

MYTHS AND REALITIES OF OIL SPILL PLANNING AND RESPONSE: THE CHALLENGES OF A LARGE SPILL



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MYTHS AND REALITIES OF OIL SPILL PLANNING AND RESPONSE: THE CHALLENGES OF A LARGE SPILL

**AN ISSUE PAPER PREPARED FOR THE
1999 INTERNATIONAL OIL SPILL CONFERENCE**

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PREFACE

The 1999 International Oil Spill Conference sponsors — American Petroleum Institute, US Coast Guard, US Environmental Protection Agency, International Maritime Organization, and International Petroleum Industry Environmental Conservation Association — commissioned issue papers covering two topics of special importance to the oil spill community. The sponsors assigned responsibility for general management and oversight, scope definition, peer review, and publication of these issue papers to the Program Committee.

The goals of these papers are to stimulate open discussion of complex and controversial issues and balance diverse positions of stakeholders. Each topic addresses varying scientific/technical and socio-political concerns. Therefore, each paper differs as to depth of study and breadth of conclusions. The views and opinions presented are those of the authors solely and do not represent the views, opinions, or policies of the International Oil Spill Conference or its sponsors.

During the 1999 Conference, each of these issue paper topics will be the subject of a special panel session. Publication of these issue papers as separate companion documents to the Conference Proceedings continues the International Oil Spill Conference Technical Report Series. The Technical Reports are published biennially in conjunction with the International Oil Spill Conference.

It is the Program Committee's hope that each issue paper topic furthers substantive discussion and serves as a catalyst for solutions to the topics discussed.



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ABSTRACT

Over the past 20 years, governments and industry have expended considerable effort to improve spill preparedness and response. This paper reviews where improvements have occurred, which elements have been most or least effective, and where future investment should concentrate.

There are a wide variety of approaches to spill response. There is no universal solution to an oil spill, and all available strategies may be required. Despite its proven effectiveness, dispersant use often is discouraged, possibly because of a persistent myth that it will cause lasting environmental damage. Responders, therefore, often are denied use of what could be the most effective tool in the right circumstances.

Other myths persist — for example, the purchase of more equipment is the solution. The reality is that, without proper planning and support, addi-

tional equipment solves nothing. Future efforts must concentrate on strengthening spill infrastructure. Another myth is that mobilising every available resource leads to better response. The reality is that, by selecting appropriate techniques and resources, together with strict cost control, successful response can be conducted at a sensible cost.

Politicians, the media, environmental interest groups, and the public must be educated that, despite response improvements, oil almost always will come ashore. In most cases, however, the environment will not be permanently damaged. Unless public expectations can be reduced to accept this, investment will never be perceived as a success.

It is concluded that, in some places, response capabilities have improved. Unfortunately, in many other places, they have not: too many myths remain, and too few realities are understood.

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EXECUTIVE SUMMARY

Over the past 20 years, there has been massive investment in oil spill response capability around the world. Considerable efforts have been made in many countries to improve the general level of preparedness by developing or updating National Contingency Plans and by examining the issues of spill management, spill risk, priorities for protection, and strategies to be employed, as well as equipment and personnel requirements. National laws, together with bi-lateral and international agreements, have introduced compensation arrangements and have attempted to ensure a higher standard of preparedness and international co-operation. This paper attempts to assess whether these investments have been successful using two criteria for post-improvement responses: Were they technically more effective, or were they perceived to be more effective? There is a danger that the latter may be compromising the former.

Using these criteria, the paper asks the following questions: Have improvements in preparedness and response capabilities been worthwhile? Have the policy and infrastructure changes made a real improvement in the response community's ability to reduce the adverse impacts of a spill? Do these improvements matter outside the context of an incident? This paper examines whether improved response capabilities and performance over the past 20 years are myths or realities. Specifically:

- Have response capabilities to clean up large spills improved over the last 20 years?
- Have increased response capabilities resulted in improved performance?
- Has improved performance had a positive effect on political, media, environmental, and public perceptions?

Information was gathered from a number of major oil spills (>10,000 tonnes or 70,000 bbls) around the world. Smaller spills also were used where they would usefully illustrate a key point. This spill information was combined with the practical experience and personal observations of the author and many oil spill response professionals from around the world, thus providing a well-reasoned basis for concluding whether the critical issues listed above are myths or realities.

The paper concludes that it is impossible to make a general statement about improvements to oil spill response capabilities and performance on a worldwide basis. Rather, specific

changes must be examined regionally or nationally to determine if increased capabilities and improved performance occurred. There have been huge increases in the quantity of oil spill response equipment in many parts of the world. In co-operation with other countries as well as industry, many governments have improved contingency planning and equipment capabilities. In other parts of the world, there may have been little improvement because of more pressing national priorities. Evidence shows that international, national, and industrial determination to improve spill response capabilities is cyclical, increasing immediately following a major spill event and waning as time progresses.

Some measures of success are difficult to quantify, such as the spill management team's efficiency and effectiveness, vessel salvage plan, or shoreline protection strategy. Other indicators are easier to measure, such as amount of oil spilled versus amount recovered at sea or from the shoreline. The lack of accurate historical information about major oil spills also makes it difficult to identify precise performance improvements. Nonetheless, conclusions can be made about the myths and realities of improvements in a number of areas.

It is a reality that international conventions and agreements have improved the commitment to preparedness planning; however, many provisions of these conventions and agreements have yet to be implemented. It is a reality that the international oil industry has invested considerably in the establishment of local, regional, and international stockpiles of equipment. Another reality is that the international response community now accepts that contingency planning is the essential prerequisite to a successful response. The scope of contingency plans has improved over the years to include risk analysis, forecasts of oil movement, identification and prioritisation of resources at risk, and selection of suitable response techniques. It also is recognised that plans must be constantly tested and updated through regular exercises. There are still far too many places in the world, however, where satisfactory planning has not been conducted, and, in some cases, inappropriate equipment purchases have been made.

In most countries where major spills have occurred, lessons learned from those spills have been incorporated into national response plans. In many countries, there is an increased awareness of the critical role of salvage in improving spill response. There are ample stockpiles of mechanical containment and recovery equipment in most parts of the world.

Dispersant use is still controversial, but is slowly gaining acceptance as the benefits become more widely accepted, and limitations become better understood. Where responders have become experienced at working together during exercises and responses, spill management has improved significantly.

Unfortunately, in those regions of the world where mechanical containment and recovery for major offshore spills remains the only or primary response method, there is unlikely to be any significant improvement in response operations because of the well-known, and to date insurmountable, limitations of this technique. In some parts of the world, spill costs have escalated significantly. Media, environmental interest group, and public pressure undoubtedly has contributed to gross over-reaction or inappropriate actions being taken. This is exacerbated by the lack of an independent, effective mechanism to determine technical reasonableness, and there being no means of penalising unreasonable or ineffective decisions or activities that may have contributed to excessive costs by refusing to reimburse them.

Generally, the factors that contribute to improved performance during oil spill response do not match those that are perceived as improved by politicians, the media, environmental interest groups, and the public. The media rarely report on the technical successes of a response and, on most occasions, dramatise potential disaster, which contribute to public outrage. It is unlikely that this will change. Environmental interest groups continue to use oil spills to promote their own agendas, despite evidence that spills are not the permanent environmental disasters that these groups prefer to portray. This also is unlikely to change. In some areas of the world, how-

ever, some success has been achieved in creating a climate of trust and co-operation, which tempers political reactions. Politicians, however, remain responsive to their constituents and follow public reaction to oil spill response performance, whether real or perceived. There is a need for the oil industry to make strenuous efforts to improve its image, attempt to educate the public about the realities of oil spill response, and reduce the public expectations of what can be achieved.

The problems that currently inhibit improved performance are not ones that massive increases in equipment will fix. Some problems are insoluble with present-day technology. Organisational problems can be overcome by better planning, acceptance of alternative response techniques, training, exercising, spill management, and cost management, with government and industry working in co-operation to plan, respond, and involve all potentially affected parties. In some countries, their current state of development may well mean that they are not ready to devote scarce national resources to the problem and will need external assistance for some years to come.

The answers to the three critical issues are yes — in some ways and in some places. In most areas, investment has not been just an expensive public relations exercise, but there are worrisome signs that some responders are beginning to think that it is. There have been major improvements in many parts of the world, and many countries are now much better prepared than they were 20 years ago. It is still unfortunately the case that in many places, there has been little or no improvement, either because of lack of resources, understanding of the requirements, or will. In the last two cases, many of the myths remain, and the realities are not yet understood.

SECTION 1

INTRODUCTION

Over the past 20 years, especially in the past 10 years since the *Exxon Valdez* spill, there has been a tremendous investment in equipment and resources to respond to a large oil spill in both the open sea and nearshore environments. This paper examines whether the investment of money, time, and effort has been worthwhile: Have real improvements occurred, or has it been the world's most expensive public relations exercise?

This paper has been written to encourage discussion and analysis in the international response community about changes in oil spill capabilities and performance that have occurred during the past 20 years, and to critically challenge some of the current thinking. Using opinions of many professionals within the response community as a basis, this paper is intended to generate a dialogue within this community with the intent of identifying strengths and weaknesses in response capabilities and ultimately to initiate performance improvements. This paper also can be used to provide feedback to the research community on capability issues that warrant further examination.

1.1 OBJECTIVES

To determine what is reality and what is myth, this paper asks the following questions concerning oil spill response over the past 20 years:

- Have response capabilities to clean up large spills improved over the last 20 years?
- Have increased response capabilities resulted in improved performance?
- Has improved performance had a positive effect on political, media, environmental, and public perceptions?

The answers are intended to challenge existing national or international philosophies and encourage a critical review of these perspectives.

To achieve this objective, information from major spills is integrated with the practical experience and personal observations of spill response professionals. Whenever possible, the paper focuses on responses to large spills (>10,000 tonnes or 70,000 barrels); however, smaller spills also are used to illustrate particular issues because of the lack of detailed information on many spills.

Much of the information in this paper is derived from personal interviews with spill response professionals throughout the world, supplemented by the author's personal knowledge from almost 20 years' experience in the industry, in addition to

an extensive literature review. Because of the scarcity of reliable information on many spills, the author has relied on the judgment, perceptions, and opinions of response professionals and regulators, as well as on personal observations and necessarily subjective opinions.

1.2 ORGANISATION OF THIS REPORT

This paper examines capabilities around the world in the areas of equipment, infrastructure, and planning and the resulting reactions.

Section 1. Introduction. This section identifies the paper's objectives and introduces the critical issues to be addressed.

Section 2. Myth or Reality? Have Response Capabilities to Clean Up Large Spills Improved Over the Last 20 Years? This section discusses whether changes in response capabilities in specific countries and regions have resulted in significant improvements in these capabilities. Worldwide implementation of the tiered response concept also is analysed.

Section 3. Myth or Reality? Have Increased Response Capabilities Resulted in Improved Performance? This section discusses whether national and international agreements, contingency planning, and response strategies have resulted in improved oil spill response performance.

