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Effecting a framework for a national oil spill contingency plan for the Kingdom of Cambodia

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EFFECTING A FRAMEWORK FOR A NATIONAL OIL SPILL CONTINGENCY PLAN FOR THE KINGDOM OF CAMBODIA

By

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Kingdom of Cambodia

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is 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: **Effecting a Framework for a National Oil Spill Contingency Plan for the Kingdom of Cambodia**

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Constant increase in an annual oil consumption world-wide from 880,632 million gallons in 1983 to 1,004,268 million gallons in 1993 demonstrates the growing demand for oil tankers to move oil from producing nations to utilising ones, resulting in incidents of oil spills into the coastal and marine environment. The most catastrophic oil spills reportedly took place in 1979 when about 193 million gallons of oil were discharged into the seas. With no exception, Cambodia is believed to encounter threats of oil pollution incidents since the nation gradually involves with maritime transport and oil and gas development. When introduced into the seas, an oil spill presents two kinds of negative impacts: ecological impact, including impact on biological processes, marine plankton, fish and shellfish, marine mammals, birds communities and ecosystems, human health, and on shore vegetation, and economic impact, including impact on fishing industry, tourism industry, shipping sectors and on other industrial uses.

To prevent, mitigate and minimise threats of oil pollution in Cambodia, a framework for a National Oil Spill Contingency Plan (NCP) is proposed to ensure a timely and effective response to oil pollution incidents by pre-designating the responsible organisation and providing adequate resources. The plan addresses issues, including emergency notification, incident evaluation and plan activation, response strategies, sensitive area identification, and communication system. To be effective, the plan should be supported by legislation. Various levels of emergency response should be provided beginning with local plans and expanding to national and regional plans.

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LIST OF ABBREVIATIONS

bbl	barrels
CACA	Cambodia Authority for Civil Aviation
Cambodia	Kingdom of Cambodia
Campex	Cambodia Petroleum Exploration Co., Ltd.
DNA	Deoxyribonucleic acid
ELF	French Petroleum Firm
Enterprise Oil	Enterprise Oil Exploration Ltd.
EPA	US Environmental Protection Agency
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Pollution
IE/PAC	Industry and Environment/Programme Activity Centre
IPIECA	International Petroleum Industry Environmental Conservation Association
JAPEX	Japan Petroleum Exploration Co. Ltd.
MAFF	Ministry of Agriculture, Forestry and Fishery
mgals	Million gallons
MIME	Ministry of Industry, Mine and Energy
MND	Ministry of National Defence
MOE	Ministry of Environment
MOI	Ministry of Information
MOJ	Ministry of Justice
MOT	Ministry of Tourism
MPH	Ministry of Public Health
MPWT	Ministry of Public Work and Transport
mt	million metric tons
mta	million metric tons per annum

NOAA	National Oceanic and Atmospheric Administration
Premier Oil	Premier Petroleum Cambodia Ltd.
RGC	Royal Government of Cambodia
TSDs	Temporary Storage Devices
UNEP	United Nations Environment Programme
VLCCs	Very Large Crude Carriers

CHAPTER I

INTRODUCTION

Marine pollution has only recently become the main focus of international concern. In fact, it was not until the second half of the present century that marine pollution received widespread concern among policy makers, scientists, sea-users and the general public (McIntyre, 1995). This concern was strongly echoed at the United Nations Conference on the Human Environment held in Stockholm in 1972. At the end of the day, the conference concluded that the greatest threat to the marine life, in particular, and the marine environment, in general, seemed to be marine pollution (Pernetta, 1995). Additionally, given the fact that life of all kinds originates from the seas and that the oceans, as a whole, need to be pollutant free, marine environment pollution and degradation is a matter of hot debate in sub-regional, regional and international fora. A great emphasis is put on the deleterious impact of marine pollution on living resources, its hazard for human welfare, its hindrance of maritime activities, its impairment of sea-water quality and reduction of amenities. All these result from the human's introduction into marine environment of domestic and industrial waste and a tremendous amount of oil.

This dissertation intends to look at marine oil pollution which is becoming increasingly important for the nation and international communities to address. Particular attention and consideration is given to oil pollution incidents experienced in the region of Cambodia as well as the rest of the world. In this regard, vessels involved in accidental oil spills and targeted for discussion are oil tankers and other carriers, including chemical tankers, liquid gas tankers, bulk carriers, OBO carriers, container ships, general cargo ships, reefer ships, special ships, RO-RO ships, cargo passenger ships, RO-RO/passenger ships and passenger ships. For non-tankers, the main focus is on accidental spillages of bunker oil as opposed to cargoes transported. To provide a broader picture, the focus is then turned to the potential for massive oil pollution from offshore oil and gas exploration and production activities.

Much effort is devoted to an analysis of the major threats of oil spill incidents to the coastal and marine environment, a growing concern among government agencies and the general public. Such analysis is intended to provide a wider awareness and better understanding of the detrimental impact of oil spilled. To this end, the significant impact on coastal and marine ecosystems and economic activities is examined separately. The ecological impact of oil spilled includes, inter alia, effects on biological processes, effects on marine plankton, effects on birds, effects on shore vegetation, and effects on human health. On the other hand, major economic activities likely to be affected by oil spill incidents include the fishing industry, tourism industry, and shipping industry, as well as other industrial users of the sea.

The trend towards oil pollution within Cambodia's waters is discussed looking at oil and gas exploration, oil products imported, as origins of possible oil pollution incidents.

The framework for a National Oil Spill Contingency Plan (NCP) is proposed to provide fundamental guidance for future development of comprehensive and effective contingency plans at all levels. Regarded as the highest level of national preparedness for emergency response, the NCP is best divided into seven main components: 1) an introduction covering such aspects as definitions, purpose and objectives, and scope of coverage; 2) organisational responsibilities dealing with response organisations, duties and responsibilities designated to individual sections within the plan, and inter-agency participation; 3) preparedness and planning, looking at environmentally sensitive area identification and prioritisation, planning and co-ordination structure, training and exercises to ensure response capability and smooth deployment of equipment, and revisions to the plan; 4) response operations (operational procedures) addressing issues of emergency notification, incident evaluation and plan activation, response strategies, clean-up and disposal of recovered oil debris, ongoing incident assessment, public and media relations, and health and safety issues; 5) regional and international co-operation; 6) resources needed, including human resources, equipment and funding; and 7) reports and communications. Finally, conclusions and recommendations are formulated.

Difficulties and challenges were faced in the development of this dissertation since the data and information required are not necessarily available or are out-of-date. Various approaches taken to alleviate these problems included personal contacts and interviews with resource persons during semester breaks and field trips; asking for assistance in terms of documents from visiting professors; ordering necessary publications from overseas libraries and publishing institutions through the World Maritime University's library; searching through the internet; constantly consulting the dissertation supervisor; and discussing with colleagues.

CHAPTER II

MARINE OIL POLLUTION FROM A GLOBAL PERSPECTIVE

McIntyre (1995) described oil as the major marine pollutant. Oil pollution of the marine environment in the form of oil spills from ships and offshore platforms and operational discharges from sea-going vessels is discussed in this chapter with an analysis of its significant environmental and economic impacts. Additional emphasis is put on trends toward oil pollution within Cambodia's waters aiming to justify the necessity for provision and development of an emergency response mechanism capable of dealing with the worst probable oil pollution incidents.

2.1 Ship-Based Oil Pollution Incidents

2.1.1 Oil tankers

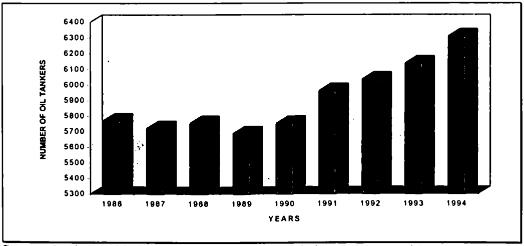
Oil is used as a major source of energy in both household and industries. Statistically, the annual amount of oil consumed by countries in different regions constantly increases (Etkin, 1997). Table 1 shows the quantity of oil used in various regions on a yearly basis. Increasing oil consumption puts a steady and increasing demand for maritime transport of oil, both crude oil and refined products, from one part of the world to another. In 1994, oil (crude and refined products) represented 50 per cent of world seaborne trade (Ma, 1996). This simply implies that numerous oil tankers (Figure 1 clearly shows increasing demand for tankers) need to be employed and, thus, accidents during loading, unloading and transporting are likely to occur.

Table 1. Annual oil consumption by region (millions of gallons[1])

Year	North America	Latin America	Europe	Middle East	Africa	Asia & Australia	Total World
1983	246,652	67,912	343,622	41,749	24,221	154,297	880,632
1984	254,401	67,069	345,462	44,534	24,527	160,352	896,345
1985	255,398	68,295	342,549	45,913	26,444	160,045	898,645
1986	263,753	70,671	351,671	45,530	25,908	167,787	925,319
1987	269,885	72,894	353,050	47,293	27,134	172,999	943,255
1988	280,462	74,427	353,817	46,910	28,131	186,260	970,006
1989	282,149	76,267	355,197	48,750	29,894	197,604	989,858
1990	275,863	77,340	359,258	52,122	31,043	200,944	1,005,571
1991	270,268	78,336	348,681	52,811	31,273	218,989	1,000,819
1992	273,947	81,096	332,431	54,192	31,656	233,936	1,007,258
1993	277,243	82,245	312,579	56,031	32,116	244,054	1,004,268

Source: Etkin, 1997. Note: [1] 10 litres = 2.63 gallons (US)

Figure 1. World oil tanker development



Source: Institute of Shipping Economics and Logistics, 1994, page 14.

Oil tankers accidents have been experienced in virtually all parts of the world, resulting in a considerable amount of oil being spilled into the marine environment. On a world-wide basis, roughly 200,000 tons of oil are spilled from tankers each year (Wardley-Smith, 1979). Oil spills reached their peak in 1979 when approximately 193 million gallons of oil was discharged into the seas (Etkin, 1997). Catastrophic oil pollution accidents has lead to a growing concern among the general public and by governments of coastal states for the safety of human health and the environment.

However, with application of regulatory measures, e.g. MARPOL 73/78, SOLAS 1974, the amount of oil entering the sea due to maritime accidents has fallen greatly in recent years. MARPOL 73/78 provides necessary mechanism to reduce the amount of oil-water mixtures that have to be disposed of during routine operations, addressing such issues as segregated ballast tanks, crude oil washing and reception facilities in ports. SOLAS 1974, on the other hand, is intended to deal with safety issues. Fire safety provisions under SOLAS 1974 are much more stringent for tankers than for ordinary dry cargo ships. These contribute to a large extent to reduction of maritime accidents and marine pollution. The United States National Academy of Sciences was cited by IMO News (1997a) to indicate that oil pollution from ships had decreased by 60 per cent since 1981, from 1.47 million tons a year to 0.59 million tons. Table 2 shows the annual number and volume of oil spills due to tanker accidents between 1974 -1995.

Nevertheless, in the region of concern to Cambodia, marine oil pollution, especially from tanker accidents, is observed and described as being relatively high in the East Asian Seas (UNEP, 1988). Here oil tanker traffic between the Middle East and the Northwest Pacific is extremely busy and incidents of spillage occur from fire, groundings, collisions, and other casualties. Table 3 shows the frequency of tanker movement in the Southeast Asia region.

Table 2. Annual number and volume of oil spills (1974-1995)

Year	Number of reported spilled (>10,000 gals)	Number of spills		Total volume of spills
		≥1-10 mgals	≥10 mgals	
1974	74	12	2	74,145,000
1975	63	7	4	122,722,000
1976	58	12	1	88,504,000
1977	54	12	2	117,341,000
1978	80	11	3	144,933,000
1979	104	14	4	193,366,000
1980	91	5	2	65,709,000
1981	69	3	0	17,316,000
1982	75	1	0	7,361,000
1983	78	2	3	123,381,000
1984	65	5	0	16,343,000
1985	52	2	1	34,449,000
1986	81	0	0	7,944,000
1987	83	2	0	10,779,000
1988	52	3	2	64,954,000
1989	90	7	2	61,034,000
1990	81	4	0	21,874,000
1991	59	3	1	30,256,000
1992	48	2	2	45,171,000
1993	53	4	1	40,518,000
1994	59	2	1	27,494,000
1995	42	1	0	5,186,000
Total	1511	114	31	1,320,780,000

Source: Etkin, 1997.

Table 3. Frequencies of tanker movement in Southeast Asia

Destination (Route)	Nominal vessel size	Frequency
South Korea and Japan	200 dwt	984/yr.
Japan	VLCCs	140/yr.
Sulawesi Sea	VLCCs & Tankers	25-30/yr.
Port Dickson, Malaysia	90,000 dwt	40/yr.
Singapore	VLCCs	91/yr.
Singapore Strait	Various	15,336/yr.

Source: UNEP, 1988.

The above information is rather dated, and in keeping with global trends the tanker traffic density on these routes has undergone a considerable increase, along with the associated risk of accidents resulting in oil pollution. An accidental oil spill was reported (UNEP, 1988) in 1974, with an estimated magnitude of 9,000 bbl, when the 5,000 ton coastal vessel Visahakit collided with another ship about 8 km from the mouth of the Chao Phraya river in Thailand. In a separate case, approximate 54,000 bbl of Middle East crude reportedly poured from the 273,698 dwt super tanker, Showa Maru, into Indonesian waters, in the Strait oi Singapore, when it grounded on treacherous shoals near the Buffalo Rock Beacon (UNEP, 1988). Table 4 demonstrates selected tanker incidents in the Southeast Asia waters. It should be admitted that the actual amount of oil being spilled from tanker accidents is probably higher in that all oil spill incidents are not reported and quantities spilled are not necessarily accurately measured. Furthermore, it is seen from the table that most tanker casualties reported took place in nearshore areas which are environmentally sensitive and economically significant. Therefore, although the amount of oil being spilled from some tankers has not been reported, the table indicates the necessity for coastal states to put in place a response mechanism for marine environment protection if sustainable development is to be achieved.

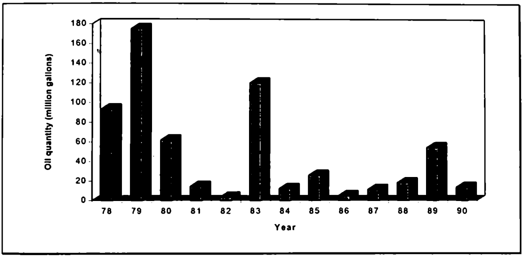
Table 4. Tanker casualties in the Southeast Asia waters

Name of vessel	Cause	Location	Date	Type of oil	Amount (ton)
Showa Maru	Grounding	Buffalo Rock, off Singapore	06 Jan. 1975	Oil	7,700
Isuzugawa Maru & Silver Palace	Collision	Outside of Singapore port	16 Jan. 1975	Crude oil	Unknown
Mysella	Grounding	01°12'04"N, 103°50'54"E	05 Apr. 1975	Oil	2,000
Neissei Maru	Collision with Ravi	01°15'03"N, 104°09'03"E	17 Jul. 1975	Crude oil	Unknown
Sachem	Collision with Gen. Madalineki	Eastern anchorage, Singapore	11 Dec. 1975		Unknown
Diego Silang	Collision with Russian ship, Vystok.	Malacca Straits	24 Jul. 1976	Kuwait oil	5,500
Citta di Savona, Philippine Star & Esso Spain	Collision	Eastern anchorage, Singap.	26 Oct. 1976	Crude oil	1,000
M.V. Fortuna	Collision with USS Ranger	South China Sea	07 Dec. 1978	Kuwait oil	10,000
Thanassis A.	Unknown	South China Sea	05 Apr. 1979	Unknown	43,626
Tadotsu	Unknown	Malacca Straits	21 Oct. 1994	Unknown	52,808

Source: UNEP, 1988 and Etkin, 1997.

Without exception, oil spill incidents have repeatedly occurred in the North Sea through the years. Anon (1989 and 1991a), in GESAMP reports and studies No 50, described annual spills of oil from tankers into the North Sea, which are shown in Figure 2. The figure suggests the highest amount of oil was spilled in 1979 followed by a declining trend during the 80s.

Figure 2. Annual quantity of oil spilled by tankers into the North Sea



Source: GESAMP, 1993, page 28.

2.1.2 Other carriers

Seagoing ships, other than tankers, are also responsible for marine oil pollution as they use oil for lubrication and power. The potential for oil pollution from this source becomes even greater over time since demand for merchant fleets, including chemical tankers, liquid gas tankers, bulk carriers, OBO carriers, container ships, general cargo ships, reefer ships, specialty ships, RO-RO ships, cargo/passenger ships, RO-RO/passenger ships and passenger ships, increases due to globalisation of trade and the increased demand for consumer goods by a growing global population as the 21st century approaches. Table 5 shows trends of world fleet development.

Table 5. World fleet development by type

Year	Number of ships[2]												Total
	Chemical tankers	Liq. gas tankers	Bulk carriers	OBO carriers	Container ships	General cargo ships	Reefer ships	Specialty ships	Ro-ro/ Cargo ships	Cargo/ Passenger ships	Ro-ro/ Passenger ships	Passenger ships	
1990	922	771	4565	350	1147	12983	1333	1640	943	311	1633	841	27439
1991	968	802	4660	352	1189	13031	1386	1735	1022	311	1697	849	28002
1992	1031	865	4685	358	1273	12891	1433	1824	1017	291	1729	898	28295
1993	1117	887	4608	344	1339	12833	1452	1852	1176	276	1778	944	28606
1994	1208	914	4590	283	1387	13068	1464	1641	1184	265	1826	1019	28849

Source: Institute of Shipping Economics and Logistics, 1994, pages 14-17.

Note: [2] ships of 300 grt and over involved in maritime transport.

In his comprehensive research and study which was published in 1979 Wardley-Smith notes that:

> "...non-tanker accidents are believed to be responsible for an additional 100,000 tons of spillage each year."

Other estimates suggest that, on a yearly basis, about 329,000 tons of oil (representing 14 per cent of the total amount of about 2,350,000 tons) are spilled from non-tankers (Coenen, Rene 1997, email, 3 September 1997). It is strongly believed that with the development of improved standards, navigational aids, training and watch keeping and traffic separation schemes that amounts of spillage have been reduced considerably. According to IFP findings in 1981, oil spills from non-tankers accounted for 17,000 tons per annum (National Research Council, 1985). This shows a significant drop in amount of oil spilled into the seas by this source.

General public sentiments towards oil pollution incidents involving non-tankers is that since the amount of oil used for bunkers and lubrication of the majority of non-tankers is relatively small compared with quantities of cárgo oil, the scale of the potential spills is very small compared to that of a tanker. However, this is not always the case as the tremendous expansion in world trade has brought about major changes in size and sophistication of merchant ships of all types. A 900-foot container vessel, for instance, with powers similar to that of large tankers, carries bunkers equivalent to the full cargo of a small ocean-going tanker; and, thus, accidents, collisions or grounding of ships in this category may also contribute a considerable potential for oil outflow. For comparison purposes, demonstration of inputs of petroleum hydrocarbons into the worlds' oceans from shipping activities is provided in Table 6, showing a significant diminishing of the domination of tankers as the primary source of shipping related oil pollution.

