea.
- In Tier 1 spills, preference should be given to mechanical recovery, because one can pick up almost all of the oil before it reaches shore.
- In Tier 2 and 3 spills, one should give equal consideration to all oil spill response resources (dispersants and mechanical equipment), because experience has shown that on average mechanical equipment is only capable of capturing up to 20 to 30% of the oil.
- The chosen oil spill response techniques should be used concurrently. That part of the oil slick which poses the greatest threat should be treated with dispersants, while the rest should be cleaned up with mechanical recovery equipment.
- Any decision to employ oil spill response assets must be based on a net environmental benefit analysis (NEBA).

5.1 Decision-Making Procedure for Dispersant Application

The success of oil spill response operations is largely dependent on the time necessary to make decisions and mobilize oil spill response resources. This statement is especially applicable to dispersant application decisions. Obtaining pre-approval of dispersant use in the region in question at the stage of preparing oil spill contingency plans is important, so that in a real-life situation the National Commander of the Oil Spill Response Management body can make the final decision in consultation with the local environmental agency. Then the parties would only have to conduct an NEBA for a real-life situation before making a decision. The following decision-making procedure is recommended in the event of an offshore oil spill caused by a ship, drilling platform, or sub sea pipeline accident (Figure 5). In this procedure, an oil spill response technique is chosen from four possible options: mechanical recovery, dispersion, burning, and shoreline cleanup. If the choice is made in favor of shoreline cleanup, then booms must be used to protect oil-vulnerable stretches of the shoreline. If the forecast indicates that the oil is moving to the open sea or ocean, then no action may be taken, but the persons in charge must arrange for monitoring of the slick, because the situation could change dramatically. Section 4.3 provides a brief description of the capabilities of different oil spill response techniques for decision-making purposes.

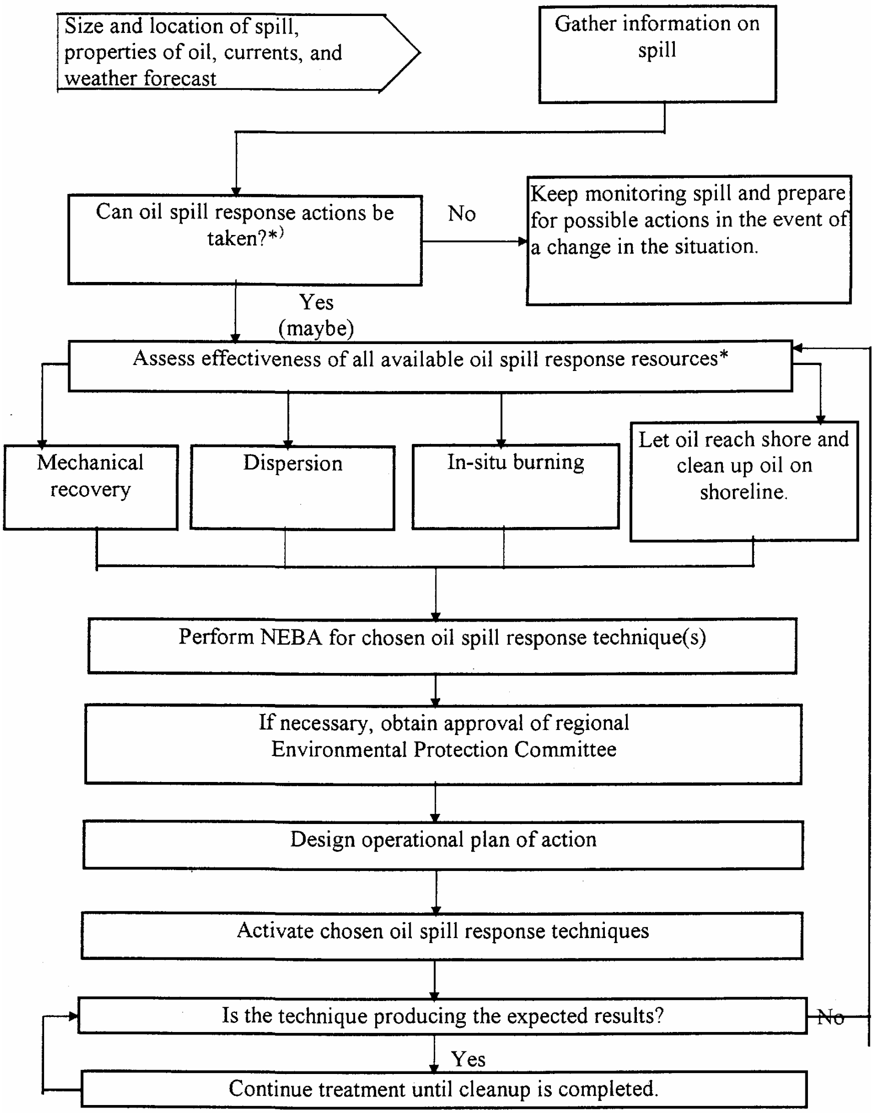


Figure 5. Oil-spill response decision-making procedure.

