GUIDELINES FOR PREPARATION OF OIL SPILL RESPONSE CONTINGENCY PLAN

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Prepared by

FUNCTIONAL COMMITTEE ON FORMULATION OF GUIDELINES FOR GUIDELINES FOR PREPARATION OF OIL SPILL RESPONSE CONTINGENCY PLAN

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Preamble

Indian petroleum industry is the energy lifeline of the nation and its continuous performance is essential for sovereignty and prosperity of the country. As the industry essentially deals with inherently inflammable substances throughout its value chain – upstream, midstream and downstream – Safety is of paramount importance to this industry as only safe performance at all times can ensure optimum ROI of these national assets and resources including sustainability.

While statutory organizations were in place all along to oversee safety aspects of Indian petroleum industry, Oil Industry Safety Directorate (OISD) was set up in 1986 Ministry of Petroleum and Natural Gas, Government of India as a knowledge centre for formulation of constantly updated world-scale standards for design, layout and operation of various equipment, facility and activities involved in this industry. Moreover, OISD was also given responsibility of monitoring implementation status of these standards through safety audits.

In more than 25 years of its existence, OISD has developed a rigorous, multi-layer, iterative and participative process of development of standards – starting with research by in-house experts and iterating through seeking & validating inputs from all stake-holders – operators, designers, national level knowledge authorities and public at large – with a feedback loop of constant updation based on ground level experience obtained through audits, incident analysis and environment scanning.

The participative process followed in standard formulation has resulted in excellent level of compliance by the industry culminating in a safer environment in the industry. OISD – except in the Upstream Petroleum Sector – is still a regulatory (and not a statutory) body but that has not affected implementation of the OISD standards. It also goes to prove the old adage that self-regulation is the best regulation. The quality and relevance of OISD standards had been further endorsed by their adoption in various statutory rules of the land.

Petroleum industry in India is significantly globalized at present in terms of technology content requiring its operation to keep pace with the relevant world scale standards & practices. This matches the OISD philosophy of continuous improvement keeping pace with the global developments in its target environment. To this end, OISD keeps track of changes through participation as member in large number of International and national level Knowledge Organizations – both in the field of standard development and implementation & monitoring in addition to updation of internal knowledge base through continuous research and application surveillance, thereby ensuring that this OISD Standard, along with all other extant ones, remains relevant, updated and effective on a real time basis in the applicable areas.

Together we strive to achieve NIL incidents in the entire Hydrocarbon Value Chain. This, besides other issues, calls for total engagement from all levels of the stake holder organizations, which we, at OISD, fervently look forward to.

Jai Hind!!!

Executive Director
Oil Industry Safety Directorate
FOREWORD

Oil industry in India is more than 100 years old handling variety of hydrocarbon material, natural gas, crude oil and petroleum products. With the technological advances and need for transportation of bulk energy carrier and natural gas Over the years a variety of practices have been in vogue because of collaboration/association with different foreign companies and governments. Standardisation in design, operating and maintenance practices was hardly in existence at a national level. This lack of uniformity, coupled with feedback from some serious accidents that occurred in the recent past in India and abroad, emphasised the need for the industry to review the existing state of art in designing, operating and maintaining oil and gas installations.

With this in view, the Ministry of Petroleum & Natural Gas in 1986 constituted a Safety Council assisted by the Oil Industry Safety Directorate (OISD) staffed from within the industry in formulating and implementing a series of self-regulatory measures aimed at removing obsolescence, standardising and upgrading the existing standards to ensure safer operations. Accordingly, the principal panelists of OISD were requested to nominate the experienced persons in line for the above functional committee. OISD had constituted the functional committee of expert persons and finalized this draft of guidelines in several periodic meetings and discussions, based on the background note. Further, OISD being nodal agency as nominated by the Ministry of Petroleum & Natural Gas for the purpose of monitoring of setting up of oil spill response facilities in the industry, has taken a task of formulation of Guidelines on Preparation of Oil Spill Response Contingency Plan in view to bring the uniformity in the preparation of Oil spill contingency plan among the oil companies. This would help industry members to formulate compatible contingency plans. Beside, this would also enhance the preparedness at the planning stage and I set the systems to manage the oil spill eventualities in effective manner.

The document is divided in two parts i.e. Part I - Guidelines & Part II – Background notes for reference. Part –I contains six chapters namely Introduction, Perceived Risks, Response strategy, Response planning, Mobilisation of resources and Data Directory, Part –II contains 12 sections.

This document was prepared based on the accumulated knowledge and experience of industry members and the various national and international codes and practices. It is expected that these Guidelines on Preparation of Oil Spill Response Contingency Plan would be beneficial to user industry.

This document will be reviewed periodically for improvements based on the new experiences and better understanding. However adequate care has been taken in preparing the guidelines in line with national / international guidelines.

Suggestions from industry members may be addressed to:

Member Coordinator
Committee on Formulation of Guidelines for Conducting Environmental Audit in Upstream Petroleum Sector (Onland)

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These documents are intended to supplement rather than replace the prevailing statutory requirements.

Note 1 in superscript indicates the changes / modifications / additions as approved in 20th Safety Council Meeting held in October 2002.
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OBJECTIVES

- To bring uniformity among contingency plans of various petroleum companies
- To provide oil spill response preparedness system in line with national and international trend
- To develop a document which can guide the companies to combat oil spill incident effectively.
- To serve as a tool for developing and placing oil spill response equipment and methodologies in place
1.0 Introduction

Every contingency plan should consider basic facts like prevailing risk of an oil spill with its possible size, maximum rate of the discharge of oil if spilled from well, tanker size (which usually passed through the area) along with likely reason for collision (between a tanker and another vessel) etc. including weather conditions. These would be essential in setting the target for oil spill response.

The next point to be considered is necessity of oil cleaning, involved risk and likely extent of damage in the event of non-mobilization of resources. It has been also observed that there is much merit in doing nothing to the oil and leaving it to the nature to remove. Further, while dealing with the shore clean up problem in particular, it is essential that local advice is taken from scientists who are concerned with the wild life. Sensitive area map must be prepared. Having marked these areas, a clean up strategy can be developed. Some areas may have to be cleaned immediately, whatever the time of the year. Other areas perhaps should never be. Finally, the equipment required to fulfill the requirements of oil spill response is to be determined. This may be divided into equipment to keep the oil away from the shore, equipment to disperse the oil at sea before it reaches the coast, equipment to contain and pick up the oil and then, when the oil comes to the beach, earth moving equipment to remove dirty beach material, oil pick up equipment, hand held and other types of dispersant equipment, pumps, sea water hoses etc. Stocks of expendable material must be purchased and stored. All these preparations, discussions and the drawing up of plan must be done before the oil arrives.