Table 6. Estimated inputs of petroleum hydrocarbons into the ocean due to shipping activities

Source	Amount (mt)	
	1981	1989
Tanker operation	0.7	0.159
Tanker accidents	0.4	0.114
Bilge and fuel oil discharges	0.3	0.253
Dry-docking	0.03	0.004
Marine terminal (including bunkering operations)	0.022	0.03
Non-tanker accidents	0.02	0.007
Scrapping of ships		0.003
Total	1.47	0.57

Source: National Research Council, 1985.

2.2 Offshore Oil Rig Incidents

The endless extension of oil exploration and exploitation into the coastal and marine environment is prompted by increasing demands for oil in both industrialised and non-industrialised nations. The potential for further development and further oil discoveries in seabed basins throughout the world is vast. The African region, in particular, is known to be rich in oil deposits in coastal basins, where about 2,400 million tons of oil (more than 80 per cent belonging to Nigeria) has already been exploited (UNEP, 1984). Oil exploration in the United Kingdom has been maintained at a high level (UK Department of the Environment, 1976). In the East Asian Seas region offshore installations processing crude oil or producing oil are considered a booming business (UNEP, 1988). With the increasing extension and number of offshore oil exploration and production sites the potential risk of oil pollution from both operational discharges and accidental spillages from oil platforms is ever present. When such accidents do occur the amount of the oil spilled often exceeds the largest of vessel-related accidents. Goldberg (1997) reported 147 million gallons of oil being poured from a drilling platform, IXTOC-I, into the Gulf of Mexico. For the purpose of this paper only accidental spills will be discussed.

The introduction of oil into coastal and marine environment from offshore installations is derived from accidents of various natures. The UK Department of the Environment (1976) and Sampson (1997) observe the main types of offshore oil platform accidents resulting in oil spills to include:

a) Blow-outs: Blow-outs usually occur when the precautionary measures which are designed to regulate the oil flow from the well break down or when an oil rig is damaged while the drilling operations are under way.

b) Failure of production platform equipment: Oil always passes through control and pumping equipment, pipes and valves at high pressure. Failure of part of the system can lead to an escape of oil and gas and to fire or explosions which, in turn, may cause a more serious rupture. Poor maintenance of equipment by the field personnel has been known to contribute to a large extent of platform accidents.

c) Structural failure of a platform or rig: The structural failure may be derived from lax application of regulations for construction and safety of offshore platforms or when the stresses of heavy weather or storm conditions are not adequately anticipated. Collapse of a platform could lead to a very serious situation of oil spillage, especially if the platform and oil storage tanks go in combination.

d) Damage to a sub-sea well-head or manifold: The sub-sea well completion could be affected by structural failure, internal erosion or corrosion if enough maintenance and regular inspection is not carried out. They may also be damaged by the activities of other vessels in the vicinity.

e) Leaks from a storage unit: Leakage from storage units may be attributed to structure failures or collisions. To date, an attempt is made to avoid destructive leakages from storage tanks by compartmenting them so that damage to one compartment would not release the contents of all.

f) Collision: Collision with a platform by a vessel out of control or negligently navigated can cause damage to platforms and subsequent oil spills.

g) Damage to pipelines: Potential danger to pipelines arises by and large from anchoring activities and the operation of trawl-boats. While any large leak from a fracture should be detected by monitoring equipment and result in the immediate shut-down of the pumps and valves limiting the possible release to only a few hundred tons of oil, this may not always be the case.

The above mentioned types of accidents may result in widely different amounts of oil accidentally discharged into the seas. The UK Department of the Environment (1976) acknowledges that an amount of oil spilling from offshore oil installations is in most cases difficult to quantify compared to that from oil tanker accidents. In this connection, the word "estimate" is commonly used to simplify the matter. Accidental spillages of oil (from offshore installations) have been experienced in several parts of the world. During 1978 an estimated 76.6 million bbl of oil, representing 6.7 per cent of the total offshore production of the region, was released into the Wider Caribbean waters due to platform fires, blow-outs, over-flows, malfunctions, pipeline accidents and other minor occurrences (UNEP, 1984). In the waters of the United States, an average spill rate for outer continental shelf platforms between 1964 and 1980 was 2.05 spills per billion bbl of oil produced (Boesch and

Rabalais, 1987). In addition pipelines were responsible for 1.6 spills per billion bbl while tanker accidents involved in transhipment to shore were responsible for 3.87 spills per billion bbl of oil transported (Boesch et at., 1987). During 1995, 87 tons of oil were accidentally spilled by the UK's offshore oil and gas operations (More oil spills in UK waters, Jan. 1997). Table 7 shows offshore mobile unit accidents by type in the United States and the North Sea accompanied by world-wide statistics from 1970 to 1981. The National Research Council (1985) noted that 40,000 to 70,000 tons of oil per annum could be attributed to offshore production.

Table 7. Offshore mobile unit accidents in US and North Sea (1970-1981)

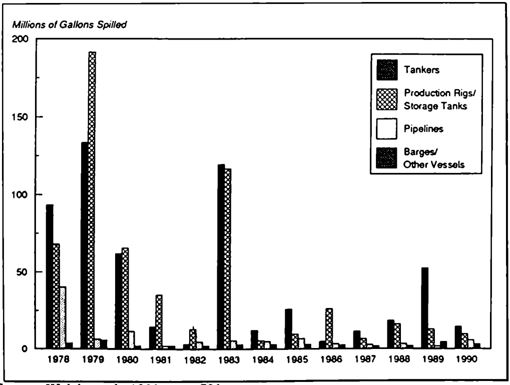
Type of accident	Number of accidents		
	United States	North Sea	World-wide
Weather	10	18	64
Capsizing	10		18
Collision	11	8	52
Grounding	1	3	13
Blow-out	18	3	39
Leakage		2	8
Machinery failure	2	4	12
Fire	8	5	25
Explosion	2	5	14
Foundering	1		4
Structural damage	10	7	42
Other	3	16	28
Total	76	71	319

Source: International Association for Bridge and Structural Engineering, 1983.

Although quantity of oil released into the waters due to the aforesaid accidents is not available, consequential spillage from those platforms is well understood. Globally, oil spill trends from different sources look to be declining between 1979 and 1990 (Welch, Stolls and Etkin, 1991). The world-wide trend of oil spills from offshore-related activity into the coastal and marine environment is demonstrated in Figure 3.

It should be noted that the above statistics are for mobile units, which implies that most accidents from production platform operations have been excluded. It is also noted that other related offshore oil and gas activities, including transporting of crude oil, which may result in oil spill incidents are not necessarily mentioned here.

Figure 3. Annual oil spills by sources



Source: Welch, et al., 1991, page 721.

It is noted that oil spills from tankers attract more public attention in comparison with accidental pollution of the coastal and marine environment by other kinds of ships, including chemical carriers. The reason behind the scene is that spilled oil is easily visible and its aesthetic impact is significant. Wardley-Smith (1979) gives two simple reasons to explain why oil spills have excited more public interest than any other forms of marine pollution:

"Firstly, oil in general floats on the water surface and so can be seen even when in a very thin layer (the soap bubble colours of the thin oil film are produced by an oily layer only about one hundred thousandth of an inch thick, 0.3 microns). Secondly, any one walking on a sea beach or swimming in the sea is almost certain to have met the nuisance of oil lumps, often called tar balls, no matter in what part of the world he lives."

2.3 Significant Impact of Oil Spills

The nature of oil is described as a complex mixture of hundreds of individual compounds, mostly hydrocarbons. Goldberg (1997) divides the oil into lighter oil and heavier oil based on its toxicity and chemical compounds. In his laboratory studies he concludes that lighter oil, refined oil, is more toxic than the heavier oil, crude oil, and more likely to evaporate or otherwise dissipate before it can reach coastal habitats, whereas heavier oil is not as toxic as lighter oil but it may more likely wash onto beaches and other coastal habitats as a persistent contaminant since evaporation ability is low. Irrespective of type of oil, one thing in common for accidental oil spills from any source is that they usually occur within a very short period of time and in a relatively small area and, thus, the oil concentration is extremely high (Goldberg 1997 and Shropshire 1997). This unusual oil concentration presents adverse and negative impacts on ecological and economic sectors which are the major topic for evaluation in this section. This section provides an insight to understanding the need for awareness of the detrimental effects of spilled oil on marine ecosystems and the effects on economic activities. Such issues, which are of world-wide applicability will be considered for their significance for Cambodia.

2.3.1 Ecological impact

Bearing in mind the various influencing factors, including oil quantity, type of oil, meteorological conditions, oceanographic conditions, physical geography of the area, turbidity of water, season, presence of other pollutants, biota types and the methods available for oil spill treatment (UNEP, 1982), an oil spill may present negative impacts on a wide range of ecological settings. Such impacts affect, but are not confined to, biological processes, marine plankton, fish and shell-fish, marine mammals, bird communities and ecosystems, human health, and shore vegetation. A quick look at such impacts is intended to build an insight and awareness of the critical threats posed by oil spills, especially to the marine ecology, which, in turn, fosters the development of preventive and response measures.

• *Effects on biological process*

This section examines the negative impacts of the aromatic hydrocarbons and heavy metals found in crude oil and refined products on biological processes of marine organisms. A study by the National Research Council (1985) indicates that crude and oil products can impair fidelity of DNA synthesis, increase sister-chromatid exchange and chromosome mutation and cause abnormalities in chromosome number. The source further notices sensitivity of sex pheromone responses, sperm, gonadal tissue development and other processes of reproduction and development to petroleum hydrocarbons. In addition, petroleum compounds are also known to present an ecological impediment to the photosynthesis process and the metabolism of marine plants, and to the feeding patterns, respiration, growth, detoxification systems and the metabolism in marine animals (National Research Council, 1985). It is, therefore, of necessity to prevent them from happening by putting in place appropriate preventive and response measures.

• *Effects on marine plankton*

Marine plankton is known to be vulnerable to oil pollution. A major effect of oil is a general and pronounced lowering of the phytoplankton and zooplankton biomes and productivity (Bishop, 1983; Clark, 1992 and Kuiper and Van Den Brink, 1987). The drastic reduction of marine plankton has put the complex food web of the seas in a remarkably fragile state. The population growth of marine plankton is readily depressed by a wide variety of petroleum hydrocarbons including both whole oils and specific compounds (National research Council, 1985). Additionally, dispersants used to break down hydrocarbon compounds can cause serious damage to marine plankton. The UK Department of the Environment (1976) notes that:

> "...spilled oil at sea suggests that there have been plankton kills after dispersal of highly aromatic oils..."

This provides a valuable conclusion and lesson to be learned to avoid use, where possible, of inappropriate dispersants.

• *Effects on fish and shellfish*

Oil spills have direct and indirect effects on fish and shellfish. The direct effect is derived from ingestion of oil or oiled prey through uptake of dissolved petroleum compounds via the gills and other body epithelia (National Research Council, 1985), whereas the indirect effect is attributed to habitat, feeding ground and nursery destruction and to change in ecosystem. UNEP (1982) describes various ways in which oil pollution causes damage to marine organisms, including fish and shellfish:

> a) direct kill of organisms through coating and asphyxiation;
> b) direct kill through contact poisoning of organisms;
> c) direct kill through exposure to water-soluble toxic components of oil at some distance in space and time from the accident;
> d) destruction of the generally more sensitive juvenile forms of organisms;
> e) destruction of food sources of higher species;
> f) incorporation of sub-lethal amounts of oil and oil products into organisms, resulting in reduced resistance to infection and other stresses (e.g. the principal cause of death in birds surviving the immediate exposure to oil);
> g) destruction of food values through the incorporation of oil and oil products into the marine environment;
> h) incorporation of carcinogens into the marine food chain and human food sources; and
> i) low level effects that may interrupt any of the numerous events necessary for the propagation of marine species and for the survival of those species which stand higher in the marine food chain.

The UK Department of the Environment (1976) presents a laboratory case where oil components have been shown to cause mortality of eggs and larvae. The situation in real life becomes much more serious when hundreds of thousands of barrels of oil may be accidentally spilled out into a relatively small area and within a short period of time. Ruivo (1972) discovers that oil and oil products in the sea are highly toxic to developing fish eggs and cause their destruction at concentrations of 10^{-3} and 10^{-4} ml/l. He goes on to compare the sensitivity of fish eggs and larvae to oil and oil products and notes that larvae are more resistant to oil pollution than developing eggs.

Shellfish also suffer from accidental spills or chronic pollution. Obviously, inshore species of molluscs, such as oysters, cockles and mussels, are very sensitive to oil pollution since they are usually found in intertidal areas, or in very shallow water, and are sedentary filter feeders, passing large volumes of water over their gills (UK Department of the Environment, 1976). Furthermore, crustacean shellfish including crabs and lobsters, although they are found further offshore, also suffer from oil spills.

Fish habitats, feeding grounds and nurseries are known to be subject to oil pollution, especially at the time of major accidental spills. In relatively shallow waters, oil of various natures may cover the feeding or breeding grounds of fish, smother colonies of bivalves and foul beds of kelp or sea-grasses (GESAMP, 1993; UK Department of the Environment, 1976 and Wardley-Smith, 1979). These, in fact, lead to the phenomenon of fish tainting which makes the fish products commercially undesirable (Bishop, 1983). In areas subjected to oil contamination, fish are likely to uptake oil by direct contact or through the food chain. Friends of the Earth (1996) studied long-term ecological damage to marine fisheries by the Sea Empress oil spill and found that quantities of:

> "...fish and shellfish have been severely reduced. Survivors will have very high concentrations of oil toxins for some time to come, which may lead to the development of tumours and stunted growth."

Although fish with low concentrations of oil or oil products can still survive, they are ultimately subject to increased vulnerability to disease or to decreased growth and reproductive success.

• *Effects on marine mammals*

With the different nature of life habits and habitat, many marine mammal species may come into contact with spilled oil in the marine environment. The dependence of seals and whales on air and the amphibious habit of polar bear ultimately enhances the possibility of contact with spilled oil on sea surface, which leads to losses of marine mammal life (National Research Council, 1985). The source reports deaths of grey whales, a dolphin, northern fur seals, California sea lions and northern elephant seals, due to an oil well blow-out in the Santa Barbara Channel, Southern California. The health of seals, whales, dolphins and porpoises is at potential risk from long-term consumption of contaminated fish and other prey (Friends of the Earth 1996). Harbor seals are susceptible to effects of ingesting oil while feeding and, therefore, they suffer the toxic effects of oil spills by inhaling the fumes from slicks (San Francisco Bay seal project 1997).

• *Effects on birds*

Marine birds can suffer major damage from oil spilled in the near-shore areas (Cormack, 1983). Depending upon various factors, including amount of oil spilled, location, season of the year, and species involved, the scale and magnitude of impact on birds differs. At particular risk are populations of birds with low annual breeding rates, species confined to a few breeding colonies and to selected prey redundant (UK Department of the Environment, 1976).

Unfortunately, precise data on annual bird mortalities on a world-wide basis due to oil pollution incidents is not available. However, an attempt is made to provide better knowledge and understanding of the number of waterfowl that may die upon contact with spilled oil and oil products. Goldberg (1997) provides an estimate of 350,000-390,000 waterfowl killed during the Exxon Valdez spill. This spill occurred in region with many concentrations of bird nesting areas. In another finding, Friends of the Earth in 1996 reported the death of up to 20,000 seabirds due primarily to oil spill incidents. The number of dead birds in particular oil spill incidents is shown in Table 8 below.

Table 8. Number of birds killed by accidental oil spills

Incident	Location	Amount of oil spilled (ton)	Dead birds found
Waddensee	Netherlands	Under 1,000	14,564
Poole	UK	300	487
Seestern	Medway, UK	1,700	2,772
Torrey Canyon	English channel	119,328	7,815
Tank Duchess	Tay, UK	87	1,368
Loch Indaal	UK	115	449
Hamilton Trader	Irish sea	700	4,092
San Francisco	Unspecified	2,700	7,380
Arrow	Cape Breton	10,400	567
Irving Whale	SE Newfoundland	under 30	625
Kurdistan	Cape Breton	7,900	1,697
Amoco Cadiz	Brittany	200,000	4,572

Source: National Research Council, 1985, page 433.

• *Effects on shore vegetation*

Shore plants, whose value ranges from innate ecological significance that include habitats, feeding and breeding grounds, to diversity of animals, coastline shelter, aesthetic and economic benefits (fuelwood, construction materials, commercial wood and traditional medicine), are suffering from oil pollution. Mangroves are vulnerable to oil spills because their breathing organs (pneumatophores) and root systems are close to the water surface and easily clogged by oil (Clark, 1992; Shropshire 1997; UNEP, 1982 and Wardley-Smith, 1979). The vulnerability of the mangrove system to oil spills resides in two different features, aerial root systems and permeability to tidal waters, as described by the National Research Council (1985):

> The root of mangroves is highly adapted to anaerobic soils or mud, emerging above the surface as aerial prop roots (red mangrove) or pneumatophores (e.g. black mangrove). The surface of these structures are marked by numerous small pores termed lenticels, through which oxygen passes into the air passages within the root system. While it is a remarkable adaptation to an otherwise anaerobic environment, this aerial root system is also the achilles heel of the mangrove in the event of oiling, for the aerial roots are highly susceptible to oiling, with clogging of the lenticels and inner air passages, eventually choking off the respiratory system. The second problem is that of permeability of this coastal system. Mangroves are the tropical equivalent of the more temperate salt marshes and share many of the physical features that make salt marshes highly sensitive to oiling...

These lead to tree mortality, leaf defoliation, deformation and stunting, seedling deformation and mortality, lenticel expansion, retarded growth of pneumatophores (UNEP, 1988). A major spill in 1973 in Puerto Rico caused extensive damage to marine communities including mangrove forests (UNEP, 1984). Petroleum compounds can be toxic to small organisms inhabiting mangroves and can possibly damage the trees themselves, the severity depending upon the nature of oil. In addition, other types of flooded forests in estuaries, salt marsh, intertidal zones, bays and lagoons suffer from oil spills.

• *Effects on human health*

Human beings are also effected by oil spills, that lead to immediate loss of life and, in less severe case, to chronic diseases. The greatest hazard to human health from oil spills is derived from explosion and fire at the spill site, while other hazards are from hydrocarbon compounds after the fire/explosion risk has dissipated at various distances from spill sites (GESAMP, 1993 and UNEP, 1984). The effect of oil spills on human health includes the acute effects from contact with oil or its constituents and the longer term carcinogenic potential from hydrocarbons derived from transfer to humans (Cormack, 1983 and GESAMP, 1993). Clean-up crews, regulatory and emergency officials, coastal residents, and members of scientific teams investigating the spill have a potential for acute exposure to oil after accidents and can possibly intake hydrocarbons through inhalation, dermal contact and even through accidental ingestion. GESAMP (1993) provides clinical evidences that hyperplastic bone marrow leukaemia is associated with exposure to benzene and that tank-clean-up personnel chronically exposing themselves to petroleum vapours suffer chromosomal aberrations in bone-marrow cells. The source concludes that while direct skin contact with oil may only lead to dermal irritation, exposure to oil and oil fumes can also cause headaches, dizziness, nausea, sensation of inebriation, vomiting, abdominal pains, severe skin irritation and erythema. In addition, specific hydrocarbon constituents (e.g. PAH) commonly found in crude oil, refined products, and other related fossil fuel sources, when entering a body through ingestion and long-term consumption of hydrocarbon-contaminated seafoods, can ultimately result in the induction of cancer in animals and even humans (GESAMP, 1993; National Research Council, 1985 and UK Department of the Environment, 1976). The author believes that non-visible effects on human health of oil spilled are not a target of immediate public reaction and concern since such hazards associated with the spills take so long to be manifested that people in most cases simply don't remember the actual cause of the condition.