Section 4. Myth or Reality? Has Improved Performance Had a Positive Effect on Political, Media, Environmental, and Public Perceptions? Building on the previous section, Section 4 discusses whether increased capabilities and improved performance have been perceived positively outside of the response community.

Section 5. Conclusions and Recommendations. This section summarises the major conclusions regarding the critical issues and recommends direction for future efforts to further improve response capabilities and performance.

Appendix A. International Agreements Following Major Spills. A summary of national and international conventions and agreements is presented.

Appendix B. Summary of Significant Spill Events. This appendix provides brief, descriptive case studies of major oil spills, which constitute much of the reference material for this paper.

1.3 CRITICAL ISSUES

HAVE RESPONSE CAPABILITIES TO CLEAN UP LARGE SPILLS IMPROVED OVER THE LAST 20 YEARS?

There is no simple answer to this question. The answer ought to be "yes," given the enormous investment in equipment in

some ways and in some places, particularly in developed and advanced developing nations, the answer is yes. In many developing countries, however, the answer is likely to be "no." Any improvement in response capability often is hampered by higher priorities such as national survival and population welfare, which compete for the limited funds and management effort available.

Improvements in response capabilities have not only occurred over the past 20 years. Indeed, international cooperation began in the late 1960s, particularly in Europe, with the signing of the Bonn Agreement and the Helsinki and Barcelona Conventions (see Appendix A). When France suffered the 223,000-tonne (1,561,000-bbl) spill from the *Amoco Cadiz* in 1978, little oil was removed at sea, and overly aggressive shoreline cleaning caused severe shoreline damage, particularly in marshes. In the aftermath of the *Amoco Cadiz* spill, an upsurge of interest in oil spill response and various additional improvements occurred. Interest in spill response then began to wane until the *Exxon Valdez* spill (1989) became a catalyst for a frenetic expansion of response capabilities worldwide. Although there is a general international determination that this capability improvement should be maintained, the pressure of low oil prices and general downturn in the world economy are having an adverse effect on maintaining improved response capabilities.

HAVE INCREASED RESPONSE CAPABILITIES RESULTED IN IMPROVED PERFORMANCE?

The first criterion by which any performance improvement should be judged is whether any subsequent responses were

technically better than before improvements were made. Since there has been considerable investment in contingency planning, equipment, and training, as well as international cooperation, there should have been significant improvements. Response professionals, however, recognise the limitations of oil spill response. Despite best efforts, a well-rehearsed contingency plan, ample personnel and equipment resources, and a well-managed response, oil is likely to come ashore. Oil on the shoreline introduces the second criterion: Was the response perceived to be successful?

HAS IMPROVED PERFORMANCE HAD A POSITIVE EFFECT ON POLITICAL, MEDIA, ENVIRONMENTAL, AND PUBLIC PERCEPTIONS?

In today's unforgiving media-driven society, it is essential not only to perform well but also to be perceived to perform well. This is important, because otherwise, the fires of perception — lit by the media, kindled by environmental groups, stoked by politicians, and fanned by the public — can easily consume a Responsible Party (RP) and responders. The twin criteria of effectiveness and perception are not necessarily mutually exclusive, but great care is needed so that media pressure does not force responders to conduct actions that conflict with the best environmental and technical advice.

SECTION 2

MYTH OR REALITY? HAVE RESPONSE CAPABILITIES TO CLEAN UP LARGE SPILLS IMPROVED OVER THE LAST 20 YEARS?

Over the past 20 years, there has been a tremendous increase in the provision of oil spill equipment in many parts of the world. This section discusses the tiered response concept, together with developments that have occurred in various nations and regions. Evidence is presented to show whether these developments have resulted in increased response capabilities or whether further investment is still needed. Many governments, but more especially the oil industry, ports, and private contracting companies, have increased equipment holdings considerably. Improvements also have been made in contingency planning and spill management but regrettably are not universal. A number of international and bi-lateral agreements have been concluded concerning co-operation among countries in the event of oil spills (Appendix A).

2.1 DEVELOPMENTS BY VARIOUS NATIONS AND REGIONS

Within the scope of this paper, it is not possible to quantify the improvements made in every country. Summary information of significant developments in response capability is provided from around the world, concentrating on developed countries that have experienced large spills. In these countries following these spills, national response arrangements have been brought to a relatively high standard.

Africa. Until recently in much of Africa, little work had been done to prepare for spills unless it has been driven by oil company commitment. In some countries, such as Nigeria, there is only a draft National Contingency Plan (NCP). In contrast, plenty of oil spill equipment exists for response in the rivers and Niger delta. A recent spill from the Idoho pipeline (1998) highlighted the shortage of offshore equipment in the region, perhaps stemming from lack of properly developed plans. In Angola, it has been decided only recently which ministry shall be the national response authority, without which there could be no NCP. In other African countries, different national problems may be more urgent, with poverty, collapsed commodity prices, and need to develop the economy and feed and house the population placing oil spill response

low on the list of priorities. With few exceptions, it is a myth that response capability has improved in Africa.

Australia. Following the *Kirki* spill in 1991, the Australian National Plan (Natplan) was reviewed completely. The outcomes of that review included the purchase of additional oil spill equipment to be stationed around the coast. In an offshore spill, the use of mechanical equipment alone will not prevent the oil from coming ashore (Purkiss, 1998). In addition, the length of the Australian coastline and often-rough weather conditions preclude mechanical equipment use. Dispersant use is allowed in appropriate situations: for example, aerial application using crop spraying aircraft was used briefly during the *Kirki* spill (Sapelli, 1998). Since then, dispersant use has expanded into the Fixed-Wing Aerial Dispersant Capability (FWADC) (Lipscombe, 1998). A minimum of two crop spraying aircraft, which can carry between 1½ and 3 tonnes (10–20 bbls) of dispersant, are available at 4 hours notice, and other aircraft can be made available with longer notice.

As a result of lessons learned during the *Kirki* and other smaller spills, the Australian spill management system is being upgraded to handle the planning and logistics necessary to mount a major oil spill response. The level of government-industry co-operation has increased, which is considered to be one of the greatest improvements. An integrated national response team has been established, and it includes representatives from government and industry. The team has been mobilised for small spills, such as that from the bulk carrier *Iron Baron* (1995) but has not been tested in a major spill. There is a similar government-industry approach to training. Various courses have been introduced covering all aspects of spill response, and the content and programmes are being developed jointly by government and industry (Lipscombe, 1998). It is a reality, therefore, that response capability has improved over the last 20 years in Australia.

France. France is particularly vulnerable to the risk of oil spills since there is considerable passing tanker traffic to the oil ports of Europe along the Atlantic and English Channel coasts (Holt, 1995). Under the National Marine Pollution Plan (POLMAR), the French Navy is responsible for the cleanup of spills at sea. Since the *Amoco Cadiz* spill, which was caused by a steering gear failure in the vessel and the inability to secure a towline onboard, multi-role tugs have been stationed

in the region permanently and equipment stockpiled for use at sea. The French government also established stockpiles of shoreline cleanup equipment at Brest and Marseilles to support the shoreline response plan. POLMAR is tested during major response exercises conducted in co-operation with the oil industry.

The Centre for Documentation, Research, and Experimentation into Accidental Pollution of the Water (CEDRE) was established to conduct research in spill response techniques, provide technical advice to the French and other national authorities in producing response plans, and form teams to assist with spill responses in France and abroad. Today, CEDRE is respected internationally and frequently assists other countries in planning and response. It is a reality, therefore, that response capability has improved over the last 20 years in France.

Gulf of Arabia. Although there has been much discussion over many years and a large increase in the amount of response equipment in the region, particularly during and since the 1991 Gulf War, there has been little governmental determination to make significant improvements. Few countries have signed any of the compensation conventions: only Oman has signed the International Convention on the Prevention of Pollution from Ships of 1973 with its 1978 Protocol, MARPOL 73/78, and only Iran has signed the International Convention on Oil Pollution Preparedness, Response, and Co-operation (OPRC Convention).

The *Pontoon 300* accident in January 1998 off the United Arab Emirates, when 6,000 tonnes (42,000 bbls) of heavy fuel oil were spilled from a barge smuggling oil from Iraq, illustrates this region's inadequate response capabilities. Poor response was exacerbated because the owner could not be identified. Adverse weather and the general unseaworthiness of the barge also hampered the eventual response. There was a 6-day delay before a belated and largely ineffective response commenced, which would not have occurred if there had been committed, determined government action. Throughout most of the Gulf of Arabia, therefore, it is a myth that response capability has improved in the last 20 years.

Norway. The State Pollution Control Authority (SFT) of the Department of the Environment is the responsible authority for marine oil pollution in Norway. Following a major blow-out from the Ekofisk Bravo oil field in 1977, SFT required offshore operating companies to ensure that response equipment was in place and available for use in an open water response. As a result, the Norwegian Clean Seas Association for Operating Companies (NOFO) was formed to manage this project. At the time, the necessary equipment did not exist to meet SFT's requirements, which gave considerable impetus to developing response equipment for open water response. This development was aided by the Norwegian authorities' willingness to allow oil to be spilled at sea for operator training and developing and evaluating new equipment.

Following the *Exxon Valdez* spill, Norwegian authorities imposed strict response preparedness requirements on Norwegian oil terminals, refineries, and industrial complexes, as well as on local authorities, which resulted in large purchases of oil spill equipment. Vessel traffic and pilot services

improved, and the Norwegian Centre for Marine Environment and Safety was established, including a National Test Centre for environmental technology and a National Training Centre for oil spill response. There has been no opportunity to test these arrangements on a major scale. However, it is a reality that response capabilities have improved over the last 20 years in Norway.

The UK. Having suffered three of the world's "top twenty" oil spills — *Torrey Canyon* (1967), *Braer* (1993), and *Sea Empress* (1996) — the UK is aware of what is required in a major spill. Though many years before the period covered by this paper, the *Torrey Canyon* spill must be mentioned since it spurred two international compensation schemes — the Civil Liability Convention (CLC) in 1969 and the International Oil Pollution Compensation (IOPC) Fund in 1971 — as well as major research and development programmes in the UK.

In the late 1970s and early 1980s, the government-owned Warren Springs Laboratory (now the privatised AEA National Environmental Technology Centre, AEA Netcen) tested new low toxicity dispersants and developed aerial application methods. Also in the late 1970s, principally the British Petroleum (BP) Sunbury Research Centre undertook a major programme for containment and recovery equipment. AEA Netcen and CEDRE were responsible for the development of "minimally intrusive" shoreline cleanup methods in the late 1980s. Techniques for use and identification of the limitations of booms to protect coastal estuaries were developed and tested by the Hydraulics Research Establishment (Newman and Macbeth, 1970, 1973). Within the UK, these techniques continue to be used for coastal protection, especially of sensitive areas (Perry, in press).

