日本財団 補助
The Nippon Foundation

International Symposium on

Marine Oil Spill Response

16-17 July 1997
Tokyo

海洋における油流出事故対策に関する国際専門家会議

1997年7月16-17日　東京

PROCEEDINGS
会　議　録

Message from The Sponsor

Japan is the world's largest importer of crude oil and is a prodigious consumer of many petroleum products. In fact, without oil imports, the industrial revival of the post-war period could not have happened, and Japan's ongoing economic prosperity is dependent on our consumption of petroleum products. However, there is another side to this story : the annual influx of billions of barrels of petroleum exposes this country to the potential danger of oil pollution.

The Nippon Foundation is strongly committed to developing ever more effective environmental protection and disaster relief strategies. Supported by the Foundation, many organizations, including Japan Maritime Disaster Prevention Center, Ship & Ocean Foundation and The Japan Association of Marine Safety, are engaged in research into measures to combat oil spills and to develop the optimum equipment to prevent or contain spills. The Nippon Foundation was quick to respond when the Russian tanker NAKHODKA sank in the Japan Sea off Shimane Prefecture, releasing a large quantity of heavy fuel oil. The resulting oil slick spread across 800 km of coastline, and affected the coastal areas of nine prefectures. The Foundation gave active support to the local communities, helping the residents and volunteers to remove the oil and clean up the polluted shorelines.

As many as 2,500 Iarge tankers transport oil across the world's oceans every day. The NAKHODKA incident draws our attention to the fact that the possibility of a disastrous oil spill is always there, whether as a result of bad weather or actions arising from political disturbances such as the Gulf War. One of the vital missions of a non-government organization （NGO） such as this Foundation is to accumulate information on oil spill incidents. This information can, in turn, be made available to other countries that also face the threat of these incidents. We believe that this is the kind of mission that NGOs like ours can well undertake.

The tanker NAKHODKA left not only oil debris but also many other intractable problems for us to address. With this latest spill still so fresh in our minds, we think it is a most opportune time to hold a symposium to discuss such topics as effective response measures to oil spills in rough weather conditions. The Japanese and foreign experts invited to this symposium are the people with direct experience in combating large-scale oil spills. We hope that this symposium will help to develop increasingly effective oil spill response measures.

Ayako Sono

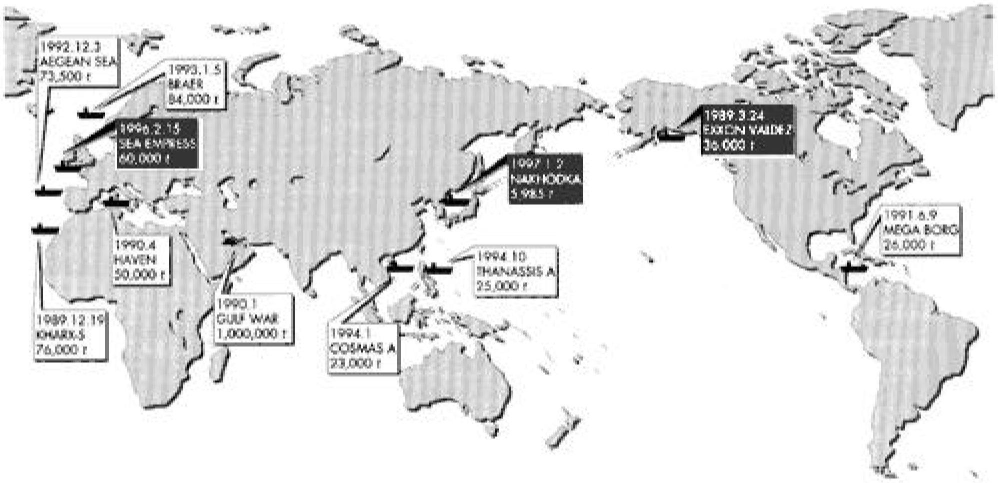
Chairman

The Nippon Foundation

Major Oil Spill Incidents

主な油流出事故

（1989 ~ Jan.1997）



Greeting

Tranquillity of the new year holidays of 1997 was shattered abruptly by a disastrous marine incident … the Russian tanker "NAKHODKA" broke apart in the Sea of Japan on January 2. Shaking off the festive mood, the Japanese mass media were busy reporting the spread of oil spilled from the superannuated tanker, the harsh weather conditions around the incident site, and devoted response activities of the Japanese Maritime Safety Agency and a large number of volunteer workers. The incident alerted many people afresh to the latent possibility of large-scale oil spills near the Japanese waters. Since 1991, the Ship & Ocean Foundation had been engaged in exhaustive researches into the fate of oil slicks by use of a special water tank at its research institute ; and the researches were then coming into the final stage.

"The International Symposium on Marine Oil Spill Response" was projected against these backgrounds. Incidentally, the Petroleum Association of Japan was also working on preparation of a conference to discuss oil spill response. To avoid adding unnecessary things, we decided to make our symposium topics more specific. Instead of theoretical studies or lab researches on response measures, the more practical sides of response activities were highlighted. Thus, our symposium featured response to intractable oil spills of the order of tens of thousands tons under severe weather conditions. We invited to the symposium Japanese experts who combated the NAKHODKA spill and as many as 10 experts from overseas : the experts from Norway have much experience in dealing with oil leakage from drilling rigs installed in the North Sea, whilst the US and UK experts combated the Exxon Valdez spill and the Sea Empress spill, respectively. We asked the speakers to share with us their valuable experiences in combating large-scale oil spills. The symposium was not opened to the public, but to dozens of selected experts.

Thanks to contributions by the eminent speakers, the symposium was a great success beyond all expectations. Just a glance over the contents of this Proceedings would suffice to learn how informative presentations were given there ; and transcribed discussions include penetrating remarks of the kind that only the people actually involved in response activities can address. Shortly after the NAKHODKA incident, the Japanese government and relevant organizations redoubled their efforts to improve oil spill response strategies. We hope this publication of the symposium results may help such efforts in some way or other.

Lastly, allow us to express our sincere gratitude to Ms. Ayako Sono, Chairman of the Nippon Foundation and Mr. Yohei Sasakawa, President of the Nippon Foundation, for their understanding and support to this symposium. Our gratitude is also due to Mrs. Setsuko Sengoku, Director of the Great Britain Sasakawa Foundation for her amazingly dexterous management of the secretariat, without which this symposium would not have been organized so impeccably within a short time of preparation.

KenSaku Imaichi

Chairman

Ship & Ocean Foundation

The "NAKHODKA" Incident

The Russian tanker NAKHODKA broke apart 106 km NNE of Oki Island of Shimane Prefecture around 02:51, January 2, 1997. Transporting aboard 19,000kL of heavy fuel oil shipped at the port of Shanghai, China, the tanker was then en route to Petropavlovsk, Russia. The severed ship's bow drifted on the raging sea, whilst the rest of the ship body sank to rest on the seabed. Some 6,200kL of heavy fuel oil were released from the ruptured cargo tanks. At the time of the incident, a NW wind was blowing at a velocity of 20 m/s or above ; and wave height and swell were estimated at 6 m min. and 4 m min., respectively. At 13:00, January 2, thirty-one crew members, were rescued, except the ship's captain whose body was retrieved later.

Both the sea current and the strong, northerly seasonal wind carried the ship's bow, together with the spilled oil, away to the coastal regions of Japan. On January 7, the ship's bow ran aground near the seaside town of Mikuni, Fukui Prefecture, and the oil polluted the shoreline. The dispersing oil spill then moved north along the coast and contaminated the long shorelines of nine prefectures from Shimane northward to Akita.

Thanks to concerted efforts of the government and private sectors, recovery operations proceeded smoothly. On April 30, the Fukui prefectural authorities announced the termination of recovery operations in their jurisdiction. And recovery

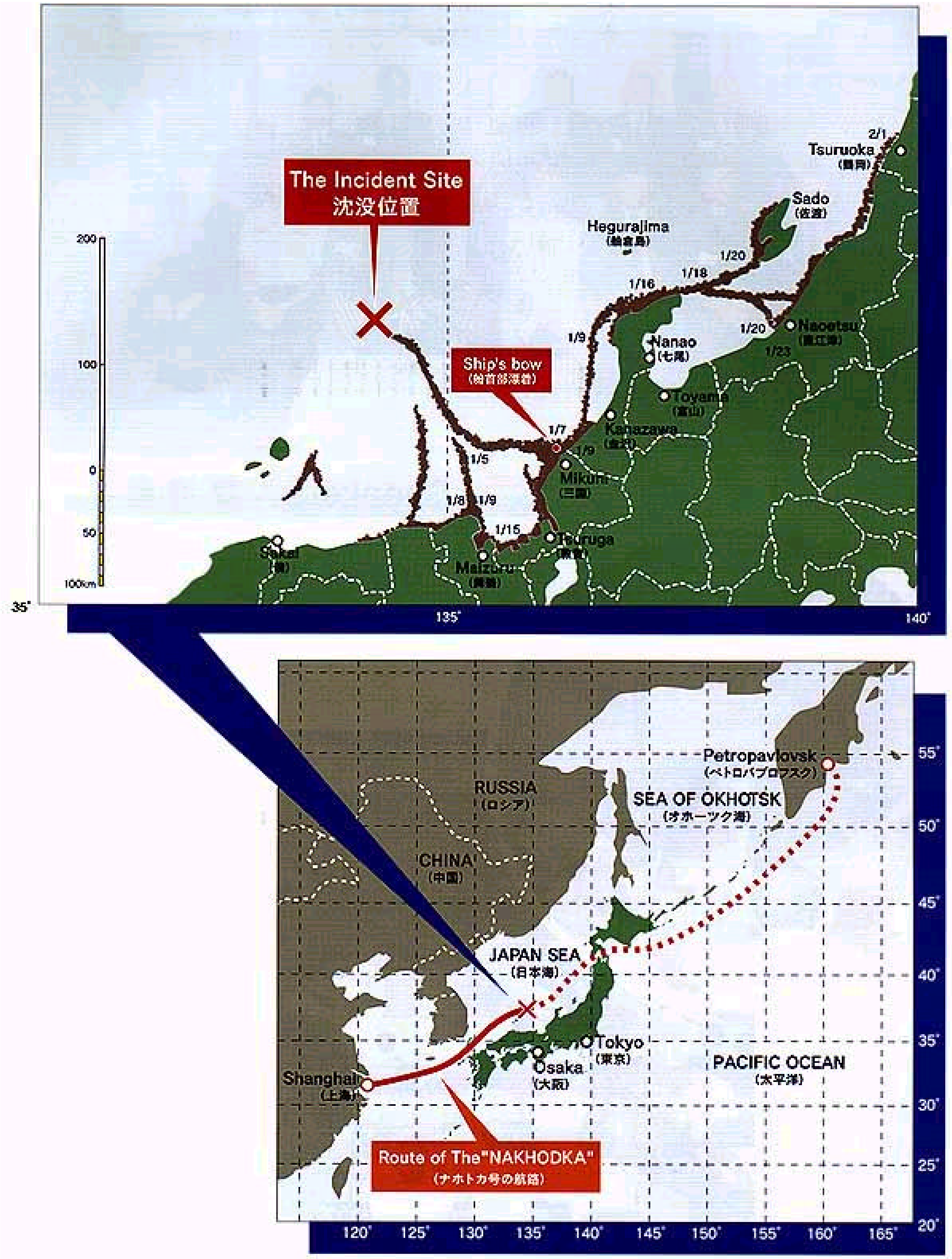
Particulars of the m.v. NAKHODKA			
Length overall:	177.2m	Draft:	9.5m
Breadth overall:	22.4m	G/T:	13,157t
Depth:	12.3m	Launch:	1970

Quantities of the oil spill and the oil/water recovered	
Oil spilled:	6,200kL
Oil/water recovered at sea:	5,665kL
Oil/water recovered ashore by skimmers:	6,620kL
Total oil/water recovered(oil waste):	57,000kL

Mobilized resources	
Maritime Safety Agency and Japan Self-Defence Forces	
Vessels	4,700
Aircraft	1,600
People mobilized(incl.volunteers)	772,000

※Source;National Council for Transport Technology,Mar.1997

Oil Spill from the "NAKHODKA"



Speakers / **講演者**

Reception / **懇親会**

Chairman / **議長**

Vice-Chairman / **副議長**

Session / **会議風景**

At Mikuni-cho Site

現場視察

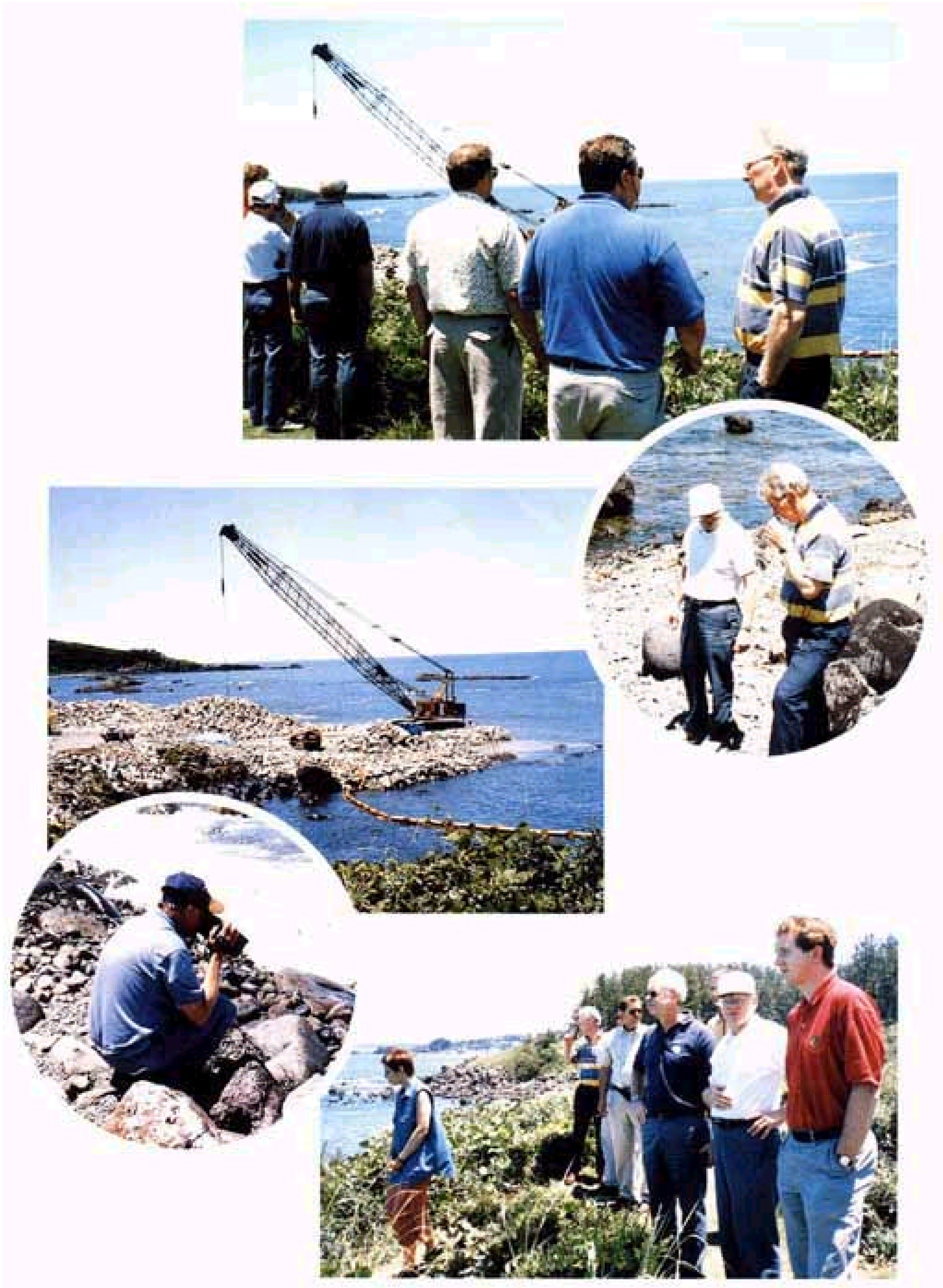


Photo by H. Oishi and M.Okawa

Time Schedule / タイムスケジュール

July16(Wed)　7月16日(水)

10:00	Opening Ceremony	開会式
10:20	Coffee Break	コーヒーブレイク
10:40	Session 1 Eisuke Kudo The Maritime Safety Agency, Japan	講　演1 工 藤 栄 介 海上保安庁
11:20	Session 2 Yoshio Suzuki Japan Maritime Disaster Prevention Center	講　演2 鈴 木 淑 夫 海上防災防止センター
12:00	Session 3 Richard E.Bennis Response Office, United States Coast Guard	講　演3 R.E.ベニス 米国沿岸警備隊本部
12:40	Lunch	昼　食
13:40	Session 4 Richard R.Lessard Exxon Research and Engineering Company, U.S.A	講　演4 R.R.レッサード エクソン工学研究所
14:20	Session 5 Robin Gainsford Marine Pollution Control Unit, The Coastguard Agency, U.K.	講　演5 R.ゲインズフォード 英国沿岸警備隊 海洋汚染対策部
15:00	Session 6 William B.Davies Pembrokeshire County Council, U.K.	講　演6 W.B.ディヴィス 英国ペンブローク シャー州 協議会
15:40	Coffee Break	コーヒーブレイク
16:00	Session 7 Per W.Schive Ministry of Environment, Norway	講　演7 P.W.シィーヴェ ノルウェー環境省
16:40	Session 8 Jan Neriand Norwegian Pollution Control Authority	講　演8 J.ネールラン ノルウェー環境省 汚染対策庁
17:20	Break	休憩
18:00	Reception	レセプション
20:00		

July17(Thu)　7月17日(木)

10:00	Session 9 Kenji Nishigaki Petroleum Association of Japan	講　演9 西 垣 憲 司 石油連盟
10:40	Session 10 Donald A.Toenshoff, Jr. Marine Spill Response Corporation, U.S.A.	講　演10 D.A.トーンショフ・ジュニア 海洋油流出対策株式会社
11:20	Session 11 Jon O.Rødal Norwegian Associaton of Operating Companies	講演11 J.O.ルーダール ノルウェー海洋 石油業者協会
12:00	Lunch	昼　食
13:20	Session 12 Tim Lunel National Environmental Technology Centre, U.K.	講　演12 T.ルネル 英国国立環境技術センター
14:00	Session 13 Alan J.Mearns National Oceanic and Atmospheric Administration, U.S.A.	講　演13 A.J.ミアーンズ 米国海洋大気庁
14:40	Coffee Break	コーヒーブレイク
15:00	Closing Session Discussion Chairman's Report	総括 総合討論 議長報告
16:00	Closing Ceremony	閉会式

July18～20(Fri～Sun) 7月18日～20日(金～日)

Post Symposium Tour	現場視察旅行
Fukui Prefecture Mikuni-cho Site	福井県 三国町現場

Symposium Information/会議概要

▽ English	▼ 日本語
▽ Title	▼ タイトル
International Symposium on Marine Oil Response, Tokyo 1997	海洋における油流出事故対策に関する国際専門家会議
▽ Date	▼ 開催期間
July 16～17, 1997	1997年7月16～17日
▽ Venue	▼ 開催場所
The Sasakawa Hall 3-12-12, Mita, Minato-ku, Tokyo 108-0073, Japan TEL：81-3-3454-5062	笹川記念会館 〒108-0073 東京都港区三田3-12-12 TEL：03-3454-5062
▽ Organizer	▼ 主　催　者
Ship & Ocean Foundation	(財)シップ・アンド・オーシャン財団
▽ Sponsor	▼ 協　　　賛
The Nippon Foundation	日本財団
▽ Co-operators	▼ 後　　　援
The Ministry of Transport, Japan The Maritime Safety Agency, Japan	運輸省 海上保安庁
▽ Courtesy	▼ パネル提供
8th Regional Maritime Safety-Headqaur the Maritime Safety Agency Headquarters Maizuru District, Japan Maritime Self-Defense Force Kyoto Prefecture Maizuru City Office	海上保安庁 第八管区海上保安本部 海上自衛隊 舞鶴地方総監部 京都府 舞鶴市
▽ Official Languages	▼ 会議用語
English/Japanese	英　語/日本語

Symposium Information/会議概要

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Seizo Motora (SOF)
Ikuo Mutoh (former；MOBAX Co.)
Setsuko Sengoku
(The Great Britain Sasakawa Foundation)
Nobuo Kozu (SOF)
Ryo Tasaki (SOF)
Akihiro Ogawa (SOF)
Yoshio Kon (SOF)
Seishi Fukuyama (SOF)

▼ 運営委員会

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玉眞　　洋
犬塚　　勤
大川　　光
後藤　直子

Chairman's Profile /

Seizo Motora, Dr.

Position Director, Ship & Ocean Foundation,
Professor Emeritus, University of Tokyo, Naval Architecture
Education Doctor of Engineening. Graduated from Department of Naval Architecture, Second Faculty of Engireering, University of Tokyo
Life honorary member of Society of Naval Architects of Japan
Life honorary member of SNAME
Life honorary member of Chinese Society of Navel Architects

Professional Experience

l) Stability and safety of ships and offshore platforms

Have been joining Subcommittee on Ship Design and Equipment and Subcommittee on Stability and Loadlines on Fishing Vessel of IMO for 25years.

Joined MEPC (Marine Environment Protection Committee) of IMO in 1992 and 1993

2) Safety assessment of offshore oil storage systems (at Kamigoto site 4,500,000kL, Shirashima site 6,400,000kL)

3) Development of superconducting magnetohydrodynamic ship proplusion

4) Feasibility study and trial design of floating airport in Osaka Bay

5) Evaluation of the effect caused by large quantity of oil spill from tankers

6) Read a key-note speech at Colloquim '94 of OPRC (Oil Spill Preparedness Response and Cooperation) in Tokyo and Colloquim '95 in, Dalian, China

7) Evaluation of oil outflow from mid-deck tankers

Vice-chairman's Profile

lkuo Mutoh

Education

1945 graduated from Department of Naval Architecture, Second Faculty of Engineering, University of Tokyo

Member : Member of Society of Naval Architects of Japan. Kansai Society of Naval Architects

1975-78 Member of Committe for Oil Spill Prevention Technology. （Japan Ship Research Association）

1983 Expert Member of National Council for Transport Technology （MOT）

1970, 1989 Expert Member of National Council for Ocean Development. （Science & Technology Agency）

1985 Member of Committee of Oil Pollution Control & Prevention in the lce Sea

Professional Experience

1949 joined Mitsui Engineering & Shipbuilding Co. Ltd. and worked at the Tamano Shipyard as ship designer

1969 General Manager of Ship Design Dept.

1970 Director and General Manager of Research & Development Dept. at Mitsui Ocean Development & Engineering Co. Ltd. （MODEC）

1983 Executive Managing Director of MODEC

1983 President of MOBAX Co. Ltd.

1988-97 Director of MOBAX Co. Ltd.

Development :

1973 Developed Inclined Plane Oil Skimmer "MIPOS"

1974 Invented a dual skirt oil boom "MOBAX", for high current

1974 Developed a recovering & cleaning apparatus for oil boom.

Lecturer（Ocean Engineering & Special Ship）:

1976-91 Nagasaki Institute of Applied Science

1978-80 Osaka University

1979-82 University of Tokyo（Postgraduate Course）

1985-87 Yokohama National University

1986-89 Japan Institute of Humanities & Sciences

International Symposium on Marine Oil Spill Response

16-17 July 1997 Tokyo

PROCEEDINGS

Session 1

Summary and Precept of the NAKHODKA Incident

Eisuke Kudo

Position Director General, Equipment and Technology Department, The Maritime Safety Agency, Japan,(Fomer Commander, the 8th Regional Maritime Safety Headquarters)

Education 1970 MA Department of Naval Architecture, Gradute School of Engineering of Osaka University

At the time of the NAKHODKA incident, he took charge from the time of occurrence of the incident as commander of the agency having jurisdiction and undertook the resolution of various problems

Introduction

International rule-making and co-operation to prevent marine pollution have been positively promoted, learning lessons from many cases of tanker incidents including the TORREY CANYON and the EXXON VALDEZ.

Relying almost entirely on crude oil imports from oil-supplying countries overseas, Japan has paid particular attention to the prevention of marine pollution by vessel with great interest as a leading shipbuilding nation of tankers and an island nation blessed with beautiful coast lines.

Nevertheless, the NAKHODKA incident, which occurred at the beginning of this year, caused unprecedented oil pollution damage to the coasts of almost all the prefectures on the side of the Japan Sea.

In this paper, probable future tasks for us all suggested by the present case of the NAKHODKA are discussed as my opinion from the position of the commander of field oil control operations after giving a brief report on the incident.

1. Summary of Measures to the Oil Spill Incident

(1) Outline of the NAKHODKA

Particulars of the NAKHODKA are shown in Fig. 1.

(2) Narratives of the incident and the oil spill control

Whole process of the incident is outlined in Fig. 2. Detailed descriptions are given below in chronological order.

① Occurrence of incident and initial response

The incident is outlined in Fig. 3. The incident occurred enroute from Shanghai to Petropavlovsk.

[Fig. 4]

2Jan. • 02:51 Distress signals from the NAKHODKA (N) monitored. Instructions were given immediately to 2 patrol vessels navigating in the vicinity of the wreck to rescue the tanker. 4 additional patrol vessels and 2 aircraft were arranged in succession.

- 08:20 The stern of the tanker sank.
- About 10:00
  Confirmed the bow drifting in the sea.
- About 13:00
  All 31 crew members but the Master rescued.

[Weather/Sea conditions]

Northwesterly 20 m/s
Wave height 6 m

Swell 4 m or more

3Jan. ・Providing information to local governments started.

・Assumed quantities of spilled oil identified [Fig. 5]

4Jan. ・Disaster Countermeasure Task Force for NAKHODKA Oil Spills at 8th RMSH established.

5Jan. ・Attempt to tow the bow failed due to bad weather.

・Patrol vessels started spraying oil dispersants.

・Oil cleanup operations were entrusted by the shipowner to the Maritime Disaster Prevention Center.

[Weather/Sea conditions]

Northwesterly 8 m/s

Wave height 1 m

Swell 3 m

6Jan. ・Attempt to tow the bow failed because of bad weather.

・Requested the Maritime Self Defense Force to dispatch troops for oil control.

・Liaison conference among relevant ministries and agencies.

(in Tokyo, 18 ministries and agencies participated)

[Weather/Sea conditions]

Westnorthwesterly 30 m/s

Wave height 6m

Swell 4 m or more

7Jan. To prevent the bow from drifting ashore, ropes were sent out from 2 patrol vessels, but resulted in parting due to heavy weather.

・ 14:30 The bow drifted and ran aground at Mikunicho, Fukui Prefecture. The oil reached the coast of Mikunicho as well.

[Weather/Sea conditions] Northwesterly15 m/s Wave height6 m Swell6 m or more 8Jan. ・ Oil slicks drifted ashore in neighbouring Ishikawa Prefecture.

・ Oil collecting operations by volunteers started.

9Jan. ・ Large oil recovery vessel SEIRYU MARU (5th Ports and Harbours Bureau, Construction Division of the Ministry of Transport) began to collect drifting oil.

10Jan. ・ Disaster Countermeasure Task Force Team for NAKHODKA Oil Spills established by relevant ministries and agencies.

② Oil control operations for drifting oil slicks and oil dwelling ashore Minimizing the quantity of drifting oil to reach the coastal areas, the following measures, which included the investigation of oil-drifting state by vessels and aircraft, as well as providing information to local governments, were taken.

(a) Measures for removing drifting oil slicks at sea

・ Oil dispersants were sprayed by helicopters and vessels.

・ Collecting oil by oil recovery vessels and boats equipped with oil-collecting equipment.

・ Collecting oil by patrol vessels, Self-Defense vessels and boats using dippers and nets, etc. [Fig.6]

(b) Measures to remove oil drifting in the coastal sea Arranging oil booms in waters near nuclear power plants or other important facilities.

- Collecting oil by vessels equipped with oil-collecting equipment.
- Collecting oil onshore, by vacuum cars and mobile concrete pumps, etc.
- Manual oil collecting operations using dippers and buckets, etc.

（c） Public announcement of oil movements expected（for the first time in Japan） Oil slicks had almost disappeared around 10 February, about a month after the oil spill incident.

On the other hand, oil began to drift ashore from 7 January, the day on which the bow of the tanker reached Mikunicho, Fukui Prefecture, and extended to the coasts of 9 prefectures facing the Japan Sea as time went on.

Before or after oil washed ashore, each local government set up a Countermeasure Task Force. Collecting operations for oil that had drifted ashore was led by local governments, collaborating with relevant agencies and volunteers, mainly by means of manual work.

③ Removal of oil remaining in the bow

Oil spilled from the bow of the tanker blackened the coasts off Mikunicho. Coastal areas may have suffer from more damage from oil contamination as the extent of structural damage to the hull of the tanker worsen due to heavy weather.

Therefore, the pressing problem to be handled was to remove oil left in the tanker, so measures to be taken began to be discussed among all those concerned to take a proper action as soon as possible.

As a result, it was decided on 14 January that, although oil was mainly collected using a crane and a barge（trimming）, another measure was also to be taken whereby the remaining oil would be collected using a crane on the path constructed to access the bow of the tanker as an emergency measure, for fear that the previous measure might be hampered by heavy weather in the Japan Sea in winter.

Oil-collecting operations were carried out and developed to a certain stage, but as was expected,

they were suspended for climatic reasons. Finally, on 25 February after completion of the path all operations were finished. On 20 April, a day on which sea conditions were quiet and moderate, the wrecked bow section was lifted from the water, transferred to the Seto Inland Sea and broken up after conducting an investigation for the causes of the incident.

④ Oil spill control near nuclear power plants As many as one-third of the nuclear power plants in Japan（compared by output） are located concentrically in areas embracing Wakasa Bay, so the imminent task was to prevent spilled oil from seeping into the plants. Therefore;

（a） Each plant was instructed to strengthen defences and remove oil around 8 January, when oil drifting in the sea began flowing into Wakasa Bay.

（b） Oil booms near cooling water intakes were subjected to stricter quality requirements, the number of lines was multiplied, and in the meantime, cleaning up oil by local vessels, etc., was started. Then, measures were taken by monitoring drifting oil at night, precisely observing drifting conditions using chartered aircraft and collecting oil slicks inside the oil booms on the shore. These actions fortunately resulted in maintaining power supplies without lowering output in all nuclear power plants. [Fig. 7]

⑤ Resources mobilized to collect oil and oil quantities collected An interim estimate made in early March, when collecting operations in the sea were almost completed is shown below. Vessels and Boats (Maritime Safety Agency, Self-Defense Force) about 4,700 vessels Quantity of oil/water mixtures collected in the sea (related to the nation) about 5,700 kL

(3) Sunken tanker and monitoring spilled oil

① It was not until 12 January, 10 days after the casualty occurred, that oil was confirmed to be drifting near waters where the tanker had sunk. Therefore, in response to the oil spill, oil dispersants were sprayed on one hand; and oil-contaminated waters were agitated by the stern vortex of vessels on the other hand; and the monitoring system in the sea area was tightened.

② During the period from late January to late February, the detailed condition of the tanker, which sank in waters roughly 2,500 m deep, was detected by an unmanned underwater robot of Japan Marine Science & Technology Center, followed by detection of the tanker's position. In addition, in the middle of February, an investigation was conducted by Dr.H.Rye (Norway) to determine the rising of oil from the wreck in cooperation with Ship and Ocean Foundation.

③ At the end of March, the Committee of the Ministry of Transport assessed the sunken tanker and leakage of remaining oil as shown below, on the basis of observations of spill conditions by patrol vessels and aircraft and the investigation described above ②.

(a) Remaining quantity of oil is 3,700 〜 9,900 kL

(b) Quantity of oil expected to leak per day is 3 〜 14 kL, which is not likely to go ashore.

(c) It cannot be expected that the hull of the tanker would suddenly break up causing a massive oil spill, although oil leaks would continue for some time.

④ Although the oil spill rate varies day by day, oil from the spring-head of the remaining hull lying on the sea bottom continued to float on the sea surface in the shape of a circle with a diameter of approximately 5 m within a circular water area with a diameter of approximately 100 m even in early June, 5 months after the incident. The oil then drifts on the sea, dividing into several long slicks measuring 100 〜 200 m wide and several km long, disappearing at the end of oil slicks due to wind and waves. [Fig. 8]

2. The Japan Sea and Marine Pollution

(1) Firstly, the number of marine pollution incidents caused by vessels in the surrounding waters of Japan has declined sharply in recent years, as shown in Fig. 9. This is considered to be ascribable to strict

observance of provisions for safety navigation by all concerned, strict management of cargo operations and down-to-earth countermeasures taken for marine pollution.

Fig. 10 shows occurrences of marine pollution by area, suggesting that the coasts on the Japan Sea side are less likely to suffer from marine casualties than that on the side of Pacific Ocean, which are heavily congested with shipping traffic.

(2) Subsequently, a rough calculation by The Japan Association of Marine Safety suggested that there are roughly 10,000 tankers operating throughout the Japan Sea yearly, and about half of them do not call at ports in Japan. The tankers' trade routes are varied and complex as shown in Figs.11and 12. The noteworthy points featured by these trade routes are, firstly, that aged tankers are operated on these routes carrying low-priced crude oil from China and Korea to Russia. [Fig.13] Secondly, on the route to Korea, where the quantity of oil imports has rapidly increased in proportion to increasing consumption, various tanker incidents have been reported lately around that country. Moreover, it is expected that an increasing number of tankers will navigate in more complicated ways in the Japan Sea in association with oil exploitation projects in Sakhalin in the future.

(3) If we look at the sea conditions in the Japan Sea, there appear to be unusually high waves in winter, just as we experienced with the casualty of the NAKHODKA [Fig.14]. Also, both sea currents and strong North westerly seasonal winds head toward Japan.

(4) Although the current rate of marine pollution incidents in the Japan Sea is relatively low, if we take the above discussion into account and realize that unseaworthy tankers are increasingly navigating under harsh climatic conditions, serious marine casualties and marine pollution caused by them will be more likely to occur in the Japan Sea than today.

3. Oil Spill Control System and Organization

(1) In Japan, the Law relating to the Prevention of Marine Pollution and Maritime Disaster prescribes the requirements for overall measures to be taken to protect the marine environment.

(2) To ensure the consolidation of the oil spill control system and organization, the Law specifically provides for;

・ Stockpiling materials and equipment for control of oil spill to be arranged by Maritime Safety Agency and Japan Maritime Disaster Prevention Center.

・ To establish councils as regional organizations ensuring coordinated oil control activities by governmental and private sectors.

・ Basic oil control measures to be taken by the party responsible for the cause under the causer-to-blame principle.

・ In case of exigent oil spills implementation of oil control measures by Maritime Safety Agency, and Maritime Safety Agency's oil control instructions to Japan Maritime Disaster Prevention Center.

・ Measures to remove oil that has washed ashore as an intrinsic task of local government.

(3) As shown in Figs. 15 and 16, stockpiling of materials and equipment for oil control has, reflecting the aforementioned characteristic geographical distribution of oil pollution, a bias toward the bay areas on the side of the Pacific Ocean and the Seto Inland Sea.

4. My Wishes

Listed below are the difficulties met in the process of commanding spilled oil control and cleanup operations at sea, in other words, hints suggesting what should be done in the future.

(1) Desseminating accurate and prompt information on the wrecked vessel and the cargo carried.

It is indispensable to obtain relevant information to determine countermeasures as soon as possible, considering temporal changes of oil properties under rough weather in the open sea. In the present case, information on the tanker's loading condition when wrecked could be gathered through interviews with rescued crew members. Furthermore, vessel's drawings, etc., could be obtained at a rather early stage from the charterer, thus it is desirable to establish an international system so that information useful for drawing up an oil control plan at an early enough stage in countries whose coastlines are expected to be damaged can be provided as duties of flag states, shipowners and operators.

(2) Establishment of procedures capable of tracking and predicting movements of spilled oil

Upon the hull fracturing, spilled oil began to spread and drift over a large sea area, and it was practically impossible to constantly monitor oil slicks, initiating immediately after the incident.

The following are hoped in the future:

・ Establish a system to collect information on drifting oil utilizing satellites

・ Workout measures to predict oil movements with greater accuracy

・ Build up an oil monitoring and predicting scheme on a non-profit basis to support countries sustaining oil spill damage.

(3) Development of materials and equipment available in rough seas

Fig.17 shows the development status of oil recovery systems worldwide investigated by Ship and Ocean Foundation. However, there are no oil recovery vessels or collecting equipment capable of operating in waters with significant wave heights of 2 m or more.

As suggested by the case of the NAKHODKA, in which oil spread and drifted over a large area within several days after the incident, it is desired to develop several classes of shipborne oil-collecting systems that are internationally standardized so that they can be used not only by patrol vessels but also by naval craft, Iarge fishing boats, ocean tugs, etc., in close co-operation.

(4) Consolidation of information for environmental disaster prevention in coastal sea areas

The questions of how many oil recovery vessels should be mobilized and in what waters to deal with spilled oil drifting over a large sea area are mainly governed by the natural and social conditions of the coasts. Accordingly, it should be urged to prepare sensitivity maps in co-operation with local governments and fishermen, in which information as to whether or not the use of treatment agents is acceptable is included.