There can be no doubt that detrimental impacts of oil spills on the above said ecological sectors lead to economic implication and consequences. When allowed to happen, the ecological impact causes long-term effects on the economic sectors of coastal states since an attempt to restore affected ecosystems is a time consuming process and involves a great amount of effort and capital.

2.3.2 Economic impact

In one way or another, the above mentioned ecological impacts result in economic consequences for coastal states. Major economic activities which may be affected by oil spills are worth examining. In this section activities such as fishing industry, tourism industry, shipping industry and other industrial uses of the sea are examined.

• *Fishing industry*

As mentioned earlier, there is substantial evidence that mangrove swamps, sea grass beds, coral reefs, coastal estuaries and lagoons contribute to the life cycle of a great majority of the commercial fish and shellfish species (UNEP, 1984); and, thus, any destruction of these ecosystems by oil spills has severe effects on fishing industries. As far as the effect of oil spills on commercial fisheries is concerned, although UNEP (1988) finds that there is not yet enough evidence that oil spills have depleted commercial fish stocks in the sea, it is not always the case since larvae and juveniles in near-shore areas are so sensitive to spilled oil. Tainting of fisheries products becomes a crucial factor influencing the economic health of the industry. GESAMP (1993) indicates that the tainting of seafoods is easily perceived by the public. Fishermen and regulatory authorities recognise this as a major issue eroding the financial strength of an affected fishing industry. Data on amount of losses due to tainted products being not marketable is not readily available. However, it is clear that reduction of demand for fishery products once consumers hear of an oil spill in a region, or taste tainted fish from that region can lead to collapse of the industry and this is ultimately attributed to oil spills.

Coastal aquaculture is becoming increasingly important in various parts of the world, including the East Asian Sea region and Europe (e.g. UK, Norway) (UK Department of the Environment, 1976 and UNEP, 1988). Places suitable for fish and shellfish farms are those where clean salt water as well as shelter is easily accessible. Oil spills can result in major losses of production and in tainting with possible serious financial consequences due to the fact that caged fish and shellfish and cultured molluscs can not avoid an affected area and thereby face a high risk of becoming contaminated or tainted by soluble or dispersed oil fractions following an oil spill (Bishop, 1983 and Cormack, 1983).

In addition, there are other ways in which spilled oil can interfere with the fishing industry. These include: 1) contamination of gear with surface or bottom oil or oily debris, tainting the catch and making it unmarketable; and 2) oil-contaminated fishing gear may have to be destroyed and, thus, require replacement (UK Department of the Environment, 1976). Furthermore, oil spills may limit the areas for exploitation for safety or other reasons.

- *Tourism industry*

Tourism is a growing industry in both developed and developing nations. Beaches with pristine marine environments are desirable for tourists. The fouling of beaches, coastlines and visitor facilities by oil spills has a profound effect on tourism in the areas. The impact might last years after the actual spill and clean-up operations as oil may infiltrate beach sediments and can be brought up to the surface by later storm action (GESAMP, 1993). The indirect impact of oil spills on the tourism industry is presented by the degradation of the coastal and marine ecosystems, including habitats, breeding and feeding grounds, which may constitute the major tourist attraction (Cormack, 1983). Obviously, direct or indirect impact of oil spills could cause economic chaos and lead to controversial conflict of interest among coastal and marine users.

• *Shipping industry*

An accidental oil spills can involve structural damage to ships or port facilities requiring repair work and other rebuilding operations. This has direct financial consequences including repair costs and opportunity costs as the ships, while in dry-dock for repair, cannot perform their maritime trade. In the worst case, ships may sink and settle in the deep bottom of the ocean as total losses. Moreover, oil spills within narrow straits, navigational channels or port areas require closing down of these areas, and, as a consequence, contribute to financial losses and at times the long term competitiveness of a port area.

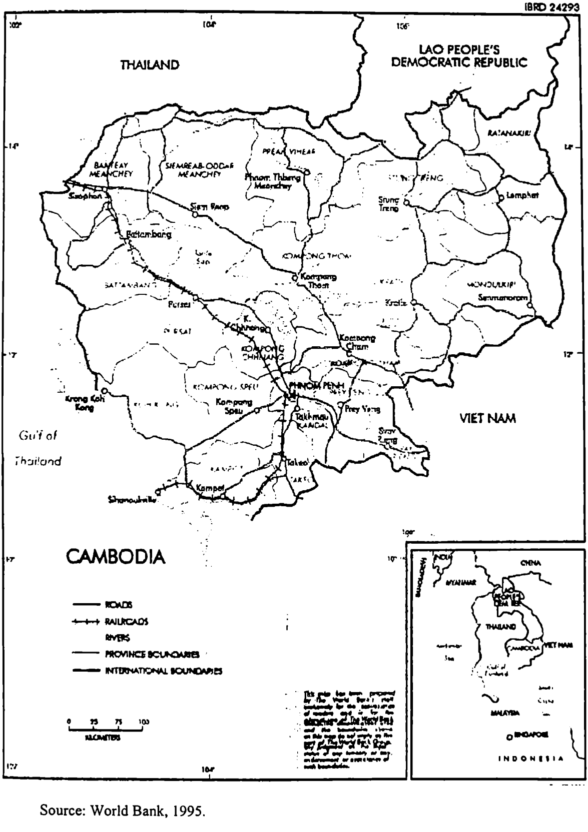
• *Other industrial uses*

Oil spills may disrupt other industrial activities located along the coastlines. Some power stations and industrial processes use seawater for cooling or processing purposes, and, therefore, the presence of floating or dispersed oil can interfere with their day-to-day operations. Desalination plants, such as those in the Persian Gulf (GESAMP, 1993), were susceptible to interference from oil pollution.

2.4 Trend Towards Oil Pollution in Cambodia

Cambodia is situated in Southeast Asia and along the Southwest coast of the Indochinese peninsula between latitudes 10° and 15° N and longitudes 102° and 108° E. The country occupies an area of 181,035 km^2, has a coastline of 435 km and shares its 2,003 km terrestrial border with Thailand to the north and east, Laos to the north and Vietnam to the east and south-east (Figure 4). The country is fully involved in oil and gas exploration and has significant maritime traffic both of which are worth discussing in this section, looking at possible oil pollution from these activities.

Figure 4. Administrative map of Cambodia



Source: World Bank, 1995.

2.4.1 Oil and gas exploration

Historically, oil and gas exploration originally started in the 1950s (MIME, 1995; Nhep, 1995 and Pum, Pen, Nin, Houy, Chan, Suon, Um, Touch, Yim and Chhoun, 1996) when a team of Chinese geologists carried out geological surveys throughout the country. Later a series of geological surveys have been conducted by various geologists and companies (MIME, 1995; Nhep, 1995 and Pum et al., 1996), including:

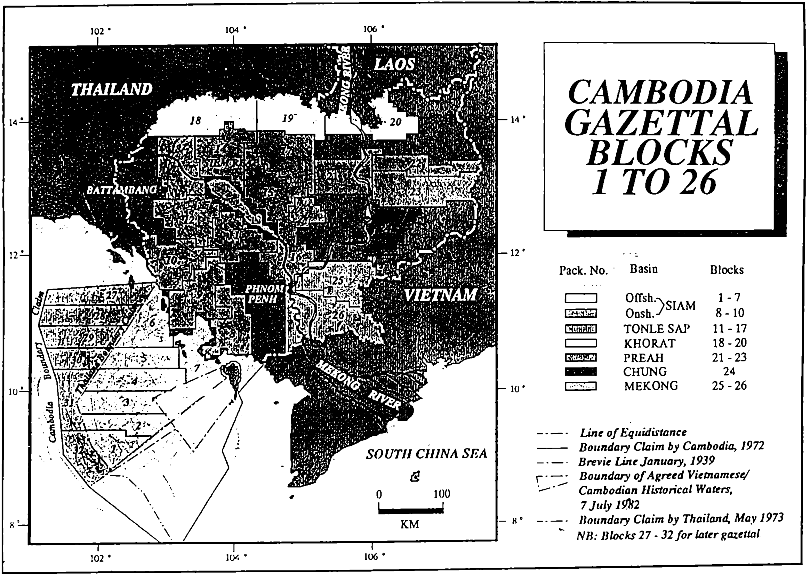
a) Geological field mapping, mainly in the western part of Cambodia, was co-operatively undertaken by former Soviet Union and Polish geologists between 1960 and 1962.

b) Follow-up surveys in 1966 were carried out jointly by Cambodian and French geologists. In the same year, a geological map locating oil and gas potential countrywide was produced serving as a baseline map.

c) Seismic surveys over 2,880 km were conducted by Elf in early 1970; the company drilled one well at a depth of 2,437 m in 1972.

d) Seismic surveys were completed by the Elf-Esso consortium in 1973; in the following year, the company carried out testing drilling for two wells, but the drilling did not locate producible reservoirs.

e) A geological and geophysical study was jointly undertaken by the former Soviet Union and Cambodian geological specialists from 1987 to 1990. This was the biggest study to identify and map six different sedimentary basins in both offshore and inland areas of Cambodia, including the Siam Basin, Tonle Sap Basin, Khorat Basin, Preah Basin, Chung Basin and the Mekong Delta Basin (Figure 5).



Source: MIME, 1995.

Cambodia is believed to have an estimated 1.5-3.5 trillion cubic feet of gas and 30-180 million bbl of oil (mainly in offshore fields) which are enough to meet its own energy needs with possible surplus of oil for export (Dennis and Woodsworth, 1992; Johnson, 1992 and MOE, 1994). This puts Cambodia in a favourable condition for foreign investment in oil and gas exploration and exploitation, a significant source of national revenue, which is hoped to reduce the budget deficit, gradually increase GNP and provide a resulting improvement of the living standard while possibly easing the pressure on forest-based energy.

To facilitate further development of the oil and gas industry, a team consisting of ex-Soviet Union and Cambodian geologists divided the areas of oil and gas deposits into 32 blocks including 7 offshore blocks (Block I-VII), 19 inland blocks (Block VIII-XXVI) and 6 offshore blocks (Block XXVII-XXXII) in overlapping areas between Cambodia and Thailand (MIME, 1995).

Since 1991 there have been three multinational oil companies awarded offshore blocks, based on public bidding, for exploration and production, including Enterprise Oil, Premier Oil and Campex (Mak, pers.comm. 1997; MIME, 1995; Nhep, 1995; Pum et al., 1996 and RGC, 1995).

- *Enterprise Oil*

Enterprise Oil was awarded two blocks, Block I and Block II, in 1991. The company started drilling one well, Angkor-1, located some 170 km southwest of the Port of Sihanoukville, in Block II on January 17, 1994 and completed this on April 17, 1994 and announced a gas and condensate discovery (Enterprise Oil, 1996; Nhep, 1995 and RGC, 1995). A 3D seismic survey offshore Cambodia was completed in December 1994 and lead to the drilling of two more wells, Da-1 and Preah Khan-1, in early 1996 (Enterprise Oil, 1996 and Nhep, 1995). With an additional well, Bayon-1, drilling was completed on November 3, 1996; the company has expended a capital investment of US$ 55 million so far (Enterprise Oil completes drilling exercise, 1996 and Enterprise Oil announces its success, 1997). Since then, the company carried out evaluation tests and concluded that a maximum flow rate of 4.7 million cubic feet of gas and 180 bbl of condensate per day was extractable (Nhep, 1995; Pum et al., 1996 and RGC, 1995). Further evaluation of amount of oil and gas which are commercially exploitable is being carried out and production of oil and gas will not take place until the year 2000 (Leonard, pers.comm. 1997; Mackay, pers.comm. 1997 and Mak, pers.comm. 1997).

• *Premier Oil*

Premier is a 33.3 percent equity holder and operator. The remaining equity is equally shared by Ampolex (AOE) Ltd. and Idemitsu Cambodia Oil Exploration Co. Ltd. (Pum et al., 1996 and RGC, 1995). The company was awarded Block IV in 1991 and finished drilling one well, Koh Tang-1, at a depth of 3,867 m, on September 26, 1994 (MIME, 1995 and Pum et al., 1996). An evaluation test carried out in 1994 provided a maximum flow rate of 1,180 bbl of oil and 1.3 million cubic feet of gas per day (MIME, 1995; Pum et al., 1996 and RGC, 1995). However, no timetable for oil and gas exploitation in the block has been finalised.

• *Campex*

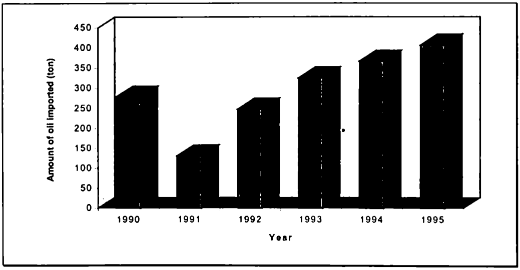
Campex, sister company of JAPEX, was awarded Block III in 1991. The company completed two wells, Apsara-1 in February 1994 at a depth of 3,308 m with test results showing a maximum flow rate of 244 bbl of oil and 73,200 cubic feet of gas per day (MIME, 1995; Nhep, 1995; Pum et al., 1996 and Sasaki, pers.comm. 1997). A second well, Devada-1 was finished on March 16, 1994 and an evaluating test produced negative results (dry well) (Mak, pers.comm. 1997; MIME, 1995 and

Sasaki, pers.comm. 1997). The remaining blocks, particularly the three offshore blocks, Block V, VI and VII, and one onshore block, Block X, have been offered for public bid. Bids submitted by 17 multinational consortiums are under evaluation (Nhep, 1995).

2.4.2 Oil products import

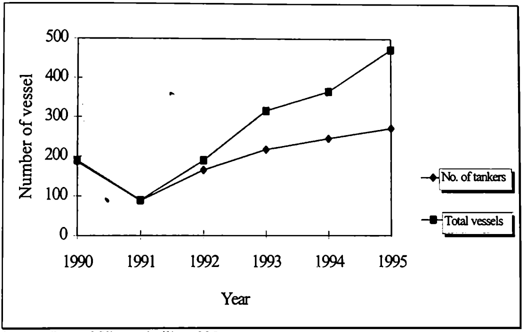
Petroleum is one of the major sources of energy for both industrial, transport and household sectors. An increasing demand for energy as the country develops and as industrial and transport sectors grow has led to a dramatic increase in imported oil products. More than 50 per cent of fuel is imported through the Port of Sihanoukville primarily by the four biggest companies, Caltex, Sokimex, Shell and Total (Ma, pers.comm. 1997). The annual fuel imported and the number of oil tankers, in comparison with total vessels calling the Port of Sihanoukville, are depicted in Figure 6 and 7 respectively.

Figure 6. Annual fuel import via Port of Sihanoukville



Source: Port of Sihanoukville, 1995.

Figure 7. Total vessels and oil tankers visiting the Port of Sihanoukville



Source: Port of Sihanoukville, 1995.

2.4.3 Possible oil pollution incidents

Existing and future development of the oil and gas industry in Cambodia poses a threat of environmental damage, the scope and magnitude depending on attitude, method of operation, technology employed and response preparedness of the operators. Oil spills involving offshore platforms are wide in range (Enterprise Oil Exploration Ltd., 1996; Rudall Blanchard Associates Limited, 1995 and MOE, 1994):

a) accidental spills during drilling and processing operations;

b) operational discharge and losses;

c) drilling fluids and oiled mud;

d) transfer of fuel from support vessels to the drilling units;

e) well testing operations; and

f) transport of crude oil from drilling fields to refineries during the production phase expected in 2000.

The dramatic growth of the maritime industry in the country, including maritime transport and offshore oil and gas exploration and production, further increases the potential for oil spill incidents in the coastal and marine environment. Although an oil tanker accident has not been recorded so far, the situation might change completely as tanker and other vessel traffic becomes heavier and traffic is not properly regulated. The absence of navigational aids, namely light towers and buoys, is also a main contributor to casualties at sea, leading to accidental oil spillage into the Cambodian waters (Sin, 1995).

A great improvement of technology relating to maritime activities in combination with co-operative efforts by states under the leadership of the international organisations, especially IMO, contributes to a considerable extent to reduction of maritime casualties. However, casualties resulting in oil spills and loss of life and property do occur as demand for oil, requiring offshore oil exploration and oil transportation by tankers, in particular, keeps increasing in both developed and less developed nations. Once they occur, oil spills present detrimental effects on marine ecosystems, human health and welfare, and the environment. Special attention should therefore be given to development of a preventive and response measure for dealing with marine pollution incidents.

CHAPTER III

PROPOSED FRAMEWORK FOR A NATIONAL OIL SPILL CONTINGENCY PLAN

The increasing movement of crude oil and refined products, expansive maritime traffic and development of the oil and gas industry, both offshore and onshore, in the region, and in Cambodia, suggests that oil spills, small and large, are inevitable even though the latest available technology may be employed. An extra emphasis is put on understanding an indepth awareness of the detrimental and subsequent effects of oil spills on public health and safety as well as on the environment, fisheries, industries and recreation. The adverse impacts of oil spills on the coastal and marine environment of Cambodia are far more significant since maritime activities constitute the major source of government revenues. The economic significance, together with the government's commitment to coastal and marine environment protection, forms a crucial foundation for establishing proactive approaches toward marine pollution incidents as opposed to reactive ones. An attempt to respond to oil spills in an emergency situation, in which time is a prime factor, usually involves many different organisations from both private and public sectors. This in most cases gives rise to disputes and conflicting interests which make effective response operations impossible, and the media is always quick to expose any indecision, weaknesses or disagreements. All of these factors cannot be dealt with effectively unless a good, well-prepared, tested and comprehensive contingency plan is available. Without such a plan, there will be the possibility for confusion and conflicting interests to defeat any attempt to respond to the emergency.

A good contingency plan is therefore an essential prerequisite for effective and timely response to an oil spill under emergency conditions. The contingency plan, hereafter proposed, is a framework document aiming to provide guidance for later development of a comprehensive, appropriate and effective plan, suitable for the existing condition and environment.