Major government equipment investment was made in the 1970s and 1980s as well. Following the *Cristos Bitos* spill (BP, 1979), emergency lightering equipment was purchased; aerial dispersant spraying was introduced; and dedicated aircraft were contracted. Notable success was achieved during the *Sea Empress* spill with dispersant being used as successfully as it previously had been used during the *Sivand* (1983), *Phillips Oklahoma* (1989), *Rosebay* (1990), and other minor spills. Limited stocks of government-owned, open sea, mechanical recovery equipment and larger stocks of shoreline cleanup equipment also were purchased.

The development of the UK NCP led to the formation of the Marine Pollution Control Unit (MPCU), which was responsible for the cleanup of tanker spills at sea. The MPCU became the focus for all marine pollution matters, with local coastal authorities assuming responsibility for shoreline cleanup. During the *Braer* and *Sea Empress* spills, the NCP was used successfully. Currently, the plan is being revised to incorporate lessons learned, recommendations from independent post-spill reports (ESGOSS, 1994; SEEEC, 1998), two reports by Lord Donaldson (Donaldson, in press; Donaldson *et al.*, 1994), and also the input from a national forum consisting of regulators, shipowners, ports, local authorities, and oil spill response organisations. As a result of these efforts, it is a reality that response capabilities have improved over the last 20 years in the UK.

Following an amalgamation of the UK Coastguard Agency and Maritime Safety Agency into the Maritime and Coastguard Agency (MCA) and the formation of four MCA regions, another plan review is underway that involves the MPCU's dissolution. MCA regions will have responsibilities similar to those of the US Coast Guard (USCG): marine safety, port state control, search and rescue, and marine pollution. At the time of writing, the final plan has not been published; however, the regionalisation proposed in the plan is a concern. Prior to the MPCU's formation, spill response in the UK was conducted on a regional basis, and it did not work. This was the *raison d'être* of a central MPCU, and it is hoped that this lesson will not have to be learned a second time. At best, there will be a hiatus for some time until the new arrangements become effective.

The US. The US NCP contains provisions on which spill response operations are based. The first US NCP was drafted in 1968 and refined through the 1970s and 1980s to the time of the *Exxon Valdez* spill. Under the pre-*Valdez* organisation, an RP was considered to have primary responsibility for the cleanup, with oversight by the USCG, US Environmental Protection Agency (EPA), and relevant state.

Throughout the 1970s to the present, both the USCG and US Navy Supervisor of Salvage (SUPSALV) purchased large stocks of pollution equipment. USCG equipment was purchased to ensure that resources would be available as commercial equipment was being mobilised and to cover any shortfalls in provision by an RP. US Navy equipment was purchased specifically to handle spills from Navy vessels and would normally only be mobilised by Federal On-Scene Coordinators (FOSCs) if they considered that an RP and a contracted Oil Spill Removal Organisation (OSRO) were unable to provide the required resources. The requirement for these resources in non-government vessel spills has diminished as the increased level of commercial equipment required by the Oil Pollution Act of 1990 (OPA 90) has become available.

The US NCP was perceived to have failed in Prince William Sound, Alaska in 1989 (Walker *et al.*, 1995). Prior to the *Exxon Valdez* spill, RPs, federal agencies, and individual states tended to plan independently for responses. When a spill occurred, each found that the others' plans were inadequate or incompatible with its own. The result was confusion and recrimination, creating an impression in the public's eyes that chaos reigned. Urgent action was needed to restore public confidence. OPA 90 was the result. Amongst its many provisions, OPA 90 requires government and industry planners to work together to devise appropriate plans and strategies for response management and operations. Vessel and facility owners are required to produce contingency plans with guaranteed levels of response equipment. The revisions to the NCP require establishing local area government-industry planning committees and programmes of joint exercises (National Preparedness for Response Exercise Program, PREP). This fundamental shift in emphasis led to perhaps the greatest improvement, co-operation between an RP and regulatory agencies. Although it is clear that such a partnership is essential, nowhere else in the developed world is the primary responsibility for conducting oil spill response placed on

industry, albeit with the government's oversight. Certainly in Europe, spill management is seen as a government responsibility. The US now has a high degree of preparedness based on regulation, contingency planning, training, and exercises, though there is still a need to increase dispersant acceptability. It is a reality, therefore, that response capabilities have improved over the last 20 years in the US.

General observations on national and regional capabilities. It is a reality that most developed nations and several of the more advanced developing countries have devoted much effort to developing a well-resourced and exercised national plan, and improvements have been made. Unfortunately, there are still too many places where response capabilities are not well organised. In the absence of an effective plan and organisation to support an oil spill response, the provision of large amounts of oil spill equipment can be dangerous, especially if managers do not understand the need for planning and responders do not have sufficient training. It is imperative that equipment purchases are not made unless they are part of a comprehensive spill planning process. Persuasive salesmen have sold inappropriate equipment to well-meaning countries that did not have contingency plans to assist in determining what equipment they required. There may be no management organisation in place to direct equipment use or logistic infrastructure to store and move it to a spill site. Often, there are no trained personnel to maintain and operate it. In too many cases, equipment is unused and not maintained and will remain so until it deteriorates and becomes unsuitable.

Even in what are supposedly well-prepared, developed countries, there is still much to be done. Oil Spill Response Limited (OSRL) often has been asked to make equipment recommendations without an existing contingency plan on which to base purchases (Salt, 1998). Within the past 4 years in the UK, the author has observed locked pollution stores or trailers for which the key is been missing, or in which the oil spill equipment is still in the manufacturers' unopened boxes. At one UK installation belonging to a major oil company, the author observed equipment that had been outdoors for so long that international orange had bleached white and skimmer powerpack doors were rusted shut.

2.2 TIERED RESPONSE

While individual nations and the oil industry have addressed their internal response planning and management concerns, both have opted to rely primarily on oil spill response organisations to supply most of the equipment and manpower necessary to mount a large-scale response. This has led to the evolution of a worldwide response capability best described by the tiered response concept (Table 1). To plan for spills ranging from small operational spills to catastrophic events, the tiered response concept has been promulgated internationally over the past 10 years by the International Petroleum Industry Environmental Conservation Association (IPIECA, 1991). The US adopted a similar approach employing different but functionally equivalent terminology.

TABLE 1.
SYNOPSIS OF TIERED RESPONSE CONCEPT

Tier 1	Small operational spills at jetties or terminals that are reported to the authorities but managed and cleaned up by the operator. The US functional equivalent is the Average Most Probable Discharge (AMPD).
Tier 2	A larger spill, either at or in the vicinity of a facility, that cannot be handled by the operator alone. The port or local authority will manage it. Personnel and equipment support will be required either from other port users or from a local spill co-operative. The US functional equivalent is the Maximum Most Probable Discharge (MMPD).
Tier 3	A major spill at or remote from a facility that will require the National Contingency Plan (NCP) to be invoked and national resources to be mobilised. Additional support may be required from outside the country under multi-national arrangements. Personnel and equipment may be required from an international Tier 3 oil spill response co-operative. The US functional equivalent is the Worst Case Discharge (WCD).

Source: Adapted from IPIECA (1991).

To avoid duplication of expensive resources that are required infrequently, various co-operative arrangements have been made. Tier 2 facilities have been developed in some major ports. Groups of oil companies have established national or regional Tier 2 oil spill response bases or international Tier 3 bases in strategic locations throughout the world.

Response capability often is measured as a theoretical, numerical cleanup capacity (a total capacity in tonnes of the equipment package or in barrels per day). These capacity estimates can be very misleading since they imply the ability to clean up a specified amount of oil. For example, an equipment stockpile might be rated as having a 10,000-tonne (70,000-bbl) recovery capacity, which is a theoretical figure that may factor in nameplate capacity, downtime, and water pickup under ideal conditions. The actual capability to clean up oil in a real spill situation will depend on many other factors, which are discussed later in this paper.

The concept of co-operative arrangements and establishment of jointly owned response bases have economic merit, particularly for developing countries, especially those where the risk is not great. Such bases also form pools of practical first-hand experience, on which countries that have little or no practical experience can draw. It is anticipated that experienced response personnel would form an important part of international response teams proposed in Section 5.

TIER 1 RESOURCES: OIL INSTALLATIONS AND PORTS

The oil industry has made great efforts to ensure that most industry-owned oil terminals are equipped to handle small spills. As these small spills constitute 92 percent of the total oil spilled from tankers (ITOPF, 1998a), there should be evidence of a marked improvement. Given favourable weather and tidal conditions, it should be possible to deploy equipment rapidly, operate it in pre-determined positions to contain spilled oil close to the source, protect local sensitive areas, and remove oil rapidly. Many ports have Tier 1 response capabilities in place, for example, to respond to bunker spills. The OPRC

Convention implicitly requires such response capabilities in facilities, and this requirement will be implemented progressively by national legislation. In the drive for economy, many terminals are short of manpower to handle emergencies. Additional support personnel must be available at very short notice to deploy response equipment, which is not always the case.

TIER 2 RESOURCES: NATIONAL, PORT, AND INDUSTRY

A number of industry-funded national or regional Tier 2 co-operatives have been established where higher risks exist because of oil exploration and production activities or high-volume tanker traffic. Some countries — including Australia, France, Norway, the UK, and the US — have developed national equipment stockpiles (Tier 2) to supplement local Tier 1 resources. Several larger ports also have developed co-operative Tier 2 arrangements to supplement the Tier 1 resources of individual installations within the port. A good example of this is the Thames Oil Spill Control Association (TOSCA) operating within the area of the Port of London Authority in the UK. In the cases reviewed below, most co-operatives are generally well managed, maintained, and operated.

Gulf of Arabia. Oil companies in the Gulf of Arabia purchased large amounts of oil spill equipment. Gulf Area Oil Companies Mutual Aid Organisation (GAOCMAO) was established in 1972 with headquarters in Bahrain. GAOCMAO owns no equipment, but, in the event of a spill, members may request assistance from other companies. This approach is not recommended, as there is no guarantee that a request for assistance will be honoured. Preferably, some equipment should be centrally stored, maintained, and operated. Although there have been increases in equipment holdings, there is some doubt whether mutual support would actually occur.

Hong Kong. There is significant risk from product movement into Hong Kong and also from other shipping in the narrow entrance channel. The oil industry is in the process of establishing a Tier 2 base in Hong Kong. At present, difficulties

in acquiring a suitable site for the base are delaying establishment. It is, therefore, too early to conclude that Hong Kong has been successful in improving response capabilities.

Malaysia. Malaysia has extensive offshore oil production, and there is considerable risk from tanker spills through the Malacca Straits. In 1994, the companies operating in Malaysia led by the state oil company, Petronas, established the Petroleum Industry of Malaysia, Mutual Aid Group (PIMMAG). PIMMAG established large stockpiles of oil spill equipment at three locations (Port Dickson for the Straits of Malacca, Kemaman for east coast Peninsular Malaysia, and Labuan and Miri for Sabah and Sarawak). A full-time team of contractors provides maintenance and a core team of personnel available for deployment to a spill location. Additional industry personnel are trained to supplement this team. The designed response time is 12–24 hours from each stockpile. The equipment resources are designed to have a total response capacity of approximately 20,000 tonnes (140,000 bbls). Malaysia, therefore, has developed suitable equipment capabilities.

