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Proposal of a contingency plan for oil spill response in Maputo Bay

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PROPOSAL OF A CONTINGENCY PLAN FOR OIL SPILL RESPONSE IN MAPUTO BAY

By

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I certify that all the material in this dissertation that is not my own work has been identified, and that no material included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: **PROPOASAL OF A CONTINGENCY PLAN FOR OIL SPILL RESPONSE IN MAPUTO BAY.**

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The need for an oil spill contingency plan in Mozambique was first initiated by the Central Government at the end of the 1980s. It was re-emphasised in 1992 after the "Katina P" incident, which occurred within the Maputo Bay.

The development of this plan, therefore, is consistent with the intent of the Government of Mozambique which recommended, as one of the ultimate goals for SAFMAR, " to develop a co-ordinated national contingency plan so that there will be an effective response to any oil spill".

The aims and objectives of the contingency plan are to provide a safe, systematic and integrated response to oil pollution incidents that may occur within the bay. An analysis of the required level of preparedness, the necessary response capabilities, and the resources that should be available to combat oil spill in the Bay of Maputo has made. Included in this plan are the oil spill reporting procedures that must be followed to keep the supervisory and management personnel informed about any oil spill incidents, and the steps to be taken for immediate action in case of such an event. Also, included in this dissertation is the needed organisational structure of an Emergency Action Group, along with a definition of the responsibilities of each individual member. Various clean-up techniques and different clean-up equipment are analysed. Finally, recommendation of the clean-up policy within relevant national legislation regarding to marine environment has been advocated.

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List of Abbreviations

CC-	Co-ordinator Centre
CLC 69-	International Convention on Civil Liability for Oil Pollution Damages, 1969
COW-	Crude Oil Washing
CP-	Contingency Plan
EC-	Emergency Committee
EEZ-	Economic Exclusive Zone
GASAMP-	United Nation Joint Group of Experts on Scientific Aspects of Marine Pollution
GT-	Gross Tonnage
HLB-	Hydrophilic Lipophilic Balance
IMO-	International Maritime Organisation
ITOPF-	International Tanker Owners Pollution Federation
LOT-	Load on Top
MARAD-	Maritime Administration
MARPOL 73/78-	International Convention for the Prevention of Pollution from Ships, 1973/78
OC-	Operational Co-ordinator
OILPOL 54-	International Convention for the Prevention of Pollution of the Sea by Oil, 1954
OP-	Operational Plan

OPRC 90-	International Convention on Oil Pollution Preparedness Response and Co-operation, 1990
ORR-	Oil Recovery Rate
OSC-	On-Scene Co-ordinator
RE-	Recovery Efficiency
SAFMAR-	Mozambican National Maritime Safety Authority
SBT-	Segregated Ballast Tank
TE-	Throughput Efficiency
TS-	Territorial Sea

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Chapter I

The merit of a civilisation is not measured
With what it can create, but with what it can
Preserve. (Edouard Herriot)

1.1. Introduction

Mozambique is a coastal state with a coastline of about 2470km, running from the north to south, and the Mozambique Canal is one of the preferred routes for oil transportation in the world. About 300 oil tankers pass through the canal daily, which makes it a high-risk waterway.

During the last 8 years two serious accidents have occurred in the canal involving two tankers, namely; Katina P. and Shin Kakogawa Maru and one of the accidents affected greatly the Maputo Bay.

The accidents brought out the problem of an absence of a contingency plan for oil spill prevention and response, as well as the lack of updated legislation regulating the environmental issues.

Since then the government of Mozambique has been taking steps towards a solution of the problem. One of the steps was the creation of a competent maritime authority with the duty to prepare a contingency plan, update the existing legislation and prepare the accession of Mozambique to the international conventions to which it is not yet part, such as, MARPOL and OPRC.

Because preparation of the contingency plan has been delayed, and concerns among different parts interested in the issues have been arising, the author of this paper found it necessary to give a contribution in the preparation of a contingency plan covering the Maputo Bay, as part of the national contingence plan.

The objective is to elaborate and propose a prototype contingency plan that can be used over the entire coastline, depending on the circumstances of each area.

The paper is divided into seven chapters. In the second chapter are outlined the main sources of oil pollution and the environmental, economical and social implications of an oil spill.

The third chapter gives the overview of the existing containment and recovery equipment as well as their purpose and use. Also, in this chapter the concept of use of dispersants and their effects is developed.

The analysis of different clean-up strategies and techniques are dealt with in chapter four, and chapter five offers an indication of what contingency planning should be and the scope of a contingency plan.

In chapter six the proposal of the Maputo Bay contingency plan is developed as conceived by the author having take into consideration the circumstances surrounding the area. Finally in chapter seven the conclusions and recommendations are given.

Adopted approach:

a) Investigation at the WMU and Malmö city libraries.

b) Advise from professors and visiting experts.

c) Interviews of the SAFMAR, MICOA, Maputo MARAD and Oil Industry representatives.

d) Uses of different contingencies planning at different levels.

Main constraint

The main constraint during the preparation of this paper was related to the short time for investigation back home bearing in mind that there is no systematic organisation of data. For same reason, it was not possible to have an opinion of other interested parties.

Chapter II

2.1. Oil Pollution

The world has faced oil pollution since ancient times. Natural seeps have been the major contributor. However, pollution has never been as alarming as it seems to be today. This is because since the industrial revolution human beings have turned to oil for production of energy for their daily needs.

Day after day, the dependence of the world on oil as a source of energy has been increasing, and hundreds of ships have been sailing day and night from one place to another transporting oil and oil products. During the production and transportation processes accidents have been taking place either at sea or in the ports. Some of these accidents have had negative environmental, economic and social impacts.

In fact, oil pollution due to accidents was not of great concern until March 1967, when the first major accident occurred involving the Torrey Canyon. She spilt large quantities of oil resulting in hundreds of miles of oily beaches and the death of thousands of seabirds (Johnston, 1976). Since than the world has realised what the real risk of oil in daily our life is. Consequently, measures have been taken to prevent and combat oil spills. This includes the development of equipment and techniques for oil response, adoption of international and national regulations, the building of contingency plans at national and international levels and the training of personnel. IMO has been an ideal tool for the world to carry out this task.

2.1.1. What is oil pollution?

The task to deal with oil pollution at sea or on the shore requires to some extent the answer of the question above. The answer is not easy, because it requires the understanding of the three groups of material pollution, namely, native or natural pollution, pollution caused by, but not created by, human beings, and synthetic pollution which can be found in the sea as a consequence of human activities. On the other hand, some of them exist naturally in the sea. Thus, it is of vital importance to comprehend the impact of each of the three groups. Furthermore, it is necessary to be aware of the existing difference between contamination and pollution. Sometimes it is difficult to make a distinction because of similarities in their impacts.

According to GESAMP, " contamination is high concentration of substances in water, sediments or organisms, i.e., concentration that are above the natural level for the area and for the organisms" (Clark R. B. 1992).

Pollution is the introduction by man, directly or indirectly, of substances or energy to the marine environment resulting in deleterious effects such as harm to living resources; hazards to human health; hindrance of marine activities including fishing, impairment of quality for use of sea water; and reduction of amenities (Clark R.B. 1992, page 6).

Or rather, contamination is an indication of deterioration of the environment, but it can not be regarded as being pollution unless it is a result of human activities or it threatens the environment.

For this reason, is quite difficult to distinguish damages caused by a low level of contamination from these types of pollution.
"Pollution is by no means as clear cut as might appear at first sight" (Clark R.B., 1992).

2.2. Sources of Oil Pollution.

About 3.2 million metric tonnes of oil enter into the sea each year from different sources. One of the essential measures in combating oil spills is to identify the sources and how much oil or oil products each source discharges into the sea. Studies have identified seven major sources of oil pollution, namely, marine transportation, offshore production, tanker accidents, municipal and industrial discharge, atmospheric fallout and run-of and natural seeps.

2.2.1. Marine Transportation Losses

Of amount mentioned above 1.47 million metric tonnes result from transportation losses, 0.7 m tonnes of which are considered as cargo residues. However, with the introduction of systems such as, Segregate Ballast Tank (SBT) and Crude Oil Washing (COW), together with Load on Top (LOT) procedures, these discharges have been diminishing significantly. To transportation losses can be included discharges of oily bilge water and fuel oil sludge calculated in about 300,000 tonnes per annum, generated by all types of ships.

Construction of reception facilities and strict management helps to control the quantities of waste oil discharged into the sea from ships.

22.2. Offshore Oil Production

Offshore oil production is one of the sources under control thanks to the safety measures adopted during the production period. However, the incidents that happen from time to time and the spilt oil may reach about 50,000 tonnes which is not to be ignored considering that there are many platforms all over the world. Three quarters of that amount is linked to blowout incidents (ITOPF, 1983). The routine operations are linked with a large number of releases, which cause a loss of oil-based drilling mud.

2.2.3. Tanker accidents

Tanker accidents are responsible for 400,000 tonnes entering the sea per annum. A considerable part of this quantity is spilt into the ports during loading and bunkering operations. Spills from accidents such as groundings and collisions are less than 10% of all spills from tankers, but a quarter of these are larger than 700 tonnes.

2.2.4. Atmospheric Fallout

Burning of petroleum hydrocarbons in ships, cars, factories and other mean using oil for energy production leads to exhaust fumes and gases into the atmosphere. Also, oil exposed to the air volatilises into vapour. All these hydrocarbon gases and oil vapours directly or indirectly enter the sea mixed with the atmospheric water vapour as rain or snow.

2.2.5. Municipal, Industrial and run off

In the recent past the shipping industry lead the discharges of petroleum products into the sea. However, nowadays thanks to the efforts of the whole maritime community this has changed. The municipalities have taken the leadership, contributing with more than 1.18 million tonnes.

In fact, domestic waste and sewage contains a large quantity of oil greases, which drain into the sea. In addition, some industrial wastes contain a considerable amount of petroleum products, which also drain into the sea. Finally, oil can be found on roads and around car service stations and garages, being washed away by rain and draining into the sea.

It has been more difficult to control pollution originated by the municipalities than that caused by the shipping industry where authorities have almost succeeded to set up national and international legislation and efforts have been made to train personnel in order to enforce it.

2.3. Characteristics of Oil

2.3.1. Density (specific gravity)

Specific gravity shows the density of oil in relation to pure water. Usually oils are lighter than water and have a specific gravity of less than 1. The density of oils and petroleum products is usually expressed in terms of API gravity in accordance with the following formula:

$$API = \frac{141.5}{\text{Specific gravity}} - 131.5$$

Furthermore, the density can give a general indication of the other properties of the oil. For instance, oils with a low specific gravity and a high API, tends to be rich in volatile components and highly fluid.

2.3.2. Distillation Characteristics

The volatility of oil can be shown by the distillation characteristics. When the temperature of oil is raised, different components reach their boiling point in turn and are distilled. The distillation characteristics are expressed as the proportions of the parent oil, which distils within given temperature ranges.

2.3.2. Viscosity

The viscosity of oil is its resistance to flow high viscosity oils flow with difficulty whilst those with low viscosity are highly mobile. Viscosity decreases with an increasing temperature. If this happens the seawater temperature and absorption of heat from sunshine affects the viscosity of oil spilt on the sea surface.

2.3.3.Pour point

The oil's pour point is the temperature below which the oil becomes semi-solid and will not flow. This effect is the result of the formation of an internal microcrystalline structure. The pour point of crude oil generally varies from -35°C to +40 °C.

2.3.4. Asphaltene Content

Asphaltene plays a very important role in the formation stability of water-in-oil emulsion. The low asphaltene oils generally do not form a stable emulsion, whilst the high asphaltene oils do.

2.4. Fate of Marine Spills.

The marine environment is a complex natural machine capable itself to assimilate the oil entering the world's oceans. The fact that despite the large quantity of petroleum spilled into the seas there is little evidence of oil residues, confirms the above suggestion.

The oil spilt on the sea surface suffers physical and chemical changes, which sometimes leads to its disappearance from the surface. The oil's properties play an important role when it comes to the consideration of the fate of oil in the sea. Different oils behave differently when spilt into the sea. Frequently, distinction is made between non-persistent and persistent oils. Non persistent oils tend to disappear and usually clean up operations are not needed. In contrast, persistent oils take a long time to disappear and clean-up operations are required. Gasoline, naphtha, kerosene and diesel are considered non-persistent oils whereas most crude oils and refined residual oil have varying degrees of persistence depending on their physical properties and the size of the spill.

Mostly specific gravity, distillation characteristics, viscosity and pour point have been the main physical properties affecting the behaviour of an oil spill.