3.1 Introduction

The growing involvement of Cambodia in the maritime transportation of oil and other merchandise, and in the offshore and onshore oil and gas industry, together with the government's strong commitment to environmental prevention and protection, prompts the development of an effective and adequate response mechanism. The most common form of this response mechanism is a contingency plan which is defined in the report of the Alaska Oil Spill Commission, cited in Etkin's study (1990), as:

> "a behaviourally or scientifically designed approach of decision-making predicated on an event that is of possible but uncertain occurrence and the determination, in advance, of the optimum course of action consistent with established goals."

The above mentioned statement is an example of the justification that needs to be included in the introductory part of the contingency plan. In addition, the introduction should be comprised of other significant aspects including, but not confined to, definition, purpose and objective, and scope of coverage of the plan.

3.1.1 Definition

Key words used in the plan should be clearly defined aimed at avoiding confusion and misinterpretation. This is a comprehensive explanation which uses simple language to clarify terminology and other concepts. The following definitions, for instance, should be included:

"Response:	any actions undertaken to prevent, reduce, monitor or combat oil pollution (IMO, 1995).
Dispersants:	those chemical agents that emulsify, disperse, or solubilise oil into the water column or promote the surface spreading of oil slicks to facilitate dispersal of the oil into the water column (US Code of Federal Regulations, 1992).
Major/catastrophic spill:	a spill which exceeds the capacity of the nation for response."

3.1.2 Purpose and objectives

Clearly defined purpose and objectives are a main factor for any successful operation, especially in an emergency situation. Having this principle in mind the purpose and objectives of the National Contingency Plan (NCP) are (Doerffer, 1992; IMO, 1995; US Code of Federal Regulations, 1992 and USCG, 1986):

a) to provide and designate a responsible organisation for emergency response to accidental spillages of oil;

b) to provide organisational structure and procedures for preparing and responding to accidental discharges of oil aimed at avoiding inconsistent or duplicative responsibilities of agencies involved;

c) to delineate a national preparedness and response system for responses to emergencies which could result in the spillage of oil into the marine environment;

d) to ensure a timely and effective response to spillages or the threat of spillages of oil into the seas;

e) to provide adequate resources, both well-trained crews and equipment, to respond to a pollution incident aimed at restricting the further spread of oil or minimising the adverse impacts on the coastal and marine environment;

f) to provide an appropriate system for detection and reporting of spills of oil; and

g) to identify potential threat or risks to areas and resources through which necessary preventive measures and clean-up operation can be made.

3.1.3 Scope of coverage

A NCP is the highest level of planning for emergency response in terms of its application within the coastal waters of Cambodia. It is intended to apply to, and to be in effect for (IMO, 1995; US Code of Federal Regulations, 1992; USCG, 1986; and Wijdeveld, 1994):

a) oil spills into the coastal waters of Cambodia up to its 200-mile Exclusive Economic Zone;

b) discharges of oil into coastal industrial sectors (e.g. oil terminals, refineries, and offshore installations) where local/industrial contingency plans are not adequate;

c) incidents caused by oil spills, including personal injuries, damage, fires, explosions, and collisions; and

d) international and regional waters, if requested by nearby countries, establishing appropriate and necessary mechanisms for jointly escalating the emergency response in the event of a major spill which may affect the countries.

3.2 Organisation and Responsibility

The effectiveness and success of an operation to respond to an emergency situation is dependent to a great extent upon a clearly-defined management structure designating lead agency(ies), supporting agencies and individuals involved and their role in the plan at different stages, including planning, organising, implementing, monitoring and reviewing. The organisation should be large enough and sufficiently funded to cope with an oil pollution incident within a specified scope. The organisation created should be lead by the most competent authority within the government.

3.2.1 Response organisation

The resources employed for emergency response can only be optimally distributed and utilised when an organisation's functions are appropriately delegated. Such organisations should be simple in their structure, administrative settings and operational procedures to avoid unnecessary delay in decision making and implementation of required measures. Considering the existing government structure, and given the fact that the responsibility for coastal and marine environment prevention and protection is segmented within various governmental organisations, response organisations should be developed in such a way that reflects these crucial aspects. Accordingly, three main elements of the response organisation created to perform the NCP include a National Committee for Emergency Response (NCER), a National Response Centre (NRC), and an On-Scene Co-ordinator (OSC) (Etkin, 1990; IMO, 1995; Jimenez, 1989; Lo, pers.comm. 1997; Mak, pers.comm. 1997; Mok, pers.comm. 1997; Touch, pers.comm. 1997; UNEP, 1992; US Code of Federal Regulations, 1992 and Wahutu, 1988).

• *National Committee for Emergency Response (NCER)*

For Cambodia, the NCER would be of the highest body in NCP's hierarchy. The NCER should consists of representatives from government agencies, including MPWT, MOE, MIME, MAFF, MND, CACA, MOJ, MPH, MOI and MOT. Each agency should designate a member to participate in NCER activities and provide sufficient alternatives to ensure representation in any circumstances. The NCER may request membership from other agencies, if so required to achieve effective performance. The NCER should be chaired by the minister of the MPWT and the vice chairperson should be the minister of MOE (Mak, pers.comm. 1997; Mok, pers.comm. 1997 and Touch, pers.comm. 1997). In order to facilitate its function, the NCER should be supported by a number of different sections, including sections to co-ordinate technical advice, regional and international co-operation, public affairs, legal affairs, science and research, safety and training, finance, and logistics.

• *National Response Centre (NRC)*

A NRC is needed to provide national communications for emergency co-ordination and response actions. The NRC should be equipped with advanced and sufficient telecommunication devices capable of receiving and disseminating notification of oil spills. It should be accessible through a free number to enable individuals of the public to use it for emergency contact. It is recommended that the telephone directory should specify the responsible officials and authorities to be notified as a significant tool to encourage and facilitate the notification process. Another aspect of great importance to address is the availability of adequate human resources. The NRC should be operated by competent and disciplined personnel who are willing to undertake further training and exercise. Alternatively, some government agencies, especially SST, may provide competent staff for the NRC and, thus, an over-staffing problem within the RGC can be mitigated.

• *On-Scene Co-ordinator (OSC)*

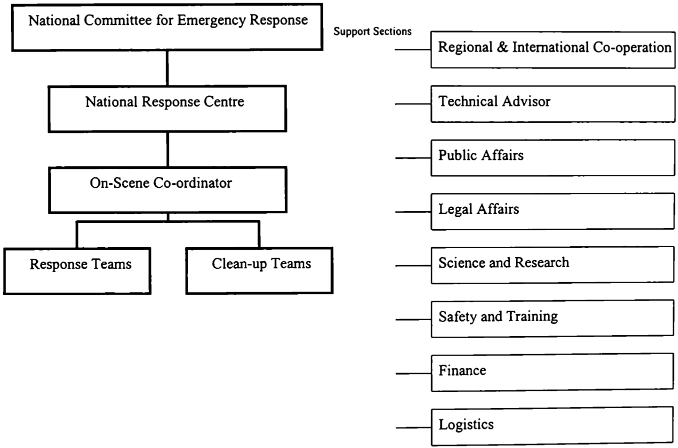
An OSC(s) should be pre-designated by the NCER. If resources allow, it is strongly recommended to pre-designate a number of OSCs to correspond to the various strategic areas, including all coastal provinces, Koh Kong, Sihanoukville and Kompot. Procedures should be in place to allow a national OSC to take over responsibility of the local OSC in cases where an oil spill exceeds the capability of the local plan.

• *Other teams*

The NCER should establish appropriate teams to deliver support to OSCs. These teams include Response Teams (RTs) and Clean-up Teams (CTs) which are under the direct control of the OSCs.

The response organisation established to undertake the NCP for oil pollution is depicted in Figure 8.

Figure 8. Structure of response organisation



3.2.2 Duties and responsibilities

Although the NCP should be developed in such a way that allows a single organisation (NCER) to have complete responsibility, a breakdown of duties and responsibilities assigned for individual sections within the organisation is still a matter of top priority if the response operation is to be successful (International Tanker Owners Pollution Federation LTD., 1985; Sampson, 1997 and US Code of Federal Regulations, 1992). Inadequate division of responsibility is apt to confuse the issue and often compound the problem. Therefore, it is extremely important that the plan addresses this issue.

• *National Committee for Emergency Response*

As mentioned earlier, the NCER would hold the single highest responsibility for policy and other decision making necessary for effectiveness and success of the plan. The duties and responsibilities to be accomplished by the NCER include, with possible enlargement, (IMO, 1995; International Tanker Owners Pollution Federation LTD., 1985; IPIECA, 1991; Sampson, 1997; 1991 International Oil Spill Conference, 1991 and US Code of Federal Regulations, 1992):

a) developing policy, strategy and operational procedures for the NCP. In this process, different competent members, representatives of government agencies, are responsible for different aspects of the plan;

b) sustaining national preparedness and readiness to respond to an oil spill within its specified scope and beyond if requested;

c) ensuring proper training and exercise for the response staff, carried out on a regular basis to test the plan's capability and the adequacy of the resources employed, and then to take any needed corrective measures;

d) conducting continuous studies and research into the changing condition of the marine environment and marine resources in order to identify environmentally sensitive areas so that the response can be tailored accordingly;

e) evaluating the plan and revising it to improve response capabilities;

f) organising short course training or seminars for outsiders to enhance participation and co-ordination of available resources from other institutions, public and private, in the event of a major spill;

g) reviewing and approving local/private contingency plans, to be developed in the future, or which can be referred to it by private enterprises including port operators, inshore facility operators, and offshore installations, whose activities have the potential to cause oil spills within or affecting the marine environment;

h) requesting assistance from other countries when the discharges affect more than one country, or when the event is so catastrophic that the NCP cannot cope with the emergency;

i) monitoring incoming reports from the NRC and OSC and activating response actions; and

j) recommending to the OSC as needed certain response actions to combat oil pollution.

• *National Response Centre*

The NRC should be the single point of contact for all pollution incident reporting and as the NCER communication centre. As such, the designated duties to be accomplished by the NRC can be described as follows:

a) the NRC should communicate notice of oil spills received from all sources, including the general public, to the NCER and the OSC;

b) the NRC should implement the policy, strategy and operational procedures developed by the NCER; and

c) the NRC should ensure the smooth flow of information and notification of all appropriate officials of the discharge of oil.

• *On-Scene Co-ordinator*

The OSC would provide direction for response operations and co-ordinate all other efforts at the scene upon receipt of an activation command from the NCER. To this end, the OSC should put RTs and CTs in operation and closely monitor the development of the incidents. In charge of executing the first response, the OSC must have clear and ultimate authority and power to make decisions at the scene of the response to implement appropriate strategy and methods consistent with those developed in the contingency plan.

The OSC should co-ordinate, direct and review the work of other agencies and contractors to ensure compliance with the NCP (US Code of Federal Regulations, 1992). As part of the preparedness planning and response, the OSC should ensure that persons designated to act as their on-scene representatives, in situations approved by the NCER, are adequately trained and prepared to undertake any assigned function. As soon as an incident is confirmed, the OSC should collect pertinent facts about the incident, including source and cause, responsible parties, location and trajectory of discharges or release, potential impact on human health, welfare, safety and environment, and verification of available resources (US Code of Federal Regulations, 1992 and USCG, 1994). Such facts should be made available to the NCER for further evaluation.

If possible, the OSC's efforts should be co-ordinated with other local or private response activities. This should be done by pre-established agreement for assistance and co-ordination to allow maximum use of existing resources of the various institutions. It should be the OSC's primary responsibility to address concerns for safety and health conditions of the response and clean-up team members and others involved at the scene. Proper use of the resources at a scene to ensure effective response to oil pollution incidents should be the responsibility of the OSC.

The OSC should submit pollution reports to the NCER as significant developments occur during response operations. Apart from this, the OSC should provide the NCER with complete reports on a regular basis, at dates and times defined by the NCER. The reports should outline: executive summary; date, time and location of incident; source and cause; response and other actions taken; details of potential threat to human and natural resources; effectiveness of response actions and clean-up methods; difficulties encountered; and recommendations on means to prevent recurrence, and to improve and change the plan (US Code of Federal Regulations, 1992 and USCG, 1994).

3.2.3 Inter-agency participation

The NCP should address provisions of inter-agency participation and support. In addition, participation by the general public, volunteer groups, industries and local communities is strongly encouraged. Their presence should be requested in response planning and implementation to enable them to provide assistance in their respective areas of expertise. They can provide assistance in different ways:

a) making significant and necessary information available to the NCER, the NRC and the OSC;

b) sending representatives to the NCER and assisting the committee in formulating the plan;

c) informing the NCER of any changes in the availability of resources to be rendered that would affect the operation of the plan; and

d) recommending changes to the plan to cover their areas of concern which can help in setting response priorities.

The local communities, in particular, can provide a better idea about areas of environmental sensitivity and other resources at risk since they are the ones dependent on the local environment for their livelihoods. Their concerns should, therefore, be seriously considered while trying to plan response options and priorities.

3.3 Preparedness and Planning

3.3.1 Sensitive area identification/prioritisation

Spilled oil tends to make its way ashore due to surface current, wind and tides exposing the coastline to the adverse impacts of spill incidents. Depending on physical and ecological conditions, sensitivity of the coastline to oil spills varies. Doerffer (1992) describes behaviour of oil in different type of shorelines, which is summarised in Table 9.

Table 9. Oil behaviour in shores

Shoreline type	**Description**
Exposed rocky headlands	Wave reflection keeps most of the oil offshore. No clean-up usually necessary.
Eroding wave-cut platform	Wave-swept. Most oil removed by natural processes within weeks.
Fine-grained sand beaches	Oil does not penetrate into the sediment, facilitating mechanical removal if necessary. Otherwise, oil may persist over several months.
Coarse-grained beaches	Oil may sink and/or be buried rapidly making clean-up difficult. Under moderate to high energy conditions, oil will be removed naturally from most of the beachface.
Exposed compacted tidal flats	Most oil will not adhere to, nor penetrate into, the compacted tidal flat. Cleaning is usually unnecessary.
Mixed sand and gravel	It may undergo rapid penetration and burial. Under moderate to low energy conditions, oil may persist for years.

Gravel beaches	Same as above. Clean-up should concentrate on high-tide/swash areas. A solid asphalt pavement may form under heavy oil spill conditions.
Sheltered rocky coasts	Areas of reduced wave action. Oil may persist for many years. Clean-up is not recommended unless the oil concentration is heavy.
Sheltered tidal flats	Areas of great biological activity. Oil may persist for years.
Salt marches and mangroves	Most productive of aquatic environments. Oil may persist for years.

Source: Doerffer (1992), page 237.

It is essential that the contingency plan emphasises response actions for the different habitats and resources based on their economic, ecological and social values. The plan, then, goes further to look at the priority of areas for protection. A complete knowledge of sensitivities of the areas and their priority for protection will enable the best use to be made of limited resources for response and clean-up operation (Etkin, 1990; IMO, 1995 and Sampson, 1997).

• *Sensitive area mapping*

Maps of sensitive areas need to be prepared early in the planning stage. Their preparation requires studies and surveys to be conducted on the ground to identify various environmentally sensitive areas including areas for: fisheries; mariculture; birds and other wildlife; areas of particular environmental significance (e.g. wetlands, marine parks and natural reserves, etc.); industrial use of sea-water (e.g. power stations, desalination plants, etc.); amenity beaches of tourist attraction; yachting and other recreational facilities; population centres, and aesthetic, cultural, archaeological or historical sites (IMO, 1995 and Sampson, 1997). This information is then displayed on sensitivity maps. Other information worth indicating in the maps includes, but is not limited to, protection priority; equipment to be used for a particular area; collection points for equipment, collection points for recovered oil and contaminated debris (USCG, 1994). An example of a sensitive area map is found in Appendix 1.

It is impossible to indicate all the information needed on a small map. Therefore, it is desirable to attach a separate sheet containing such information as shoreline/habitat to be protected; wildlife/resources to be protected; protection strategy; access to areas; nearest available resources; and other resources available (USCG, 1994). A typical attachment sheet used in the United States (Savannah) shown in Appendix 2 can be useful and the format can be directed by the NCP. Alternatively, to date such difficulties are alleviated by computer-based software, including Geographic Information System (GIS), Mapping Application for Response, Planning and Local Operational Tasks (MARPLOT), Computer-aided Management of Emergency Operation (CAMEO), and Areal Locations of Hazardous Atmospheres (ALOHA). GIS and MARPLOT are both designed to store geographic information based on mapping application, which is organised into overlays, and, thus, helpful during planning and emergency response operations (EPA and NOAA, 1993). An application of GIS may reduce the response time and qualify the decision process as it allows information on position and size of the oil spill to be plotted on maps in GIS and a priority for response operations according to pre-identified sensitive areas to be carried out (Klint 1995). Developed by the Chemical Emergency Preparedness and Prevention Office of the EPA in co-ordination with the Hazardous Materials Response Branch of the NOAA, IE/PAC, and UNEP in 1992, CAMEO is designed to manage information about hazardous substances and to help emergency teams plan for the safe handling of chemical accidents; and ALOHA is a tool for estimating the movement and dispersion of gases and pollutants concentrations downwind from a spill source, taking into consideration the toxicological and physical characteristics of the spilled material, the physical characteristics of the spill site, the atmospheric conditions, and circumstances of the release (EPA and NOAA, 1992 and EPA, IE/PAC, NOAA and UNEP, 1992).

Obviously, the sensitivity of the coastline varies seasonally. Sampson (1997) supported by Etkin (1990) studies seasonal variations to the risk faced by coastal and marine resources and concludes that:

> "a. Recreational beaches may be primarily important in tourist season.
> b. Turtle nesting beaches may be only important between nesting and hatching.
> c. Fish hatcheries may be only important when fingerlings are released."

Sensitive area maps should be prepared in such a way that they reflect the seasonal variations. It may be advisable to develop such maps for each month of the year with indications of which particular species are most likely to be present with regard to reproduction, migration and feeding behaviour, and indications of which specific coastlines are of importance to tourist attraction. To be accurate and effective, the maps need the review of governmental agencies, private entities and local communities. This is especially important to achieve consensus on pre-designation of spill response priorities. Unlike other maps (e.g. administrative maps), sensitive area maps need frequent updating to reflect any changes of significance to spill response activities.

• *Sensitive area prioritisation*

All of the above mentioned sensitive areas may need protection from the negative effects of oil contamination. However, the protection of all areas may sometimes simply not to be feasible, especially in the case of major/catastrophic spills, from the standpoint of practicality and economics. Therefore, it is essential that the question of prioritisation of areas and resources for protection is adequately addressed before hand in the contingency plan. Etkin (1990) indicates consideration must be given by contingency planners to priority for protection and clearly concludes that:

> "In the case of a major spill, it is unlikely that all the resources at risk can be successfully defended. For this reason, contingency planners need to consider the priorities for protecting the various sensitive areas in a particular location."

An attempt to define which sensitive areas and resources have priority over the others is not an easy task. It is mainly because the value of each resource to the community is dependent upon the weight given to human welfare, environmental, recreational, economic, and political considerations. In a broader sense, priorities given to the protection of resources vary from one location to another and even from one country to the next. In this regard, an individual nation may develop criteria for ranking priorities for protection of the resources based on their ecological, economic and social values to different communities. In particular, the following protection priority criteria developed by the USCG (1994) are worth considering for their practical application to Cambodia.