* Based on the availability and possibility of delivering oil spill response resources, the size and location of the oil slick, and water and weather conditions.

5.2 NEBAs in the Event of Oil Spills

The purpose of this NEBA is to prepare recommendations concerning the choice of environmentally and economically optimal oil spill response technique(s) in a real-life situation. An optimal technique is defined as one that will minimize the spill's adverse impact on the region's environment and economy.
This analysis should be performed on the basis of the following information on the spill and oil spill response resources:

- the size and location of the spill;
- oil properties (gravity, viscosity, and flash points);
- current and predicted water and weather conditions (wind and current speed, ambient temperature);
- a forecast of the drift of the spill (the time it will take to reach the shoreline and shoreline structures, shallow waters, nature preserves, and other environmentally valuable areas);
- the area's biological and economic value;
- the available oil spill response resources and resources for their delivery and deployment;
- the possibility of using oil spill response resources in a real-life situation;
- the effectiveness of oil spill response resources;
- the availability of manuals and pre-approval of dispersant application.

5.2.1 Requirements for Members of NEBA Team

The members of the NEBA team must be selected in advance in preparing oil spill contingency plans. The plan must list the organizations involved and their addresses. The list of hired experts must be approved by the National Commander of the Oil Spill Response Management body and updated on a regular basis in conducting drills and training exercises.

The NEBA must include specialists in the following fields:

- Ecology;
- Bird, mammal, fish, and benthos biology;
- Oil spill response techniques and systems;
- The application of oil dispersants.

The team must be headed by an authorized representative of the environmental agency.

Analysts may immediately rule out consideration of certain techniques because of their ineffectiveness in the given conditions and rank others in terms of effectiveness and preferability. They may recommend the use of different techniques for different parts of the slick. With respect to pollutant dispersal, the recommendations must indicate whether it is possible or impossible to use pre-approved dispersants in a given situation, which parts of the slick should be treated with dispersants, the dispersant-oil ratio, and actions to monitor dispersant use. The NEBA results must be documented in a report approved by the regional environmental agency.

5.3 Procedure for Obtaining Permission to Apply Dispersants in a Real-Life Situation

An approved NEBA report constitutes permission from the regional national environmental agency to use a specific dispersant to clean up a particular oil spill. On its basis the Commander of the Oil Spill Response Headquarters may decide to treat an oil spill with a dispersant, provided that the conditions specified in the report and dispersant application manual are met.

A regional national environmental agency may give its permission to use a dispersant on the basis of preliminary NEBAs performed in the process of drafting plans and during drills and training exercises if the scenarios on whose basis the NEBAs were performed are the same as or similar to the actual spill scenario. In this case, the operational plan approved by the Commander of the Oil Spill Response Management body must include the appropriate references to the earlier NEBA. This kind of permission may be given only for pre-approved dispersants (Section 3.3).

5.4 Brief Description of Other Oil Spill Response Techniques

Below are provided the basic characteristics of oil spill response techniques for the purpose of making sound recommendations in an NEBA.

5.4.1 Mechanical Oil Capture and Recovery Resources

These resources are the most preferable for oil spill responses, but their use in medium and major spills is limited by their capacity and dependence on wind and weather conditions (wind and current speeds, wave height and form, and ambient temperature). All of these resources are either completely or extremely ineffective at current speeds greater than 0.5 m/s; at wave heights greater than 2 meters, and in surges and wind-driven waves. All skimmers require the availability of booms and tanks to store the collected oil.

5.4.2 In-Situ Burning

Burning oil may be considered a possible oil spill response technique that requires compliance with a number of conditions. One must prevent the possibility of uncontrolled spreading of the flame and guarantee human safety. The burning of oil on water depends on a number of factors, primarily the oil slick's thickness and the oil's water content. Burning is also subject to government environmental agency approval.

5.4.3 Avoidance of Offshore Spill Responses

In this case there are two possible options: 1) one may allow the oil to reach the shore and clean up the oil on shore; 2) one may avoid taking any action if the slick is moving towards the open sea or ocean.

In the first case one must identify environmentally and economically valuable sites on shore and if possible protect them with booms or guide the oil by means of deflecting booms to places of no particular value, where the oil is relatively easy to clean up. This technique may only be considered if the shoreline is of low social, environmental, and economic value.

In the second case one must always track the movement of the slick and make sure that the actual and projected trajectories are similar. Tracking may involve the use of aerial surveillance from a helicopter or fixed-wing aircraft or instruments.