2.4.1. Weathering Process

The oil spill on the sea surface passes from different processes that lead to the change of its composition and behaviour. These processes are called the "weathering process". They are strictly dependent on the physical characteristics of the oil in particular the specific gravity, viscosity and volatility; composition and chemical characteristics of the oil; meteorological and hydrological conditions (sea state, sunlight and air temperature); characteristics of the sea water (specific gravity, currents, temperature, presence of bacteria, nutrients and dissolved oxygen and suspended solids).

During the process of preparation and implementation of a contingency plan for oil response the knowledge of all these processes and how they interact is of great value.

2.4.1.1. Spreading

The spreading process is dependent on the nature of the oil and the prevailing environmental conditions: the wind has an influence on the spreading rate, and the sea temperature may have a very substantial effect, mostly on the highly viscous oil or those which tend to solidify at low temperature. The volume of the spilled oil has a major influence on the spreading process at its earlier stage, provided that the oil is above its pour point. For instance, a large instantaneous spill is going to spread more quickly than a slow discharge.

At the releasing time, spreading on the sea surface is rapid and predominant, decreasing significantly until it ceases within one to ten days. It has to be mentioned that, except in the case of small spills of low viscosity oils, spreading is not a uniform process, and a large variation of oil thickness occurs within the slick.

2.4.1.2. Evaporation

The evaporation process is determined primarily by the volatility of the oil. The large quantities of components with a low boiling point, the greater the evaporation. To an extent evaporation is affected by the initial spreading rate of oil. Rough seas, high wind speed and warm temperature increase the rate of evaporation. Volatile components with boiling points up to 200 °C will evaporate within 24 hours. In some cases light oil can evaporate completely.

There is a danger of fire and explosion when volatile oils are spilt in close areas. Although, it is often possible to ignite slicks, particularly of fresh oil, it is difficult to maintain combustion even when wicking agents are used due to the thinness of the oil layer and the cooling effect of water.

2.4.1.3. Dispersion

The unstable state of the sea surface caused by waves and turbulence act on the slick and break it into small droplets able to remain suspended in the water column. This leads to the increased surface and, by this dispersed oil can enhance other processes such as, biodegradation and sedimentation.

In this situation, every breaking wave is going to remove almost all the oil in the wave-affected area from the surface into the water column and the rate of dispersion will be directly related to the frequency of breaking waves.

The remaining oil fluid may spread unhindered by other weathering processes and disperse completely within few days. Oil with high viscosity tends to form thick lenses on the water surface, and is going to disperse very slowly. This kind of oil may persist for some weeks.

2.4.1.4. Emulsification

When the seawater surface is agitated by wind, and specially when foam and spray result, water is absorbed by the masses of oil spilt into the sea. Some oils can in a short period of time absorb more than 50% of their weight in water and form brown masses dubbed as "chocolate mousse" (Gerlach A.S. 1981).

Water-in-oil emulsion can be also being formed, particularly with heavy crude and residual oils. The resulting emulsion contains 80% water but has a semisolid texture (Bishop P. L. 1983). The stability of emulsion depends upon the concentration of asphaltenes. Oil with highest content of asphaltene than 0.5% tend to form stable emulsion "chocolate mousse", whilst those containing less are likely to disperse (ITOPF, 1993). When the oil absorbs water it changes its colour to brown, orange or yellow (ITOPF, 1993). With the continuation of water absorption the density of the emulsion increases and approaches that of the water. After a long time, the mousse may disintegrate into lumps of tars, but at the same time the chances of its washing upon to the beaches are enhanced.

2.4.1.5. Dissolution

Some oil components will be lost from a slick by dissolution in underlying water, although, only the low-molecular-weigh hydrocarbons and those containing polar groups such as sulphur, nitrogen and oxygen have an appreciable solubility in water. These are the same hydrocarbons which are susceptible to the evaporative process.

This situation becomes, however, more complicated when there is a complex mixture of different compounds, which, as regards solubility, have reciprocal effects.

2.4.1.6. Oxidation

The hydrocarbon molecule once on the sea surface, breaks down into soluble products due to the reaction with oxygen. Sunlight stimulates oxidation. When oil is decomposed under the action of ultraviolet sunrays by oxidation, water-soluble fatty acids and fatty alcohol are produced which are easier for micro-organisms to degrade than the original hydrocarbons. Although, this is right during the lifetime of the slick, the effect of oxidation on dissipation is relatively less compared to other weathering processes.

2.4.1.7. Sedimentation

Some spilled oil ultimately sinks, often through association with suspended matter. Several of the previously discussed processes tend to make oil denser, and thus able to settle. Evaporation and dissolution remove the lighter fractions from semisolid globular tar bars. These often occur as small dense particles that can sink.

Agglomeration of dispersed oil particles in the water column, followed by an uptake onto suspended inorganic sediments, often occur particularly in coastal waters and estuaries where many suspended sediments are present. Fine-grained clay material may absorb large quantities of dissolved hydrocarbons from water. Once on the bottom, tarry materials may move great distances. Much of this material may become stranded on beaches, particularly at high tide level.

2.4.1.8. Biodegradation

Once oil is spilled on the sea surface various marine bacteria use it as a source of carbon and energy. Such bacteria can be found almost everywhere in the sea; however, they are common in chronically polluted water such as those which receive industrial discharges and untreated sewage. The temperature and availability of nitrogen and nutrients, mostly compounds of nitrogen and phosphorous, are likely to affect the rate of biodegradation. The degree of weathering often has an effect on the rate of biodegradation due to the evaporation of toxic components, which leave the slick less bactericidal (Bishop P. L., 1983).

2.5. Forecasting the Movement of Slick.

Immediately after the oil has been spilled on the sea surface it starts to move. In order to take appropriate response measures it is necessary to forecast the position of oil slick. This can be achieved only if data on wind and currents are available, since both are likely to affect the movement of the floating oil. The speed with which an oil slick drifts under the influence of wind depends on the wind force and oil thickness. Typically it will move at between 2% to 5% of the wind speed measured 10m above the water surface (IMO, 1988). It has been found empirically that floating oil in open water will move downwind at about 3% of the wind speed (ITOPF, 1983).

2.5.1. Aerial Surveillance

For an effective and successful oil response it is not enough to predict oil movement, as there is a need of a constant verification through regular surveillance. This is possible using an aircraft, since from the vessel it is inefficient. The changes that an oil slick suffers are because of the combination of various processes, which can lead to a mistake for the observer who is not familiar with them. For instance, the change of colour from black to brown, yellow or orange contrasts with silver at the thinner parts.

To help detection of the oil slick a number of airborne sensors have been developed, some of which can be use at night-time. The most common airborne ones are: UVLS, IRS, and SLAR. In some cases they can be combined. The recorded data are used in the oil combating process.

2.5.2. Oil Spill Assessment

A well designed clean up operation can be carried out successfully if an assessment of the oil spill is made. The assessment is mostly visual; it can be affected if there is a potential for hiding, for example, sand, snow or vegetation such as mangroves. Careful attention is paid to the location where the character of the shoreline changes or where the oil coverage appears to change.

2.6. Effect of Oil Spill

A single oil spill can cause severe ecological, economic and social damages. Depending on how is the oil spill is dealt with, its impact can be minimised or aggravated. The effect of the oil spill depends upon where it occurs, the meteorological conditions, type of oil, season and oceanographic conditions. The impact does not reflect necessarily the amount of oil spilt. A little oil in a sensitive area can harm more than a large spill on a desolate rocky shore.

2.6.1 Impact of Oil on Coastal Activities

When a clean-up operation does not take place at sea or if it does for any reason the oil succeeds in reaching the shore, there is always an eminent threat to the recreation activities such as bathing, boating, angling and diving. Tourism will be affected, because of the disturbance on the coastal area.

2.6.2. Effect on Industry

Any industrial estate along the coast will be affected, particularly those using seawater for cooling purposes. Similarly ports may be closed if the spill is large.

2.6.3. Impact of Oil on Specific Marine Habitat

The spilled oil on the sea surface can affect plankton. From here it is possible to disturb the marine food web, since plankton is the base of the marine food web. The oil effect on the marine micro-organisms depends on the type and amount of oil spilled, the physical nature of the area (e.g. open ocean or estuarine marsh), nutritional status, oxygen concentration, and the previous history of the area impacted with regard to hydrocarbon exposure. Because of its high toxicity light oils will have higher biological effects than the heavy crude.

Fish and mammals can be affected directly by petroleum, either by ingestion or oiled prey, through the gills. Despite the fact that an overlying water column protects bentic organisms they are not safe from oil impact. With the vertical mixing of hydrocarbon into and throughout the water column, the impact can be felt (National Academy Press, 1985). The incorporation of oil into sediments can lead to a residence time of several years in localised areas, with the possibilities of sub-lethal effects and tainting of commercial species.

2.6.4. Biological effects

The overall heredity risk to marine population from oil is difficult to assess because of unknown natural mutation rates, the occurrence of natural mutagens, and multiplication of unrelated mutagenic population. To this can be added varying species sensitivity and acclimation, variable cell and tissue sensitivities, and variable tissue accumulation and metabolism. However, there is no doubt about the deleterious biological effect of oil pollution on the marine ecosystem.

The ability of the marine population to recover from oil spills and the time taken for the re-establishment of a normal balance in the habitat depend on the sensitivity and duration of disturbances and the recovery potential of each specie. In general the process of recovery in tropical zones is faster then in cold areas.

Though the restoration process of the oiled habitat to meet its pre-spill physical conditions is possible, the limitation of its extent is recognised. The cleaning of mangrove and salt marsh areas requires a very careful exercise to avoid more physical damage that can be more severe than effect of an oil spill.

On the shoreline, the oil spill effect differs from one area to another. Fore instance, on areas of rock, sand and mud uncovered by the tide the effect is great. However, inter-tidal organisms are likely to resist short-term exposure to adverse conditions. At the end of the day, re-colonisation of the shore area by native species is usually rapid.

Mangrove forest, and coral reefs spread in most coastal areas of tropical zones require special attention when an oil spill occurs. Both coral reefs and mangrove forest are very important habitats with diversified marine biota. Furthermore, both have commercial and social importance.

2.6.5. Impact of oil on Fisheries and Marineculture

Fish can be affected directly by petroleum, either by ingestion of oil or oiled prey, through the uptake of dissolved petroleum compounds through the gills and other body epithelia, though effects on fish eggs and larval survival, or through changes in the ecosystem which support fish. Furthermore, more commercial fisheries as well as the sport and subsistence fisheries can be affected through the contamination of gear. Cultivated stocks are more at risk from oil spill.

Chapter III

Containment, Recovery Equipment and Use of Dispersants

3.1. Introduction

When an accident takes place and the oil is being discharged at sea, there is a need to prevent it spreading and affecting a wide area of the sea. For this purpose different kinds of containment and recovery equipment have been developed. The most common equipment available nowadays is booms and skimmers.

The use of the available equipment depends upon various conditions such as type of oil, sea state and, weather conditions that are prevailing during the response operations. The recovery and collection systems can be either dynamic or static. The dynamic system actively pursue the oil, whilst the static system relies on oil drifting into the system.

Booms and skimmers can be classified in different categories and grouped in different ways according to their types and characteristics.

3.2. Containment equipment

3.2.1. Booms

Booms, or simply barriers, are conceived to contain or deflect the oil from reaching sensitive areas. The containment helps the recovery process by gathering the oil in a desired point from where can be collected using skims.

According to the way the booms are made they can be divided into two groups as follow.

Commercial booms

Improvised booms

Commercial booms can be characterised according to the following design features:

1 Freeboard

2 Sub-surface skirt

3 Floatation chamber or buoyant material

4 Longitudinal tension component

Finally, commercial booms may be grouped according to their basic types and performance as well as their physical characteristics as shown in Table1.

Table 1- Types of boom, performance and physical characteristics

Type of boom	Environmental Conditions			Performance characteristics		Physical characteristics		
	Open sea $Hs>3$ $V<1$	harbour and bay $Hs<3$ ft $V<1$kt	protected inshore $Hs<1$ft $V<0.5$	Wave response	Strength	Easy of hand-ling	Easy of clea-ning	Compactability
1. solid flotation	2	1	1	2	2	2	1	3
2.external tension	1	2	2	1	1	3	3	2
3. inflatable:								
pressure inflatable	1	1	2	2	1	1	1	1
self inflatable	2	1	1	1	3	1	2	1
4.fence	3	2	1	3	2	2	3	3

Source: manual on oil pollution

Hs = significant wave height

V= velocity of surface current

1= good; 2 = fair; 3 = poor

3.2.1.1. Solid flotation boom

A solid floating material, for instance, plastic foam with cylindrical or rectangular form secures the flotation of a boom. As part of the boom below the floating element is an oil and water-resistant skirt with ballast along its lower side. To facilitate the use of these kinds of booms they are usually supplied with a length not more then 20 meters that can be linked by connectors.