"Protection Priority Criteria

♦ ♦ ♦High (A) Protection of public health
Public drinking water intakes

Safety and health of response workers
Industrial water supplies potentially impacting public needs and/or safety
Endangered or threatened species and their habitats
National estuarine research reserves
National wilderness areas
National wildlife refuges
State wildlife refuges and game management areas
Legal or private wildlife refuge areas
Seasonal breeding, spawning, and nesting areas
Salt marshes
Brackish marshes
National parks, monuments, and seashores

♦♦Medium (B) State and county parks
National historic register sites
Commercial and recreational fisheries management areas
Sheltered rocky shores and seawalls
Exposed tidal flats
Gravel beaches and riprap
All other beaches
Other undeveloped land
Public parks, recreation areas, and facilities
Private recreation areas and facilities

♦Low (C) Industrial water supply not potentially impacting public needs and/or safety
Other tourist/recreation areas
Exposed vertical rocky shores and seawalls

Agricultural land
Other developed land
Industrial facilities"

Such priorities must be considered in balance with the economic dependence of the region/nation on the resources at risk. If oil contamination would have a long term negative impact (for example, oiled tourist beaches, where tourism is the major economic activity), then the priority for protection may need to be increased. In the process of deciding priority for protection, a wide variety of interested parties need to be consulted to enable them to contribute their concern and interest. The agreed priorities must be made publicly available and cross-referenced to sensitive area maps. This can reduce to a great extent the risk of disagreement and indecision when encountering difficult choices during an oil spill incident.

3.3.2 Planning and co-ordination structure

The national planning and co-ordination, as mentioned in the previous section, is accomplished by the NCER consistent with procedures and guidelines developed in advance. A planning and co-ordination structure is designed to ensure compatibility of the local and private response plans and strategies the national plan for emergency response to oil pollution incidents.

3.3.3 Training and exercise

The ultimate effectiveness of response to oil pollution incidents, irrespective of sophistication of the equipment, depends by and large on how well personnel are trained to assume their assigned duties. Regardless of the job, each responder must be familiar with response procedures and have expertise in mastering response and clean-up equipment as well as knowledge about relevant environmental, economic and practical issues (Etkin, 1990). These can only be achieved through training and exercises. The speed and co-ordination necessary to respond effectively to oil spills will be lacking, and a myriad of operational, logistical, communications and other problems will overwhelm the response effort if training of personnel and others involved is not regularly conducted.

To be effective, the NCP must address the training requirement. Training can be accomplished in a variety of ways, including classroom sessions, on-the-job briefings, recall exercises, communication exercises, full-scale operational exercises, and disaster simulation. The scenario should be as realistic as possible. The training needs to be conducted for all levels, ranging from response personnel to top managers (IMO, 1995 and International Tanker Owners Pollution Federation Ltd., 1985). IMO (1988) develops two generally-recognised types of training with separate objectives. These include hands-on training and training on management of oil spill clean-up. The hands-on training is designed to train a crew to become proficient in the deployment and operation of particular types of equipment or in the execution of a specific clean-up technique. With an objective to familiarise each trainee with equipment and its use, the hands-on training contains initial instruction and frequent exercises. The outline of a hands-on training course is shown in Appendix 3. On the other hand, the training of management of oil spill clean-up is intended to provide a thorough background in the subject and to enable the trainees to become familiar with their areas of responsibility, on the ground and within the organisation. The outline of such a training course is shown in Appendix 4.

As mentioned earlier, the contingency plan, to be effective and well-prepared, must be exercised on a regular basis. These exercises and drills will ensure that contingency arrangements function properly and that all involved in the spill response become fully familiar with their particular responsibility. The exercises allow equipment in the inventory to be mobilised and deployed to test its actual availability and performance. Only through exercises, if no real incidents occur, can weaknesses in the contingency plan be exposed, bottlenecks in the arrangements for equipment deployment be identified, timescales required to implement instructions be realistically assessed, and a team-work spirit be developed. Lessons learned from each exercises serve as the main basis for improving and even revising the plan, which in turn, allows a high degree of national planning and preparedness to be achieved.

Conducting an exercise, especially a full-scale one, involves a great amount of resources which sometimes is prohibitive. To overcome this, component-by-component exercise is an alternative. IMO (1995) supports this argument for reason of practicality and highlights that:

> "Although the entire system needs to be exercised at one time to ensure all of the response components mesh together properly, it is beneficial to exercise some of the components of the response system separately to allow for more thorough evaluation and the opportunity for the responders to become familiar with the different components."

A most effective exercise is the one which is known as a tabletop exercise (Sampson, 1997). To conduct this exercise, a simulation is used and all of those who are involved in the emergency response are invited. The exercise is intended to evaluate procedures for co-ordination of responsible agencies and personnel, timely deployment of equipment and personnel, and overall effectiveness of the plan.

Exercises and drills must be conducted periodically and participated in by the main players. It is observed that in most cases, top managers at decision-making level send their assistants or secretaries to take part in the exercises (Sampson, pers.comm. 1997). This practice has to be prevented from happening as in a real response to pollution incidents only those designated managers have ultimate responsibility in the operation.

The contingency plan should address provision of communities' involvement and participation in the exercise to ensure that the needs and interest of the entire communities are adequately tackled.

3.3.4 Revision of plan

The contingency plan is a living document which is subject to modification and changes to reflect changing circumstances. Sampson (1997) provides positive response to this and indicates that:

> "A contingency plan must be a "living" document that remains abreast of all changes related to risk levels, resources in need of protection, and preparedness to mount a response."

Revisions to the contingency plan need to be made periodically to ensure that experience gained from regular exercises/drills and actual incidents is incorporated (IMO, 1995 and USCG, 1994). The USCG (1994) identifies the relevant areas for revision, including: emergency notification, response equipment information (type and amount of equipment available), sensitive areas, hazard/risk assessment of the area, response strategy (based on new technology, equipment, etc.), and dispersants approval. Other areas include organisational changes, legislative revision and changes in priority for protection, which effect response organisation, strategy and policies.

All revisions and amendments to the plan must be recorded and communicated to the participating organisations and everybody involved. Revised pages can be easily inserted into the original plan by using a loose-leaf (binder) format (International Tanker Owner Pollution Federation LTD., 1987). The loose-leaf format also allows outdated pages to be removed without destroying the rest of the plan.

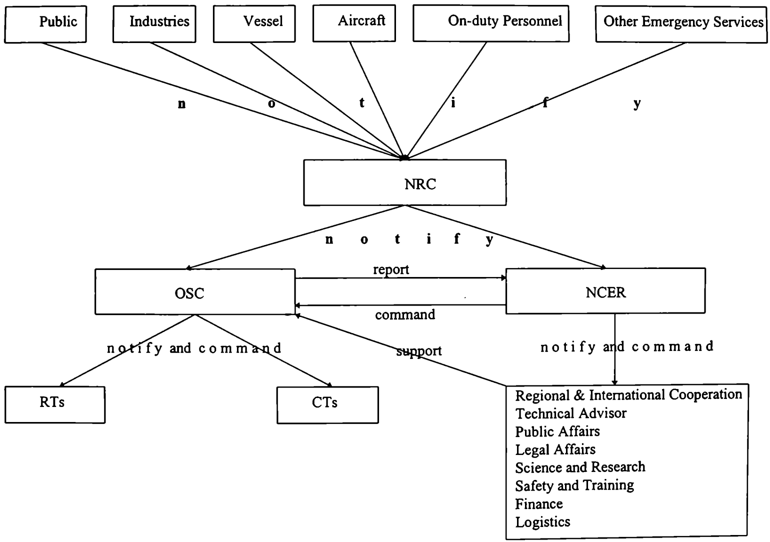
3.4 Response Operations

The response operation segment of the plan details the actual actions to be taken in accordance with defined policy, strategy, procedures and responsibilities at the scene of oil pollution incidents. Many events during an oil spill response operation will take place concurrently, but the format of the operational plan should follow a roughly chronological order which is indicated in the following sequence.

3.4.1 Emergency notification

Information on the occurrence of an oil pollution incident may be discovered through various channels. These include a report submitted by a person in charge of an industrial operation (ports, offshore platforms, refineries, etc.), by other emergency services (police and ambulance), on-duty personnel, and by a fortuitous discovery or observation by representatives of other government agencies or the general public. The information must be reported orally, by telephone, or by facsimile to the NRC which provides 24-hour emergency communication services. The NRC should ensure that all necessary information, including date, time, position, source and cause of the accidental discharge is obtained. As soon as knowledge of the discharge is received, the NRC must promptly notify the OSC, the NCER, and other interested parties. An example of a spill notification form developed by the Louisiana Department of Environmental Quality is found in Appendix 5. Ultimately, it is the responsibility of the NCER and OSC to keep their subordinates alert and ready to carry out response operations. The emergency notification procedure is shown in Figure 9.

Figure 9. Emergency notification system



3.4.2 Incident evaluation and plan activation

First hand information on an oil pollution incident is often sketchy and incomplete and, therefore, additional investigation needs to be accomplished by the pre-designated OSC. Main tasks of the OSC in this regard are (Etkin, 1990; International Tanker Owners Pollution Federation LTD., 1985; Louisiana Oil Spill Co-ordinator's Office, 1995 and US Code of Federal Regulations, 1992):

a) to promptly initiate a preliminary assessment of pollution incidents using available information, supplemented where necessary and possible by an on-scene inspection;

b) to pinpoint source and cause of incidents and responsible parties;

c) to evaluate the magnitude and severity of the incidents and potential threat to human health and welfare and environment;

d) to take necessary actions to prevent, minimise or mitigate threats, including analysing water samples, controlling the source of discharge and placement of physical barriers to deter the spread of oil slicks;

e) to ensure adequate ground-based and aerial surveillance over the movement of spilled oil, tracking oil slicks, and over the response actions taken to minimise or mitigate the threat; and

f) to recommend activation of the plan if the situation is so required.

The OSC then submits a report to the NCER for further assessment. The report thereby submitted should contain (International Tanker Owners Pollution Federation LTD., 1985 and 1987 and Louisiana Oil Co-ordinator's Office, 1995):

a) date and time of observation;

b) position, indicating latitude and longitude, or other identified ground-marks (objects), and accessible route to the scene;

c) source and cause of incident, e.g. name, flag and type of vessel, collision or grounding;

d) estimate of amount of oil spilled and likelihood of further spillage;

e) description of oil slicks including direction, length, breadth and appearance;

f) type of spilled oil and its characteristics;

g) weather and sea conditions;

h) expected potential threat to human health and welfare and environment;

i) action, both taken and intended, to combat pollution and to prevent further spillage; and

j) recommendations.

The NCER should undertake thorough evaluation of the pollution incident upon receipt of the report form the OSC. This evaluation should determine whether or not the activation of the contingency plan is necessary. It should also determine the levels of response required including (International Tanker Owners Pollution Federation LTD., 1985 and US Code of Federal Regulations, 1992):

a) if the evaluation shows that no key resources are threatened, no response may be necessary beyond monitoring the movement and behaviour of the oil slicks;

b) if the evaluation shows that key resources are threatened, a decision needs to be made whether their protection is best achieved by application of chemical dispersants, mechanical recovery or by in-situ burning;

c) if the evaluation shows that only limited protection is feasible for resources threatened, a decision on priorities for protection needs to be made using the pre-defined environmentally sensitive areas list; and

d) if the evaluation shows that no protection measure is feasible, or if resources have already been affected, a decision on the priorities for clean-up operation needs to be made.

To facilitate the rapid deployment of manpower and equipment, arrangements and procedures should be included in the contingency plan. For instance, the RTs and CTs are placed on stand-by, equipment may be loaded onto vehicles ready for dispatch, and paperwork and other formalities may be completed before an actual mobilisation order is confirmed.

3.4.3 Response strategies

In planning response strategies, various factors should be taken into consideration that may affect the whole operation. These include, inter alia, spill sources, spill causes, effects of sea and weather conditions, properties and behaviour of spilled oil, personnel health and safety concerns, and concerns for marine ecosystem (Doerffer, 1992; IMO, 1988 and Sampson, 1997).

• *Spill sources*

The source of an oil spill is not limited to discharges from vessels. Other sources that have the potential for spills of major significance to the coastal and marine environment include trains, trucks, pipelines and facilities. These indeed dictate different strategies for response to accidental spills.

• *Spill causes*

Different causes of the marine environmental emergencies may require different response strategies. The causes of oil spills include collisions of vessels, groundings and capsizings of vessels, explosions and fires on various transport means or at industrial or storage facilities, dragging of anchors across submerged pipelines, collisions with bridges, structural or technical failures, and extreme weather conditions.

• *Effects of sea and weather conditions*

Sea and weather conditions can significantly affect capabilities to mount an effective response. Waves exceeding two feet in height make the deployment and tending of recovery equipment difficult and dangerous and even if the deployment of recovery equipment is managed, its capacity and effectiveness is reduced dramatically (e.g. containment boom becomes rapidly less effective and problems of oil splashing over the top of the boom and entrainment under the boom occurs as wave heights exceed two feet in combination with wind velocities approaching 20 knots) (Sampson, 1997). Wind-driven surface currents in excess of three knots make utility of boom to contain or concentrate a spilled oil difficult and ineffective as entrainment problems usually begin when the floating substance encounters the boom orthogonally at velocities greater than one and one-half knots (Sampson, 1997). Water and air temperature can change the viscosity of the spilled oil, which in turn dictates the selection of recovery equipment. In addition to winds and waves, water and air temperatures play an important role in the weathering process of spilled oil, including spreading and drift; evaporation; dissolution and advection; dispersion of whole oil droplets into the water column; photochemical oxidation; water-in-oil emulsification; microbial degradation; adsorption onto suspended particulate material; ingestion by organisms; and sinking and sedimentation (Doerffer, 1992 and Sampson, 1997).

• *Properties and behaviour of spilled oil*

The properties and behaviour of oil vary widely from refined oil to crude oil and even to crude oil from different fields. However, the most important properties to be considered when planning response strategies are specific gravity, viscosity, pour point, flash point and solubility (Sampson, 1997). Sampson (1997) provides definition of these properties including:

> "Specific gravity of a substance is an indication of how heavy the substance is when compared to fresh water.
>
> Viscosity of an oil is an indication of how fluid the oil will be at a given temperature.
>
> Pour point of an oil is a temperature below which it will take on semi-solid characteristics and essentially not behave as a fluid.
>
> Flash point of an oil is an important indicator of how dangerous the product is to work around from the standpoint of its readiness to be ignited.

Solubility of an oil gives an indication of how much of the product will dissolve, or go into solution in water column."

This information is extremely important to incorporate into the contingency plan as it assists in formulating effective response strategies for a specific type of oil spilled into a given environment. For example, when a spill of a refined product occurs, its behaviour at known ambient conditions is accurately predictable and strategies for response can be selected accordingly.

• *Personnel health and safety concerns*

The hazards that a spilled oil presents to response personnel include, but are not limited to, inhalation, ingestion and dermal contact resulting in headaches, dizziness, dermatitis, eye irritation; fire; and explosion (Sampson, 1997). In addition to hazards associated with the spilled oil, other safety considerations should also be given adequate emphasis. One of the most important is the issue of boat-operating safety. All these health and safety considerations determine response strategies for oil pollution incidents while protecting response personnel from the hazards.

• *Concerns for marine ecosystem*

The marine ecosystem within an area where an oil spill occurs is a main factor determining strategies used for response. In the near-shore waters where larva of many species are found, use of dispersants are restricted while mechanical recovery is recommended.

Once all of these factors are adequately addressed, the most appropriate strategy(ies) should be selected from various response options commonly used world-wide. These are:

• *Chemical dispersion*

Chemical dispersion is a process in which dispersants are used to enhance natural dispersion of spilled oil by wave action and turbulence. The oil is then broken into small droplets in a more rapid fashion and sinks down into the water column, which provide more rooms for bacteria to attack.

Dispersants used are chemical agents which are intended to alter the physical behaviour of oil on the sea surface. They are made up by a mixture of surface active agents dissolved in a solvent which assists penetration of the mixture into the oil (Doerffer, 1992 and IMO, 1988). The surface active agents reduce the surface tension of the oil and, thus, increase the rate of droplet formation and inhibit coalescence of the droplets (IMO, 1988) resulting in an increase in the rate of biodegradation. Therefore, the use of dispersants can reduce the potential threat posed by surface oil to sensitive resources such as bird colonies, coastal habitats and amenity beaches.

However, toxicity of dispersants can cause damage to organisms in the water body if the right dispersants are not used for the right place at the right time (Doerffer, 1992; Etkin, 1990 and IMO, 1988). To overcome this, pre-approval of dispersants that can be used with less negative impact on the marine environment needs to be reached among planners and government regulatory authorities, consistent with internationally acceptable standards. Types of dispersants used world-wide are found in Appendix 6. Areas where dispersant application is permissible need to be identified early in the planning phase, taking into account their sensitivity to the dispersants and dispersed oil. Areas which may be sensitive to the dispersants and dispersed oil include fish breeding and feeding grounds, shellfish beds, wetland areas, tidal flats, lagoons, and coral reefs (Etkin, 1990 and International Tanker Owner Pollution Federation LTD., 1987). Chemical dispersants reach the peak of their effectiveness when they are applied in a matter of an hour, as dispersibility of oil decreases rapidly with the oil weathering process (Doerffer, 1992 and Etkin, 1990). Therefore, when the dispersant option is selected, the logistics involved in application, including making dispersant stocks and the application equipment available on scene as well as the vehicle and spraying equipment operators, trained in the appropriate procedures, must be in place.

Success of dispersant use is also dependent on techniques employed. Two spray techniques commonly used are aerial spray system using aircraft and shipborne spray system using vessels (IMO, 1988). For response to large spills, given the time considerations for dispersant effectiveness, aircraft are likely the only viable option.

• *In-situ burning*

In-situ burning is another clean-up technique based on combustion of spilled oil at the scene. This technique is considerably effective when the spilled oil is in heavy concentrations and fresh, meaning before it becomes emulsified and before the lighter ends of oil product are evaporated. In order for oil spilled on water to burn, it must be relatively fresh and at least three millimetres thick (Etkin, 1990 and IMO, 1997b). This also underlines a relatively small window of opportunity of about one to two hours during which the process of in-situ burning will be most successful, after which the oil may become difficult or impossible to ignite.

Concerns over safety, health effects, and air pollution from smoke emissions is a main reason for some countries, especially those in Europe, to not consider in-situ burning as a response option. However, pollution and health effects may not be particularly well founded (Etkin, 1990). In Etkin's study (1990), the US Office of Technology Assessment suggested that the visible air pollution from an in-situ burning must be balanced against the invisible air pollution caused by allowing evaporation of toxic volatile components of the spilled oil.

Since the in-situ burning needs to be carried out within the early hours of a response, decisions on which specific circumstances and in which locations the technique is permissible need to be made in advance. Such pre-approval should be disseminated to government agencies, private contractors, industries and local communities, especially the ones in areas where oil spills are predominantly expected.