Norway. Prior to the Ekofisk Bravo platform blow-out in 1977, SFT produced a very strict requirement for offshore pollution control equipment: equipment must be capable of operating in wave heights of 2.5 metres. When the rules were formulated, this was impossible to achieve with the available equipment; however, oil spill exercises using real oil have been conducted annually to test and evaluate new equipment and train response crews.

Each offshore platform, in addition to its Tier 1 resources, must be able to recover and store 8,000 m³/day (40,000 bbls/day). Of this amount, 25 percent of the resources must be onsite within 24 hours and the remainder within 48 hours. This is achieved by NOFO, an offshore oil industry organisation that operates five onshore bases from which equipment is deployed. Within the bases, there are a total of 14 oil recovery systems, each with a team leader and three operators. The equipment can be loaded on any of 15 converted rig supply vessels that are classified as oil recovery vessels with onboard storage for 1,000 m³ (5,000 bbls) of oil. Fishing vessels are available for towing boom. Shuttle tankers are available for recovered oil disposal. As such, Norway has developed suitable equipment capabilities.

The US. The US has the greatest concentration of Tier 2 resources in the world. Even before the *Exxon Valdez* spill, co-operatives had been formed in many parts of the country to support oil industry operations. At the time of *Exxon Valdez*, there were over 90 industry-owned contractor co-operatives in the US, such as the Clean Seas Co-Operative based in California to cover oil production operations in the Santa Barbara Channel.

Other tier 2 co-operatives. Other Tier 2 co-operatives are either forming or in existence: in Alaska, where both Alaska Clean Seas and the Ship Escort Response Vessel Service (SERVS) possess large stockpiles of oil spill equipment; in Thailand, the Oil Industry Environmental Safety Group; in Guam, Guam Response Services Limited (GRSL); and in Korea, Korea Marine Pollution Response Corporation. The increase in oil spill awareness and reduction in oil company staff has pro-

vided the opportunity for many private contractors to establish and expand their operations in various parts of the world, and improvements in Tier 2 response capabilities continue to be made.

TIER 3 RESOURCES: INTERNATIONAL RESPONSE BASES

The oil industry has established major co-operative response organisations on a regional basis throughout the world to provide equipment and specialist manpower to reinforce local capabilities in responding to the largest spills.

Australian Marine Oil Spill Centre. The Australian Institute of Petroleum (AIP) established the Australian Marine Oil Spill Centre (AMOSC) at Geelong near Melbourne. AMOSC's area of operation includes Australia, New Zealand, the South-west Pacific, and Papua New Guinea. The equipment, therefore, is ready to be airlifted at short notice to any part of this large region. The centre has a small staff that is supplemented by oil company personnel during response.

Clean Caribbean Co-Operative. Clean Caribbean Co-Operative (CCC) was formed in 1977 by eight oil companies with a base in Fort Lauderdale, Florida. Since the *Exxon Valdez* spill, it has grown in equipment holdings, contractor staff, and membership. Its primary area of operation covers the Caribbean, which is at risk because of extensive oil movements from Venezuela, Africa, and the Middle East. Coverage recently was extended to all of South America, Central America, the Bahamas, and Bermuda.

East Asia Response Limited. In 1989, a recommendation was made to upgrade the Tier 2 Tiered Area Response Capability (TARC) in Singapore (Stacey, 1989). The recommendation was reinforced by a risk study conducted by oil companies operating in the region. Singapore is located near the major oil shipping route through the Straits of Malacca. It is a large refining and product distribution centre and a hub for air routes throughout the region. By 1994, TARC was upgraded and renamed the East Asia Response Limited (EARL) with a 30,000-tonne (210,000-bbl) stockpile. The designated operational area stretches from the Straits of Hormuz and East Africa in the west to the International Date Line in the east (Irvine, in press).

Fast Oil Spill Team. The French oil industry established the Fast Oil Spill Team (FOST) base at Marseilles airport to cover its particular interests in the countries of the Mediterranean and East Africa, recognising that there could be language difficulties for English-speaking responders in these countries. FOST does not have an offshore oil recovery capability but concentrates entirely on nearshore and onshore cleanup. The operating personnel are drawn from the Marseilles Marine Fire Service.

Marine Spill Response Corporation. After *Exxon Valdez*, the US oil industry supplemented the local co-operatives and contractors with a national organisation. Under the umbrella of the Marine Preservation Association (MPA), the Marine Spill Response Corporation (MSRC) was formed. Approximately \$1 billion was invested in five stockpiles of equipment, each with a 30,000-tonne (210,000-bbl) capacity.

capacity. Sixteen dedicated response vessels were built to deploy offshore equipment, and barges were purchased for recovered oil storage. Initial start-up costs and infrastructure maintenance costs, however, were so high that, faced with competition from contractors, MSRC was forced to reorganise into three regions, replace management, relocate headquarters, reduce staff numbers, and supplement its resources with a network of local contractors. The overall response capability, however, was not reduced.

National Response Corporation. The National Response Corporation (NRC) is the second Tier 3 responder within the US. Unlike MSRC that owns most of its resources, NRC relies on a network of subcontractors to provide equipment in the event of an oil spill. NRC had initial difficulties in convincing sceptics of the guaranteed availability of equipment from such varied sources, but as much of the capital equipment was already in place and as the overheads and charges were greatly reduced compared to MSRC, membership grew rapidly.

The NRC and MSRC now form the backbone of large-scale response capability in the US. Both NRC and MSRC are Tier 3 organisations, and although they are dedicated principally to response in the US, overseas response feasibility is being investigated actively.

Oil Spill Response Limited. In 1980, BP consolidated its oil pollution equipment for major spill response at the Oil Spill Service Centre (OSSC) in Southampton, which became a facility for worldwide response with a permanent staff and capacity to respond to two 10,000-tonne (70,000-bbl) oil spills. In 1985, five major oil companies, including Exxon, joined BP and formed OSRL. Their commitment was justified when the OSRL team arrived at the *Exxon Valdez* spill within 36 hours of the call out, the first OSRO on scene from outside the state of Alaska.

Following that spill, OSRL increased its capacity to respond to two 30,000-tonne (210,000-bbl) spills with a mix of mechanical and dispersant technologies. The proportion of offshore mechanical recovery equipment stockpiles was reduced with a commensurate increase in the proportion of nearshore and shoreline equipment. This change reflected one of the key realities of spill response that, despite responder's best efforts, a large proportion of spilled oil is likely to come ashore. The OSRL expansion report (Stacey, 1989) recognised that speed of reaction was essential and improved use of aircraft as a means of rapid equipment delivery should be investigated. Following the OSRL expansion, its membership grew rapidly, and now 26 of the world's major oil companies belong to OSRL.

OSRL is the only Tier 3 base with a worldwide area of operation. With the establishment and expansion of other Tier 3 bases, OSRL principally will be employed to respond to spills in Europe, the former Soviet Union, the Mediterranean, Middle East, and Africa. It will be available to support other bases in the remainder of the world, particularly with trained personnel (Irvine, in press).

Petroleum Association of Japan. The Petroleum Association of Japan (PAJ) has taken a different approach. As one of

the world's leading importers of oil, Japan established seven response bases in Japan and five abroad (Ras al Khafji, Saudi Arabia; Abu Dhabi; Port Klang, Malaysia; Singapore; and Jakarta, Indonesia). In a spill, equipment use is free, although it must either be returned in good condition or replaced. Although local contractors maintain the equipment, it is the spiller's responsibility to provide operating staff. None of the PAJ bases contains offshore oil recovery equipment, and they are not prepared for air transport (Salt, 1998).

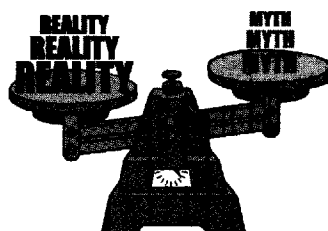
Tier 3 co-operative specialised capabilities. OSRL, CCC, EARL, and MSRC each have high-capacity dispersant spraying capability, namely the Airborne Dispersant Delivery System (ADDS) pack, available for deployment by contracted Hercules aircraft at short notice. For each organisation, these aircraft also are available for rapid deployment of recovery equipment.

OSRL, CCC, FOST, AMOSC, and EARL have placed particular emphasis on equipment mobility. Equipment has been reduced in size and/or weight and stored in containerised or palletised packages, ready for immediate air transportation. Aircraft self-unloading equipment also has been developed for use at airfields that do not have adequate cargo handling equipment.

2.3 RESPONSE CAPABILITIES CONCLUSIONS

MYTH OR REALITY? HAVE RESPONSE CAPABILITIES TO CLEAN UP LARGE SPILLS IMPROVED OVER THE LAST 20 YEARS?

The answer varies around the world.

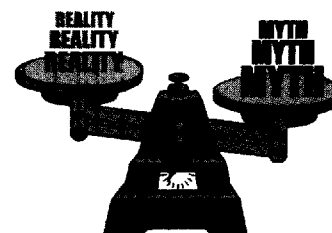


It is a reality for certain nations and regions of the world. Many nations, especially those that have experienced a major oil spill, have devoted much effort to developing a well-resourced and exercised

NCP. In general, oil spill response capabilities in those countries have improved.

It is a myth for certain nations and regions of the world. There are some areas of the world where there has been very little performance improvement over the past 20 years.

Because of either lack of national resolve or resources, the necessary planning has not occurred in many countries. In the absence of such planning, resource and infrastructure improvements are difficult, if not impossible, to achieve. If equipment alone has been procured, then a false sense of preparedness may exist.



SECTION 3

MYTH OR REALITY? HAVE INCREASED RESPONSE CAPABILITIES RESULTED IN IMPROVED PERFORMANCE?

Over the past 20 years in some regions of the world, there have been improvements in international co-operation, contingency planning, spill management arrangements, dispersant efficiency and methods of aerial application, provision of equipment, and training of personnel. In many instances, most improvements have followed rather than preceded a large oil spill. Two criteria are discussed in this paper to determine whether increased response capabilities have resulted in improved performance during spills. The first criterion is whether responses were technically effective. The second criterion is how politicians, the media, environmental interest groups, and the public perceived performance during spill response. This section examines key issues to discover what contributes to technical success and, hence, help disprove some myths and support some realities of a major spill response. Specific subsections include:

- what is meant by improved performance,
- influence of international conventions and agreements on improved performance,
- influence of OPA 90 on improved performance in the US,
- the essential role of response planning in improving performance, and
- improvements in response performance.

3.1 WHAT IS MEANT BY IMPROVED PERFORMANCE?

This will depend on what is meant by improvement, which yardstick is used, and the many variables involved in a response. Does a better response mean:

- A more technically effective response that is well managed by a closely integrated spill management team, in which damage to the environment is minimised?
- Greater than average amounts of oil are recovered at sea, or large amounts of oil are dispersed chemically, resulting in less oil reaching the shoreline?