The solid flotation booms have two major advantages. First, they do not need inflating. Secondly, their buoyancy can not be affected by simple damage. As a disadvantage it can be pointed out that they need a large storage capacity.

3.2.1.2. Inflatable boom

For inflatable booms the used floating element is an air chamber or tubes. The air is supplied by an external system before the boom is deployed into the sea. However, there are other types of inflatable booms with internal springs and no-return valves that enable the self-inflation of the boom.

Inflatable booms have good wave characteristics and do not require a very large space for storage. Their disadvantages are that they take a long time to deploy because they need to be supplied with air unless self-inflatable. In addition, small damages on the chamber can affect the buoyancy of the boom.

3.2.1.2. Fence booms

A single sheet comprises a fence boom, which serves as a freeboard and skirt; flotation elements are attached almost in the middle and the ballast weights at the lower part of the sheet. Both floats and ballast weights are attached at intervals.

The fence boom’s main advantage is that it does not require auxiliary equipment to supply with air since the floaters are solid. Its major disadvantage is that due to the wind and current effects its long span tends to lie over.

3.2.1.3. Bubble barriers.

A bubble barrier consists on a perforated pipe laid on the sea bottom. If air is pumped into the pipe a screen of air bubbles rise and generate a counter-current on the sea surface, which flows in both directions away from the bubble stream and holds oil against a water flow up to 0.7 knots. Its main advantage is that it does not obstruct navigation in the area for this reason can be used without problems in ports and elsewhere in shallow water areas. Disadvantages include less effectiveness in deep water and strong currents.

3.2.1.4. Sorbent booms

Sorbent booms are made of material with a high capacity of sorption. They can be used for retaining or absorbing the oil. Because they are not very resistant, therefore, they can not be towed, and can thus only be used in static work for retaining and collecting oil in the case of small spills. Sorbent booms can be used in sections of different lengths. Different to other booms, they are very light and can easily be transported. They can only be used one time and their treatment and destruction requires a lot of exercise.

3.2.1.5. Improvised boom

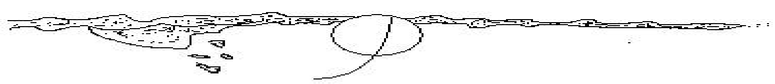
When a spill happens in remote area where is difficult to have the necessary quantities of booms to contain the oil, booms may be made using indigenous available material such as straw, coconut husks and others. Materials like wood, bamboo, oil drams, hoses and rubber tyres can be useful for the construction of improvised floating booms. Beaches and sensitive coastal areas can be protected using sand barriers and stones.

3.2.2. Common boom failure during operation

3.2.2.1. Submergence Failure of the booms

Submergence failure is the situation when the boom is pulled below the water surface. This occurs when the towing speed is too high. Normally it happens while positioning the boom in the right configuration before the actual oil containment takes place. If the boom already has contained some oil, entrainment failure will always occur before the submergence failure. This can be corrected reducing the towing speed of the boom, using a buoyancy ratio of 10:1 or higher. During transportation of a boom to the oil spill area it should be pulled by only one vessel in a long tow, thus minimising the forces on the boom.

Fig 1 submergence failure of the boom

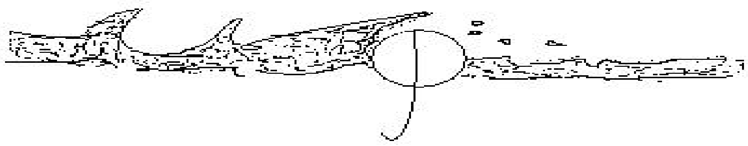


3.2.2.2. Splash-over failure

Splash-over means that some of the contained oil passes over the freeboard of the oil boom. It occurs when waves are choppy, i.e. the wavelength in relation to wave height is lower than 5:1. This is often seen in shallow water. The risk of splash over can be influenced by the construction of the boom due to the lower freeboard and a low buoyancy ratio (less than 4:1) making it difficult for the boom to follow wave rhythms.

Splash-over can be overcome byusing sorbent booms as breakwaters upstream from the boom formation, using a boom with a high buoyancy ratio in choppy and high waves.

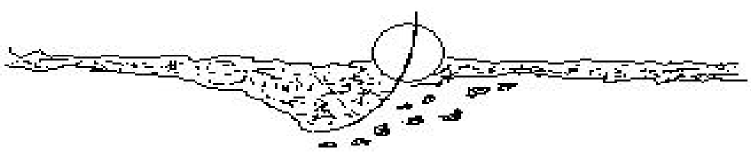
Fig. 2 splash over failure boom



3.2.2.3. Drainage failure

Drainage failure is the situation when the oil contained in boom configuration escapes under the skirt of the boom. Due to the current, when a large quantity of oil is contained by the boom the skirt can not withstand the forces and the oil will begin to escape beneath the skirt. This phenomenon can be reduced by placing a skimmer in the drainage area, decreasing the relative speed of the boom; the depth of the skirt must not exceed 1/3 of the water depth.

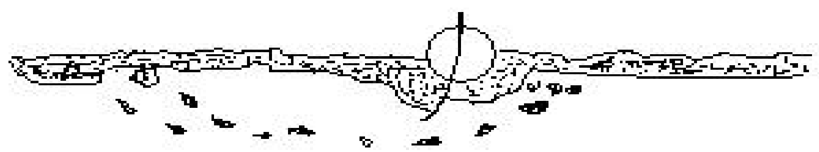
Fig 3 drainage failure boom



3.2.2.4.Entrainment failure

Entrainment failure is a situation when oil drops break away from the oil slick bottom, which is enclosed within the containment boom configuration, and resurface outside the boom configuration. It is also known as (sweep away or tear away). Normally, the oil will flow with the same speed as the current and will be affected by the wave velocity. It is impossible to avoid entrainment failure, in order to minimise the entrainment problem; the velocity of the oil perpendicular to the boom wall has to be lowered. This can be done in open water by lowering the boom velocity in relation to the current. With fixed installation, often used in rivers, the only way to minimise the problem is to deploy the boom in an angle to the current; this will result in reducing the current speed perpendicular to the boom wall and prevent oil from being stopped by the boom, otherwise the boom into the area with lower velocity will deflect the oil.

Fig 4 entrainment failure boom



3.2.3. Deployment of booms

Normally, the deployment of the boom takes place over the stern of the vessel. A tugboat has a good open main deck, which is very suitable for deployment of containment booms.

The equipment will often be used on board a vessel not designed for this purpose, or without any special designed lashing points on the deck to secure the boom. In both cases it is necessary to follow the following steps: Secure the equipment to the deck, attach the towing equipment, deploy the boom in sections, ensuring that the boom is secured to the deck and connect the boom to the auxiliary vessel.

3.2.3.1. Standard boom configuration for open sea operations.

The basic purpose of deploying oil booms is to contain the oil, which is concentrated in the apex of the boom. Boom configurations will depend on the number of vessels involved in the operation. Typical configurations are:

1. Single vessel configuration with:
    - Single sweep
    - Dual sweep
2. Two vessel configuration
3. Three vessel configuration

In all these configurations, different formation are used like the V-formation in (single sweep/dual sweep), J-formation in two vessel operations and U/open U-formation in three vessel operations. Basically deployment and recovery of containment booms are performed in the same way.

3.2.3.2. Standard boom configurations near shore and in rivers

A containment boom is often deployed near the shore in order to deflect the oil from sensitive areas. Performing a successful operation requires familiarity with:

1. The prevailing environmental conditions, especially current direction and velocity, in order to be able to determine the correct deployment angle.
2. The skit depth of the boom under water depth which, often is low in such areas. The skirt depth should not exceed 1/3 of the water depth.
3. The tidal level differences, especially when e.g. an entrance to a harbour has to be closed by booms.

To compensate for tidal levels, it is an advantage to use a guide roller to secure the oil tightness of the boom configuration during the change in tidal levels.

In near shore areas and rivers it is vital to have deployment points as well as anchoring points prepared in advance. The boom deployment angle has to be determined to ensure successful oil containment. In areas of fast current several skimmers should be deployed. The areas with calm waters create optimal conditions for the skimmers. It is important to prevent debris from reaching the booms.

3.3. Recovery equipment

Once the oil is contained, there is a need of quick recovery so it can not flow out and reach safe areas. For this purpose a range and diversified amount of equipment has been developed including skimmers, pumps, sorbents, vacuum trucks and others. Each piece of equipment is used in certain conditions; some at the shore, others offshore.

3.3.1. Skimmers

There are different kinds of skimmers, either in size or in their way of work. However, all of them are contain almost of an oil recovery, floatation or support arrangement and pump. Self-propelled skimmers are quiet complicated since they can incorporate more than one recovery element, a storage tank and some times may have an oil- water separation facility.

According to the way they pick up the oil, skimmers can be divided into two groups: suction and adhesion. The skimmers using the suction approach are fitted with a pump or air suction system, which enables them to pick up the oil from the sea surface. The main problem with that kind of skimmer is that it collects a large quantity of water. It is clear that it will need a big storage capacity.

Contrary to skimmers using the suction approach, skimmers, which adhesion is their basic approach such as oleophic belt, discs, or synthetic rope do not collect large volumes of water. The disadvantage of the skimmer with the adhesion approach is related with viscous water-in-oil emulsion, which can be non-adhesive. In addition, oil with low viscosity, for example diesel, does not accumulate on the oleophic surface.

To increase the efficiency of skimmers, a new generation has been designed which can be permanently fixed on board ship with the possibility to carry out a long operation at the sea. These vessel skimmers can act independently because they have sufficient storage capacity. Vessel skimmers have been designed in different versions namely, a sweeping arms, a combination of barriers and skimmers and scissors ship.

In all cases, skimmers work perfectly in good sea conditions and are likely to be affected by rough sea. Oil weathering and sewage gathering affects mostly the conventional skimmers. Also, as problems in operating with conventional skimmers it can be mentioned the fact that they need an external power supply.

Most skimmers have a range of viscosity in which they can work best, though there are no hard and fast rules, and they can be grouped according to the viscosity in which they are most effective. A generalised grouping by performance according to oil viscosity is shown below.

a) Light oil

Weir skimmer
Suction skimmer
Submersion belt skimmer
Submersion plane skimmer

b) Medium oil

Disc skimmer

Drum skimmer

Rope mop skimmer

Floating head belt skimmer

Sorbent lifting belt skimmer

Sorbent submersion belt skimmer

Submersion belt skimmer

Drum-brush, chain brush skimmers

Submersion plane skimmer

Boom-skimmer

Vorlex skimmer

c) Heavy oil

Padle belt skimmer

Sorbent lifting belt skimmer

Rope mope skimmer

Drum-brush, chain brush skimmers

Weir skimmer with progressive cavity pump

Oil head weir skimmer

Waves and currents affect the performance of skimmers significantly. Waves affect performance because rough seas move the skimmer's collection mechanism away from the oil floating on the water surface, while the currents affect the performance of skimmers because they cause the oil to escape under the collection booms. Also, high currents may swamp intakes or cause surface oil to move and pass the collection element so fast that it is not effectively recovered.

There are three performance parameters by which a skimmer can be tested. The first parameter is **Recovery Efficiency** (RE), measured as the percent of oil in the recovery mixture. The second parameter is **Throughput Efficiency** (TE), which represents the ratio of oil recovered to oil encountered, expressed as a percent. Finally, the **Oil Recovery Rate** (ORR), the rate at which pure oil is being recovered in litters per minute (LPM) and cubic meters per hour (m^3/h).

3.3.2. Sorbents

The recovery of oil using sorbents is based on adsorption or absorption properties of certain materials. This has to be seen strategically as an alternative or auxiliary response operation; at the same time it can be taken as a principal response option in the case of small spills. The kind of sorbent to be used will depend upon availability and its performance. However, it has to have acceptable characteristics namely, high absorption efficiency, easy recovery after absorption and easy processing after recovery.

According to the material make up the sorbents can be divided into three main groups; firstly, natural organic material, such as cotton, pine bark peat and pulp; secondly, mineral- based material namely, volcanic ash, perlit and vermiculite.

In all cases the use of sorbents must observe three phases. The first stage is distribution of the sorbent, followed by collection ending with disposal. The disposal process is of great importance since the sorbents are mixed with oil and need to be stored in a place defined before in co-ordination with an environmental agency.

3.4. Use of dispersants

Along with the development of the containment and recovery equipment another methods of combating oil spills have been developed. These combating methods are based on the use of dispersants and relay on the characteristics of molecules of certain substances to be able to develop affinity with oil and water at the same time. The affinity for oil is known as oleophile and the affinity for water is known as hydrophile. The application of dispersants on the sea surface covered by oil enables the reduction of tension between the two liquids and creates the appropriate condition for formation of very small droplets which disperse in an area relatively bigger than the previous. In fact dispersants do not remove the oil from the sea but divide it into small particles enabling it to disperse through the water column.