The proposed guidelines has been developed having in mind the elements discussed as above. The guidelines are site-specific, installation and operational facilities-specific and various sources of oil spill have been considered for the preparedness. The behavior of all kinds of oil has been considered from its characteristic point of view vis a vis prevailing environmental conditions.

2. Scope

- The guidelines are for Petroleum organisations of upstream and downstream sector i.e. the organisations which are handling offshore oil & gas production, transportation by tanker, subsurface pipeline or any other means.
- Applicability of these guidelines are to only spilled oil at the marine surface or at coastal sites, harbors, beaches, marine life, fish breeding areas, national marine parks and large canal and river system from where oil is transported.
- In-addition import of crude for refining purpose by different size of tankers by the refineries.

It is envisaged from the operators of all Petroleum organisations that the Oil Spill Contingency Plans are developed in line with these guidelines in a systematic and uniform pattern.

3. Definitions

3.1 Amenity Beaches: Potential tourist/recreational beaches.

3.2 Arial Survey: Assessment of extent of oil pollution by using air craft/helicopter.
3.3 Boom: Artificial barrier designed to contain the oil on water surface.

3.4 Bio-degradation: Breaking down of oil or oil waste by using biological processes.

3.5 Crude oil: Complex mixture of hydrocarbons of varying molecular weight and structure.

3.6 Clean-up chemicals: The chemicals that may be used in cleaning of oil from the various type of beaches & surface.

3.7 Dispersants: A blend of surfactants which consist of emulsifier, wetting agents and a solvent system. It is designed to emulsify the oil into the water column in the form of oil droplets small enough to remain below the surface and not reform as slick.

3.8 Contingency Plan: Behaviorally or scientifically designed approach of decision making predicated on an event that is possible but uncertain occurrence and the determination in advance of the optimum course of action with established goals.

3.9 Evaporation: Release of Lighter volatile fractions from spilled oil under the influence of prevailing wind, temperature and other meteorological parameters.

3.10 Emulsification: Oil spilled on water surface form either micelles oil-in-water (o/w) emulsion or water-in-oil (w/o) emulsions under the influence of wind energy, sea, temperature etc. Micelles are colloidal aggregates of the oil suspended in the aqueous phase. The w/o emulsion is known as mousse.

3.11 Incineration: Process of burning the oil or oily waste under the controlled condition.

3.11.1 Infrared Line Scanning: Techniques used for assessment of oil pollution on water surface, which gives some information on thickness.

3.12 Land filling: Burial of oil and oily wastes and then covered with top soil, seeded and forgotten.

3.13 Mangrove: A type of vegetation that survive in the inter-tidal zone in the coastal regions.

3.14 Mud Flats: Area usually covered at every tide and normally consist of mud.

3.15 Mutual Aid System: Arrangement among the local / regional operators for sharing of oil spill and current data.

3.16 Oil Spill Tracking: Rough assessment of oil slicks movement by using prevailing wind and current data.

3.17 Oil Spill Mapping: Tracing of oil slick shape during aerial survey.

3.18 On-scene commander: Person responsible for the implementation, effectiveness and cost of entire oil spill clean-up operation. Has complete authority over clean-up personnel at the site of the spill.

3.19 Petroleum product (POL): Products derived from refining of crude oil.

3.20 Protective Equipment: Set of equipment used for protecting the sensitive location from oil pollution.

3.21 Response Equipment: Equipment used in responding to oil spills at sea which including equipment for containment and recovery.

3.22 Skimmer: Type of floating pumps used to collect oil as on the surface of water.

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3.23 **Sensitivity Map:** Drawings indicating the sensitiveness of coastal location to oil with ranking depending upon the vulnerability of the resources at risk.

3.24 **Salt March:** Area of grass and needs, which are covered only occasionally by high tides.

3.25 **Sedimentation:** Sinking of oil in the water column.

3.26 **Tier – 1** is concerned with preparedness and response to a small spill within the capabilities of an individual facility or harbour authority. Seven hundred tons is often cited as the upper limit of tier 1; however, the circumstances of the spill and the surrounding environment will determine the actual level of response.\(^{\text{Note 1}}\)

3.27 **Tier – 2** is concerned with preparedness and response to a spill that requires the co-ordination of more than one source of equipment and personnel. For a tier 2 response, assistance can come from a number of entities within their respective operational area or from sources outside the immediate geographic area. Tier – 2 describes a wide range of spill sizes and potential scenarios comprising of either national capability and area capability.\(^{\text{Note 1}}\)

3.28 **Tier – 3** is concerned with a major spill requiring the mobilization of all available national resources and depending upon the circumstances, will likely involve mobilization of regional and international systems.\(^{\text{Note 1}}\)

3.29 **Ultra-violet Line Scanning:** Techniques used for assessment of oil pollution on water, which estimate the area of the spill by using reflection of UV radiation by the oil. It also define the pollution as hydrocarbon or otherwise.

4. **PERCEIVED RISKS**

Operator shall perceive the risk of the oil spill from their operating facilities considering likely sources of spill, expected quantity and its impact on the environment. A contingency plan shall include following elements while describing perceived risks:

4.1 **Sources and expected quantity of oil Spill**

4.1.1 Pipelines, Hoses and Arms Leakage / Rupture

\(^{\text{Note 1}}\)
Riser Failure

- Sub Sea Portion
- Splash Zone Portion

Flow Line / Hoses / Arms

- Partial Rupture
- Total Rupture

Main oil Line

- Partial Rupture
- Total Rupture
- Total rupture

4.1.2 Blow Out

Different phases of drilling viz. Exploratory drilling, Developmental drilling, and Producing well should be assessed separately and included in plan.

4.1.3. Leakage From Couplings / Joints / Valves

Spillage due to likely leak from following sources should be considered.

- Hose Joints
- Valves and Blinds
- Swivel Joints
- Flange Joints

4.1.4. Tanker Grounding / Collision / System Failure

Spill depends on the size and the extent of damage to the ship

The plan should describe the size of tanker/ barge involved in the transportation. The incident should be assessed for the scenarios given here.