Besides, it is desirable in the future to unify supporting information in the event of a disaster, including information on support available from voluntary groups and foreign countries. In this connection, NOWPAP now underway is considered to be promising. [Fig.18]

Outline of the Nakhodka

Name	NAKHODKA
Flag	Russia
G.Tonnage	1 3 ,1 5 7 ton
L×B×D	177.2 × 22.4 × 12.3 (m)
Launch	in 1970
Crew	32 persons (All Russian)

Fig. 1

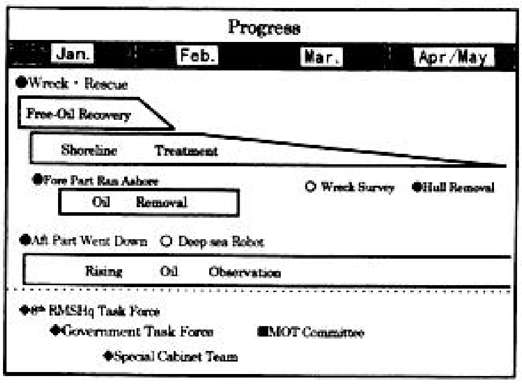

Fig. 2

Outline of the Wreck

Date	Jan. 2 , 1997 (02 : 51 SOS)
Place	106 km NNE off Oki Island
Route	Shanghai to Petropavrovsk
Weather	Wind 20m/s Wave Height 6m
Cargo	Banker —C 19,000 kl
Spilled Oil	Cargo Oil 6,240 kl (est.)
Rescue	31 saved (ex. Captain)

Fig. 3

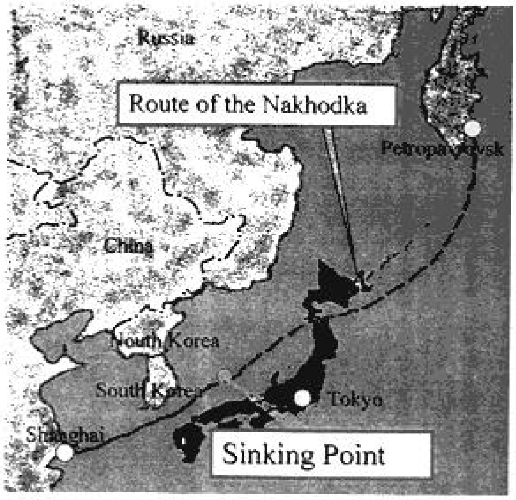

Fig. 4

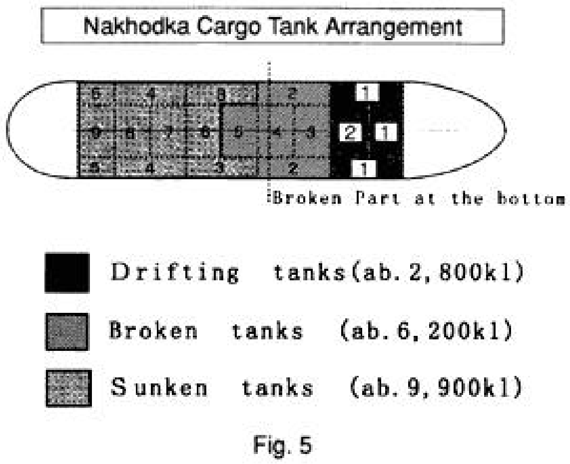

Fig. 5

Fig. 6

Fig. 7

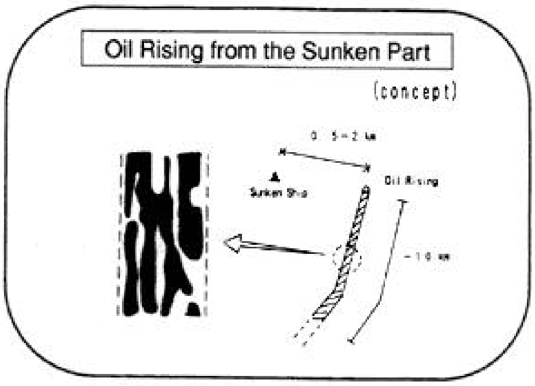

Fig. 8

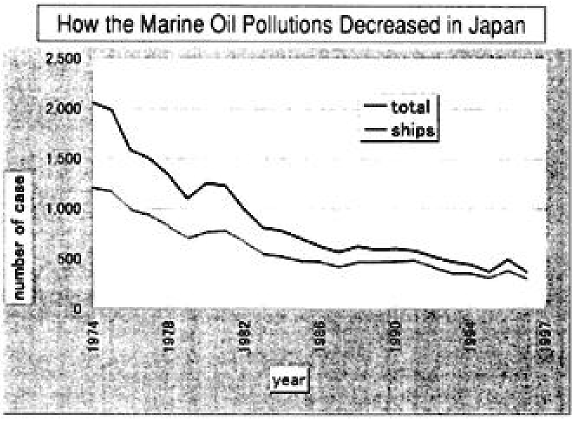

Fig. 9

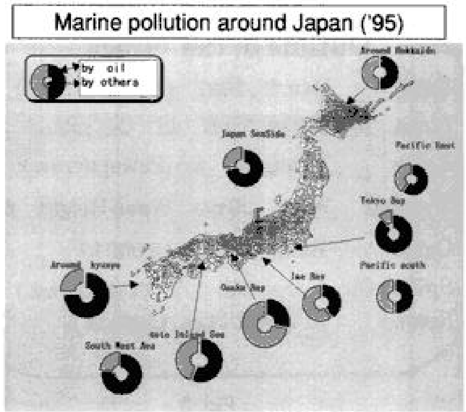

Fig. 10

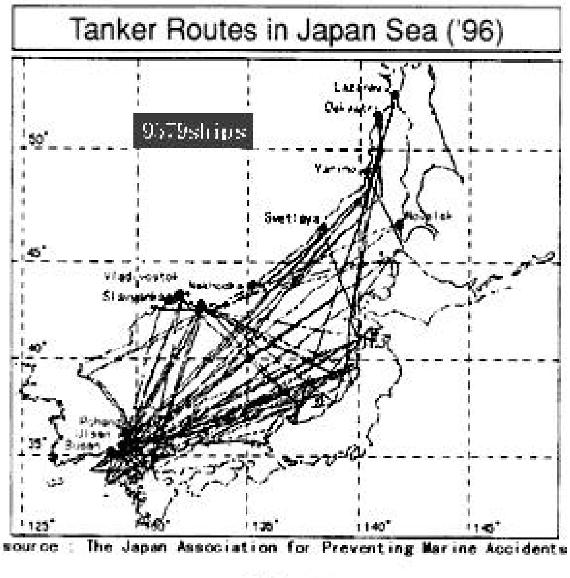

Fig. 11

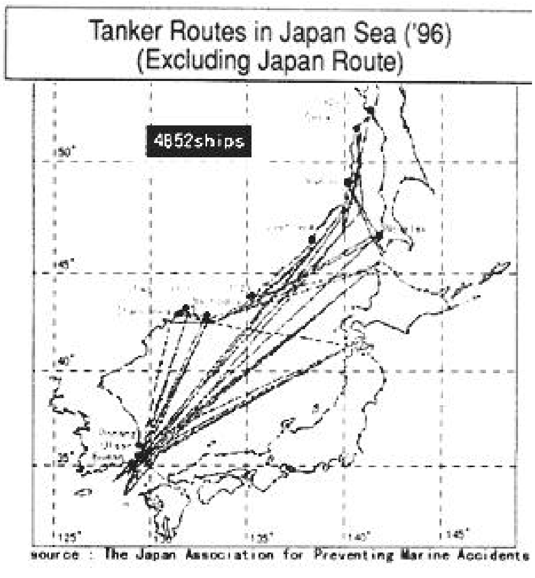

Fig. 12

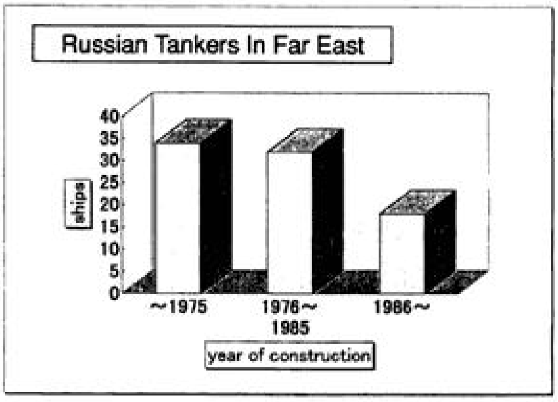

Fig. 13

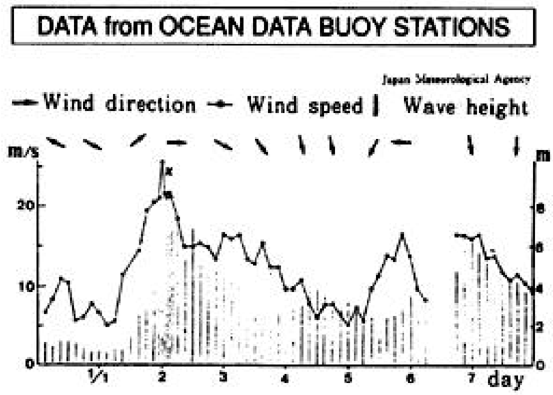

Fig. 14

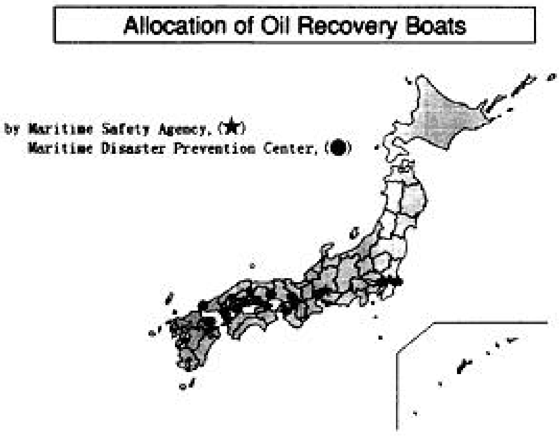

Fig. 15

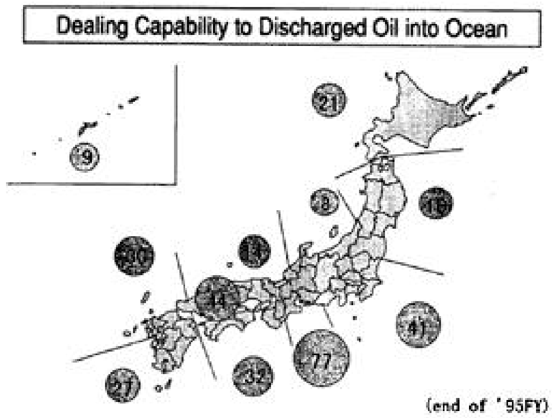

Fig. 16

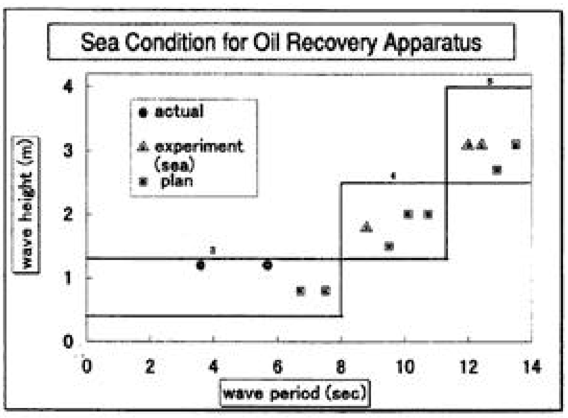

Fig. 17

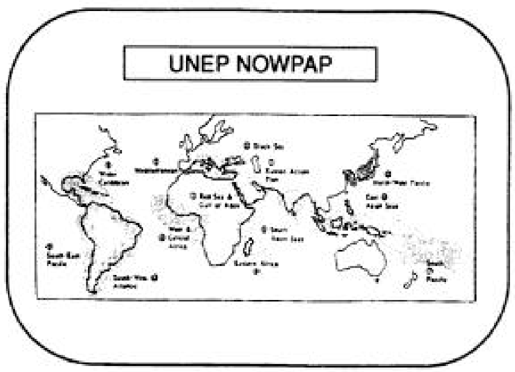

Fig. 18

Discussion

Mearns： What was the damage to marine life from the spill — birds, mammals, fish?

Kudo： During one-and-a-half month period up to mid February, we had protected 1,269 birds. We don't know, of course, how many birds were killed in total.

Schive： You said in your wish for the future that you want to establish a system to collect information on drifting oil utilizing satellites. How in fact was the drifting oil observed during the NAKHODKA incident?

Kudo： Just for a short time in the initial stage of response activities,we observed the oil spill by use of satellites. But for the most part of the response activities, we made daytime observations by using helicopters of our own or P3C of the Maritime Self-Defense Forces to gather necessary information. Everyday we analyzed, the collected information by the evening of the sarne day, and based on the analysis, we predicted where the spill would drift next day. Of course, we were informed that the Canadian Radarsat took Photographic images of the spill. Yet, since the spill spread over a vast surface of the sea, we did not use always satellite information, due to our restricted funds to obtain such information.

Lessard： I noticed in your slide the difficulty in applying the dispersants in high wind from the ships. Is there an aircraft capability, or are you thinking you might want to fortify your existing capability with aircraft?

Kudo： By using helicopters, we did apply dispersants in the waters not adjacent the coast, for several days, but because of the nature of the spilled oil, we estimated that it would not be effective. And since the aerial application of dispersants from helicopters had various operational difficulties, we gave up the operation. Only when we confirmed much spill at the leakage point, we applied some dispersants.

Motora： In Japan, there is a discussion that we should also establish a preauthorization system for swift application of dispersants. I would like to ask aquestion to Mr. Kudo. During the NAKHODKA incident, you mentioned that dispersants were used at an early stage. How was it possible for you to use it at a relatively early stage?

Kudo： The hull was broken apart in the open sea; before the oil actually drifted ashore,there was a lot of time — I think more than five days. So on the second day after the incident occurred, that was January 3, through the responsible sections of the local government authorities, discussions were held with the fisheries unions and associations to obtain approval for application of dispersants. Therefore, in the NAKHODKA incident, we were able to use dispersants at an earlier stage of response.

Motora： Likely in the DIAMOND GRACE incident which took place in Tokyo Bay, dispersants were used at an early stage, thanks to which the damage was minimized. How was it possible?

Kudo： I am not in a position to answer about this incident, because I was not involved in the response. But according to the information I have, the fishermen knew very well about the properties of the oil; and they knew dispersants are very effective for crude oil at an early stage of response. Therefore approval was obtained soon and it was possible to start dispersant operation within three days. But there was a request from the fishermen not to continue using the dispersants after the third or fourth day.

Motora： Listening to your report, it seems that in Japan alike, it is possible to establish this preauthorization system. Is that correct?

Kudo： On that particular question, I believe the situation is different for the DIAMOND GRACE incident and the NAKHODKA incident, and different local government authorities may have different views. So I can not give you a simple answer of yes.

Session 2

Recovery of Oil Spilled from the NAKHODKA and Equipment Used

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He was involved in control operations at the site of the oil spill at the time of NAKHODKA incident

1. Initial Responses to the incident of the NAKHODKA

A massive oil spill, which was caused by the fracturing of the hull of the Russian tanker NAKHODKA (gross tonnage: 13,175 t) occurred at about 0250 hours on 2 January, 1997, was first identified together with the sheared-off bow section on the Japan Sea by an aircraft and a patrol boat of the Maritime Safety Agency on the following day, 3 January. A large amount of oil spilling from the sheared-off bow section of the wreck and oil slicks drifting in the vicinity were verified during this first discovery.

A salvage boat dispatched at the request of the shipowner for rescue operations arrived at the scene of the incident at 2130 hours on 4 January, and tried to tow the bow section, which was then drifting, with assistance provided by the patrol boat. The drifting bow in the bottom-up position, exposing only a small portion above the water, coupled with the heavy seas prevented them from belaying towing hawsers.

On the morning of 5 January, the head of the spilled oil drifting together with the bow had already approached a point 40 nautical miles off Mikunicho. The oil pushed by northerly winds was likely to menace the coast of Japan.

The patrol boat and other vessels began to remove drifting oil, while making an attempt to tow the bow. At the initial stages, recovery nets were used to recover the oil, oil dispersant were sprayed onto the sea, and on 5 January, a helicopter was tested for spraying oil dispersant.

2. Off-shore Drifting and On-shore Conditions of Oil

It was estimated that about 3,700 kL, contained in the bow section, of about 19,000 kL of C heavy oil that the NAHKODKA carried had instantaneously been discharged into the sea through fractures following the hull damage. (The investigation performed afterwards made us estimate the oil spill to be 6,240 kL.)

The oil slick drifting on the sea surface were broken up in places by waves but thick layers of the principal part and the bow pushed by the currents and northern seasonal winds were approaching the coast of Honshu, Japan.

The drifting bow reached a point off Anto Misaki. Mikunicho. Fukui Prefecture at about 1100 hours on 7 January, while rough weather continued dominating the waters of the Japan Sea. Another oil spill from the bow was identified. All these oil slicks reached and landed on the neighbouring coasts.

On 8 January, diffusing layers of oil came ashore consecutively on the coasts of Fukui Prefecture and Ishikawa Prefecture.On 20 January, the oil layers drifting northwards along the Noto Peninsula finally passed the northern coasts of the Peninsula and were driven to Sado Island, Niigata Prefecture, eventually reaching other coasts of Niigata Prefecture on the Honshu side. As a result, contamination of waters was found to be affecting 9 prefectures including Shimane and Akita.

3. Oil Recovery Operations

All oil recovery operations included recovery of oil drifting on the sea, recovery of oil drifting near the coast and recovery of oil driven onshore and dwelling on sandy shoals and rocky beaches.

(1) Recovery of oil drifting on the sea

The spilled oil was driven onto the long coastline from Shimane Prefecture to Akita Prefecture. Part of the oil took a northern course off from Wakasa Bay and along the coast of Fukui Prefecture and Ishikawa Prefecture and reached the coast at the northern end of Noto Peninsula, Toyama Prefecture and Niigata Prefecture, widely diffusing on the sea.

When more than one week had passed since 2 January, the date the incident occurred, the spilled oil which had been continuously stirred by waves since then became a emulsified oil containing a large amount of water. According to data, the properties of the oil carried by the tanker, which was loaded in Shanghai, are: kinetic viscosity: 137.46 cSt at 50 ℃ (about 6,000 cSt at 10 ℃) ; pour point: -17 ℃. The drifting oil sampled on 5 January presented a viscosity of 1,232,000 cSt at 12 ℃.

a) Crane barges and grab dredgers

It was foreseen that such high-viscosity oil could be recovered more effectively by means of crane barges and grab dredgers than by oil recovery systems. Such vessels were chartered and used for oil recovery operations at sea.

For the operations, a total of 5 crane barges or grab dredgers were chartered at ports on the coast of the Seto Inland Sea. This was because, as always, no vessels appropriate for oil recovery operations were available in the Japan Sea during winter, which is characterized by rough weather (most of the work boats had been transferred to the Pacific side.)

The initially planned sweeping formation consisted of one vessel towing a guide boom and one crane barges recovering oil collected by the boom. However, the actual operations were carried out by a single crane barges, because the planned operational co-ordination between the 2 vessels was not possible or was difficult under the prevailing bad weather. It is estimated that a total of about 1,000kL of the mixture of spilled oil (85%) and sea water (15%) has been recovered.

b) Oil recovery vessels and equipment

The oil recovery vessel ASUWA of the Fukui Oil Storage Co., Ltd., registered in the Port of Fukui, was engaged in operations at sea from 9 January, 1997 when the rough weather temporarily ceased to dominate the area.

On 4 January, 1997, 5 days before these operations, the Maritime Safety Agency had already requested the dredger/oil recovery vessel SEIRYU MARU of the Ports and Harbours Bureau, Nagoya, Ministry of Transport, to proceed to the affected areas and commence oil recovery operations. The SEIRYU MARU actually commenced operations on 9 January.

The other vessels chartered for oil recovery operations include the TAKAHOKOMARU NO. 3 of Mutsu-Ogawahara Oil Storage Co., Ltd. and the HAKURYU of Shirashima Oil Storage Co., Ltd.

Vessels and equipment from overseas, which were dispatched in co-operation with the operations, included RO-SKIM system of EARL, Singapore, and oil recovery vessels from Russia carrying oil booms, oil trawl nets, DESMI 250 and FOXTAILS.

The oil recovery operations carried out by these vessels and equipment proved to be poor in terms of operational efficiency because of the high viscosity of the oil. They are assumed to have collected oil/water mixtures of about 1,100 kL (oil: about 100 kL). The RO-SKIM system failed to recover oil. The amounts of the oil/water mixture recovered by the Russian systems and equipment were about 430 kL of which about 200 kL were oil.

c) Others

Groups each comprising 2 small fishing vessels carrying recovery nets also participated in the operations. These vessels towed oil recovery nets and used dippers.

The oil recovery operations by these vessels covered large areas including Wakasa Bay, sea areas off Mikunicho (Fukui Prefecture), Kaga City. Kanazawa City, Noto Peninsula (each Ishikawa Prefecture), Toyama Prefecture and Niigata Prefecture, which were affected by the diffusing and drifting oils. Special measures were taken to prevent the oil from approaching the cooling water intakes of the nuclear power plants located on Wakasa Bay in Tsuruga City and in Shigacho, Ishikawa Prefecture.

(2) Recovery of oil drifting near the coast

The oil spilling from the bow and drifting oil slicks were driven ashore on the coasts of Ojima, Mikunicho, on which the bow ran aground on 7 January, 1997. The layers of oil near the coast lines passed under the Ojima Bridge and continued drifting southward toward Tojimbo. Oil booms were stretched along the bridge to prevent the oil from further diffusing and other items of oil recovery equipment were used.

a) Oil recovery equipment

2 types of recovery equipment, wear and disk types, as well as beach cleaners owned by the Petroleum Association of Japan were used. These items of equipment were used as oil transfer pumps between the beach and the drum cans/FASTANK, because oils subjected to cycled wave motions on the shoals tended to become highly viscose oil mass.

b) Vacuum cars and mobile concrete pumps

Vacuum cars were used for drawing oil directly from the coast and indirectly drawing oil from drum cans.

Despite their inferior suction ability to vacuum cars, mobile concrete pumps were used safely because of their advantageous features - long suction lines and availability of remote control even under unfavourable sea and weather conditions.

(3) Recovery of oil washed ashore on the coast

The drifting oil that had reached ashore was removed manually from the coast by numerous people. Oil washed ashore on the sandy beaches was collected by heavy machines such as bulldozers and back hoes. The collected oil was separated from sand afterwards.

Oil solidified in the sand was first subjected to a water jet to drive it onto the water surface and then the separated oil was recovered. Operations for recovering drifting oil and oil washed ashore were performed both on the sea and on the coast. The operations involving vessels at sea were completed on 20 February, while those on the coast were finished at the end of April. After these dates, operations related to oil recovery were continued -cleaning the coasts and removing oil on and between the tetrapods and in isolated places inaccessible either from sea or land until June.

4. Materials and Equipment Used

The materials and equipment used for recovering drifting oil and oil washed ashore include:

a) Operations at sea

Vessel	Owner	Number of vessel-days	Remarks
SEIRYU MARU	Ports and Harbours Bureau	32	Dredger/oil recovery vessel equipped with 2 types of recovery system:vortex and ramp types
Three vessels including ASUWA	A national oil Storage Co.,Ltd.	39	Oil recovery vessels of oil stockpiling base. Ramp-type ASUWA and TAKAHOKO MARU NO.3 and suction-float-type HAKURYU. Screw pump was substituted for the transfer pump from the recovery pit to handle the high-viscosity oil.
Five vessels including KOTOBUKI	A private company	21	Pusher barges and grab dredgers for grabbing oil clots
RADON and others	Dispatched from Russia	3	Multi-puropose rescue vessel which replaced NEFTEGAZ 5 and which is equipped with a wear-type oil recovery system,RO-BOOM and FOXTAIL
KOYO MARU	A private company	2	Ocean tugboat equipped with an oil recovery system provided by EARL
Fishing vessels	Maritime Disaster Prevention Center and others	Many	Manpower operation using pairs of boats equipped with oil recovery nets and dippers.

Other vessels engaged in oil recovery operations include patrol boats, Self-Defense Force vessels, and fishing inspection boats.

The total amount of oil/water mixtures recovered from the sea is about 8,700kL.

b) Operation on the coast

The materials and equipment used for recovering oil on the sea near the coasts include:

b) Operation on the coast

The materials and equipment used for recovering oil on the sea near the coast lines and coasts include:

Material	Owner	Number of equipment-days	Remarks
Oil recovery equipment	Petroleum Association of Japan	110	Wear-type and disk-type recovery equipment used as transfer pumps
Beach cleaner	Petroleum Association of Japan	224	Used for recovering oil near the coastlines.Poor efficiency because of the oil's high viscosity
Vacuum cars	A private company	562	Used for both direct recovery from the water and indirect recovery from drum cans
Mobile concrete pumps	A private company	16	Its poorer suction force than a vacuum car is offset by the availability of remote control provided by the long suction lines

FASTANK and drum cans were used as recipients for recovered oil.

The total amount of oil/water mixtures recovered using these items of recovery equipment is about 6,600 kL. To this number should be added the amount of the oil recovered by many volunteers' manual operations; the total amount of oil/water mixtures recovered and delivered to appropriate reception facilities is accordingly about 47,000 kL.

c) Preparation of provisional storage pit for oil recovered

As the amount of oil drifting and washed ashore increased, it was anticipated that the amount of oil recovered also would increase to the extent that temporary storage in drum cans could not keep up with such an increase. Therefore, provisional storage pits were installed in the Fukui, Tsuruga and Suzu areas where the amount of oil/water mixture recovered has already proved to be relatively large.

5. Conclusion

(1) Decontaminating capability in areas of the Japan Sea

In winter, it is practically impossible to perform maritime operations due to strong winds in the Japan Sea. For this reason, most of the work boats based on the Japan Sea side are moved to the Pacific side, and there remain a limited number of such boats available for emergency use.

The number of vessels calling at ports on the Japan Sea side is smaller than on the Pacific side and the number of large vessels and tankers navigating under unfavourable sea and weather conditions is also smaller.

Thus, there are few work boats immediately available for decontamination for oil spills in areas on the Japan Sea side in winter. The overall decontaminating capability on the sea is extremely limited on the Japan Sea, compared to that on the Pacific side.

(2) Materials and equipment available for oil recovery in open seas

In Japan, most of the materials and the equipment available for oil recovery operations are located in waters accessed by tankers, which are characterized by heavy shipping traffic, such as Tokyo Bay, Ise Bay, Osaka Bay, Seto Inland Sea and in enclosed and calm areas of petrochemical complexes that have a port. Hence, these materials and equipment are designed for use under smooth sea and weather conditions.

In the case of the NAKHODKA, all of the vessels except for the oil recovery vessels actually mobilized are designed for use in harbours and are not serviceable under stringent conditions in open seas.

(3) Private decontamination organizations

Decontamination organizations include governmental (national and local) competent and obligatory organizations, Oil Spill Decontamination Conference (legally formed semi-governmental organization), and private organizations - PAJ Oil Spill Cooperative Organization (organization formed under the Petroleum Association of Japan composed of oil companies), and different contractual oil pollution prevention organizations composed of harbour-based shipping companies and tugboat operators prepared for practical operations organized around the nucleus body of the Maritime Disaster Prevention Center. The private sector (except salvage companies) mainly covers harbour areas and has no capabilities for working in open seas. These conditions justify reconstruction in terms of both material and management of these private organizations mainly composed of salvage companies to cope with similar accidents in open seas.

(4) Limitations on oil removal operations under contract with shipowner

The Maritime Disaster Prevention Center may carry out oil removal operations at the request of shipowners. In addition, the Center must follow instructions and obtain consent from the same shipowner and the surveyor in charge of P & I insurance. For example, the Center must consult the surveyor on operations in new areas if the contamination has expanded to such areas. Besides, there may be differences of opinion. These conditions may cause time delay before taking necessary and timely measures.

In any cases, it is necessary to establish a unified control and operation system supported by cooperative work of the parties concerned in on-scene operations.

(5) Disposal of recovered oil

The oil recovered as oily waste amounts to about 47,000 kL. The entire amount was disposed of as industrial waste in appropriate reception facilities in accordance with the relevant domestic laws and regulations. However, the procedure for industrial wastes under normal and not emergency conditions was followed, which prevented steady disposal of the recovered oily waste from being executed.

Properties of the oil carried by the NAKHODKA

Item	Data provided by the oil refinery in Shanghai
Density	0.959g/cm3 at 20℃
Water content	0.17%
Kinetic viscosity(at 50℃)	137.46 cSt
Pour point	-17℃
Flash point	91℃
Sulfur content	1.29%
Residual carbon	9.22%
Remarks	C heavy oil carried

1/ Geographical dispersion of drifting spilled oil

2/ Location of shipwreck

3/ Sakai

4/ Maizuru

5/ Tsuruga

6/ Mikuni

7/ Bow

8/ Kanazawa

9/ Nanao

10/ Toyama

11/ Naoetsu

12/ Niigata

13/ Hegura Jima

14/ Sado

Discussion

Gainsford： Could I ask about the purpose of the causeway?

Suzuki： Initially it was estimated that there remained 2,800 kL in the bow. But while the bow was drifting, some had leaked, so the estimate was revised to be 2,000 kL. After the bow was grounded, the salvage vessel continues, of course, off-loading the oil offshore, and the access way was also created to off-load the oil from the shore. We used these approaches concurrently, and the reason for that is the sea conditions were severe, with very strong wind and waves. There are a very limited number of days at this time of the year in which the sea is mild, If there are two or three consecutive days of mild weather, then offshore off-loading will become possible. But if the mild weather lasts only one day, it will not be sufficient, because you need from a half day to a day for preparation. This means that we cannot depend on offshore off-loading alone. Therefore, we decided to use both approaches ─ that is, from offshore as well as from the shore, using the access way to off-load the remaining oil from the bow section.

Gainsford： Are there indications that the IOPC Fund are happy to pay for that? Are they happy with the causeway as well as the offshore off-loading of the oil?

Suzuki： Unfortunately, I must say that the prospect is rather pessimistic, but we intend to request compensation from the IOPC Fund for the overall cost. This matter would be decided at the general meeting of the IOPC Fund or the board meeting.

Davies： What is your estimate of the cost of the oil recovery and are you proceeding with your claim from the Fund ? If so, have you had any payment to date?

Suzuki： The MSA, the Ministry of Transport and the SDF-these are the national entities that would be making the claim. In addition the prefectural governments, of which shores were subject to pollution, and the local autonomies that have provided equipment and maneuvered people to deal with the pollution, will be sending their claims. The private sectors will be using the MDPC as a contact point through which they will be filing their claims. As for the claims that will be made to recover the cost, we are calculating the total cost of the operations from January to March. There is an IOPC office for dealing with compensation matters related to the NAKHODKA incident in Kobe, and the claims will be submitted to it. From the IOPC, we have so far received 540 million yen which we needed immediately.

Schive： I have a question which I think is equally important as the economical aspect. It relates to the safety of the people involved. A lot of people were involved in the cleanup of the oil spill. What are your considerations relating to the safety of those people ? Do you have any particular experience related to the safety of the workers?

Suzuki： As for the safety of the operators, especially when it comes to the offshore operations, you have to think about the safety of the vessel as well. This will also have a bearing on the efficiency of the collection of the oil. Offshore, under rough sea conditions, we suspended the operation and had them stand by. So we did not coerce the workers to carry out operations during rough weather.

Regarding onshore operations, we took nesessary measures so that people would not be knocked down by the waves. We had a system in place to keep close watch so that people would not be harmed by strong waves during onshore operations.

Lunel： ...How much oil was contained in 47,000 kL of oil and water that was recovered?

Suzuki： We have not determined the exact amount yet. We collected 110,000 drums of oil. The oil recovered offshore was stored in barges and then it was transported to the storage facilities. We used flexible containers and drums for storage of recoverd oil. Of the 1,100 kL recovered by skimmer vessels, we estimate the actual oil at about 200 kL.

Lunel： ...it sounds in total like about between 5 and 10 % was recovered at sea. Do you have an idea overall whether you're talking about 40 % or 80 % oil in the waste oil recovered, just as a rough idea?

Suzuki： The oil and water recovered offshore is estimated to contain 30 to 40 % of oil in total. As for the onshore beach operations, a lot of oil stuck on to the garbage, so an estimate is very difficult.

Davies： As to the solid waste material, such as oiled debris and garbage, what was your route for disposal of that?

Suzuki： All of the waste was sent to a processing plant to for disposal by incineration.

Session 3

Partnerships, Planning and Preparedness for Public and Private Resources in a Major United States Oil Pollution Response

Richard E.Bennis

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Education BSc Natural Resource Development, University of Rhode Island / Attended the Coast Guard Office Candidate School in Yorktown, Va / MA Energy and Environmental Policy, Harvard University

Assigned to Valdez Alaska during the EXXON VALDEZ pollution response.

Recent major oil pollution incidents in the United States have clearly demonstrated how far we, the marine oil pollution response community, have come since the EXXON VALDEZ spill in 1989.

We previously had what appeared to be a somewhat divisive atmosphere in the response arena highlighted by a perceived lack of cohesiveness and organization between the responders, the responsible party and the impacted maritime community.

The lessons of the EXXON VALDEZ incident have taught us well, we learned much and have fashioned an oil pollution response methodology which has proven to be a dynamic, flexible and extremely successful system.

From a federal government regulatory standpoint, The Oil Pollution Act of 1990, known as OPA 90, provided the legal impetus to initiate many initiatives covering areas of oil pollution response ranging from financial liability, compensations for damages/loss, vessel and facility operating requirements, exercise requirements, equipment prestaging to planning and preparedness aspects of pollution response.

The basis for succes of the U.S. model of oil spill response is premised on the tenets that the polluter, or responsible party, is responsible for cleanup. That response occurs at the direction of the federal government. Further, while the federal government representative (the U.S. Coast Guard in marine incidents and the U.S. Environmental Protection Agency for most inland spills) has the responsibility to ensure cleanup is satisfactory, the inclusion of what we refer to as stakeholders is absolutely essential to a successful response. These stakeholders include, but are not limited to, other government representatives from state and local municipalities; natural resource trustees; historic preservation representatives and environmental concerns. Their participation in response planning and execution ensures a more effective and efficient response than existed prior to the EXXON VALDEZ response.

These relationships with the aforementioned stakeholders and all those who could possibly be impacted by a pollution event are captured by the all encompassing U.S. National Contingency Plan, created by OPA 90, which gives our current response the force of law. Our planning makes its way to all levels of government and community as, from the National Contingency Plan, we have developed Regional Contingency Plans and, from these, finally Area Contingency Plans. It has been clearly learned, through experience, that the Area, or local, contingency plan is of paramount importance. It is here that cleanup priorities are pre-identified, based on environmental sensitivity analyses. It is also the plan which identifies the response resources available within the area as well as the cascading of resources from other locales as the situation mandates or escalates. The response organization is described here and includes all local representatives, contacts and positions/roles within the response.

This plan is the product of an Area Committee where local stakeholders meet to discuss concerns and achieve consensus on what the most important local issues are in a pollution incident. While the environment is always of paramount concern, issues which are also critical to the welfare of the impacted community, like economic impact, are also extremely important. Local fishermen, shipping interests, recreational concerns, scientific interests and other members of the maritime community are all part of the process which develops the Area Contingency Plan and are afforded the opportunity to express their response priorities. One key factor to the planning process is simple... in the end, consensus must be reached. The common thread that runs throughout our lessons learned is that extensive planning, partnering and networking with all who may be impacted by a pollution event goes a long way to removing controversy during the actual response, and ameliorates a painful legacy from the EXXON VALDEZ spill.

While the Area Contingency Plan planning process builds consensus amongst government agencies during the planning process, a key factor essential to the smooth implementation of the many months of planning is the designation of one person in charge. That individual, known as the federal on-scene coordinator (FOSC) is charged, by law, with directing the response to any spill that threatens public health or welfare.

The far reachng interpretation of public welfare places the FOSC in the directing mode for the majority of all medium and larger spills. Other spills, which have a known responsible party who is responding in a proper manner will be monitored by the FOSC as the cleanup progresses. The FOSC always retains the ultimate responsibility to ensure cleanups are satisfactorilly conducted in accordance with the applicable contingency plans. This designation of one person in charge has proven to be exceptionally effective as it clarifies the question as to who the final arbiter is when contentious issues arise.

The natural outgrowth of the Contingency Planning process is the strategic implementation of those plans into a logical, universally known and accepted response organizational structure. Cleanup management, under the FOSC direction, is done through the use of a unified command structure which includes the FOSC, the State (or States) OSC and the cleanup manager for the spiller, or responsible party. This triad will determine the strategy for the response. In the unlikely event that agreement is not reached, however, the FOSC has the legal mandate to resolve the issue in contention with his determination as to the best resolution of the probelm.

This Incident Command System (ICS), under the triad described, is further broken down into 4 main sections. These are Planning, Logistics, Operations and Finance. Staffing of these are jointly shared and pre-determed in the response planning process. All potential response management areas of concern are coordinated through this system. Often neglected areas in previous planning methodologies are now covered (I.E. Volunteer coordination and training, dignitary visits, protocol, media relations, etc.). It is extremely flexible internally, it can grow or shrink to meet the specific demands and size requirement of an incident. We intend to implement it soon for use in our responses to what we currently refer to as incidents of national significance. This will expand the concept beyond our traditional utilization in oil pollution response to other areas of incident response.

Concurrent with the aforementioned planning, preparedness and exercising process the FOSC is supported by all of the other government agencies. This is a requirement of the NCP and it allows the FOSC to enlist the aid and special capabilities of these agencies in battling a spill. Included among these agencies is the Department of Defense which opens up a vast array of manpower and logistics support for a FOSC.

The National Response Team (NRT) and the more geographically oriented Regional Response Teams (RRT) are comprised of day members of each these federal agencies and include state representatives at the RRT level. These individuals are at the ready to assist the FOSC in expediting the resoltion of what might ordinarily be bureaucratic nightmares. These teams also are instrumental in working towards the resolution of final pre-approval agreements for different response methodologies like dispersant application and in-situ burn.

OPA 90 has required the potential spillers to be responsible and prepared to mount their own response to a pollution incident. Should the spill source be a tank ship or tank barge, the operator must have pre-existing contract with a designated oil spill removal organization (OSRO) to cleanup a "worst case discharge". Simply put, this would be a loss of the entire cargo under adverse weather conditions. Each of these vessels is now required to demonstrate financial responsibility to respond to a pollution incident. They must have approved vessel response plans which are, in effect, a vessel specific contingency plan for pollution response. The planning, coordination and conduct of the many and varied exercises required by OPA 90 have produced a response environment which is prepared for all contingencies. The combination of a joint public and private response effort, under the direction of a single federal official, the Federal On Scene Coordinator, in accordance with an agreed upon contingency plan are the pillars of our extremely successful U.S. model.

In addition to the advances made in planning, preparedness and spill management techniques we remain actively engaged in considering, evaluating and adding alternate spill response technology to our cleanup capabilities. While we insist on a privately funded and staffed response, it behooves us to remain current in our capability to provide the best response and, if necessary, best first response capability we can if private resources are either time or resource constrained in the early hours of a response.

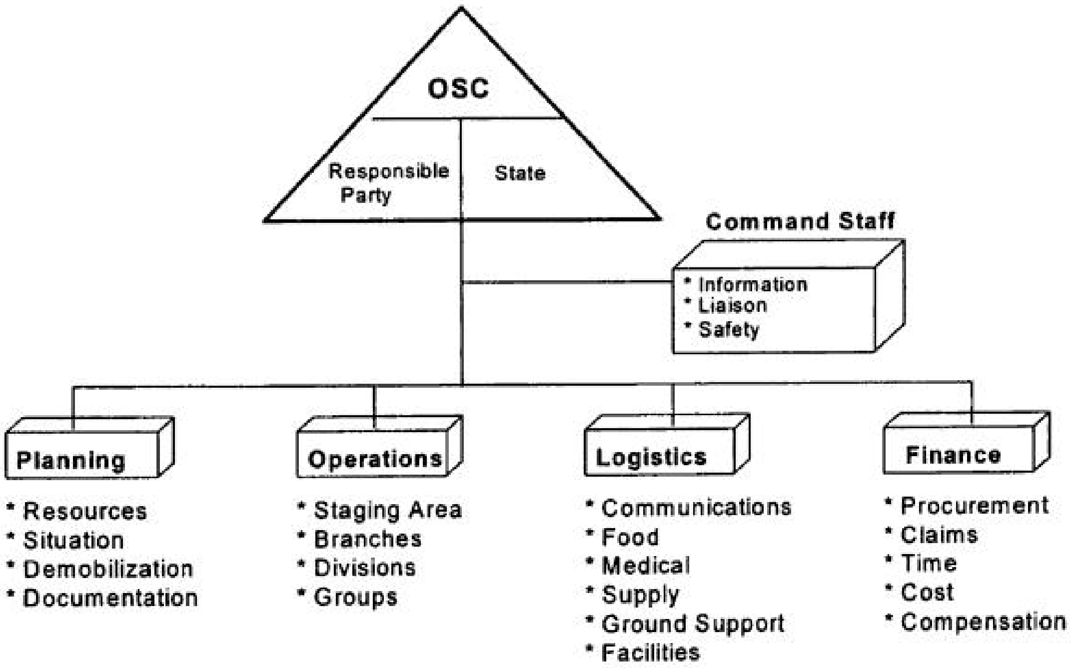
With the exceptional professional development and increased response capabilities of our OSROS We find a diminishing need for traditional response capabilities (I.E. boom and skimmers) in the Coast Guard ready response arsenal. We are expanding our horizons to address the areas of dispersant application and in-situ burn methodologies as areas of expertise and response that are rapidly developing but are not yet universally available.

The mid 1990s have seen a tremendous increase in the number of memorandums of understanding for the pre-approval of dispersant application. Had agreements such as these been in place during previous major responses it would have eliminated significant contentious discussions and allowed for expeditious implementation of this time critical mitigation tool. We have worked aggressively with our Regional Response Teams and Area to obtain these pre-approvals and in the majority of cases we have successfully obtained either pre-approval or accelerated approval procedures by the applicable government authorities and/or resource trustees. This capability provides yet another tool for FOSC to use in mounting the best response possible.

Tranditional recovery and removal remains the response methodology of choice. Notwithstanding this, there is a growing awareness among responders, stakeholders, trustees and involved agencies that utilization of other methods (I.E. chemicals and in-situ burning) may be necessary and, in fact, preferable to prevent large quantities of product from coming ashore into inter-tidal regions.

In summary, we have found that our post EXXON VALDEZ approach to oil pollution response is a system wherein we, as a community partnership, plan together, exercise together, and respond together. Our successes are victories we share. Our failures are lessons we learn from together. An oil spill response is no longer automatically seen as a divisive event but a challenge we face together.

Basic Incident Command System Organization



NATIONAL RESPONSE TEAM
FEDERAL AGENCY MEMBERSHIP

ENVIRONMENTAL PROTECTION AGENCY, CHAIR
(environmental effects and pollution control techniques)
(planning and response for inland areas)

U.S. COAST GUARD, VICE-CHAIR
(planning and response for coastal areas)

FEDERAL EMERGENCY MANAGEMENT AGENCY
(emergency planning, training and relocations)

DEPARTMENT OF DEFENSE
(specialized response equipment and personnel)
(response to certain incidents)

DEPARTMENT OF ENERGY
(response to radiological hazards)

DEPARTMENT OF AGRICULTURE
(evaluation of impact on natural resources)

DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
(scientific support for coastal response)

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
(health hazards to responders and public)

DEPARTMENT OF THE INTERIOR
(protection of natural resources)

DEPARTMENT OF JUSTICE
(legal expertise)

DEPARTMENT OF LABOR
Occupational Safety and Health Administration
(worker safety)

DEPARTMENT OF TRANSPORTATION
Research and Special Programs Administration
(transportation of hazardous materials)

NUCLEAR REGULATORY COMMISSION
(radioactive materials)

DEPARTMENT OF STATE
(international agreements)

TREASURY DEPARTMENT
(Customs agency, hazardous materials at borders)

GENERAL SERVICES ADMINISTRATION
(logistics and communications support)

Discussion

Kudo： The Federal On-Scene Coordinator — does he need to have frequent contacts with Washington every time something happens? The reason I ask this is because there are, I believe, many decisions to be made, such as decisions on cost as well as the legal coordination and adjustments to be made between different organizations. Is the Federal On-Scene Coordinator given the authority and the power to make the decisions himself?

Bennis： ...as the Federal On-Scene Coordinator (FOSC), I would have to use the phrase, "the buck stops here". The Federal On-Scene Coordinator has the authority to make all the decisions. In a huge pollution incident, as in the EXXON VALDEZ, we may bring in a more senior officer. In the EXXON VALDEZ the Commander was replaced by a more senior Vice Admiral, because of the intense public and political interest.

But, until that three star Admiral was brought in and designated as the new FOSC, the responsibility to authorize the money and determine what the response consists of remains with the pre-designated FOSC.

Without that authority, we would not be successful. Military rank is not the issue for the FOSC. His supervisor, historically, is an Admiral but the FOSC need not go to his supervisor for approval, permission, or to discuss issues. The FOSC will have a lawyer on his/her staff to advise him. He will have members of the Oil Spill Liability Trust Fund Staff to advise on procedures, but, the final authority in a successful response has to lie with the Federal On-Scene Coordinator and that authority.

Gainsford： I have two questions. Do you split up the marine side of the operation from the shore side in the headquarters or do you try to combine the two headquarters to deal with at-sea response and onshore response? And the second point is, do the local authorities or state authorities have a statutory duty to clean-up and also to contingency plan prior to the event, or is it a voluntary effort?

Bennis： Offshore, near-shore, inland, river — they are all planned as one. We do not separate offshore incidents and near-shore incidents. The states — it certainly behooves them to participate in their area contingency plan and in their regional response team meetings. Of all our states, we have three states, which will go nameless, that are very aggressive in their response programs. I won't name them, but I think they are Texas, California and Florida. They, too, get very involved, but historically, in our responses, we have the Federal On-Scene Coordinator, the responsible party and the state representative in that triad at the top of the response, the Unified Command. So there is no competing between the federal government and the state governments. They are all part of the team, and they work together. Those states that perhaps get a little more involved are those states that are fortunate enough to have more money and more manpower to participate a little more aggressively, and we welcome any money and manpower that someone brings to the table.

Gainsford： When you said near-shore, was that shoreline as well?

Bennis： Yes.

Gainsford： But doesn't the actual operation center become too large?

Bennis： It could on a spill of national significance as in the EXXON VALDEZ. I think we ended up having four centers. We had four primary centers. One center was basically the mother ship, where the Federal On-Scene Coordinator was, and he sent three other representatives to the other centers to run those and brief him out on a regular basis. But certainly, in a geographic issue, we will have sub-units as far as responding, but they'll report back to the mother ship or the main response organization.

Gainsford： One final question, if I may. Is there any transfer of funds from federal to state to do the contingency planning prior to an event?

Bennis： Under OPA-90, we have funds available for OPA-90 preparedness exercises, and each regional response team, each region, is funded a certain amount for the prep exercises, area contingency plan, planning, production, and that money comes from the Oil Spill Liability Trust Fund. It's not tax dollars, it's Trust Fund dollars.

Suzuki： The U.S. compensation system only applies domestically, in the United States, I believe. As to authority given to the Federal On-Scene Coordinator, you mentioned that he is endowed with very broad authority and power given, but when it comes to costs incurred for this response and for damage compensation, is the Federal On-Scene Coordinator in a position to decide on these matters as well?