The efficiency of the dispersant depends on many factors. First, the viscosity of the oil, normally oil with very high viscosity does not react satisfactorily to the application of dispersants. Second, weathered oil up to a state of viscosity greater than 2000 cSt resists the effect of dispersants. Furthermore, special additives in lubricating oil influence badly the effectiveness of the dispersants. Finally, after a long time of oil exposure the dispersant may not be effective.

3.4.1. Types of Dispersnts

There are two types of dispersants available today, namely, hydrocarbon and concentrate dispersants. Hydrocarbon or conventional dispersants as they are known, rely on hydrocarbon solvents. Dilution with seawater before application reduces their effectiveness. The second type dispersants, concentrate or self-mixed are a mixture of emulsifiers, solvents and wetting agents, containing very active elements capable of dispersing a greater volume of oil than the conventional.

4.4.2. Application of Dispersants

Dispersants can be sprayed using a vessel or an aeroplane. In both cases special equipment must be installed on board. The vessel or aircraft to be used can be selected depending on the size of the spill. However, when the vessel is to be used there always will be a need to use an aircraft to facilitate the location of the slick once the oil has drifted away from the source.

With the lack of appropriate equipment, the fire fidgeting equipment can be improvised for the purpose, although, not in the case of using hydrocarbon solvent dispersants knowing that their pre-dilution affects their effectiveness.

The use of an aircraft is much better than vessel spraying, because is rapid and provide an effective surveillance. However, weather conditions can limit the possibility of aircraft use. The appropriate dispersants to be used in aircraft spraying are the concentrate dispersants because they do not need the additional mixing of the wave effect.

3.4.3. Environmental problems

The use of the dispersants has been a subject of discussion, due to the fact that some of the substances are toxic and are not considered environmentally friendly. Furthermore, the fact that dispersants do not remove the oil from the sea, but break it into small droplets and allow the oil to disperse in a larger area, raises the concern because of the eventual threat to the biota. Next, dispersants by themselves are nutrients, this means that their use represents an addition to the nutrients in the sea, which is not permissible in close waters, knowing that it can contribute to eutrofication. Bearing in mind all these, problems each country has its policy related to the use of dispersants. Some use dispersants as the principal method for oil spill combating, others use them as an alternative, and some countries have banned their use. In order to formulate a policy on the use of dispersants, the risk of environmental damage resulting from their use must be balanced against the probable effects of the untreated oil. Dilution potential will be an important consideration. The policy for dispersants use should be agreed in advance for each area and in all cases the use of dispersants must be co-ordinated with the specialised environmental authorities.

Chapter IV

Clean-up Strategy and Clean-up Techniques

4.1. Clean-up strategy

At the outset of the oil spill, a strategical decision is made on whether to respond or not, and the techniques and technologies that will be employed. However, to some extent these decisions might be pre-designed and agreed in the contingency planning process. Depending on the geographical area, size of spill, environmental and economic resources endangered, options are limited and focused on in the beginning. Thus, a definition of a clean-up policy, mapping of shoreline and, preparation of a decision guide should be part of the clean-up strategy, which should be clearly indicated in the CP, particularly in the clean up policy, in order to facilitate a quick decision response.

The strategic decision making process necessarily needs a good comprehension of technologies and operational constraints of various countermeasures and clean-up techniques. Any anticipated environmental effect and policy constraints that may apply, for instance, the use of dispersants and in-situ burning in some areas should be included in the contingency plan.

4.1.1. Assessment of the problem

Along with clean-up the strategy, the assessment of the problem gives a real picture of the situation on the ground and helps to find the real solution. As soon as the oil spill is identified or reported the very first step to be taken is to determine the quantity of oil and identify the source. In addition, determining the possible area and the type of the coastline threatened is necessary. This can be achieved by using visual aerial surveillance, the use of boat to have access to the close areas and a survey of the shoreline on foot or by car.

The assessment, in the first moment of the emergency should be used to decide the strategy to follow between possible options. For instance, in some countries the use of dispersants depends on the conditions on a case by case basis.

In order to minimise the debate over the most appropriate response option it is very important to involve all interested groups from the beginning. However, the assessment of oil impact must be done at the time permitted or with a specific written waiver obtained in advance to avoid any waste of time in discussion.

4.2. Clean-up techniques.

The purpose of clean-up techniques is to offer an overview of various techniques developed through the years based on experience the of previous oil spill combating operations. The currently used response techniques include booming, which is the use of physical barriers to contain oil for removal; exclude and divert it from sensitive areas. In diversion booming, the boom is deployed at an angle to the approaching slick. The oil is diverted away from sensitive areas for recovery. This is used on inland streams where currents are greater than 1 knot, across small bays, harbour entrances, inlets, rivers or creek mouths where currents exceed 1knot and breaking waves are less than 1.5 feet; and on straight coastline areas to protect specific sites.

The environmental effect of diversion booming is characterised by minor disturbances to the substrate at the shoreline anchor point; the diverted oil can heavily contaminate downwind and down the current shoreline.

In exclusion booming, the boom is deployed across or around sensitive areas and anchored in place. The approaching oil is deflected or contained by the boom. Its primary use is across small bays, harbour entrances, inlets, river or creek mouth where currents are less than 1 knot and waves are less than 1.5feet in height. Its environmental effect is linked with minor disturbances to the substrate at shoreline anchoring points.

Chemical treating agents, which involves the application of chemicals to accelerate the dispersion of on oil spill into the water column, wash it from the shoreline, herd it into a small area, or modify it to facilitate its removal. Its environmental effects are the same as the dispersants effects. In dispersants the active ingredients are surface-active agents or surfactants. These surfactants have varying solubility in water and have varying actions toward oil and water. A parameter that has been used to characterise surfactants is the hydrophillic-lipophilic balance (HLB). A surfactant with an HLB of about 1 to 8 promotes the formation of water-in-oil emulsion and one with an HLB in the range from 12 to 20 promotes formation of oil-in-water emulsions.

Dispersants have usually HLB's in the range of 9 to 11. The HLB as defined is only applicable to non-ionic surfactants, however, ionic surfactants can be rated using an expanded scale and often have HLB ranging of 25 to 40. They are strong oil-in-water emulsifiers, very soluble in water, relatively insoluble in oil, and generally work from the water to any oil present. Such products have little application to oil-in-water because they rapidly disappear in the water column, having little effect in oil.

In-situ burning involves the burning of the oil on the sea surface, or in some cases on the shoreline. The oil can be ignited with a high degree of efficiency if the oil slick is:

- Of adequate thickness
- Relatively fresh

- Not too much emulsified

The following equipment and trained personnel are necessary for in-situ burning.

- A fireproof boom with about 500 feet length
- Two sections of a conventional boom that can be attached to the fireproof boom
- Two towing vessels capable of towing the assembled boom at 0.7 knots and having at least 500 feet of towline each
- A heli-torch suspended from the helicopter
- Clean-up crew with appropriate equipment
- A boat to collect residues

The primary advantages of the in-situ burning technique are, first of all, a large quantity of oil can be removed rapidly and efficiently (typically 80%/90%) (A. A. Allen 1991). Secondly, virtually any type of oil can be burnt. Next, oil can be safely and effectively eliminated without the need for recovery, transfer, store and disposal. Furthermore, in-situ burning can be conducted with a minimal amount of logistics and personal support. Finally, it is possible to undertake an in-situ burning operation under a broad range of environmental conditions. It may be the only practical response technique in areas which are partially covered with ice or in shallow water situation.

The disadvantages of in-situ burning are related to the environmental and operational concerns and include, first, a generation of black smoke. Second, it involves the usual safety risks that accompany any large petroleum fire, such as high temperatures and reduction of visibility. Finally, the surface between the seawater and oil will be heated. However, this area is small compared to the total surface area.

Mechanical removal involves physically removing the oil from the sea surface using skimmers and sorbents.

Shoreline clean up includes a wide range of techniques to remove oil and oiled materials from the shoreline.

3.2.1. Bioremediation.

Boiremediatiom is the application of nutrients and in some cases jointly with bacteria (fertiliser containing nitrogen and phosphate) to the shoreline to accelerate the natural biodegradation of oil. Oil biodegradation is the natural process by which micro-organisms oxide hydrocarbons, ultimately converting them to carbon dioxide. It can only take place at an oil-water interface. It is limited by the availability of oxygen, moisture, and nitrogen/phosphorus nutrients needed by microbes. Bioremediation is typically used as a final treatment step after completing conventional shoreline treatment, or in location were other forms of treatment are either not possible or not recommended.

4.3. Disposal of Oil and Debris

The type and quantities of wastes resulting from oil spill cleanup are the very important factors in the disposal of wastes. These factors depend mostly on the cleanup methods used and are the subject of change as the work is progressing. Thus a management program to deal with oil and debris must be set up based on following the principles:

- Provide safe working conditions and necessary personnel protection.
- Comply with the applicable laws and regulations
- Minimise future liability
- Co-operate with local community and environmental agencies to minimise impact on local waste disposal facilities.
- Handle, store and transport the oil waste in appropriate containers/tanks.
- Minimise the amount of waste generated by implementing waste reduction principles

- Segregate oily wastes and non-oily wastes to allow optimum reclamation and disposal of each waste stream.
- Dispose of all waste streams in a safe way an at approved disposal sites.

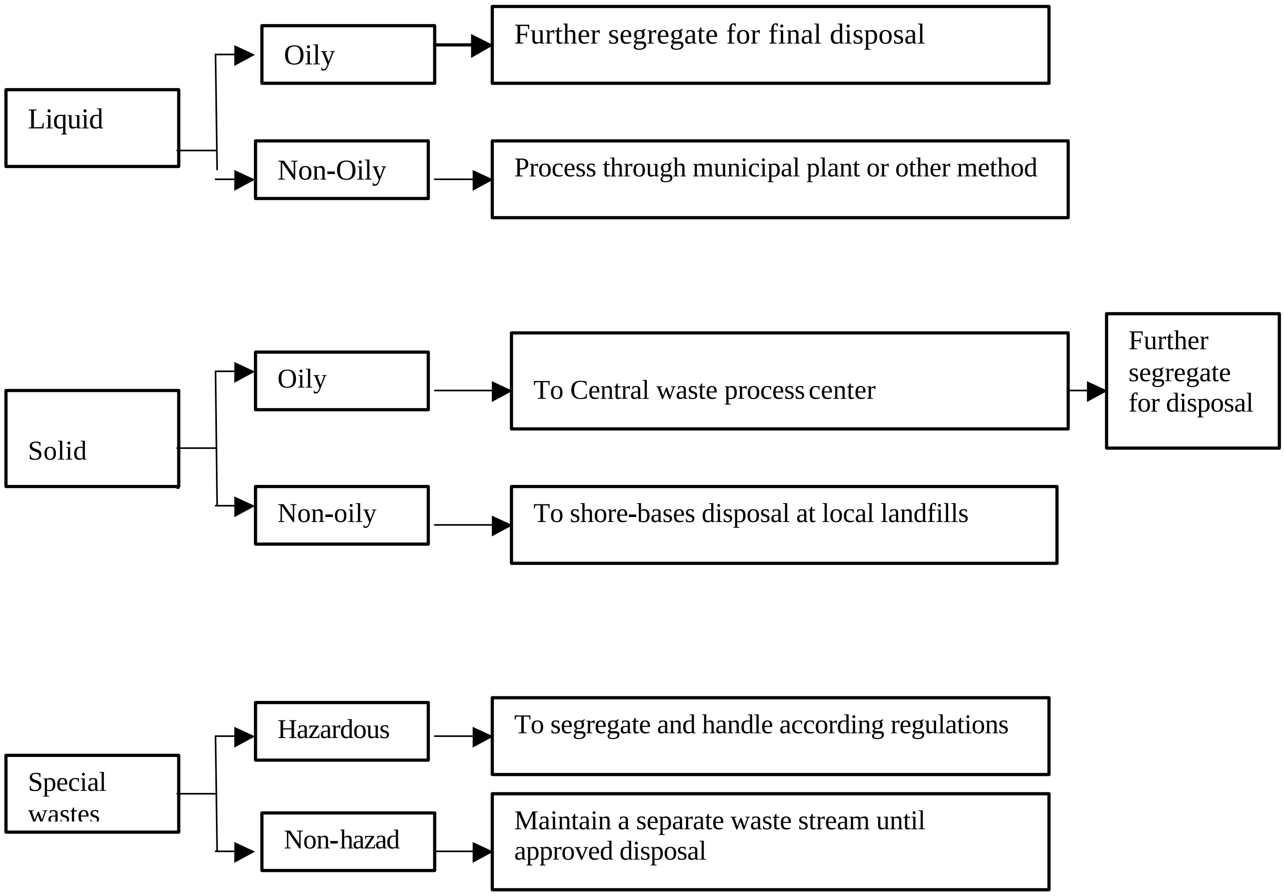
Plans for handling and temporary storage of wastes during the initial stages of oil of an oil spill response should be discussed with the regulatory agencies involved. If there is any doubt, specialists should be consulted.