6. Dispersant Application Techniques

6.1 General Recommendations

The effectiveness of dispersants is largely determined by the time that has elapsed since the spill and intelligent application of the chemicals. Because of evaporation of the oil's light fractions, the "window of opportunity", i.e. the time in which dispersants may be applied most effectively, ranges from 24 hours to several days (in the case of an ongoing spill).

In order to treat a slick effectively, dispersants should be sprayed in a sufficient amount and as evenly as possible on the slick. This can be accomplished only by means of equipment that can generate dispersant droplets of an optimal size. If the droplets are more than 1 mm in diameter, they will penetrate the oil slick and get lost in the water, while very small droplets less than 0.1 mm in diameter are easily carried off by the wind and fail to reach the slick, which also results in chemical losses. Thus dispersant droplets should be kept within a size range of 0.1~1.0 mm (normally 400 to 700 μ. Third-generation dispersants may be applied as an aqueous solution or in pure undiluted form. If possible, dispersants should be applied to the oil slick in undiluted form in order to make treatment more effective.

6.2 Dispersant-oil Ratio

The amount of dispersant needed to treat an oil slick depends on the following factors:

- the type and amount of oil on the water's surface;
- the dispersant application technique;
- the need to achieve an instant effect and the possibility of achieving a long-term effect.

Less dispersant is needed to treat newly spilled light low-viscosity crude and light petroleum products (diesel fuel, light fuel oils with a viscosity of less than 100 cSt) than high-viscosity heavy petroleum products and watery oils (1000 ~2000 cSt) that have been on the water for a long time. In the first case a dispersant-oil ratio of 1 to 5% may be required, while in the second case this ratio may be 10 to 30%. The use of dispersants to treat oil with a viscosity of more than 2,000 cSt is usually ineffective. In practice, the term dispersant-oil ratio is usually used and is expressed as a proportion, such as 1:10, meaning that one part dispersant is needed to treat 10 parts oil.

The dispersant-oil ratio is also determined by the type of dispersant (see also Annex 2). This ratio is 3 to 5 times higher for second-generation dispersants than for concentrated third-generation dispersants.

The capacity of the dispersant pumps and dispersant consumption per unit of treated oil slick area should be calculated by the following formulas:

$$F = S \bullet u \bullet d \bullet D,\ l/s$$

where:

V is pump capacity, l/s;
S is the width of the treated swath in meters;
u is boat (aircraft) speed in m/s;
d is the thickness of the oil slick in mm;
D is the dispersant-oil ratio.

$$P = 10^4 \bullet d \bullet D,\ \text{liters per hectare}$$

where:

P is dispersant consumption in liters per hectare.

In practice it is very hard to determine the amount of spilled oil and thus the required amount of dispersant with the naked eye. Color is recommended as the basis for estimating the thickness of an oil slick: a 0.1-mm slick will be black, while a silvery or rainbow slick will be 0.01 to 0.001 mm thick.

The amount of dispersant required to treat an oil slick will also depend on the required effectiveness of treatment. If a slick is far enough from an environmentally or economically valuable area (estimated travel time of more than 24 hours), there is no need to try to destroy the slick right away and one may reduce the dispersant-oil ratio by a factor of 3 to 5 (to 20 to 50 liters per hectare). Even with this low dispersant-oil ratio, a treated slick will disperse before it gets close to a threatened area.

6.3 Safety Precautions in Dispersant Application

It should be avoided prolonged contact with the skin and use personal respiratory organ protective gear and protective eyewear when handling dispersants. When dispersants get onto the skin or into the eyes, they should be flushed out with plenty of fresh water.

Dispersants are classified as flammable materials, that is why it must be not handled them near an open flame.

Detailed safety requirements for oil spill response operations involving the use of dispersants are given in the dispersant application instructions.

6.4 Techniques for Applying Dispersants to an Oil Slick

Special workboat equipment, crop duster helicopters and planes, transport planes with special dispersant tanks and sprayers, transport helicopters with special outboard dispersant tanks and sprayers, and boat fire systems and monitors may be used to apply dispersants to an oil slick.

Detailed equipment specifications and use procedures are provided by equipment manufacturers and are also given in the instructions. Below it is evaluated application systems and their advantages and disadvantages, which must be taken into consideration in an NEBA.