5. Over Flow From Tanker / Barge

Depends on pumping rate and period of overflow
6. **Others**

- Escape of oil from nearby installations through storm drains,
- Escape of oil along with treated effluent water,
- Seepage from on shore collection / storage facilities
- Overflow from jetty slop tank / collection trays / on shore tanks.

The quantity of spill from the various sources under different scenarios shall be indicated, in the plan.

6.1 **Characteristic and behavior of oil**

The plan shall indicate characteristics of oil being handled by the operator and its behavior (weathering process) on spill under various environmental scenarios. Plan shall have information on density, pour point, viscosity, asphaltene content and flash point.

6.1.1 **Probable movement of oil slick**

Operator shall indicate the probable movement of oil slick, resulting from various sources, under different sea and atmospheric conditions during various seasons/periods of the year.

6.1.2 **Facilities/Resources at Risk**

The operator shall identify in the plan, the facilities/resources of Commercial, Social, Ecological and Recreational value, around its installations, which are likely to be affected in the event of spill. Sensitivity of facilities/resources shall be ranked for deciding protection priorities, in consideration of prevailing legislation and directives of the regulatory authority on the subject. Sensitivity maps need to prepared and required to mentioned in the plan.

7. **RESPONSE STRATEGY**

The operator shall develop and indicate the strategies for prevention and control of oil spill in contingency plan. The preventive strategies shall include the identification of system both pre & post commissioning of operating facilities. The plan shall also incorporate strategies for Control of oil spill in sheltered water, Tidal port, High seas and beach cleaning etc., for TIER I, II & III spills in accordance with NOS-DCP.

7.1 **Response organization:** Operator shall define the response organisation for TIER I, II & III spills which shall include emergency organogram, roles and responsibilities etc.,

7.2 **Manpower & Training:** Operator shall constitute emergency response team for managing the coordination centre and response operations. The training needs of team members shall be identified and programme to be developed for continuous up-gradation of skill. Mock Drill with frequency shall to be mentioned.

7.3 **Equipment identification:** The Operator shall identify the equipment requirement for assessment, monitoring, response, containment recovery and logistic support etc. in line with strategies developed. The details of stockpile of equipment, quantity and locations are to be included in the plan.

7.4 **Response Techniques :** The operator shall develop criteria for the selection of suitable technique for Surveillance / Monitoring, containment & Recovery, storage & disposal and Protection of sensitive areas etc.

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8. RESPONSE PLANNING

8.1 Reporting oil spill incident:
Immediately upon notice of oil spill, “Incident Reporting” shall be done in the prescribed format to the following:

a. Internal within Organisation
b. Oil Industry Safety Directorate
c. Directorate General of Hydrocarbon (DGH) in case of private/JVC operators
d. Indian Coast Guard
e. Concerned Port Authorities
f. Mutual Aid partners

The typical Format as prescribed in NOS-DCP is appended at ANNEXURE - 1

Subsequently the operator shall undertake detail investigation and assessment of oil spill scenario and report as prescribed in NOS – DCP.

8.2 Assessment and monitoring
Immediately after the spill, assessment of quantity of spilled oil shall be carried out observing any one or more of various methods available like

a. Visual observation
b. Arial surveys
c. Use of imaging techniques
d. Oil spill mapping

The procedure for mobilizing resources for initial assessment survey and roles & responsibilities of concern persons shall be defined in the plan.

8.3 Prediction of movement of oil spill
The operator shall predict the movement of oil slick by using meteorological data like wind velocity, water current, atmospheric and water temperature, tide etc., The plan shall contain details on sources for collection of the data.

8.4 Notifying response and base team members
Once the spill is reported, the members of Response and Base Team shall be notified and Base Control Room shall be established by the concerned Operator. Contact numbers of control rooms to be reported to all concerned for effective co-ordination.

8.5 On-scene Co-ordinator
The Operator shall identify On-scene Coordinator (senior level executive trained in oil spill management) immediately after reporting of spill. The plan shall describe roles and responsibilities of On-scene Coordinator.

8.6 Development of Site Specific Response Plan
After initial assessment report is received, Site Specific Response strategies shall be developed by On-scene Coordinator (OSC). He shall identify the facilities required and the sources from where these facilities are to be mobilized.

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The strategies shall include:

a. Immediate Response Plan  
b. Long Term Response Plan

8.6.1 Immediate Response Plan

The Plan shall include control of spill at source, keeping the pollution confined near to the source and use of dispersant. The Plan shall primarily highlight whether response is at all necessary.

8.6.2 Long Term Response Plan

The Plan includes containment, mechanical recovery, choice of equipment to be deployed, storage and disposal of recovered oil and protection of sensitive locations.

8.7 Selection and quantification of Response Equipment

The plan shall describe the procedure for selection of site specific equipment including factors like availability of equipment, resource personnel and condition of spilled oil.

8.8 Logistics and Manpower Planning

Contingency plan shall clearly identify the sources of logistic support such as vehicles, trucks, boats, cranes, forklifts and skilled/un-skilled manpower etc. The quantity of available resources and lead time for mobilization of these resources from various sources shall be indicated in the plan. The Contact numbers and addresses of suppliers shall be included in the data directory.

Training needs of resource personnel to be identified and people to be trained periodically. Local societies of fisherman can be good source manpower. The contact details of such societies shall be included in the data directory. Plan shall also include procedure for conducting drills and exercises for these persons.

8.9 Arrangement of Basic Facilities

The potential sources of facilities like food, accommodation, drinking water, emergency lights, medical help and security shall be identified and procedure for mobilization including roles and responsibilities shall be defined in the plan.

8.10 Cleaning Operations

The plan shall identify and define the procedures for various cleaning operations like containment and Recovery, dispersant application, shore cleaning, storage & disposal.

The possible treatment process for the different type of beaches viz., Sandy Mud flats, rocky, Mangrove etc., Their equipment and other facilities requirements shall be identified and included in the plan. The clean up processes may require assistance of local people, environmentalists, marine biologist etc in order to ascertain the sensitivity of affected beaches. The plan shall include references of all resource agencies who may be of any help in the clean up operations. Contingency plan shall have details of disposal of oil along with reporting methods disposed oil to coast Guard/SPCP etc. agencies.