Since each type of waste has a different optimal or alternate disposal method it is important to:

- Segregate wastes by type
- Minimise the quantity of each type
- Avoid mixing hazardous and non-hazardous wastes together, resulting in a large volume of hazardous waste
- Label all waste containers and identify the source.

One way to improve the efficiency is to combine similar wastes and segregate dissimilar waste. Fig (5) can help in segregation of wastes.

Fig 5 chart for waste separation



Segregation of wastes at the point of generation should be done to facilitate subsequent handling and disposal.

- All oily wastes should be segregated from non-oily wastes
- Non-oily wastes (domestic refuse and trash) should be transported to shore-bases for disposal at local landfills.
- All oily solid wastes should be transported to a central waste processing area.

- Oily wastes should be further segregate as required to final disposal.

Contracts or service agreements with the parties assisting in the cleanup operations should clearly state that the contractors are responsible for the handling and disposal of waste not generated from oil spill itself, such as their engine oil from changes.

4.4. Disposal Options

There are varieties of safe disposal methods developed to be available in the case of an oil spill response occurring. Most of these methods like waste storage, transport, labelling, recycling, and should be identified in an applicable oil spill contingency plan. Selection of an appropriate disposal method depends on the following factors:

- Applicable laws and regulations
- Availability of existing reception facilities
- Source of material (e.g. onshore or offshore)
- Volume for disposal
- Type of material (e.g. fresh, emulsified or weathered oil; whether oil contains debris such as sorbents, sticks, logs, seaweed, sand and gravel).

The disposal alternatives can be landfill, land farms, open burning, portable incineration, process incineration, reprocessing, and reclaiming/recycling.

4.1 Landfill disposal

Industrial landfill can be used for the disposal of bulky oil spill waste, such as sea grass, shoreline vegetation, woods, sand and general oily trash. The disposal rate depends on local capacity and access constraints as well as governmental restrictions. It is used particularly for oily solid waste disposal. Earth-moving equipment and trucks are used as auxiliary tools. The landfill method has two advantages; first, is useful for a wide variety of debris types. Secondly, it can be rapidly implemented. The disadvantages of this method are, it can be a costly, and can cause future liability.

When deciding to use the method it must be sure that the site is permitted to accept oily wastes and is on the approved waste site list.

4.4.2 Land-farming

For many years hydrocarbon-processing plants have used this method for the disposal of oil sludge. Other than the existing on-site land-farms or commercial or commercial land-farms, there may be significant permitting and regulatory requirements. The method is used for the disposal of liquids and oil mixed with sand or sediment.

To implement land-farming disposal methods, transport, tillers and fertiliser are necessary. The advantages of the land farming method are; first, it can be implemented quickly. Second, oil degrades rapidly. Finally, it uses proven technology. Among its disadvantages can be mentioned the following: first, it requires a large surface area. Second, it is not suited to large oil debris. Next, periodic maintenance requires fertilising, tilling and spreading oil. Finally, the final product may require removal or capping.

4.4.3. Open burning

Burning in open areas or pits is a method primarily used for the disposal of combustible debris like sorbents, vegetation, logs, and large bulky items. Open burning is often conducted by excavating several ditches and alternately loading and burning in each one. As auxiliary equipment sand moving, trucks, fire fighting equipment and air blowers can be used. The method is useful in remote areas, and eliminates contaminated waste permanently. Its problems are linked with air pollution, contamination of underlying soils and incomplete which combustion may leave a residue requiring further disposal.

4.4.4 Process Incineration

Incineration of recovered oil spill materials can be accomplished at facilities with stationary process incineration. These incinerators can be found at refineries, hazardous waste disposal sites and oil reclamation plants. The disposal rate is typically up to several hundred barrels or a few tons per hour. It is used as disposal for both liquid and solid wastes. It requires an efficient storage and transportation network. Its advantages are; first, it can be implemented quickly. Next, permits usually are already in place. In addition, the emission release can be controlled. Finally, it is safer than open incineration. Its disadvantages are; high cost and most incinerators are designed to burn a narrow range of products.

4.4.5. Reprocessing

When oil is recovered in an almost uncontaminated state, reprocessing is an excellent means of disposal. Typical sites which can accept the oil include refineries, pipeline pump stations, terminals and production facilities. Some locations with oil/water separators can also accept debris-free emulsion for reprocessing.

The advantages are that oil is salvaged and can possibly be sold. The disadvantages are linked with the transportation costs.

4.4.6. Reclaiming/Recycling

Oil contaminated with small amounts of sand, gravel, or debris less than 5% can be sent to power plants for reclamation. They typically produce fuel grade oils. An example of fuel use is in cement kilns. Another recycling use is as road-surfacing material when blended with asphalt. This is used to dispose oil or emulsion with a small amount of debris and for weathered oil. It has the same advantages and disadvantages as reprocessing.

Each of the discussed disposal methods can be used after discussion with all the parties interested, and should be part of the contingency plan. If for any reason not permitted the use of one or more methods should also be a reference in the contingency plan.

Chapter V

Contingency Planing

5.1. Scope and Content of a contingency Plan

An oil spill can occur within a campany geographical area or outside, with the possibility the campany to deal with it or not. Thus normal a contingency plan must indicate clearly the geographical area it covers and the mechanisms that can be followed to have access to the next stage. Generally local, national or international plans have a similar format at each level. This makes the change from one stage to another easy.

The CP should define the policy and responsibilities, and should identify the leading organisation or authority responsible for implementation of the CP as well as the supporting legislation and agreements if they exist.

5.2. Strategy

Normally a CP comprises two component strategy and operational plan. The strategy part focuses mainly on the policy, responsibilities and all the theoretical and organisational matters, which are essential for the normal function of the operational plan.

Assessment of a spill risk, prediction of movement and persistence of oil, assessment of resources threatened by possible oil spill, selection of suitable response techniques, outline of the response organisation, training and review procedures are all part of the strategy plan.

5.2.1 Assessment of spill risk

The assessment of an oil spill risk is a process of consideration and judgement about the possibility of its occurrence. Usually the expected frequency, the probable amount and the type of oil likely to be spilt has been taken in to consideration. Since this is not an easy task because some time there is no information available, comparisons with other places with the same characteristics can be made. The frequency of entrance into an oil terminal, the frequency of traffic, for example, in major oil routes can be used as data for the assessment of the risk and applied to the appropriate development of a CP. Depending on the risk the CP will be focussed on the identified risk.

5.2.2 Movement and persistence of oil spill

A well-designed CP should give the possibility to foresee the possible direction of the movement of spilt oil in a certain area. This can be achieved by analysing different types of oil, which probably can be discharged in relation to the prevailing seasonal weather conditions and hydrological data in the area. Nowadays, different computer models capable of predicting the movement of an oil slick once fitted with information of tidal streams, currents and oil characteristics as well as the behaviour of oil spills and introduce the data in the CP are available on the market. The use of such computer models facilitates the process of decision making regarding which area to pay attention, particularly in connection with the protection of sensitive areas.

5.2.3 Resources at risk from a spill

As part of the preparation of the future success for a CP it is very important to prepare maps containing exact information about the resources available in the area covered by the CP. The maps should indicate the location of sensitive areas constituted either of biological or industrial and amenity resources, as well as the definition of strategies for the protection of such areas.

These areas should be graded according to their priority for protection. The possible seasonal changes, which can affect the priority in application of protective measures, must be considered. A mapping process is very important for the future implementation of an operational plan; thus all parties interested should be involved in this stage to avoid future discussions. Normally, this crucial moment reflects the policy all the contingency planning should be based on.

5.2.4 Selection of the Response Techniques.

According to the policy adopted for oil spill fighting and the information available related to the area covered by a CP it is possible to select in advance the response techniques to be used in that area. Every shoreline part of the CP should be clearly identified regarding the clean-up technique to be applied. This can be achieved by using the maps identifying these areas. The selection of response techniques to advance not only helps the operational decision but is also useful for equipment deployment. Location of stockpiles should be identified in the CP. Having selected the response techniques in advance the deployment of non-necessary equipment for the area can be avoided. Furthermore, it helps to locate the stockpile of each type of equipment near the area where it could be needed.

5.2.5. Outline of the Response Organisation

A CP can only be effective and successful if there is an appointed organisation to respond. Such an organisation should have a clearly defined task without interference of any other organisation, except the co-ordinating organisation. Even in that case the limit of intervention of such an organisation should be well identified in order to avoid confusion that can create problems for the normal management of the CP. In different countries different organisations are in charge of the CP. In many countries government agencies are in charge of the CP at open sea while at shorelines the port authorities or the municipalities take care of the CP. However, there are some countries where the private organisations are in charge of the CP while government agencies play the role of co-ordinators, for instance South Africa.

Some government agencies that could be in charge of a CP are the Navy, Coast Guard, Maritime administrations or specialised agencies in the area of spill response.

An organisation responsible for a CP should be granted communication means and logistic support. In addition, it should be given the opportunity to be exempt of customs and immigration formalities. Next, the organisation should be able to take care of liaison arrangements and, documentation of important actions regarding the cleaning process. In some cases the organisation could not afford a large spill response. If this is the case it should request technical support from experienced organisations.

5.2.6. Training and Review Procedures.

Every CP should contain instructions about the training procedures and exercises. Thus training programs should be outlined taking in to consideration all levels defined in the CP. Regular exercises with equipment and simulation of oil spills should be carried out in order to familiarise the personnel with their use. In some cases, at the first moment when a CP is being conceived there is no experienced personnel to be in charge of the training process, then the authority should hire outside experts to train and formulate the training procedure until the local people gain acceptable experience.

The reviewing process of a plan can be based on results obtained during exercises, real operation or as a result of research on newly developed techniques for oil spill response. In all cases it is important to keep all the parties involved aware of these changes.

5.3. Operational Plan

An operational plan gives in detail practical procedures how to respond to an oil spill including all possible events that have taken place since the time the spill occurs till the moment the cleaning operations are concluded. These events include notification of the occurrence of the spill, evaluation, response decisions, clean-up operations, communications, the chain of command and termination of clean-up operations. Though, the referred events during a spill response process may be occurring at the same time, there is a need to outline them sequentially in the plan.

The information required in each of these steps should be described in detail to facilitate the working process. Normally the chronological order is as follows.

5.3.1 Notification

For notification purposes an Emergency Communication Centre (ECC) should be identified, it should have telephone numbers, telex numbers and radio frequencies enabling it to be in contact with other agencies 24 hours a day. All officials taking part in the CP should be able to be in contact with the centre during the same period of time if necessary. In order to help the officer in duty to request the necessary information, a check list form is developed. This usually contains the following information to be asked:

- Date and time of occurrence (observation) specifying local time or GMT.
- Position, for instance, latitude and longitude or nearest landmark.
- Source and cause of pollution.
- Estimated amount of oil spilt.
- Description of oil slicks including direction, length, breadth and appearance.
- Type of oil and its characteristics.
- Weather and sea conditions.

- Action taken to prevent or combat the spill.
- Source giving the information.

The first three items are most important, as with them the ECC can notify other parties expected to take place in the operation while getting additional information.

5.3.2. Evaluation

Detailed information about how to conduct the evaluation process should be laid out in the operational plan. This information may serve as a guideline for the on-scene co-ordinator to assess the situation and easily make conclusions about the threatened areas and resources.

The key points to be addressed in the evaluation process are the following:

- Identification of type of oil and its characteristics.
- Determination of the expected track of the oil slick at regular intervals using data on currents, tides and winds.
- Organisation of surveillance using aircraft if available.
- Identifying threatened resources.
- Informing the parties who might be affected by the spill.

Among the information sources to organise a required evaluation can be mentioned the CP, the shipmaster, salvor, insurer and port authority.

5.3.3 Response decisions

The post spill situation is in some cases tense and can affect the decision making process which can lead to a complication of the clean-up process. This can be avoided by building up a scenario in which all clean-up options are taken into consideration having in mind the type of coastline being threatened. This should represent the practical implementation on the OP of the strategy policy response for the area. In short, this part of the OP can look as follows:

- If no key resources are threatened, no response may be necessary beyond monitoring the movement and behaviour of the slick.
- If key resources are threatened, decide whether their protection is best achieved by combating the oil at sea or by the use of booms or other measures to defend specific sites.
- If no protection is feasible, or if the resources have already been affected, decide on the priorities for clean-up.
- Select the necessary equipment and manpower required and determine availability and location.