6.4.1 Boat Treatment

a. Treatment with Diluted Dispersants

Even though it is recommended that dispersants, including concentrated third-generation chemicals, be applied in undiluted form, sometimes in practice solutions of dispersants (usually in concentrations of 10 to 30%) are used, especially for treating thin slicks and low-viscosity oils with a viscosity of less than 500 cSt. In this case one may use the boat's firefighting system and inject the dispersant into the boat's fire main. The angle of the monitor (tip) of the fire hose should be adjusted by the operator on the basis of the boat's speed and the wind so that the stream of dispersant will cover as wide a swath as possible. One disadvantage of this system is that it is impossible to adjust dispersant concentration. Special dispersant sprayer rigs (Fig. 6), consisting of two pumps (for the water and the dispersant), a mixer, and outboard booms with spray nozzles set as close as possible to the bow of the boat to counter the effect of breakers may also be used to apply a solution of dispersant in seawater. These rigs make it possible to adjust dispersant concentration during application.

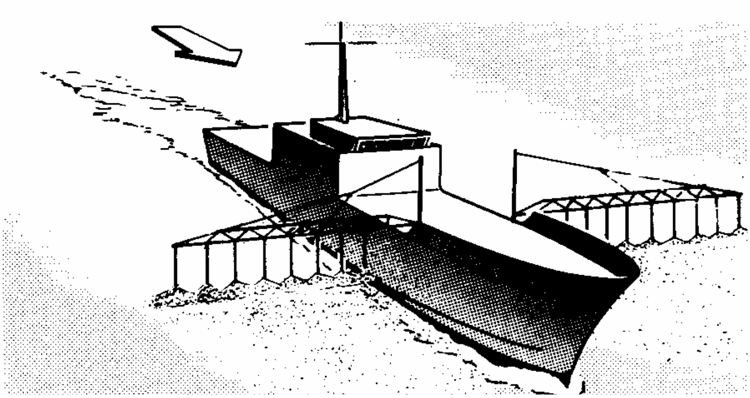


Figure 6. Dispersant application from ship
Source: CEDRE/IFP

b. Treatment with Undiluted Dispersants

Treatment involves the use of a rig similar to that described above, but without the water pump or with air replacing water. The wind has a considerable effect on the effectiveness of undiluted dispersants, which is why treatment should be carried out when the boat is traveling against the wind in order to counter wind effects. Boat speed is generally kept in the 4~8 knot (2~4 m/s) range, while the width of the treated swath does not exceed 30 meters (Fig. 7 and 8).

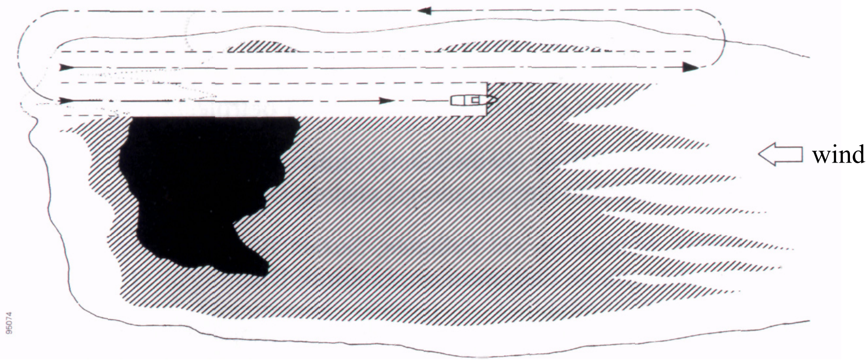


Figure 7
Source: Bocard, C. and F. Merlin (1987)

The advantage of boat application is the continuity of the process, because a boat can hold a one-day or more supply of dispersant, and moreover, the quality of treatment can be easily adjusted on board a boat. Usually less dispersant is consumed in boat treatment than in aerial treatment.

SPECIFIC CASE: Case where the oil has gathered in narrow crosswind strips: treat following the strips, but only with the downwind spraying equipment. See figure 8.

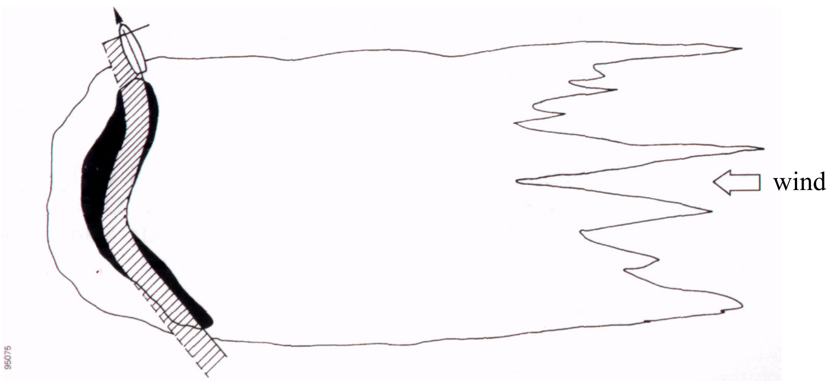


Figure 8

Source: Bocard, C. and F. Merlin (1987)