Bennis： As the final authority with regard to the level of response, the amount of money expended on the response ─ if I understand your question properly. I would say the answer is yes. We have incidents that, when the response is over, the responsible party will come back and say, "It appears that more was spent than I anticipated would be spent," and they may question certain areas of expenditure ─ as was mentioned earlier, there was a question on the causeway. The FOSC would be the individual who would come back and he would say, "We spent the money on this causeway because ...," or he would say, "That's a good point." We are flexible. As an example, we have had incidents in the U.S. where we have required the use of a United States Coast Guard helicopter, and afterwards somebody said it would have been much cheaper to use a private helicopter. We're negotiable on that. We will then fund a certain portion of that out of the Fund.

I will say this, as an interesting note that I didn't bring up: Under the Oil Pollution Act of 1990, if we identify a spiller, a responsible party, and he refuses to accept responsibility or denies responsibility and we use our Fund to conduct that cleanup, under the law, if subsequent to the cleanup we determine that that responsible party was in fact the spiller, we can recover the cost of cleanup from that spiller times three. So there is a certain incentive there for a spiller, if they know they're the spiller, to step right up to the plate and accept responsibility and fund the response ─ because if they don't, and they know they're the responsible party, it will cost them three times the response.

Session 4

EXXON VALDEZ Oil Spill : Application to Today

Richard R. Lessard

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Education MS and PhD Chemical Engineering, the University of Marine / Member of the Executive Committee of ASTM F-20 / Chairman of the Marine Preservation Association / Heads of the American Petroleum Institute's Marine Research Work Group coordinating oil spill research in US.

Involved in the clean-up of the 1989 EXXON VALDEZ spill as coordinator of laboratory studies to develop new techniques for cleaning the beaches, such as by bioremediation and chemical washing.

Introduction

The EXXON VALDEZ oil spill in 1989 had many significant and far-reaching effects, both on the shorelines of Prince William Sound, Alaska and subsequently on the entire U.S. structure for combating oil spills. It also led to a number of successful new programs within Exxon and industry aimed at reducing incidents, minimizing spillage of oil worldwide, and improving the capability to respond in the event of a spill. The VALDEZ was the largest marine oil spill in U.S. history. Exxon's response effort is widely acknowledged as the largest peacetime industrial mobilization ever in the U.S. and possibly in the world. Exxon spared no expense in committing resources and personnel to cleanup the shorelines affected by the spill. Noted oil spill experts confirm that the area is essentially recovered, in large part because of efforts made during 1989-91.

The VALDEZ spill is the most studied ever. The cleanup involved application of technology not previously applied to large spills. Many of these applications are now the subject of ongoing international research programs aimed at improving the ability to respond. This paper, written by an Exxon scientist who coordinated several technical studies in support of the cleanup, summarizes many of the learnings and advances to come out of the spill experience, with emphasis on how these many apply to today's spills. This paper discusses only the response and cleanup. Exxon also initiated a number of programs to mitigate impacts on people, communities and wildlife affected by the spill.

Summary of the Spill

On March 24, 1989, the EXXON VALDEZ, a 300 m (987 ft), state-of-the-art tanker carrying 1.25 million barrels (196,000 t) of Alaska North Slope (ANS) crude oil went aground on Bligh Reef in Alaska's Prince William Sound. The grounding opened 8 of the vessel's 11 cargo tanks and 3 of the 5 ballast tanks, releasing about 260,000 barrels (41,000 t) of ANS into the water, almost all of it within the first few hours. The site of the spill was very remote, far from major population centers and only a accessible by boat and aircraft. Consistent with the area oil spill contingency plan, the initial response was carried out by Alyeska Pipeline Service Company (operator of the marine terminal at Valdez) and by the U.S. Coast Guard. Exxon has very limited operations in Alaska. However, company personnel began arriving from its main center of operations in the Gulf Coast of Texas, some 5,000 km away, on the first day of the spill. Exxon acknowledged responsibility for the spill, expressed its regrets, and committed to cleanup the spill. After a short transition period, Exxon took over management of all response operations working under the direction of the U.S. Coast Guard Federal On-Scene Coordinator (FOSC).

Though this spill still remains the largest in U.S. history, the amount spilled ranks relatively low on the list of alltime worldwide spills - number 53 according to the latest data summary issued by Cutter Information Corp. (3). What made the VALDEZ spill noteworthy and led to such a massive response effort was the extent of shoreline impact (over 2,000 km), and the environmentally-sensitive area in which it occurred.

Exxon personnel arriving on the scene had 4 priorities (8). The highest and most immediate priority was to off-load 1 million barrels (about 160,000 t) of crude which remained on the VALDEZ - about 80% of the original cargo. Though the vessel was precariously balanced on Bligh Reef, Exxon experts worked closely with Coast Guard personnel to successfully transfer all the cargo to other tankers. This was later viewed as a major achievement, particularly because it was achieved over an 11 day period without injury of further loss of cargo despite 5 m tides and a major storm.

The next priority was identification and protection of sensitive environmental areas. All parties involved, including fishermen, developed a priority listing of valuable resources. At the top of the list were salmon hatcheries. The early boom deployment focused on the hatcheries and important salmon streams and the oil was kept out of those areas. This probably contributed to record salmon catches recorded in the years immediately following the spill. This was another very positive achievement.

The third priority was on removal of oil from the water. For this priority there were several disappointments, as summarized in the following section. Overall, only about 60,000 barrels (9,400 t) of emulsion containing about 25% oil content were collected by mechanical skimmers.

The fourth priority was the removal of oil from the shorelines.

On-Water Response During Day 1-3

Spill response experts agree that spills which have had obvious and significant biological impacts have always involved nearshore or intertidal accumulations of oil (10). A successful response is one that prevents or minimizes oil from reaching sensitive areas, preferably by removing it from the water but failing that, by dispersing it into deep water where its impact will be less damaging.

The most critical time period during an oil spill response is early in the spill while the oil is still on the water. During that early period, oil is in its most confined and thickest state. All response options, be they mechanical, dispersion, or burning, have highest efficiency and effectiveness when applied as soon as possible once the spill has occurred. In the case of the VALDEZ, a number of factors impeded the use of the response options specified in the area contingency plan. First, mechanical equipment was for the most part unavailable in the first few days because the barge used for storage and transport of this equipment was under repair. Second, for a spill as large as the VALDEZ, air application of dispersants is practical and desirable, In fact, Alaska was one of the few states in the U.S. during 1989 to have defined areas where dispersants were pre-authorized for use. However, pre-authorization still required specific approval by the FOSC prior to use. Unfortunately, a key window of opportunity for dispersants was missed because the on-scene Coast Guard Commander decided to implement effectiveness trials to demonstrate conclusively to state agencies and to private interest groups, such as fishermen that dispersants would work in this situation. It took 2 days to satisfy all parties that dispersants were indeed effective for this spill but by then a major storm arose, whipping the oil into mousse emulsion and distributing it over a large area of Prince William Sound. The delay caused by testing demands meant that the main response weapon, the only practical one available, was not allowed to be used during the most critical part of the spill. An excellent opportunity was lost and the result was widespread oiling of shorelines in Prince William Sound and in the Gulf of Alaska.

Ironically, at about the same time a special committee, set up by the U.S. National Research Council to review dispersants, issued its final report following several years of study. It concluded that under proper conditions, dispersant use can result in a net benefit to the environment and recommended that dispersants should be considered as a potential first response option to oil spills, along with other response options. Had this report issued earlier, it is possible that the Coast Guard would not have been as hesitant to approve immediate dispersant application. On hearing of the hesitation to approve dispersants for the VALDEZ spill, Dr. James Butler, Head of the NRC Committee on Effectiveness of Oil Spill Dispersants commented that this would have been an excellent opportunity for dispersant use because the added energy provided by the storm would have helped disperse the oil into the water and then tidal currents would have carried it to the open ocean where it would be still further diluted, rendering it much less harmful than the untreated slick (4).

Application to Today : In the U.S.,there has been significant change in attitude toward dispersant application since VALDEZ spill. By the end of 1997, it is expected that most of the U.S. coastal states will have pre-authorized zones for dispersants. This means that when certain conditions are met, dispersants can be approved by the on-scene commander, without need to consult with other agencies or with other interested parties, such as fisheries groups. My company is a strong supporter of using all response options available in as timely a manner as possible. But we are particularly supportive of dispersants because we believe that for large spills, dispersants can sometimes be the only practical response option (5). Because they are applied by aircraft, the area that can be covered in a given time can be 10-40 times as much as by a fleet of skimmers, which can be limited by maximum speed requirements and by adverse weather conditions. This is especially true if the spill is many miles offshore. Also, we feel it is not wise to spent excessive time evaluating effectiveness, when it could result in missing the most critical response window of opportunity, as happened in the VALDEZ incident. The U.S. Coast Guard is now more pro-active in recommending dispersants, and for the Gulf of Mexico, it has established a target of applying dispersants within 5-6 hours after the start of a spill.

In addition, recent advances in dispersant formulation make the latest generation of products effective for a wider range of oils, making the need for tests less necessary than in the past. For example, COREXIT 9500 - developed by Exxon as part of a new research effort commissioned after the VALDEZ - can disperse even the heaviest bunker oils as long as they are still fluid enough to spread (6). Moreover, earlier worries about adverse effects of dispersed oil which were based on traditional 48-96 hour tests have been put into better perspective. Many of today's dispersant formulations have much lower toxicity than common products used every day in kitchens around the world. In the marine environment, contact is relatively brief and traditional toxicity tests which keep marine species in contact with test solutions for extended periods do not apply. More relevant tests have been developed which now indicate that toxic effects will be much lower than would have been predicted by the earlier methods - up to 100 times less toxic (7).

Management of the Response Effort

During the initial days of the VALDEZ spill, involvement of numerous parties in the decision process became problematic. In the U.S., the National Contingency Plan established the U.S. Coast Guard as FOSC for marine oil spills; however, the FOSC was not empowered to make unilateral decisions. In the emergency phase, while oil is on the water, decisiveness and speed of decisions are critical to mounting a successful response effort. Input from local towns, states, fishery groups and environmental entities should be obtained long in advance of such an emergency so that all points of view have been weighed in establishing the contingency plan well before any incident. During the crisis, there should be one sole authority who can balance the diverse and often contradictory interests of the many parties involved. Though involvement of all the parties in the post-emergency phase (i.e., shoreline cleaning) may be appropriate, when time is of the essence, as in the oil response phase, a lead agency must always be in command to make the final decision in an expedited manner. In the U.S., this agency is the Coast Guard; in the U.K. it is the Marine Pollution Control Unit, a branch of the U.K. Coast Guard.

Application to Today : In Japan, it is the Maritime Safety Agency (MSA) which is the lead organization However, in Japan over 15 national government agencies cooperate with MSA during a major spill, including the Fisheries Agency which coordinates and negotiates with fishermen unions before dispersants can be used. Such negotiation is proper for nearshore fisheries, and mariculture areas, but when the oil is in deep water offshore, it would be advantageous for Japan to consider adapting the pre-authorization approach used by other countries and delegating clear authority to MSA to approve dispersant use in these zones without the need for time-consuming consultation.

Shoreline Cleaning Innovations

After the oil reached the shorelines in Prince William Sound and the Gulf of Alaska, Exxon, working with government and local groups, committed itself to their cleanup. This cleanup was a mammoth task complicated by geographical and ecological factors. At its peak in 1989, the effort involved over 11,000 people. Nearly 6,000 km of shoreline were surveyed by assessment teams which generated geomorphological, biological, archaeological and oiling information that led to site specific treatment plans (12). Most of the shoreline oiling outside of Prince William Sound was very light, involving scattered mousse and tar balls which could be cleaned by manual techniques (shovels, buckets, and hand-held tools). In Prince William Sound, the oiling was more severe and the heavily oiled shorelines required water washing to dislodge the oil. The consensus of all parties involved (up to 14 organizations) as well as of oil spill consulting experts was that it was imperative to improve bulk oil from the shorelines to minimize its potential for refloating and affecting additional shorelines or wildlife beyond that already impacted. Some of the more aggressive cleanup techniques, such as hot water washing have been criticized by others, but it must be realized that intertidal biota had already been impacted by the oil and all parties involved in the decision to clean the beaches deemed it critical to remove the oil to minimize impact on other wildlife using the Sound.

This was the first spill to utilize the Net Environmental Benefit Assessment (NEBA) concept to help define cleanup extent, methods, and priorities. Net Environmental Benefit is determined by weighing all factors and deciding the course of action with the lowest negative impact on the overall environment. Ultimately, 2,400 km of shoreline were cleaned. The principal cleaning method on the 400 km of moderate to heavily oiled shorelines was to wash the oil from the rocks, using warm or cold water, or both. The oil was flushed into the Sound where it was contained by booms and removed by skimmers for subsequent separation and treatment.

Because of safety considerations, it was agreed that operations would need to end by mid-September because of the onset of winter storms. For this reason, Exxon elected to pursue a number of innovative methods to accelerate the cleaning process. Exxon Corporation has supported an active oil spill response research program for nearly 30 years - the largest commitment in the oil industry. Exxon was able to call on its own experts to provide innovative methods for accelerating the cleanup rate. One technique to achieve this was a workhorse piece of equipment called the maxi-barge. These custom-built barges had a crew of 50, some 10,000 ft of boom, several oil skimmers, fuel and storage tanks, generators, and water heaters. Many were also provided with unique equipment to treat those shorelines not accessible by foot. Called an "omni boom," this is an adaptation of a system normally used for pumping concrete on construction projects. These were ideal for the rugged rocky shorelines commonly found in the Prince William Sound and helped to clean hard-to-reach areas safely.

A second innovative application was bioremediation, pursued in partnership with the U.S. Environmental Protection Agency. The concept, covered separately at this Symposium by Dr. A. Mearns of NOAA, involves stimulation of indigenous oil-degrading microbes through the addition of fertilizers to accelerate the rate of natural degradation of the oil. Exxon spent over 10 million US$ on applications of bioremedation during 1989 through 1991. A highlight of the Exxon program was development of a unique analytical approach to map the degradation rate by tracking the concentration of a non-degradable marker called hopane. In this way, the studies confirmed that addition of nutrient accelerated the removal of hydrocarbon by 3-5 times as compared to reference beaches which were not bioremediated (1). Over 120 km of shoreline were remediated in 1989 with dramatic results. Bioremedation was only used after bulk oil had been removed.

Another advance from the VALDEZ cleanup project was an improved understanding of how natural cleanup proceeds following oiling of shorelines. Natural processes have long been recognized as effective in removing spilled oil from the marine environment. Data collected at 16 monitoring sites in Prince William Sound showed significant continued reductions in shoreline oil content during the winter of 1989-90 after cleaning operations had ceased. On high and moderate nergy beaches, this natural cleaning appeared to be a result of wave action associated with winter storms. However, observations from low-energy areas showed similar removal without benefit of the wave action and this generated high interest in better understanding how oil is released from rock surfaces.

Exxon scientists, working with specialists who had previously studied beach cleaning phenomena, confirmed a mechanism for beach cleaning not previously reported in the literature. Interactions between fine mineral particles, such as clay, and polar components in the oil residue were found to play an important role by facilitating the mobilization and removal of both surface and subsurface oil (9). These interactions formed flocculated aggregates of a solids-stabilized emulsion in which small oil droplets are coated with micro-sized mineral fines and surrounded by sea-water. In this form, the oil no longer sticks to the sediment surfaces so that it can be removed even under low energy conditions. The large specific surface area of the flocculated oil promotes its eventual biodegradation by indigenous microorganisms.

This was a major advance. Subsequent to the VALDEZ cleanup, this mechanism has been confirmed for other spills where oil removal has occurred over time under low energy conditions. At the second International Oil Spill Research and Development Forum in London in 1995, oil spill experts from around the world collectively expressed high interest in this phenomenon and rated the continued improved understanding of the role of oil/fines interactions in shoreline cleaning as a top research priority. Several internationally-funded studies are now underway aimed at better clarifying how the learnings from VALDEZ and other spills can be turned into a pro-active technique for accelerating natural cleaning through addition of fine minerals such as clay.

The final shoreline cleaning advance to come out of the VALDEZ spill was a new chemical cleaner. Realizing that the Alaska North Slope crude on the shorelines was weathering rapidly with time, making removal by water wash more difficult, Exxon's scientific task force undertook the task of developing a low toxicity chemical product which could loosen the viscous oil and render it easier to remove without having to resort to very hot water. The preference was to identify an existing product that would suit this purpose. However, after screening more than 100 different formulas, none was found that met all the criteria established by the authorities: effective, Iow toxicity, non-dispersing. Therefore, Exxon scientists developed a brand new agent in a period of only a few months- the product now marketed as COREXIT 9580. After testing at several shorelines in Alaska, and considerable toxicity evaluation in New Jersey, Exxon was certain that COREXIT 9580 was animportant means of improving the efficiency of washing the beaches without the need for high water temperature. However, government authorities never approved widespread use of COREXIT 9580 in Prince William Sound.

Application to Today: For inaccessible rocky environments, cleaning techniques developed for the Alaska cleanup are a means of efficiently removing bulk oil and thereby protecting species from further contamination.

Use of bioremediation on the VALDEZ spill provided impetus for international interest in this technique for spill cleanup. A large number of follow-on studies in Canada, Norway, France. U.K. and the U.S. have been carried out since, generally confirming the findings in Prince William Sound. It continues to be an attractive option for accelerating oil removal from shoreline environments. However, bioremediation is primarily effective for removing whatever oil remains after removal of the bulk oil, including sub-surface oil. Therefore, its main advantage is rapid improvement of the visual appearance of the beaches.

Secondly, the presence of high concentrations of fine sediment may signal rapid recovery in terms of oil removal. Definition of the size and characteristics of naturally occurring fine sediment in areas of spilled oil may provide a better understanding of how long it will take for beaches to recover. Tests are underway to determine if addition of fine sediment can effectively accelerate natural cleaning. Exxon scientists were recently granted a U.S. patent for this technique.

Chemical beach cleaners can facilitate cleanups of oiled shorelines by improving the efficiency of washing with water. In subsequent spills after the VALDEZ, COREXIT 9580 has more than lived up to the early expectations. It was tested by NOAA on beaches in Puerto Rico and has been used to clean shorelines in Texas and in Canada. The Canadian government's own labs in Ontario have confirmed not only that it is the most effective cleaning agent available, but that it is also the least toxic to rainbow trout - the Canadian toxicity test species (2). This product, developed during but not used in the Alaska cleanup is now the only beach cleaner which is allowed to be used in Canada. COREXIT 9580 has also been shown to be non-toxic to vegetation. Tests by professors at the University of Miami and at Louisiana State University have shown that it is one of few options for cleaning oiled mangroves and marsh grass (13) (11). It is particularly helpful in spills of heavy oil which are very difficult to clean using water alone.

Summary

The EXXON VALDEZ spill was an unfortunate accident which happened to an oil company with one of the best marine safety records in the oil industry. It demonstrated that oil spills can happen to anyone, at any time unless constant vigilance is sustained and emphasized. It was a milestone event, not just for Exxon, but for the entire U.S. oil industry. Prevention is clearly the first priority and Exxon has taken a number of specific steps to reduce the risk of oil spills and to strengthen response capabilities. New Exxon systems have since been implemented which have reduced the rate of spillage from an already impressive record. In the U.S., the total number of Exxon oil spills reaching water has dropped 60% since 1990. Between 1990 and 1995, only 250 gallons of oil have been spilled from Exxon vessels, representing less than 0.01 % of the total oil spilled from all U.S. vessels.

The VALDEZ experience also yielded important lessons about management of a crisis as well as several new technical options for dealing with spills. Important summary messages are:

- Timely, effective action - the kind needed in an emergency - cannot be taken by committees. Someone who can weigh the issues, cut through the disagreements and force timely action with overall net environmental benefit in mind must clearly be in charge.

- Response technology must be approved in advance and no option should be ruled out. In many cases, dispersants are an important tool for responding to a large spill, but their use must be cleared in advance so that they can be rapidly applied while their use is most effective.

- Learnings from Exxon's application of techniques for accelerating natural recovery of shorelines have been extensively documented and shared with others. Each of these has been the subject of numerous follow-up studies internationally. Many are still ongoing and Exxon's R&D funding continues to support a number of them.

- Bioremediation and the Chemical cleaner COREXIT 9580 were demonstrated to be safe and effective techniques for certain cleanup objectives.

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Discussion

Nerland: What was the reason the government didn't approve the chemical?

Lessard: There were several reasons. The first one is that it did take us a few months to develop, and it became available too late for use in 1989, so we worked through the winter to demonstrate that it should be considered for 1990. A couple of things happened. We spent up to half a million dollars in some of these demonstrations. In some of the tests where we used the chemical, some of the fine mineral I was talking about, which is glacial silt, was also coming off the rocks, and the agencies misinterpreted that as being dispersed oil. We spent a lot of money during the winter demonstrating that that's exactly what it was, the glacial silt, but they still remained opposed on the basis that they thought it was not going to separate the oil the way they wanted.

So the final judgment came-it was a close call, but Admiral Cingaglini made his decision in March of 1990 and I think it was under considerable pressure from the state people who were concerned about whether or not we were putting some of the oil back into the water. So we didn't get approval. But the other factor is that by the summer of 1990, the winter storms had done such an effective job that really we were at a different stage of the cleanup, and most of the bulk oil had already been removed from the shoreline, so it became less of an urgency for us to use the cleaner. The main advantage of that cleaner is we wouldn't have had to go up to 140 degrees F water, which is what we were having to do. We could have stayed with 100 degrees (that's like 60 versus 40 degrees C) in terms of the temperatures that we were using. Cold water would have been effective with the cleaner. Without chemical, we would have had to use the hotter water. So there are a number of considerations that came into play for why we didn't get to use it.

Motora: As for the application of the dispersants, you mentioned that there is a system for preauthorization, which covers most of the coastlines in the United States. We are very surprised to learn this, and I think that it is full of suggestions for us. But I think there are many interests involved-the economies of various regions, fishing communities, protection of the environment-and there would probably be conflicts of interest among them. But I wonder, is it that easy to come to this conclusion that preauthorization could be made, because of this conflict of interest. What is the process and procedure taken in coming to this conclusion?

Lessard: It's a matter of bringing all the interested parties-all the parties that have a concern in the situation-together to weigh the options. I think it's important to realize that no matter what we do, there is going to be environmental impact. Something is affected when you have an oil spill. Dispersants are an option which offer an alternative to the oil coming ashore if you can't remove it. I think there has been enough demonstration that you can use dispersant safely in very deep water with minimal effect on fish, because fish have an ability to sense the presence of oil and, as we stated this morning, will probably avoid those areas. You have to bring all the parties together, as was done in the United States-we did it region-by-region-have symposiums, bring the experts in to talk about it, weigh all the factors, and then afterwards, bring in all of the parties who have a decision and debate the issues and make those judgments about what it is that is your highest priority. If your highest priority is fisheries, then you decide one way. If your priority is mariculture in the intertidal zones, you may decide another way. Everybody is going to have a different set of priorities. It's a matter of weighing all of these issues and then making what you feel is the best judgment for yourselves. But we work that region-by-region in the United States and it is very successful.

Most of the states have acknowledged that dispersant is an important tool. That doesn't mean that they are always going to use it. It just means it is in the arsenal, and if the conditions are right, they at least have the option of considering it. If you don't plan for its use before the spill, there is absolutely no practical way you'll be able to use it during the spill response.

Nerland: To be able to use dispersants fast and effectively, you need quite a stock. Do you have that much dispersant stocked up and ready to be used within hours?

Lessard: In the U.S., we have significant stockpiles. In Texas, my own company has access to 1,200 drums. There are also another three or four hundred stocked in Florida. The question is the logistics. It's really not the availability of the dispersants that we're working with in the U.S. In the U.S. there are probably about six or seven thousand drums altogether. It's a question of how you get them to where you need them. That takes preplanning. And that's where we're at right now in working with the MSRC and others is deciding the logistics for how you bring it to where you need it, where you get the application aircraft-the military in the U.S. has offered its C-130 airplanes to be available if the private resources aren't available. Those are the kinds of steps that have to go on, but before you can do that, you have to have encouragement that people are going to approve their use. When MSRC was set up, the conditions in the U.S. were such that there wasn't a lot of encouragement that if we stockpiled dispersants everywhere that they would be used. So the people who were paying the bills were somewhat hesitant to invest that much without some assurance that there would be proper consideration and approval for certain emergencies. That exists now, and so MSRC's focus is on looking at the logistics of how you bring all of these dispersants to where you need them. But as far as stockpiles, my company has available worldwide over 12,000 drums. We've done an inventory, we know where they're stored, we know exactly how we're going to bring them from Texas to where they're needed, not just in the U.S. but worldwide. We have a strategic plan in place, and we know that the local stockpiles are going to be fine for the first few days and after that you need some more advanced dispersants, because as the oil weathers and gets more viscous, you have to go to a different product. That's the product we would be shipping for availability on day three, four or five. But there's a lot of that planning that has to go on.

Nerland: For how long can you keep those 1,200 drums in stock? Doesn't it have an expiring date, like milk?

Lessard: No, thank goodness it doesn't. The people in the U.K. have actually opened some of these drums and tested them after five or seven years. We've done some tests on our own products after ten or fifteen years. They still have their efficacy as long as they haven't been opened. When you open the vessel and you introduce moisture, air, organisms, then there's some possibility for degradation. But as long as they stay sealed, they keep their effectiveness 20 years, probably.

Marine Pollution Control in the United Kingdom

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A. Role of MPCU and aerial dispersants as the prime means for the UK counter pollution

1.0 Introduction

1.1 The National Contingency Plan, developed by the United Kingdom Government in consultation with all interested parties, sets out the arrangements for dealing with pollution arising from spillages of oil or other hazardous substances from ships into the marine environment. The central objective of all counter pollution activities is to minimise the threat from pollution to the UK coast or UK interests.

2.0 Summary of Responsibilities

2.1 HM Government accepts the responsibility for dealing with major spillages of oil and other hazardous substances at sea from ships which threaten UK interests.

2.2 The Department of Transport's Coastguard Agency exercises HM Government's responsibilities through its dedicated unit - the MPCU. This Unit is the competent national authority as required by the Oil Pollution Preparedness, Response and Co-operation Convention 1990.

2.3 Shoreline Local Authorities in England, Scotland and Wales and the Department of Environment (Northern lreland) have accepted non-statutory responsibility for dealing with pollution of the shoreline. This situation is under review and consultation.

2.4 Ports and Harbour Authorities have accepted the responsibility for dealing with pollution within port and harbour limits.

2.5 HM Government accepts that shoreline local authorities and port and harbour authorities may need assistance with a major incident causing exceptional pollution. In such circumstances, the MPCU will not only direct offshore operations but will also assist local authorities with co-ordinating the shoreline cleanup response and equipment to ensure a fully integrated and co-ordinated response.

2.6 All reports of spillages of oil or other hazardous substances from ships in or near UK waters should be reported to HM Coastguard who maintain a 24 hour a day, 365 days a year, radio watch. HM Coastguard is responsible for alerting the MPCU whose staff are on call 24 hours a day to assess, monitor and respond to any incident.

3.0 Functions of MPCU

3.1 Oil Spill Response

- Acting as the competent national authority as required by the OPRC Convention 1990 and maintaining the Government's National Contingency Plan for dealing with oil and chemical spills from ships at sea.

- Monitoring and following up reports of oil or other hazardous substances from ships in or near UK waters and directing offshore pollution response operations.

- Procuring and 'maintaining adequate stocks of dispersants and the means of applying it by aerial and ship borne spraying, and equipment for the recovery or transfer of oil at-sea and on the shoreline. (TWO at sea and one ship transfer stockpile of equipment available)

- Maintaining an airborne remote sensing capability with a data link to land and a computer system to aid assessment of the quality, likely movement and characteristics of the oil spills.

3.2 Chemical Incidents

- Maintaining computer-based risk assessment and response models to provide initial advice.

- Maintaining a contracted Chemical Strike Team, and a Chemical Hazards Advisory Group to provide expert advice.

3.3 Pollution Prevention

- Issuing directions or taking direct action under the Secretary of State's statutory powers of intervention to prevent or reduce pollution.

- Maintaining a contracted capability to fly 925 hours of surveillance flights in a year to detect and deter illegal operational discharges from vessels and oil installations.

3.4 Local, Port and Harbour Authorities

- Providing guidance to authorities on local contingency plans and the establishment of Joint Response Centres.

- Provide and maintain 2 shoreline cleanup stockpiles for local authority use.

3.5 Research

- Commissioning approx £ 1 million per year worth of research which will improve the UK's response capability.

3.6 Prosecutions and Compensation

- Submitting evidence to the Treasury or Marine Safety Agency Solicitors for consideration of prosecuting those responsible for illegal discharges.

- Preparing and making claims for compensation from those responsible for illegal discharges.

3.7 International responsibilities

- Under the terms of the Bonn Agreement (UK, France, Belgium, Holland, Germany, Norway, Sweden, Denmark and EEC) giving counter pollution assistance to other 'Bonn States' and reporting any pollution incident which may affect another member state.

- Representing the UK at the plenary and technical working group meetings of the Bonn Agreement.

- Maintaining and developing separate bilateral agreements, eg with France (MANCHEPLAN) and Norway (Norbrit Plan), and participating in exercises. Developing similar arrangements with the Republic of Ireland.

3.8 Training

- Running courses in shoreline cleanup and management techniques.

- Organising one national and 10 local oil pollution exercises per year and 2 chemical training events.

4.0 Broad approach to dealing with oil pollution

4.1 The quantity of oil spilled from a tanker or other ship casualty will depend on a number of variable factors -principally, the relative speed at the moment of collision or grounding, the angle of incidence of impact, strength of hull construction, and whether cargo or bunker tanks are protected by double bottoms or wing tanks. All incidents are different and, depending on the particular combination of these factors the spillage of oil may range from nil to the whole cargo.

4.2 All at-sea cleanup techniques have severe limitations and variables such as weather and oil type can signif-icantly affect the quantity of oil that can be dealt with at sea. The effectiveness of any at-sea counter pollution operations in response to a spillage depends on the distance from shore of the casualty, the type of oil, the wind and tide, and the time taken to deploy resources to the scene.

4.3 The most desirable at-sea cleanup option is to recover the oil from the surface of the sea. This prevents it from stranding on the shoreline, reduces the possibility of damage to biological and other resources in the sea and in the littoral zone and avoids the high cost of removing oily material from the shore. In practice, at-sea recovery is never fully effective.

4.4 Fluid oils spilt at sea spread rapidly to cover very large areas - 1 m3 can cover l0,000 m^2 at a typical 0.1 mm thickness. Evaporation causes a reduction in total volume depending on the type of oil, but this is accompanied by an increase in viscosity. With some oils water-in-oil emulsions may form which increase the viscosity still further and at the same time increase the volume of oily material fourfold. With other oils natural dispersion willreduce the amount of oil on the sea surface. The rate at which these various processes occur will depend on oil type and weather. The oil remaining on the surface will be driven by wind and tide. Water-in-oil emulsions and the associated increase in viscosity progressively renders the oil untreatable by dispersants and increasingly difficult to recover by mechanical means.

4.5 Whilst there is a wide range of oil recovery systems available, all suffer limitations in the sea conditions prevalent around the UK shoreline and may take days to deploy to the scene of an incident. Government policy therefore, is that the use of dispersants is the only at-sea cleanup system known to be effective in the turbulent seas that surround the UK. However, as explained in a statement made by Ministers in the House of Commons on 28 July 1977, the policy on the use of such dispersants is that generally, where an oil spill is not causing or threatening damage, it is preferable for it to be allowed to evaporate and degrade naturally. Dispersant action will be initiated only where it is likely to be effective and in the judgement of experts, there is a significant threat of damage to birds or marine life on the coast of the UK, or where an offshore operator considers it necessary for safety reasons.

4.6 This opinion was affirmed by Lord Donaldson in his Inquiry into the prevention of pollution from merchant shipping entitled "Safer Ships, Cleaner Seas" presented to Parliament in May 1 994. Paragraph 21.84 states:

"We have concluded, after much discussion and careful consideration of the costs that it is right to retain an aerial spraying capacity for dispersants as the front line of defence for the United Kingdom against pollution by oil."

4.7 Because speed of response is essential (most oils form emulsions which are not amenable to dispersants after 48 hours) the MPCU has developed aerial dispersant spraying as its first line response and has, under contract, dedicated dispersant spraying aircraft with a capacity to treat 14,000 t of oil in 48 hours. These dispersant spraying aircraft are directed and controlled during spraying operations by 2 contracted aircraft equipped with sideways looking radar and infra-red and ultra-violet line scanners.

4.8 Scientific evidence has shown that in most cases the biological impact of an oil spill is temporary and that biological systems will recover in time; the length of the recovery time will vary according to the type of system that has been impacted. The MPCU and other interests concerned, including the Fisheries Departments and the Nature Conservancy Organisations, will consider whether or not the oil is likely to damage fisheries, seabirds, ecologically sensitive areas or amenity beaches. If not, the oil may be left to disperse naturally. Where damage is likely to occur, the prospect of successful treatment to disperse the oil must be balanced against both the environmental consequences of the dispersed oil being distributed throughout the water column rather than remaining on the surface, and the cost of operations.

B. Overview of oil spill response operations in major oil spill incidents such as the SEA EMPRESS in its incipient stage to end of operations. Some lessons learnt.

1.0 SEA EMPRESS Incident (Extract from Chief Executive's Report)

1.1 "The SEA EMPRESS incident was the third largest oil spill in UK waters (after TORREY CANYON, 1967, 119,000 t and BRAER, 1993, 84,000 t) when it spilt over 72,000 t of Forties Crude when she grounded at Milford Haven, UK, on 15 February 1996. It demonstrated the successful implementation of the UK's National Contingency Plan. The resources needed to deal with the oil pollution were quickly mobilised and were available where and when they were needed. They included about 1,100 people. There is no way that an oil spill of this size can be prevented from doing environmental damage, but, given that inevitability, the response struck a balance between an intrusive- and costly - over reaction which might have done as much harm to the environment as the oil itself, and those measures necessary to give the environment a good chance of recovery, to enable the wind, waves and natural processes to play their part in removing the oil, while restoring beaches and fishing grounds as quickly as possible to those whose livelihoods depends on them or who use them for recreation. At no stage during the response operation were we hindered by lack of people or equipment. The Joint Response Centre was set up and operated according to plan. Given that the response to an incident like this can only rely to a certain extent on contingency planning - in the event most of the structures have to be set up ad hoc - I believe the overall response to the SEA EMPRESS will be judged to have been successful."

1.2 Some lessons learnt

- Good contingency planning prior to the event encompassing liaison, planning, training and exercising paid off but a major event like SEA EMPRESS requires imaginative expansion of the basic plan.

- The use of 446 t of aerial sprayed dispersant reduced the amount of oil arriving on the beach by a factor of ten .

- At Sea recovery could take place alongside spraying operations but were very much costlier and less effective. Fishing boats with booms were used to collect and bring the oil from the shallower waters to the oil recovery vessels in deeper water

- During aerial spraying operations it was most important to have a vessel in the area checking on the efficiency of the dispersant spraying by taking samples at differing water depths. Often the aircrew thought the spraying was becoming ineffective when it was taking time for the dispersant to function. Close liaison is essential between the responders and the Government Agency which provides approval for spraying operations ie Ministry of Agriculture, Fisheries and Food.

- There must be 2 separate response centres one for marine and the other for shoreline as the large number of people involved makes it impractical to combine both. This requires close and regular communication between the 2 centres.

- Never underestimate the insatiable appetite for information and interviews from the media around the clock. This detracted on the concentration of those dealing with the incident. A senior, if not the most senior manager, needs to regularly respond on behalf of the responders and co-ordinate with central government and host VIP visits.

- Grossly undermanned for a long term full blown incident. Plans must be made to ensure that everyone gets at least 8 hours off every 24. This must be a Health and Safety requirement to ensure people don't endanger themselves and that dangerous management decisions are not taken. MPCU manning needs to be able to expand rapidly in a major incident.

- Verbal reports from the surveillance aircraft on the size, amount and extent of the oil spill were time consuming and inaccurate. Some form of data link from aircraft to ground station is essential (now incorporated in MPCU's contracted aircraft).

C. Legal problems associated with;

Response to oil spill incidents in open waters caused by foreign flag vessels.

Response to oil spill incidents within your territorial waters caused by foreign flag vessels.

1.1 The UK has recently established a 200 mile pollution zone around UK or to the median line with adjacent countries. Outside this area UK would have little interest other than to offer assistance in accordance with any International Agreements. Inside this area UK has sweeping powers to deal effectively with oil spill incidents and could intervene to prevent or minimise oil pollution and in the case of foreign flag vessels would inform the flag state through the Foreign and Commonwealth Office.

D. Co-operation between the Coastguard and local government in terms of commands and communications.

1.1 The concept of the Joint Response Centre was introduced wherein Central Government, represented by the Marine Pollution Control Unit, and Local Government would integrate their response to oil pollution of the coastline. The responsibility for clearing on-shore pollution not dealt with by MPCU at-sea resources rests with the local authorities. If Local Authorities can cope with an incident using mainly their own resources, MPCU scientific/technical advice will again be available free of charge and MPCU staff will, if required, be deployed to local control centres as appropriate items of MPCU specialised shoreline cleanup equipment will be made available on a repayment basis.

1.2 However, if a shipping casualty-related spill is of a size such that Local Authority resources, even supplemented as described above, are clearly insufficient to cope with the situation, then the MPCU will, at the request of the Local Authority, consider whether the establishment of a JRC is necessary to co-ordinate and lead the on-shore response. When a JRC is established the MPCU will bear the cost of resources it makes available from its own stockpile together with other resources it decides are necessary and which Local Authorities cannot reasonably be expected to provide. Local Authorities will continue to bear the cost of any resources they make available .

1.3 The role of the JRC is to co-ordinate and lead the on-shore response. In order to achieve this it must:

(a) Determine the extent of the problem along the affected coastline.

(b) Agree a strategy and assign priorities for cleanup action.

(c) Initiate response actions or agree local proposals (with a view to minimising environmental damage and the amount of oily waste arising from such actions).

(d) Obtain and allocate resources on an agreed priority basis

(e) Determine methods for disposal of oily wastes arising from the cleanup operations.

(f) Monitor progress of the cleanup operation.

(g) Issue regular briefings to the press, elected members, and Government Ministers.

1.4 It is essential that participating parties in the JRC act within groups defined by their function rather than separate individual organisations. Experience has shown that the establishment of functional groups, with defined responsibilities, will enable participating organisations to coalesce rapidly within a JRC and perform effectively. The main functional groups are the Management.

Technical and Procurement Teams and these are supported by the Press Team, Environment Group and the Finance Group.

E. Cleanup operation in a rough sea; Operations policy, strategy and equipment employed

1.1 Mechanical recovery operations at sea above wind force 6 are ineffective and potentially dangerous to personnel working on deck. Aerial spraying operations can continue further but a decision needs to be taken on whether the oil droplets are being blown away and not making a good contact with oil. The point is if the conditions are really rough then nature is carrying out the dispersant operation for you and no further means of assistance is needed from man. The BRAER incident in 1993 is an example where there were storm force winds for much of the time so no at sea operation was mounted, except aerial spraying was tried right at the beginning but was terminated due to weather, and no oil landed on the beach as it was dispersed naturally in the water column.

1.2 It is not considered cost effective for UK to make a heavy investment in larger vessels because of its long coastline and poor weather conditions. It is estimated that mechanical recovery is not feasible for over 70% of the year. There is always a limitation with mechanical recovery of oil going under a boom at more than 3/4 kt and over the top above force 5.

1.3 There will always be a major problem with heavier fuel oils which are not amenable to dispersants but new dispersants are being produced which claim to be more effective on heavier viscous oils and UK is conducting trials this September in the North Sea to check their veracity.

Discussion

Toenshoff: Mr. Gainsford, you have a very sizable amount of spill response equipment in your inventory. I was wondering, how are your steady state operations funded for capital as well as operating expenses? Are they funded by government or by industry?

Gainsford: Well, obviously, oil spill response is a joint effort between central government,local government and industry. Central government does provide a certain amount and has funded those stockpiles, which are by no means totally comprehensive. So in a major oil spill incident like SEA EMPRESS, we rely heavily on contractors, who work our equipment, and also on the oil industry to provide backup in manpower, particularly beach masters, and also in other equipment. We have about 1,200 t of dispersant, which is quite sizable, and that's backed up by about 300 t of industry's dispersant. So it is a joint effort and always will be.

Toenshoff: With only 13 people, what is the source of your response personnel and do they have any special training requirements in the U.K.?

Gainsford: We've always kept the main team very small. In that 13, there are three scientists, three mariners, 6 Administrators and myself. And we centralize so that we are available to go anywhere around the coastline, although H.M. Coast Guard operate the opposite policy of devolving to the coastline and running incidents from the coastline, from their emergency centers there. But we are centralized, and basically we're facilitators and enablers and provide the management and expertise in any incident. We have to go outside for local authorities who provide the shoreline cleanup, industry to provide those resources I've already mentioned, and our own contractors, who work the ships and fly the aircraft, and we provide some training to them.

Toenshoff: In the United States, the responsible party, or the spiller, plays a very significant role in the decision-making process for development of an oil spill contingency plan, and it is ultimately the responsible party that pays for the response operations. How is that different from a spill response in the U.K. using your resources?

Gainsford: Well, outside the States, as I understand it, we all come under the IOPC Fund, so you don't have to prove liability. If there is any spill from a tanker, then we can immediately claim redress through the IOPC Fund, and that amount has been recently increased. But it is a tortuous process and far from simple, as I'm sure my local authority colleague may mention. So it is absolutely critical that you retain totally comprehensive records of all expenditures and what you do, because months later it can be very difficult to actually recover all your costs.

Since the TORREY CANYON in 1967-up to that stage, we expected•the shipowner to clean up his own mess, but after TORREY CANYON, we realized that that was not feasible and that the government would have to take responsibility. So the owners have a role to play, but they will be incorporated in our management system. Dealing with oil rigs is different, because we expect more from the oil company. Their license is let for them to be able to respond, and if they're not able to respond, then we haven't done our job in checking the spill plan before.