Elaboration of such a guideline not only allows the decision-makers to save time but also helps them to avoid long discussion. However, the user of the guideline should bear in mind that during the process may be necessary to change the decisions depending on the evolution of the situation.

5.3.4. Clean-up Operations

An operational plan should contain instructions how to mobilise the necessary means for clean-up operations and how to conduct the operations. In this part of the OP various solutions can be presented regarding how to deploy equipment at sea and also the alternative how other processes may take place according to the situation can be given. Mainly the most important elements dealt with in this section are:

- How to mobilise the necessary equipment and manpower.
- How to deploy the equipment at the required place depending on the response decisions.
- How and when to find the logistical support.

- Which means are to be used for surveillance at different points according to accessibility of the area.
- Selection of the most suitable disposal route.
- Revision of the clean-up operation process depending on the situation on the ground.
- Keeping detailed records for each clean-up location.

While using the guideline, the officer in charge should have in mind that different spills will never be similar, neither in behaviour nor in magnitude. Depending on how the spill will be handled since the very first time it occurs, the subsequent clean-up operation will be different.

5.3.5. Termination of Clean-up

It is not an easy task to develop a termination guideline for clean-up operations because of the way such endings evolve. Since they are required to end while become ineffective or when the satisfactory level of clean-up has been achieved, an instruction should be laid down for:

- Liaison with all interested parties regarding the conduct of the operation and the level of cleaning to each location.
- Standing down equipment and returning it to stores for cleaning and maintenance.
- Re-ordering consumed materials and repairing or replacing damaged equipment.
- Restoring a temporary storage site and tidying up other working areas.
- Preparing a detailed report on the operation, which can be used to support any claim for clean-up expenses and to review the CP.

Drafting a CP is a task that should evolves various parties with an interest in the area covered by the plan. However, these should be in a position to understand and interpret data given by different institutions in order to design the strategic and operational plan in accordance with the local conditions. Furthermore, experienced people in field operations will be necessary to lay down a workable OP that can be easily understood. Next, the CP should be practised by all people involved and should have the commitment of the top management. To summarise, the CP should be of concern to all parties, not only for the organisation in charge.

5.4. Formulation of claims

Funds for compensation of costs caused by spill damages from ships is normally guaranteed by the assurance companies or by the shipowners' mutual protection. Though, to get access to these funds requires the fulfilment of certain procedures, which can be in some cases linked with the operational procedures, for example a record of all expenditures or identification of resources threatened. In some cases the impediment of getting funds can be caused by the non- ratification of relevant international conventions.

The complexity of the claim formulation is not only derived from fields technical matters but also from a legal point of view. Thus, it is necessary to involve experts in legal matters. The best way to overcome the problem is to hire a specialised agency.

A guideline for formulation of claims usually contains the following information.

- Name and address of the claimant
- Date and location of the accident
- Identity of the source involved
- Type, quantity and geographical impact of the spill
- Evidence in the form of chemical analyses, or movements of floating oil, to establish the original source of pollution and link it with the claim.
- Summary description of the events of the incident; the action taken in response to it; and the extent of damage to property or activity.

- A break down of costs related to specific clean-up activities at each main work site, e.g. labour, equipment, material, and transport costs on a daily or week basis.
- Costs incurred or anticipated in replacing or repairing items of declared age.
- Comparative figures of previous earnings and lost profits to prove economic losses
- Maps and photographs illustrating the above points.

The way the events mentioned above are handled can influence the window-time necessary for solving the problem.

Chapter VI

Maputo Bay Contingency Plan

6.1. Introduction

The Bay of Maputo is located along one of the major important routes for world shipping. Thus, about three hundred tankers carrying crude oil pass by the area each day posing a threat to the environment. In addition, some ships enter the bay bringing hydrocarbons imported by the country.

The ever-growing importance of crude oil in the world economy, and to Mozambique in particular cannot be over-emphasised. The growth of the oil industry in Mozambique during the last decade has been accompanied by environmental concerns. One of the problems usually associated with the production, transportation and use of oil is its unavoidable release into a different environment. Consequently, the need to clean up those areas. In order to carry out a successful clean up operation a contingency plan is needed.

The Concise Oxford dictionary defines *contingency* as an "uncertainty of occurrence" and *planning* as an "arrangement for doing or using something considered in advance"; therefore, Contingency Planning is "a prior arrangement for a possible happening".

An effective Oil Spill Contingency Plan should have an organised and predetermined course of action to be pursued in the event of a spill. Furthermore, a good contingency plan should spell out, in detail, the exact steps or procedures to be taken in case a spill occurs. Therefore, an effective Oil Spill Contingency Plan has basically three functions:

a) To ensure that the environment is protected
b) To ensure that manpower, equipment and funds are available to effectively contain and cleanup the oil spills.
c) To ensure that good record keeping is maintained and accurate information concerning the spill is disseminated to the public and government.

Obviously, a great deal of planning is required to accomplish these functions. Therefore, during the process of planning, three requirements should always be kept in mind. These are;

a) The plan must provide guidelines for co-operation, communication and assistance from appropriate indicated bodies.
b) The plan must cover both foreseeable and non-anticipated situations;
c) The plan must be realistic and updated.

6.2. Objectives

The Maputo Bay CP is intended to spell out the guideline and responsibilities for an effective response to the oil spills that could occur and threaten the environment within the bay.

The second objective is to ensure an organised and effective response to the oil spill or threat of oil spill, by identifying a viable operational organisation with the inclusion of interested agencies as well as highlighting the sensitive areas and suggesting a reasonable clean up policy for the area.

Finally, the plan is intended to provide the guidelines for an effective co-ordination between different plans, for instance, the Companies CP within the bay, the Maputo Bay CP and the National CP.

6.3. Location of Maputo Bay and Environmental considerations.

The Bay of Maputo lies between latitudes 25°50´S and 26°15´S. Three islands are located within the bay, namely, Inhaca Island, Ilha dos portugueses Island and Xefina Grande Island. The bay is situated on the latitude corresponding to the climate transition from tropical climate to the warm temperate (Macnae & Kalk, 1969).

Maputo City is built around the bay therefore, Maputo and Matola Ports are located along the bay. Along the Maputo Bay coastline are situated three local famous beaches, namely, Catembe beach, Costa do Sol beach and Macaneta beach. Amenity activities grow year after year in the region, thus marine terminals are being rebuilt.

A less dense mangrove forest extends from Costa do Sol area till Macaneta. Mangroves also cover part of Inhaca Island and Catembe coastline along the Matola Channel.

Fishing activities take place within the bay. These activities are mainly artisanal drift gill netting from small boats, artisanal set gill net and semi-industrial shrimp trawling fisheries.

Three species of marine mammals have been identified within the bay. These are the bottlenose dolphins, the Indo-Pacific humpback dolphin and the dugong. All the three species populate mostly the eastern part of the Bay.

One of the threatened species living in the Bay is the sea turtle. A project for their protection is currently underway at Inhaca Island.

The Inhaca and Portuguese Island have been declared biological reserves by the government, and protection of dune forests, turtle nesting beaches, mangroves and coral reefs is taking place under the supervision of the department of biological science of the Eduardo Mondlane University (SIDA, 1992).

All that makes Maputo Bay as a whole a sensitive area which needs to be protected from any threat of an oil spill.

6.4. Risk Assessment

Mozambique imports approximately 206.000 tons of hydrocarbons through the Port of Maputo. The only national refinery is situated in Matola Port, but although, it does not work now, there are negotiations going on to put it into service.

With the country living a peacetime the economy is reviving, and the landlocked states are regaining confidence in using Maputo Port. Therefore, the shipping traffic is intensifying within the Bay. To this should be added the transit traffic of ships carrying millions of tonnes of crude oil. The example of a threat of passing vessels is the 1992 accident in which Katina P spilt 72,000 tons damaging mangrove forests as well as the fishing and tourist activities in the Bay

Section I: Basic Criteria

6.I.1 *Definitions:*

I.1.1- **Maritime Administration. -** Maputo Maritime Administration is the authority, and the Maputo Bay is under its jurisdiction.

I.1.2- **SAFMAR-** Is the National Maritime Authority under which the Maputo Maritime Administration is subordinated.

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I.1.3. **Operational Centre-** Is the place from where the Operational Co-ordinator co-ordinates the activities of the different groups involved in oil spill response.

I.1.4. **Operational Co-ordinator-** Is the person indicated by the Maritime Authority to co-ordinate the work of different groups engaged in oil spill combat operations.

I.1.5. **On-Scene Co-ordinator-** Is the person to which the Maritime Authority has assigned the field co-ordination task during the clean up operations.

I.1.6. **Advisory Technical Team-** Is a group of specialist with different background which is assigned the task to assist the Emergence Committee in maters related to specifics subjects linked to the oil spill response.

I.1.7. **Accidental pollution-** Any spill of any contaminant substance resulting from accident at sea or resulting from any other non premeditated action.

I.1.8. **Response.-** Any action taken with objective to prevent, contain, reduce, survey or combat any spill

I.1.9. **Response Group-** Is a group prepared to give direct response to any accident using all available means to prevent, combat spills at sea or on shore.

I.1.10**. Area of Responsibility -** The area at sea or on-shore in which an authorised authority exercise its jurisdiction.

I.1.11**. Support Group-** Is a group intended to do supplementary work in order to permit effective function of the response groups.

6.I.2. Type of Contingency Plans Linked with Maputo Bay CP.

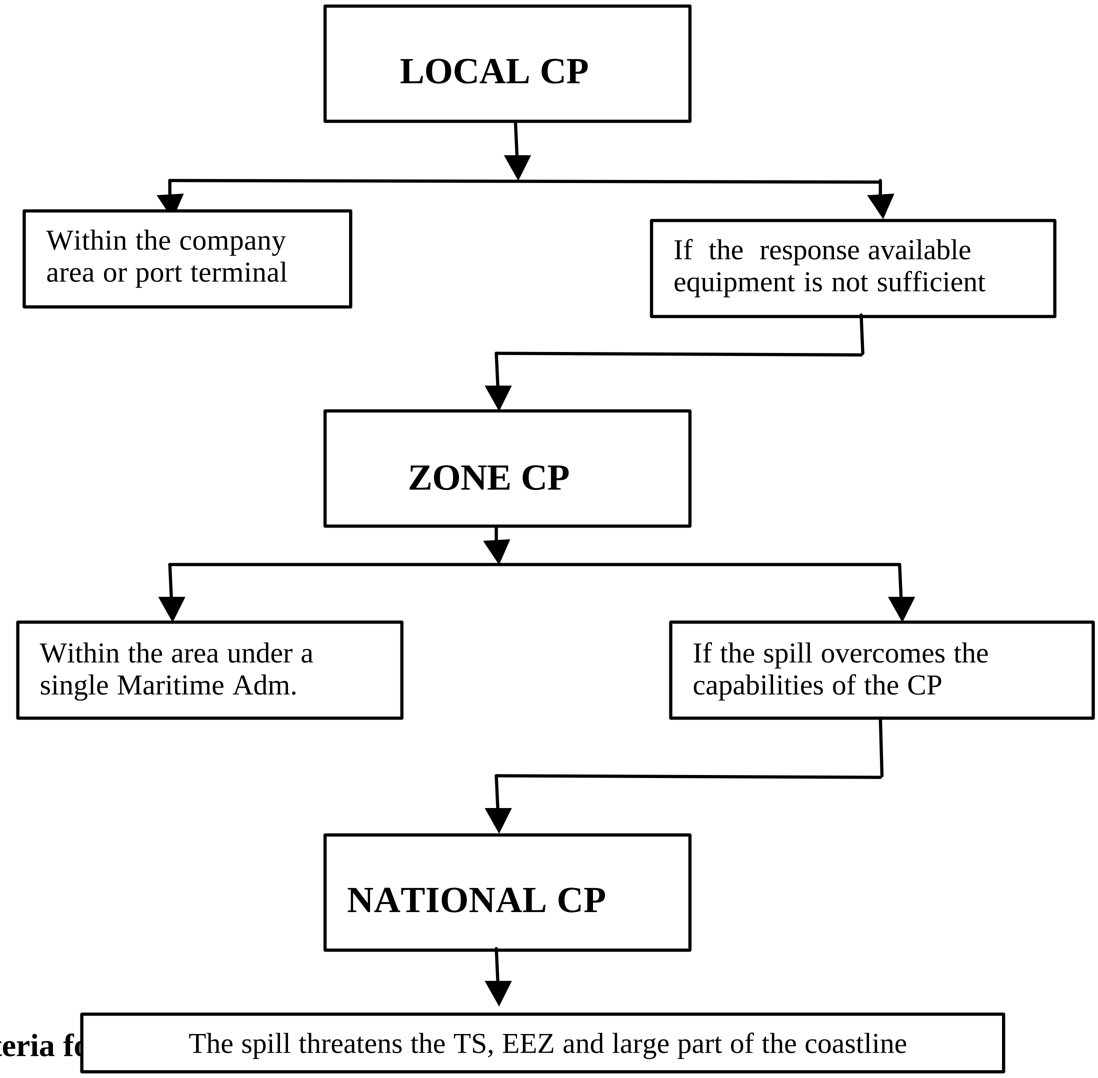
I.2.1. **Local CP-** Is a CP, covering the jurisdiction area of a company or port terminal.