6.4.2 Aerial Treatment

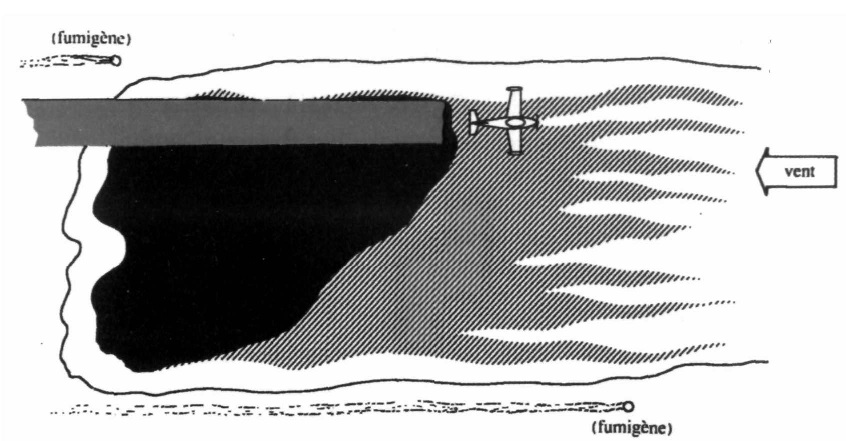


Figure 9

Source: Merlin, F. and C. Bocard (1989)

Aircraft are mainly used to apply dispersants in undiluted form, and crop duster equipment may be used for this purpose (Fig. 9). This equipment consists of a pump and calibrated nozzles. Treatment quality is highly dependent on flying conditions during the process. Treatment should be carried out with the wind at a minimal altitude and at speeds no greater than 300 km/hr. At higher speeds, the dispersant droplets are atomized very finely by the oncoming stream of air, and it is difficult to control their deposition on the surface of the slick because of the wash.

SPECIFIC CASE: If the oil is concentrated in a narrow strip across the wind: treat by small successive runs in the axis of the wind or, if applicable, treat cross-wind, taking into account the transverse drift of the dispersing agent. See figure 10.

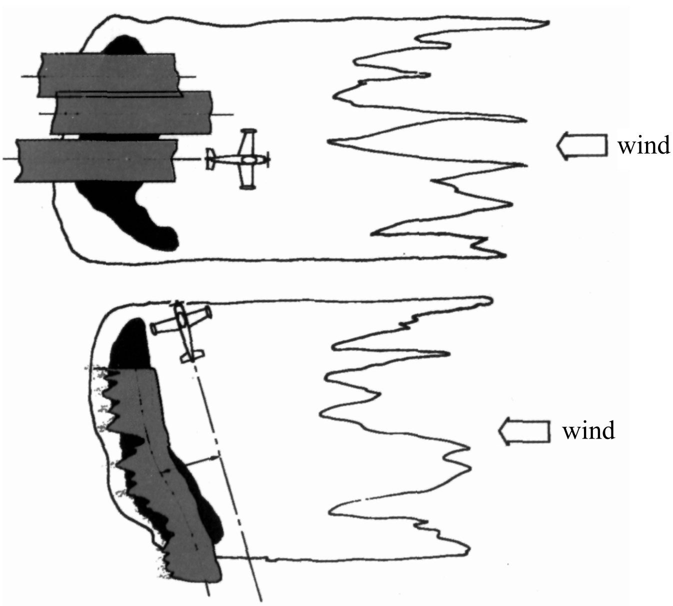


Figure 10

Source: Merlin, F. and C. Bocard (1989)

a. Helicopter application

Crop duster helicopters have attached chemical sprayer equipment that may be used to apply dispersants without any adjustment. The use of these helicopters is limited by distance to shore and payload capacity (300 to 860 kg), which is why helicopters can only be used in coastal areas near landing pads. Fuel and chemicals must be delivered to the landing pad in order to ensure adequate treatment capacity.

Helicopter capabilities may be expanded by using outboard sprayer rigs. These include a tank, nozzles, and a pump. In this case one may use transport helicopters with no restrictions in terms of distance from shore to the open sea and with a much greater payload (3 to 8 tons).

b. Treatment with Fixed- Wing Aircraft

Single-prop crop dusters may be used to spray dispersants without any equipment modifications. These aircraft do not require improved airfields and are highly maneuverable, but have a limited payload (1 ton) and range from shore. They may be used only in the littoral zone.

Dispersants may also be applied from specially equipped heavy transport planes. These aircraft can treat large polluted areas but require improved airfields.

Planes and helicopters can apply the calculated amount of dispersant (50 to 100 liters per hectare) over a 15 to 20 meter wide swath (helicopters and single-engine aircraft) and a 20~50 meter swath (transport planes).

One disadvantage of using aircraft in relation to boats is the impossibility of adjusting the dispersant dosage during the application process, which may lead to excessive dispersant consumption.