• *Mechanical recovery*

Mechanical methods of oil spill response are designed to contain and recover spilled oil from the sea surface. It is ecologically essential and technically and economically feasible only as long as the oil is floating on the water surface and has not reached a state of total dispersion (Doerffer, 1992).

Mechanical recovery using booms and skimmers generally results in no more than 10-15 % oil recovery under even the most favourable conditions (Etkin, 1990). Despite its inefficiency and limitations, it is always needed and employed in clean-up operations, particularly when other methods, such as chemical dispersion and in-situ burning, are prohibited for ecological and safety reasons.

Boom consists of following basic components: freeboard to prevent or reduce splashover; subsurface skirt to limit escape of oil under the boom; flotation by air or some buoyant material; and a longitudinal tension member (chain or wire) to withstand effects of wind, waves and currents (IMO, 1988). It is used to contain the oil slick, to reduce spreading and to facilitate recovery; to divert oil to areas where recovery is possible; and to protect specific areas, such as environmentally sensitive areas. Depending on the spill situation, location and physical conditions (winds, waves, currents, etc.), different kinds of booms can be chosen, including:

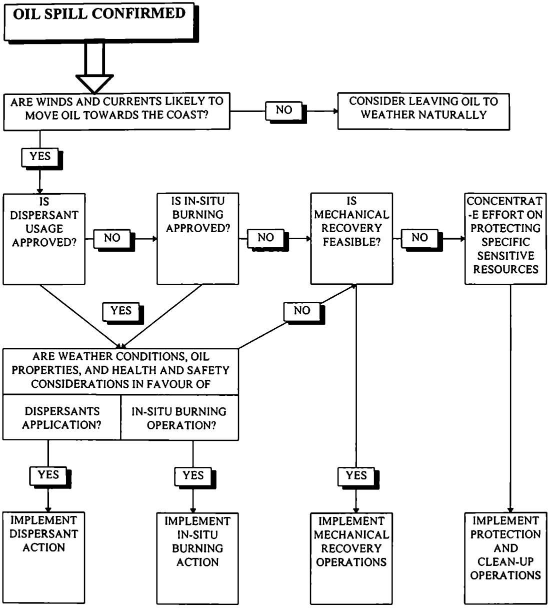
> "a) Solid flotation boom: flotation consists of buoyant material such as plastic foam, and skirt is made of oil and water resistant fabric ballasted along its lower edge (IMO, 1988);
>
> b) Inflatable boom: it consists of inflatable air chamber or tubes. The air is normally provided from a low pressure blower, but some inflatable booms contain internal springs and non-return valves which permit self inflation. The skirt is made of oil and water resistant fabric (IMO, 1988);
>
> c) Fence boom: it consists of a single sheet of material which constitutes both freeboard and skirt; floats and ballast weights are attached at intervals (IMO, 1988); and
>
> d) Pneumatic barriers: these employ a screen of air bubbles released below the water surface, usually from a fixed pipe on the seabed. Rising air bubbles generate an upward water flow which diverts horizontally at the surface. This surface current flows in both directions away from the bubble stream and can retain oil under low currents (IMO, 1988)."

There are other types of booms commercially available. In general, booms can be deployed by towing them using vessels at sea or mooring them in shallow or inshore waters.

Other key elements in mechanical recovery are skimmers designed to recover oil from the sea surface. There are different kinds of skimmers which vary from one another in size and principle of operation. In general, they are divided into seven basic types (Etkin, 1990): weir skimmers; skimming barriers (booms which incorporate skimming devices); oleophilic disc skimmers; oleophilic mop skimmers; belt skimmers; vortex skimmers; and vacuum skimmers. The effectiveness of any skimmer depends on a number of factors, including type of oil spilled, oil thickness, oil viscosity, degree of emulsification, sea conditions, and storage capacity (Etkin, 1990 and IMO, 1997b). When selecting skimming equipment to stockpile for emergency response, planners should consider these factors. Obviously, mechanical recovery equipment involves significant capital investment which often presents a barrier to procurement of an adequate supply as financial resources are always limited. To minimise the financial constraints, the cost effective decisions need to be made on type of booms and skimmers whose capability and efficiency can be maximised.

It is noticed that between different techniques used for oil spill clean-up operations, different results are realised. The chemical dispersion technique can lead to degradation of up to 80-90% of the spilled oil; the in-situ burning obtains efficiencies as high as 95-98% of the spilled oil; while mechanical methods, unless the most favourable conditions prevail, can recover no more than 10-15% of the spilled oil (Etkin, 1990 and IMO, 1997b). Although up-to-date data is not available, it is believed that greater improvement of equipment and technology should allow higher efficiencies for mechanical methods. With these various methods in mind, response strategies rest with an OSC but contingency planners need to decide which strategies should be available and facilitated. To assist in the decision-making process, a schematic decision-making guide (Figure 10) is a helpful tool to be considered. The guide can be used either in the planning process to develop worst probable scenarios and/or in actual response operations. This process is much easier for OSCs and response personnel to use than a volume of text. However, in using this guide, one should be aware of the danger of over-simplification.

Figure 10. Decision-making guide



3.4.4 Clean-up and disposal

Clean-up operations take place after clean-up techniques are approved. This has already been discussed in previous sections, and the most effective options should be designed for specific locations and time.

In many cases, spilled oil will work its way to the coastal areas and shoreline clean-up operation to remove oil and oily debris needs to be carried out. This involves a large workforce and considerable amounts of equipment which the contingency plan should ensure arc adequately supplied, preferably from existing stockpiles. However, in a major case, assistance from other agencies, including, but not limited to, the Royal Armed Forces, the Royal Navy, MAFF, MOE, MIME, MPWT, MOT, private contractors, local communities, and volunteer groups, may be required. Agreement should be reached with those agencies along with mechanisms to organise such resources; both workforce and equipment must be planned to be put rapidly in place. One mechanism to facilitate such actions that is worth considering for incorporation into the plan is an Incident Command System (ICS). This has been specifically crafted for oil spill emergencies by the USCG and will be discussed in more detail in section 3.5.

To ensure smooth operation of the clean-up, the contingency plan should lay down procedures for:

a) mobilising the necessary equipment and related manpower;

b) deploying equipment at sea and on shore in accordance with the response decision;

c) organising sufficient logistical support to avoid bottlenecks (e.g. between oil collection, temporary storage and final disposal), including the provision of needed food, clothing and other consumables;

d) monitoring the progress of the clean-up operation using inputs from aerial surveillance and personnel on site to reassess the response decision; and

e) maintaining accurate records, on a daily basis for each clean-up location, of all actions taken, workforce and equipment deployed, and amounts of material used.

Another essential aspect of clean-up operation is the temporary and/or ultimate storage and disposal of recovered oil and oily debris. In general, oil spill clean-up operations generate large quantities of oil and oily debris which must be dealt with either by disposal or recycling (IMO, 1997b). The contingency plan should identify facilities for transporting any recovered oil and oily debris to collection and disposal depots, and for temporary or intermediate storage. Failure to address this issue may result in bottlenecks, or in failure of emergency response and clean-up actions.

Several disposal options should be looked at, depending on type and condition of the recovered oil. Some recovered oil might be attractive to refineries, contractors specialising in recycling waste oils, power stations, cement and brick works. Dry or pasty oily wastes with a relatively low content of oil mixed with binding agents or untreated solids (< 3% of oil) could be used for landfilling, while oily wastes containing up to 20% of oil can be acceptably disposed of along with domestic wastes (Doerffer, 1992). Oily debris can be spread out evenly over land specially prepared for this purpose using oil degrading bacteria and micro-organism as well as nutrients.

3.4.5 Ongoing incident assessment

Ongoing incident assessment needs to be undertaken by both the OSC and NCER using the most up-to-date data collected by field personnel. To provide more reliable and effective data, aerial surveillance should be arranged by the NCER to:

a) determine the size, quantity and location of oil spilled;

b) determine the movement of the oil;

c) note changes in the appearance and distribution of the oil over time;

d) forecast which marine and coastal resources or areas are under threat;

e) keep response equipment active in heaviest concentrations of oil;

f) observe and report on effectiveness of response measures; and

g) monitor overall response and clean-up operation.

The assessment is intended to ensure the effectiveness and appropriateness of response techniques employed and to keep track of the whole operation. Changes to the response and clean-up methods may need to be made as a result of the assessment. These means of assessment may also be useful in determining the time for termination of clean-up operations.

3.4.6 Public and media relations

Public and media relations are an important part of the contingency plan. Often, the success of a clean-up operation is ultimately judged by the perception of success as reported by the press and visiting dignitaries rather than the actual number of gallons of oil recovered and/or natural resources protected (Etkin, 1990). Good relations with the media may also be essential to protect the public from the hazards presented by the emergency and to enlist the assistance of the public in performing response actions. With this in mind, the plan should pre-designate a competent person to be responsible for liaison with the general public and media. Under administration of the Public Affairs section, responsibilities are to:

a) give the public and media prompt and accurate information on the nature of the incident, actions needed for public safety and actions underway to prevent and mitigate damage to human health, welfare, and environment;

b) ensure that all appropriate public and private interests are kept informed and that their concerns are considered throughout the response operation; this should be accomplished through regularly scheduled briefings or meetings and press releases; and

c) arrange meeting points for survivors and their relatives.

To facilitate the assigned tasks, provision should be made for suitable office space and telephone lines, separate from those used for the response operations. An office should preferably be located near the scene to co-ordinate the public and media relations and to issue official announcements of the incident.

3.4.7 Health and safety issue

Health and safety of field personnel and others who are likely to be exposed to an incident should receive the first priority in selecting response strategies and operations. It is extremely important that the contingency plan addresses the health and safety issue, clearly defining responsibilities, potential dangers that the spilled oil presents and procedures to monitor any potential hazards such as the presence of volatile hydrocarbons.

The OSC during actual response operation embraces the ultimate responsibility for occupational safety and health issues. This person must ensure that proper personal protective clothing and equipment and first aid services and medial kits are in sufficient supply for the field personnel before they go to the scene. Evacuation means need to be arranged to ensure timely dispatch of affected personnel to pre-designated hospitals. After the response operation, medical check-ups are necessary for the field personnel to discover any immediate health effects. In addition, the medical check-ups should be provided on a regular basis to follow up health conditions of any affected personnel.

3.5 Regional/International Co-operation

In a major oil spill, it is obvious that it may exceed the nation's capacity for response, resulting in oil spreading and threatening shorelines of not only one, but several coastal states. In this case, a greater workforce and more equipment may need to be drawn from countries within the region to combat the marine pollution. Such combined efforts normally cannot be realised on short notice unless a mechanism for such an assistance request exists in the form of bilateral and/or multilateral agreements within the NCP. The agreements for co-operation in this regard must be concluded and are intended to form a legal basis for immediate intervention, especially by neighbouring nations. Such assistance is provided for by the International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC 1990). Therefore, the benefits of coastal states becoming signatory to this Convention must be considered and encouraged.

In operational aspects, the NCP should lay down procedures for organising resources from many disparate sources for response to avoid confusion and to make maximum use of such resources. In this connection, the ICS model, developed by the USCG, should be considered for incorporation into the NCP. This ICS model is designed to allow representatives of participating organisations to be incorporated into a single response organisation facilitating overall commitment to a single set of collective objectives of a cohesive action plan under a single OSC, known as the Incident Commander in this system. It consists of eight basic components:

a) Common terminology: It provides a unifying language for multi-organisation response. By using the unifying language, possible confusion and misunderstanding commonly found in multi-agency response operations can be avoided.

b) Modular organisation: ICS organisation starts by designating an Incident Commander who often can independently manage various sections within the organisation. These sections include operations, planning, logistics and finance. An example of an ICS response organisation is found in Appendix 7.

c) Integrated communication: This provides integration of on-hand communications equipment with the organisation's needs.

d) Unified command structure: This is used when, because of the nature of the spill extending across jurisdictional boundaries, a single pre-designated Incident Commander is not established; and, thus, representatives of agencies with major jurisdiction can form a Unified Command structure to jointly assume the Incident Command responsibilities. Unified Command develops common objectives and strategies to guide the development of a single action plan to be implemented by an operations section.

e) Consolidated action plan: The action plan is needed to keep response activities on track toward objectives. The action plan should be a written document, especially when resources from several agencies are committed, several jurisdictions are involved, or when duration of operations requires a shift of personnel. It should address objectives, incident briefings, radio communication plans, organisation and division assignment lists, medical plans, and weather information.

f) Manageable span of control: This increases accountability, adherence to the action plan, and reduces freelancing that may cause injuries and loss of effective operational control.

g) Designated incident facilities: within the system, each person becomes familiar with each type equipment and assumes a personal responsibility for the equipment.

h) Comprehensive resource management: Resources are organised and managed through use of an extensive inventory of materials, detailed procedures, ready-made signs, label tags, colour-coded cards, and standardised forms.

3.6 Resources Needed

The effectiveness of the NCP entails the provision of resources needed for timely response to oil pollution incidents. The resources required to maintain and upgrade oil spill response capabilities include human resources, stockpiles of equipment and funding from various sources.

3.6.1 Human resources

The contingency plan, to be effective, should put a great emphasis upon the adequate provision of manpower, including high-level managers, specialised personnel and field staff, to fill the various posts established in the plan. The manpower to be employed under the plan should be correlated to the response and clean-up strategies chosen. For instance, if a response and clean-up operation involves chemical dispersion, dispersant specialists, pilots for aircraft or vessels, etc., are required.

However, provision of human resources may not always be satisfactory with regard to number and capabilities, especially when a major/catastrophic oil spill occurs. The emphasis should then be put on pooling resources from various agencies, including the Royal Armed Forces, the Royal Navy, local authorities, MOE, MOT, MIME, MPWT, MAFF, MINS (Police and Fire Department), universities, industries, private contractors, volunteer groups, Non-Governmental Organisations (NGOs), and from foreign countries. To ensure the smooth assimilation of personnel from these various sources, it is vital that the contingency plan incorporates procedures which allow inter-agency agreements to deal with temporary supply, command and compensation of such manpower. Such personnel can temporarily work for response and clean-up operations, in accordance with their competence, while retaining long-term attachment to their routine jobs. It is equally important that the contingency plan contains a list of the agencies with the number and qualifications of the human resources available for emergency response if requested. Such a list needs to be updated on a regular basis in order to enable the planners to be able to identify NCP adequacy and/or deficiencies.

Necessary training courses and exercises should be conducted for personnel in those various agencies to encourage their participation and to make them familiar with the emergency response strategies adopted in the plan. Only through training and exercise can confusion of their role in the response and clean-up operation be avoided and maximum use of such pools of resources be achieved.

3.6.2 Equipment/logistics

The equipment to be employed cannot be overlooked as it is a key factor, determining capability of the contingency plan, and the level of preparedness the country has in place. Obviously, acquisition of equipment ready for the relatively rare occurrence (possible but uncertain) of an oil spill may be an expensive investment. Therefore, in order to optimise the limited resources the planners must consider the cost effectiveness of various types of response equipment to ensure it is consistent with the strategies for response laid down in the plan. The planners must weigh the financial investment in preparedness and response capability against the priorities for protection and clean-up of environmental, economic and recreational resources which influence to a great extent the sustainable development of the country.

The contingency plan should address procurement of certain basic specialised equipment dedicated to response and clean-up operations. For example, this would likely include booms, skimmers and oil collectors, ships modified for spill control tasks, aircraft for spill detection, surveillance and dispersant application, chemical dispersants, dispersant application equipment, beach cleaning equipment, temporary storage facilities, and communication means. IMO (1995) provides guidelines for identifying response equipment (Appendix 8), which can be used as an equipment check list in the plan. In general, the response equipment can be divided into three categories: primary, auxiliary and support (IPIECA, 1991). This division can assist the planners in selecting the necessary and most appropriate equipment when financial means are in short supply. The categories of equipment are found in Table 10.

Table 10. Categories of equipment

Primary	Auxiliary	Support
Booms	Shovels	Aircraft
Skimmers	Diggers/loaders	Communications (VHF, satellite...)
Absorbents	Drums	Catering
Sprayers	Trucks/tankers	Housing
Dispersants	Vacuum trucks	Transportation
Radio communications	Plastic sheeting	Control room
Boats/tugs	Protective clothing	Medical/first aid
Pumps/hoses		
Tanks/barges/TSDs		

Sources: IPIECA, 1991.

Attention should be paid to the time needed to transport and deploy the equipment, and its effectiveness in different oil spill situations. This can be accomplished through conducting tabletop and field exercises.

Like human resources, the contingency plan should consider equipment readily available in other agencies, both government and commercial companies, so that a timely response to worst-case situations can be mounted. In addition, consideration should be given to resources accessible within inventories of other countries, both in- and out-side the region. In both cases, agreement and procedures for mobilising equipment should be prepared and included in the plan. For the latter (foreign assistance) the contingency plan should make administrative arrangements to expedite custom formalities, immigration and other control of the resources entering or leaving the territory for the purposes of assisting the nation in combating oil spill incidents.

Other logistical support for the response and clean-up effort, especially in the worst case, need to be considered in the plan, including protective equipment, medial kits, food stuff, water, electricity, transportation, communications, accommodations, and sanitation facilities.

3.6.3 Funding

A main source of funding for the NCP should be a government budget approved by the National Assembly on a yearly basis. Reimbursement of costs incurred for response actions and other services also forms an essential financial element of the NCP. In addition, compensation covered by several legal regimes, including the 1969 Civil Liability Convention (CLC 1969) and the 1971 Fund Convention (Fund 1971), provides for significant contribution to replenish the funding of the NCP. Fund 1971 is a supplementary convention to the CLC 1969 and, therefore, only those states which have become parties to the CLC 1969 can become parties to the Fund 1971. This puts Cambodia in an easier position for ratifying the Fund 1971 since it has already become party to the CLC 1969.

3.7 Reports and Communication

3.7.1 Communication system

As discussed earlier, the NRC serves as an ideal focal point through which notification of incidents, information on response operations, and control of clean-up and logistic support operation can be channelled. Given the vital role that communications plays in response and clean-up activities as a whole, the centre should be equipped with all necessary facilities, including telephone, facsimile machine, telex and radio communication systems and access to internet databases and E-mail capabilities. In addition to a common radio frequency, consideration should be given to allocating separate frequencies for each operation. It is noticed that accidents occur in areas where communication facilities are relatively inaccessible or unavailable. In such cases, portable communication centres should be considered and temporarily located as close to the scene as possible. A particular communication problem to be overcome is the availability of common frequencies or communication channels for direct communications between aircraft and vessels used in the response actions.

3.7.2 Post-incident reports

In addition to the initial and subsequent reports, the OSC should be assigned to prepare a post-incident report for the NCER. This report is intended to form a basis for improving and updating the NCP. To this end, among other things, the report should clearly address effectiveness of the response actions, difficulties confronted, and recommended amendments to the plan. The report should also be used as a legal basis (evidence) for reimbursement and cost recovery and, thus, it should precisely identify the source and circumstances of the spill incident, the identity of responsible parties, the response actions taken, the resources utilised, accurate accounting of costs incurred for response and clean-up operations, and monetary value of affected public health and natural resources of local, national and international significance. In valuation of the public health and natural resources affected, the OSC should take into account the long-term effects as well as immediate ones, and the whole spectrum of ecosystems rather than any specific resources damaged.