I.2.2. **Zone CP-**Is a CP, covering the territorial sea but does not include the EEZ.

I.2.3. **National CP-** Its scope of application covers all the TS, EEZ and all the national coastlines.

The following figure shows the different CPs as they should be activated.

Fig 6 chart representing the link between different Contingency plans



I.3. Criteria fo

I.3.1. When an oil spill occurs within a company's area or port terminal where response equipment is available, the Local CP should be activated, though the Maritime Administration should be informed. If the activation of next the plan is likely to occur the Maritime Administration should be informed too.

I.3.2. If the spill takes place in the TS or happens within the port or any company's jurisdiction but overcome their response capabilities, the ZONAL CP should be activated and the SAFMAR should be informed. The National CP shall be ready to be activated in case the Local CP does not succeed to take the operations to the end.

I.3.3. When the oil spill occurs within the EEZ or all of the previous plans fail to give an effective response to an oil spill and it threatens to cause more damage the national CP should be activated. The entity in charge of the national CP should look for other options to surplus the efforts being made within the national CP in case it fails.

6.I.4. Mechanism of Activation of Maputo Bay CP.

I.4.1. The Maputo Bay CP shall be activated by the **Emergence Committee** in places where it has been activated a local CP if the circumstances require such action.

I.4.2. The Maritime Administration shall activate this plan to provide a response to any spill within the Bay and along its coastline

I.4.3. This plan should be always activated through the Co-ordinator Centre following the information given in the report filed according to the report model adopted by the organisation

6.I.5. ORGANS, ENTITIES AND COMPANIES PART TO THIS PLAN

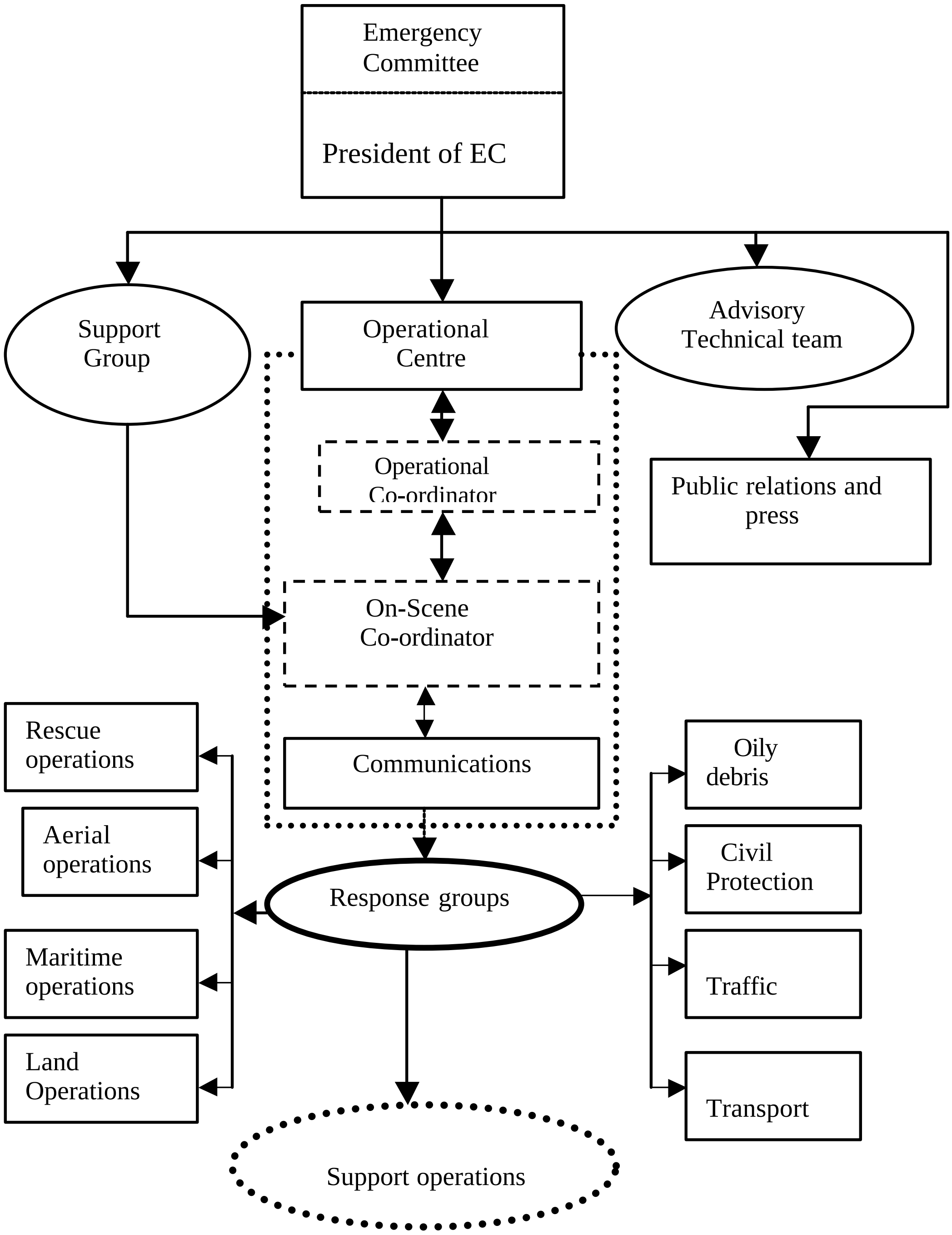
I.5.1 The success of a plan does not depend only on the designation of the authority in charge but also depends on the involvement of other entities supposed to render assistance to the designated body. In this case these shall be:

a) Maputo Port Authority
b) The Maputo Municipal Government
c) The City Fire Brigade
d) The City Health Directorate
e) The City Police Headquarter
f) Oil and Shipping Industry
g) The City environmental Co-ordination Directorate
h) The City Custom Directorate and
i) Non Government Organisations.

I.5.2.-The Authorities, Organs, Entities and Companies party to the CP will be integrated in different leading and operational groups described below.

I.5.3. **ORGANISATIONAL STRUCTURE**

Figure 7



6I.6.-Responsibility and Response Organisation.

I.6.1. **The Emergency Committee-**has duties to organise and lead the operations as well as co-ordinate institutional relations with other entities. Its responsibilities cover the following aspects:

a) Taking general decisions related to the operational response problems and order their execution.

b) Keeping permanent contact with the OSC and evaluating permanently the situation.

c) Establishing links with other Institutions, organs and companies.

d) Establishing the framework, which should provide support to the operational groups.

c) Recording and documenting the information about the response process and allowing the registration of claims.

I.6.2. **Advisory Technical Committee-** Its duty is to advise the Emergency Committees in technical and legal matters related to response operations and its functions should include the following:

a) Evaluating the development of an oil spill response and propose further actions in order to accomplish the response operations successfully.

b) Collecting all data of the spilt Substance and study the possible effects of a such substance on the ecosystem and local fauna and propose protective measures if possible.

c) Making an analysis and suggesting necessary legal measures supposed to help solve claims and other problems faced during the oil spill response process.

Specialists from different fields such as maritime environmental protection, civil protection, public administration and lawyers should constitute the Committee.

I.6.3**. Support Group.-** This implements the Emergency Committee's decisions and serves as a link between the Emergency Committee and the OSC. It provides logistic support to the response groups and exercises public relations duties.

I.6.4. **Operational Co-ordinator.-** This supervises all technical aspects of different response groups involved in field operations through the field On-Scene Co-ordinators.

I.6.5**. Response Groups.-** These carry out all the field practical operations as recommended in respective operative plans. These groups are under authority of the Field On-Scene Co-ordinator.

6.I.7. Training, Periodical Exercise Plan and Plan Revision.

I.7.1 It is important that personnel who have been identified for oil spill response should receive training in the various response strategies. Thus the Emergency Committee should organise yearly training programs for all levels of oil spill response personnel. The training sessions should include exercises with all the means available.

I.7.2. Short courses should be arranged abroad possibly every year for the key personnel in order to update them in the new techniques.

I.7.3. The On-Scene Co-ordinator, assisted by one member of each of the response groups, should endorse the Emergency Committee's proposals for revision and annually update the plan if necessary.

SECTION II. GENERAL OPERATIONAL PROCEDURES

6.II.1. Notification

II.1.1. In any spill operation the possibility to design an operative plan can be possible only if information is provided. Initial information can be provided by the ship involved in the accident or by the surveillance team. In both cases a report form should be filed.

II.1.2 The report form should be filed by the observer of the spill or by the authority or entity which has received the information and should send the form as soon as possible, to the Co-ordinator Centre.

6.II.2. Immediate Action to be Taken by the Co-ordinator Centre.

II.2.1. Immediately after receiving spill notification, the Maritime Surveillance Department should be informed, all Emergency Committee members and the OSC should be informed and, information should be sent also to the Maputo City government and SAFMAR.

II.2.2 If the polluter source is an identified vessel the CC should make effort to maintain communication with her using all available means.

II.2.3 The CC should request all data related to the spilt substance according to the report.

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II.2.4. According to the available information, if necessary the local or regional plan should be activated or the activation of the National Contingency Plan should be requested.

6.II.3. How to Activate the Different Institutions of the Plan

II.3.1. If the oil spill information received by the CC after evaluation requires activation of this plan the Maritime Administration, through the CC, should call a meeting for all permanent members to decide the activation of different entities as the circumstances require.

6.II.4. Evaluation of the Situation and Setting Up of the Operational Plan.

II.4.1 Evaluation of the current situation after an oil spill report includes dissemination of all data received by the CC, which can be useful during the preparation of an operational plan. This should have in consider the following:

a) The sensitivity of the areas being threatened by the spill.

b) Whether the area affected by the spill falls into the priority coast according to mapping system.

c) The properties of the substance spilt and possible effect on the ecosystem.

II.4.2. Once the evaluation is finished and all possibilities have been consider, the following step is to establish of an operational plan taking into consideration the following:

a) The establishment of possible movements of slicks using all means and data available.

b) Organising the surveillance service.

c) Identifying the sites with priority to be protected.

d) Organising the logistic support.

e) Establishing communication systems between different groups involved in the operations.

f) Identifying the routing system suitable for the evacuation of collected oily debris and deployment of logistic support if needed.

g) Establishing a registration system for compilation of the daily operation and equipment involved.

h) Cleanup procedures and maintenance of equipment.

i) Forecasting for the end of operations and personnel transportation and delivery of equipment back to stockpile.

6.II.5. Protection of Sensitive Areas

II.5.1 Protection of sensitive areas should have in consideration the information available on maps made specially for protection purposes if they exist, as well as additional information obtained during the working process.

6.II.6.- Introduction of Changes to Operational Plan.

II.6.1. Flexibility of the OP should be allowed to facilitate introduction of changes according to the evolution of cleaning up operations. If such amendments are related only to technical aspects can be made by the members of CC in order to avoid any delay by the EC should be informed.

II.6.2. If the proposed changes to be introduced include major protective alterations in places considered as a priority and the moving of staff from these places is contemplated then the decision should be taken by the EC with the TC's advice**.**

6.II.7. Communication

II.7.1 The success of any oil spill response depends upon the communication system designed before and during the operation itself. Thus, it is recommended to establish the means of communication in the CC and these means should be provided to every response group in the field.

II.7.2. During the preparation process the OSC shall agree with the leaders of the response groups the convenient means and the frequencies to be used.

II.7.3. Each RG should have at least two frequencies, one of which is to be used for communication between the RG and its leader. The second will be for all groups and is intended to be used for general instructions between the groups and the OSC.

II.7.4. Communication should be arranged between the CC and the EC. This should include telephone, fax, radio and telefax.

II.7.5. The key members of each organ in this plan should have their home phone number registered at CC.

6.II.8.- Public Relations

II.8.1 The EC should establish a group with the duty to prepare the press statements and other documents to be endorsed by other institutions if necessary.

II.8.2. All official Press Statements related to the response operation should be agreed upon and signed by the EC.

II.8.3. The press' access to the field should be organised by the group stated above in co-ordination with the OSC but should be approved by the EC.

SECTION III. RESPONSE DECISION

III.1 All response decisions should take into consideration the surrounding circumstances to every spill. Thus, an analysis should focus on the possible effect on the environment and activities taking place within the area as well as the vulnerability of the coastline being threatened. This will help in the design of a successful response operation. In all cases attention should be paid to:

III.1.2. The possible biological threat posed to the area, which endangers marine life and disturbs the ecosystem stability. This can be caused either by the spilt substance or by the used cleaning techniques if wrongly applied.