Marine Clean-Up Experiences -Local Authority Role in Marine Oil Spill Response

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County Oil Pollution Officer for Pembrokeshire for the management of the clean-up operations, following the SEA EMPRESS Incident. The Joint Response Centre is still in operation, some 14 months after the initial grounding of SEA EMPRESS. Most important issue now is the compilation of the claim for consideration by ITOPF on behalf of the IOPC.

Background

Following the TORREY CANYON incident off the Sicilly Isles in 1967, the U.K. Government recognised that it was not reasonably practical for owners of deep sea tankers, which voyage world-wide, to make contingency arrangements for dealing with oil spills, wherever they may occur. Accordingly, Central Government decided to accept the responsibility for dealing with spillages of oil at sea from shipping casualties which threaten U.K. interests.

At the same time, shoreline Local Authorities at both Country and District level accepted the non-statutory responsibility for both contingency planning and the cleanup of shoreline pollution arising from oil spills.

Local Authorities have no specific statutory duty for cleanup of the shoreline, but have the power to incur expenditure to alleviate the effects of an emergency oil incident. Lord Donaldson's inquiry into the BRAER Incident recommended that Local Authorities (and harbour authorities) should be given a statutory responsibility for cleanup and a duty to produce contingency plans. The Government has agreed to consider this.

Prior to 31 March 1996, the Oil Pollution Response Plan was written and maintained by the Civil Protection Planning Unit of Dyfed County Council on behalf of the County Council and all the maritime District / Borough Councils in West Wales. The Plan detailed the response to be made by the CPPU Duty Officer in notifying the County Oil Pollution Officer and other agencies to respond to an oil pollution incident.

Following Local Government Reorganisation in Wales in April, 1996, the roles of the County and Districts have merged. An officer from the CPPU has been appointed to each new Unitary Authority and he will work closely with the County Oil Pollution Officer to maintain a Local Contingency Plan for the new authority.

The aim of the Local Contingency Plan is to provide a plan for Carmarthenshire, Ceredigion and Pembrokeshire that will assist them to mount an effective response to oil pollution of the coastline. Also, that the contents of the document are consistent with those of the Milford Haven Port Authority, oil companies, and other agencies, and to collate and record information on all available resources pertaining to oil pollution cleanup. It must also, of course, be consistent with the National Contingency Plan.

The Dyfed Oil Pollution Advisory Group (DOPAG) was set up to foster close working relationships amongst the key local organisations. In 1993, the Group produced beach data and cleanup guidelines which involved detailed sessions between key officers of the various organisations within the Group. The exercise helped to concentrate minds on crucial issues such as access routes and appropriate cleanup methods, and provided very useful 1:10,000 annotated maps showing agreed temporary holding locations.

The Group recently held its first meeting following Local Government Reorganisation, under its new name of WWOPAG, the West Wales Oil Pollution Advisory Group. One of its first tasks will be to update the Local Oil Pollution Contingency Plan, following lessons learnt from the SEA EMPRESS.

Training is an essential part of planning to deal with oil spills. The Marine Pollution Control Unit (MPCU) run courses in shoreline cleanup and management techniques, and also arrange demonstrations of oil cleanup equipment on a regular basis. DOPAG have also run training exercises, including major exercises involving the establishment of a Joint Response Centre.

Booming exercises have also been carried out, and provide a good opportunity to identify the real problems associated with these techniques; such as health and safety issues and difficulties with access to booming points. Boom trials are usually carried out in near ideal conditions, and it is important to realise that conditions may well be far from ideal in a real incident.

Preplanning of waste management is essential, not only for final disposal sites and methods of disposal, but also for setting up secure intermediate storage areas. The Beach Data and Cleanup Guidelines associated with our Plan have outlined various sites for immediate temporary holding of oily waste material, whether it be in skips or lined pits. If this arrangement is likely to persist, then liaison with the Environment Agency needs to be undertaken as soon as possible, as licensing arrangements will need to be pursued.

Consideration also needs to be given to the range of waste which is generated from an oil spill, and the best option for dealing with it. From a spill, the solid wastes are oiled sand and shingle, oiled beach materials such as seaweed and jetsam (timber and plastics), and also materials oiled in the cleanup, such as mops, sponges, booms, protective clothing, and pompoms.

SEA EMPRESS

The SEA EMPRESS ran aground in the entrance to Milford Haven on the evening of the 15 February 1996. The Duty Officer of the Civil Protection Planning Unit of Dyfed County Council, who was also the County Oil Pollution Officer responded to the call from HM Coastguard and made his way to the offices of the Milford Haven Port Authority, which was the designated Oil Spill Coordinating Centre (OSCC) under the Local Oil Spill Contingency Plan. At 0230 hrs on 16 February 1996, a JRC was requested and agreed by MPCU. This was set up immediately and the first briefing session of the JRC Groups was held at 0700 hrs. As the ship had come to grief within the jurisdiction of the Milford Haven Port Authority, the coordination of the initial response and the Chairmanship of the Management Team fell to them.

The Marine Team is not officially part of the JRC organisation and are usually located in the nearest Coastguard Centre. Conveniently at Milford Haven, this was adjacent to the Port Authority offices where the JRC was based.

Under the Oil Spill Plan for the Port of Milford Haven, the oil company receiving the ship provides the first level of support to the incident. In this case, the incident escalated to involve not only the Port Plan, but also both the Dyfed and National Oil Spill Contingency Plans.

Texaco established its initial incident response centre within half an hour of the SEA EMPRESS grounding. Initial beach cleaning operations around the Pembroke / Angle peninsular were managed by Texaco on behalf of the JRC. As the main cleanup organisation was established, these operations were fully integrated within the JRC.

The whole issue was further complicated by the fact the Local Authorities in Wales were only 6 weeks away from a complete restructuring. Many people who were vital to the response had other priorities clamouring for their attention.

Indeed, many of the key personnel who responded to the incident retired on the 31 March and this required a carefully organised handover to the newly formed Unitary Authority, Pembrokeshire County Council. Also, the Waste Regulation Authorities, NRA (National Rivers Authority) and H.M.I.P. (Her Majesty's Inspectorate of Pollution) were in the process of reorganising. The new Environment Agency had Waste Management Managers appointed, but their staff were still with the District Councils.

All incidents of this size and complexity offer good opportunities to test arrangements and discover their strengths and weaknesses; SEA EMPRESS was no exception. The first few weeks were extremely stressful with long hours and a myriad demands. It was heartening to discover that the pre-planning was successfully in many areas. The setting up and operation of the JRC worked well. It proved invaluable that individuals thrown together into such a major incident knew each other from previous Dyfed Oil Pollution Advisory Group (DOPAG) meetings and exercises. The Beach Data and Cleanup Guidelines, which gives information on every accessible beach on our coastline and were produced by DOPAG, proved invaluable. The maps from this document were reproduced with a Site Survey Report form and this proved useful. The maps were also photocopied and used to make environmental reports on the condition of beaches.

It is very important that a team dealing with an oil spill moves from emergency status to project mode fairly quickly. In the case of SEA EMPRESS, there was an unusually long delay because of the difficulties associated with Local Government Reorganisation. Procurement was handled by the

Technical Team and constituent organisations, as there was no separate Finance and Procurement Team. The lack of a distinct Finance function meant that financial records early in the incident were inadequate, and this led to difficulties later when attempting to compile information for claim purposes.

In order to facilitate continuity, it was decided to set up a Coordination Group to deal with the day to day cleanup operations while the Management Team dealt with the more strategic issues.

Proper communication links are vital in an incident of this size, and this caused problems initially as we started without a switchboard, with 10 lines taking calls in at random. Maintaining contact with the teams working on numerous beaches is also vital, and this problem was solved with the aid of the local Radio Amateur Emergency Network (RAYNET), who provided 43 licensed Radio Amateurs covering 16 locations and amounting to over 3,000 hours.

Other support services who provided invaluable assistance in the operations were British Red Cross (36 trained first aiders at 14 locations amounting to over 2,000 hours), St Johns Ambulance (9 trained first aiders at 8 locations amounting to over 800 hours), Royal Society for the Prevention of Cruelty to Animals (RSPCA) (50 trained Inspectors supported by approximately 200 volunteers amounting to 4,200 hours, covering from the Gower to St Davids Head), Salvation Army (8 members involved at 8 locations amounting to over 750 hours), and the Womens Royal Voluntary Service (WRVS) (79 members giving 3,400 hours and serving nearly 8,000 meals). We had many offers of help from volunteers, and these were directed to voluntary agencies such as the RSPCA, as they could not be safely used on beach cleanup operations.

Cleaning a beach is rarely straight-forward. Practical issues must be addressed such as the amenity status of the beach, the access to the beach for large items of equipment and the ability to support heavy machinery if required. The environmental impact of cleaning must be assessed with regard to the marine communities in the inter-tidal zone, marine vegetation, sea birds, fish and mammals. In some cases, the strategies recommended by representatives of the different ecological communities conflicted and the environment team had to devise an acceptable compromise.

The immediate task of the cleanup operation was to act quickly to remove as much bulk oil as possible. Final polishing would be left until there was no oil remaining at sea and no evidence of significant refloatation of oil from polluted beaches. Beach cleanup operations from the 24-29 February removed the majority of the bulk oil from accessible sites.

The JRC mounted a major operation that involved at its peak over 900 men on shoreline recovery of oil. These manual resources were supplied by a combination of Local Authority employees (Direct Labour Organisation), Local Contractors, MPCU Contractors, Texaco, OSRL, and NRA.

Beach cleaning equipment was supplied through Standing Conference / Texaco stock, OSRL stock, MPCU stock, NRA stock, Local Authority stock, and local Civil Plant Hire. Also, the Farmers Machinery Ring provided an essential source of agricultural vacuum tankers, without which we could not have achieved the shoreline oil recovery in the Tenby and Saundersfoot Area. During one period of 36 hours, over 3,000 t of liquid was removed from the beaches.

Disposal of oily waste is always a major problem. The SEA EMPRESS incident generated over 20,000 t of liquid waste and over 12,000 t of solid.

Liquid waste recovered at sea was taken by sea to Milford Haven and transferred to the Texaco refinery. Liquid waste recovered from the beaches was transported by road tanker to Texaco, and Gulf refinery. In total, the refineries handled over 22,000 t of liquid waste (95% through Texaco). Rate of liquid recovery would have been significantly inhibited without refinery sites adjacent to the incident.

The solid beach material posed a more difficult problem, not least because in total over 12,000 t have been recovered, consisting of oiled sand, several hundred m3 sorbent booms, plastic bags, oiled personal protection equipment and large quantities of oiled seaweed.

Of this, over 4,000 t have been sent to a landfill site at Merthyr Tydfil about 100 miles away. 120 t were stabilised in asphalt. Over 7,000 t of oiled sand were taken to Texaco for landfarming. This process involves spreading the waste over a controlled land site and allowing bacterial action to convert it into less harmful components.

Temporary storage sites were set up at Preseli Pembrokeshire District Council (PPDC)'s Thornton yard and at the Texaco refinery so that solid waste destined for landfill sites could be consolidated before being transported.

Had this accident occurred away from Milford Haven, and its refineries, a very different picture could have emerged. Large quantities of oily wastes would have been looking for a distant disposal route, at potentially high environmental and financial costs. Next time, the UK may not be as fortunate, unless robust waste disposal plans are in place to cover all likely scenarios.

Once the bulk oil was removed, attention could be given to the method and amount of secondary cleaning required. Priority was given to the main amenity beaches which by early April were sufficiently free of bulk oil to be available for the Easter Holidays.

Effort was then directed to the more challenging beaches, where there were problems with access and with the nature of the beach material.

We were very conscious of the need to keep the locals and tourists as informed as possible of the success of the cleanup operations, and we provided the local Tourist Information Centres with regular Beach Reports. We were very successful in achieving a cleanup of the main amenity beaches by the Easter Weekend, and the number of visitors over that period was high, although what proportion of visitors came out of curiosity is not known. However, the general reaction at that time to the cleanup was very complimentary.

We also made a point of continually amending the signage on beaches as conditions improved, again to provide as positive an approach as possible to the cleanup, but at the same time ensuring that the Public were aware of any potential problems.

The transition from the Emergency Phase to the Project Phase, as has already been described, coincided with Pembrokeshire County Council officers taking over responsibility for the management of the JRC. The Media, Support and Marine Groups had been disbanded, and we began to concentrate our attention on the problem of secondary cleaning. The Technical / Environmental Teams spent much time deliberating over the strategy to follow on individual beaches and areas of beaches. Also, written method statements, and where possible, detailed costings were prepared for ITOPF, the Insurance Fund Technical Assessors, who were beginning to take a very keen interest in the reasonableness of our proposals.

After Easter (Week 7), it was also recognised that manpower levels needed to be increased to tackle the numerous projects identified, in preparation for the main holiday season.

Many non-amenity beaches and coves on the open coast have been left to self-clean naturally, although in some cases the bulk oil was removed where there was a real threat of recontamination of adjacent beaches. Areas on some beaches were also left untreated as an experiment, to determine the natural weathering and degradation of the stranded oil in comparison with treated areas.

The majority of the cleanup involved the removal of the water-in-oil crude emulsion. However, about 360 t of heavy fuel oil was also spilled, and this has far greater capacity to contaminate beaches, and so had a large impact on the cleanup. Heavy fuel oil is a refined oil product consisting of the heavy fractions only. It is more viscous than crude oil, and neither disperses nor forms an emulsion readily; is persistent in the environment, and is much more resistant to natural degradation and active cleanup than Forties crude oil. As the temperatures increased, the heavy fuel oil often formed thin hard inert layers ('pavements') of asphalt, concealing pools of mobile oil.

A major problem encountered on many beaches was the extreme mobility of the beach sediments which resulted in oil being covered and uncovered. Sometimes, more than 2 m of sand would be deposited or removed during one tide. This meant that beaches had to be revisited for cleaning on a number of occasions, and many will probably require future visits. Control marks have been established on most beaches to enable the movement of sand to be accurately monitored.

The method of secondary cleaning depended mainly on the type of beach substrate and usually followed standard techniques, but in a number of cases, special or newly developed or experimental techniques were used.

Rocky Shore

If possible, rocky areas of coastline were left for the oil to degrade naturally as marine communities can be damaged with any type of cleaning such as dispersants or high pressure water washing. There were frequent access problems to many beaches. Where oily sand had adhered to a rocky surface, it was removed manually by brushing, scrubbing and wiping with rags. High pressure washing was also used and occasionally absorbent material such as pompoms. Although dispersants can harm marine life in the inter-tidal zone, it was agreed with the Environment Team of the JRC that amenity issues should have priority on the important recreational beaches, and dispersants were used to remove weathered oil adhering to rock surfaces.

Boulders

Boulders beaches were cleaned using the same techniques as for rocky shores together with flushing with high volumes of water to release oil trapped between boulders.

Cobbles

This type of beach introduced two main problems: oil can penetrate much deeper into the substrate so making it very difficult to clean; and the physical surface makes vehicle mobility more difficult.

Oil was usually removed using brushing and scrapping with degreaser. 2 special techniques were used, Pit washing and Surf washing.

Pit Washing

Pit washing was used here for the first time to clean cobbles. Large pits were dug to hold between 50 and 100 t of material and lined with a heavy duty plastic liner, in fact, 2 liners were used with a sand layer between to reduce the risk of puncture. Cobbles were added and washed under high pressure with water and degreaser (De-solvit). Oil was then skimmed off the surface and cleaned cobbles returned to the beach.

In some cases, skips were also buried and used as the pit (e.g. Telpyn, Glen Beach).

Berm Relocation and Surf Washing (AEA Technology)

To be covered by Dr. Tim Lunel.

Shingle

Shingle poses the same problems of oil penetration and vehicle mobility as cobbles. Normally the oil was scooped off mechanically; on beaches with difficult access oil was recovered manually using hand tools, then shovelled into bags.

4 special techniques were used, Surf washing as for cobbles, Stone washing, Tractor harrowing and Bioremediation.

The stone washing technique mimics that used to polish gemstones. On several beaches a washing station was set up in which oily material is added to a lorry-mounted cement mixer together with sea water, and degreaser. The abrasion of the cobbles against each other loosens the oil and the assembly is left to separate. The main advantage of using cement mixers is that the oily run-off water can be contained in watertight skips and the oil recovered from the surface using skimmers. The washing rates are in the region of 6 t per hour.

The Tractor harrowing technique uses agricultural tractors to dig deep into the beach material, thereby releasing oil into the surf zone where it is dispersed naturally. Care had to be taken with this method to avoid releasing too much oil and so causing ecological problems and reoiling. Where used, this technique was carried out after close consultation with the Environment Group.

Bioremediation

To be covered by Dr. Tim Lunel.

Sand

As with cobbles and shingle, soft sandy beaches can bring problems with vehicle mobility and with increased penetration of oil into the beach. This in turn can lead to larger quantities of beach material being removed to clear the oil. It was important to monitor how much sand was removed from certain sensitive beaches to minimise erosion. The mobile oil was scraped off and flushed into trenches.

The oily sand was removed by shovelling and subsequently disposed of. The oil remaining after cleaning dry sand beaches forms nodules or tar-balls of oils sand up to 50 mm diameter which had to be recovered manually. Tractor harrowing was also used.

Mud

Many techniques which are effective on other beach surfaces may do more harm environmentally than good if applied to mudflats. Physical removal of the oil may cause severe damage to the substrate and vegetation and application of dispersants may cause the oil to penetrate deeper into the substrate and harm animal and plant life. Where possible, it may be preferable to leave the oil to disperse naturally. There are also problems with this type of substrate with respect to the load bearing capacity and its ability to support vehicles as the terrain will also vary considerably with the tide. If cleaning was considered necessary the oil was removed by low pressure flushing. As this type of shoreline is usually wet on the surface, water flushing floats off the oil into a collection area. It is important to use only low pressure water to avoid pushing oil into the substrate

Inaccessible beaches and coves

Many of the beaches and coves where operations were carried out were very inaccessible and could only be accessed with difficulty. Some sites were only accessible by sea, or with the aid of a crane to provide access for labour and plant and also for the removal of materials.

Winding Down of Operations

Operations were wound down prior to Winter, and the JRC was relocated to a portakabin in Pembroke Dock. This is particularly convenient, as the Finance Section is also located there, and this assists in the preparation and validation of our claim, which is still on-going.

Regular monitoring of affected beaches continued over the Winter period with hit squads being deployed to react to any problem which arose. It was hoped that the high energy generated during the Winter storms would assist in breaking up and dispersing naturally any remaining oil contamination still present.

We have just completed a detailed survey of all beaches and other sites that were treated as part of the shoreline cleanup. The results of this survey have enabled us to assess the degree of natural cleanup achieved over the Winter period, and also to identify areas where problems still exist. The information will enable us to identify and plan operations still required prior to the main tourist season.

Lessons Learnt

A wash-up exercise was held in late September 1996, to review the operation of the JRC. This proved to be a very constructive exercise, with the individual teams within the JRC (Management, Technical, Environmental, Media, Support and Marine) meeting separately to discuss their views on the operation, and then reporting back with their findings.

The aim of the wash-up was:

To identify the strengths and weaknesses of the operation of the JRC.

To note the lessons leamt and make recommendations for the future.

To produce a full report on the proceedings

This information will then be used to modify the National Contingency Plan and to revise MPCU's information sheets (Scientific, Technical and Operational Advise (STOp) Notes). It will also be used to modify our own Local Contingency Plan.

Discussion

Suzuki: In your presentation, you mentioned about waste management and waste disposal, which was quite instructive to us. But there is one thing I wanted to know further. I believe you mentioned about the refineries, where the recovered oil had been transported. What was the technique employed to finally dispose of such oil at the refineries? Because in Japan, in the NAKHODKA incident, the waste oil were discharged into certain designated areas, where the industrial wastes were treated, and incinerated. So how did you do this at your refineries, in your case?

Lunel: In this particular case, they're actually going to try and reprocess the liquid waste through the refinery itself. There's about 1,000 t of oil, and they're blending it in very slowly with the oil that is already coming into the refinery and they're actually going to reprocess it. The solid waste was taken to a land farm. So this only applies to the liquid waste.

Session 7

Two Cases : The Policy of Contingency Planning /
The Legal Right to Intervene in Oil Spill Incidents

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Abstracts:

Part I of this paper deals with policy, legal and organisational aspects of contingency planning. First, it tries to identify the major expectations that are directed towards contingency planning. Further it presents and discusses the legal and organisational aspects of contingency planning in Norway. The point of departure is the obligation laid down in the Pollution Control Act for anyone operating an enterprise which could cause acute pollution to provide for a contingency system to prevent and limit the effect of the pollution.

Part II of the paper deals with the which extent a coastal state has a right to intervene in case of a maritime accident taking place in open waters or in its territorial waters.

Part I.

Policy, organisational and legal aspects of contingency planning

Introduction

When discussing oil spill combattment and contingency planning, focus is often directed towards the equipment. The efficiency of different technologies' like oil booms, skimmers, chemical dispersants, biological remediesmay be dicussed extensively. However the equipment is only one part of the picture. Policy aspects, the legal framework and in particular the organisational superstructure are parts of the contingency planning that will also have to be addressed in order to make the picture complete. Policy aspects are maybe the most diffuse of the three. This will be dealt with as a separate issue. The legal and organisational aspects are on a superior level interlinked and will be discussed together.

1. Policy aspects

The expectations that are generally directed towards the oil contingency system are many. A country that experiences a major oil spill at its coasts, as by now a large number of countries have unfortunately done, knows how the oil spill quickly becomes of major concern to the entire society. The pictures of oil that has polluted miles of beaches and shoreline, and in particular seabirds that are slowly dying covered with oil, has in many ways become the illustration of the modere society's harm to and imbalance with the nature. A major oil spill will soon be recognised as an environmental disaster. While the impacts are spreading and the cleanup costs are rising, the search for scapegoats is without mercy.

There is usually a strong demand for concrete action to strengthen the oil spill contingency system after a major oil spill incident. There is a considerable willingness to spend money on new equipment in order to demonstrate ability to take action. That may be very well, but the chance of failure already at the next incident is considerable if improvements are not also made within the legal and organisational fields.

In general the expectations to the contingency system are very high. A general policy aspect in this context will be to pave the ground for more realistic expectations. To this end we have in Norway over the last years considered it important to repeatedly tell the public that if an oil spill occurs close to the shore, then oil will reach the coast. It is not realistic to expect that all the oil may be recovered on the sea, despite the fact that we possess good equipment. Bad weather with heavy winds and high waves are conditions when even the most advanced oil spill systems will have to (capitulate).

At the same time, for those who have the responsibility for building up, maintaining and improving the national contingency systems on a more day to day basis, there is a need for a tool or specific criteria to define and evaluate the efficiency of the contingency system. In Norway we have developed 4 simple criteria for the purpose of evaluating the efficiency of an oil spill contingency system. Certainly this may be done more sophisticate, but the benefit of having an easy system is that it is easier to communicate and to understand.

The 4 criteria that we use are:

- time for response
- treatment capacity
- professional skill
- endurance

Time for response is the time it takes from the warning of an oil spill is received till the organisation is ready to start the recovery of oil or other mitigating measures. This is for instance for oil drilling operations in general defined as within 24 hours. However, in particularly sensitive areas it has been defined as within 1 hour, which in practice means that you will need to have a particular vessel on standby at the oil rig. In order to get the necessary approval for its contingency plan, the company will have to make the presumptive evidence that it is able to fulfil this requirement. Through exercises it may demonstrate whether it does in fact meet them. This criterion may also be applied for the contingency system that is run by the State. For instance you may say that if an oil spill incident occurs in a particular area, the maximum time for response is x hours. The different parts of the coast may have different times for response based on the variation in environmental vulnerability.

Treatment capacity is a measure of how much oil the equipment may deal with per time unit under different environmental conditions. This is a criterion used then for defining the amount of oil that the equipment included in a contingency system may recover by oil booms and skimmers within a certain period of time under given whether conditions. If the equipment in a real situation meets the defined treatment capacity, then the operator meets the expectations to his equipment.

Professional skill is the level of competence and availability of competent personnel to run an oil spill operation. The level of competence may be defined through what kind of particular education and instruction that is undertaken. The availability of competent personnel is how many people with that level of background a company may mobilise in an emergency situation. A requirement for getting approval of a contingency plan may according to this criterion be that a particular number of employees in a company may have to go through a certain educational programme in oil spill combattment.

Endurance is how long the organisation may run an oil spill combattement operation efficiently without a reduction in the treatment capacity and professionality. This criterion is used in order to define how many oil spill recovery systems and teams of crew an operator should have available.

The application of such criteria may meet several needs. In particular they may be used as a basis for a decision on which specific requirements a contingency system shall fulfil. In the context of the policy aspects of contingency planning this is useful for the purpose of bringing the general expectations to the contingency system down to a more realistic level. That should be in the interest of all concerned.

2. Legal and organisational aspects of contingency planning

The legal regulations related to contingency planning is the point of departure for how the contingency system on a superior level is organised. This paper will in the following present the contingency system in Norway, how it is regulated and how the organisational response has been in order to fulfil the legal requirements.

a) The private contingency system

The Norwegian legislation on acute pollution is laid down in the Pollution Control Act of 13 March 1981, Chapter 6. Art. 40 of the Act lay down the general principle that <>. In other words the obligation of having a contingency system is in the outset an obligation laid upon the private sector. The role of the authorities is to <> concerning the private contingency systems. Art. 41 decides that <> and that <>.

The major industry in Norway that in this respect <> is the offshore oil and gas industry. In order to meet the requirements the operating oil and gas industry has established a particular organisation, the Norwegian Clean Seas Association for Operating Companies (NOFO). NOFO possesses 5 depots containing oil spill equipment and connected personnel. Although the obligation to develop and obtain approval for a contingency plan is directed towards the individual company, it is the NOFO organisation that in practice fulfil the obligation. However, a particular field specific contingency system will have to be established on the individual oil field in addition to the NOFO system. This will be a system for dealing with minor oil spills from the rig and be the first frontier system in the event of a larger spill. The land based industry such as oil terminals, tank farms and refineries do all have individual oil contingency systems.

b) The municipal contingency system

According to the Pollution Control Act paragraph 43, the <>. In this sense the municipalities nay may be said to be the cornerstone of the contingency system along the coast. The municipal contingency system shall be able to take care of lesser spills at the coast and within the territorial sea (Norway has a limit of territorial waters at 4 nautical miles). The municipal contingency system is organised through 52 intermunicipal contingency areas, each of them having a particular executive body which as the private industry will need to have an approved Contingency Plan. The forces within the municipal contingency system consists of personnel from the port authority, the police, the fire brigade, technical personnel and so on. The knowledge that these forces possess related to i.e. overview of environmentally sensitive areas, local currents in the sea and wind conditions may be essential in an oil spill combattement operation. The municipal forces will also be the essential in cleaning beaches and shoreline from oil.

c) The State contingency system

<> (Pollution Control Act paragraph 43,2). In other words it is the responsibility of the State to deal with oil spills that are not covered by the private or the municipal contingency systems. This will in practise mean major acute oil spills from ships. In the case of a major spill that may not be taken care of by the municipal contingency system, it will be the State, by the Norwegian Pollution Control Authority that is a subordinated agency under the Ministry of the Environment, that will be in charge of the oil spill operation. The State oil spill system consists of:

- A head office and 2 agencies
- 15 oil depots along the coast
- 5 smaller vessels
- A particular agreement with the Coast Guard which have oil recovery equipment on board several ships
- 1 specially equipped surveillance aircraft
- International agreements on assistance in the case of major oil spills

There is a particular obligation that these 3 levels of contingency systems assists each other upon request (paragraph 47). At the same time the State may on its own initiative take command of the action to combat accident whenever considered necessary (paragraph 46).

The further development of the legal and organisational aspects of contingency planning in Norway will be based on this separation into 3 separate contingency systems. The search for improvements is certainly a continuos process. For instance in recent years the close co-operation between the Navy / Coast Guard and the Norwegian Pollution Control Authority has resulted in an a considerable strengthening of the State contingency system. This will also lead to certain amendments in the legal system, by giving legal power to the Coast Guard with respect to oil spill operations.

The legal and organizational solutions differ from country to country. Nobody may claim to have found the final answer. However, all may agree that the policy, legal and organizational aspects of con- tingency planning are cornerstones in the establishment of a comprehensive national contingency system.

Part Ⅱ.

Legal problems associated with:

a. Response to oil spill incidents in open waters caused by foreign flag vessels

b. Response to oil spill incidents within your territorial waters caused by foreign flag vessels

Introduction

Freedom of navigation is traditionally the general principle laid down in customary international law. However, several major acute oil spill incidents from such as the TORREY CANYON (1967), AMOCO CADIZ, EXXON VALDEZ (1988), BRAER (1993) and now the NAKHODKA incident, emphasised that there must be a limitation to this principle on the basis of the interests of the coastal state. This part of the paper will focus upon those limitations related to oil spill incidents caused by foreign flag vessels.

a. Open waters

The term <> is understood as the sea area beyond the outer limit of the territorial sea, which will include the High Seas and the Exclusive Economic Zone (EEZ). According to Art. 3 of the UN Convention of the Law of the Sea of 10 December 1982 (UNCLOS) <>. Several coastal states has declared a territorial sea of 12 nautical miles. Norway has an outer limit at 4 nautical miles. In the open waters there is according to UNCLOS Art. 87 no.1 and Art. 58 no.1 freedom of navigation.

However, customary international law on the basis of the principle of necessity in a situation of distress gives a coastal state a right which is superior to the freedom of navigation. This right is in particular expressed through the International Convention relating to Intervention on the High Seas in cases of Oil Pollution Casualties of 29 November 1969. The adoption of the Convention was a direct follow-up of the TORREY CANYON oil spill outside Cornwall in the English Channel in 1967. The Convention has been ratified by at least 59 countries. It entered into force 6 May 1975. The International Maritime Organisation is the secretariat for the Convention.

According to Art. 1 of the Convention the Contracting Parties <>.

The Convention defines its geographical application to the High Seas. However, because the concept of Exclusive Economic Zone was developed after the Convention was adopted, the Convention must be interpreted also to cover the EEZ.

There are several conditions that have to be fulfilled before an intervention may take place:

- maritime casualty; which according to Art.Ⅱ.1 means <>. In general the casualty will have to be considered as severe and difficult to master for the crew.

- danger to their coastline or related interests; a coastal state can only intervene if the accident threatens its own coastline. <> will according to Art. Ⅱ. 4 mean for instance important fisheries, tourist attractions or conservation of wildlife. Probably it will also include offshore installations such as oil rigs.

- expected to result in major harmful consequences; it is not indifferent what kind of consequences the oil spill may have on the coastline or related interests. The consequences will have to be grave. However, probably this evaluation may be undertaken on the basis of a worst case scenario. It can not be justified that the coastal state will have to refrain from intervening because of uncertainty of the real consequences.

- grave and imminent danger.....reasonably be expected; the danger of the harmful consequences must be <> and there must be a clear causal link between the casualty and the expected consequences. In addition to these conditions there is in Art. III an extensive procedure that the coastal state have to follow before any measures is taken. The coastal state shall for instance as the general rule:

- consult with other States affected by the maritime casualty, particularly with the flag State or other States;

- notify without delay the proposed measures to any person and company known to have interests which can reasonably be expected to be affected by those measures.

- consult with an independent expert, chosen from a list maintained by IMO

With regard to the measures to be taken these shall be <<.......proportionate to the damage actual or threatened........>> (Art.IV).

Evaluation

A general conclusion that may be drawn is that there are strong conditions that have to be fulfilled before a coastal state can execute an intervention to a foreign flag vessel in open waters. However, there are no limitations to the efforts the Coastal State may undertake to combat the oil spill at sea. The regulations regarding the possibility of having the costs for an oil spill operation reimbursed and the damage economically compensated, are laid down in several Conventions and their related Protocols, in particular the International Convention on Civil Liability for Oil Pollution Damage of 1969 (CLC) and the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage of 1971 (the Fund Convention). The discussion of whether these Conventions provides sufficient compensation is a consideration that falls outside the scope of this paper.

b. Territorial waters

The term <> is understood as the territorial sea and the internal waters. UNCLOS Art. 2 states that <>. Art. 8 says that <<...waters on the landward side of the baseline of the territorial sea form part of the internal waters of the State>>. This means in other words that the territorial waters are covered by the jurisdiction of the coastal state.

In Norway the relevant regulation is laid down in the Pollution Control Act. Paragraph 7 contains the general principle that << No person may possess, do or initiate anything which may entail risk of pollution unless this is permitted by law.........>>. It continues that<>. If a foreign vessel has a breakdown or is in danger of a breakdown, the point of departure is that it is the person responsible for the ship who shall take the necessary measures to prevent or reduce the pollution. In addition the same person will have a particular obligation to notify Norwegian authorities in accordance with regulations enacted pursuant to the Pollution Control Act.

In this situation the Norwegian authorities will have an advisory and supervisory role. The situation will have to be solved through co-operation with the person responsible for the ship. Paragraph 7,4 says in this connection that <>. However, if the person despite such instructions does not take the necessary measures, the authorities will have the right to intervene in accordance with paragraph 7,4. This paragraph says that <>. Such measures will have to be <>. An overall evalution of the danger of pollution and the possible consequenses will have to be made by the pollution control authority before measures are taken.

Evaluation

The major difference between the provisions of the Pollution Control Act compared to the Convention on Intervention, is the seriousness of the conditions that will have to be fulfilled before the intervention is executed. There are stronger conditions contained the Convention than the Pollution Control Act. A <> is a less stringent term than <> and <>. There will in other words be possible to intervene at an earlier stage or in relation to a smaller incident within territorial waters than in open waters. This is reasonable. Territorial waters are closer to the coast and there will be less time available for evaluating the development of an accident before measures should be taken. At the same time it is a higher probability for the oil to pollute the shore and for damage to occur.

Discussion

Motora: I understand that, in Norway, oil production and / or oil tanker operators may present grave and imminent danger. Therefore, they will have to place a contract with, for example, NOFO. What I wanted to know is whether this kind of contract is also mandatory for foreign tanker operators navigating within your territorial waters.

Schive: It's not an obligation. We don't have this kind of system for the time being in Norway. This may be considered as a weak point because from the governmental point of view and because of the costs related to maintaining a contingency system on the state level, it would have been preferable to have somebody to take care of the costs also when there are no accidents. But in the case of an oil spill or danger of an oil spill from a tanker, it will be the state level of the response contingency system that will respond to the accident.

Mutoh: Among the photographs you showed, you showed an oil boom being effective in currents of 1.5 kt. Is that true? Is it really effective under a 1.5 kt current?

Schive: This is the requirement for the authorities, and certainly the requirement is based on what we consider to be possible. I think this will be presented in more detail by Mr. R φ dal, who is in fact responsible for meeting those requirements.

Mearns: How is the word “pollution” defined in Norway, or is there an agreed definition? Does the presence of a material in the ocean constitute pollution, or is there a higher level definition than that?

Schive: It will be at a higher level, and this is defined in the Pollution Control Act. I cannot by heart say what that definition is, but it is at a higher level than only contamination.

Session 8

Oil Spill Incident Taken Place in Norway

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Since The Norwegian Pollution Control Authority (SFT) was established in 1972 we have had very few really large spills in Norway. None of the magnitude likes the EXXON VALDEZ or the SEA EMPRESS. We had of course the BRAVO blow out in the North Sea in the late seventies, but even that blow out did not create any large impact on the coastline. This incident, however, gave Norway the possibility to build up what is a relatively comprehensive oil spill preparedness system.

The spills that have created most problems have been spills of bunker oil. We have quite heavy traffic of large bulk carriers along the Norwegian coast and many of these ships are of very low standard. In many cases engine trouble results in lost control of the ship and as a result the ship comes adrift and run aground resulting in spillage of large quantities of bunker oil. In most cases such incidents take place during wintertime, in bad weather and close to shore. As a result of that most of the oil will hit the shoreline. And as I am sure you know, bunker oil, is very difficult to handle.

January 12, 1992 the bulkcarrier “ARISAN”, loaded with 140,000 t of ore run aground northwest of Runde on the West Coast of Norway. A total of about 150 t of bunker oil leaked out. Owing to the wrecks position, it was unavoidable that oil reached the shore. Weather conditions were extremely bad, but 8 days after grounding 520 tof oil was successfully unloaded as a result of collaboration between SFT and The Norwegian Maritime Directorate. Runde is one of Norway's most important bird-sanctuaries, more than 200,000 couples are nesting here. There are 221 different species whereof several are threatened with extinction. Altogether 90 t of oil was recovered from land and sea, over 30 km of shore-line were polluted with oil and work with cleaning up involved 4,560 days' work. 3,000 sea birds died, loss of birds was registered over a stretch of 190 km. The discharge occurred before the nesting season had begun and this resulted in relatively low numbers of dead sea birds.

Investigations were carried out in connection with the consequences of the oil discharge. Notes from the shore cleaning operations have provided material of experiences gained, which can be used in later actions, especially those connected with the division of areas according to vulnerability.

The operation period was from January '92 to October '92. Total cost of the operation was about 34.5 million NKr. (5 million USD.)

The potential damage to this area on the West Coast, was of such magnitude that the central authority, in this case SFT, was mobilised.

This means that the government accepts the full responsibility for the planning and the implementation of the planned action for protection of the area and the whole cleanup operation.

According to the Pollution Control Act there are 3 pillars of Norwegian National Contingency.

- Private preparedness
- Municipal preparedness
- Governmental preparedness

The most important contributors to the private preparedness for oil and chemical pollution control are refineries, petrochemical and chemical plants and the offshore petroleum industry. For the latter, SFT has set special standards at 3 levels; Oil combat services at production installations, general preparedness in case of major pollution (blow-outs) and special preparedness for drilling near land. Approximately 26,000 m of booms and 65 oil recovery devices are stored on ships and in depots owned by private companies. In case of pollution from the industry, The Norwegian Pollution Control Authority will monitor and verify that the polluter himself is responding according to the pre-approved contingency plan.

Municipalities shall provide for a preparedness system to combat cases of acute pollution which may occur or may cause damage inside the municipality, and are not covered by the private system. Since the late 1970's the Norwegian coastline has been divided into 51 inter-municipal (two or more municipalities) preparedness areas each with its own contingency plan and combating equipment. More than 70,000 m of booms and about 300 oil recovery devices are available. In the late 1990's a reorganising process will be completed resulting in 35 preparedness areas. This preparedness will cover land and sea. Local fire brigades will play an important role in combating spills whatever type of pollution, while harbour departments will normally be an important factor in oil recovery at sea.

The final and third pillar is the governmental preparedness under the leadership of The Norwegian Pollution Control Authority (SFT). This contingency is put into effect in case of acute pollution where the source of the pollution is unknown or the polluter himself is not capable of responding. The governmental preparedness system is in the latter case responding on behalf of the polluter who afterwards will face the bill. This means in fact the discharge of oil from ships sailing along the coast and for whatever reason runs aground or is involved in a collision. This preparedness system holds more than 40,000 m of booms and approximately 100 oil recovery devices. 6 Norwegian Coast Guard vessels, 4 purpose-built response vessels and one twin turboprop Fairchild Merlin 111B special equipped surveillance aircraft. In addition a databank of ships that can be mobilised is available.

After receiving the message of the grounding of the “ ARISAN ” the local authorities were alarmed and asked to establish a command post in the area. The municipalities were asked to use all available equipment, including government equipment from the nearby depot, in order to protect special vulnerable areas. SFT was in the beginning established at its headquarter in Horten, but at first daylight the necessary staff was moved to the West Coast and established its command post there. Necessary government equipment was mobilised and five hours after first notification 3 recovery systems were in operation. The main task for the recovery systems was to pick up as much oil from the sea as possible and try to prevent the oil from reaching vulnerable areas. This strategy was based on available data of the area, wind and current situation and available resources. The weather condition made it impossible to protect the important island of Runde. Therefore it was decided that 2 other fjords equally important should be prioritised.

National strategy for oil spill combat operations

Oil recovery by the use of mechanical methods is the basic principle of Norwegian preparedness. Chemical methods are regarded as supplementary. Response shall take place as close to the source of the pollution as possible. Since the main goal of any oil combat operation is to limit environmental impacts, biological assessment is the key input to strategic decisions in Norwegian preparedness.

The nations oil pollution preparedness is heavily dependent on vessels of opportunity and personnel not working full-time with environmental issues. The Coast Guard vessels, tugboats, ferries, fishing vessels, supply vessels and coastal tankers are key resources in the National Contingency Plan.

The Norwegian coastline has been pre-mapped with respect to biological sensitivity. Hence, in case of an oil spill is approaching the coastline and the available oil combat resources are insufficient for total protection, priority of different coastline areas is possible on short notice.

One refinery has received pre-approval from SFT to conduct chemical dispersion of oil if certain conditions are fulfilled. Hence, immediate chemical response is possible- a key factor for effective chemical combat. SFT has made special regulations for the use of chemicals in environmental emergency operations.

Emergency offloading:

SFT had been informed that the “ ARISAN ” was carrying 400 t of fuel oil and 30 t of diesels. It was anticipated that about 100-150 t were released when the ship grounded. This information came from the captain who was taken off the ship with his crew at an early stage. This information proved to be wrong. After inspection of the ships tanks, and other information brought forward it was calculated that the ship was carrying close to 700 t of fuel oil. It was therefore vital at this stage to arrange for an emergency offloading of the ship before it started to break up.

Emergency offloading is the responsibility of The Norwegian Maritime Directorate. In circumstances like the above-mentioned incident, representative of the Maritime Directorate will join the SET operation Head Quarter. Equipment for emergency offloading is stored on 3 sites along the coast and can be brought to the effected area by helicopter if necessary.

In the case of the “ ARISAN ” the emergency offloading was a very complicated operation. The ship was aground in an area where other ships could not go alongside. The weather was so rough that you could not get any closer than 100 m. The only solution then was to bring pumps and hoses over by helicopter. The next problem was to get to the bunker tanks. Some tanks could only be reached through the engine room. That was quite a dangerous operation since we were afraid that the ship could start breaking up any time. However, the operation was successful and 520 t of fuel oil was pumped out of the ship. It took 2 days to prepare for the operation. 3 days were spent waiting for better weather conditions and then another 2 days for the pumping operation. A Transrec oil recovery system was used for the operation.

Oil recovery at sea:

The mobilisation of government equipment and personnel started immediately after the notification of the grounding. 2 hours after notification representatives from SFT could inspect the situation from a ship, and 5 hours after notification the first booms could be deployed.