6.5 Strategic Recommendations for Dispersant Application

Usually an oil slick on water is of a variable thickness (see Section 2), and the dispersant dosage should be adjusted on this basis during the application process. When using boats to apply the dispersant, dispersant flow may be adjusted by adjusting the output of the proportioning pump, changing nozzles, or changing boat speed. When aircraft are used, dispersant dosages may only be adjusted by changing nozzles on the ground. It should be pointed out that using dispersants to treat thin rainbow-colored oil sheens, which do not pose a significant environmental threat, is not recommended. In order to achieve the maximum treatment effect, one should:

- start treatment from the edge of the slick and move towards the middle;
- apply the dispersant in parallel and continuous runs;
- spray dispersants from aircraft with the wind and from boats against the wind;
- when using aircraft, factor in the time it takes to prepare the aircraft and dispersant transport caused by wind action. Smoke canisters may be used to determine wind direction.

During treatment one must try to:

- avoid breaking up the slick into several smaller slicks, i.e. avoid applying the dispersant at the middle of the slick.

6.6 Tactic Recommendations for Dispersant Application

Dispersant treatment should be discontinued when black oil slicks disappear from the surface and/or instrumental monitoring indicates that additional treatment is not having any effect on the oil's concentration in water. In treating floating watery slicks spraying should not be discontinued abruptly, because more time and a bigger dispersant dose are needed to break up these emulsions.

For both aircraft and ships, a wind speed of up to 25 to 30 knots is probably an upper limit. Above these speeds the application becomes less efficient, as sprayed dispersant is blown away by the wind and because dispersant is applied onto vigorously breaking waves. Dispersant application operations must be targeted:

- dispersant should not be applied to oil sheen, and
- dispersant should be applied to the thick parts of the slick (dull gray to dark brown appearance).

A methodical procedure must be adopted. Dispersants should be applied with parallel and continuous runs to be certain that the entire slick has been treated. Both aircraft and ships need to be guided towards the thickest areas of the slick by a dedicated spotter aircraft-flying overhead.

In case of extensive pollution and the simultaneous use of several methods of dispersant application, the different operations must be coordinated:

- the target allocated to each application method should be determined in a way to optimize its use (e.g. helicopters, which have limited range, would be directed towards the near-shore area while large fixed-wing aircraft would logically be used for offshore operations);
- the spill area should be divided into zones, and each zone should be allocated to the different methods or group of methods of applying dispersants;
- if several methods are used for treating the same area, it is essential to have a spotter aircraft at the location.

It is important to treat the different parts of the slick in the correct chronological order:

- if sufficient dispersant and application methods are available to treat the entire quantity of oil, then the thickest parts of the slicks should be treated first;
- if dispersant and/or application means are inadequate, only part of the slick can be completely treated. If mechanical recovery is possible, the thinnest parts of the slick (which can represent large areas) should be treated with

dispersants and the thickest parts handled by mechanical recovery. Sheen, however, should not be treated.

When managing the operations, it must be kept in mind that dispersant should not be used simultaneously with other techniques (e.g. booming, recovery) on the same part of the slick.

In case of a continuous oil release the dispersant must be applied as close to the source as possible.

Before an extensive treatment operation, a test must be done to ensure that the treatment is effective.

Logistics for large spills

The quantity of dispersant to have at hand is 5 to 10% of the amount of oil to be treated (e.g. for a 10,000 t oil spill the amount of dispersant required is between 500 and 1,000 t). Supplying an adequate quantity of dispersant in a very short time to deal with a large spill can be a problem that must be included in the contingency plan.

Similarly, it is often difficult to get enough spraying platforms (aircraft, helicopters or vessels) to fully treat the spill at relatively short notice. Other general logistical requirements have to be considered, such as a spotter plane to direct the aircraft or x'essels towards the parts of the pollution to be treated. Large spray aircraft have specific logistical requirements, such as airfields with adequate runways and refueling facilities, which must be considered.

If the operation is subject to logistical limitations it is important to optimize the use of what is available.

6.7 Water and Weather Considerations in Dispersant Application

One should not use dispersants in confined areas of the sea with slow water exchange (bays, lagoons), in shallow waters less than 10 meters deed, or at ambient temperatures below +5°C. Some dispersants may emulsify spilled oil in an ice environment, but because oil degradation almost stops in the winter, dispersants should be applied in ice environments only after a painstaking NEBA. In the process one must keep the following considerations in mind:

- oil degrades very little;
- water emulsification in an oil slick, especially because of snow, is quite significant and dispersants may impede this process;
- the effectiveness of oil dispersal in water is much lower in an ice environment than in other seasons;

- dispersant-treated oil is very difficult to clean up with mechanical recovery equipment;
- the mixture of oil and dispersant sticks to marine mammal fur and bird feathers in much smaller amounts and can be easily rinsed off with water.