8.10.1 Protection of sensitive locations

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The sensitive locations around the potential sources of oil spill shall be identified in the plan and shall be ranked according to the sensitivity for deciding the protection priority. The equipment required for the protection of different locations, methodology of deployment of these equipment and their sources shall be described in the plan.

8.10.2 Termination of clean up operations

The criteria for assessment of satisfactory completion of the clean up operation, whether at sea or shore, shall be developed. The checklist required for assessment and the procedure, roles and responsibilities for termination of clean up and other related operations shall be described in the plan.

8.10.3 Media management

The release of information to various concern agencies is essential during oil spill emergencies. The plan shall describe the procedure, roles and responsibility for release of information to press and other concern agencies.

9. MOBILISATION OF RESOURCES

The plan shall spell out the procedure for the mobilisation of resources, in the least possible time (within the elapsed time), at the site of spill.

9.1 Surveillance and monitoring equipment

The equipment and trained manpower required for initial assessment survey shall be identified and the procedure for its mobilisation shall be defined in the plan. The contact numbers and address of the resource personnel shall be indicated in the Data Directory.

9.2 Logistic Support

The plan shall identify resource agencies for the supply of logistic support, with details of equipments available and contact numbers, addresses etc.

9.3 Response equipment

- The plan shall contain details of the equipment (type, quantity & location), stock pile / pre-staging site, mobilisation & deployment procedure.
- The procedure to activate the mutual aid system, available in the region, shall be included in the plan.
- The contact details of suppliers of equipment and chemical shall be included in the plan.

9.4 Laboratory / testing facilities

The plan shall contain the details of laboratory facilities for testing spilled oil, Oil spill dispersant (OSD) and other chemicals.

9.5 Assistance of technical institution

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The plan shall identify the procedure, contact details for mobilising the assistance of environmentalists, Oceanographers, meteorologists, marine scientists and local resource personnel.

The plan shall include the details of available national & international resource agencies.

9.6 Police and local administration

The contact details of concerned government agencies like electricity, water, security etc. shall be included in the plan and the procedure including the roles and responsibility for mobilisation of such assistance to be described in the plan.

10. DATA DIRECTORY

10.1 GENERAL INFORMATION

The plan shall include details of the coastal facilities, access roads, relevant telephone numbers (fire, police, Local administration, port authorities, coast guard, neighboring companies, state and central pollution control board, OISD and other concerned govt. agencies etc.), shore line characteristics, oil spill disposal sites etc.

10.2 TECHNICAL INFORMATION

The plans shall include the details of installations, type of oil handled and their characteristics, sea & weather conditions, meteorological and oceanographic data. The plan shall also include details (address, contact number and area of expertise) of the experts on environment, marine science, oceanography and meteorology.

10.3 CHEMICALS, EQUIPMENT & SUPPLIER

The plan shall include the details of the chemicals, equipment (type, quantity & location) and the contact address & number of suppliers.

The plan shall also include the details of national, international resource agencies including the mutual aid agreements.

10.4 MANPOWER & LOGISTICS SUPPORT

The plan shall include the details of suppliers’ of skilled & unskilled manpower & logistics facilities, including their contact address, phone numbers.

10.5 MAPS & DRAWINGS

The plan also shall contain the maps indicating the details of of coastal areas, roads, environmental sensitive areas and waste storage & disposal sites. Flowcharts of operating facilities, pollution control equipments and firefighting facilities shall be attached to the plan. The plan also shall contain coastal charts, current & tidal range charts and prevailing wind rose diagrams. Sensitivity maps need to prepared and required to mentioned in the plan.

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Annexure – 1 & 2

CHARACTERISTICS OF OIL

The key characteristics which determine the fate of spilt oil are given here. Contingency plan must have ready data for various types of oils which are handled or likely to be handled at a location.

Specific Gravity

It can provide clue about the broad class of oil (light, middle, heavy etc.) though not always. As a fundamental property it indicates whether the oil will float or sink if spilled over water.

Pour Point

It is the temperature at which oil ceases to flow or pour. Oils having pour point higher than ambient sea temperature will solidify when spilled.

Viscosity

It is a measure of resistance to flow and is directly related to temperature. High viscosity oil present special problems during recovery and transfer to storage. Viscosity also dictates the spread of oil.

Asphaltene Content

Oil with Asphaltene content higher than 0.5% exhibit tendency to form oil-water emulsions. Rate of formation of emulsion depends on type of oil, temperature and sea conditions. Emulsion formation increases volume and viscosity thereby leading to problems in recovering, storage and handling of oil.

Flash Point

The lowest temperature at which a combustible liquid gives off sufficient vapor to form a vapor mixture with air near the surface of liquid. This is property gives an indication about fire hazards.

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CLIMATIC AND SEA CONDITIONS THAT EFFECT THE BEHAVIOR OF OIL SPILL

Temperature : Max. / Min. and seasonal averages
Humidity : Max. / Min. and seasonal averages
Wind velocity : Month wise wind rose during normal conditions.
Velocity during cyclonic weather
Rain - fall : Max. / Min. and seasonal averages
Wave height : Max. / Min. and seasonal averages
Barometric Pressure : Max. / Min. /Av.
Surface Current Velocity :
Tide Patterns : Highest and Lowest Recorded
Mean Water Spring : Low and High
Mean Water Neap : Low and High
Sp. Gr. of water gm. / cc :
Annexure 4

SPREADING OF OIL SPILL

The main driving force behind the initial spreading of oil is its weight. A large instantaneous spill will therefore spread more quickly than a slow discharge. This gravity assisted spreading is quickly replaced by surface tension effects. During these early stages, the oil spreads as a coherent slick and the viscosity of the oil also influence the rate of spreading. The high viscosity oil spreads slowly and those spilled at temperatures below their pour point, hardly spread at all. After a few hours the slick begin to break up and form narrow bands or windrows parallel to the wind direction. At this stage, the fluidity of oil becomes less important, since further spreading is primarily due to turbulence at sea condition such as currents, tidal streams and wind speeds. About twelve hours after the occurrence of spill, the oil can be scattered within an area of up to 5 square kilometers, thus limiting the possibility of effective clean up at sea. The maximum oil spill radius with respect to time be determined and data shell be presented in the following manner:

<table>
<thead>
<tr>
<th>Magnitude of Oil Spill (tonne)</th>
<th>Time Interval (hrs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6  12  24  48  72  96  120  144</td>
</tr>
<tr>
<td>Diameter (km.)</td>
<td></td>
</tr>
</tbody>
</table>
Annexure 5.