Because of the heavy weather only ocean goings booms were used. 3 separated systems were in operation with 200 m of ocean boom each. After 12 hours 4 systems were in operation. At the time of the grounding it was blowing gale force wind and the waveheigth was approximately 5-6 m. In that kind of weather booms will not be effective at all. SFT has experienced that ocean-going booms can work fairly well in waveheigths up to 3-4 m. However, the boom system must not be towed faster then 1 kt. SFT has also experienced that it some times is necessary to turn the systems around and go with the wind and sea. The recovery of the oil confined in the booms in heavy weather can be difficult. It is important to make sure that booms and skimmers in a system are designed for the same kind of weather, wind and sea. It is also important that the equipment is flexible and easy to handle and maintain and at the same time is robust. As a general rule one can say that if it is possible to confine the oil and keep it inside the boom it should also be possible to recover it. In this operation we were using a rope mop skimmer, The Foxtail, and a Transrec system. Oil concentration by towed booms can be slow and a single skimmer may be sufficient to serve several boom systems. After 4 hours of operation 10 t of oil was recovered, and after 24 hours 27 t. The rest of the oil ended up on the shoreline.

Emulsified oil:

SFT's experience with recovery of emulsified oil is mostly based on real tests in the North Sea where a relatively small amount of crude oil mixed with 40-70% of water into a stable water in oil emulsion have been released. We also have experience real operations like the " ARISAN " incident where we had to deal with heavy bunker oil mixed with 30-40% of water.

Experience show that recovery of high viscous oil makes it necessary to add water into the recovery device to reduce the friction in the discharge hose. We are often operating with hoses of 100 m and even a working pressure of 5-6 kg/c m^2 not enough to pump the oil through.

SFT has learned that the best result is obtained by using a screw pump instead of a centrifugal pump. A screw pump will normally give you a higher pressure and at the same time mix less water into the oil. You will then have an oil with lower viscosity than if you used a centrifugal pump. By using a centrifugal pump you can also create an oil in water emulsion and as a result it takes a long time to settle the oil and emulsion breakers will not have any effect.

In addition SFT has experienced that the use of emulsion breakers are not very effective on heavy oil, but can be used on light product oil and crude oil.

The shoreline operation:

It was obvious from the first day that most of the oil would reach the shore. And a command post with an on scene commander and his staff were established in the area where it was expected that most of the oil would land. The on scene commander was from SFT but the rest of the staff was recruited from the local authorities.

The on scene commander co-ordinated the work along the beaches based on observations from helicopters, boats and local observers. Plans for the cleanup work were made where each affected area was prioritised according to the risk of damage. More than 30 km of shoreline was affected. It is important to conduct a proper shoreline survey before you start the work. Estimating the amount of stranded oil with accuracy is difficult on most types of shorelines because the distribution is seldom uniform. However, even rough estimate of oil quantity is desirable for the purpose of organising the most appropriate shoreline cleanup response and identifying the manpower requirements for the task.

The overall extent of pollution can be assessed visually by first overflying the area. A more detailed evaluation of the oil present on a short representative section of the affected shoreline can be made on foot. This has to be repeated on other sections where the degree of oil coverage may be different or where the character of the shoreline changes. At the same time, the shoreline survey provides a good opportunity for confirming access routes and the feasibility of cleanup.

Priorities for action will need to be decided after consideration of potential conflicts of interest. For example, the use of most effective techniques may be damaging to some environmental sensitive habitats, whilst elsewhere amenity interests may overrule such considerations. This will require a balance judgement on a site by site basis.

The spill from “ARISAN” was not a large spill. A total of about 150 t of oil leaked out. Still the cost of the operation ended on about 5 million US$. The very successful emergency offloading operation of 520 t reduced the cost of the cleanup operation by millions no doubt.

Discussion

Gainsford: My understanding is that now for contingency planning for the oil platforms, you instruct the oil companies to consider dispersants as one of the options that they ought to review in the contingency planning process. Is that correct?

Nerland: It has always been like that, actually. There's nothing new about that.

Gainsford: As I understand it, the emphasis now has changed to actually encouraging companies to stockpile dispersants as part of their contingency planning, particularly for the offshore sites. What I was going to lead on to is that, given that that is the case, do you think it is likely that, say, in the next five to ten years, the state pollution authorities will also consider having dispersant application equipment and dispersants in their stockpile?

Nerland: Yes.When we established our depots in the late 1970s and the early 1980s, we had a stockpile of dispersants, and we had spraying equipment that could be put on ships. But then, of course, we hardly ever used it because, as I mentioned, most of the incidents we had were at with heavy oil. And it's not very effective in heavy oil. So we don't have those stockpiles anymore, because, and also another thing-that's why I asked the question earlier here-we got the information from the manufacturer that the dispersants that we had in those days expired, and after a certain date, you couldn't use it anymore. It has changed now, I understand, but in those days it was like that, and we have never restocked, so to speak. I want to be a bit careful about saying too much about it, but it is a little different view now than it has been. But still, there is a long way before we agree completely change on policy.

Gainsford: In your list of resources, you had six coastal tankers. What are they doing each day if they're not being used during a major incident?

Nerland: Each day, they're going back and forth along the Norwegian coast, carrying oil. I don't know how many coastal tankers we have-there are quite a lot-but we have an agreement with six of them, and they are spread around the coast most of the time, so what we will use them for is, if we have an incident, we need a place to store the recovered oil. That's why we bring them in. And they also have a little bit of equipment on board-a skimmer and booms. So they will be used for storing recovered oil. That's the reason we have an agreement with them.

Gainsford: So they've got to go and off-load their cargo first, and then are ready.

Nerland: If they are fully loaded, yes, then we'll have a problem. But not all of them will be fully loaded. -it's the same thing that we have with our stockpiles around the coast. We have an agreement with ten local people to man the depot when something happens. These are school-teachers, bus drivers, whatever. But we have calculated, and if we can get five of them, we'll be happy. But most of the time, all ten showed up, actually. It's the same thing with the coastal tankers; there will always be one empty. They are not loaded all the time-they are going from the refinery, they are discharging, going back. But of course, you could be very unlucky, and then you could not use them. But at the same time, we also have an agreement with fishing vessels which can carry 1,000 t (1,200 m3 of oil in their tanks, so we can bring them in. That's one option. And we always will have supply vessels that can carry about the same amount. We can bring them in. So as I said, we are depending on the vessels of opportunity, actually.

Davies: I was interested to hear about the technique you mentioned at the end-is it spreading pine bark on the oil? Could you elaborate on that slightly, please?

Nerland: Yes, this is the brown stuff you see. That's the pine bark. We have been using that for many years, actually, not only on the beach-you can see here a beach with boulders and stones- but also on grass. Because it stays there for a while, and then it turns into compost. We have been back in this area after a couple of years, and saw everything is green and nice, and cows are there. But of course, you had better to take away as much as you can of the oil before you do that. But we've been using this for many, many years. And we have stocks of that actually.

Davies: It doesn't refloat?

Nerland: Well, of course it does. But there's not much oil on those stones. So, you take off the rest, then it will refloat eventually, but still it will go away from there. And then when it comes out, the oil will be washed out, so if it drifts back on shore in another place, we have experience that it doesn't really matter.

Lessard: I'm curious about your physical dispersion. At least in my experience, that varies widely with the type of oil that you are dealing with. Obviously in the BRAER, that completely dispersed, but in the VALDEZ, as I mentioned, the Alaskan North Slope Crude was exposed to very violent conditions in the storm, and yet the percentage that was physically dispersed was very low, and it sounds like in the NAKHODKA spill as well that even though the seas were 6 to 8 m, it still managed to coat 800 km of shoreline. So I'm really wondering if you have done some kind of study in Norway that we could benefit from, because this is an issue that's been raised by the Germans as well. We get the same argument in Holland as well that you don t need chemicals because it's going to physically disperse. That seems to vary very much around the world, and I think it's because of the type of crude. But I'd like your experience on that.

Nerland: Well, you're probably right. I'm not an expert on this, but Mr.R ф dal knows more about this than I do, so I think he will mention this tomorrow.

Kudo: I understand that even for those vessels calling on Norwegian ports, it is not madatory to have an advance contract with the contractors, like NOFO. For the shipowners or shipping companies who have met with incidents or accidents, even though they might have large pockets in terms of funding and money, I believe it may take time to actually contract the contractors in Norway to operate. As there may be no time to lose, the Norwegian government would have to make an immediate decision, perhaps on their own account, to do the operation. Is that right? Of course, I understand that they will be posting the bills to the spillers later on. But in the case of foreign vessels, don't you find any troubles with foreign shipowners in terms of contract terms and so forth?

Nerland: It's always a problem to get the money. But, I think Mr. Schive can explain, this is a political thing. As it is now, it is the government that has to respond. Whether that will be changed, I don't know, but as it is now, the government has to respond. If the ship is aground, at least you have the polluter there, and you can always get hold of his insurance company and maybe the owner, you never know. In the case of ARISAN, I don't know how long we spent before we found the owner, but we finally found him. This happened in 1992, and I think the last bill was paid last year. So it takes some time. But maybe Mr. Schive could explain something about that.

Schive: I would like to confirm that it's our policy that the state will immediately enter into action if an oil spill occurs. We found it very important to act immediately and not rely on any different organization to come in and start a debate about how the action should be performed and so on. We'll take action first, and then deal with problems which may arise later. This also will have to do with the kind of picture of traffic that is in Norwegian water. I think our picture of traffic in Norwegian water is quite different from for instance the one that is faced within the United States. It's more diffuse related to what kind of ships are in our waters, compared to the United States, for instance. Thank you.

Session9

Major Oil Spill Response Programme
-Based on precedent of lent equipment-

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Petroleum Association of Japan (PAJ) started the implementation of major oil spill response (OSR) programme in 1991 and has been stockpiling and lending oil removal materials and equipment since. In this international symposium, I would like to give a summary of the association's operations and present situation, introducing examples of the lent equipment for the NAKHODKA incident which occurred at the beginning of this year and the SEA PRINCE incident which occurred 2 years ago.

Since PAJ is participating in the International Symposium on Marine Oil Spill Response from Japan's oil industry's position, first, I would like to introduce the overall trade flow of oil to Japan from the world.

In 1996, there was a little over 280 million t of oil imported to Japan, which is 15% of the total amount of worldwide trade. As a single country, Japan is the second largest importer of oil in the world after USA. 74% of 280 million t, or 210 million t of oil is transferred from the Middle East region (Table 1).

When crude oil imports is broken down by areas and countries, the vast majority is imported from Middle East, followed by Southeast Asia. 81% of the total imports is from the Middle East, lead by UAE, followed by Saudi Arabia, Iran, Qatar, Kuwait, Oman and the Neutral Zone. 11% of the total oil imports comes from Southeast Asia, lead by Indonesia. As for other Asian countries, 5% is imported from China. A small amount is imported from as far as the African countries, such as Nigeria, Gabon and Angola. Japan also imports a small quantity of oil from South America and Australia (Table 2).

As one can see, Japan imports oil from many countries. Next, I would like to look at the distance of oil transportation. The distance between Japan and Southeast Asia, which is the closest, is over 3,000 nautical miles, about 6,000 nautical miles from UAE in the Middle East and approximately 6,600 nautical miles from Mexico in Central America. Approximately 1,270 vessels (VLCC converted) per year are estimated to come to Japan transporting the aforementioned distance. This means that an average of 3.5 vessels come to some ports in Japan every day (Table 3). Based on these figures, one could say that the possibility of a major oil spill occurring in Japan is high.

Petroleum Association of Japan started implementing major oil spill response programme in 1991 triggered by the EXXON VALDEZ incident in Alaska. After the incident which occurred in March 1989, Japan's minister of international trade and industry expressed the intent of Japan's commitment to contribute to the response to oil spills as a part of international cooperation on such occasions as the lEA ministerial meeting and the Paris Summit. It was decided that the PAJ which has the experience of oil spill response would carry out the actual implementation of the operation with the support and subsidies from MITI (Ministry of International Trade and Industry).

At present, there are 5 overseas oil spill response materials and equipment stockpile bases located along the " main oil road ", the tanker route from Middle East to Japan. The 5 bases are: AI-Khafji, Saudi Arabia in the innermost part of the Persian Gulf, then Abu-Dhabi, UAE, across the Indian Ocean to Port Klang, Malaysia facing the Strait of Malacca, Singapore, and Jakarta, Indonesia. Going through the South China Sea and the East China Sea to Japan, there are 6 stockpile bases located in the country. They are from the south; Okinawa, Mizushima, in the Seto Inland Sea, Yokkaichi, Chiba, Niigata on the Japan Sea side and Muroran in Hokkaido. There are a total of 11 bases in-and-outside Japan. (Diagram 1).

Details of the base and available materials and equipment stockpile are mentioned in the pamphlet.

We have stockpile of equipment such as the various kinds of booms, oil skimmers, portable tanks, barges, lighting system. Overseas bases have stockpile of the basic equipment such as inflatable boom, weir-type oil skimmer, beach cleaner and portable tank.

PAJ's concept of oil spill response stockpile and lending is shown in Diagram 2. This reference is used to explain to the countries located along the main oil route from Middle East to Japan about such matters as when the equipment are lent and how they can be lent.

Each of the countries has their state-owned oil companies with their oil spill response centers. The OSR centers have human resources, equipment and mobile system and vessels. They have their oil spill contingency plans and risk management programs. However, when a major incident occurs, there may be a case when these are not adequate. In such a case, as the parties concerned, they are able to borrow PAJ's equipment from the nearby base upon request. Lending of the equipment is free of charge. However, the actual expenses for trans-portation, deployment and clean-up and maintenance required for the use will be borne by the user. At normal times, PAJ will store the materials and equipment in the condition ready to be used at anytime by having maintenance conducted by contractors. It is the concept of PAJ to offer an access to the supplementary equipment when in need. The concerned party signs the contract upon confirming the conditions and terms according to the “Agreement for lending oil spill response equipment”. Agreement is concluded after the borrower submits the “request for lending” to PAJ and receives “approval notice” from PAJ. PAJ will then give instructions to the appropriate base to lend and prepare for the shipment of the requested equipment. It is the general rule for the borrower to come to the base and be responsible for the shipment of the equipment. However, judging from the urgency and convenience of the case, PAJ will make arrangements for the transportation of the equipment on behalf of the borrower upon request to be transported to the place designated by the borrower.

This is the way the system is set up. However, since few people own similar equipment in Japan, it is one of our biggest concerns that few people can operate the equipment when we lend them. In the case of NAKHODKA incident and the previous SEA PRINCE incident, we have experienced the problem of lack of personnel with the ability to operate the equipment. Nurturing human resources is time-consuming and though we recognize the need, the reality is that we are only making a slow progress concerning this matter.

PAJ is, slowly but surely, continuing to conduct exercise and training programs in order to solve the problem.

There are 2 types of exercise programs:

One type is where PAJ base is the core and the PAJ's maintenance contractor independently conducts drills on the assumption of an emergency, or conducts drills jointly with the person in charge of disaster prevention in PAJ member companies, or conducts drills jointly with PAJ Oil Spill Cooperative Organization (POSCO).

The other type is where PAJ conducts a joint drill with organizations other than member companies, such as Maritime Safety Agency (MSA), Maritime Disaster Prevention Center (MDPC) and port and harbor authorities where the overseas equipment bases are located, or where PAJ participates in the drills conducted by these organizations.

PAJ also provides training programs to increase the number of personnel who can operate OSR equipment. It is called “Training Course for Actual Operation of Equipment”, a 2-day training course offered at 6 OSR bases in Japan. The program consists of the following; half-a-day spent on lectures about the mechanism and system of the equipment and one-and-a-half day spent on hands-on training of the operation of the equipment and review of the training course.

Participants of the training course is mainly people from PAJ member companies and oil-transportation-related companies. The number of trainees is limited to about 20 people. We think that this number is appropriate for achieving the goal, which is to have all the participants be able to operate the equipment.

The lecturers of the training program are, at present, members of POSCO oil spill response committee. Instructors of the hands-on training are supervisors of the maintenance work contractors.

Now, I would like to introduce the examples of cases which we have lent OSR equipment.

Table 4 lists the major cases which we lent OSR equipment. First of all, as I mentioned previously, the SEA PRINCE incident which occurred in the summer of 1995 at Yosu, Korea. In this case, we transported 7 containers from Mizushima base in the Seto Inland Sea to Pusan with Kanpu ferry and from Pusan to Yosu with trucks. There was a request to provide personnel with the equipment, but we could neither provide operators nor people who could supervise the operation.

In December 1996, the Dong You incident which was a Chinese freighter going aground off Okushiri Island in Hokkaido occurred. This year in January, the NAKHODKA incident occurred. In April, the OH SUNG No.3 incident occurred at Tsushima. In July, the DIAMOND GRACE incident occurred. Though, it was often, we lent equipment for all the incidents.

I would like to look at the case of the NAKHODKA incident. Table 5 shows what and how much equipment we lent and what the lent ratio was to stocks. Table 6 shows the status quo of the stock for each base in Japan.

As was explained yesterday, the NAKHODKA spill polluted an extremely long coastline. Therefore, there were requests for borrowing OSR equipment from many local governments as well as the owner of the ship.

What can be said when the table is related to reality is that the rate of actual use is not as high as the lent ratio.

It is true that the spilt oil drifted along many km of the coastline. However, a great quantity of equipment was lent because the NAKHODKA incident was a major maritime incident, the first time in 25 years, and the borrowers requested for the equipment as prevention measures. In the future, when orders, instructions and decisions concerning response method are unified, there may not be a need to lend this much of equipment.

Along with the lending of the equipment, for 3 months from January after the occurrence of the incident to end of March, over 400 man-days of equipment supervisors were dispatched upon request from PAJ and 6 bases in Japan, domestic and foreign equipment manufacturers and equipment import agencies to give instructions for operating the equipment. Nonetheless, sufficient supervising was not performed because the polluted coastline was of great distance and there were many drifted-oil recovery points.

Next, I would like to introduce some pictures. This picture shows the bow of NAKHODKA which had drifted to Mikunicho, Fukui Prefecture and the solid boom spread out around the bow to prevent spilt oil from the bow drifting offshore.

The next picture is one of the scenes of the equipment transportation. The equipment was transported from all over Japan. Since transporting from Hokkaido would take too much time, it was decided that Self-Defense Force (SDF)'s C-130 would be used. This picture was taken when the equipment was being loaded at Chitose Airport to be transported to Komatsu Airport.

This picture shows SDF personnel using PAJ's oil skimmer. The place is the coastline in Mikunicho. Here, the water was so shallow that the float of the oil skimmer could not be used. The SDF personnel was the one who worked on the rocky, dangerous places as is shown in this picture. At the bottom of the cliff, which is about 10 m in height, the float of the oil skimmer was removed so that it could be used as a pump to transfer the oil which was recovered in a hopper manually. This picture shows the transfer.

Oil which was recovered from the surface of the sea and coastline was stored as a temporary measure in a large pit made in haste at the pier of Fukui Port. The stored oil had to be transferred to the waste treatment site with a vessel. The pump of the oil skimmer was used to transfer the recovered oil/debris mixture from the pit to a vessel. Since the recovered oil contained a lot of seaweed, ropes and other debris, we made a basket like the one shown in the picture. The transfer to the vessel was made by putting the pump in the basket and dropping the basket inside the pit. However, a great amount of seaweed and other debris would get stuck in the pump. We had to repeatedly disassemble and clean the pump.

This picture shows a provisional storage pit made out of steel plates, which was also filled with oil. Recovered oil was transferred from the pit to a crane barge which was anchored close-by using the pump of an oil skimmer put in a basket. After the pit was emptied, the pit was used to wash the lent material and equipment. FASTANK (portable tank) which was placed near-by was filled with fresh water used to do the final wash-up.

In March, most of the lent materials and equipment was returned and placed at the pier of Fukui Port. As one can see in the picture, all of the materials and equipment is stored in a container. The containers can be loaded on a truck or an aircraft so that they can be transported anywhere. The spacious pier enabled us to spread out the 250m- long inflatable boom and check for any tear or contamination.

On April 20th, the wrecked bow section was lifted out of the sea and transferred to inspection/treatment site. The foreign object was removed from the coast of Mikuni-cho.

The next picture shows the SEA PRINCE incident which occurred in Korea. This was taken in the beginning of August from a helicopter. There was evidence of an explosion in the engine room. Even 2 weeks after the occurrence of the incident when the picture was taken, one could see black streaks of oil on the surface of the sea. In this case, the crew of EARL (East Asia Response Ltd.) was despatched with C-130 from Singapore and oil dispersant was sprayed offshore.

PAJ's materials and equipment was transported from Moji to Pusan, Korea by ferry and loaded onto 2 barges, making 2 units. Each barge or unit consisted of booms and oil skimmers. A small tanker was moored beside the barge and the boom was spread out. The recovery system of operating the oil skimmer and collecting in the tanker was taken.

However, by the time this system reached the incident site, not much oil was offshore, but oil had drifted to the shoal. Therefore, beach cleaners were used instead to recover oil. Approximately 700 t of oil was recovered over a period of 1 month. This was the first case that PAJ had lent materials and equipment overseas.

Besides the aforementioned cases, we had materials and equipment on stand-by to transport them by aircraft from the domestic bases for the Maersk Navigator incident which occurred in January 1993. It ended on stand-by.

In March 1994, when the Seki collision incident occurred off Fujairah of the Arabian Peninsula, materials and equipment stockpiled at Al-Khafji base in Saudi Arabia was put on stand-by to be transported to Fujairah. If we had actually transported the equipment, there may have been some trouble with the customs procedure. In any case, we did not actually transport the equipment.

Therefore, the major incidents which PAJ lent equipment were SEA PRINCE incident, NAKHODKA incident and DIAMOND GRACE incident which occurred in July. At first, we had heard that DIAMOND GRACE had spilt 15,000 kL of oil and we thought we would be spending many sleepless nights. Fortunately the quantity was much smaller than anticipated and we were able to withdraw the lent equipment soon.

Now, everything is calm and quiet. My wish is that it remains this way.

This concludes my explanation.

Table 1

Intel-area movements of oil 1996

unit ; Milliontonnes

		To												
		USA	Canada	Mexico	S & C America	Westerm Europe	Central Europe	Africa	Aust-ralasia	China	Japan	other Asia	others	Total
From	USA	-	5.8	6.8	11.1	9.3	-	0.5	1.0	0.4	2.1	5.9	4.2	47.1
	Canada	70.0	-	-	0.4	0.8	-	-	-	-	0.1	0.1	2.0	73.4
	Mexico	61.8	1.1	-	8.6	6.5	-	-	-	-	4.5	-	-	82.5
	South & Central America	126.6	3.1	1.5	-	11.8	-	0.6	-	-	0.2	4.7	-	148.5
	Westem Europe	36.3	18.8	-	2.2	-	11.0	8.6	-	-	0.1	5.1	3.6	85.7
	Former Soviet Union	1.2	-	-	2.2	92.3	31.0	0.4	-	0.9	0.5	3.8	27.3	159.6
	Central Europe	0.2	-	-	-	3.4	-	-	-	-	-	0.3	0.5	4.4
	Middie East	81.7	5.6	-	28.3	175.4	14.9	29.4	10.2	12.1	209.6	285.6		852.8
	Africa	74.8	4.8	-	15.2	150.1	4.1	5.1	0.4	1.8	1.9	20.4	3.2	281.8
	Australasia	1.7	-	-	-	0.1	-	-	-	0.2	2.5	6.4	3.0	13.9
	China	2.9	-	-	0.1	-	-	-	0.3	-	11.6	9.3	-	24.2
	Japan	-	-	-	-	-	-	-	-	1.1	-	5.0	0.1	6.2
	other Asia	4.6	-	-	2.0	2.0	-	1.0	13.2	21.3	48.5	6.3	-	98.9
	others	3.8	1.7	-	-	21.2	-	1.6	1.6	0.6	-	1.1	-	31.6
	TOTAL	465.6	40.9	8.3	70.1	472.9	61.0	47.2	26.7	38.4	281.6 (14.7%)	354.0	43.9	1910.6

Source : BP Statistical Review of World Energy 1997

Table 2

平成8年度国別原油輸入比率
Crude Oil Imports by Source(FY1996)

地　域　(Area)	国　名　(Country)	比　率(Percentage)
東 ア ジ ア(E.Asia)	中　国 (China)	4.9
東 南 ア ジ ア(S.E.Asia)	ベ ト ナ ム (Vietnam)	1.7
	マ レ ー シ ア(Malasia)	1.7
	ブ ル ネ イ(Burunei)	1.0
	イ ン ド ネ シ ア (Indonesia)	6.6
	小計　(S.Total)	11.0
中　東(M.East)	イ ラ ン(Iran)	10.5
	イ ラ ク(Iraq)	0.1
	サ ウ ジ ア ラ ビ ア(Saudi Arabia)	20.4
	ク ウ ェ イ ト(Kuwait)	5.5
	旧 中 立 地 帯(N.Zone)	5.0
	カ タ ー ル(Qatar)	6.3
	オ マ ー ン(Oman)	5.4
	ア ラ ブ 首 長 国 連 邦(U.A.E)	27.3
	イ エ メ ン(Yemen)	0.6
	小計　(S.Total)	81.0
欧　州(Europe)	ロ シ ア (旧ソ連) (Russia)	0.0
北　米(N.America)	ア メ リ カ(U.S.A)	0.1
中 南 米(S.America)	メ キ シ コ(Mexico)	1.7
ア フ リ カ(Afrika)	ナ イ ジ ェ リ ア(Nigeria)	0.3
	ガ ボ ン(Gabon)	0.1
	ア ン ゴ ラ(Angola)	0.1
	小計　(S.Total)	0.5
大 洋 州(Oceania)	オ ー ス ト ラ リ ア(Australia)	0.8
合 計	(Total)	100.0

出所(Source):通産省(MITI)
FY=Fiscal Year : April to March

Table 3

○輸送距離 (Transportation distance to Japan)

航路 (Area)	距離(海里) (Distance Nautical miles)	備 考 (Remarks)
東南アジア(S.E.Asia)	3,094	Dumai～横浜間の距離を適用 (Applying the distance between) Dumai(Indonesia)and Yokohama
中 東(M.East)	6,483	Jebel-Dhana～横浜間を適用 (Applying the distance between) Jebel-Dhanna(UAE)and Yokohama
中 南 米(S.C.America)	6,600	Salina-Cruz～横浜間を適用 (Applying the distance between) Salina-Cruz(Mexico)and Yokohama

○ Number of Vessels to Japan(FY 1996)
1,272 Vessels/Year
3.5 Vessels/day

Table 4

石油連盟資機材貸出事例
PAJ's precedents of lent equipment

○ 1995年8月　シー・プリンス号座礁事故(韓国)
○ August, 1995　The Sea Prince Incident(Korea)

○ 1996年12月　東友号座礁事故
○ December, 1996　The Dong You Incident

○ 1997年 1月　ナホトカ号沈没 ・ 漂流事故
○ January, 1997　The Nakhodka Incident

○ 1997年4月　韓国 0号座礁事故
○ April, 1997　The Oh Sung No.3 Incident(Korea)

○ 1997年7月　ダイヤモンド・ グレース号座礁事故
○ July, 1997　The Diamond Grace Incident

Table 5

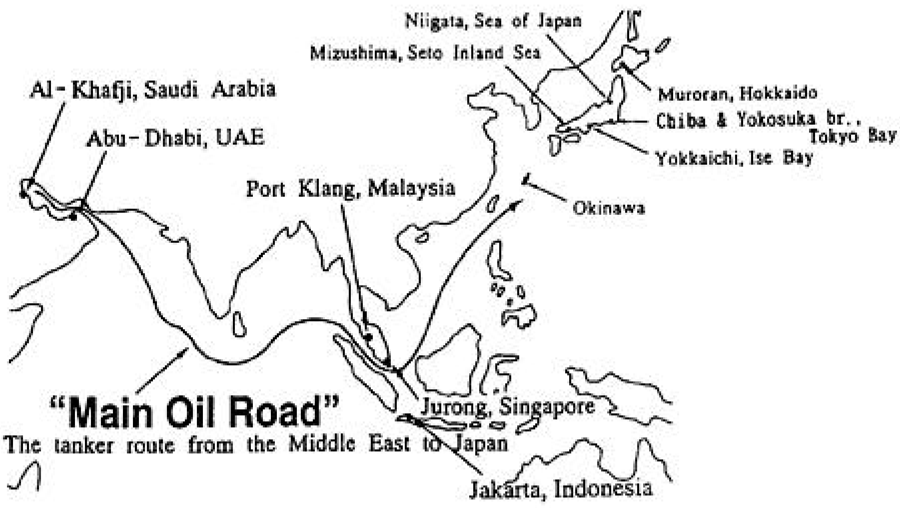
資機材貸出比率
LENT EQUIPMENT

資機材 Equipment \ 基地 Base		保有量 Stocks(A)	貸出量 Lent(B)	貸出比率(%) B/A(%)
オイルフェンス(m) BOOM(m)	固形式 Solid Boom	20,000	8,640	43.2
	充電式 Inflatable Boom	6,000	4,700	78.3
油回収機 OIL SKIMMERS	GT 185	12	8	66.7
	DESMI 250	18	14	77.8
	KOMARA 12K	24	4	16.7
ビーチクリーナー(基) BEACH CLEANER		12	6	50.0
仮設タンク(基) PORTABLE TANK		144	104	72.2

Table 6

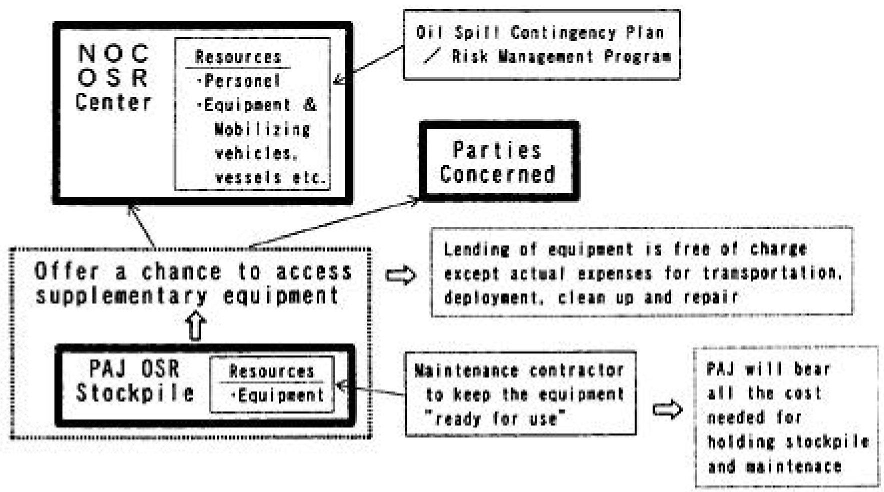
基地名	第1号		第2号	第3号	第4号	第5号	第6号
	東京湾基地	横須賀分所	瀬戸内基地	伊勢湾基地	日本海基地	北海道基地	沖縄基地
配備資機材(Equipment)							
固形式大型オイルフェンス (Solid Boom)	8,000m	-	4,000m	2,080m	1,920m	1,920m	2,080m
充気式大型オイルフェンス (Inflatable Boom)	1,000m	250m	1,000m	1,000m	1,000m	1,000m	1,000m
砂浜用オイルフェンス (Beach Boom)	320m	-	320m	320m	320m	320m	320m
油回収機(DESMI 250) (Oil Skimmer)	3	1	3	3	3	3	3
油回収機(GT-185) (Oil Skimmer)	2	1	2	2	2	2	2
油回収機(コマラ12K) (Oil Skimmer)	4	-	4	4	4	4	4
ビーチクリーナー (Beach Cleaner)	4	2	4	4	4	4	4
油水分離機 (Oily Water Separator)	2	-	2	2	2	2	2
移送ポンプシステム (Crane Sweep System)	1	-	1	1	1	1	1
回収油バージ (Inflatable Barge)	1	-	1	1	1	1	1
仮設タンク (Portable Tank)	24	6	24	24	24	24	24
投光器 (Portable Lighting System)	2	-	2	2	2	2	2

Diagram 1



Stockpile Bases

Diagram 2



Concept of PAJ OSR Stockpile

Discussion

Nerland: You mentioned training. I was just wondering if your organization has considered the IMO training course? The training courses worked by the OPRC working group for first responders, on-scene commanders, management level and so on?

Nishigaki: Yes, we know that the IMO course does exist, and we have also received the information about that. But we would like to first of all try to increase the number of people who can operate the units. And what will follow is that we need to have a training course for on-the-scene commanders and managers of the response systems. So we are thinking of having EARL in Singapore to conduct the training. First of all we would like to have a training course abroad, and then look back to Japan to have a course at home. We are planning such a program this year. Last year we also had training in EARL. We plan to join in the EARL training course this year as well.

Mutoh: Your list of equipment for rent includes oil skimmers, beach cleaners, portable tanks. Most of them are foreign-made equipment. Is domestic equipment inappropriate, or are there any reasons why you employ so much foreign-made equipment?

Nishigaki: We did not avoid using equipment made by Japanese manufacturers. It was just that we could not get the necessary performance with Japanese-made equipment. For over 20 years, we did not have a major incident, so the Japanese manufacturers did not feel that they could sell equipment even if they had made equipment with such performance. And our idea was to get what is most popular internationally and durable. It would be better if as many people throughout the world as possible could use it, so we selected equipment that is popular and has been proven to be durable.

Mutoh: Does that apply to oil booms as well?

Nishigaki: Yes, with respect to domestic oil booms, we stockpile the solid booms. We have very nice solid booms manufactured in Japan. We have 20,000 m of the solid booms eary on. But when it comes to inflatable booms, we have no domestic products. And the concept of our project is that whenever there is a request we transport the booms anywhere. So what's important is that they be compact and convenient.

Suzuki: Mr. Nerland asked earlier a question regarding the training program. At MDPC we have a training center in Yokosuka. And an oil spill response course has been established there. And under the overall training scheme, the IMO training program is exercised.

Gainsford: Can I ask what equipment was used in the DIAMOND GRACE, and how effective it was?

Nishigaki: In the case of DIAMOND GRACE, we lent solid booms and two GT-185s and 8 fast tanks (portable tanks). What was actually used, however, was the oil booms to surround the DIAMOND GRACE. The oil booms had a height of 115 cm (45 cm freeboard, 70 cm draft). It is reported that they were fully effective.

MSRC - A Company of Change to Meet the Needs of its Customers

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His participation in the oversight and direction of numerous spill responses: 1993 Tampa Bay, Florida Spill / 1994 MORRIS J. BERMAN Spill, San Juan, and The San Jacinto River, Texas Spill / 1996 JULIE N Spill Portland.

MSRC is a non-profit oil spill response organization with its primary response capability located in the coastal regions of the United States, including the U.S. Virgin Islands and Hawaii. MSRC is a progressive company which has evolved to meet its customers' ever changing needs as the U.S. federal and state regulatory environment changes.

To understand the MSRC of today, we must first look at the history of the organization, the events that created MSRC, and the changes that have occurred since 1989, both external and internal to MSRC. This will help explain the evolution of MSRC which has occurred to meet the needs of its customers - including the members of the Marine Preservation Association.

Milestones in the Marine Spill Response Corporation's Development

The history of MSRC is traced to a sequence of events in the United States beginning with the oil spill in Prince William Sound Alaska in March of 1989. Like many catastrophic events, this one led to the enactment of legislation in the United States Congress to not only provide for a response system in the United States, but also to attempt to prevent such environmental disasters. This law is known as the Oil Pollution Act of 1990, or OPA-90. While the U.S. Congress was debating the provisions of this law, the U.S. oil industry through the American Petroleum Institute, or API, was also taking action to determine what the industry as a whole could do to both prevent and respond to such an incident in the future.

Prince William Sound Oil Spill - March 1989

The oil spill in Prince William Sound was the catalyst for the creation of MSRC and its national response capability. The incident raised serious questions within the minds of oil industry executives about the ability of the industry to respond to incidents of such magnitude. The industry created a task force under the auspices of the American Petroleum Institute to study not only the current U.S. response capability, but also what capabilities needed to be created to respond adequately to such a spill.

This Task Force's members consisted of 8 high level oil company executives representing Amoco, Arco, BP America, Chevron, Exxon, Mobil, Shell and Texaco. The Task Force was chaired by Allen Murray, then Chairman of Mobil Corporation. The Task Force's mission was to review current U.S. response capabilities and prevention efforts.

The Task Force released their findings barely 3 months after the Prince William Sound incident. The report stated that the U.S. - industry and government - was not prepared to deal with a catastrophic spill. The Task Force considered a catastrophic spill to be defined as a release of oil in the offshore environment similar to the size of the Prince William Sound spill - about 30,000 t, or as any release beyond the local response infrastructure which could be a lot less than 30,000 t in some areas.

The Task Force Report also included recommendations including the support of prevention programs and the establishment of the Petroleum Industry Response Organization, or PIRO.

Petroleum Industry Reponse Organization (PIRO) - Fall 1989

When the Task Force issued their Report in June 1989 they also established a Steering Committee to make recommendations on the implementation of PIRO. By the time the Streering Committee Report was issued in January 1990, the membership in PIRO had grown from the original 8 major oil companies to 20 companies. They had also established committees to study personnel, equipment, vessels, training, insurance and other issues to include about 75 of the oil industry experts in each of their respective fields.

The Steering Committee Report recommended the formation of 2 organizations, one to be the funding organization the other to be operational. When the Steering Committee Report was issued the estimated 5-year costs for the 2 organizations (MPA/MSRC) were approximately US $400 million. This included US $145 million for capital equipment, an annual operating budget of US $65-$70 million and a 5-year research and development budget of US $30-35 million and an organization consisting of 303 people nationwide.

Oil Pollution Act of 1990 (OPA-90) - August 1990

At the same time that industry was creating PIRO, the U.S. Congress was drafting legislation in both houses of Congress to not only prevent but to also respond to such environmental disasters as the Prince William Sound incident. 17 months after the vessel ran aground in Prince William Sound the President signed the Oil Pollution Act of 1990 into law on August 18, 1990. The new law was the first comprehensive oil pollution law in the United States, combining numerous U.S. laws into one.

OPA-90 had many provisions including:

- Expanded federal authority and responsibility to the U.S. Coast Guard for response activities
- National Planning and response system
- Mandatory response plans, relying on private response capability
- It applied to vessels, oil exploration & production platforms, terminals and pipelines
- Equipment requirements and inspections - both on the response and prevention side
- Federally mandated exercise and drill program
- No federal preemption of state legislation
- A strict implementation schedule by February 1993

OPA-90 also provided another important provision which is referred to as "responder immunity." This provision provided a responder with a limited exemption from liability as long as the responder didn't cause personal injury or wrongful death, or act with gross negligence or willful misconduct. Since a response organization, much like a fire station, doesn't choose the time of day, weather conditions or circumstances to its response efforts, they should be protected from liability that may be placed on them due to these factors. Most U.S. States adopted similar provisions, and as a result, the U.S. Congress and every coastal jurisdiction in the U.S. agree that this provision has made good public policy to encourage response operations.

Marine Preservation Association/Marine Spill Response Corporation - September 1990

Shortly after OPA-90 was signed into law, and after the PIRO studies, the oil industry announced the creation of 2 new organizations designed to provide the kind of response capability discussed in the law. The Marine Preservation Association (MPA) and the Marine Spill Response Corporation (MSRC) were created in September of 1990. MPA is a not-for-profit organization created to fund the response capability of MSRC. MPA members are entitled to contract with MSRC for response services. MPA provides the funding which has allowed for the capital expenditures and annul operating budgets of MSRC.

When the 2 organizations were founded, it was estimated that the 5-year costs would be approximately US $825 million, double the amount estimated in January of 1990. This figure now estimated capital equipment purchases to be about US $325 million, annual operating budgets to be approximately US $100 million, and the initial estimation for R & D to remain at US $30-35 million for the 5-year program. The estimated number of personnel necessary to operate and start up MSRC was estimated at 395.

U.S. Regulatory Requirements Under OPA-90

OPA-90 tasked many different agencies of the U.S. government with implementation and regulatory responsibilities, however, none more so than the U.S. Coast Guard. Amongst other things, the U.S. Coast Guard had responsibility for drafting rules to implement Vessel Response Plans (VRPs), Facility Response Plans (FRPs) and Guidelines for Oil Spill Removal Organization (OSRO) Classification Systems. 2 other agencies of the U.S. government also had responsibility for other kinds of facilities, for example the U.S. Department of the Interior under the auspices of the U.S. Minerals Management Service has responsibility for offshore facilities and the U.S. Environmental Protection Agency for onshore facilities that are non-transportation related facilities.

Vessel Response Plans

This rule was established through a negotiated rule-making process in which the U.S. Coast Guard, industry representatives (response, oil and shipping) and the environmental community developed the rule jointly. The rule established time frames and capability for response within U.S. waters. The rule requires that any vessel destined for a U.S. port must file and have approved a vessel response plan by the U.S. Coast Guard (prior to entry into U.S. waters).

Oil Spill Removal Organization (OSRO) Classification System

The U.S. Coast Guard issued Guidelines in December 1995 to create a voluntary classification system for Oil Spill Removal Organizations. MSRC, like many response organizations, chooses to participate in this program since it aids our customers in the writing of their vessel response plans and ultimately the approval of the same.

Classification levels are issued for an U.S. geographic area based on the U.S. Coast Guard Captain of the Port zone. Classifications are based on the response organization's capability to meet planning parameters for skimming, boom and temporary storage capacity requirements in that area. These classifications in no way remove a planholder from the responsibility of ensuring that their response organization is capable of meeting the planholder's obligations under OPA-90.

MSRC（1991-1995）

After its creation MSRC began to create a national infrastructure of oil spill response capability that would provide its customers with the oil spill response resources to meet their expected OPA planning requirements. MSRC contracted for the construction of specially designed and constructed Oil Spill Response Vessels（OSRVs）. The company also began testing and purchasing boom and skimming systems to provide what the company believed would be the level necessary to meet the response capability required by the law. MSRC developed a Research & Development Program, and created a Spill Management capability.

Dedicated Oil Spill Response Vessels（OSRVs）

In 1991, MSRC contracted with 2 shipyards in the U.S. Gulf of Mexico to design and construct 16 OSRVs prior to February 1993. The following are the characteristics for the Responder Class vessel:

- Length Overall - 208'-5 ” （63.5 m）
- Depth - 17'-0 ” （5.1 m）
- Max Draft - 14'-O ” （4.3 m）
- Beam - 44'-0 ” （13.4 m）
- Quarters - 38 Persons
- Fuel Capacity - 112,890 Gallons（427,335 L）

Additionally, each vessel has 2 oil/water separation systems on board, 4,000 barrels of temporary storage, high capacity Trans-Rec skimming systems, oil containment boom, and full remote command and control capabilities for response activities.