6.8 Monitoring the Effectiveness of Dispersant Application

The results of oil slick treatment and the effectiveness of dispersant action may be monitored both visually and instrumentally. Visual surveillance is effective during the daylight hours in treating oil slicks from aircraft, because easily spotted traces of dispersed oil in the form of brown or orange clouds form on the water's surface. But in certain cases, especially in boat treatment, visual surveillance may be difficult, and moreover certain oils, depending on the condition of the sea, will start to disperse in a few minutes or even tens of minutes after the dispersant is applied. That is why it is recommended constant instrumental monitoring of oil concentrations in the water column. These oil-in-water concentrations should be determined before and after dispersant treatment. Treatment results should be considered satisfactory if:

- orange or brown clouds of dispersed oil appear in the water;
- oil concentrations in the subsurface layer of water rise dramatically.

6.9 Monitoring environmental effects

Monitoring environmental effects is an important part of oil spill response. When dispersants are used, no monitoring is required additional to that needed for other oil spill response techniques.

Fish and mobile organisms will try to move away from the oil spill. Surface plankton may experience some additional mortality due to dispersant use but this is not significant since rapid recolonization occurs.

Following a spill, it may be necessary to prohibit fishing and collection of shellfish for consumption, regardless of whether dispersant was used or not. To determine when the fisheries should be re-opened after such a ban, the fish and shellfish should be monitored. The monitoring can be carried out by having people on "taste panels" and/or by conducting chemical analyses.

Appendix. Requirements to Physical and Chemical Properties of Dispersants

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 for dealing with oil on beaches in the UK. Mixtures of dispersants and hydrocarbon solvents (already used by the industry as industrial cleaners, degreasing agents for engines, and tank cleaning agents) proved their efficiency in emulsifying stranded or floating oil. These products were known to be highly toxic due to their aromatic solvent content. It was, however, thought that the high dilution capacity of the waters of the open sea would suffice to bring the concentrations down below the levels lethal for marine life.

The first extensive use of these early dispersants, in response to the *Torrey Canyon* oil spill off the English coast in March 1967, unfortunately demonstrated that their toxicity was much too high and that they had a devastating impact on the marine life which outweighed their efficiency as pollution clean-up agents.

Very soon after the *Torrey Canyon* accident, new formulations appeared on the market. These formulations were made up of less toxic surfactants and the toxic aromatic solvents were replaced by much less toxic (1,000 times) low-aromatic or non-aromatic hydrocarbons (e.g. low-aromatic kerosene or high-boiling solvents containing branched saturated hydrocarbons). Although their efficiency was lower than that of the first "detergents", their very low toxicity rendered their use, even on a large scale, environmentally acceptable. These new products became known as "second-generation" dispersants and are still in use today.

Dispersants of the "third" generation, often referred to as "concentrates", appeared by the mid seventies. These are mixtures of emulsifiers, wetting agents and oxygenated solvents. They are very much less toxic than the "second-generation" dispersants, and can be used either pre-diluted with seawater or neat. The introduction of concentrates, with higher concentrations of active components and less solvents, made it possible to use aircraft in spill response operations. Most of the products marketed today belong in this category.

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

Nomenclature of currently available dispersants

Dispersants can be classified either by their generation number or their type number, as shown in the table 1 below:

Table 1

STANDARD NAME	NAME BY GENERATION	NAME BY TYPE	MODE OF APPLICATION	TYPE OF SOLVENT
Concentrate dispersants	3rd	2	Diluted, from vessels	Oxygenates (e.g. glycol ethers) and non-aromatic hydrocarbons
		3	Undiluted (neat), from vessels and/ or aircraft	
Conventional dispersants	2nd	1	Undiluted (neat), from vessels	Non-aromatic hydrocarbons

It should be noted that the first-generation dispersants ("detergents") are no longer used today.

Composition of dispersants

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

- surface-active agents (surfactants), and
- solvents.

Surfactants are chemical compounds composed of molecules containing both hydrophilic and oleophilic groups. Those with predominantly oleophilic character tend to stabilize water-in-oil emulsions, while those with mainly hydrophilic character stabilize oil-in-water emulsions. The latter types are usually used in formulating dispersants. Surfactants are divided into four groups (anionic, cationic, non-ionic and amphoteric), but only non-ionic and anionic surfactants are used in modern dispersant formulations:

- Non-ionic *surfactants:* 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.

Two or more surfactants are often combined to improve the performance of the final product.

Solvents may be divided into three main groups: (1) water, (2) water-miscible hydroxy compounds, and (3) 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.