- Sensitive resources are well protected, reducing environmental and socio-economic impacts?
- A fast, efficient shoreline cleanup occurs with minimal additional shoreline damage from the cleanup itself?
- Overall cleanup costs are kept to a reasonable minimum?

Or is success only a matter of perception? In that case, does a better response mean: There is a more favourable reaction from regulatory and post-spill review authorities? Media and public perception of the response is favourable or critical? If it is the latter, does any costly political or legislative reaction follow the response, such as OPA 90?

The matters of effectiveness and success were addressed at a previous International Oil Spill Conference (Walker *et al.*, 1995) where there was considerable ambivalence in attitudes. In a survey of spill responders, factors considered to be measures of success did not correspond to their stated objectives for the response. Interestingly, the objective rated most highly by 71 percent of respondents — “preventing or minimising damage to the environment” — was also rated the highest as a measure of success by 53 percent of respondents. Conversely, “perception of the media and the public” was seen as an important objective by only 9 percent of respondents, but it was rated as a measure of success by 41 percent of respondents.

This attitude toward perception has been mirrored in many conversations over the years with response personnel within major oil companies. It often is stated that “Oil spill response is only a public relations exercise anyway!” This probably means that, although a company may state its commitment to oil spill response and the protection of the environment, in reality the protection of the corporate image is actually its most important goal. In the US, a major oil spill is a crisis that is likely to have the most severe adverse impact on an oil or shipping company. The associated response cost in terms of lost business, cleanup costs, litigation, punitive fines, and Natural Resource Damage Assessment (NRDA) is potentially so high as to put company survival at risk.

Neither of these measures of success is wholly right or wrong: to most responders, success is both technical and perceived. But how can the parameters be measured? Only some are quantifiable, for example, amount of oil spilled, amount

recovered at sea, or amount cleaned up on the shoreline. Others are less precise, such as the success or otherwise of a spill management team, vessel salvage, protection measures, amount of oil evaporated or chemically or naturally dispersed, damage done by oil or subsequent cleanup, and environmental or socio-economic impacts. Others are subjective and may depend on public and political perception. Effective relations with the media are very important to perception, as it is quite possible for a good technical response to be marred by a poor media response.

These conventional measures of success ignore the growing realisation that, in certain cases, the best means of achieving environmental recovery, and hence success is to do nothing. Doing nothing is always very difficult to sell as a strategy and almost always is open to severe media and public criticism, being perceived as the "cheap" option. Considerable work is needed to educate opinion formers of the scientific justification for this technique when it is employed.

SCARCITY OF RELIABLE INFORMATION

The paucity of really comprehensive, accurate, and universally available post-spill reports causes major difficulties in deciding whether improvements have occurred. Some basic facts are readily available, but it is often impossible to determine the full details of a response. For many spills, statistics either do not exist or are unobtainable, thus making it difficult to build a fully factual case to support either myth or reality. This difficulty was recognised by Dr. James Butler of Harvard University in a 1978 report (quoted in *International Oil Spill Statistics*, Etkin, 1995, p. 16) that examined available spill data:

"The news media are heavily biased towards incidents that occur near large coastal cities, the tanker companies and insurance companies do not usually publicise the information they have, and government agencies normally will not concern themselves with events outside their own jurisdiction."

Butler cited many examples of conflicting data from the same major incidents. In her article, Etkin (1995) reports that little has changed since then. The problem is that very few major spill responses result in comprehensive, independent reports being produced. Notable exceptions have occurred in the UK following the *Braer* and *Sea Empress* spills, where independent, scientific, technical evaluations occurred. Parties involved in a response often write comprehensive spill reports, such as those on the *Exxon Valdez* and *Morris J. Berman* spills and MPCU's on the *Sea Empress* spill. Although such reports are useful in matters of fact, any conclusions drawn may be partial and not subject to critical independent analysis. In this paper, therefore, the author has had to place much reliance on the judgment, perceptions, and opinions of response professionals and regulators, as well as on personal observations and necessarily subjective opinions.

DIFFICULTIES IN ESTIMATING PERFORMANCE IMPROVEMENTS

There are many variables in determining whether performance has improved. Although the amount of oil spilled may hit the headlines, spill location, oil type and characteristics, meteorological and oceanographic conditions, and hours of darkness will have a major impact when considering whether response is effective. Other factors that could affect the technical success of response may include:

- effectiveness of the contingency plan,
- effectiveness of the spill management team,
- responders' speed of reaction,
- availability of local equipment and trained personnel resources,
- arrangements to import any additional resources and required assistance,
- logistic support, and
- reception, storage, and disposal facilities for recovered oil and oiled debris.

Despite a well-managed spill response, poor recovery rates or high shoreline impact could occur because of factors that are not in responders' control (e.g., weather, tides). In another spill, high recovery rates and low impact might be achieved regardless of management and resource efficiency. Response performance improvements, therefore, may be difficult to detect. Care must be taken to avoid incorrect conclusions being drawn.

Factors that influence external perception are notoriously variable. The *Exxon Valdez* spill response was not perceived to be effective despite the massive resources brought to bear. The *American Trader*, *Morris J. Berman*, and *Kure* responses were all perceived to be reasonably successful, which may have been because every resource available was deployed, even though this may have been considered unreasonable under other compensation regimes. The *Evoikos* spill (1997) may be an example of the opposite situation. The overall response was not considered to be well managed by many that observed it, yet it was perceived to be successful. Thanks to nature rather than man, no oil came ashore in Singapore during the time that media attention was still focused on the spill. The media also were managed very carefully and had little chance for direct observation because of haze from the Indonesian fires, which prevented overflying. If perception alone was the yardstick, then things have improved on some occasions.

3.2 INFLUENCE OF INTERNATIONAL CONVENTIONS AND AGREEMENTS ON IMPROVED PERFORMANCE

Various international developments over the past 20 years have been examined to determine whether and where improvements have occurred. The intent of international conventions

and agreements is to ensure that adequate response arrangements are developed universally, at least to a minimum acceptable standard. Among the issues that various conventions attempt to regulate are contingency planning, equipment capabilities, and training and exercises requirements.

Major international and regional conventions are evaluated below for improving spill response effectiveness. Appendix A contains a more-detailed discussion of various international conventions and agreements from around the world.

INTERNATIONAL CONVENTION ON OIL POLLUTION PREPAREDNESS, RESPONSE, AND CO-OPERATION

The International Maritime Organisation (IMO) is the United Nations (UN) body tasked with facilitating co-operation among countries on international watercraft movements. The IMO's responsibilities include regulating tank vessel operations and establishing pollution prevention, preparedness, and response criteria for those vessels. The IMO also provides guidelines and assistance to its member nations regarding issues such as contingency planning and response. In the aftermath of the *Exxon Valdez* spill, the IMO adopted the OPRC Convention in 1990. The OPRC Convention requires tank vessel owners to prepare Shipboard Oil Pollution Emergency Plans (SOPEPs). Signatory governments must ensure that they have a proper NCP and that government and industry co-operate in preparing national measures for planning, training, and response. The OPRC Convention requires governments to provide response assistance to other countries, if requested, at the time of a spill and assist other countries with equipment transport across their territory. The OPRC Convention encourages the promotion of bi-lateral and multi-lateral co-operation in preparedness and response and designates the IMO to facilitate the provision of assistance to states to establish national or regional response facilities.

Prompted by the OPRC Convention, the IMO and IPIECA joined to promote implementation of the OPRC Convention and effective government-industry co-operation in various countries around the world. IMO and IPIECA developed the following three-phase programme:

1. Achieve government-industry consensus on oil spill response objectives, and develop a global education programme to maintain that consensus.
2. Identify priorities for government-industry support.
3. Assist individual countries to develop action plans linking local industry and governments to ensure a sustainable response preparedness programme.

In the first phase of the programme (1991–1995), IMO and IPIECA conducted a series of seminars in various locations (Jakarta, Cairo, Caracas, Gabon, Bahrain, Curaçao, and Hong Kong) to raise government awareness of potential spill risks and need for regional and national commitment to response planning. As part of the global education programme, IPIECA produced a report series covering many aspects of oil spill response, including contingency planning, dispersants, biological impacts, and, in conjunction with the IMO, sensitivity map-

ping and exercise planning. The second phase, referred to as the "Global Initiative," began in Cape Town, South Africa in 1996. The intent of the second phase is to foster industry-government partnerships at national levels to establish a national response infrastructure and an NCP. IPIECA has developed a priority matrix for action based on risk, preparedness, and exposure. This has identified other regions that need support, and future seminars will be held in those regions, which will incorporate the lessons of Cape Town (Lerch, 1998). Currently, several African nations are involved in the Global Initiative, which may only have limited success in improving oil spill arrangements in these developing nations. There will be support for this programme only if a country is politically secure and economic conditions enable the country to devote adequate resources to it.

In some countries, assistance may well be essential because industry activity has caused a heightened risk. In those countries, assistance may be needed from the IMO to draft laws and regulations. Where a company has a presence, Tier 1 or 2 plans and resources should already be in place. As a result, it may not be necessary for individual, especially poorer, countries to hold fully comprehensive national stockpiles. Although the Global Initiative aims to make countries self-supporting, internal problems may prevent these countries from developing a full spill management team. Should a major spill occur, government might require external management support from an international team of specialists.

It is too early to decide whether all aspects of the OPRC Convention and the IMO-IPIECA Global Initiative will succeed. Some arrangements were tested successfully during Gulf War spills, when offers of emergency assistance were filtered, coordinated, and matched to need by IMO in London. As time passes, and as more countries ratify the OPRC Convention, it certainly should help to improve preparedness.

REGIONAL AGREEMENTS

Bi-lateral arrangements have been implemented around the world to foster co-operation in pollution planning and response among countries on a regional basis, typically those which share a common sea, such as the North Sea or the Caribbean, and are equally at risk from any oil spill incident. It is, therefore, in their best interests to plan and respond jointly.

The Bonn Agreement in the North Sea and the Helsinki Convention in the Baltic are examples of international co-operation among neighbouring countries. Additionally, there are UN-sponsored agreements in other regions of the world, including the Caribbean, South Pacific, and Red Sea. For example, the Regional Organisation for the Conservation of the Environment of the Red Sea and the Gulf of Aden (PERGSA) currently is assisting Sudan in drafting an NCP. The sharing of information on a routine basis (such as aerial surveillance) and regular international meetings have helped to develop good working relationships among participating countries. During the *Volgoneft 263* spill, emergency assistance from other participating countries in the Helsinki Convention was integrated into the response easily (Fagoe, 1991).



3.3 INFLUENCE OF OPA 90 ON IMPROVED PERFORMANCE IN THE US

National laws have assisted spill response improvements in those countries to which they apply. OPA 90 is one example, but as other countries introduce legislation to implement the OPRC Convention, response capabilities and performance should improve more widely. There have been tremendous improvements in contingency planning in the US since OPA 90 passed, including production of vessel and facility response plans and linking of government, regional, and area contingency planning. Large areas of the coast (e.g., Delaware Bay) have detailed coastal protection plans.