The NCP is a proactive approach toward a probable but uncertain occurrence of marine pollution incidents. To be effective, the NCP should be provided with adequate resources and regularly tested and exercised to find out any possible deficiencies and to take corrective measures. The NCP should be supported by a legal instrument providing enough power and authority to a person in charge. This allows decisions on response to be made quickly and at the scene.

CHAPTER IV

CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Continually increasing demands for fuel consumption in both industrialised and non-industrialised nations results in an increase in movement of oil by ocean-based means of transport, and a steady pressure for further development of offshore oil and gas reserves. Ultimately, these correspond to a constant increase in both size and number of oil tankers employed to meet the demand for oil.

Although preventive measures have been incorporated into numerous international conventions (most importantly MARPOL 73/78, SOLAS 1974 and STCW 1978, adopted by IMO) and new and emerging technology has been introduced to enhance safety levels, it is recognised that oil pollution incidents are still a matter of probable occurrence. The detrimental effects of oil pollution incidents on human health and welfare, and the environment continue to dominate the agenda in international fora and attract public attention. The scale and magnitude of these effects are dependent upon many factors, including, inter alia, volume of spilled oil and its physical, chemical and toxicological characteristics, local conditions at the time of incidents (e.g. wind, wave, temperature), seasonal variation, the presence of resources, and location of spills in relation to the nature and mixing of sediments, sea bottom topography and geomorphology of the coast. Two main types of effects are ecological and economical. The ecological effects can be described as physical and chemical changes in habitats, changes in productivity and growth, physiology and behaviour of individual organisms and species, toxicity and increased mortality in organisms and species and destruction or modification of entire communities of organisms through the combined effects of toxicity and smothering. The economical effects, on the other hand, include effects on fisheries, tourism and maritime transport, and other industrial uses, including power stations and processing industries using seawater for cooling, and desalination plants.

Accordingly, the nation must be prepared for oil pollution incidents if ecologically sustainable development is to be achieved. To this end, the nation should make an concerted effort to produce the NCP capable of dealing with the worst probable oil pollution emergency. The NCP must clearly define response strategies and operational procedures for combating oil spilled at sea, removal of oil from the surface of the sea, and the clean-up of amenity beaches and other shorelines. To ensure acceptance, the NCP should be subject to public comment.

To be effective, the NCP should include, inter alia: clearly defined objectives and scope of coverage; pre-designation of a responsible organisation and OSC; notification and alerting systems; identification of environmentally sensitive areas; provision of response and clean-up equipment and procedures for mobilisation; provision of manpower; and training and exercises. Worst probable scenarios need to be designed for regular exercises to get personnel well prepared for actual incidents. Moreover, provision should be made for solicitation of assistance from other agencies, private contractors, and neighbouring countries when the incidents exceed capability of the NCP. This can be accomplished through multilateral and/or bilateral agreements concluded during the planning stage by parties involved.

Obviously, the contingency plan involves a relatively large capital investment in equipment in order to maintain and upgrade response capability and effectiveness. This can produce a dilemma for the country where feeding the poor can overwhelm any priority for environmental protection. However, one should realise that it is more cost effective and much cheaper to invest in the prevention and countermeasures than in paying for the loss or clean-up of affected resources.

4.2 Recommendations

Taking account of the present situation, and recognising the necessity for the nation to provide a state of preparedness for response to oil pollution incidents, the following recommendations should be considered:

- *National policy*

Oil pollution preparedness and response should be established as part of the national policy for prevention, reduction or minimisation of detrimental impact from oil spills on human health and welfare, and the environment. It is important that the policy addresses provision of adequate human resources and equipment to back up the plan for emergency response. Special consideration should be given to capacity-building for response personnel, and to public education and awareness of pollution incidents and the public's role in reporting and supporting response to oil pollution incidents.

- *National legal instruments*

The Law on Environmental Protection and Natural Resource Management adopted by the National Assembly and signed into force by the King on November 18, 1996 stipulates provisions for environmental protection (chapter V, article 12 and 13) and empowers the MOE in collaboration with ministries concerned to hold full responsibility for environment protection. However, it is a framework legislation intended to provide a legal basis for the MOE to further develop secondary legislation when it deems necessary. In this connection, legislation should be developed under which a contingency plan is made mandatory for the public and private sectors whose activities are likely to cause oil and other hazardous substance pollution.

• *International legal instruments*

The nation should consider ratifying the OPRC 1990 which addresses, inter alia, the development of contingency plans on the national and international level, and provision of mechanisms for co-operation with relevant subregional, regional or global intergovernmental organisations, and, where necessary, industry-based organisations, and Fund 1971 which provides supplementary compensation to those who cannot obtain full compensation for oil pollution damage under the CLC 1969.

• *Other agreements*

Multilateral and/or bilateral agreements should be concluded with neighbouring countries for mutual assistance in major accidental pollution events, capacity-building, and for information exchange.

• *Contingency plan awareness*

Particular attention needs to be given to awareness programs to provide the public with the basic knowledge and philosophy behind the necessity for the nation and industries to put in place an effective contingency plan to combat pollution incidents. This should include organisation of seminars and/or short course training for representatives from government agencies concerned, industries and the general public.

• *Contingency plan development*

Contingency plans should be developed taking account of the worst probable incident for an area so as to enable the plans to accommodate all other lesser incidents which may happen to that area. The development of contingency plans should begin at the local level and work up to the national plan. Irrespective of whether they are local or national, contingency plans should follow a similar layout to enable them to be easily understood and integrated when necessary for large scale response actions. Similarity in layout will assist compatibility and ensure smooth transition from one level to the next as the size of response is enlarged. A plan should be reasonably complete in itself and should not entail reference to a number of other publications, which may cause delays.

• *Data and information*

An effective contingency plan rests on accurate data and information on: environmentally sensitive areas and other resources at risk; oceanographic characteristics including wave, wind, current, tide, and water depth; area particulars such as shoreline types, accessible routes; and resources available for response in various institutions. There is a need to understand the natural variability of the marine environment, the function and stability of the ecosystem, the role of key species, and the biological significance of the loss of populations of rare species. In addition, data on type and quantity of oil expected to be transported through the areas should be maintained. This data and information is a main contributory factor to the contingency plan as it dictates and determines response strategies which differ from one situation to another.

Probable but uncertain occurrence of marine pollution incidents is envisionable as the nation becomes increasingly involved with maritime developments, including transport of oil and other cargoes, and oil and gas exploration and production. There is enough evidence that incidents associated with these activities can result in oil spills that present significant threats to marine ecosystems and economic activities which, in turn, affect human health and welfare. To mitigate and minimise deleterious impacts, the NCP is regarded as an effective countermeasure and a proactive approach to management of pollution incidents. This must be developed and its full and efficacious implementation ensured. If effectively executed, the NCP provides a crucial prerequisite for achieving sustainable development in the maritime sectors.

Working in this direction, this dissertation could serve to initiate a NCP in Cambodia. Covering such areas as organisation and responsibility, response operations, regional and international co-operation, resources for response, and reports and communication, it is intended to be used as vital guidance and to form a significant foundation for planners to further conceptualise the complexity of preparedness and response to marine pollution incidents. In short, it is a valuable source of information which may facilitate a contingency planning process. To produce a good and effective NCP, scientific research needs to be carried out to identify geographic conditions of specified areas, resources at risk due to marine pollution incidents, and their priority for protection, especially when resources for effective response operations are limited. Without accurate and up-to-date data and information, successful response and clean-up operations will be difficult to achieve.

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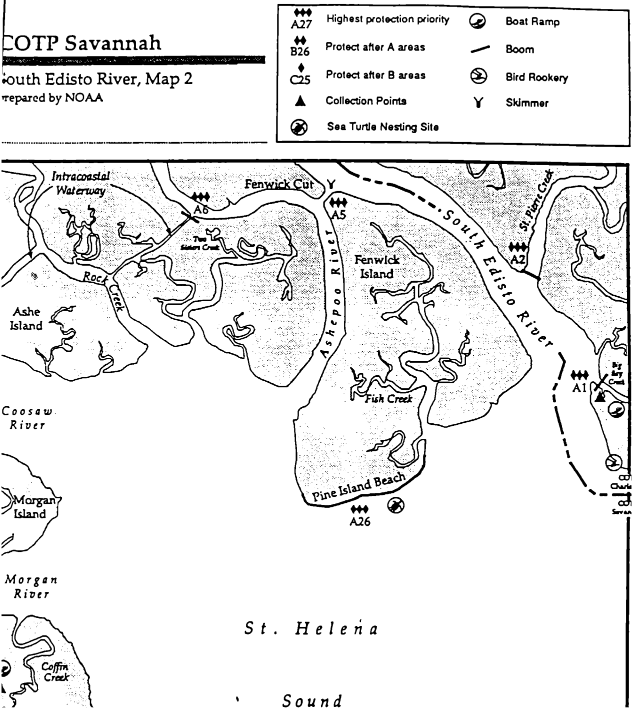
Appendix 1. Sensitive area map



A7-Mosquito Creek **Map # 1**

Latitude: N 32 33.08 Longitude: W 80 28.59

Trustee Agency/Manager:	Contact	Phone Number:
SC Department of Health and Environmental Control	Chris Staton	(803) 253-6488 (24 Hour)
		(803) 935-6323 (work)
SC Wildlife and Marine Resources Department	Jane Settle	(803) 762-5068 (work)
		(803) 795-5138

SHORELINE/HABITAT TO BE PROTECTED:
High Sensitivity-salt marsh both shorelines

WILDLIFE/RESOURCES TO BE PROTECTED:
Ospreys, diving birds, shorebirds, wading birds-feeding, all seasons
Bottlenose dolphins-all seasons
Estuarine finfish, crustaceans, shellfish-all seasons

ENDANGERED SPECIES:
None known

PROTECTION STRATEGY:
Boom off mouth of Creek with 500 feet of boom. Use 1 or more skimmers supported by small boats or vacuum truck on barge.

COLLECTION POINTS:
Bennett's Point Boat Ramp at the mouth of the Creek; shrimp boat piers in vicinity

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ACCESS TO AREAS:
Vehicular: ☐ Helicopter: ☐ Boat: ☐ Aircraft: ☐

ACCESS/DIRECTION/STAGING AREAS:

AVAILABLE RESOURCES:

NEAREST AVAILABLE RESOURCES:

Boom	Type	Length	Point of Contact	Phone No.
	_____	_____	_____ _____	_____ _____
	_____	_____	_____ _____	_____ _____

Skimmer	Type	Number	Point of Contact	Phone No.
	_____	_____	_____ _____	_____ _____

Personnel Available: _____

OTHER RESOURCES AVAILABLE:

Appendix 3. Typical outline of a hands-on training course

1 Safety considerations

2 General theory of containment and recovery

3 Detailed instruction in deployment and use of different booms

4 Practical exercise mooring and towing booms

5 Detailed instructions in deployment and use of different skimmers

6 Practical exercise of above skimmers in different oil types

7 Detailed instruction in use of temporary storage facilities and transfer pumps

8 Practical operation of pumps

9 Practical deployment of booms, skimmers, temporary storage and transfer pumps:
   1 from shore
   2 on open water

10 General theory of use of dispersants

11 Detailed instruction in use of different dispersant application systems

12 Practical deployment of spraying equipment at sea

13 General outline of shore-line clean-up techniques

14 Detailed instruction in use of different equipment types

15 Practical beach clean-up exercise comparing different techniques

16 Quiz

17 General discussion

18 Course assessment

Appendix 4. Typical outline of an operational management training course

1. Types of oil (samples of each)
2. Risks of spills
3. Fate and movement of oils
4. Effects and resources at risk
5. Surveillance and assessment
6. Response options-general introduction and major limitations of each technique
7. Use of dispersant: theory followed by practical session
8. Containment and recovery: followed by practical session
9. Shore-line clean-up: followed by practical session
10. Oil and oily debris disposal techniques
11. Organisation and contingency plan
12. Use of computer systems
13. Public relations
14. Sources of compensation and preparation of claims
15. Emergency response and safety considerations
16. Paper exercise-working through an oil spill scenario in groups
17. Course assessment

Appendix 5. LDEQ 24-hour notification hotline

(504) 342-1234 HOTLINE CONTACT:________________

DATE REPORTED:______________________________ TIME REPORTED:_______

SPILL INCIDENT/RELEASE CITIZEN COMPLAINT

CALLER INFORMATION: Citizen___________ Industry___________ Anonymous____________
Other (i.e. Coast Guard) ____
NAME:______________________________ TITLE:______________________________
COMPANY NAME (if applicable):____
ADDRESS:____
TELEPHONE #:_____________________________ PARISH (of occurrence):______________
IS CALLER REQUESTING A FOLLOW-UP TELEPHONE CALL? YES___________ NO____________

NOTIFICATION INFORMATION

IS THIS AN EMERGENCY? YES______ NO______ IS THIS A DRILL? YES______ NO_______

HAS STATE POLICE BEEN NOTIFIED? YES_____ NO_____
(STATE POLICE 24-HOUR # 504-925-6595)
HAS THE NATIONAL RESPONSE CENTRE BEEN NOTIFIED? YES_____ NO_____
(NATIONAL RESPONSE CENTRE 24-HOUR # 1-800-424-8802)
HAS COAST GUARD BEEN NOTIFIED? YES_____ NO_____
HAS LOCAL/PARISH HAZARDOUS/EMERGENCY RESPONSE GEOUP BEEN NOTIFIES?YES_____ NO_____
LIST OTHER AENCIES NOTIFIED:____

SITE INFORMATION

DATE OF DISCHARGE IF DIFFERENT FROM DATE REPORTED:____________________________
TIME DISCHARGE WAS NOTICED: (BEGIN)____________________ (END)________________
MEDIA AFFECTED: SOIL_____________ WATER_____________ AIR______________
IF WATER IS AFFECTED, NAME OF NEAREST WATER BODY:_______________________________
IF AIR IS AFFECTED, NOTE WIND DIRECTION/WEATHER CONDITIONS IF PROVIDED:______________
____

QUANTITY AND NAME OF PRODUCT/MATERIAL RELEASED:__________________________________
____
NATURE OF PROBLEM:
____
____
____
HOW WAS SPILL CONTAINED?____
HOW WAS SPILL CLEANED?____
NATURE AND EXTENT OF ANY REPORTED INJURIES:_____________________________

PROVIDE DETAILED INSTRUCTIONS FOR REACHING THE SITE:
____
____
____

REFERRED TO:______________________ DATE:_____________ TIME________

Appendix 6. Licensed, registered, or approved dispersants

Product name	Manufacturer	Type	Country
ABR Bi-Chem	Sybron Chem, Salem, VA	B/O	US
AE Biosea Process	Alpha Environmental, Austin, TX	B/O	US
Agma DR 379	Agma PLC	CON	UK*
Agma OSD 540	Agma PLC	HC	UK
Agma OSD 559 (= EP559)	Agma PLC	CON	UK
Agma superconc 379 (= DR91)	Agma PLC	CON	UK
Ameroid OSD/LT	Drew Ameroid UK Ltd	HC	UK
Applied 8-42	Applied Chemicals Ltd.	HC	UK
Aquarite AWX	Albright & Wilson Ltd	HC	UK
Ardrox SR 61	Ardrox Ltd	HC	UK
Arpal OSD 95SC	RP Adam Ltd	CON	UK*
Arrow Emulsol Conc Type A	Arrow Chems Group Ltd	CON	UK
Arrow Emulsol Conc Type B	Arrow Chems Group Ltd	CON	UK
Arrow Emulsol Superconc LE 2	Arrow Chems Group Ltd	CON	UK* (LE3)
Atlan'tol 3211/E (EC.OATALN'TOL?)	Atlan'tol Laboratory	CON	UK
Atlan'tol AT7-floating	Atlan'tol Laboratory	HC	UK
Atlas Colrelx OSD	Atlas Prod & Serv Ltd	HC	UK
Atpet 787	ICI Specialty Chemicals	CON	UK
Bactozyme	International Enzymes, Las Vegas, NV	BIO	US
Bioreico R93	Societé Reico	CON	FR
Bio Solve	Metra Chem, Shrewsbury, MA	W	US
Bioversal	Bio Versal USA, Inc., Mt. Prospect, IL	W	US
Bio-zyme	High-Line Chemicals, Saskatoon, Saskatchewan, Canada	BIO	US
BMD SM 53	Smyth-Morris Chems Ltd	HC	UK
BP 1100 X	BP Detergents Ltd, Scotland	HC	(US)
BP oil solidifier	BP Chemicals Ltd	SOLIDIFIER	UK
CD 202	ICI plc (Paints Division)	CON	(UK*)
Centisolve 010	Century Oils Ltd	CON	(UK*)
Centisolve 011	Century Oils Ltd	CON	UK*
Cleansea III	Gamlen Chem Co UK Ltd	CON	UK*
CN-110	Chemex Inc., Lafayette, LA	?	US
Cold Clean 500	Essex Fire & Safety, Houston, TX	W	US
Compound W-1911	Petrolite Ltd	CON	UK
Compound W-1986	Petrolite Ltd	CON	UK
Compound W-2096	Petrolite Ltd	CON	UK*
Conco Dispersant K	Continental Chem, Clinton, NJ	CON	US
Corexit 7664	Exxon Chemical, Houston, TX	W	US
Corexit 8667	Exxon Chemical, Houston, TX	HC	US, UK
Corexit 9123	Exxon Chemical, Houston, TX	CON	UK*
Corexit 9130	Exxon Chemical, Houston, TX	CON	UK
Corexit 9517 (= 9527)	Exxon Chemical, Houston, TX	CON	UK*
Corexit 9527	Exxon Chemical, Houston, TX	CON	US, CAN, (UK*)
Corexit 9550	Exxon Chemical, Houston, TX	HC	US, CAN
Corexit 9580	Exxon Chemical, Houston, TX	SHORELINE CLEANER	US, CAN
Corexit 9600	Exxon Chemical, Houston, TX	CON	UK
Corexit CRX-8	Exxon/Esso Chemical		CAN
Corexit OC5	Essochem Performance Chems Ltd	COLLECTOR	UK*, US
Customblen	Sierra Chem. Co., Milpitas, CA	BIO	US