A number of dispersants in use today are marketed as biodegrading dispersants. These are formulated with the addition of nutrients (nitrogen, phosphorus) which promote the natural biodegradation processes by microorganisms present in seawater.

Modern dispersants have the following general composition:

- ***Conventional (second-generation) dispersants:***
  - 10 to 25% surfactant,
  - hydrocarbon solvent;
- ***Concentrate (third-generation) dispersants:***
  - 25 to 60% surfactant,
  - polar organic solvent or mixed with hydrocarbon solvent.

Dispersants were first used to clean up the oil spill from the tanker *Torrey Canyon* in 1967. These dispersants contained highly toxic aromatic solvents. As a result, the environmental damage caused by these chemicals was quite significant.

Soon after the *Torrey Canyon* accident, specially designed second-generation dispersants came onto the market. They contained low-aromatic solvents or branched aliphatic hydrocarbons that were 1,000 times less toxic than the first generation dispersants. These dispersants are still being used in certain countries.

The mid-70s witnessed the appearance of new "third-generation" dispersants, which contained more surfactants and oxygen-containing solvents (alcohols, glycols). They may also contain substances that promote the growth of oil-oxidizing bacteria in water. This has made them much more effective and less toxic. Third-generation dispersants are sometimes called concentrated dispersants.

Second-generation dispersants may only be used in undiluted form, while third-generation dispersants may be mixed with water or used in pure form. Dispersants may also be classified by type (Table 1).

Facts about dispersant

The amount of dispersants applied to an oil slick will depend on the dispersant-oil ratio recommended by the manufacturer or may be determined experimentally. Experience has shown that, notwithstanding manufacturers' recommendations, the dispersant-oil ratio for concentrated dispersants varies from 5 to 10% for oils with a viscosity of up to 1,000 cSt and 10-15% for oils with a viscosity of 1,000 to 2,000 cSt. Regular dispersants are mainly used in amounts as high as 30 to 50% for low-viscosity oils and up to 100% for high viscosity oils.

1. Most modern dispersants are relatively non-toxic and are less toxic than the oils they disperse.
2. Dispersing oil where there is sufficient water for dilution has never shown toxic effects on marine or benthic biota.
3. Toxic effects of using dispersant could be evidenced where there is little dilution potential, as in shallow bays or over shallow coral reefs.
4. Dispersants will generally remove a certain percentage or portion of an oil from the sea surface if the particular dispersant is "compatible" or effective with the oil type/composition, etc.
5. The percentage of oil removed depends on oil and dispersant composition and on sea energy.
6. Many oils will disperse naturally in higher seas. Dispersants serve to enhance this process.
7. Heavier oils generally disperse poorly. This is oil-composition-dependent.
8. Due to weathering processes, the time window for effective dispersion can be short, often one to two days.
9. Dispersants function by assisting oil break-up into small droplets which behave as if neutrally buoyant in the water column.
10. Dispersant effectiveness is also dependent on proper application. This is achieved by applying an optimal droplet size on the thicker portion of the oil slick.

Table 2 contains the requirements to the dispersants in the NOWPAP countries. It can be seen that they are rather similar in different NOWPAP countries.

Table 2. Requirements to the dispersants

China's Standard of Dispersants

Item		Specifications
Appearance		Clear, without layers
Flash point in open cup (℃)		> 70
Viscosity at 30℃ (mm^2/s)		< 50
Effectiveness (%)	10 min	> 20
	30 s	> 60
Biodegradable BOD_5/COD (%)		> 30
Acute Toxicity fish Gobiidae		3000 ppm MLC > 24h

Japan requirements to oil dispersants

Item		Approval criterions
Flash point ℃		More than 61
Viscosity (cSt) 30 ℃		50 or less
Emulsification rate	After 30 secs.	60 or more
	After 10 secs.	20 or more
Biodegradability (%)		90 or more
Biological toxicity	Skeltonema costatum (ppm)	100 or more
	Himedaka (LD50< ppm)	3000 or more

Korean Requirements to oil spill dispersants

Flash Point ℃ : more than 61
Biodegradability % : more than 90
Toxicity : Sceletomena costatums - 1 week at concentration 100 ppm,
Orizias latipes $LC_{24}50 > 4000$ ppm
Brine Shrimp Artemia $LC_{24}50 > 4000$ ppm
Rock Fish $LC_{24}50 > 2000$ ppm
Viscosity, set at 40 ℃ : Less 30 cSt

Russian Requirements to oil spill dispersants

Item		Ministry of Nature resources approval criterions
Flash point ℃		> 61
Viscosity (cSt) 30℃		< 50
Emulsification rate	After 30 secs.	> 60
	After 10 secs.	> 20
Biodegradability (%)		> 90
Toxicity, limit allowed concentration (LAC) mg/l		< 0,005

Blank

Guideline for the Use of Dispersants