NATURAL PROCESS AND THEIR IMPACT ON OIL SPILL

Early Weathering Processes That Change Oil Properties

Evaporation

The rate and extent of evaporation is determined primarily by the volatility of the oil. The greater the proportions of components with low boiling points, the greater the evaporation. The initial spreading rate of the oil also affects evaporation since the larger the surface area, the faster the light components will evaporate. Rough seas, high wind speeds and warm temperatures will further increase the rate of evaporation. In broad terms, those oil components with a boiling point below 200°C will evaporate within a period of 24 hours in temperate conditions. Spills of refined products, such as kerosene and gasoline, may evaporate completely within a few hours and light crude can lose up to 40% during the first day. In contrast, heavy crudes and fuel oils undergo little, if any, evaporation. When extremely volatile oils are spilled in confined areas, there may be a risk of fire and explosion. The flammability of oil has often led to the idea of burning slicks on the sea surface. The residues remaining after partial combustion are usually more troublesome and difficult to deal with than naturally weathered oil.

Dispersion

Waves and turbulence at the sea surface act on the slick to produce oil droplets with a range of sizes. Small droplets remain in suspension while the larger ones rise back to the surface. Droplets small enough to remain in suspension become mixed into the water column and the increased surface area presented by this dispersed oil can enhance other processes such as biodegradation and sedimentation. The rate of natural dispersion is largely dependent upon the nature of oil and the Sea State, proceeding most quickly in the presence of breaking waves. Slick thickness, which is related to the amount spilled and the degree of spreading, is an important factor in the rate of dispersion since smaller droplets are produced from thin films. Oils which remain fluid and can spread unhindered by other weathering processes may disperse completely in moderate sea conditions within a few days. Conversely, viscous oils or those, which form stable water-in-oil emulsions, tend to from thick lenses on the water surface, and will show little tendency to disperse. Such oils can persist for several weeks.

Dissolution

Light components of oil are soluble in water in a process called dissolution. The rate of dissolution depends on the oil's chemical composition and the surface area of oil and water. Only a few components in oil are soluble in water, so dissolution involves only a small fraction of oil.

Emulsification

Many oils tend to absorb water to form water-in-oil emulsions which can increase the volume of pollutant by a factor of between three and four. Such emulsions are often extremely viscous and so the processes which would dissipate the oil are retarded. This is main reason for the persistence of light and medium crude oils on the sea surface. Emulsions may separate out into oil and water again if heated by sunlight under calm conditions or when stranded on

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shoreslines. The rate at which emulsification takes place is primarily a function of sea state although viscous oils tend to absorb water more slowly.

**Long Term Weathering Processes**

**Biodegradation**

The rate of biodegradation depends on the water temperature and the nutrient level. Long term, biodegradation is the dominant weathering action on an oil spill. The hydrocarbons and other compounds found in crude oil are naturally occurring materials and represent a potential energy source for over 90 species of naturally occurring bacteria. When bacteria consume oil, they convert it into more soluble, oxidized products and eventually to carbon dioxide and water.

**Oxidation**

Oxidation occurs when radiation (particularly ultraviolet rays) interact with oil and change its chemical characteristics. Usually, the resulting compounds are more soluble in water. For most spill situations, the amount of oxidized compounds is very small and dissolution of these compounds will reduce the volume of oil spilled only slightly.

**Sedimentation**

Sedimentation is the process by which particles of floating oil sink to the bottom of the water. When first spilled, most oils are lighter than water and float to the surface. As the oil weathers and the light compounds evaporate, it becomes heavier and begins to sink. Once in the water column, the oil droplets collide with and adhere to particulate matter - such as sand, clay and inorganic material - and become part of the bottom sediments.
PREDICTION OF OIL SLICK MOVEMENT

More complicated calculations are required when currents and winds are variable over time and distance, particularly in shallow coastal areas. Detailed hydrographic information may be required to describe the current movements and computer models may provide faster and more accurate prediction of the slick movement. However, an approximate prediction of slick movement is also possible by using vector diagram. The details of slick movement prediction are given below:

IMPACT OF WIND (3%)

MOVEMENT OF OIL SLICK

IMPACT OF OCEAN CURRENT (100%)

Reliability of prediction of slick movement depends on realistic data on ocean current and wind velocity. The information so collected to be recorded in the manner given here.

<table>
<thead>
<tr>
<th>Month</th>
<th>Possibility of spill reaching coast</th>
<th>Time lapse (hrs.)</th>
<th>Probable Location</th>
<th>Affected length of shore line (In km.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annexure 7

AREAS OF SPECIAL VALUES AND SENSITIVITY

Different types of shorelines are affected in different ways by stranded oil and therefore, require different clean-up strategies. Detailed coastal maps are needed for all areas covered by the plan.

Sensitivity mapping must be carried out for areas at risk of oil pollution. For this purpose type of shoreline likely to be affected and areas of commercial, social, ecological and recreational values must be known to devise an effective spill management strategies.

<table>
<thead>
<tr>
<th>Commercial</th>
<th>Social</th>
<th>Ecological</th>
<th>Recreational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea water intake</td>
<td>Water use by Settlements on shore / along back water</td>
<td>Coral reef</td>
<td>Tourist areas</td>
</tr>
<tr>
<td>shipyards and ports</td>
<td>Places of social importance such as shrines etc.</td>
<td>Swamps/marshes / Forests</td>
<td>Bathing beaches</td>
</tr>
<tr>
<td>Fishing</td>
<td>River estuaries</td>
<td>Fish spawning areas</td>
<td>Yacht Marinas</td>
</tr>
<tr>
<td>Agriculture along shorelines backwaters</td>
<td>Bird breeding / locking areas</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity of Shorelines and Marine Habitats

The marine environment is made up of complex interrelations between plant and animal species and their physical environment. Harm to the physical environment will often lead to harm for one or more species in a food chain, which may lead to damage for other species further up the chain. Where an organism spends most of its time in open water, near coastal areas, or on the shoreline will determine the effects an oil spill is likely to have on that organism.