PREP reinforces these planning links and ensures that oil companies, vessel owners, and oil-handling facility owners: (1) conduct oil spill exercises with the USCG, EPA, and state authorities; (2) understand each others' problems and agendas; and (3) contribute to the improvement of future responses. PREP also refined the Incident Command System (ICS) to incorporate the Unified Command Structure (UCS). ICS now is practised regularly and works, although further improvements are possible. For example, in comparison with systems elsewhere in the world, ICS produces a very large management organisation that may complicate the decision-making process (Nichols, 1998).

OPA 90 requires continued reliance on mechanical recovery at sea as the primary response option, and, despite the historically poor open sea recovery record of such equipment, vessel and facility response plans still require large quantities of mechanical containment and recovery equipment for major oil spill responses at sea. During congressional hearings on OPA 90, the US Congress Office of Technology Assessment (OTA, 1990) reported:

"Historically, it has been unusual for more than 10 to 15 percent of oil to be recovered from a large spill, where attempts have been made to recover it" (p. 1). "Improvements in mechanical recovery technologies that can be expected from stepped up Research and Development efforts are unlikely to result in dramatic increases in total oil recovered from a catastrophic spill" (p. 6).

The OTA report was not widely distributed, and its findings appear to have been ignored. As a result, Americans may well have an expectation that future major oil spills at sea will be cleaned up easily, a myth that needs to be dispelled.

Emphasising mechanical recovery may contribute to the noticeable tendency in the US to mobilise every available resource during a response, regardless of need, thus giving an impression of doing everything possible. The *Morris J. Berman* spill in San Juan, Puerto Rico in January 1994 illustrates this point well: the de-rated daily skimming capability provided was ten times greater than the worst case discharge of the Vessel Response Plan (VRP) and five times greater than the total amount of oil carried on the barge (ITOPF, 1994). During the

Kure spill (1997) in San Francisco, California, all the cleanup contractors specified in the Area Contingency Plan were mobilised for 17 tonnes (119 bbls) of oil (ITOPF, 1998b). Such overreaction, which cannot be justified technically, may likewise be influenced by media pressure rather than by actual technical needs. This strong reaction also is fuelled by the USCG policy of "shoot first ask questions later," thus resulting in inflated response costs.

While OPA 90 acknowledges potential for increased dispersant use, it falls short of mandating dispersant use when appropriate. The resulting over-reliance on mechanical equipment has hindered responders in the past. Although dispersants cannot always be used (because of the type and weathering of oil and the proximity to particular environmental resources), international experience has shown the value of dispersants as a primary, high removal rate, rapid response technique. If dispersant use was supported more enthusiastically in the US, dispersant capabilities would become an integral part of VRPs, thus giving a more balanced armoury of open sea response tools. If this is allied to a guaranteed rapid decision-making process to authorise such use, future responses should benefit considerably.

In the offshore armoury, mechanical equipment will continue to be required on the occasions when dispersants cannot be used. Furthermore, in the inshore areas, mechanical equipment has considerable uses, particularly in the protection of sensitive areas and as a Tier 1 response at terminals. The availability of all types of mechanical oil spill equipment in the US is more than adequate, and the country probably has the best support logistics in the world to deploy it. There are ample supplies of fixed-wing transport aircraft, helicopters, trucks, supply vessels, boom-towing vessels, and recovered oil barges. Based on this, there seems to be no technical justification for the proposed 25 percent increase in mechanical equipment currently being considered by the USCG (1998).

OPA 90 was passed after the *Exxon Valdez* spill amid predictions that reputable shipowners would not trade with the US because of its potential unlimited liability provisions. These dire predictions did not happen. Though many OPA 90 provisions were controversial, those relating to planning, preparedness, and training have been effective, although more still needs to be done to increase the range of response options. The twin drivers of OPA 90 and oil companies' response to public and media pressure following *Exxon Valdez* have combined to produce improvements, although they have yet to be tested in a large spill. Nevertheless, the US should be under no illusion that when the next major spill does occur, despite all these improvements, there is unlikely to be any significant improvement in open sea response. This will only occur if early dispersant use is permitted, in the proper circumstances, as a primary response.

3.4 THE ESSENTIAL ROLE OF RESPONSE PLANNING IN IMPROVING PERFORMANCE

The need for comprehensive contingency planning is widely recognised as the fundamental element in a successful response, and, although not always fully or accurately describing the detail required, this is stressed in almost every book and paper written on oil spill management. Yet, contingency planning has not been conducted comprehensively in many countries and regions.

Without a comprehensive, frequently exercised, updated contingency plan, even the best oil spill management teams will have great difficulty improving response performance, particularly in the early stages of a spill when a team is assembling and not yet fully functioning. To be effective in these early stages, a plan must include detailed initial actions that responders can take based on a prioritisation of resources at risk. These initial actions can save many hours of discussion in a command centre and help initiate response techniques early (e.g., dispersant spraying and protective measures such as booming) while there is still a reasonable chance of success.

An effective planning regime is likely to include multiple planning levels. A national or regional plan will detail overall response policies, including response priorities, strategies, and co-ordination among subregional planning units. Subordinate plans may be specific to a port, terminal, vessel, or facility. These plans are tied to a national plan and provide specific strategies and tactics for implementing guidelines offered in an NCP. In addition to planning requirements prescribed by national governments, ITOPI (1985) and IPIECA (1991) have produced guidelines for the organisation and content of contingency plans.

Contingency plans should contain two main sections. The first, or **strategy section**, includes all pre-planning issues. The second, or **operational plan**, includes actions to be taken when a spill occurs. It is the **strategy section** that is so important yet so often poorly written. It should contain the following components: risk analysis, oil movement and fate, resources at risk, selection of techniques, and location of equipment and manpower resources.

Risk analysis. Risk analysis includes historical information about spills (how many, where, size, type of oil). This need not be a numerical risk analysis but a practical assessment of oil operations that may cause spills. Each operation should be specified, and the most likely and worst case situations identified.

Oil movement and fate. Using the risk analysis results, planners can estimate the likely quantity of oil. The ability to forecast the wind and current and tidal conditions accurately enables a prediction of the most likely movement of oil. Knowledge of oil properties, either from crude assay sheets or spilled oil experiments, enables a prediction to be made of the likely fate of oil.

Resources at risk. By knowing the likely fate of oil, resources likely to be impacted can be identified and probable degree of impact determined. Environmentally sensitive areas,

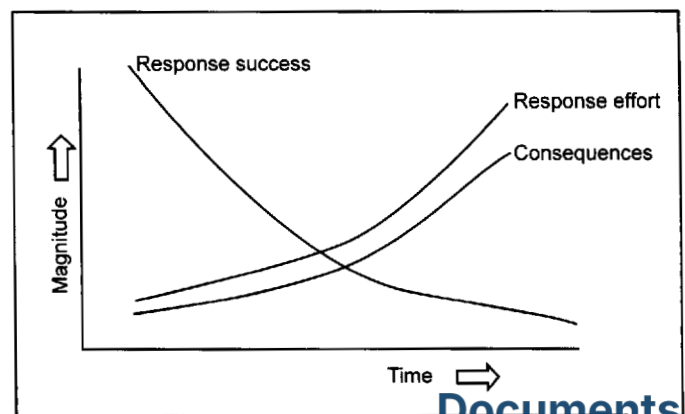
amenity areas, fishing grounds, and industrial seawater intakes should be identified and mapped. It is unlikely that all resources can be protected in a major spill; therefore, they must be prioritised. Only government authorities can make final decisions on priorities after consultation with environmental authorities and the potentially affected community.

Selection of techniques. Appropriate strategies can now be chosen to mitigate impacts. The whole coastline will need to be studied to identify access routes, shoreline types, and appropriate cleanup methods. Cleanup techniques and equipment used to implement appropriate techniques can now be determined and not, as in too many cases, before a contingency plan has identified a need. Response techniques may change with the seasons, depending on the predominant environmental risk. It is important that all participants in the planning process agree on response actions, so that when a spill occurs, these actions may be implemented rapidly. If dispersants have been included in a response strategy, the necessary pre-approvals should be sought to enable rapid authorisation and use. Where protection of sensitive areas is desired, the following items should be specified: access arrangements; location, layout, and amounts of booms and ancillaries; cleanup equipment to be employed; temporary storage locations; and disposal routes. It is equally important to identify and agree on locations that cannot be protected and why. This information will help to deflect pressure from politicians, environmental interest groups, and the media to perform either technically unsound or impossible tasks.

Location of equipment and manpower resources.

Once response techniques and priorities are determined, equipment stockpiles should be identified and/or procured and situated to enable rapid deployment. To be effective, a response organisation must become operational quickly. Figure 1 shows that the later response efforts begin, the greater the effort required to control the emergency and the greater the consequences. The location of response equipment and manpower mobilisation times in a plan, therefore, should be determined by the need to react quickly. It is sometimes the case that equipment is stored in remote warehouses, and equipment and manpower mobilisation times are determined by

FIGURE 1.
THE EVOLUTION OF A RESPONSE



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economy and not by operational requirements. Given the severe cost pressures within the oil industry, only government regulation, which affects all companies equally, will ensure that adequate numbers of personnel and timely mobilisation times are achieved. Once plans are completed, they must be tested regularly in exercises or responses, evaluated, and amended.

3.5 IMPROVEMENTS IN RESPONSE PERFORMANCE

While assessments of international agreements, domestic legislation, and preparedness activities are indicators of desire to improve performance, trends in response operations, management, and cost can be evaluated to provide measures of performance improvements. For this subsection, spill incidents summarised in Appendix B were reviewed to provide evidence of improvements in operational and administrative issues.

As noted previously in almost all of the cases in Appendix B, records were incomplete, and the accuracy of many of the data, especially total quantity spilled and treated or recovered, could not be verified. Nonetheless, the cases do provide sufficient information to estimate trends in performance.

OPERATIONAL ISSUES

Issues common to large spill responses were selected from the case studies in Appendix B where there has been considerable change during the past 20 years. This subsection focuses on these changes and evaluates whether there have been performance improvements. The selected issues are:

- salvage,
- offshore mechanical recovery,
- offshore chemical dispersant application,
- offshore *in situ* burning,
- shoreline cleanup, and
- computer modelling.

Salvage. Awareness has been heightened regarding the importance of adequate salvage capability in the event of a vessel emergency. In oil spill response, salvors and spill response teams always need to work closely together, as certain stages of a salvage operation may require special pollution control measures. Salvage and pollution operations should be managed together and addressed in any NCP.

There are numerous examples indicating salvage is an integral part of spill response. For example, during the *Cristos Bitos*, *Exxon Valdez*, *Kharq V* (1989), *Aegean Sea* (1992), *Sea Empress*, and *Morris J. Berman* spill responses, salvors prevented a potential complete loss of cargo and, therefore, an even greater response effort. On other occasions, drifting or aground vessels have been rescued with no oil, or no further oil, being spilled. In Australia in 1991, the *Kirki*, which had been abandoned by its crew with the remaining cargo still

onboard, was rescued by salvage tugs when only 2 miles off the west Australian coast. The cargo was successfully offloaded at sea by salvors.

