

OIL SPILL RESPONSE – EXPERIENCE, TRENDS AND CHALLENGES

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INTRODUCTION

Major tanker spills are now exceptionally rare events. However, world-wide statistics are no consolation to those whose coastlines and livelihoods are affected by the consequences of accidents such as the ERIKA off the west coast of France in December 1999 or by smaller spills such as the LAURA D'AMATO in Sydney Harbour in August 1999. In such cases the inability of responders to prevent spilled oil from fouling beaches and damaging wildlife and coastal resources is all too plainly demonstrated to an increasingly environment-conscious public by a media that now has the capability to relay dramatic real-time pictures around the world, sometimes faster than responders can get on scene. Such highly visible events also have dramatic and expensive consequences for the owners of the tanker and cargo, as well as for the oil transportation industry as a whole since they inevitably attract the attention of politicians and regulators. Unfortunately, the resulting activity is sometimes driven more by political expediency and public perception than by technical requirements.

This paper seeks to take advantage of the first SPILLCON of the New Millennium to review some of the experiences and trends in the incidence of and response to marine ship-source oil spills over the past 30 or so years, drawing on ITOPF's first-hand experience of over 400 incidents world-wide. This includes recent major accidents such as the ERIKA in France, NAKHODKA in Japan, SEA EMPRESS in the UK and TREASURE in South Africa.

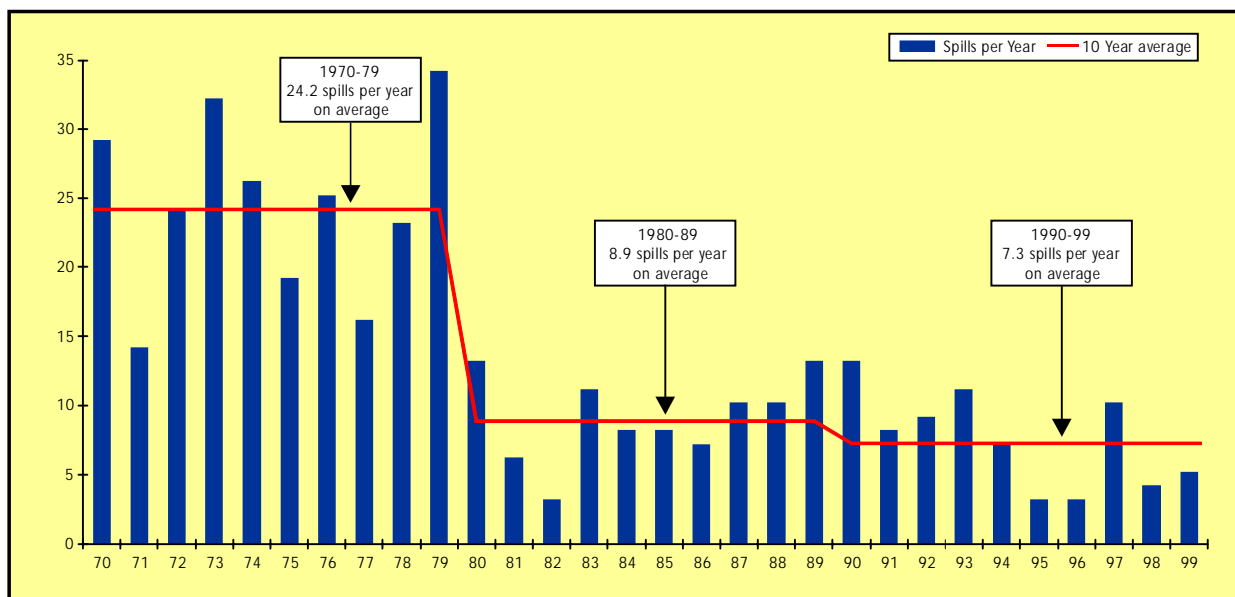
Whilst the world is much better prepared and equipped to deal with major marine oil spills than it was in 1967 when the TORREY CANYON lost some 120,000 tonnes of crude oil in the south-western approaches to the English Channel, it is still the case that we are not able to overcome some of the fundamental technical problems associated with combating such events. What is more regrettable is the fact that most significant oil spills are not dealt with as effectively as current technology should allow. This is frequently because those responsible for managing the response operations take insufficient account of the extensive technical knowledge and experience that is available, especially in terms of the lessons that have been learnt from previous spills around the world. Expressed another way, the mistakes of past cleanup operations are all too often repeated. This gives rise to serious questions about the adequacy of the organisation and management of response operations, contingency planning and training programmes. The challenge is to improve this situation in the future.

INCIDENCE OF SHIP-SOURCE SPILLS

The only real solution to minimising the environmental and economic damage that can result from major ship-source spills lies in preventing such events happening in the first place. It is therefore entirely appropriate that the first session of SPILLCON 2000 should be devoted to this important topic.

Tankers

As the graph below illustrates, the concerted efforts of the International Maritime Organization, individual governments, the oil transportation industry and various other key groups have resulted in a dramatic reduction in the incidence of major tanker spills over the past two decades. Whilst the relatively small number of spills over 700 tonnes precludes detailed statistical analysis and there are considerable annual variations, the overall trend is clear. Thus, the average number of spills of this size each year in the 1980s and 1990s was about one-third of that experienced in the 1970s. The average annual amount of oil lost as a result of tanker accidents has also been reduced since the beginning of the 1980s and now represents less than 0.01% of the total quantity transported by sea each year, which is an exceptionally good loss prevention record for any major industry. The problem is that this 0.01% can make a terrible mess if lost in a few highly visible accidents.