In open water, marine organisms such as fish and whales have the ability to swim away from a spill by going deeper in the water or further out to sea, reducing the likelihood that they will be harmed by even a major spill. Marine animals that generally live closer to shore, such as turtles, seals, and dolphins, risk contamination by oil that washes onto beaches or by consuming oil-contaminated prey. In shallow waters, oil may harm sea grasses and kelp beds, which are used for food, shelter, and nesting sites by many different species.

Spilled oil and cleanup operations can threaten different types of marine habitats, with different results:

- Coral reefs are important nurseries for shrimp, fish and other animals as well as recreational attractions for drivers. Coral reefs and the marine organisms that live within and around them are at risk from exposure to the toxic substances within oil as well as smothering.

- Exposed sandy, gravel, or cobble beaches are usually cleaned by manual techniques. Although oil can soak into sand and gravel, few organisms live full time in this habitat, so the risk to animal life or the food chain is less than in other habitats, such as tidal flats.

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Sheltered beaches have very little wave action to encourage natural dispersion. If timely cleanup efforts are not begun, oil may remain stranded on these beaches for years.

Tidal flats are broad, low-tide zones, usually containing rich plant, animal and bird communities. Deposited oil may seep into the muddy bottom of these flats, creating potentially harmful effects on the ecology of the area.

Salt marshes are found in sheltered waters in cold and temperate areas. They host a variety of plant, bird and mammal life. Marsh vegetation, especially root systems, is easily damaged by fresh light oils.

Mangrove forests are located in tropical regions and are home to a diversity of plant and animal life. Mangrove trees have long roots, called prop roots, that stick out well above the water level and help to hold the mangrove tree in place. A coating of oil on these prop roots can be fatal to the mangrove tree, and because they grow so slowly, replacing a mangrove tree can take decades

**Sensitivity of marine birds and mammals**

An oil spill can harm birds in several ways, by direct physical contact, toxic contamination, and destruction of food sources.

- **Physical contact** – When fur or feathers come into contact with oil, they get matted down. This matting causes fur and feathers to lose their insulating properties, placing animals at risk of freezing to death. For birds, the risk of drowning increases, as the complex structure of their feathers that allows birds to float becomes damaged.

- **Toxic contamination** – Some species are susceptible to the toxic effects of inhaled oil. Oil vapours can cause damage to the animal's central nervous system, liver, and lungs. Animals are also at risk from ingesting oil, which can reduce the animal's ability to eat or digest the food by damaging cells in the intestinal tract. Some studies show that there can be long-term reproductive problems in animals that have been exposed to oil.

- **Destruction of food resources** – Even species that are not directly in contact with oil can be harmed by a spill. Predators that consume contaminated prey can be exposed to oil through ingestion. Because oil contamination gives fish and other animals unpleasant tastes and smells, predators will sometimes refuse to eat their prey and will begin to starve. Sometimes, a local population of prey organisms is destroyed, leaving no food resources for predators.

Following guidelines can be used for sensitivity mapping.

<table>
<thead>
<tr>
<th>Index</th>
<th>Type of Shoreline</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exposed Rocky Head Land</td>
<td>Wave reflections keep most</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of oil offshore</td>
</tr>
<tr>
<td>2</td>
<td>Wave Cut Platform</td>
<td>Most oil is removed by</td>
</tr>
<tr>
<td></td>
<td></td>
<td>natural process</td>
</tr>
<tr>
<td>3</td>
<td>Medium Sand Beaches</td>
<td>Oil does not penetrate.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mechanical clean up</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th></th>
<th>Coastal Habitats</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Coarse Sand Beaches</td>
<td>Oil mobile with tide but little penetration.</td>
</tr>
<tr>
<td>5</td>
<td>Exposed Tidal Flats</td>
<td>Oil penetrate. Difficult to clean.</td>
</tr>
<tr>
<td>6</td>
<td>Gravel Beaches</td>
<td>Deep penetration. Difficult to clean up.</td>
</tr>
<tr>
<td>7</td>
<td>Vegetated Tidal Flats</td>
<td>Sediments less mobile but difficult to clean up.</td>
</tr>
<tr>
<td>8</td>
<td>Sheltered Rocky Coast</td>
<td>Heavy accumulations in cracks and pools.</td>
</tr>
<tr>
<td>9</td>
<td>Sheltered Tidal Flats</td>
<td>Priority protection from impact of oil.</td>
</tr>
<tr>
<td>10</td>
<td>Salt Marshes / Mangroves / Areas shown under 'Social' in the table mentioned above.</td>
<td>Rich aquatic environment. High sedimentation rates. Oil may persist for very long period. Areas to receive top priority.</td>
</tr>
</tbody>
</table>
Annexure-8

Oil Spill Report Form

1. Name of person reporting incident : 
2. Title/Designation : 
3. Company : 
4. Telephone/Fax numbers : 
5. Date and time : 
6. Spill Location : 
7. Type and quantity of oil spilled : 
8. Cause of Spill : 
9. Response to spillage (If any) : 
10. Any other information :
Annexure-9

Assessment and monitoring of oil spill

Immediately after spill, the first priority is to assess the quantity of spilled oil and present status of spilled oil. This is essential to plan response strategies and select suitable response techniques. There are various methods for approximate estimation of spilled oil, a few are described below:

Aerial Survey

An expert in aerial observation fly in helicopter over the length and breadth of oil slick. The time required to cross the slick is noted and using helicopter speed, approximate size of spill can be determined.

The colour of oil slick and thickness of oil changes with the passage of time due to spreading and weathering of oil. The correlate table given below, is quite useful in the estimation of the thickness of oil, its colour and approximate size of spill per unit area.