Dedicated Skimming Capabilities

MSRC currently has 106 skimmers nationwide. Originally, MSRC purchased 96 skimmers which has grown to the current level. MSRC's combined skimming capability (as rated by the U.S. Coast Guard) is 454,178 barrels per day of Effective Daily Recovery Capacity (EDRC) including the following types of skimming equipment:

- Trans-Rec 350
- Aardvac 800
- Desmi Ocean
- GT-185
- Seawolf
- Walosep W-4
- WP-1
- Vikoma 3-Weir

Dedicated Temporary Storage

In addition to designing and constructing the OSRVs, MSRC purchased 17 offshore barges ranging in capacity from 32,000 barrels to 68,000 barrels. MSRC re-outfitted these barges to allow for crew quarters and made other changes to make the vessels suitable for oil spill response activities. MSRC also has 68 Shallow Water Barges capable of containing 400 barrels of recovered oil each and 84 towable storage bladders in 500 barrel and 3,000 barrel sizes. MSRC's combined temporary storage capability is 902,300 barrels.

Dedicated Boom

MSRC purchased 311,340 ft of boom including Offshore, Inshore and Intertidal Boom. Thus providing MSRC with booming capabilities in all depths of water and environments.

Research & Development

MSRC's 5-year Research & Development program funded research in the following areas:

- Remote Sensing capability
- In-Situ Burning

- Dispersants
- Oil/Water Separation Systems
- Counter Measures Effectiveness
- Bioremediation
- Evaluation of Spill Effects

Spill Management

MSRC's Spill Management capability that was offered to its customers included the following areas of expertise:

- Command & Control
- Operations
- Health & Safety
- Planning
- Logistics
- Finance & Administration
- Communications
- Public Affairs
- Government Affairs
- Scientific & Technical Support

Structure/Budget

MSRC operated out of 5 geographic Regional Response Centers, 2 on the West coast, 2 on the East coast and one in the Gulf and from 21 pre-positioned equipment sites around the country. MSRC was designed to respond only to large oil spills that were beyond the capability of the local response infrastructure. MSRC did not provide plan citation or response capability to its customers for “Shoreline Cleanup.” At the end of the 5-year period, the total cost of MSRC had reached over US $900 million.

Catalyst for Change

As MSRC was being developed, other activities were occurring in the regulatory community and in industry tochange the U.S. approach to what was considered a necessary response capability in the U.S. In the regulatoryenvironment, the U.S. Coast Guard's rulemaking process proved to provide less rigorous standards than hadorigninally been anticipated after the enactment of OPA-90.

At the same time, some members of the oil industry who were the predominant funding companies for MSRC and MPA no longer felt a strict obligation under the law to maintain this kind of dedicated resource. This led tomany changes in the structure and composition of MSRC.

MSRC（1996 Onward）

MSRC realized that the changing regulatory and industry environments necessitated change within the organization.

Restructuring/New Budget

Most importantly, MSRC maintained its commitment to retaining the dedicated oil spill response capability that MSRC had established. During all the changes that have occurred at MSRC since the beginning of 1996, there has been no reduction in response equipment. To reduce costs and focus our services on those most desired for our customers. MSRC also eliminated offering Spill Management services. At the time, many of MSRC's customers had the capability to provide Spill Management through own in-house resources or had contracted with various organizations in the U.S. who provide these services. The loss of this service eliminated a redundancy that existed for many of our customers. Additionally, at the end of its 5-year program, MSRC eliminated its Research & Development program.

In January 1996 a new Senior Management Team took over the company and began to focus on continued customer awareness. By conducting customer surveys, holding customer meetings, and becoming more aware of the needs of its customers, MSRC restructured to meet these changing needs. MSRC's annual budget was reduced from US $96 million（1995） to US $42 million and the member of employees dropped from 441 to 177 nationwide. All of this while still maintaining the same level of dedicated response equipment.

Regional Approach

MSRC's 5 regional concept was reduced to 3: Eastern, Southern and Western. Each region was uniquely designed to allow for MSRC to alter operations to satisfy regional customer requirements. MSRC decentralized and placed more authority with the Regional Vice Presidents. The office which was previously known as MSRC's“ Headquarters ” now became the Virginia Group. The Virginia Group's responsibilities include:

- Oversight
- Quality Assurance
- Services

The President, Chief Financial Officer, corporate attorneys, and others necessary to run a company are located within this group. This office also serves the regions by ensuring that such administrative services as payroll and accounts payable do not have to be duplicated by the regional offices.

Spill Team Area Responders（STARs）

MSRC also established an enhanced network of environmental response contractors known better as Spill Team Area Responders, or STARs. These 60+/- companies represent environmental contractors recognized leaders in the response industry. They provide such services as:

- Personnel
- Response Equipment
- Local Knowledge
- Logistical Support

New Services

MSRC also established a number of new services to provide its customers with the range of services they desired. MSRC now can provide the following services:

- Response to Spills of All Sizes
- “Average Most Probable Discharge”
- Shoreline Cleanup
- International Response（if certain criteria are met）
- Hazardous Materials（if certain criteria are met）

Business Opportunities/Customer Service

MSRC has also established other activities in the customer service and business development areas. MSRC has refocused to become more customer service oriented. The company presently is reviewing partnering opportunities with other OSROs, to provide our customers with a more cost-effective approach to maintaining dedicated response capability. Other areas of opportunity which MSRC focuses on include: international shipowner marketing, international business opportunities, as well as other business opportunities.

Alternative Technologies

MSRC continues to recognize alternative response technologies such as insitu burning and dispersants as a viable alternative, in some cases, to mechanical recovery operations. As U.S. federal and state authorities have pre-approved the use of insitu burn capability in certain geographic areas, MSRC has purchased and located insitu burn systems in those areas of pre-approval. At this time 6 of these systems are in place in MSRC's area of service. With respect to dispersants, MSRC continues to review, in conjunction with industry, an appropriate infrastructure for this capability.

In Summary: The MSRC of Today

The MSRC of today has changed substantially in some regards, and minimally others, to the organization formed in 1990. Still committed to provide a dedicated, stand-by response capability, the organization has increasingly embraced a customer-oriented approach.

Key to this change has been the development of a business plan which:

- Embraces commercial efficiency
- Provides for total customer satisfaction
- Enhances a solid, external reputation

However, the incident in Prince William Sound was over 8 years ago and time tends to allow for a certain forgetfulness and a less rigorous regulatory environment may continue to see an erosion in the national response infrastructure in the U.S. MSRC will continue to adapt to the ever-changing needs of its customers' as circumstances warrant.

Discussion

Kudo: You mentioned MSRC is in possession of the 16 dedicated oil spill response vessels. What do the crews of these dedicated vessels do when there are no spills?

Toenshoff: During the downtime for non-spill response, the crews of our vessels do several things. First, they do maintenance and repair of our vessels, and they do maintenance and repair for numerous other equipment that we have in inventory. We also spend a considerable amount of time and money training our personnel in oil spill response. Additionally, we spend a considerable amount of time training with our customers. As it is required in the United States, it is our customers who must initiate their response plan, and as an integral part of that response plan, they must train with their spill removal organization, and as such, we will train with them. So they are kept very busy.

Mearns: Could you explain a little more about what MSRC is doing in the shoreline cleanup area? You are re-entering that, and are you going to bring in traditional as well as alternative technologies?

Toenshoff: It is a requirement under the planning guidelines to contract for shoreline cleanup capability, which MSRC never provided before. As an enhanced service to our customers, we now provide that capability. Shoreline cleanup, as we've seen in the previous presentations, is very labor-intensive and often takes a very long time. What we have done is we have developed relationships with a series of subcontractors called STARS（Spill Team Area Responders）and we have under contract approximately 6,000 personnel that are trained in oil spill response, meet all the U.S. requirements for health and safety, and are oil spill response veterans. We will bring those personnel to work for our customer at our customer's direction, in concert with the U.S. Coast Guard at the direction of the U.S. Coast Guard. We do not unilaterally decide whether we should use alternative technologies or we should use a beach-cleaning medium; that is up to our customer and the Coast Guard to decide in the Unified Command as to what is the best approach. In this case, we provide the personnel, the services, and the tools, but not the direction as to how it is to proceed.

Gainsford: Do you intend to have any dispersant spraying capability, either from vessels or air?

Toenshoff: Right now, we're working with government and with industry to come up with an infrastructure in the United States. The infrastructure in the United States is much different from that in the U.K. Different cooperatives-local, smaller geographic area, oil spill cooperatives, which are all funded by industry-have got numerous contracts in place for dispersants. What we are contemplating and suggesting is a national dispersants capability where we should be able to achieve some economies of scale and provide an enhanced capability for our customers at the lowestpossible cost. Right now, we're just in the process of discussions with some of the fixed-wing aircraft providers, commercial contractors in the U.S., and we're in discussion with the other coops, so it is a little early to determine where that is going to go.

Nerland: Those 16 ships-how many days a year are they occupied with actual oil spill response? Do you have any statistics on that?

Toenshoff: The answer is not very many. In the United States, prevention has worked very well, and many operators of ships and refineries and terminals are very cautious about oil spill response or oil spills, they're very concerned about the cost directly for response, as well as the cost for their reputation. As such, industry has taken a very proactive position to minimize and prevent oil spills. As such, our boats don't really go to work very often, which is okay, because there is not a need for them to go to work very often. As a not-for-profit organization funded by our customers, we do not need the boats to go to work to maintain the capability. We just need to have a series of customers, such as most of the major politically observative companies, take a stance with us to continue to fund us.

Schive: Who are your customers, and who are not your customers? You said that you had to build down your company because there was a shift in the picture of the customers. What were the reasons for that kind of development?

Toenshoff: We have approximately 62 customers in MSRC. Of the 62, 17 are oil companies-companies such as Exxon, Mobil, Chevron, BHP, Star, Texaco, Shell, Amerada Hess, the larger integrated oil companies. Forty-five of the 62 companies are smaller terminal operators as well as shipowners. We do have some of the more notable shipowners-as an example, Mitsui OSK Line is one of our customers, Tokyo Marine is a local customer of MSRC-as well as other international and non-international shipowners.

I prefer not to address who is not our customer and who left us. They have their own reasons that they left us, primarily because the regulations allowed them, in many regards, to find alternative methodologies at a cheaper cost. However, these are non-dedicated capabilities, and I think we would all agree that dedicated is often better than non-dedicated.

Mearns: As a marine biologist, I'm very concerned about something that's happening, and that is a general national and perhaps worldwide decline in R&D in developing new technologies. I think 10 percent of the world's R&D experts in new technologies are in this room right now, and as the community continues to invest in infrastructure and hardware and so on, where is the R&D going to come from? Who is doing it? Do you have any regrets or thoughts as far as who's taking up the R&D that was dropped at MSRC?

Toenshoff: Maybe Mr. Lessard could address that. Mr. Lessard was chairman of the Marine Preservation Association Research & Development Oversight Committee. The Marine Preservation Association is the group that funds MSRC. Mr. Lessard?

Lessard: That's exactly what I was going to contribute, I wasn't going to ask a question. For the research program that was proposed by MSRC, we spent quite a bit of time convincing the American Petroleum Institute to pick up the best features of that-certainly not continuing at a $6 million dollar-a-year level, but the very best of those programs is being funded on a more broad basis, if you will, because the API picks up a lot more of the industry than the MSRC was, so it's a fairer distribution of the money, and we're able to leverage with government organizations, with private industry, Exxon is supplying funds-and I think we are able to continue a pretty good research presence even though it's not funded under the MSRC anymore.

Suzuki: You have 16 dedicated oil spill response vessels. What is the limit of the operation for those vessels? Under what sea conditions and weather conditions will the vessels be able to operate? In the Hawaii region as well as in regions such as Alaska, where it is very cold, and also on the Atlantic side, the sea conditions and weather conditions may differ greatly. So the shape of the ship or the equipments to be put on board the ship may differ from region to region. So what may be the criteria employed to decide on those equipments as well as the shape of the ship?

Toenshoff: I'd like to address the limitation in two steps. First, there's a limitation based on the sea condition. These vessels were designed to operate under “defined adverse weather” under the Oil Pollution Act. I don't know what the upper limit of that is. It all depends upon how significant the sea state is. As I was speaking this morning with Mr. Kudo on NAKHODKA spill, with a 10m sea height, it is very difficult to respond. With 6m, it is sill very difficult to respond. That's a very significant sea height. These vessels were designed to operate in many meters. The equipment we have on board was designed in Norway. It's a Frank Mon Transrec system. And it was tested up in the North Sea, which does have adverse weather additionally. I'm not sure what the operational limitation is on the system. However, I would like to also address limitation as a function of time. These vessels were designed to operate for 30 days off-shore, without support. They've got food on board. They've got diesel fuel. They've got supplies and stores on board to operate off-shore for30 days without being replenished by outside sources.

Suzuki: You mentioned “for 30 days continuously.” What happens to the oil recovered? I think you need to store that. What is the capacity of the storage tank in the vessel?

Toenshoff: Our vessel's capacity is 4,000 barrels of temporary storage. However, each vessel has two oil-water separators on board, one on the port side, and one on the starboard side. And the capacity of the oil-water separators exceeds the capacity of the skimmer. As such, our vessels are very efficient skimming mechanisms, where it will bring the oil-water mixture in and it will discharge the water overboard so you will only have, as much as possible, only oil remaining in the tank.

However, I agree with you also that in a very larger-scale operation, where you are off-shore for many days, you need to off-load your tanks. And as such, we own 17 off-shore barges, which are capable of being towed out and having our vessels discharge into the off-shore barge. As such, in the event of a larger spill, we would set up-the American term is a “milk run”-where you would run the barge out to vessel, off-load into the barge, then bring the barge back and off-load to storage tanks, to keep the system skimming as much as possible.

Offshore Oil Spill Contingency in Norway

Jon 0. R ф dal

Position Director, Operations, Norwegian Association of Operating Companies (NOFO)

Education 1965-66 Military Academy / 1969-70 Nautical Academy / 1972 MasterMariner

Main responsibilities are making and maintaining oil spill contingency plans, educate oil spill response personnel, participate in developing equipment, oil spill combat tactics and methods for collecting spilt oil. Further, on behalf of the oil companies that operate on the Norwegian continental shelf, to maintain and develop the oil spill offshore contingency organisation which is required by Norwegian authorities.

A. Organisational Character and Role of NOFO

NOFO is a co-operating association of operators on the Norwegian Continental Shelf, and not an independent business enterprise.

An operator is defined in the“ Act Pertaining to petroleum activities ” as follows:“ When granting a production licence, the Ministry shall appoint or approve an operator who shall conduct the day-to-day management of activities which are carried out pursuant to the licence. ”

At present all the operators on the Norwegian Continental Shelf are members of NOFO. If an operator should choose not to be a member of NOFO he would have to establish his own organisation with capacities equal to that of NOFO.

The object or role of NOFO is to establish and maintain a contingency program aimed at combating oil pollution. This includes elements such as common administration of purchased and leased equipment, coordination of oil recovery vessels, personnel, maintenance of contingency plans etc.

NOFO's contingency, equipment and strategy shall primarily be aimed at, and have as its priority, the combating of major spills associated with activities set forth in the above mentioned act. That is: Uncontrolled blow outs or other major oil spills on the Norwegian Continental Shelf caused by the oil industry.

The guidelines to the regulations in question issued by Norwegian Petroleum Directorate, the Ministry of the Environment and the Directorate of Health stipulates recognised standards for preparedness against acute oil pollution. The standards that regulate NOFO's activity include the following:

a） 25% of the oil pollution control equipment based on dimensioning oil spill（8,000 m 3shall be operativewithin 24 hours.

b） The remaining oil pollution control equipment for recovering 8,000m 3shall be operative within 48 hours. NOFO's governing bodies are:

The General Assembly

All NOFO members are represented in the General Assembly.

The sphere of responsibility incumbent on the General Assembly is as follows:

- Approve all agreements
- Approve budgets
- Approve accounts
- Approve the annual report
- Elect the Board, the chairman and vice-chairman of the Board

- Elect auditor
- Elect the election committee
- Approve the associations overall plan / strategy

The Board

The responsibility of the Board is:

- Draft Budgets
- Draft accounts
- Draft annual reports
- Draft the Associations overall plan / strategy
- To appoint the Managing Director
- To work out the job instructions for the Managing Director
- To determine the salary of the Managing Director and the salary frames for all other staff
- To approve administrative procedures
- To implement quality assurance audits

The Administration

- The permanent administration takes care of the day-to-day operation of NOFO.

The Contingency Organisation

Bases

NOFO has 5 bases along the Norwegian coast. The location of the bases is such that any oil field in Norwegian waters can be reached within the stipulated response time and with enough equipment to satisfy the guidelines for recovered volume.

Oil Recovery Vessels

The oil recovery vessels are standard offshore supply vessels which have been modified to accommodate both the necessary equipment and the recovered oil. All the members have signed a separate “vessel agreement” which makes it possible for NOFO to incorporate any suitable vessel in to the contingency organisation. (The requirements for modifying a supply vessel for oil recovery operations can be obtained from the speaker).

Towing Vessels

The fleet of towing vessels are modified offshore fishing vessels which are under contract to NOFO. They operate as ordinary fishing vessels but have to stay close enough to the coast to meet the required response time.

Contingency Personnel

The contingency personnel who operate the equipment during an emergency are employed by different companies along the Norwegian coast. NOFO has agreements with its employers who give NOFO the right to summon the personnel in case of an emergency and further for necessary training and exercises.

On Scene Commanders

NOFO has available a group of trained on-scene commanders. All participants in the group are employed by members of NOFO. They get necessary time off from their normal duties for training and exercises. Furthermore, they are on a roster and one of them is on dutyat all times.

Tank Vessels

For the disposal of large amounts of recovered oil, NOFO has agreements with the company that operates mostof the shuttle tankers which serve the Norwegian oil industry.

Remote Sensing / Surveillance

In order to carry out efficient operations at night, NOFO has the following surveillance systems available:

- Aerostatic surveillance with infra-red camera

- Surveillance plane （available through the Norwegian authorities） with Side Looking Airborne Radar andinfra-red and ultraviolet scanners.

- Helicopter home infra-red cameras where the images are transmitted to the bridge on the oil recovery vessels

B. Offshore Oil Recovery Operation including Effective Measures to Prevent Oil Spill Drift fromReaching the Shore

Norwegian regulations relating to emergency preparedness in the petroleum activities reads as follows: “ The emergency preparedness relating to acute oil pollution shall ensure that any acute oil pollution resulting from activities under the Petroleum Act is effectively collected near the source of discharge as quickly as possible. Furthermore, the emergency preparedness shall ensure effective limitation of acute oil pollution threatening the coastline ”

Offshore oil recovery operations require relatively large vessels and heavy equipment which is suitable for the varying weather conditions in open waters. In order to achieve the highest efficiency possible it is important for offshore recovery units to be as self-sufficient as possible. This includes:

- Ample stock of spare parts.

- Personnel who are trained in repairing the equipment in the field. Ideally the same personnel who perform routine maintenance should also operate the equipment in the field. This to ensure good familiarity with the equipment.

- Ample stock of protective clothing and other necessary gear for personnel who come in contact with crude oil.

- The recovery vessels need large enough tank capacity to operate until tank vessels reach the operations area.

- If damages occurs that field repairs cannot rectify, as much spare equipment as possible should be available.

- Offshore operations should as far as possible be pre-planned and described in the contingency manual - Enough booms to cover large areas of the surface. See figure below from NOFO's contingency manual.

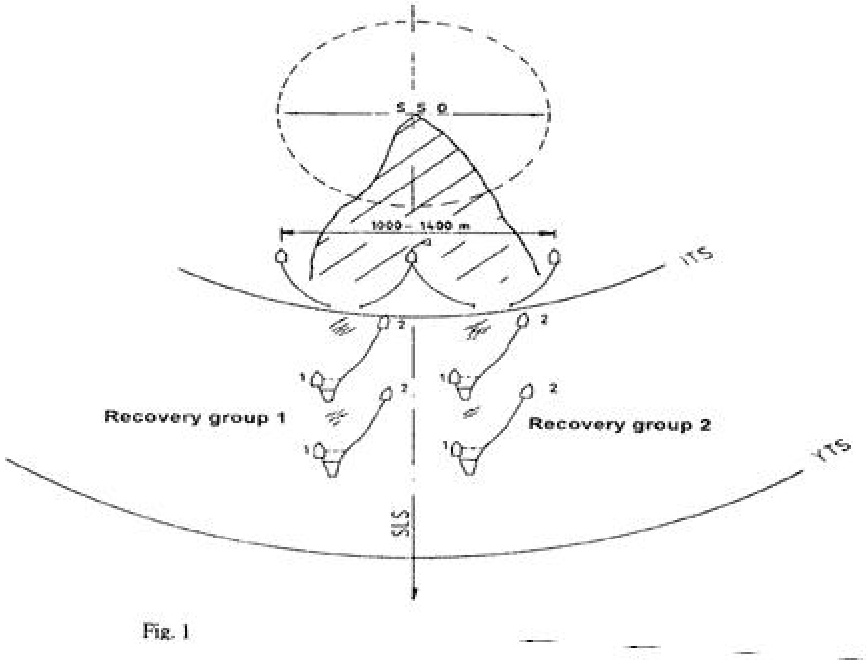


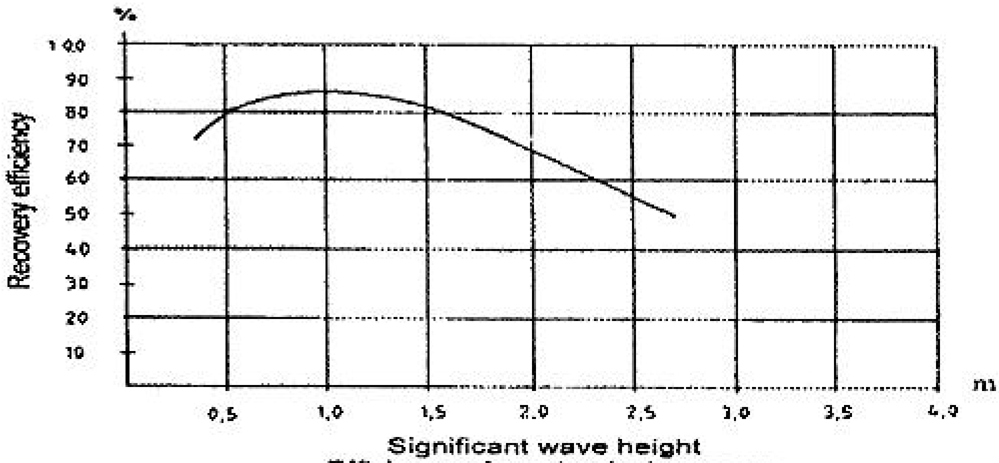
Fig. 1

NOFO's total strategy, which is based on requirements from the Norwegian authorities, is aimed at minimising the damage oil spills can cause to the environment. A major part of the same strategy is to prevent spiltoil from reaching the coast, or if this is impossible, at least minimise the amount that will.

One elements of this strategy is to recover spilt oil as near the source of discharge as possible. In order toachieve this reliable trajectory models are needed to predict where and when the drifting oil will reach the coast. The response time has to be adjusted if the source of potential pollution is close to shore. The standard set by Norwegian authorities for drilling or other petroleum activities, near shore, which has the potential to cause oil pollution is that 50% of the equipment needed to recover 8,000 m3/day shall be operative within half of the minimum time it will take for the oil to drift to shore, based on recognised drift calculations, and further that the rest of the equipment shall be operative before the oil reaches the shore. If the time it will take the oil to reach the shore is less than 20 hours, 25% of the same equipment shall be located at the installation and shall be operative within 2 hours.

If an offshore oil recovery operation with mechanical equipment shall have any chance to succeed, realistic recovery rates must be established/calculated.

First of all the equipment must be thoroughly tested under all weather conditions for which it is designed. Further, the tests must be carried out with oil on the water surface. Tests where oil has been substituted with other substances have proven not to be reliable. Having in this way established reliable performance curves (see example below) for the equipment, including the vessels, the personnel must be well trained and educated for the task at hand. The human aspect of an oil recovery operation cannot be emphasised enough. Experience proves over and over that without advance knowledge of the conditions that may be expected in the operations area, such as winds, waves, currents etc.-and without planning and training, oil spill recovery can be anything from unsuccessful to disastrous.



Efficiency of mechanical recovery

From the skimmer capacities which have been established during realistic trials in different weather conditions, the following must be deducted in order to estimate how much pure oil it is possible to recover:

- Free water collected together with the emulsion.

- Water content of the emulsion (most oils will absorb water and form an emulsion, water content can be as high as 70%)

- Time needed to transfer recovered oil to tankers.

- Allow time for field repairs.

Average recovery rates over a period of time can be as low as 20% of normal rates when the above has been taken into account.

Efficiency of Mechanical Oil Recovery in Marginal or Bad Weather

If breaking waves exceeds 3.5 - 4 m in significant height, mechanical recovery rapidly become impossible. Fig. 2 indicates 0 efficiency at around 4 m. From time to time there is equipment promoted where high foul weather efficiency is claimed. We believe this to be misleading for several reasons. With the presence of breaking waves of any size most of the oil will disappear from the surface and into the water column. If the oil is broken into fairly large droplets it will be distributed in the water down to a depth equal to the wave height. In this case the oil may surface again if the weather calms down. With smaller droplets the oil will be naturally dispersed into the water column. Further, the oil which remains on or in the vicinity of the surface will be impossible to contain in a boom because of the apparent increase in current velocity caused by the waves.

C. Measures Taken to Combat Continual Crude Oil Leakage from Ocean-floor Oil Fields. Combating Incidents on Ocean-floor.

Oil recovery operations aimed at collecting oil from underwater blow outs or leakage from sub sea pipelines are much the same as for oil spilt on or near the surface. The main difference is that the oil most likely will spread over a much larger area and consequently form a much thinner layer on the surface. This complicates the recovery operation in the sense that more equipment, especially booms, is needed (see Fig. 1). The boom loss, which always occurs when drifting oil is contained and subsequently concentrated by the forward motion of the boom, will proportionately increase with the extra amount of boom required.

If the release velocity on the bottom is high enough, recent field trails (in the North Sea in 1996) have shown that the oil will form very small droplets with small rise velocity. In the case of the 1996 field trails the oil slick which formed on the surface had a thickness in the order of 5 - 20 mm. In this case, the oil film was too thin to be recovered. The energy conveyed to the water surface by the booms caused the oil to disperse into the water column. This indicates that some underwater oil spills may be impossible to recover even under reasonable weather conditions.

To combat or stop oil leakages from sources on the ocean floor is far too complex to be covered by this presentation. However there are examples of very successful operations where wrecks have been emptied of oil. Reports from such operations are available.

D. Clean-up Equipment Employed by Oil Spill Response Bodies, Specifications and Reasons for Choice

When exploration for oil started on the Norwegian Continental Shelf, followed by production in the late 70s/early 80s, the authorities introduced their requirements for contingency against oil spills. The requirements are mentioned earlier in this presentation. The authorities further directed the oil industry to document that they were able to meet the issued requirements. To enable the industry to achieve this the Pollution Control Authorities in Norway granted spill permits for the purpose of testing- and development of oil recovery equipment. It soon became obvious that there was no equipment available on the market which was suitable for the conditions in the North- and Barents Sea and which could satisfy the standards set by the government.

A development- and test program was started. Tests/exercises, where oil was released, were arranged offshore once or twice a year. Both independent contractors and the pollution control authorities monitored the release and recovery of the test oil. In 1987/-88 the Transrec unit had been developed and the industry could document a recovery rate of 300 m3/hour under favourable conditions. Even though the offshore tests had proven the recovery rate to fall sharply with worsening weather conditions they showed that the requirement of 8,000m3/day in significant wave height up 2.5 m had been met.

Brief Description of Transrec

The Transrec system is electro-hydraulically operated and driven by the OR vessels' hydraulic power unit. Transrec consists mainly of the following parts:

- Lower baseplate with towing attachment and hydraulically operated wheels that can be lowered for low-speed transportation over short distances.

- Upper, revolving baseplate with drum and control panel.

- Floating hose with f 150 mm transfer hose and hydraulic hoses and electrical cables for the control and operation of the skimmer functions.

- Skimmer head with pump.

- Emulsion-breaker system for continuous injection of oil/water emulsion-breaking chemicals during the recovery process.

- The Transrec system can be operated from the control panel or by remote control by radio from the bridge.

- A tension system that automatically pays out or reels in the hose during a transfer operation if the distance between the vessels increases or decreases.

Framo NOFO Transrec systems are designed to operate in seas with waves with a significant height of up to 4.0 m, and have a maximum capacity of 300 m3per hour against a 55 m water column and viscosity of 1,500 cSt.

The system can be operated by I person. When installed, the Transrec system serves 2 purposes:

1. Recovery of oil from the boom systems.

2. Transfer of recovered oil to another vessel or to a tank onshore.

Parallel with and after the development of the Transrec unit, a boom suitable for offshore conditions was developed/selected. After numerous tests, an existing boom which was modified to meet NOFOs requirements was selected. The main characteristics of this boom is a depth of 1.5 m and a flotation chamber which has a diameter of 1.3 m. Each length of boom is 400 m.

Requests/Orders for Operations

Any member of NOFO has the right to activate the whole organisation in an emergency. As part of the contingency organisation, NOFO has an alarm centre where qualified personnel are on duty at all times. NOFO's resources may be activated by telephone, provided the operations order is confirmed as soon as possible in writing.

Chain of Commands

According to Norwegian law the responsibility to take action when an oil spill has occurred lies with the polluter.

This means that should one of NOFO's members have an oil spill, NOFO's resources will be placed at his disposal and he will have the full responsibility to recover the oil or otherwise minimise the damages to the environment as much as possible. The law makes provisions for the government to take command of the operation if the polluter does not perform to their satisfaction.

Procedures for an Oil Spill Response Body which is Funded by a certain Group of Oil Companies to Get Involved with an Incident Imputed to the Third Party

According to Norwegian law anyone operating an enterprise which may lead to acute pollution shall provide the necessary emergency preparedness to prevent and limit the effect of the pollution. Again according to Norwegian law, if there is danger of very considerable pollution damage, any person or organisation may be required to provide material or personnel in order to combat the accident. As a consequence of this NOFO will, even though not an commercial organisation, have to assist in cleaning up an oil spill caused by a third party. The right to request such assistance lies with the pollution control authority. Anyone who provides assistance in accordance

Discussion

Nishigaki: On the Transrec system, Mr. Nerland explained yesterday that it was used in the ARISON incident. How many examples of use of the system do you have in actual cases?

R φ dal: I cannot recall the actual incidents. We have what that Mr. Nerland mentioned yesterday. And addition to that, we have been in action 4 or 5 times. All the times have been occasions where we have assisted the state pollution-control authorities.

Gainsford: I would like to respond on the mechanical vs. dispersant debate later this aftemoon. But I would like to emphasize that certainly the U.K. government doesn't rely totally on dispersant spraying. It has a backup of mechanical means. And we do believe in a mixed bag of clubs to respond.

R φ dal: It sounds like in my presentation that we only have mechanical equipment, too. But we do have some dispersant capability, actually.

Session 12

Response to the Pollution Caused by the SEA EMPRESS Incident and the Shoreline Restoration Process

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INTRODUCTION

This paper gives an overview of the response to the 72.000 t (19 million gallons) of Forties Blend and 480 t of Heavy Fuel Oil (HFO) spilt during the SEA EMPRESS incident. Quantification of the effectiveness of the response operations have been obtained through a monitoring programme and carried out by the National Environmental Technology Centre (NETCEN) of AEA Technology at the request of the Marine Pollution Control Unit (MPCU) of the Coastguard Agency, UK Department of Transport. In the past, researchers and responders have suggested that a monitoring programme could not be mobilised for the initial stages of a response. MPCU's early mobilisationof the NETCEN monitoring team has set a precedent in demonstrating the use of scientific measurements made in real time at an incident to guide a successful response to an oil spill.

The decision making at the incident was also aided considerably by the fact that the crude oil spilt, Forties Blend, is one which NETCEN has used extensively in field trials in the North Sea. Therefore, we were able to place a great deal of confidence in our predictions of oil fate and the potential for different response techniques. We have shown in field trials that Forties Blend forms emulsions readily and that in the absence of treatment that these emulsions can be relatively persistent (Walker et al.1993).On the other hand, in field trials before the SEA EMPRESS spill, Forties Blend has been shown to be amenable to treatment both by dispersants and demulsifiers (Lunel & Lewis 1993; Walker and Lunel 1995; Lunel & Davies 1996) giving confidence that a successful dis-persant operation could be mounted.

OVERVIEW OF THE FATE OF THE CRUDE OIL

Around 59.000 t Forties crude oil cargo was transferred to the Texaco refinery once the SEA EMPRESS had been brought alongside a jetty in Milford Haven. The oil budget considered here, therefore, refers to the 72,000 t of Forties crude which was spilt at sea. The oil budget was clearly not fixed for the entire duration of the spill, it is a time dependant variable. The oil budget on the 29 February is described in this section At this point, 2 weeks after the SEA EMPRESS went aground, only sheens remained at sea and the majority of the bulk oil had been removed from the beaches.

Evaporation - 40% (range 35-45%):

The evaporation of the lighter components of crude oil is one of the most important processes that removes oil from the water surface. Hydrocarbons of a composition containing 15 carbon atoms or less will have evaporated within the first 2-5 hours after being spilt reducing the acute (short-timescale) toxicity of the remaining surface oil to the marine environment since themost toxic components have been lost to the atmosphere.

Samples collected during the first 2 weeks of the incident and modelling predictions showed that between 35% and 45% of the volume of the oil had evaporated.

Date	Time at which samples were collected (GMT)	% Evaporative Loss
16/02/96	10:15	41
17/02/96	13:08	45
17/02/96	13:10	45
17/02/96	13:18	45
21/02/96	10:30	35
21/02/96	13:20	37
21/02/96	14:58	36
22/02/96	15:27	40

Table 1. Showing the volume percent that had been lost through evaporation in the samples collected during the SEA EMPRESS incident.

Oil recovered at sea - 2% (range 1.5-2.5%):

Approximately 4.000 t of water-in-oil emulsion, with an average water content of 50-70% was removed at sea by skimming operations. This emulsion was then kept in separating tanks and lagoons to settle out into oil and water. The mass of oil recovered at the refinery from at sea operations is estimated at 1,500 ± 300 t. The oil was then reprocessed at the Texaco refinery by bleeding in the oil at very low rates so that the sea salts incorporated into the oil did not contaminate the catalysts in the refining process. This accounts for around 2% of the oil.

Oil recovered from the shoreline - 2% (range 1.5-2.5%) :

The oil recovered from the shoreline was composed of 2,500 t of liquid emulsion of 20 % oil reprocessed at the refinery (the mass of oil was measured at the refinery as 500 ± 200 t) ; 3,500 ± 500 t of oiled waste at 10% to landfarm ; and 7,800 ± 200 t of oiled sand at 5% oil to landfarm. Therefore, of the 72,000 t only around 1,250 ± 250 t (2%) was recovered from the shoreline.

Oil remaining on the shoreline - 5% (range 3-7%) :

The estimate of the volume of oil remaining stranded comes from extrapolating from the relatively few sites extensively studied during the earlystages of the spill. We estimate that around 5-9% of the oil released impacted the shoreline, 2 % was recovered leaving 3-7 % stranded on the shoreline on 29 February 1996.

Dispersion - by difference = 51% (range 43-59%) :

The rapid dilution of the dispersed oil together with the large volumes over which the oil is distributed means that it is not possible to generate an effective monitoring programme which can accurately quantify the dispersed oil budget. However, fluorometry measurements at sea showed that the dispersion process was a significant process in determining the fate of the spilt oil.

Using the figures available at present, if 40%± 5% evaporated, 2%± 0.5% was recovered at sea, 2%± 0.5% was recovered from the shoreline and 5%± 2% was left stranded on the shoreline after cleanup of the initial bulk oil, then by difference around 51%± 8% of the oil is likely to have dispersed through a combination of natural and chemically enhanced dispersion.

INFLUENCE OF THE RESPONSE OPERATION ON THE FATE OF THE SPILT OIL

Once oil has been released into the environment the effects of the oil will be seen to some extent by all com-partments. The role of response to the spill is to provide a net environmental benefit (Baker 1995). Over time natural processes break the oil into small droplets and biodegrade the oil. In summary, there are 2 main approaches to oil spill response.

- To fight these natural process and concentrate the oil and remove it from the environment.
- The second is to enhance the rates of the natural processes of dispersion and degradation.

The first approach has the advantage of removing oil from the environment following a spill but the disad-vantage that it is fighting natural processes which are tending to disperse and dilute the surface oil. The second approach of relying on natural processes can be effective in reducing the environmental impact of a spill. For example, The conclusion of the 2 year study on the environmental effects of the BRAER was that there was no significant environmental impact. At most spills where the weather conditions are not as extreme as the BRAER there is a net environmental benefit in enhancing natural processes.

Mechanical recovery at sea

It is generally agreed that a maximum of around 10% of the oil spilt can be recovered by mechanical recovery at sea. In the BRAER spill where storm conditions existed throughout the incident no oil was recovered from the sea surface while during the EXXON VALDEZ response which relied heavily on mechanical recovery 8% of the surface oil was recovered (Wolfe et al.1994). As we have described above, despite the unfavourably high wind speeds at the SEA EMPRESS, mechanical recovery (using 4 mechanical recovery systems) removed 1.5-2.5% of the oil spilt. This prevented some 3,500-6,000 t of emulsion impacting the shoreline.

Dispersant application

The main strategy of dispersant use at the SEA EMPRESS was to enhance the natural dispersion process in order to remove oil from the sea surface and thereby reduce the potential environmental impact to sea birds, coastal waders, intertidal vertebraes and invertebratea and the many amenity beaches in the area. It is clearly difficulto toestimate what percentage of the total 51% dispersed was through natural dispersion and what percentage was dispersed through the use of dispersants since during a response to a major spill leaving an experimental control where no response is mounted is not a realistic option when environmentally sensitive sites are threatened.

However, NETCEN had carried out field trials using Forties Blend crude oil prior to the SEA EMPRESS spill (Lunel et al. 1995, Lunel & Davies 1996). These carefully controlled experiments with oil in the field used steady state releases of Forties Blend crude oil so that quantitative measurements of the dispersed oil phase could be made and also experimental controls could be set up which were not treated with dispersant. These experiments showed that 6% (a range 3-9%) of the Forties Blend will disperse naturally in the first 30 minutes after release in conditions typical of those at the SEA EMPRESS (Lunel et al. 1995, Lunel & Davies 1996). In these same steady state releases (Lunel et al. 1995, Lunel & Davies 1996) when Forties Blend was treated with the dispersant Dasic Slickgone NS (one of the dispersants used at the SEA EMPRESS incident) the total per-centage of Forties Blend dispersed in the first 30 minutes was on average 22% (a range 16-28%).

In the field trials natural dispersion accounted for 6 ± 3% the chemical dispersion was around 16 ± 9% out of the total of 22 ± 6% dispersed. Thus, the ratio of natural : chemical dispersion in these field trials was 1 : 2.7 (range 1 : 1.8 to 1 : 8.3) under wind conditions typical of those at the SEA EMPRESS incident. If this same ratio of natural : chemical dispersion occurred at the SEA EMPRESS incident then of the 51 % dispersed 37% (range 29-45%) would be from chemical dispersion and 14% (range 6-22%) would be from natural dispersion.

It is not possible to give a definitive split between natural and chemical dispersion. However, the range of 6-22% dispersion from the natural dispersion process alone is consistent with our field trial experience and the output of the field validated model OSIS.

Estimated Mass Balance for Forties Blend for 29 March 1996

During this period some 446 t of dispersant was applied to enhance the rate of natural dispersion (the dis-persants used in decreasing order of volume sprayed were : Finasol OSR-51, Dasic LTSW, Dasic Slickgone NS, Dispolene 34S, Superdispersant 25, Enersperse 1583, Corexit 9500) . It was not possible to gather quantitative data at the spill on the relative effectiveness of different dispersants on Forties Blend crude. A notable feature of the spray response was the highly effective targeting achieved by the use of remote sensing aircraft positioned above the spray aircraft to direct the spray pattern. This operation is well tried and practised in the UK and allowed the DC3 aircraft in particular to target effectively ribbons of oil as narrow as 10-20 m. Since 446 t of dis-persant were used this implies that each tonne of dispersant resulted in the dispersion of 47 to 73 t of oil, with a mean around 60 t. Clearly this represents a highly successful dispersant operation.

Therefore, we estimate that if dispersants had not been used at the SEA EMPRESS incident the instead of the estimated 10,000-15,000 t of emulsion impacting the shoreline, 72,000-120,000 t would have impacted the South Wales coastline. Clearly this would have resulted in a significant increase in the 6,900 bird casualties, would have smothered the intertidal zone in thicker layers of emulsion for longer periods of time and would have provided a near-impossible task for the teams trying to re-open tourist beaches in time for Easter at the start of April.

OVERVIEW OF THE FATE OF THE HEAVY FUEL OIL

Heavy Fuel Oil (HFO) is used as the fuel for the majority of ships. Therefore, spills of HFO are not uncommon. Experience from around the world, including the NAKHODKA spill, has shown that despite the fact that spills of HFO are often not the largest spills in terms of volume, the impact of these spills can be significant because HFO does not disperse and biodegrade readily. Laboratory weathering studies carried out on the HFO from the SEA EMPRESS indicates that only around 2-5% will evaporate. From previous experience once would expect less than 5% to disperse naturally since the HFO is highly viscous even when fresh. Therefore, in the absence of recovery of the oil from the sea surface 90-95% of an HFO spill will typically impact the shoreline.

However, the precise fate of the HFO at the SEA EMPRESS spill will have been influenced by whether it was released outside the Haven (230 t from the ship's gauges), while the SEA EMPRESS remained grounded, or inside the Haven alongside the jetty (250 t). The HFO released at the mouth of the Haven between 15-22 February was, it is believed, released at the same time as the Forties Blend crude oil. Since the oils are readily miscible the HFO would have been mixed into the Forties Blend crude and affect the properties of the oil mixture on the sea surface. However, since the HFO formed a small percentage (on average 0.3%) of the oil mixture, the properties of the mixture would have been dominated by the properties of the Forties Blend crude.