Product name	Manufacturer	Type	Country
Dasic Slickgone LT2	Dasic Internat, Romsey, U.K.	HC	UK* (LT4)
Dasic Slickgone LT2 (= LT = LT2?)	Dasic Internat, Romsey, U.K.		CAN
Dasic Slickgone LTSW	Dasic Internat, Romsey, U.K.	CON	UK* (LTS also)
Dasic Slickgone NS	Dasic Internat, Romsey, U.K.	SOLV	(US), UK*
Dasic Slickgone SC 100	Dasic Internat, Romsey, U.K.	CON	UK*
De-solv-it	Orange-Sol, Inc., Gilbert, AZ	?	US
Destroil	Anti-Pollution Chemicals Ltd	CON	UK
Destroyl	Spectrum Maintenance Services	HC	UK
Dispersant 11	Dubois Chem, Cincinnati, OH	CON	US
Dispolene 34S	SEPPIC	CON	UK*
Dispolene 36S	SEPPIC	CON	FR, (UK*)
Dispolene 38S	SEPPIC	CON	UK*
Drew Dispersant LT (= OSD/LT)	Drew Chem Co, Boonton, NJ	CON	CAN
Ebbclean	Bestobell Paints & Chems Ltd	HC	UK
EC.O ATALN'TOL AT7 (Atlan'tol?)	ASPRA Inc, Seattle, WA	W	US
EDF Emulsa Fire	SynTech Products Int., Toledo, OH	W	US
EEC Biological Media	Environmental Engineering Consultants, Stillwater, OK	BIO	US
Elastol	General Technology, Manassas, VA	VISCOELASTIC	US, CAN
Emkem Spillwash LT	Emkem International Ltd	HC	UK* (Super Con LE3)
Emulso A-1984	Toho Chemical Industry Ltd	CON	UK*
Emulso E-309	Toho Chemical Industry Ltd	HC	UK
Emulsol LW	Arrow Chem Group Ltd	HC	UK
Enersperse 1037	BP Oil Ltd. Detergents Division	CON	(UK*)
Enersperse 1100 (= BP 1100X)	BP Detergents, W. Lothian, Scotland	HC	UK, US
Enersperse 1100 X	BP/PetroCan Chem		CAN
Enersperse 1495	Youngs Detergents Ltd	CON	UK*
Enersperse 1583	Youngs Detergents Ltd	CON	UK*
Enersperse 1990	Youngs Detergents Ltd	HC	UK
Enersperse 700	BP Detergents, W. Lothian, Scotland	SOLV	US, CAN
Ergospill 1502	Energeco S.A.	CON	UK
Finarep	Petrofina (UK) Ltd	COLLECTOR	UK*
Finasol OSR-121	Petrofina (UK) Ltd	HC	UK*
Finasol OSR-2	Petrofina (UK) Ltd	HC	UK
Finasol OSR-3	Petrofina (UK) Ltd	HC	UK
Finasol OSR-4	Petrofina (UK) Ltd	HC	UK
Finasol OSR-51	Petrofina (UK) Ltd	CON	UK*
Finasol OSR-52	Petrofina (UK) Ltd	CON	UK, FR
Finasol OSR-7	Amer Petrofina, Dallas, TX	W/CON	US, UK
Fleetex 83/1 (= Quell Oil)	Isaac Bentley & Co Ltd	CON	UK
Fleetex BD 3	Isaac Bentley & Co Ltd	HC	UK
Formula 98	Malone Chem., Linden, NJ	W	US
Gamlen Oil Dispersant	Gamlen Chem Co (UK) Ltd	CON	UK
Gamlen Oil Dispersant LT	Gamlen Chem Co (UK) Ltd	CON	UK
Gamlen Oil Dispersant OD4000 (PE998)	Societé Gamlen	CON	FR
Gamlen OSR 2000	Gamlen Chem Co (UK) Ltd	HC	UK, CAN
Gamlen OSR 4000	Sybron Chimie France S.A.	HC	UK*
Gamlen OSR LT 126	Gamlen Chem Co (UK) Ltd	HC	UK
Gold Crew	Ara Chem, San Diego, CA	W/CON	US
Grancontrol O	C & A Products, Elmwood Pk., NJ	W	US
Greensafe S	Kayclean (UK) Ltd	HC	UK
Greensafe W	Kayclean (UK) Ltd	CON	UK
HA 1232	Atlas Chem. Ind. (UK) Ltd.	CON	(UK*)
Hydrobac	Polybac Corp., Allentown, PA	BIO	US
Inipol EAP 22	Elf Aquitaine	BIO	US
Inipol IP 80	Elf Aquitaine GRL	CON	UK*, FR
Inipol IP 90	Elf Aquitaine GRL	CON	UK*, FR, US

Product name	Manufacturer	Type	Country
Jansolv-60	Sunshine Tech, W. Hartford, CT	W/SOLV	US
Lankromul OSD	Lankro (Diamond Shamrock)	HC	UK
Liquid Oil Bond-200	Toho Titanium Co., Tokyo, Japan	GEL AGENT	US
LTOD	Anti-Pollution Chemicals Ltd.	CON	(UK*)
Magna MEP 554	Baker Oil Treating/Magnachem Ltd	CON	UK
Magna ML 897	Baker Oil Treating/Magnachem Ltd	CON	UK
Magnotox	Magnus Maritec, Palisades Pk., NJ	W/CON	US
Mare Clean 505	Mitsubishi Intern, New York, NY	SOLV	US
Micropro Now Bac	Environmental Remediation, Inc., Baton Rouge, LA	BIO	US
Micropro D	Environmental Remediation, Inc., Baton Rouge, LA	BIO	US
Micropro Super Cee	Environmental Remediation, Inc., Baton Rouge, LA	BIO	US
MC #1 Dispersant	Safeworld Products, Brentwood, TN	W	US
Munox 101	Microlife Technics, Sarasota, FL	BIO	US
Munox 201	Microlife Technics, Sarasota, FL	BIO	US
Munox 501	Microlife Technics, Sarasota, FL	BIO	US
Nalfleet 9-010	Nalfleet Marine Chemicals	CON	UK
Nalfleet Maxi-Clean 2	Nalfleet Marine Chemicals	HC	UK
NEOS AB 3000	NEOS Co, Kobe, Japan	HC	US, UK
NK-3	GFC Chemical, Lafayette, LA	W	US
Nokomis 3C 4-F (Slik-a-way)	Groundwater Tech/oil Recovery Sys	CON	UK
No-scum	Natural Hydrocarbon Elimination Co., Houston, TX	BIO	US
Norsorex	Custom Environmental	SOLIDIFIER	CAN
O.M.I. Type One Dispersant	O.M.I. Ltd	HC	UK*
O.M.I. Type Three Dispersant	O.M.I. Ltd	CON	UK*
Oclansorb	Walker Air Cond (UK) Ltd	ADSORBANT	UK
OFC D-609	Chem Link Petroleum, Oklahoma, OK	CON	US
Oil Bond-100	CdF Chimie S.A., Paris	PLASTICIZER	US
Oil Herder	ASI, Inc., Long Beach, CA	COLLECTOR	US
Oil Spill Disp./NF (new formula)	Chemo Hellas Ltd	HC	UK
Oil Spill Elastol	General Technology, Manassas, VA	VISCOELASTIC	US, CAN
Oilex 3225 Oil Spill Dispersant	Kjemi-Service A/S	HC	UK
Oilsperse 43	Diachem Industries		CAN
Omni-Clean	Delta-Omega Tech., Lafayette, LA	W	US
OSD 18	Chemie Appliquee Marin Industrie	CON	UK
OSD/LT (new formulation)	Drew Chem, Boonton, JN	CON	US, CAN
Petro-Green ADP-7	Petro-Green, Dallas, TX		US
Petrobac	International Biochemicals (UK) Ltd; Polybac Corp., Allentown, PA	BIO	UK, US
Petrobac 8	International Biochemicals Ltd		UK
Petrocon Oil Spill Eliminator IV	Petrocon Marine Chemical Corp	HC	UK
Petrodeg-100	Bioteknika International Inc. Arlington, VA	BIO	US
Petrodeg-200	Bioteknika International Inc. Arlington, VA	BIO	US
Petrolock	Custom Environmental	SOLIDIFIER	CAN
Petromend MP-900-W	Petromend, Dallas, TX	W/CON	US
Petrotite M.M.E.	Heath Consultants Inc., Stoughton, MA	W	US
Phenobac	Polybac Corp., Allentown, PA	BIO	US
Phirex	Environmental Security, Inc., Gloucester, MA	ORG	US
Premier 99	Gold Coast Chemical Corp, Hollywood, FL	SA	US
Proform-Pollution Control Agent	Proform Products, Palo Alto, CA	W/CON	US
Quell Oil Cl	Lankro (Diamond Shamrock)	CON	UK
Rawflex	Custom Environmental	SOLIDIFIER	CAN
Re-entry KNI	Envirosolv, Inc., Jacksonville, FL	?	US

Product name	Manufacturer	Type	Country
Remospill 1	Performance Chemicals Ltd	HC	UK
Rigidoil	BP Chemicals Ltd	SOLIDIFIER	UK
Rochem Oil Spill Remover (WSA)	Rochem Chemicals (Belgium) Ltd	HC	UK
Ruffnek cleaning agent	Malter International, Gretna, LA		US
Sana oil disperser	Petrofina (UK) Ltd.	CON	(UK*)
Scavenger Slick Dispersant	Edgar Vaughan & Co Ltd	CON	UK
SDS-300	Services Marketing Group, Houston, TX	HC	US
Seacare OSD Conc. 2021	Perolin Marine	HC	UK
Seacard OSD Conc. 2021X	Perolin Co Ltd	HC	UK*
Seacare OSD Conc. 2023	Perolin Marine	CON	UK*
Seacare OSD conc. 2023X	Perolin Co Ltd	CON	UK*
Seacle L-500	Dai-Ichi Kogyo Seiyaku Co Ltd	HC	UK
Seaclean	MTM Specialist Products Ltd	CON	UK
Sea-Jell	Ajinomoto Co. Inc., Tokyo, Japan	GEL	US
Servo CD 2000	Servo Chemische Fabriek BV	HC	UK
Servo CD 2009	Servo Chemische Fabriek BV	CON	UK*
Shell Demulsifier LA 1843	Shell Chemicals (UK) Ltd	DEMULSIFIER	UK*, CAN
Shell Dispersant Concentrate	Shell Chemicals (UK) Ltd	CON	UK
Shell Dispersant HEC	Shell Chemicals (UK) Ltd	CON	(UK*)
Shell Dispersant ND	Shell Chemicals (UK) Ltd	HC	UK*
Shell Dispersant VDC	Shell Chemicals (UK) Ltd	CON	UK*
Shell Oil Herder	Shell Chemicals (UK) Ltd	COLLECTOR	UK*, US
Simple Green	Sunshine Makers Inc., Huntingdon Harbour, CA	W	US
Silk-A-Way	MI-DEE Prod, Pleasanton, CA	W	US
Slickgone LT	Dasic Internat, Romsey, U.K.	CON	CAN
Slickgone NS	Dasic Internat, Romsey, U.K.	CON	US
Slicktreat 1200	IDF Production Chemicals Ltd	HC	UK*
Slicktreat 1400	IDF Production Chemicals Ltd	CON	UK*
Slicktreat 1600	IDF Production Chemicals Ltd	CON	UK*
Slix-Treat	Hydrokem I/S	CON	UK
Spillaway	Forward Chemicals Ltd	CON	UK
Super all #38	Tavelle Corp., Hollywood, FL	CLEANING AGENT	US
Superdispersant 25	Noble Consultancy Service	CON	UK
Surflo OW1	Exxon Chemical Energy Chemicals	CON	UK
Surflo RD2284	Exxon Chemical Energy Chemicals	CON	UK
Techmar 125 Spillclean	Techmar Chemical Co Ltd	HC	UK
Techsol Superconcentrate	Techsol Manufacturing Ltd	CON	UK*
Teklene TC 48	Teckem Ltd	HC	UK
Toho Cactus Clean LA-500	Toho Titanium Co Ltd	CON	UK*
Topsall No.30 cleaning agent	Sutton North, Mandeville, LA		US
Toxigon 2000	Formula IV Corporation, Scottsdale, AZ	?	US
Tretolite 2922	Petrolite Ltd	CON	UK
Tros Seaclean	TR Oil Services Ltd	CON	UK
Type L, DBC plus	Flow Laboratories Inc., McLean, VA	BIO	US
Type R-5, DBC plus	Flow Laboratories Inc., McLean, VA	BIO	US
Unisperse M 74	Universal Matthey Products	EMULSION BREAKER	(UK*)
Water Witch Slickleen Concentrate	Liverpool Water Witch	CON	UK
Welchem Wellaid 3300	Amoco Chemicals UK Ltd	CON	UK
Welchem Wellaid 3315	Amoco Chemicals UK Ltd	CON	UK*
Wellaid 3316	Welchem, Inc., Houston, TX	?	US
WMI-2000	Waste Microbes Inc., Houston, TX	BIO	US
Woodace Briquettes	Vigoro Industries Inc., Fairview Heights, IL	BIO	US
X-3125 Oil Spill Dispersant	MW Webber & Co Ltd	HC	UK

Notes:

BIO	= biological additive
CON	= concentrate
HC	= hydrocarbon base
ORG SA	= organic surfactant
SOLV	= other solvent base
W	= water base

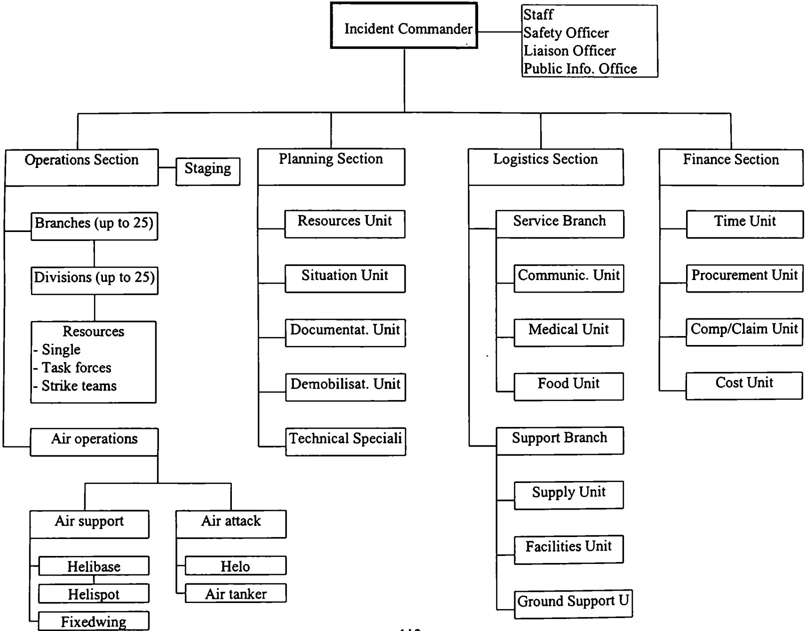
Cnadian listings are from the Environmental Protection Service, March 1991 (products).

UK listings are from a May 1990 printout of approved oil treatment products, Food and Environment Protection. Act of 1985 (RAA Blackman, 1990, pers.comm.; 124 products in all). Products withdrawn or expired were omitted from this list. Items noted with an asterisk (*) were listed as "qualified products" by the Warren Spring Laboratory, Feb. 1989. Items on this list but not on the May 1990 MAFF list are in brackets.

US lisings are based on the produt schedule of the EPA National Contingency Plan, Sept. 1990 (73 products). Brackets indicate the product was included in the 1987 list but not in the 1990 list.

French listings are from R: Kantin, CEDRE, pers.comm.

Source: GESAMP, 1993.



Incident Commander
Staff
Safety Officer
Liaison Officer
Public Info. Office
Operations Section
Staging
Branches (up to 25)
Divisions (up to 25)
Resources
- Single
- Task forces
- Strike teams
Air operations
Air support
Helibase
Helispot
Fixedwing
Air attack
Helo
Air tanker
Planning Section
Resources Unit
Situation Unit
Documentat. Unit
Demobilisat. Unit
Technical Speciali
Logistics Section
Service Branch
Communic. Unit
Medical Unit
Food Unit
Support Branch
Supply Unit
Facilities Unit
Ground Support U
Finance Section
Time Unit
Procurement Unit
Comp/Claim Unit
Cost Unit

Appendix 8. Guideline for identifying response equipment

Boom
Type
Total length
Draught/freeboard length and weight per unit
Additional support equipment necessary
Design or intended use (e.g. use in open sea or sheltered water operations)
Mobilisation time
Means of transportation required
Available transportation
Personnel for handling/operating
Procurement cost/m versus rental cost

Specialised shoreline clean-up equipment
Types/function
Weight and size per unit
Additional support equipment necessary
Design or intended use
Mobilisation time
Means of transportation required
Available transportation
Personnel for handling
Procurement cost versus rental cost

Aircraft
Mission
- dispersant application
- surveillance
- transport

Type, rotary/fixed wing
Operating speed
Specialised equipment
Endurance
Passenger capacity
Load capacity
Mobilisation time
Fuel/ramp requirements
Estimated daily rental cost

Dispersants
Types, total stock of each type in litres
System of storage
Method of application
Approval data (e.g. country of approval, approval number)
Toxicity and efficiency data (e.g. tests applied and results obtained)

Skimmers and other pick-up devices
Types, total numbers
Weight and size per unit
Additional support equipment necessary
Design or intended use (e.g. use in open sea or sheltered water operations)
Mobilisation time
Means of transportation required
Available transportation
Personnel for handling/operating
Procurement cost versus rental cost
Estimated daily rental cost
Available equipment, not dedicated to oil spill response, that can be used (pumps, etc.)

Mobile equipment for temporary storage of recovered oil
Types, total numbers/capacity
Weight and size per unit
Additional support equipment necessary
Design or intended use (e.g. use in open sea or sheltered water operations)
Mobilisation time
Means of transportation required
Available transportation
Personnel for handling/operating
Procurement cost versus rental cost

Specialised vessels
Type, length, breadth, speed, function
Fuel/dockage
Work-crew accommodation
On-board storage capacity in cubic metres (if applicable)
Application (open sea or sheltered waters)
Mobilisation time
Personnel for handling
Estimated daily rental cost

Vessel and aircraft dispersant spraying equipment
Stocks held, by type and size
Whether suitable for dispersant concentrate and in what ratio
Design or intended use
Mobilisation time
Means of transportation required, weight per unit
Available transportation
Personnel for handling

Types of spraying equipment required
Sources of supply and mobilisation time
Means of transportation required, capacity of unit
Available transportation
Estimated price/litre

Dispersant pillow tanks
Total stocks, by type and capacity and weight empty/full
Means of securing on board
Mobilisation time
Means of transportation required, weight per unit
Available transportation
Personnel for handling

Wildlife chemical treatment/rehabilitation
Bird scaring devices
Recovery/handling equipment (nets)
Holding pens/facilities
Cleaning agents and supplies
Husbandry experts
Mobilisation time
Transportation/delivery (boats/trailers)
Cost of operations

Lightering equipment
Pumps, total stocks by type/capacity and weight including prime mover
Hoses, length, diameter and weight/section
Fenders, total stocks by type/size and weight
Personnel for handling
Estimated procurement cost
Estimated daily rental cost
Mobilisation time

In.situ burning
Fire boom, amount
Support equipment
Mobilisation time
Transportation/delivery
Personnel for handling
Ignition methodology
Procurement cost

Communications and auxiliary equipment
Equipment available
Mobilisation time
Portable equipment (on board and ashore)
Frequencies
Types of emission
Power source
Signalling lamps
Estimated daily rental cost versus procurement cost