<table>
<thead>
<tr>
<th>Approximate film thickness (micron)</th>
<th>Approximate quantity of oil 1 km² in area, lit.</th>
<th>Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>10⁻⁶ in</td>
<td>10⁻⁶ m</td>
<td>Barely visible under most favourable light condition</td>
</tr>
<tr>
<td>1.5</td>
<td>0.04</td>
<td>Visible as a silvery sheen on water surface</td>
</tr>
<tr>
<td>3</td>
<td>0.08</td>
<td>First trace of colour may be observed</td>
</tr>
<tr>
<td>6</td>
<td>0.15</td>
<td>Bright bands of colour</td>
</tr>
<tr>
<td>12</td>
<td>0.30</td>
<td>Colour begin to turn dull</td>
</tr>
<tr>
<td>40</td>
<td>1.0</td>
<td>Colour is much darker</td>
</tr>
<tr>
<td>80</td>
<td>2.0</td>
<td></td>
</tr>
</tbody>
</table>

Visual Colour Photography

Colour photography can be used to provide information about the extant of pollution of sea or shoreline. The best result are possible in clear light weather. If there are too many clouds the photography may not be very effective. While using this technique for assessment of oil pollution scene, following tips should be kept in mind:

- try to get as near and take vertical shot as far as possible
- use shortcut exposure time possible (1/250 m or faster)
- overlap photograph by above 20%
- use high speed slide colour film (200 or 400 ASA)
- use polarizing filter to reduce glare from water surface
- photograph taken at low tide will give more information on the shore line

Thermal type Infra-Red Line Scanner

It is composed of an air born detection system, including an infra red line scanner camera and additional equipment and ground system for data reception and real time viewing. It differentiate very small temperature difference and is therefore highly dependent on metero-graphical conditions. Interpretation errors are possible.
Use of this camera need person to have requisite experience in the interpretation of photograph.

Ultra Violet Line Scanner

This type of scanner uses detector to scan the radiation of sun reflected by the oil and gives an accurate estimate of the area of the spill. It can also define the pollution as hydrocarbon or otherwise. It can work during day light.

Side Looking Air-born Radar (SLAR)

It is an imaging radar, which transmit energy pulses in the hyper frequency range (x-band). The radar receives back a signal which has been diffused, diffracted on board by object on the water, while oil gives very little reflection and thus lick appears black on the screen. It has a range of 20 meter on both sides of the plane and it used to show maximum extant of the slick. It can operate during day or night and in most weather conditions. But it gives no indication of thickness of oil layer.

Micro wave Radio Meter

It Measure natural hyper frequency energy sent out or reflected by the environment. It is particularly good at measuring the thickness of the slick and surface area and therefore, gives a good indication of volume of oil (±1.20%). The swept area is small since it is necessary to the slowly at low altitude to get best result.

Flouri Meter Laser

Emits energy in the ultra violet band and receives energy in the visible band used or given o indication of the type of hydrocarbon. Thickness of slicks and spectral finger print of the hydrocarbon, when can be compared with the previously known data. It can operate during day & night but not during misty or rainy conditions. Swept area is small since it is necessary to fly at low altitude.

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Annexure-10

SELECTION OF RESPONSE TECHNIQUE & QUANTIFICATION OF EQUIPMENT

Spill location have a direct bearing on the selection of response strategies. Generally speaking most durable way of treating oil at sea is to remove it Physically. In doing so, further harm to marine environment can be eliminated. In high seas, where the oil slick subject to high wind and difficulties in availability logistics of response craft can be expected, Physical removal will often be difficult. Most of the presently available equipment are suitable for moderate sea conditions and relatively calm waters. However, if heavier equipment are used it will be possible to carry out physical removal even to high sea. This requires the use of large & stable vessels and well trained crew.

When it is not possible to collect the oil by means of mechanical recovery, following strategies could be adopted.

- Leave oil alone, allow oil to degrade by natural processes.
- Combat oil pollution with chemical dispersant.

The variety of response techniques are available for the recovery and dispersion of oil from different locations viz sheltered water, high seas and beaches. The most widely used technique and their suitability under various conditions are described here under.

Response technique for high seas

Following techniques are widely use for combating oil spill at high seas.

1) Mechanical recovery
   - Booming
   - Skimming
   - Storage and disposal of debris

2) Dispersion
   - Aerial dispersion
   - Vessel mounted dispersion equipment

Response techniques for sheltered water

Most oil spread quickly on water surface and form thin layer of oil. Therefore unless confined by some means, any metro of oil recovery by mechanical means can not be effective such means is a boom. Floating barrier.

Booming

In order to prevent spreading of spilled oil and confining of spilled oil, various types of booms are developed. The common type of booms include Fence, Curtain, Shore sealing, Self expansion and sorbent boom. The choice of boom depends on various factors. The table below describe the boom choice guidelines.

<table>
<thead>
<tr>
<th>Type</th>
<th>Fence</th>
<th>Curtain</th>
<th>Shore sealing</th>
<th>Self expansion</th>
<th>Sorbent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ease of deployment</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Wave following</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Speed of Deployment</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Shore sealing</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Ease of maint.</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Storage factor</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

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Scale:  Good = 1  
          Bad  = 5

a  =  Permanent deployed barrier for protection  
b  =  Excellent containment boom  
c  =  Outstanding shore sealing qualities  
d  =  Rapid deployment for fast response  
e  =  Good general purpose boom for small spill in sheltered water.

Boom selection for a given situation must take into account the following consideration:

- The circumstances under which boom will operate i.e. weather conditions wave heights, open or enclosed water current speed etc.
- Logistic requirements i.e. are they to be used at affixed site or will they need to be easily transported perhaps over rough country.
- Availability of manpower and equipment to deploy the boom.
- Necessity of making different types of boom compatible with each other.

Deployment of Boom

Booms are deployed for oil collection, containment and protection. The guidelines for these operation are out under below :-

Oil Collection (Ocean Booming)

In this mode boom is towed in a particular configuration i.e. J, U or V to a position where oil is known to be floating and boat at either end is used to collect the oil. Such a system is applicable in high sea where there is an adequate stretch of clear, navigable water available.

Deflection (River Booming)

Such operations are normally required in shore line or rivers situations. In this arrangement booms are used to divert the oil to the oil collection in the river boom or shore.

The current velocity across the boom in the river/streams plays important role so that the critical velocity / current across the boom does not exceed critical limit of 1 knot. The booms may not be effective, if current is more than 1 knot. In that situation under current below the booms start and oil

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starts escaping under the booms. To minimize the oil loss, it is necessary to angle boom to an extent that reduces the current perpendiculars to the boom to below the critical value. If the current speed is more than 4 knot or more, the length of boom required becomes so long and unmanageable that boom deployment is not recommended.

Effect of current on the effectiveness of booming is shown in fig below :-

River booming (Chevron and staggered type)

In all estuaries and coastal areas changes in current direction often observed, the boom therefore would be effective for collecting and deflecting oil in one direction only, when current changes the direction additional boom may be required.

In situation where no current is observed en-circling of spill considered effective.

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A knowledge of seasonal current and wind forces data should be used to advantage before deployment of boom. The current and wind forces should be over estimated rather than under estimate to ensure that the boom will perform effectively.