Maintaining ready salvage capability is a very expensive proposition, and payment to support these vessels is always a difficult matter. Specially chartered tugs are available on standby status in some areas, such as in France since the failure to rescue the *Amoco Cadiz* before she grounded. The UK government also charters tugs during the winter months, one of which, the *Far Minerva*, pulled the tanker *Santa Anna* off the rocks at Torbay, Devon in January 1998. There are numerous other examples where pre-positioned salvage tugs have saved vessels.

There always will be a need for a healthy salvage industry, especially when the likelihood of the need for salvage support in a given area is very remote. Thus salvage capability worldwide continues to erode, while government and industry continue to ponder equitable schemes to maintain it. Marine accidents will never be eliminated entirely because humans are fallible and continue to make mistakes.

Offshore mechanical recovery. According to conventional wisdom, the use of offshore mechanical recovery equipment at an oil spill at sea rarely will collect more than 10–15 percent of the amount spilled. In most cases, the amount recovered at sea will be much less than this, with a range of 1–6 percent being much more common. This is attributed more to the laws of physics than to the responders' competence. Oil spreads so rapidly that, unless it can be contained close to the source, the slick will very quickly approach such proportions that it will be impossible to boom and skim.

An oil slick never remains static; it spreads under the influence of tides, currents, and wind, losing coherency and breaking into smaller, widely dispersed patches. Most often by the time a response can be mounted, it becomes impossible to do more than clean up small parts of a spill. For example, at first light during the *Exxon Valdez* spill, the slick had grown to 8 square miles or just over 2.5 miles in diameter. If four offshore recovery vessels had been available immediately, operating at their maximum skimming speed of 1 knot, it would have taken approximately 24 daylight hours, or 2 to 3 skimming days, to sweep through the entire slick.

In all the cases reviewed in Appendix B, only a small proportion of oil was removed from the water surface. In the *Exxon Valdez* spill, very little oil was recovered on the water despite mobilising the largest amount of mechanical containment and recovery equipment ever assembled. On a smaller scale, only 2 tonnes (14 bbls) of oil were recovered of the 17 tonnes (199 bbls) spilled from the *Kure* despite mobilising a large amount of offshore cleanup equipment and shoreline protection equipment. Yet in the US and other countries such as Norway, mechanical containment and recovery at sea remain the preferred response despite rarely being very successful. In countries that are signatories to the CLC and Fund Convention, very large offshore cleanup efforts may not be considered "reasonable" given this low probability of success. Compensation from the funds may very well not be forthcoming as a consequence. Given the weight of evidence, it is

unclear why so much reliance has been placed on this technique in the US.

The following are two exceptions to poor mechanical recovery results:

- The 1,000-tonne (7,000-bbl) spill from the vessel *Volgoneft 263* in the Baltic in 1991, in which almost all spilled oil was recovered (Fagoe, 1991).
- The 80 percent recovery of heavy fuel oil from the tanker *Katina* in the North Sea in 1982.

On both occasions, the weather was favourable, and the oil slick remained intact. In a more limited way at the *Mega Borg* spill (1990), ORSL crews recovered 375 tonnes (2,625 bbls) of oil in 3 hours. As described earlier, the laws of physics, together with factors such as the time late at the spill, weather and currents, oil spreading, low oil encounter rate, and inability to contain it will reduce the chance for success, despite the best efforts of response personnel.

Offshore chemical dispersant application. In responses where the oil type and environmental situation make dispersant use the most appropriate technique, evidence from the case histories in Appendix B shows that dispersants provide the best means of high-rate oil removal from the sea surface. In these circumstances, the toxic effects of dispersed oil do not appear to be significant. This has now been sufficiently well documented as to counter the anti-dispersant argument. There is still much ignorance about dispersant toxicity, which is still being quoted in Alaska as "using a toxic material to disperse another toxic material" (OSIR, 1998a). The marginal costs of aerial application make it the most cost-effective response method as well, although the high cost of retaining aerial application systems at short notice is wasteful unless it can be shared, as is the case in Tier 3 response bases. Another cheaper alternative, where such planes are available, is offered by the use of crop spraying aircraft such as the Australian FWADC.

To date, only Singapore and the UK have used dispersants on a very large spill. No figures have been released for the amounts of oil dispersed from the *Evoikos* in Singapore. In the UK, dispersant use was extremely effective on Forties crude oil during the *Sea Empress* spill (Table 2) and made a major con-

tribution to reducing shoreline oiling and cleanup costs. Successful dispersant use during the *Sea Empress* response appears to confirm the results from earlier uses (*Sivand*, *Phillips Oklahoma*, and *Rosebay*) in which significant proportions of spills were dispersed.

In the US, dispersant use has never been prohibited completely; however, the decision process for dispersant use has been so cumbersome as to make the decision regarding its use unworkable. Over the last 4 years, every region of the US has adopted some form of pre-approval or expedited approval process for dispersant use. In the near future, dispersants are expected to be used more frequently to combat spills in the US. Inclusion of a dispersant equipment capability may be mandated by the USCG as part of the 25 percent increase in the capacity requirements of VRPs (USCG, 1998). The experience of the UK and Texas should help to sway the doubters. For example, in the Gulf of Mexico, dispersants have been used on at least three spills in the past few years: High Island Pipeline (1998), *Red Seagull* (1998), and South Pass Pipeline (1989). UK and US response successes have shown, in the right circumstances and on the right oils, dispersants can have a much more positive influence on an offshore spill than other techniques. In areas where use is allowed, investment in dispersant spraying has been worthwhile.

A strong case can be made for a more positive attitude toward immediate dispersant use in suitable areas by national authorities. New dispersant formulations are increasing efficacy on heavier and more weathered oil, including heavy fuel oils (OSIR, 1997a). The 1:20 dispersant:oil application rate has been shown in some cases to be excessively conservative, and windows-of-opportunity for spraying are becoming longer. During a January 1998 spill in Nigeria, scientists from AEA Technology observed the chemical dispersion of a 6-day old slick, 200 km from the spill site (OSIR, 1998b). Norway, although retaining its preference for mechanical recovery, is considering dispersant use seriously. A recent exercise in Spain (Exercise Cadiz 97) demonstrated that, given the weather conditions likely to be experienced on the Atlantic Coast and high tidal speeds prevalent in some sensitive areas, dispersant spraying might be the only effective offshore response technique.

Offshore *in situ* burning. Burning at sea is unlikely to be more than a niche technique. *In situ* burning depends on containment of oil; therefore, the technique suffers from all the well-known problems of offshore containment. If oil can be contained for burning, it also can be contained for mechanical recovery. If conditions are suitable for offshore recovery, there seems little purpose in burning oil, unless it has not been possible to obtain certificated oil spill recovery vessels and storage barges.

In calm or otherwise confined waters, *in situ* burning may have considerable value. Its utility has been observed for spills on ice and in marshes (Hyde *et al.*, 1998; Pahl and Mendelssohn, 1997). Current fire booms suffer from problems that are not experienced by conventional booms. They are extremely bulky so transport to a spill site can pose logistical problems, and fire booms are not very durable, though recent developments are promising (OSIR, 1998b).

TABLE 2.
DISPERSANT EFFECTIVENESS IN LARGE-SCALE APPLICATIONS

VESSEL	SPILLED OIL		DISPERSED (%)
	tonnes	bbls	
<i>Sivand</i>	6,857	48,000	16-33 ¹
<i>Puerto Rican</i>	6,857	47,999	20-30
<i>Phillips Oklahoma</i>	901	6,307	100 ¹
<i>Rosebay</i>	1,100	7,700	60 ¹
<i>Sea Empress</i>	72,000	504,000	24-52

¹ Includes natural dispersion and evaporation.

Shoreline cleanup. Before discussing shoreline cleanup, it is important to understand that oil spills are not long-term environmental disasters in the way that, for example, the permanent loss of land habitats to development can be. This is because, in most cases, spill damage will recover naturally over a period of time. Scientific studies conducted after many major spills confirm this. "The recovery times for most spills will be between 3 to 5 years, regardless of whether they had been cleaned or not" (Baker, 1997). One year after the *Exxon Valdez* spill, Baker *et al.* (1990) reported that:

"Our experience in Prince William Sound, one year after the spill held few surprises..."

"Only a portion of the shoreline had been oiled, and, as with most other oil spills, the bulk of the damage had disappeared in the first year. The area retains its natural beauty; there are abundant signs of plant and animal life, and recovery is underway in even the most severely impacted beaches..."

"Since there are few sheltered areas with extensive mudflats, which elsewhere have sometimes taken a long time to recover, the overall impact of the oil spill on the environment of Prince William Sound and the Gulf of Alaska, is likely to be short-lived."

"If it is allowed to proceed without interruption, it will continue and be robust, as it has been, following other oil spills throughout the world."

Two years later, Baker *et al.* (1992) reported:

"Oil impacts are short term. Concerns that damage which is not currently apparent will appear in future years is not supported by scientific evidence from any previous spills."

Following the *Braer* spill, an environmental report by the Ecological Steering Group on the Spill in South Shetland (ESGOSS, 1994) stated:

"Overall, the impact of the oil on the environment and ecology of South Shetland has been minimal. Adverse impacts did occur, but were both localised and limited. The resilience of the ecosystems and species populations has already been powerfully demonstrated and provides confidence and reassurance for the future."

In all the spills in Appendix B when oil came ashore, it was ultimately cleaned up or left to nature. Over the past 20 years, shoreline cleanup equipment improved, became more readily available, and was used extensively to cleanup spills. It has been recognised, however, that aggressive cleanup techniques often cause more environmental damage than they prevent (Baker *et al.*, 1992; OSIR, 1998d). This recognition, coupled with increased research into the environment effects, has shifted emphasis during spill response to reducing spill impacts.

Shoreline cleanup is not an exact science, and there is always room for disagreement on the best cleanup methods in

a given situation. Recently, there has been a growing realisation, particularly in Europe, from an environmental benefit standpoint that, wherever possible, the shoreline should be allowed to self-clean. This has normally been the case in high-energy areas such as cliffs and exposed rock platforms and very low-energy areas such as salt marshes, where any cleaning is likely to cause unacceptable damage. Yet as recently as 1997, it was reported that at Martinez, California, marsh cleanup was occurring following a pipeline rupture. It also was reported that cleanup could last a year and that the heavy equipment being used (and pipeline repair equipment) was driving oil into the marsh mud (OSIR, 1997b).

Self-cleaning decisions are becoming more common in other lower-energy areas, especially if oil and fine particle interaction (clay oil flocculation) is occurring. In these situations, careful removal of bulk oil may be required to reduce the smothering effect (for example, in rock pools) and prevent oil migration to previously clean or more sensitive areas. Aesthetic reasons alone are no longer sufficient to require aggressive cleanup, except in amenity areas that must be cleaned to a high standard.