At the BRAER incident a similar mixing of HFO into the crude oil cargo (combined with the high sea states) explained how the HFO was dispersed completely into the water column by natural dispersion. In the absence of the crude oil, even under those high wind conditions at the BRAER we would have expected a shoreline impact from the HFO released from the tanker.

However, the 250 t of HFO which was released on the 22 February inside the Haven was not accompanied by a release of Forties Blend. The HFO impacted along most of the coastline inside the Haven. The fraction of the oil pollution that was HFO ranged from almost entirely HFO (Pwllcrochan) to around a third of the total pollution at Gelliswick. A rough estimate of the level of oiling from HFO can be gained from the length of coastline inside the Haven, around 50 km, giving a typical level of oiling of 5-7 t/km.

The persistence of the HFO meant that inside the Haven, where it was not mixed with the crude oil to a great extent, it resulted in a shoreline impact proportionately much higher than the Forties Blend crude oil.

MOBILISATION OF THE DISPERSANT OPERATION

In response to the grounding of the SEA EMPRESS at the mouth of Milford Haven, MPCU activated the UK national contingency plan and immediately deployed surveillance aircraft to fly over the vessel to estimate the extent of the spill. Information on the position and size of the slick which was neededn for making operational decisions was provided by MPCU's 2 dedicated remote sensing aircraft equipped with Side-Looking Airborne Radar (SLAR), and downward-looking Video, IR, and UV cameras. 7 DC3 dispersant aircraft were loaded with dispersant and flown to the scene in readiness to begin spraying operations at first light, if required.

Predictions of where the major areas of oil contamination were to move and the likely weathering state of the oil were provided by the oil spill model OSIS. This model is used as the operational response model by MPCU. OSIS has been developed by AEA Technology (NETCEN) and British Maritime Technology (Leech & Walker 1992) .

As an example of the interplay between modelling and remote sensing model runs, on the evening of 15 and early 16 February OSIS predicted that the oil released would move SE towards Linney Head and beach at this location under the prevailing westerly wind at 18-20 kt (Fig 1) . As the spill was close to shore where local oceanographic features can have an important impact on the trajectory of the spill, it was important to obtain early confirmation of the slick trajectory using

MPCU's remote sensing aircraft. The predicted trajectory was confirmed by side-looking airborne radar (SLAR) imagery at 23:02 on 15 February (Fig.2) and from daylight reports on oil beaching at 07:00 on 16 February.

This combination of remote sensing and predictive modelling was used throughout the incident to help to plan response operations. The incident demonstrated that in the case where a major spill occurs and pollution authorities are immediately notified then existing techniques of remote sensing and sea trial validated predictive modelling (i.e.OSIS) provide the information necessary to make operational decisions. One of the lessons learnt from the SEA EMPRESS spill is that the detailed analysis and dissemination of this remote sensing and modelling information requires a dedicated team as part of the response operation. This team will be mobilised at future major oil spills in the UK.

The strategy used in the UK for applying dispersant is for the remote sensing planes to direct the spray aircraft to the areas of thickest oil and for the spray aircraft to repeatedly pass over the region of thickest oil until the surface oil has been dispersed. As expected, the dispersants were most effective on the fresh oil emerging from the grounded tanker. Therefore, the MPCU strategy for dispersant application was, in the first instance, to target any significant fresh releases of oil from the tanker. Once these had been successfully treated with dis-persant then a secondary target was the larger patches of more weathered oil further offshore. These patches were probably the result of oil releases at low tide during the hours of darkness which could not immediately be treated with dispersants.

MONITORING THE EFFECTIVENESS OF THE DISPERSANT RESPONSE THROUGH FLUO-ROMETRY AND REMOTE SENSING

Sometimes, as was seen for the application of dispersant to fresh Forties Blend being released form the SEA EMPRESS, aerial observation is sufficient as the dispersant can produce a visible plume of dispersed oil just below the water surface. However, as reported in NETCEN field trials (Lunel 1994, 1995) and incorporated into the IMO/UNEP guidelines on oil spill dispersant application (IMO 1995), field experiments have shown that enhanced oil concentrations can occur in the water column following dispersant use, without the appearance of plumes. This indicates that dispersion can occur in the absence of the usual visual indications, and therefore the IMO guidelines suggest that subsurface oil concentrations should be measured in addition to conventional aerial observations.

The SEA EMPRESS incident showed that this subsurface monitoring is essential once the oil had weathered for more than 12-18 hours. By this point surface sampling had shown that 40% had evaporated and that a 70% water-in-oil emulsion had formed. In the absence of dispersants natural dispersion still resulting an exposure of the marine environment to dispersed oil although elevated concentrations were mostly restricted to the top 1 m of the water column (Fig. 3) . On emulsification after 12-48 hours, the natural dispersion process slowed signif-icantly. When dispersant was applied to emulsions of Forties Blend, the first application of dispersant tended to break the emulsion while subsequent additions increased the concentrations of dispersed oil (Fig. 4) . This was consistent with previous trials in the North Sea with Forties (Lunel & Lewis 1994, Walker & Lunel 1995) and other North Sea crudes (Lewis et al. 1995 ; Brandvik et al. 1995) when the dispersant operation was successful in breaking the water-in-oil emulsion and then dispersing it. Monitoring of the surface oil properties by boat was critical for the dispersant operation to treat the emulsified oil since it is very difficult to get a clear indication of the extent of emulsion break down from visual observations from the aircraft. NETCEN scientists were able to inform MPCU of the demulsifying effect of the dispersant even though dispersed oil concentrations were not elevated greatly immediately following treatment.

MONITORING THE RATES OF DILUTION OF THE DISPERSED OIL

The initial monitoring of oil concentrations in the water column was carried out with a focus of determining the efficiency of the dispersant operation. Evidence from NETCEN monitoring programmes has shown that the dis-persant was effective in removing oil from the sea surface. The hazard posed by a particular pollution event is a combination of the toxicity arising from the concentration of the pollutant and the length of exposure to the elevated concentrations. The potential for environrnental disbenefit is in the possible generation of oil concen-trations in the water column which :

- are acutely toxic
- cause long term tainting of commercially important fish and shellfish

There is much debate on the threshold of oil concentration where toxic effects are likely to be observed. The 2 major issues being firstly, that different components of the oil have very different toxic effects (the light aromatic compounds such as benzene and xylenes having the greatest effect), secondly, different species and life stages have a wide range of tolerances to dispersed oil. A workshop was held in the USA in 1995 on the impli-cations of the use of dispersants since the USA is increasingly considering dispersants as one of their response options to oil spills. The workshop addressed concerns over the potential toxicity of dispersed oil has limited the use of dispersants in responding to major oil spills. This included many of the main researchers in the oil spill field. One of the workshop's conclusions was that"the available acute(short-timescale) toxicological data support the conclusion that, at water column concentrations at or below 10 ppm dispersed oil for 2-4 hour exposure duration, adverse ecological effects are not expected".

During the dispersant operation at the SEA EMPRESS dispersed oil concentrations only locally exceeded 10 ppm for short periods of time. Therefore, in terms of acute (immediate) toxic effect, the dispersed oil concen-trations generated by the initial natural dispersion and the dispersant operation are likely to have had only a limited environmental impact, and concentrations rapidly diluted to less than 1ppm. By June 1996 oil concen-trations in the water column had returned to background levels (1-10 ppb) over the affected area.

Therefore, the dispersed oil concentrations (which rapidly diluted to less than 1 ppm)are likely to have had only a limited environmental impact. The SEA EMPRESS Environmental Evaluation Committee (SEEEC) interim report identified lower shore bivalves, and urchins as the main casualties the dispersed oil, with some species washed up in their hundreds (SEEEC 1996).

With commercial fish and shellfish, however, the major issue is tainting. Ministry of Agriculture, Fisheries and Food (MAFF) introduced a fisheries exclusion zone immediately following the spill. Fin fish, however, were found to have little or no contamination, and the ban on salmon and sea trout was lifted on 3 May, and on other fin fish on 21 May (SEEEC 1996) . Shellfish, especially bivalve molluscs, were more hevily contaminated and have recovered more slowly, though it is likely that the ban on these have been lifted progressively.

Therefore, the major environmental and economic impact from the SEA EMPRESS spill has not been from the dispersed oil (accounting for 50% of the oil released) but from the much smaller percentage, 5-9%, of surface oil which resulted in 6,900 oiled birds (66% of which were common scoter) , a heavy impact on the intertidal zone resulting for example in fewer than 20 of the previous 150 rare cushion starfish remaining in West Angle Bay (SEEEC 1996) , and a shoreline response lasting over 12 months.

CLEAN-UP OF THE BULK OIL FROM THE SHORELINE

(15 February to 29 February)

Approximately 10,000-15,000 t of Forties emulsion impacted 200 km of the South Wales coastline by the 29 February. The HFO released (480 t), mainly impacted on the coastline of Milford Haven.

The initial area of oiling from 15 to 21 February was from Skomer Island to St. Govan's Head. From the 22 February the winds changed direction from northerly, which they had been from 19-21 February, to southerly. As a consequence, the remaining surface emulsion which had not evaporated or dispersed, headed towards the shoreline of Carmarthen Bay. Emulsified oil first started coming ashore in Carmarthen Bay on the 24 & 25 February between Pendine and Tenby. The most significant oiling of Carmarthen Bay occurred during the period of the 27 to 29 February.

Beach cleanup operations, which relied heavily on manual techniques and light equipment in order to minimise the impact of the cleanup operation itself, removed the majority of the bulk oil from accessible sites from the 24 to 29 February.

SECONDARY CLEAN-UP AND POLISHING OF IMPACTED SHORELINE

(1 March 1996- May 1997)

By March 1996, the majority of the bulk oil had been removed from the beaches in Milford Haven and Car-marthen Bay. However, there were still several oiled areas of concern including inaccessible coves and sites con-taining contaminated cobble and shingle which were stranded as the high tide receded. Residual oil on beaches where primary cleanup has been completed, still presented a challenge to the response team, as their concen-trations were still of concern in terms of both environmental and amenity considerations. The contaminated areas of shoreline can be categorised into high and low energy environments.

High-energy environment : Surf washing

It had been noted throughout the response that the oil contaminating the shore had not adhered tightly to the coastline. When the samples of oil and beach sediments from Carmarthen Bay were agitated with sea water from the surf zone it was possible, using optical microscopy, to identify a natural interaction between mineral fines and oil droplets. Direct observations under epifluorescence microscopy by Department and Fisheries and Oceans, Canada confirmed that water samples taken from the intertidal zone of Amroth beaches contained oil droplets which were surrounded by the mineral fines as a stable floc (Fig.5 a,b) . The figure shows an image of clay, diatom and oil droplets under phase contrast (Fig. 5a) and UV epifluorescence (Fig. 5b) . Under epifluo-rescence, individual oil droplets are clearly distinguished from the mineral fines. We were thus able to confirm that an intrinsic oil spill countermeasure process previously described as "clay-oil flocculation" (Bragg & Yang 1993 a & b) was occurring at the coastal sites impacted by the SEA EMPRESS incident.

This interaction between the mineral fines and the oil :

- Minimised the contact of oil directly with the substrate, thereby reducing the adhesion of the oil to the shoreline.

- Prevented the re-coalescence of oil droplets, thereby promoting the dispersion of oil within the surf zone.

Recent studies with samples collected from previous spill sites (e,g., Arrow 1970 ; Metula 1974 ; BIOS test spill, 1981 ; Fred Bouchard 1993) have demonstrated the almost universal ability of the different crude and refined oil types to flocculate in the presence of seawater and mineral fines under various environmental con-ditions (Owens et al. 1994 ; Bragg and Owens 1995) . The finding that clay-oil flocculation was taking place in Carmarthen Bay beach sediments, resulted in a modification of the planned operational response. The oiled cobble zone at the eastern end of Amroth beach (a site of high amenity value) was subjected to "surf washing". The technique is essentially a matter of using an excavator while the water is at low tide to move material from the oiled zone at the high water mark towards the middle of the intertidal zone. As the tide rises, the energy imparted in the surf zone is then sufficient to remove the Forties emulsion from the oiled cobbles. The mineral fines in the waters of the surf zone are believed to act as surface active agents to promote the removal of the oil from the substratum and to allow dispersion of the oil into the surf zone. We estimated that half of the oil being released from the cobble was dispersed (stabilised by the mineral fines). The other half was released as a broken surface slick (weathered emulsion, in appearance like tea leaves floating on the sea surface).

Over 4 days, the cobbles from the high water mark were moved down the beach at low water. The oiling of the cobbles was reduced at each tidal cycle so that by the 5th day there was no longer significant oiling in the cobble zone at the eastern half of Amroth beach. Boulders at the western end of Amroth were not subjected to surf washing since they were greater than 30 cm in diameter, were not moved by the energy in the surf zone and hence were not subjected to the same degree physical energy. This area was therefore treated with dispersants at a later date.

The success of the surf washing on Amroth beach meant that other beaches were also subjected to surf washing as a final polishing process.

High Energy Environment : Dispersant treatment

As the Easter vacation approached there was increasing pressure from the local councils to cleanup the high amenity value areas of Carmarthen Bay, in time for the arrival of the tourists. Over the last 2 weeks of March, particular attention was given to cleaning up the holiday resort of Tenby. Type III dispersants were shown to be effective at cleaning both the natural and man-made surfaces contaminated with oil.

Carmarthen Bay is a shallow-water bay important for both fisheries and the ecology of the area. Therefore, it was important to monitor the impact of the dispersant operation in terms of raising the levels of dispersed oil in the bay. NETCEN monitored the concentration of dispersed oil in the bay generated by each application of dis-persant prior to the high tide. The dispersed oil concentrations were found to be relatively low (3 ppm as a maximumand more typically <1 ppm) and also very localised (typically affecting areas of around 20m diameter).

In April and May dispersant application has been extended to Saundersfoot, the westrn end of Amroth, Marros. Lydstep, Manobier, Freshwater West, Monkstone. The Glen, and Swallow Tree. Monitoring at each of these sites showed that the dispersant application had a negligible effect in terms of raising the levels of dispersed oil in the water column. This monitoring allowed the JRC to proceed with the cleanup of high amenity areas with confidence that the localised operations were not having a major impact on the surrounding marine environment.

Low-energy environment - Potential for Bioremediation

The low-energy environment refers mainly to the coastline within Milford Haven itself. As with the high-energy coastline, the first stage of bulk oil removal was largely completed by the start of March. The techniques used most extensively within Milford Haven have beenbulk removal of contaminated sand and sea water flushing.

Most sites can then be left to recover naturally since this type of treatment protocol has been demonstyated to minimise long term environmental impact (Baker 1995). In this paper we will discuss the easibility of additional bioremediation treatments to enhance the natural remediation process in sheltered environments.

In Alaska, following the EXXON VALDEZ incident, bioremediation was used to treat residual oil remaining within the sediments after the initial cleanup operations (Pritchard & Costa 1991 ; Bragg et al. 1994 ; Swannell et al. 1994) . The addition of sources of nitrogen and phosphorus by scientists from both the US Environmental Pro-tection Agency (US EPA) and Exxon was found to stimulate the biodegradation rate of the oil and hence promote a more rapid decontamination of the oiled shorelines (Pritchard et al. 1992 ; Bragg et al 1994).

A randomised block design was used to test the effect of 2 treatments at the site selected, Bullwell Bay. 3 blocks of 3 plots (each 9 m long by 0.9 m wide) were placed perpendicular to the sea 1.25m apart. An initial lithium tracer experiment had shown that this was adequate to prevent migration of the treatments between the plots. In each block one plot was left as a control, one was treated with, a weekly application of fertiliser (sodium nitrate and potassium dihydrogen phosphate) dissolved in seawater, and one was treated with a slow release inorganic fertiliser. At the beginning of the experiment the Total Petroleum Hydrocarbon (TPH) measurements, made colorimetrically, showed that the contamination was fairly consistent across all plots, with the highest oil concentration persisting at the landward end of the plots.

The conclusions of the bioremediation treatment at Bullwell Bay were :

- The in situ rate of biodegradation of a mixture of HFO and Forties Blend was increased.

- The treatments had no effect on the nutrient content of the seawater in Bullwell Bay.

- There were no detectable toxic effects on the environment as determined by the sensitive oyster embryo bioassay

- The slow release and weekly application of fertiliser were equally effective implying that the former may prove a cost effective technique for enhancing the natural recovery of shorelines.

SUMMARY OF SHORELINE CLEAN-UP ACTIVITIES

Despite the release of around 72,000 t of Forties crude oil and 480 t of HFO we estimate that only around 10,000-15,000 t of Forties emulsion and around 430-460 t of HFO impacted the shoreline. Around 2% of the oil released was recovered by the 29 February, 3-7% remained stranded on the shoreline in areas where it was difficult to remove further bulk oil.

Therefore, shoreline cleanup operations focusing on the stranded oil, which in fact comprises only around 3-7% of the total oil released, has been the main on-going activity since March 1996. The techniques employed on the high energy shorelines have been natural remediation, surf washing and dispersant application. The techniques used on the low energy shorelines have been natural remediation, and flushing. Bioremediation as a final polishing step has been shown to be appropriate for Bullwell Bay.

CONCLUSIONS

As a result of the grounding of the SEA EMPRESS, 72,000 t of Forties Blend oil was released into the envi-ronment making this incident among the 20 largest oil spills of all time. With 35-45% evaporating the potential was for 40,000-47,000 t of oil to come ashore. Since Forties Blend oil rapidly emulsifies to produce a 70% water-in-oil emulsion (Walker et al. 1993 ; Walker et al. 1995 ; Walker & Lunel 1995) this could have translated into 120,000-140,000 t of emulsion impacting the South Wales coastline if dispersants and mechanical recovery had not been used.

Fortunately, the result of the combined dispersant and mechanical recovery operation was that only around 10,000-15,000 t of emulsion impacted the shoreline. The mechanical recovery operation accounted for around 2,000 t of oil while it is estimated that 21,000-32,000 t of oil was dispersed.

The value of having a dispersant operation in place as a first response (along with monitoring of the spill) as part of the UK national contingency plan was clearly demonstrated. It was only because the MPCU control structure, surveillance aircraft, dispersant spray planes, trained pilots and monitoring teams were all in place in advance of the spill that a targeted and successful dispersant operation was feasible at this incident. Through NETCEN'S monitoring programme we have shown that the dispersant operation significantly enhanced the natural dispersion process and resulted in a net environmental benefit. The reduction in the volume of oil on the sea surface and impacting the shoreline limited effects on sea birds, coastal waders, intertidal habitats and tourist beaches. These benefits have outweighed the limited impact on the marine environment observed to date.

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ACKNOWLEDGEMENTS

Firstly, our thanks to MPCU for the way in which the monitoring programme was inter-linked with the response operation itself. This forward-looking policy has set a precedent for other countries to follow. The monitoring measurements on dispersant effectiveness would not have been possible without the co-operation of Air Atlantique. We thank them for the close coordination which allowed these unique measurements to be made. Our thanks also to the Environment Agency for collaboration, including the provision of their research vessel VIGILANCE, in the total hydrocarbon measurements carried out after 24 February to determine the dilution of the dispersed oil once the dispersant operations had ceased.

Figure 2. Side-Looking Airborne Radar (SLAR) image of the SEA EMPRESS at 23:02 on 15 February. The figure shows trajectory of the oil (dark feature) heading towards Linney Head where it beached in the early in agreement with predictions made by OSIS (fig.1)

Figure 3. Summary of the peak oil concentrations in the water column at 1-5 m depth below the seasurface generated by NATURAL dispersion before application of dispersant. This demonstrates that even in the absence of chemical dispersant operation the marine environment is subjected to dispersed oil.

Figure 4. Summary of the peak oil concentrations in the water column at 1-5 m depth below the oil which had been sprayed with dispersant. Before dispersant application <2 ppm concentrations of dispersed oil were restricted to the top 1 m of the water column. Following treatment with dispersant 1-10 ppm level oil concen-trations were seen to penetrate down to 5 m indicating a successful dispersant operation.

Figure 5. Clay, diatom and oil droplets under phase contrast (a) and UV epifluorescence (b) . The oil droplets fluoresce under UV fluorescence and can be distinguished from the mineral fines.

Figure 1. OSIS modeling estimate for 08:00 on the 16 February 1996

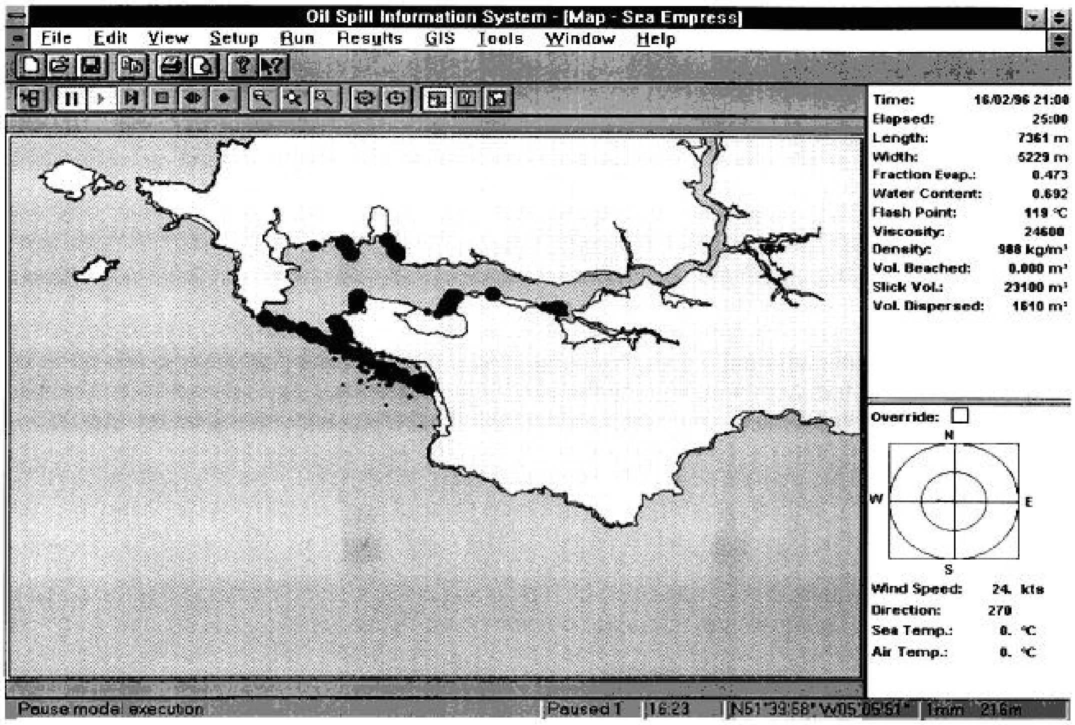


Figure 2a. MPCU SLAR imagery - 23:02 on 15 February 1996

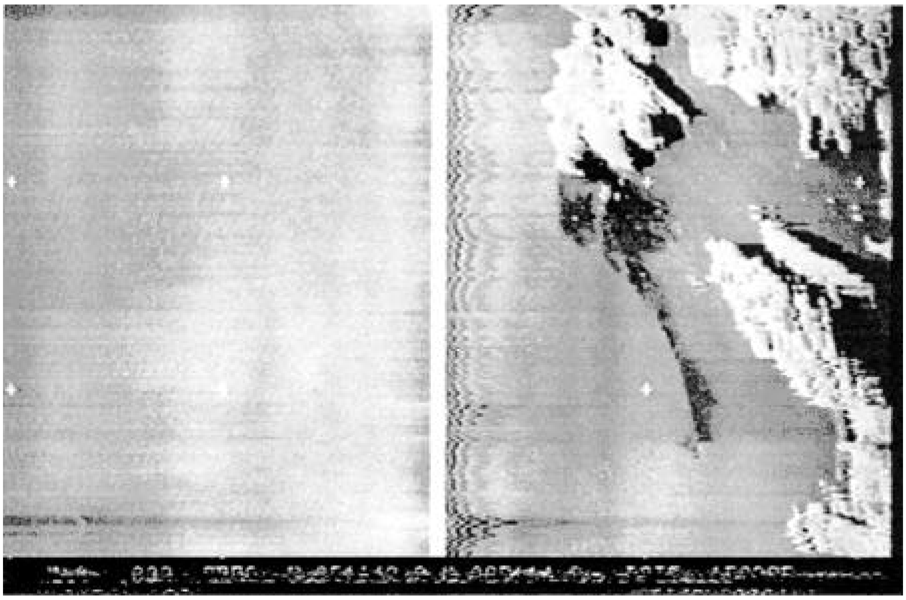


Figure 2b. MPCU SLAR imagery - 03:39 on 16 February 1996

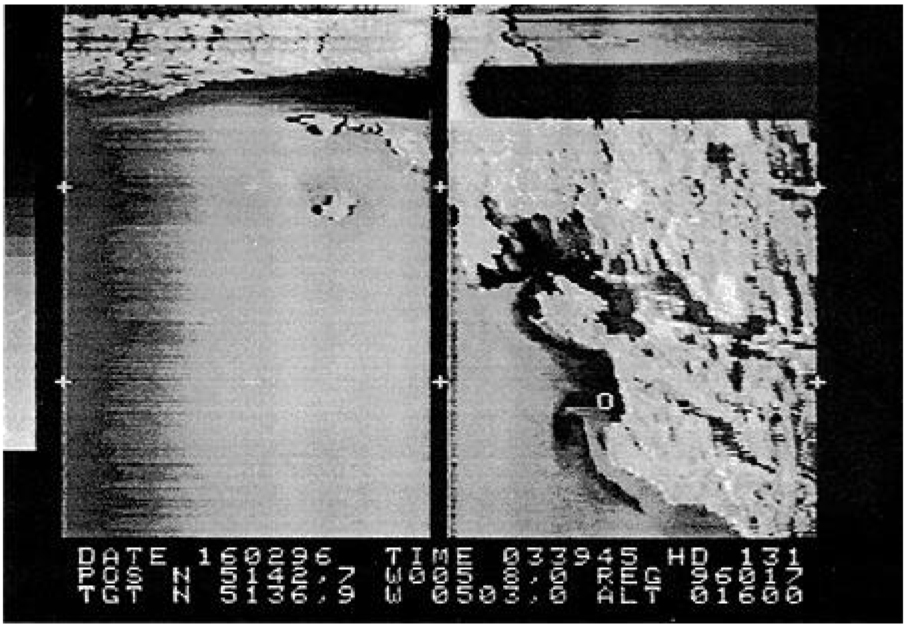
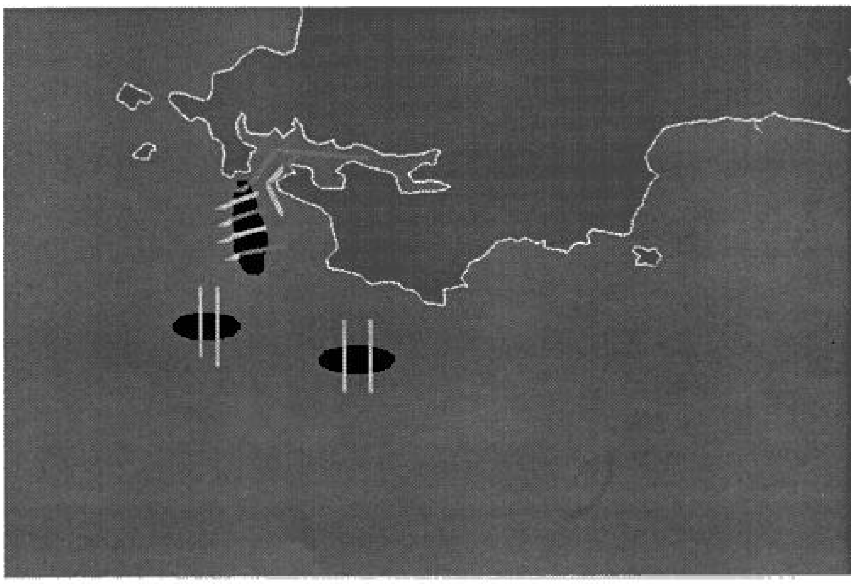
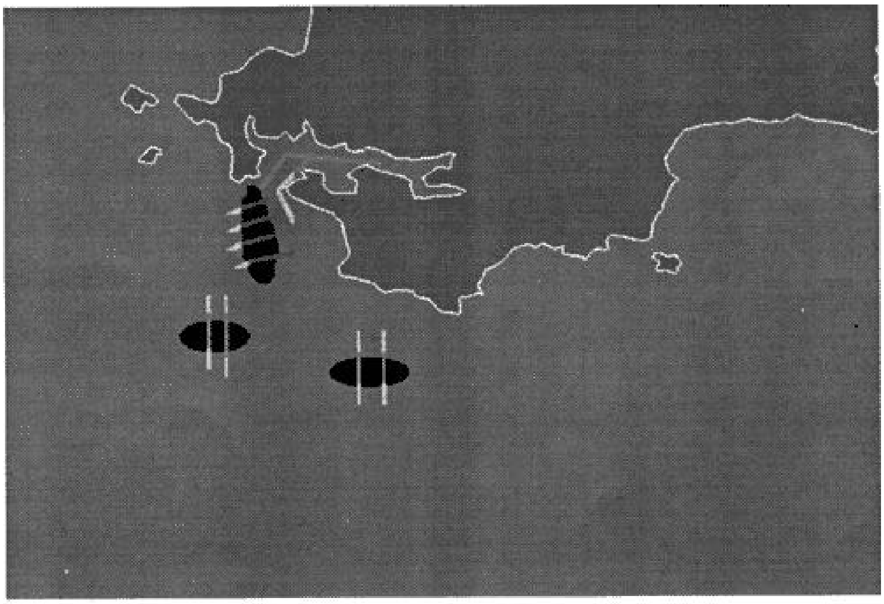


Figure 3. Summary of the peak oil concentrations in the water column at 1-5m depth below the sea surface generated by NATURAL dispersion before application of dispersant. This demonstrates that even in the absence of chemical dispersant operation the marine environment is subjected to dispersed oil.

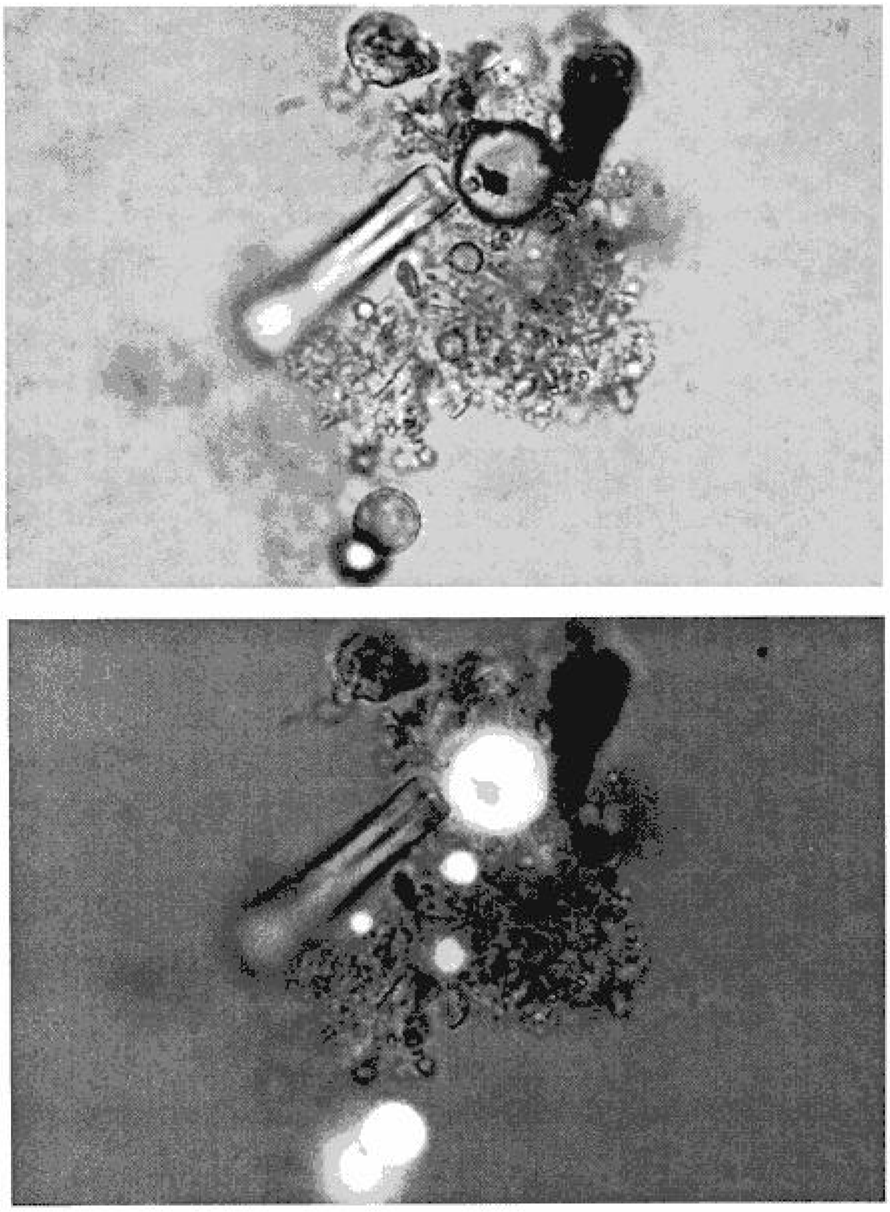


> 5ppm; 1-5 ppm; <1ppm

Figure 4. Summary of the peak oil concentrations in the water column at 1-5m depth below the oil which had been sprayed with dispersant. before dispersant application < 2 ppm concentrations of dispersed oil were restricted to the top 1m of the water column. Following treatment with dis-persant 1-10 ppm level oil concentrations were seen to penetrate down to 5m indicating a suc-cessful dispersant operation.



> 5ppm; 1-5 ppm; <1ppm



25 μm

Fig. 5 Clay, diatom and oil droplets in a floc shown under phase contrast (above) and under UV fluorescence epi-fluorescence (below) microscopy. The oil dropplets fluoresce under the UV epi-fluorescence and can therfore be easily distinguished from the mineral fines.

Discussion

R φ dal : Are you spraying at night using infrared for targeting?

Lunel : No, we didn't do any spraying at night. It was more important to keep the crews fresh so that the operation was effective during the day. When you consider that the crew have to beup there and continually spraying during the day, that it would be too much of a strain on the air crew to also keep that operation going during the night. So that was not an option that was used on the SEA EMPRESS. It is something that is considered, but I think it has to be a balance between hitting the oil early, but also making sure that the application is efficient.

Kudo : Did you use remote sensing technique by satellites or aircraft for drift prediction?

Lunel : It was very much integrated between the modeling and the aerial remote sensing of working out where they might go, but then confirming it with aerial remote sensing. Those are the twotools that we use. The satellite image was available at the time. I think it came in 2 days after the actual overpass. But it was not used, because we knew that the image from the satellite was actually mis-leading. So we feel that the satellite is probably more useful for looking at small discharges, maybe operational discharges, and monitoring those, and maybe is of more limited use in a major incident. We wouldn't discard it in a major incident, because it gives us anoverview, but it does need very careful interpretation.

Effectiveness and Effects of Shoreline Oil Clean-up Methods ：
Lessons from the EXXON VALDEZ, Other Spills and
Recent Research on Bioremediation

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1989-participated in cruises to evaluate impacts of the EXXON VALDEZ oil spill in Alaska / The team have participated in many oil spill response in the USA, and internationally and have conducted many investigations of the effectiveness and effects of bioremediation and other open-water and shoreline clean-up methods.

Abstract

Although many methods are available for removing or degrading oil stranded on shorelines, not all are effective, many are appropriate for only a few shoreline types and some are more damaging than no cleanup at all. The EXXON VALDEZ Oil Spill offered a unique opportunity to compare and contrast the short-term and long-term (years) effectiveness and effects of several shoreline cleanup methods including no response, high-temperature high-pressure washing, berm relocation and use of chemical shoreline cleaners. Much of the shoreline marine life survived the initial oiling but was destroyed by the pressure washing and has been slow to recover even though a lot of oil was removed. One shoreline cleaner produced few impacts on surviving marine life, but it was not used in the response. The results of bioremediation were controversial and unclear, even though it was approved and used extensively. Subsequent field research on bioremediation indicates that it is useless to add oil-degrading microbes to shoreline but under some circumstances, continuous application of nutrients (fertilizers) can accelerate oil degradation. The bottom line is that each cleanup method must be tailored to specific types of oils and shorelines and that care should be taken to protect marine life that survives the initial oil spill.

1.0 Introduction

Since the 1989 EXXON VALDEZ oil spill in Alaska, a "new wave" of field research has been conducted to evaluate both the effectiveness (oil-removal efficiency) and effects (biological injury) of shoreline oil spill cleanup methods. In addition, the overall benefits and impacts of past response strategies are being reviewed. As a result of this work, much of it still ongoing, response authorities are now much more selective and careful about methods used to treat shorelines. In addition, they are careful to answer the ultimate question, "How clean is clean enough?" This paper is a review of the status of shoreline oil spill cleanup methods, and cleanup research, with focus on benefits and effects on marine life.

2.0 How Bad is Oil on the Shoreline?

The public, policy-makers and the media generally assume that oil spilled in the marine environment is a very damaging and persistent substance and that it must be quickly and completely removed. On the water, it kills birds and mammals by smothering; if these animals remain coated or exposed for more than a few hours, the oil can also be toxic to them or their young (nesting bird and turtle eggs). On a resort beach, oiling will immediately cause lost uses and income to resort villages, even if the oiling is light or non-toxic. Fisheries may be closed for fear of contaminating sea food products, even if it does not do so. This public image of death and destruction from oil spills is not completely true and should not be the primary factor directing the response and shoreline cleanup.

2.1 The Fate and Toxicity of Oil

Oil is a highly-variable and complex natural substance (top, Figure 1). When released into theocean or coastal waters its properties and chemistry undergo important changes caused by exposure to various physical, chemical and biological processes (lower left, Figure 1). Among other things, these processes work to make oil more or less toxic (usually less) to marine life and marine ecosystems (lower right, Figure 1). By the time it reaches the shoreline, or has been stranded for many days, this "weathered" oil may damage shoreline marine life by smothering, but it's toxicity may decrease rapidly. Furthermore, it begins to experience additional processes (clay/oil interactions, biodegradation, etc.) that accelerate its degradation and destruction.Only in very heavy oiling (Saudi Arabia during the Gulf War Oil Spill) do shorelines not recover from an oil spill within a few years.

2.2 The Nature of Shoreline Marine Life and Its Recovery from Oil Spills

Most of the world's shorelines provide habitat for a great variety and abundance of marine life. Rocky shores, cobble beaches, marshes, mangroves, tide flats, and even sandy beaches and man-made structures jetties, groins) each have a unique, abundant and constantly changing assemblage of marine life that provide food and shelter for the entire coastal food web, including fisheries and seafood consumers. Shoreline organisms include thousands of species of fishes, crabs, barnacles, sea urchins, starfish, marine worms, clams, oysters, snails, limpets, chitons,sea weeds and kelps, sea grasses and micro-organisms (including oil-degrading bacteria!). These plants and animals live, feed, compete, prey and reproduce in loosely-knit biological communities. These shoreline resources and biological communities are threatened and can be severely damaged by the initial impacts of an oil spill. However, many organisms survive an oil spill and, if carefully protected, they will recover their populations and help treat the remaining oil.

The best historical example of cleanup "over kill" is the 1969 TORREY CANYON Spill in England : a lot of marine life that survived the oiling was killed by the kerosene-based solvents used to clean the rocky shorelines. Yes, the shoreline was clean (the removal was effective), but a lot of damage was done to surviving marine life (Hawkins and Southward 1992). A more recent example is the 1989 EXXON VALDEZ oil spill. On rocky shorelines, a large amount of inter-tidal marine life survived oiling but was killed by high-pressure hot-water washing (Lees et al. 1996). The washing was effective in removing oil from the rock surface but, compared to untreated shorelines, it also delayed recovery of marine life. Use of a chemical shoreline cleaner reduced the need for heavy washing, but it was not approved (Lees et al. 1996).

On cobble and sandy shorelines, hydraulic washing removed not only oil but also the fine-grained silt and mud that is required for successful growth of clams. Indeed, during washing it was possible to see many sediment plumes entering the clear water offshore (Mearns 1996). In addition, long-term monitoring studies at both spills confirm that heavy cleanup activity delayed recovery of shoreline marine life. In the case of the EXXON VALDEZ, which we have studied in great detail, heavy washing delayed the onset of recovery of seaweed by a least one year (Figure 2, Houghton et al. 1997 and Mearns 1996). Today, 8-years later, marine life thrives at both oiled and treated shorelines but the marine communities are still notfully recovered in terms of their structure and species composition (Houghton et al.1997).

2.3 Marine Life Protection: A Global of Shoreline Cleanup

As a result of this new understanding it is now generally agreed that the goal of shoreline cleanup is NOT to "get all the oil out" off the shoreline but rather to remove enough of the oil so that nature can complete the job. Too much cleanup (too many people, too many chemicals, too much washing) can add injury to marine life that has otherwise survived the spill itself, In short, too much cleanup can delay recovery.

3.0 Overview of Shoreline Cleanup Alternatives

Alternatives for shoreline cleanup include no response, physical treatment and removal, chemical treatment and biological treatment (bioremediation). Physical methods include manual treatment (pick up, raking, manual absorbents), mechanical treatment (tilling, scraping, berm relocation), flooding and hydraulic washing (cold or hot water, low or high pressure with skimming), burning (mainly in marshes), sand blasting and others. Chemical treatment includes use of surfactants or other chemicals to aid in physical removal or biodegradation. Biological treatment includes use of nutrients, tilling and / or oxygen to stimulate natural biodegradation or application of oil-degrading microbes. Each method works best within a certain "window of opportunity" and only on certain shoreline types and specific oils and fuels. Experience has lead NOAA and other agencies to use a "Shoreline Countermeasures Matrix" that guides the responder to the best methods for a specific situation and to deter inap-propriate applications (for example, Whitney 1994.)

3.1 Effectiveness of Shoreline Cleanup

"Effectiveness" describes how much oil is removed compared to how much was present or remains. No method is 100% effective. In some situations (sandy beaches, manmade structures in harbors) almost all the oil can be removed with manual, physical or chemical treatments with little or no impact on marine resources. However, on rocky and cobble shorelines (such as in the EXXON VALDEZ) and in marshes only a small fraction of the stranded oil can be removed without further damaging marine life. Overall, shoreline treatment removed 4 to 9% of the oil stranded on Alaska shorelines following the EXXON VALDEZ oil spill (Wolfe et al. 1994 ; Mearns1996) ; the rest was removed by winter storms and natural biodegradation (Michel et al. 1991). A small amount remains trapped inside several shoreline segments today. Elsewhere, such as in marshes, burning may be highly effective (Mendelssohn et al. 1995).