**Mechanical Recovery (Skimming)**

Skimmers are used to collect oil floating on the surface of the water. They are classified into the following 4 groups as the basis of their operating principles viz.

- Weir skimmers
- Oleophelic skimmer
- Vacuum skimmer
- Mechanical skimmer

Advantage & dis-advantages of skimmer type

<table>
<thead>
<tr>
<th>#</th>
<th>Skimmer type</th>
<th>Advantage</th>
<th>Dis-advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Weir skimmer</td>
<td>Simple to operator</td>
<td>Only good in very calm condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Skim all kinds of oil, over water in oil emulsion, provided video sets in</td>
<td>High water recovery (10% water)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Not effective in</td>
</tr>
<tr>
<td>2</td>
<td>Oleophelic skimmer</td>
<td>Very low water pick up</td>
<td>Not effective for oil located with dispersants</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Best efficiency restricts to medium video set range</td>
</tr>
<tr>
<td>3</td>
<td>Vacuum skimmer</td>
<td>Wider available</td>
<td>Collect lot of water with the limited size of vacuum containment vessels.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collect all kinds of airs &amp; emulsions.</td>
<td>Often causes an erratic clean up.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Are often portable.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Mechanical</td>
<td>Ideal for retrieving heavy oil all.</td>
<td>Not effective for light oils</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tolerate debris</td>
<td>Requires very thick oil layer.</td>
</tr>
</tbody>
</table>

The viscosity of oil on water, affect the choice of skimming device during spill response operations. The operating range of four types of skimmer is shown in fig. Below :-

---

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Use of Dispersant

In making the decision to use dispersant the following point must be considered.

a) The spill oil must be a type which is amenable too dispersant treatment.

b) The dispersant must be applied to the surface oil at the correct dose rate and in the correct manner.

c) Sufficient mixing energy must the available to remove dispersant / oil mixture from surface and disperse it into the sea.

d) Oil which is initially amenable to dispersant treatment can become resistant to treatment over a period of time due to weathering process. Therefore, speed of response is crucial in providing effective dispersant system.

Application, Dose Rate and Mixing Energy

The floating oil is treated by means of spraying equipment, which apply the dispersant in the form of an even spray of droplets on to the oil layer. The spraying system are designed to produce droplets, of required diameter to resist the effect of wind drift but not so small so that they will pass completely through the oil layer and be lost to the under laying water.

Dosage of dispersant depends on the type of dispersant used.

Conventional dispersants are used in the range 1:1 to 1:10 (dispersant : oil) according to the viscosity of the oil with crude oil in the range is 1:3 to 1:4.

Concentrated dispersant are used in the range 1:10 to 1:30 according to the viscosity. In practice with most crude oils the preferred rate 1:10.

When need they are used in the range 1:20 to 1:75 according the viscosity of the oil.

The method of use of dispersant depends on the type of dispersant.

A : Conventional Dispersant are always applied neat at sea by means of boat fitted with spraying equipment

Near Shore means of portable spraying equipment or any kind of module pumping units designed to lope with the job.

B : Concentrated dispersant are applied neat or diluted

At Sea : By means of boats fitted with spraying equipment using neat or water diluted dispersant or by means of any kind of aircrafts fitted with spraying equipment suitable for neat application.

Dosage

For application by boat, the discharge rate is calculated as under :

\[ Q = 30.87 \times V \times L \times E \times C \text{ (Lit/min)} \]

\[ Q = \text{Discharge / out put in lit/min.} \]

30.887 – Distance in per minute covered by the ship, if speed in one knot.

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V - Speed of ship (Knot)
L - Width of spraying boom in meters
E - Arrange thickness of slick in MM
C - Volume of neat dispersant mixture needed to ensure efficient dispersion of the litre of oil (Given by manufacture)

For application by Air Craft:

\[
Q = \frac{0.447 \times N \times SW \times E \times R (lit/sea)}{0.447-} \quad \text{Distance Traveled by air craft in one second}
\]

N : Speed in Miles/hrs.
SW : Swath width on the water surface in meters
E : Arrange thickness of oil layer (in MM)
R : Ratio of dispersant to oil being dispersed

**Pros and cons of Dispersant usage**

It is always difficult to decide whether to use dispersant or not. Frequently the decision will not be taken by the on scene commander but by the local authorities.

**Advantage**

- Dispersant work in all conditions weather and sea
- Dispersion is the fastest response to fight an oil slick
- Dispersion of floating oil minimize oil contamination of birds and sea mammals
- Dispersion enhance biodegradation because it increases oil surface available for the bacterial work
- Dispersion tends to inhibit photo oxidation of oil contamination of oil to toxic peroxides and acids
- Dispersion reduces fire hazards when volatile hydrocarbons are present
- Dispersion at sea of floating oil greatly reduces shore pollution
- Immediate use of dispersants reduces the possibility of chocolate –mouse formation
- Compared to shore recovery, dispersion at sea is much less expensive

**Disadvantage**

The use of dispersant may affect:

- Mollusks or other slow moving species
- Fish
- Spawning ground
- Aquaculture
- Nursery grounds
- Salt marshes
- Estuaries
- Dispersion on sandy beaches increases penetration into the sand
- Dispersion reduces photo oxidation thus avoiding partial disposal of oil
- Dispersion may increase turbidity of the water
- Dispersant are ineffective when used on heavy or weathered oils or water in oil emulsion

**Quantification of equipment**

The boom length required for the containment of oil at sea can approximately worked out by using following methodology:

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For effective recovery of thickness of oil layer is required to be increased at least up to 5mm. For example the boom required for 100 tonnes of spill would be:

Size of spill : 100 tonnes
Size of spill after emulsification : 500 tonnes
(water: oil 80:20)
Radius of spread area

\[
500 \times 0.89 = (3.13 \times R^2 \times 0.05)
\]
Radius= 168 meters
Length of boom= 2x3.14x168 = 1000 meters approximately

If boom is required in coastal areas where shore is protected or boom can be laid from shore approximately 755 of this length would be sufficient to contain 100 tonnes of oil.

The skimmer capacity required can be calculated as under:

\[
\text{Capacity} = \frac{500}{8 \text{ hrs.}} \times 4 \text{ working days} \times 0.3 \text{ (efficiency)}
\]

= 52 tonnes

Two skimmers of 30 t capacity may be adequate.