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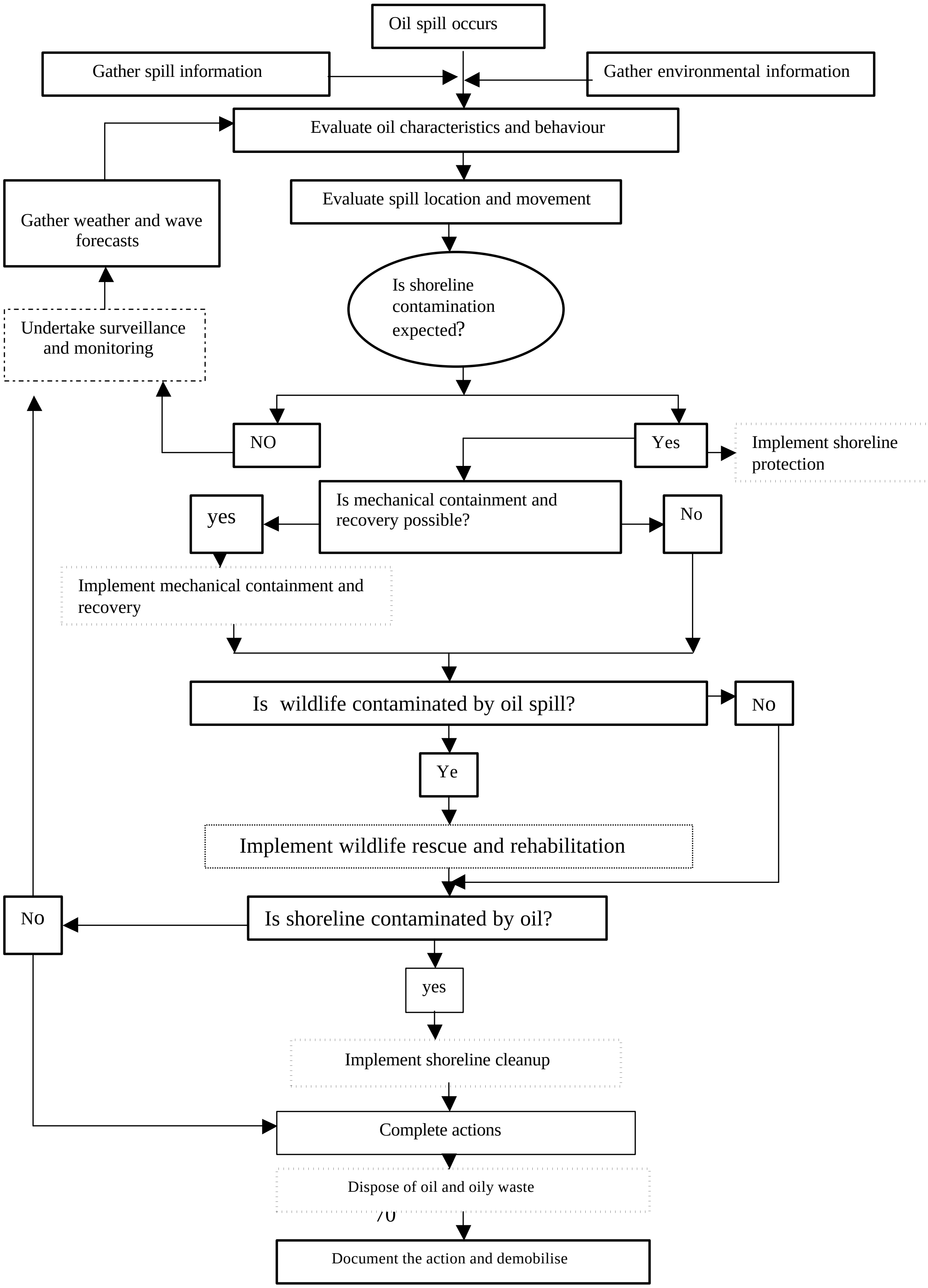
III.1.3. Attention should also be paid to the effect of ongoing activities, for instance, tourism, port and industrial activities

Fig.8.Decision flow-chart for oil spill response in the Maputo Bay area.



6.III.2. SPECIAL MEASURES For SENSITIVE AREAS AND CRITERIA FOR THEIR PRIORITISATION.

III.2.1**.** One of the tasks during oil spill preparedness is the identification of sensitive areas for posterior prioritisation in order to concentrate efforts on the protection of these qualifying as the highest sensitive areas during an oil spill response**.**

III.2.2. Three factors should be taken into consideration when determining coastline priority.

a) Its sensitivity index;

b) Its ecological and economic importance

c) The level of threat in relation to other places.

III.2.3. Since there is a possibility to fail the protection of all the places threatened because of lack of protective equipment, the sites with the highest index of sensitivity should have priority.

III.2.4. The TC should advise the EC in the process of taking decisions for the protection of such sites**.**

6.III.3. - Selection of Clean-up Techniques

III.3.1. Maputo Bay presents a lagoon environmental with complex hydrographic characteristics. The highest depth is about 18 meters within the water channels. This narrows the possibility of use of different response techniques.

III.3.2. Having in mind considerations what is state in point 3.3.1. the use of dispersants should not be permitted

III.3.3. Containment and mechanical recovery techniques are recommended to be the basis of the clean up policy in the area.

III.3.4. Polluted sand beaches should be cleaned manually.

III.3.5. Use of trucks and bulldozers on sandy beaches should be reduced to a minimum level.

III.3.6. The type of coastline shall determine in all cases the clean-up technique to be chosen.

6.III.4. Initiation of response

III.4.1. The chairperson of the EC should carry out the proposal of initiation of response.

6.III.5. Report on the situation

III.5.1. The permanent reports during the spill response shall provide updated information on the situation, which is necessary to determine the effective management of resources and the satisfactory result of a response.

III.5.2. The situation report shall be sent as often as necessary with the purpose of providing a complete description of the problem, action taken, future plans, recommendations or request for assistance

6.III.6. Termination of a response

III.6.1. A recommendation to terminate a response shall be made after consultation between the On-Scene Co-ordinators, Filed On-Scene Co-ordinators and the members of the EC. Following the consultations, the Chairperson of the EC may declare the termination of the response.

SECTION IV. MANAGEMENT OF RESOURCES AND SERVICES

IV.1**. -** The EC is responsible for acquiring and managing resources as well as contracting services if these are to be done by an independent organisation.

a) Contracting procedures should be decided by competent institutions according to the public administrative rules.

b) Contracting procedures binding the entity supervising this PC and the oil industry and port authority holding private resources should be laid out.

c) The SG should be entitled to have the management, control and maintenance of all technical resources at their disposition.

6.IV.2.- Control of Dispenditures

The SG should registrate all dispenditures undertaken within the program of this plan and files all the process as will indicated in special provisions.

SECTION V. National Legislation

V.1. Protection of the environment is possible only if an adequate legal system and enforcement of regulations exist. However, the lack of secondary legislation in developing countries has been the major problem.

For instance, marine environment protection legislation in Mozambique is still in its early stage of development, thus very little detailed regulations governing operational procedures and fixing penalties can be found. However, the basic legislation is already developed, though, some of this legislation is dated from the colonial period and still is not updated. The existing basic legislation includes the National Constitution of 1990 which in its articles 35,36.37,38,39,47,54,72 and 89 gives the general provisions concerning to the environment and, the National Law of the Sea of 1996, the Presidential Decree of 1994 giving power to the Government to present claims at National and International Judicial Entity on behalf of national citizens and companies affected by an oil spill. The only regulation dealing with oil spill, from ships was published in 1973 based on the very first convention that addressed marine pollution problems, OIL-POL 54.

6.V.1. International conventions,

Although, Mozambique has ratified a satisfactory number of conventions addressing safety and environmental matters, it has failed to ratify the most important international provisions in the area of marine pollution prevention and preparedness, namely MARPOL and OPRC- 90. The International Conventions that Mozambique has ratified are: IMO convention 48, COLREG 72, SOLAS 74/78, LOAD LINE 66, CLC 69, FUND Convention 77, LAW of the SEA Convention and STCW 78/95 Convention.

a) The CLC 69 Convention.

This convention deals exclusively with damages caused by oil pollution, as well as the preventive measure taken to minimise damages caused on environment within the territorial sea and the EEZ as stated in Article II of the Convention. In the light of the CLC 69 Convention, the tanker owner is liable for any damage caused by oil escapeing from ships as a consequence of an incident occurring in the water of the member states. The Convention not only regulates the ship owner's strict liability for oil pollution damage, but it imposes a compulsory system of liability insurance under the Article III. According to the Article every shipowner of a ship carrying more than 2,000 metric tons of persistent oil as cargo or bunker is therefore obliged to have insurance covering oil pollution damage liability, up to the limitation amount, which is underwritten by the shipowner's P&I Club. Therefore tankers are required to carry on board a certificate issued by the Flag State attesting the insurer.

According to the Convention the shipowner has exemption from the liability if the accident resulted from:

-An act of war or act of God.

-Sabotage by a third part, or

- The public authority's negligence in maintaining navigational aids.

In some cases the shipowner can limit his liability to the following amounts:

-For ships < 500 GT, 3 million SDR (approximately US$4.3 million).

-For ships between 5000 and 140,000 GT, 3million SDR + 420 SDR, and

-For ships > 140,000GT, 59.7 million SDR (approximately US$85.8million).

The payable amount as indicated above, reverts to the claimants in proportion to their proven claims.

b) FUND Convention 71

The Convention is an instrument intended to supplement the CLC69. Its purpose is to provide supplementary compensation to those who cannot obtain full compensation under the CLC Convention. Its particularity is that only the CLC members can become part of the IOPC Fund. In this instrument the cargo owners are the one who contribute to the funding.

The claim should be made within the period of three years from when the date of the accident and damage had occurred.

SECTION VI: LEGAL ASPECTS

6.VI.1. Presentation of claims:

Claims can arise as a result of pollution damage to property, economic loss or cost due to the pollution prevention and control activities.

VI.1.1.All the claimants should address their claims for registration to the Maritime Administration.

VI.1.2.The Maritime Administration should present all the claims against the person, ship or company responsible for the oil spill

VI.1.3.All costs to the company resulting from a contract for a response operation should be settled on the basis of that contract.

6.VI.2. Information required from the claimants.

VI.2.1 In order to present a credible claim a minimum of information is required froms the claimant. Such information should contain the following data:

a) Name and address of the claimant,

b) Date and location of the incident,

c) Identity of the source involved,

d) Type, quantity and geographical impact of the oil spill,

e) Evidence in the form of technical analysis, or movement of floating oil, to establish the original sources of the pollution and links it with the claim.

f) Breakdown of costs related to specific clean-up activities at each main work site: e.g. labour, equipment, material and transport costs on a daily or weekly basis.

g) Comparative figures of previous earnings and lost profits to prove economic loss.

h) Maps and photographs illustrating the above points.

Chapter VII

1. Conclusion and Recommendation

7.1.1. Conclusion.

This dissertation emphasises the need of a contingency plan covering the Maputo Bay, to enable the local maritime authority to deal with possible oil spills in the future.

In response the author sincerely attempts to answer the needs of the local authorities, by offering a proposal of a workable plan and trying to identify the possible organisation responsible for it, as well as giving indications which are the institutions should join such organisation.

Furthermore, attempts to give solutions to the problems regard to whom and how to activate the plan. The links between different plans are dealt with to some extent. In addition, the organisational structure, the decision making process, the responsibility and duty of each group party to the plan is developed in detail in chapter six.

Moreover, as part of the whole effort to offer full information related to contingency plan building, information about different equipment as well as various clean-up techniques is developed through the dissertation.

Finally, waste management and disposal as well as the basic national legislation and international conventions that Mozambique is part of, dealing directly or indirectly with maritime environment and oil pollution are dealt with in some extent.

7.1.2 Recommendations

One of the very serious problems that the country faces is a lack of well-trained personnel and updated legislation. Thus, the country shall concentrate its efforts on building training programs, updating the national legislation and accedes to the MARPOL 73/78 and OPRC 90 Conventions.

The Administration shall prepare a contingency plan document and adopts legislation to implement such contingency plan. The country experience shows that though it ratifies conventions, they are not integrated to the national legislation. Therefore, is recommended to integrate them into the national legislation, in order to be effective tools for the purpose they are intended to.

The Administration is recommended to request Oil industries the Maputo and Matola Ports to develop their own contingency plans in order to be integrated to the Maputo Bay contingency plan.

Since the Republic of South Africa has experience in this field, it could be useful to have technical co-operation in the light of the inter-governmental agreement that exists between the two countries.

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