3.2 Effects and Limits of Shoreline Cleanup

It is important to repeat that lot of shoreline plants and animals survive light and moderate oiling. Anything that can be done to maintain their survival will speed the ecosystem recovery process. However, if surviving marine life is killed or removed along with the oil, ecosystem recovery will take longer. We are slowly learning what some of the limits of cleanup are. For example, in hydraulic washing in biologically-rich areas, water tem-peratures should not exceed 40 ℃ (Mauseth et al. 1996). Some shoreline chemical cleaners are more toxic than oils, others much less so (sensu Fingas et al. 1995). Thus, in biologically-rich areas, only the least toxic ones should be used. Some bioremediation agents contain toxic materials so their use should be restricted in bio-logically-rich areas. On the other hand, burning heavily-oiled marshes, while very destructive to vegetation, can quickly reduce the risk of oiling to migratory birds and still result in rapid and complete recovery of the marsh (Mendelssohn et al. 1995). Thus, each method has its limits.

The real question during a response is "How Clean is Clean Enough?". That has to be decided by consensus, but that consensus should now include an evaluation of the sensitivity of various shorelines and the natural processes that will ultimately clean up the remaining oil.

4.0 Bioremediation

What is bioremediation and what is its role in shoreline cleanup? Bioremediation is our attempt to accelerate the natural biodegradation of oil in the environment. Biodegradation is the process by which bacteria chemically degrade specific compounds in oil. Compounds amenable to natural or enhanced degradation include alkanes and polycyclic aromatic hydrocarbons (PAH's). Compounds that are not amenable to enhanced degradation (in the time frame of a response or restoration activity) include asphaltenes and waxes. Of these, the PAH's are of most ecological concern because they are toxic and carcinogenic. Therefore, an effective bioremediation activity is not necessarily one that removes the oil, per se, but one that substantially accelerates degradation of the PAH'S.

Until the EXXON VALDEZ oil spill, many believed that it was necessary to add oil-degrading bacteria to the sea coast to accelerate the degradation of oil. Many people also believed that using microbes, oil could be degraded in a few days. In the laboratory, the culture and addition of oil-degrading bacteria to oil does, in many cases, accelerate the degradation of oil in controlled experiments, even over a period of a few days. However, the sea coast is not a controlled experiment. Weather, currents, wind, waves, rainfall, and microbial competition and predation all act to limit the usefulness of adding bacteria or other materials to an oil spill. Numerous shoreline oiling experiments in Alaska, Canada, the lower US and Europe have all shown that oil degrading bacteria are present everywhere along the coast and that the primaryfactors limiting biodegradation are nutrients (N,P), oxygen (in anaerobic marsh soil) and the oil itself (some are more degradable than others) (Swannell et al. 1996 ; Venosa et al. 1996 ; Hoff 1993 ; Hoff et al. 1995). Therefore, most active researchers today support the concept that to accelerate biodegradation it is necessary to supply only those factors that are limiting : in many cases this will be nothing. In a few cases it may be necessary to add nutrients (nitrogen, phosphorus) or oxygen (via chemical or physical aeration; Swannell et al. 1996). The best way to determine what is limiting is to measure existing concentrations of nutrients and oxygen in oiled shoreline sediments. For example, Venosa et al. (1996) suggest that in beach sand, soluble nitrogen may be limiting if it is below 2 mg / L in the sediment. In that case, nitrogen could be supplied continually in a dissolved state (as described by Venosa et al.1996) or in "slow-release" forms such as prills, pellets or briquettes.

Shoreline bioremediation experiments conducted by Venosa et al. (1996 ; also cited in Mearns et al. 1997) on a sandy beach in Delaware (USA) demonstrate the attributes of successful bioremediation and how it compares to natural processes (Figure 3). Using a randomized-block design they subjected inter-tidal plots of Nigerian oil to no treatment, nutrient treatment only, and treatment with oil-degrading bacteria-plus-nutrients. The experiment lasted 3 months. Half the oil was removed from the shoreline every 28 days simply due to physical washing and weathering processes. Alkanes and PAH's in the oil that remained on the shoreline were degraded naturally (with no nutrient or bacteria added) with additional half-lives of about 28 days. Added nutrients doubled the rate of degradation of alkanes (from 28 to 14 days ; and increased the rate of degradation of PAH's by about 50% (Figure 3C and D)). Addition of oil-degrading bacteria did nothing. In fact, within a few days of simply adding the oil, Venosa et al. (1996) found that natural concentrations of alkane- and PAH-degrading bacteria were about one million organisms per gram of sand (Figure 3E and F). In addition, 4 out of 5 bioassays revealed that regardless of treatment, oiled beach sediment rapidly lost its toxicity to microbes, sea urchin larvae and shrimp embryos (Figure 3G through J). However, even a low weathered oil concentrations, the oiled sediments were still mod-erately toxic to amphipods (Figure 3K).

Similar experiments have been conducted in other shoreline environments including tidal flats, marshes, wetlands and cobble beaches (Swannell et al. 1997). All agree with the general principle that if anything is limiting oil degradation it will be nutrients and oxygen, not bacteria. As a result of all this, Mearns et al. (1997) proposed a bioremediation response action plan that includes (1) Pre-treatment Assessment (is bioremediation a viable response? and determination of the rate-limiting process), (2) Treatment Planning and Monitoring (selection of rate-limiting treating agent, load rate calculations, monitoring needs), (3) Implementation (Acquisition and deployment of treating agents and delivery system and personnel training) and (4) Termination of treatment.

5.0 Future

In the US and Canada, we believe we know enough about shoreline cleanup methods to provide specific guidance to responders. The most recent advice is contained in a new "Marine Manual" being prepared by the American Petroleum Institute with review and contributions by many agencies in the US, Canada and Europe.

However, there remains much work to do. Various cleanup methods, including bioremediation, need to be tested on oiled beaches in other parts of the world and in other environments. We also need to more fully test various methods on different types of oils, which vary round the world. For example, there appears to be a great need to test cleanup methods on spills of orimulsion, the new bitumen-containing fuel oil from Venezuela. Japanese scientists could expand this knowledge by conducting controlled cleanup experiments on experi-mentally-oiled shorelines. Tests could be done with a variety of physical, chemical and bioremediation agents not yet subjected to such testing in the US, Canada or Europe. Product field-testing guidelines and criteria have been established and should be used to conduct any experiment (Mearns1995) and the results should be published in the scientific literature. In addition, Iong-term recovery studies (such as described in Houghton et al. 1997) should be conducted at test sites to document the rate at which oiled and treated shoreline ecosystems fully recover. With this information, response agencies will truly have a "tool-box" of alternative shoreline cleanup methods that work and do not cause further injury. We at NOAA's HazMat Division look to continued collab-oration on this important work.

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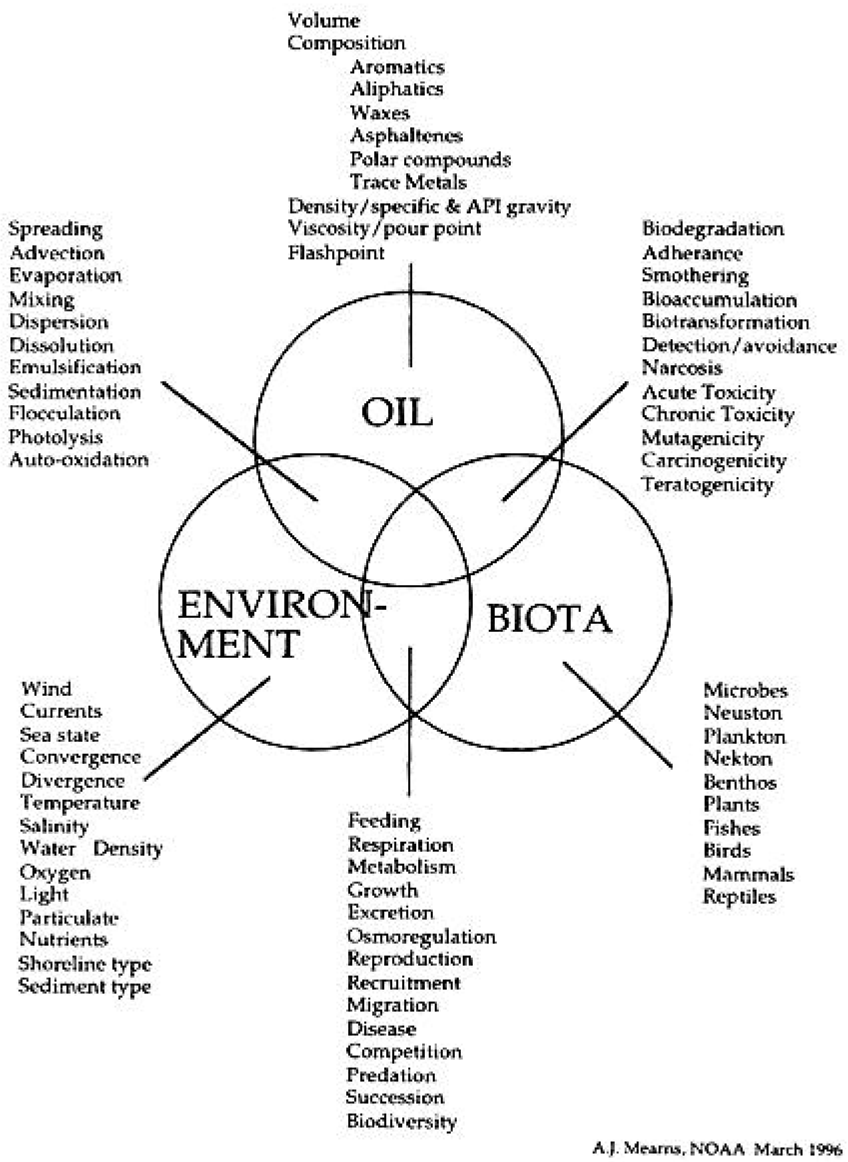


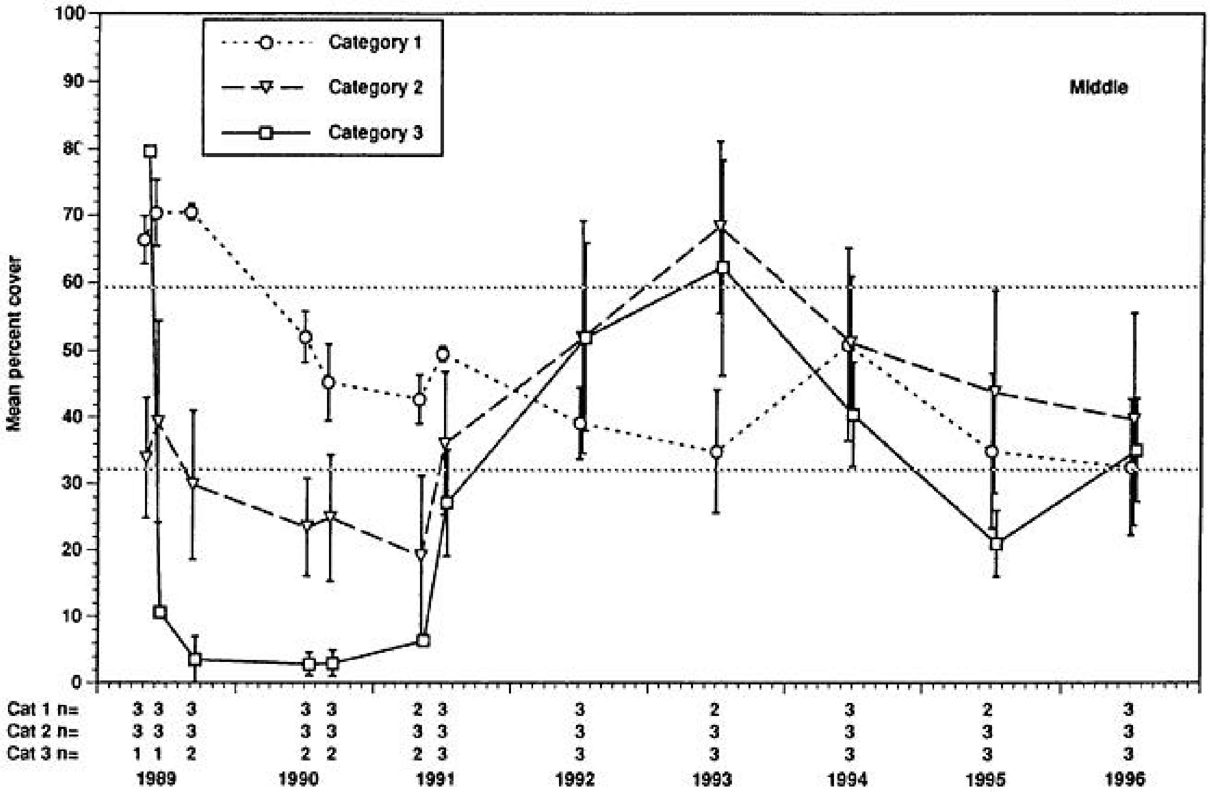
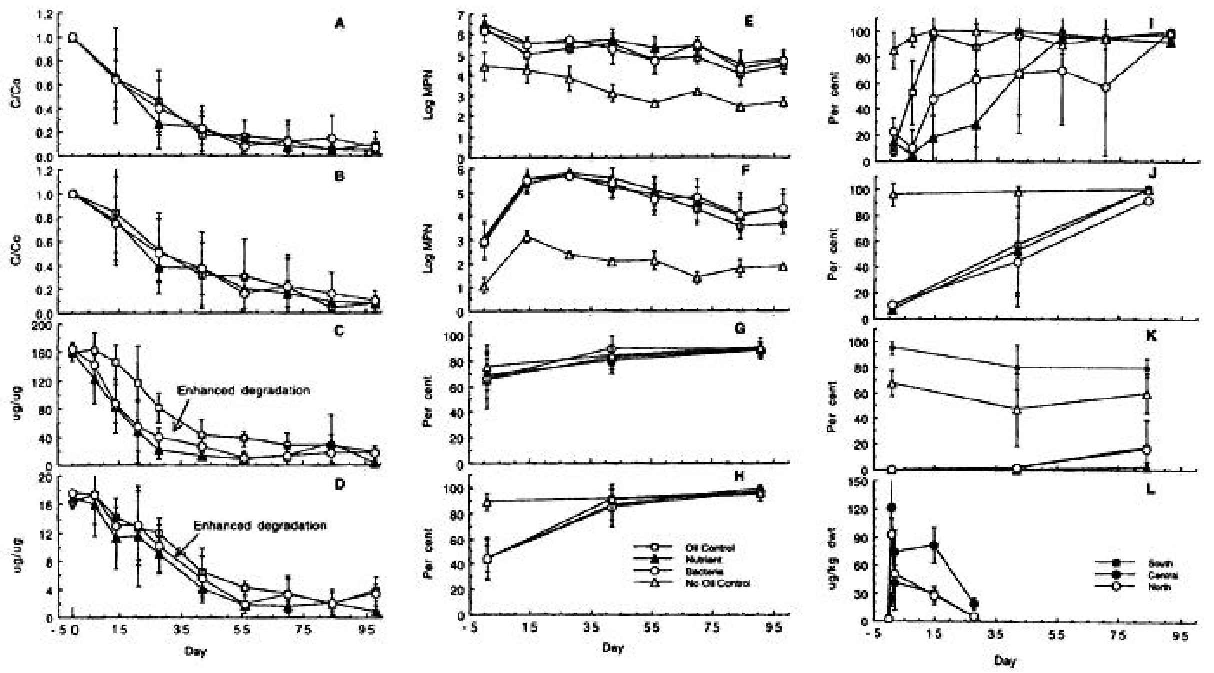


Figure 2. Longterm ternds in the amount (per cent cover) of the seaweed, Fucus gardneri, at three categories of middle intertidal rocky shoreline sites in Prince William Sound, Alaska, 1989 through 1996. Category 1, unoiled sites ; Category 2, oil but untreated sites ; and, Category 3, oiled and high-pressure, hot-water washed sites. Dashed lines indicate the range ofvarination at unoiled sites. NOAA HazMat data in press, 1997.

Figure 3. Comparisons on a common time scale (100 days, about 14 weeks) of mean (± 1 SD) of sediment chemical, microbial and toxicological conditions in replicate (n=5) plots treated with weathered Light Bonney Nigerian crude oil (Oil control, open square), oil plus continuous application of dissolved nutrients (Nutrient, closed diamond), oil treated with both dissolved nutrients and cultured bacteria consortia (Bacteria, dark square), and unoiled and untreated (NO oil control, open diamond) on a sandy beach in Delaware, July-0ctober, 1994. There were no significant differences among the 3 oiled treatments for loss rates of extractable organic material (EOM, a rough measure of TPH, total petroleum hydrocarbons) (A)or hopane, a recalcitrant (non-degradable) hydrocarbon (B). All measurements of EOM and hopane referenced to initial concentrations (C/Co ; Co about 5,000 mg/kg dry wt for EOM and about 200 μ g/kg dry wt for hopane ; background EOM was bout 10 to 80 mg/kg dry wt and hopane about 0.007 μ g/kg dry wt). However, relative to untreated oil controls, analyte-to-hopane ratios demonstrated that nutrient and nutrient+bacteria application equally and doubled the loss rates of C10-C35 alkanes (C) and increased by 20 to 50% the loss rates of the total of 27 2-5-ring polycyclic aromatic hydrocarbons (D). Concentrations of sediment alkane degrading bacteria (E) increased rapidly in response to both treatments and then slowly declined whereas concentrations of PAH degrading bacteria (F) increased more slowly in responseto both treatments and then declined. Relative to unoiled controls, beach pore water samples taken at 42-day (six-week) intervals from oiled plots were initially slightly inhibited sea urchin egg fertilization (G) but significantly depressed light production of photoluminescent Microtox bacteria (H)and hatchability of grass shrimp embryos (I ,n = 2 per treatment per sampling event) ; toxicity was lost at diferent rates but with no significant difference among oil treatment types. Bulk sediment elutriate was initially highly toxic to Microtox organisms (J) but toxicity declined. Bulk sediment from oiled plots also highly depressed 10-day survival of benthic amphipods (K) throughout the entire monitoring period and there was some toxicity in the on oiled control plots themselves. Oil lost from the 1-km beach study zone was initially accumulated (as PAH'S) in oysters placed in cages several meters seaward of the study blocks (Central), upstream of the study site (South) and downstream of the study site (North)(L) ; in all cases depuration was nearly complete in 28 days.



Discussion

Lessard： I would like to know what your current recommendation is on the cleaning of heavily oiled beaches. Where do you come out on that, given some of your studies?

Mearns： I think we've seen many examples, from vacuuming, manual pick-up,use of various kinds of absorbents. We didn't cover all of those today. And washing. I think the question is, "How clean is clean enough?" I don't think we have to, in many places, necessarily to remove all of the oil. If we remove the fluid oil — the oil that is mobile at ambient temperatures and ambient pressures — and let nature come in and finish off the process, first of all we will save money, and second we will save a lot of marine life that can help recolonize and get some of these shorelines back to a recovery mode again — coupled with manual pick-up activities. And I think in the case of the EXXON VALDEZ, I wasn't around when the decisions were made, and so on, but I would have argued more for vacuuming, such as we have seen in the recent spills, including here in Japan.

Davies： The cormmunity was actually pushing for us to clean every rock individually. We were seeing some really extreme positions. I think what we did was a compromise solution at the time. But I think your work is useful.

Mearns： Thank you. I would like to underscore this one statement again.:"How clean is clean?"l guess that is just something to think about.

Davies： On the SEA EMPRESS incident, where rocky platforms and boulders had been impacted by oil, it appeared that they were recovering quite well, because there was a proliferation of green weed appearing on the rocks, but apparently that was not a natural situation. It was due to the slow return of naturally occurring grazing animals such as the limpets. Is that to be expected?

Mearns： Yes, it is. That happened in the EXXON VALDEZ spill, and we all learned all it from the TORREY CANYON, when it took even longer for recovery because the chemicals that were used in the TORREY CANYON incident killed the grazers, the animals that eat seaweed — very, very high mortality. I think what you saw in the SEA EMPRESS incident is just the short term, an eco-logical pulse of this green algae. The grazers should be coming back in great numbers right now, as long as you didn't treat it too heavily.

Observer（R.D. Tait, Exxon）： I have one comment. There is a real challenge for the biologists and scientists to go on and communicate the things that we are learning here today and have learned over the past 5 years or so of spills, 7 years since the EXXON VALDEZ. We really do have to get the message across on the natural recovery, and the ability of the environment to rebound from these insults that go on. And until we can do that effectively to the broader audience, we are always going to have the political and the community pressures to go out there and overreact. I think one of the real challenges is to be able to demonstrate that, and certainly through Tim's work that we are seeing now from the SEA EMPRESS, we are getting more scientific data out in a faster time frame that is helping to serve our cause in dealing with these events.

Mearns： I agree.

Discussion

Kudo： I have a question for the British delegation. In the case of the BRAER incident, Lord Donaldson has made a report "Safer Seas and Cleaner Ships." I believe he made 103 recommendations in that report, of which 86 points have been completely accepted, I have heard. Of the remainder, 4 have been rejected, and 13 are on hold. I believe that was the situation as of March in the U.K. From my own experience of the NAKHODKA incident, I suppose there may be some points where Lord Donaldson's recommendations may be of use. So, if you could share with us how his recommendations are being actually implemented in the U.K.

Gainsford： The Lord Donaldson report, as I said in my presentation, has had a tremendous impact in the U.K., and I think actually worldwide, because it was a very considered and useful document. That is why, on behalf of the British government, we have taken seriously all those recommendations, and had already implemented over 80 of them. A Iot of them were implemented by the Marine Shipping and Maritime Security Bill of 1997, which has just gone through Parliament before the election process. And that was establishing a pollution zone out to 200 miles, increasing pollution fines fivefold. So, we're up to 250,000 pound fines for offenders of the MARPOL regulations, also increasing the intervention paths of the Secretary of State to intervene in incidents and to direct, and extending that direction to harbor authorities, pilots, harbor masters, etc. So all the main recommendations have been taken to heart. Also, we have incor-porated a power in that bill to ensure that, if necessary, Iater we can assign statutory duty to local authorities to carry out beach cleanup and to make contingency plans. As I emphasized in my presentation, it is now a voluntary act. But we have put a power in there, and we could, if necessary,through statutory instrument, make a regulation.

The outstanding recommendations need international agreement, and are being discussed at IMO. That is why they are taking longer to implement. The 4 refusals ー I can't remember exactly, but I think they were mainly the financial provision for oil-pollution services, which we haven't been able to make progress with, I think because they would put British shipping and commerce on and adverse footing with the rest of the world. But, also, there are chances that Lord Donaldsonmay participate in the validation of the review of the national contingency plan subsequent to the SEA EMPRESS incident, especially to do with salvage. So I think you might hear more from him in due course.

Imaichi： Dr. Lunel, I have a question for you. The dispersant, I understand, is extremely effective, but does the dispersant itself and the toxicity of the dispersant ever come into question? You said the fish were tainted. Do oil droplets affect the gills or the digestive orgams of the fish? Do they cause any negative effect on the fish and plankton?

Lunel： About the toxicity of the dispersant, the modern dispersants are of very low toxicity. And it has been recognized by most of the countries that use dispersants that the toxic effect comes not from the dispersants itself, but from the fact that the oil is dispersed in the water column. Now, most of the countries that use dis-persants will test the toxicity of the dispersant, not by using dispersant on organisms, but by making sure that when dispersant is used on oil that it doesn't increase the toxicity of the oil itself. In the example for the U.K., Kuwaiti oil is used on the brown shrimp, Crongon Crongon, as a test organism, and the toxicity of the crude oil is compared with the toxicity of the crude oil that has been dispersed by using the dispersant. And as long as the toxicity is not increased when dispersant is used, then that dispersant is approved.

The reason I mentioned the tainting in particular is that it is a lower-level effect. The first effect that you-might look for, I agree, is a toxic effect resulting in a kill of fish populations. Even in the BRAER incident, where you are getting as high a concentration of oil as you are ever likely to get, the fin fish swam away from the dispersed oil. So therefore, there were no acute toxic effect to any moving organisms. That was also the case in the SEA EMPRESS incident. There were no acute effects to any organisms that could actually move away from the dispersed oil. The organisms that are more likely to be affected by the dispersed oil are those like the bivalves, which are anchored to the substatum. With them, there is more likely to be an effect of physical smothering, and the oil droplets, particularly for the filter feeders, clogging up their filtering mechanisms. There were some acute effects, particularly near the spill site. I mentioned those with regard to the SEA EMPRESS, again the same with the BRAER. Those are very localized within something like the first kilometer from where the oil was spilled in both those cases. Bivalves were affected, and there was actual mortality with the bivalves in that local area. But it was very localized, and as soon as the concentration is diluted to below about 10 parts per million, then there aren't those acute toxic effects. And that has been a threshold level that has been agreed upon in some of the workshops that have been held in North America recently. If the concentrations are not exceeding 10 ppm for more than 2 hours, then acute toxic effects are unlikely.

Coming back to the tainting issue, there is the possibility of tainting of the flesh, in terms of being able to taste the oil in the flesh, which makes the fish unmarketable, at much lower oil concentrations. But that's a commercial fisheries' issue rather than an environmental issue.

And the final point that you raised, on the plankton, in the area where the oil is first dispersed into the water column, if the concentrations are significantly above 10 parts per million, which does not happen often, and did not happen in the SEA EMPRESS incident, even after dispersant application, there is likely to be a toxic effect. And there will be some reduction in the plankton population. I think then, in terms of net envi-ronmental benefit, that effect has to be weighed against what might be a toxic effect if the oil hits the shoreline. There is very rapid recolonization of plankton in most open seas. I am not aware of, and Alan Mearns might want to comment in more detail about, any studies that have shown that dispersed oil in any concentration results in a significant impact on any open-sea plankton population.

Mearns : In the United States some years ago, we seemed to be approaching whether or not to use dispersants from the point of view that if you did not use dispersants you would not have any oil in the water. With most of the oils and fuels that we deal with, there will always be some amount of oil in the water. So, from a marine biological point of view, I think that the answer is not that we are putting oil into clean water, but we are putting oil into water that already has oil in it. And the question is : "How much is too much?" But to start with the assumption that there is no oil in the water is wrong.

The second thing is that we have learned a lot from these oil spills in the U.K., and in Canada to some extent, and in the United States about how fast tainted animals lose oil. It's what we call depuration. And there is a very fast process, perhaps a half-life of a week or 2 weeks at the most, for most fish or crustaceans that are contaminated to lose their oil. It's a very rapid process, once they get into clean water.

There is another point that I have been very interested in for a long time, and I think I have discussed this with Dr. Lunel and his colleagues to some extent. There was a very interesting study done in Canada 25 years ago, where a scientist sampled the plankton, copepods and small animals, and found they were alive during an oil spill, and they had 7,000 parts per million of Bunker-C oil in them. They were feeding on these fine dispersed particles of oil and using the oil as food. And they were alive and well and producing fecal pellets.

This is where I think we need more research, because these things touch on the ultimate question, which is "What is the fate of oil in the ocean?" Most of the oil that we spill will remain in the ocean, and we have little hints of information about its fate. And the fate looks like that it becomes part of the food chain. So I think we need to understand all of these points when we are trying to decide whether or not to use chemical dispersion, and so on : (1) that there is already oil in the water, (2) that we may be accelerating a process that is natural and is going to go on anyway whether we do anything or not, and (3) we really ought to monitor and observe carefully what is happening during these events.

Davies： Dr. Lunel, on the chemical dispersant, you were very closely monitoring the actual planes that were dispersing this chemical. How close could you get safely?

Lunel： In terms of health and safely, the important thing was to have face masks on, to prevent us from actually breathing in any of the small particles that might be in a respiratable fraction. And then it's purely a case of how much you trust the pilots. In the case of Air Atlantique, we have worked with them regularly in field trials. That raises an additional point. If you're going to have a dispersion operation and have it successfully mounted, you actually have to practice everything for real. You have to actually go out and treat oil. I think that is one problem that the United States might have in going to increasing use of dispersants. And that is, unless you can actually exercise on a real oil spill, you won't get that relationship and that trust of how close you can let the planes come. Certainly, we never felt in danger, and they are used to coming close to vessels during experimental trials, and in real operations. And they are good at their job.

Davies： How close do you need to get to obtain valuable results?

Lunel： At a minimum, you have to be within 500 m so that you can go in immediately after application of dis-persant. There were cases where we were closer than that, because we wanted to have a look at that very initial process. You don't necessarily have to be in as close as we were to get the bare minimum information. And I think, therefore, it's a balance between safe operation and getting the information you want.

Mutoh： Dr. Lunel, do you have any advice for Japan?

Lunel： At the moment, because of the experience with heavy-fuel-oil spills, most of the response has been geared to spills that have already happened around Japan. With the increasing traffic in crude oil that we have been hearing about, it might be appropriate to Japan review whether the response needs to consider in more detail those spills that may be less likely to happen but maybe of larger potential volume. Clearly, you have a mechanical recovery in place that is going to be very appropriate for the heavy-fuel-oil spills, but you might want to consider,for example, a national dispersant response to complement the mechanical recovery. Clearly, the balance between how much mechanical recovery vs. dispersant you might use is going to depend on the specific oil type or the specific conditions at the time of the spill. But having that extra option might be appropriate, particularly from what we have been hearing about the trends of oil movement around Japan. As an outside observer, I would be interested to know how you would feel about that.

Kudo： Regarding mechanical recovery, You mentioned that the quantity of oil recovered by using mechanical recovery was around 5 to 10%. But I think mechanical recovery can collect more than 10%. And I think the Japanese people actually favor mechanical recovery.

Earlier you mentioned that funding for R&D was limited and therefore development work could not be fully done. In Europe is there any movement of joint research on this mechanical recovery? It seems the U.K. is pro-dispersant and Norway pro-mechanical recovery. So it may be difficult to use a common fund, but in Europe is there any movement of joint research?

Lunel： I think there is very much a movement, not only within Europe, but also with North America as well. I mentioned that the trials that are taking place in September will also involve not only the European states, but also North America, and Exxon in particular. On the specifics of mechanical and dispersants, there is research that is going on in both. As I hoped to emphasize in my talk, despite the different emphasis between the U.K, and Norway, I think actually the differences are very small. It is purely a matter of which response method one wants to use first. Both options are viewed with an open mind in the U.K. and Norway. And I think that is becoming the case in North America. And, to me, it would seem a reasonable way to go forward-to leave both as an option.

There is joint research on dispersants. In terms of mechanical recovery, there has been less actual research on mechanical recovery methods, largely because it is viewed as a relatively well-established industry. There have been very few innovations in the area of mechanical recovery in the last 10 years. Where there are new challenges, there is joint research. And we are working particularly with France on recovery at sea and also recovery of oil emulsion from shorelines. And we had anticipated some trials in September on oilmulsion. They have been postponed, probably until next spring. But there, we would anticipate it being a joint research program. And I think if you have techniques that you feel would be appropriate to test in field trials, then as a possible collaborative program, we are always very interested in that.

Gainsford： I would like to expand on that from the government point of view. We prefer to have a mixed bag of clubs. We want to have the capability to disperse and also to recover at sea. It comes down to cost. And you have heard the American option, which is extremely effective but is costly. We haven't gone down that line, I think because we don't have the intention of stationing dedicated ships all round the U.K. coast to deal with the risk assessment. I think in Norway they have a more targeted risk assessment from the actual oil rigs. And therefore, mechanical means can be focused more rapidly. In our case, we need to respond within hours to anything out to the 200 mile zone all round the U.K. and Northern lreland. There is no way we could do that by mechanical means initially.

So that is the main reason we rely on aerial dispersants as the prime means of counterpollution. And it can be implemented within 2 to 3 hours anywhere within the 200 mile zone. But if the conditions are right, and the threat is there to the environment or to the coastline, we would support that, as we did with the SEA EMPRESS, with mechanical recovery.

Around this table, there are lots of experts, but my understanding is that in no major oil spill has mechanical recovery recovered more than 10%. And that is borne out by evidence from previous incidents. That is just a fact.

Observer（H. Rydland, The Marine Group）： I think first of all maybe we have to appreciate that Japan might be slightly more sensitive to damage to the marine environment than many other countries around. This includes the use of dispersants. I would like to take this opportunity to make a few comments, and perhaps ask one question.

For any method to be effective in fighting an oil spill, you need to have the proper hardware, the proper software, and it needs to be applied in time. When it is being said here that in no major oil spill has mechanical recovery recovered more than 10%, I think one has to keep in mind that in most of these cases, no equipment has been deployed which has been proper for use offshore to recover oil under those conditions. This includes the SEA EMPRESS. And it has not been deployed in time.

When it comes to the SEA EMPRESS incident, when the French navy was engaged with a Transrec skimmer system, that system successfully recovered a substantial amount of oil, and I think that to reply to Nishigaki-san's query about test results for the Transrec, I think those results are available from the report that the French navy made on the SEA EMPRESS operations.

I would also like to comment on the question regarding tests of mechanical-recovery equipment. The NOFO organization, during their annual oil-on-water exercises in the North Sea, will always put mechanical recovery equipment to the test. That means that they actually invite manufacturers to bring out new equipment, and that equipment is put to the test in front of a number of visitors from all around the world, who can witness whether or not the equipment works. So, this is probably the occasion where most mechanical recovery equipment is put to the test.

My question： One recovery method which has gained momentum and increased recognition in the United States is in situ burning. This is something that has not been mentioned in relation to the NAKHODKA spill in Japan. And my question to the Marine Safety Agency or PAJ or whichever body might be the correct one to answer is: Has in situ burning been considered as a method for fighting a major spill in Japan? And if so, what procedures would have to take place to get approval to carry out in situ burning in Japanese waters?

R φ dal： He emphasized that we did a bit of testing of offshore equipment, which we have done in many of our field trials. But I do agree with him that in a lot of offshore mechanical recovery operations, suitable equipment has not been used. And the people who have put it to use haven't had the proper training, and the ships haven't been ideal for the operation. One shouldn't necessarily judge mechanical equipment by past performance .

Suzuki： On in situ burning, Nippon Foundation has subsidized a project in which we, Marine Disaster Prevention Center have done research and investigation for several years. The in situ burning treatment method has been established. A the time of the NAKHODKA incident, there was no rule introducees for in situ burning yet. We requested for official permission to test in situ burning offshore, but in vain. If we were to burn near the shore, we would have opposition from the commnunity. So we couldn't actually do that.

Kudo： The NAKHODKA was an incident that took place on the open sea off our shores. Let us imagine that there was a vessel passing near Hawaii and there took place a spill; and because of the current Hawaii became polluted. I think this problem would not be covered by what was anticipated by OPA '90. But if such an incident were to occur, what would you do?

Bennis： If I understand the question properly, it is, "Should a spill occur in international waters and impact our shores, how would OPA '90 handle that situation?" Quite simply, if there is a substantial threat to the shores of the United States from an incident, regardless of where that incident may occur, we can then utilize the Oil Spill Liability Trust Fund created under OPA '90. We, the Coast Guard would contract for a cleanup contractor to respond to that incident. We would use all the tools we've gathered under OPA '90. We would go to our list of Oil Spill Response

Oganizations. We would go to our response inventory, and we would then contract with a cleanup contractor to attack that problem.

Imaichi： In the NAKHODKA incident, as time went on, the oil became heavier and congealed. Have you not thought of making it solid, instead of dispersing? If it were solidified, it might be removed easily. Then 5 or 10% rate for mechanical recovery could be improved.

Lessard： Our research program has taken the industry lead on solidifiers for the last 3 years, under the umbrella of the Petroleum Environmental Research Forum, which is an organization that brings together petroleum companies to jointly fund studies. It is an exception to the antitrust rules of the United States that allows us to pool resources and work together on environmental matters. Under that umbrella, we have been studying the application of solidifiers for spills on water and on land, and have issued several reports on that. The bottom line is that there are a number of solidifier materials. These are polymers that actually react and bond with hydrocarbons, often leading to a solid mass that can be physically removed from the water, or from the soil. However, they are most effective when the oil is very light. On a diesel or gasoline spill, for example, the rate is very fast, and the efficiency is very good. However, it is a rate process, so the thicker and the heavier the oil, the longer it takes. And often, with a very heavy oil, such as you had in the NAKHODKA spill, the outside of the polymer becomes plugged up with these large molecules, and the efficiency becomes very low. And so if we had very light oil spills, solidifiers would be very applicable. But for heavy oils, it is less so.

Chairman's Report : Chairman Motora

This time we had planned an intenational symposium with a purpose of learning lessons from the NAKHODKA oil-spill incident, and also to learn from the experiences of the past major oil-spill incidents in other countries from those experts who have been involved directly in those oil-spill responses, so that we will be able to be given guidance and advice that will be useful in preparing response in future oil-spill incidents.

We heard very enlightening comments and speeches from the guest speakers from many countries, and had very active and intensive discussion among the guest speakers. So, I feel the symposium was very useful and valuable for us indeed.

I will not have time to cover all the valuable points made at this symposium, but allow me to share with you my own impressions of this symposium. :

1） Initial action in any oil-spill response is crucial. You need to try very promptly to deal with the situation. Therefore, you need to firmly establish a contingency plan at all the levels, and try to establish a cooperative liaison system amongst all the responders and the different levels.

2） In oil-spill-response activities, you need to make quick decisions under uncertain situations; therefore you need very prompt provision of information. And such information obtained should be shared by all the responders. When an incident occurs in international waters, for the wrecked ship, we need to have information quickly notified from the flag country, from the ship owners, as well the operators. I believe we need to make this obligatory through international agreement or something of the like.

3） We need to have unified response approach. This, I believe, is an especially acute problem for Japan, because we don't have much interdepartmental communication in Japan. We need to unify and integrate our efforts.

4） It is necessary to appoint an on-scene commander or coordinator, and to delegate the power in order to make the necessary decisions.

5） As for performance of the mechanical-recovery units, especially under very bad weather, NOFO has been conducting oil-on-water tests, so their assessment is indeed invaluable. There are many noteworthy points in their assessments on performance. At a significant wave height of 2.5 meters and current speed of up to one meter, that kind of recovery is quite feasible, according to the data provided, which is quite encouraging to us.

This is just my personal view. In Japan, under the law, we are forbidden to conduct real oil-on-water experiments on the sea. But, in the NAKHODKA incident, is still leaking. 3 to 14 kiloliters of oil from the main body of the NAKHODKA. If we can utilize this opportunity for training purposes or to improve the mechanical-recovery units or to confirm the effect of dispersants, then we can get something good out of the bad experience.

6） According to the experience of the SEA EMPRESS incident, it is said that out of the oil spilled into the sea, 40% evaporated, 2% was mechanically recovered offshore, 2% was recovered on-shore, and 5% was residual on-shore. Natural dispersion was 14%. And through application of dispersants, 37% was dispersed. Hearing these data, we realize anew how difficult it is to recover oil under rough weather conditions offshore. When we think of the winter in the Sea of Japan, as in the case of the NAKHODKA incident, when we think about cleanup activities, we need to give full heed to these data in formulating policies for cleanup.

As for offshore recovery, and when using equipment in natural situations, we need to pay heed to the opinion that we should think of the performance of the equipment as being 20% of what the manufacturers claim in their catalogs. Also noteworthy was the point made about standarizing on-board skimmers into several categories and introduce common units that could be used throughout the world.

7） As can be seen from the SEA EMPRESS incident, aerial application of dispersants was extremely effective. But at the initial stage whether to apply dispersants or to perform mechanical recovery or to leave it to natural dispersion, that decision is very much related to the prediction as to whether oil will be hitting the shoreline. So it is very difficult to make that decision. Therefor, for this purpose, we need to improve and create a reliable drift-prediction system. PAJ has already developed several general-purpose programs for simulation, including realtime meteorological information covering several sea areas. At the Ship and Ocean foundation we are about to develope a program for prediction of changes in the properties of oil as well as prediction of drift. And we hope to have a database to include tide and current information which covers a larger area of the ocean.

8） With regard to the use of dispersants, unless they are applied within 48 hours, the effect is largely lost. But we expect some toxicity from dispersants. The fishing industry is very worried about use of dispersants. So as is done in Norway and the United States, it would be preferable to introduce a preauthorization system of use of dispersants for different regions so that we can respond very quickly. And we need to take a forward-looking attitude about the introduction of such a system. For this, it would be favorable to have sensitivity maps created for each sea area. I understand that the Marine Disaster Prevention Association is moving ahead with a project subsidized by Nippon Foundation in this regard.

9） We can fully anticipate that groups with different interests will propose different methods for cleaning the shorelines. Therefore, although it is very difficult, it is a must to have an overall evaluation made, and to have an agreement beforehand as to what should be the priority for that particular shore.

10） In the SEA EMPRESS incident, concrete mixers were used for cleaning up the cobbles. In Japan it was also reported that vacuum trucks and jet pumps of fire engines and barges were used for collecting the high-viscosity oil. I don't think we will be able to immediately have such equipment, but what is desired is to have the documentation for such equipment and how it was used, for future reference.

11） We need to consider the need for temporary storage facilities for the oily waste, and also for final disposal. The collected materials, by law now in Japan, are handled as industrial waste. In the U.K., oily sand is used for road construction, mixed together with asphalt. Or it isreused after biodegradation. Therefore, I think we need study how to reduce the amount of waste by some method.

12） It is noteworthy to having a contract beforehand with the local fishing boats for the operation. This was mentioned by several speakers.

13) Now the report on recovery of marine life affected by oil pollution, and the increase in salmon returning in the year following the incident in Alaska, even exceeding the populations of previous years, is something that gives us hope. Shoreline cleaning, such as high-temperature, high-pressure water washing, does give a better appearance, but it delays ecological recovery. Therefore, though somewhat incomplete, resorting to normal-temperature, low-pressure water washing, and leaving the rest to the natural cleaning process, and to promote biodegradation by adding fertilizer would facilitate ecological recovery. And I think we really should take to heart the meaning of "How clean is clean?" So I think we should make efforts so that cleanup methods using microorganisms would really be established and approved.

Finally, I would like to take this opportunity to express my appreciation to the guest speakers, who have given their very valuable presentations and discussion, as well as the observers, who listened for many long hours.

With this, I would like to close these very significant sessions. Thank you.