In the most recent major spill (*Sea Empress*), minimum shoreline cleanup was conducted. In a detailed report on the spill, the *Sea Empress* Environmental Evaluation Committee (SEEEC, 1998) found that there were few signs of significant long-term damage. Thus it may be concluded that this was an effective shoreline cleanup response because "the inevitable environmental impacts were not made worse by inappropriate or intrusive cleanup techniques."

Computer modelling. Computer models are useful indicators of likely oil movement. Because of the extreme difficulty and cost of modelling and the variations in tides and currents (particularly close to the coast), models are unlikely to have the ability to predict exact spill movement and, hence, beaching locations with complete and repeatable accuracy. In addition, seasonal variations of ocean currents are very difficult to predict. Unless local observation can be fed into the model at the time of a spill, variation can cause the model to predict oil movement in the opposite direction from what actually occurred. Models are usually very good at showing what happened after an event and can be useful in contingency planning to show the most likely direction of oil movement. There is, however, no substitute for regular visual or remote sensing of exact oil position and movement.

ADMINISTRATIVE ISSUES

Along with the technical, operational issues of an oil spill response, effective administration is essential. Two administrative issues — management and cost — were selected from the case studies in Appendix B because of the magnitude of change that occurred in recent years. For example, the topic of response management was the subject of an issue paper for the 1995 International Oil Spill Conference (Walker *et al.*, 1995). This subsection evaluates whether there have been performance improvements.

Response management. It is axiomatic that, unless an oil spill response is managed successfully, as with any other human endeavour, it will fail both technically and in the minds of the public. Various management systems exist for co-ordinating various spill response activities. For example, the ICS with a UCS is now universal in the US. Other systems are in use elsewhere, tailored to their national requirements. There is no correct way to organise and manage a spill: it is much more important for all personnel to be competent, understand their roles, and have practised regularly in drills and exercises. The value of exercises was well demonstrated at the *Sea Empress* spill, where the core of the response team had regularly exercised together over many years. The ensuing teamwork contributed greatly to response success (author's personal observation).

A poorly managed response is unlikely to be successful even with unlimited access to the most modern equipment and resources. Conversely, a well-managed response with well-trained personnel can result in a successful response in spite of obsolete or makeshift equipment. This seems obvious, yet there are still places where it is not understood. The retention of experienced personnel in the planning and response stages should be beneficial, for example, from ITOPF and Tier 3 response bases.

Well-trained, effective teams can make a successful response. Developing good working relationships among government, responders, regulatory bodies, and environmental groups is one of the key elements necessary for response improvements. Effective training and a carefully devised, progressive series of exercises (such as PREP in the US) can achieve performance improvements.

Response costs. There is no obvious link between cost and spill size. In general, a small spill will cost more per tonne than a large spill, probably because there are no economies of scale for small spills. Many factors influence the magnitude of these costs (Etkin, 1998a, b), including the following:

- amount of oil spilled,
- type of oil,
- location and timing of the spill,
- sensitive areas affected,
- liability limits in place,
- ability of the spiller to pay,
- local and national laws,
- cleanup techniques employed,
- weather during the cleanup operation, and
- human decisions.

Other factors could include local rates of pay and equipment purchase and hire costs. Table 3 lists a number of spills that occurred in various parts of the world since 1977. Using such a small sample, it would be difficult to draw too many conclusions. Since the *Exxon Valdez* spill, the average cleanup cost of oil spills worldwide has more than doubled, while in the US, the average cleanup cost has increased fourfold. Why should costs in the US apparently escalate by so much in comparison to the rest of the world? Table 3 draws attention to the

TABLE 3.
COSTS OF SELECTED LARGE SPILLS

YEAR	SPILL	SPILL SIZE		CLEANUP COST (1997 \$US)	COST PER TONNE SPILLED (1997 \$US)
		tonnes	bbls		
1979	<i>Burmah Agate</i>	36,395	254,765	15,351,510	421
1980	<i>Tanio</i>	17,313	121,191	148,652,180	8,471
1984	<i>Alvenus</i>	10,088	70,616	67,617,000	7,122
1984	<i>Puerto Rican</i>	6,857	47,999	6,811,968	612
1985	<i>Patmos</i>	2,000	14,000	12,608,167	6,304
1989	<i>Exxon Valdez</i>	37,415	261,905	2,635,000,000	90,145
1990	<i>American Trader</i>	1,418	9,926	12,780,000	10,866
1991	<i>Haven</i>	142,857	1,000,000	199,765,555	1,637
1991	<i>Tenyo Maru</i>	588	4,116	15,587,960	26,096
1992	<i>Aegean Sea</i>	74,490	521,430	27,633,500	421
1993	<i>Lyria</i>	2,721	19,047	7,749,000	2,572
1994	<i>Morris J. Berman</i>	2,684	18,788	91,659,000	34,150
1994	<i>Seki</i>	16,000	112,000	11,017,852	688
1994	<i>Apollo Sea</i>	2,596	18,172	6,500,000	2,700
1995	<i>Sea Prince</i>	1,401	9,828	25,142,090	17,941
1995	<i>Yuil No. 1</i>	2,597	18,178	15,281,537	5,883
1996	<i>Sea Empress</i>	72,000	504,000	30,922,375	427
1997	<i>Nakhodka</i>	6,201	43,407	171,872,000	27,718
1997	<i>Nissos Amorgos</i>	8,571	59,997	29,860,000	3,483
1997	<i>Evoikos</i>	28,571	200,000	10,786,500	377
1997	<i>Kure</i>	17	119	12,000,000	705,882

Note: US spills in bold.

widely varying spill response costs in the US compared to the rest of the world. There are bound to be differences in costs among countries, but, when the differences become great, there is a legitimate interest in analysing the reasons, some of which could include:

1. The aggressive "shoot first ask questions later" policy advocated by the USCG (Appendix B, *Morris J. Berman* spill).
2. Irrational media and public pressure demanding action (Section 4).
3. Technically unsound, or unreasonably large, response actions made in response to this pressure, such as overcleaning of beaches and steam cleaning of shorelines in a cold environment (Appendix B, *Exxon Valdez* spill).
4. Favourable or less unfavourable media response to such over-reaction (Appendix B, *Kure* spill).
5. Vociferous environmental interest groups that either do not understand, or do not wish to understand, the realities of oil spills. These same people often choose to ignore scientific data when they conflict with dearly held prejudices. The dispersant argument is an obvious case (Section 3.5).



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6. High labour rates and equipment hire costs.
7. An RP's Qualified Individual being provided from the OSRO, which might have led to conflicts of interest (OSIR, 1997c).
8. Spill expenditure is in the hands of an RP or his cleanup contractor. Once an RP's limit of liability is reached, provided that the shipowner can limit his liability, funds are provided from the Oil Spill Liability Trust Fund (OSLTF). As it is no longer an RP's money, there is little incentive to economise (de Bettancourt *et al.*, in press). By comparison, the international compensation conventions, CLC and IOPC Fund, have a requirement that cost recovery should only be available for actions judged to be technically reasonable. There is an external oversight mechanism to assist in cost control, with highly experienced agents, normally from ITOPF, appointed by the Protection and Indemnity (P&I) Clubs and the IOPC Fund to note which activities are considered to be reasonable. Although the OSLTF also has a similar requirement to provide reimbursement only of reasonable costs, the oversight appears to come from the UC, led by the USCG, which is not a disinterested party (see 1 above).
9. The utilisation of massive resources is a national characteristic. Anything is possible if enough resources are used to deal with a problem.

The Britannia P&I Club has been moved to observe that,

"In the United States, there is now a major series of industries which make their money out of oil spills, and in whose interest it is to whip up the greatest possible level of hysteria so as to try to justify the spending of ridiculous amounts of money..." (OSIR, 1998e).

Despite "objective evidence" that ships are spilling less oil and that properly handled spills cause little long-term environmental impact, in the US:

"Shipowners are treated as criminals; cleanup is about contractors making money and politicians or bureaucrats making reputations; and large and arbitrary penalties are being imposed, either as fines or NRDA Compensation for long term damage which does not exist and cannot be measured in dollars, or paid to those who suffer" (OSIR, 1998e).

As the response to the *Sea Empress* demonstrated, it is a myth that all spill responses must have massive resources and be vastly expensive to be successful. The reality has been that other factors often unrelated to the technical merits of the spill have driven costs upwards. In the US, the view that it should not be necessary to respond with such massive resources and large response teams has never reached the agenda. Has the US been out of step with the rest of the world, or has the rest of the world been out of step with the US? Recently, there have been encouraging signs that the reasons for cost escalation

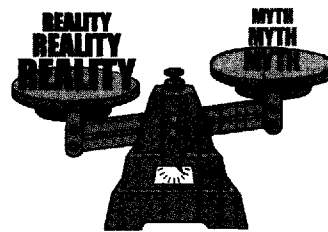
in the US are now beginning to be critically questioned. It is hoped that this will lead to a full review of how responses are managed and ultimately to a reduction in how much they cost.

3.6 IMPROVED PERFORMANCE CONCLUSIONS

MYTH OR REALITY? HAVE INCREASED RESPONSE CAPABILITIES RESULTED IN IMPROVED PERFORMANCE?

As discussed earlier, the lack of comprehensive, accurate information following spill responses creates major difficulties in quantifiably determining if performance improvements have occurred. Consequently, the conclusions below are qualitative and based on case studies along with the author's experience and input from spill response professionals.

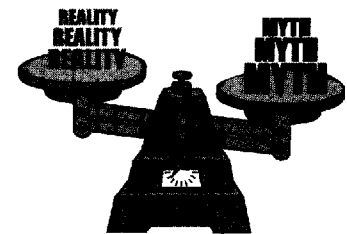
MYTH OR REALITY? HAVE INTERNATIONAL CONVENTIONS AND AGREEMENTS IMPROVED PERFORMANCE?



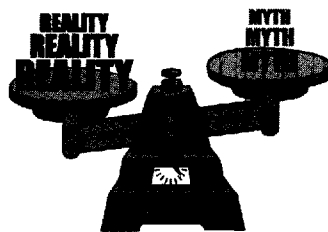
There have been performance improvements as a result of the adoption of international conventions and agreements. The development of the OPRC Convention signifies international commitment to

preparedness planning, and the establishment of equipment stockpiles worldwide is a major improvement. Regional agreements such as the Bonn Agreement and the Helsinki Convention provide further evidence that governments are making commitments toward improvement.

While some aspects of conventions and agreements have begun to be implemented, all provisions of these agreements are not yet in place. Further initiatives to implement them have not spread throughout the world.



MYTH OR REALITY? HAS OPA 90 IMPROVED PERFORMANCE?



In the US, OPA 90 has resulted in improved performance, most notably in preparedness because of the emphasis on contingency planning and exercises. OPA 90 also has resulted in increased discussion

on dispersant use as another response technique available to responders. Although dispersant use needs more promotion, OPA 90 can be credited with providing the first step toward improved acceptance of dispersant use.