Tanker Spills over 5000 barrels (700 tonnes), 1970-1999

Other Types of Ship

Whilst attention is usually focused on tanker spills, it should be recognised that certain other types of ship, such as container liners and bulk carriers, can carry more bunker fuel than many small tankers carry as cargo. While bunker spills tend, on average, to be relatively small in volume they can give rise to greater problems (including higher claims for compensation) than many equivalent sized crude oil spills from tankers. This is indicated by the fact that about 28% of the oil spills attended on site by ITOFF staff over the past fifteen years have involved bunker fuel spilled from non-tankers. In the last two years this percentage has increased to about 50%.

Australia has first hand experience of the oil spill risks posed by non-tankers as a result of incidents such as the IRON BARON that grounded on Hebe Reef off the north coast of Tasmania

in July 1995. The resulting loss of fuel oil from this bulk carrier affected widely scattered and remote shores, including amenity beaches, a nature reserve and an important penguin colony. The recent TREASURE incident off South Africa involving another bulk carrier, on this occasion laden with iron ore, caused similar impacts, resulting in the cleaning, rehabilitation and evacuation of many thousands of Jackass (African) Penguins.

Bunker spills from non-tankers have increasingly become the focus of attention of politicians, regulators and environmental groups in a number of countries, partly due to high profile events such as the NEW CARISSA. This wood-chip carrier grounded on the coast of Oregon, USA in February 1999 during a period of severe weather. The consequences of the spill of some 250 tonnes of bunker fuel were relatively minor but the world's media (who invariably cannot tell the difference between a bulk carrier and a tanker) was enthralled by the pyrotechnics surrounding the attempts to burn the bunker oil remaining in the ship's tanks and, later, by the fact that it ultimately took a torpedo fired from a nuclear-powered submarine to sink the bow section beyond the 200-mile limit, the hulk having proved surprisingly resistant to gun fire from a naval vessel!

The high level of attention that is now being given to bunker spills from non-tankers is probably not a reflection of any increase in the incidence of such events. It is probably more due to greater awareness of environmental concerns, coupled with a realisation of the particular difficulties posed by spills of heavy fuel oils. It is probably also an indirect consequence of the very welcome decline in the incidence of major tanker spills. Whatever the case, the problem is felt to be sufficiently important by a number of countries, led by Australia, that they are actively promoting the development within the International Maritime Organization of a liability and compensation Convention specifically for bunker spills from non-tankers. This will be discussed and hopefully agreed during an IMO Diplomatic Conference in March 2001.

FATE AND BEHAVIOUR OF SPILLED OIL

To understand the fundamental problems that continue to defy a simple technological solution to oil spills it is necessary to examine some of the main factors that determine the seriousness of a spill, before examining the limitations of the cleanup techniques that are currently available.

Oil movement

When oil is spilled onto the surface of the sea it spreads very rapidly, and after a few hours the slick will usually also begin to break up and form narrow bands or "windrows" parallel to the wind direction. Within a very short time, therefore, the oil will often be scattered within an area of many square miles with large variations in oil thickness being evident. This is one of the fundamental factors that limits the effectiveness of all at-sea response techniques.

Whilst computer models can be used to calculate the probable movement and spreading of spilled oil, experience shows that it is unwise to place total reliance on such predictions. Inadequate knowledge of surface currents in the area of the spill, local wind variations and the unpredictable behaviour of some oils (e.g. submergence of heavy oils in rough seas or low salinity waters due to neutral buoyancy) are among the factors that can cause spilled oil to move in surprising directions. This is why aerial surveillance by experienced observers, possibly supplemented by remote sensing equipment if available, is an essential element of an effective response. Surveillance flights should be undertaken at the outset of an incident and then on a regular basis thereafter to confirm the location and extent of the pollution and to verify and update predictions on the oil's probable movement and the threat it poses to sensitive resources. It is important to co-ordinate

flights and flight plans to avoid duplication, and to prevent unnecessary disturbance of colonies of seabirds and marine mammals, which might otherwise be frightened into diving into nearby floating oil.

Regrettably, experience shows that aerial surveillance following spills is often inadequate, with common problems including the use of inappropriate aircraft (e.g. jet fighters) and inexperienced observers who are unable to distinguish between thin sheens, thick oil, "mousse" and a variety of other phenomena that can look like oil from the air (e.g. underwater sea grass beds). A further very common problem is a failure to transmit clear reports on oil location and reliable estimates of amount to the control centre in a timely manner.

Weathering

At the same time as the oil spreads, moves and fragments it also undergoes a number of physical and chemical changes, collectively termed weathering. Most of these weathering processes, such as evaporation, dispersion, dissolution and sedimentation, lead to the disappearance of oil from the sea surface. On the other hand, the formation of water-in-oil emulsion ("mousse") and the accompanying increase in viscosity as the oil absorbs up to four times its own volume of water, promote the oil's persistence. Ultimately, the marine environment assimilates spilt oil through the long-term process of biodegradation.

The speed and relative importance of the processes depends on factors such as the quantity and type of oil, the prevailing weather and sea conditions, and whether or not the oil remains at sea or is washed ashore. An understanding of these interacting factors and processes is essential in order to determine the seriousness of a spill and the need for a cleanup response.

Type of oil

One of the most significant factors in any spill is the type of oil, especially its probable persistence in the marine environment.

In general, non-persistent oils include light refined products (e.g. gasoline) and even some light crude oils which are highly volatile materials with low viscosities. As they do not normally persist on the sea surface for any significant time due to rapid evaporation and the ease with which they disperse and dissipate naturally there is usually only a limited requirement for cleanup. Such oils may, however, pose a significant fire and explosion hazard as well as cause public health concerns if they occur close to centres of population. They may also cause significant environmental impacts due to their high concentration of toxic components but, as these same components evaporate rapidly, any such effects will usually be highly localised.

At the other end of the spectrum of oil types are heavy crudes and heavy fuel oils. These oils are highly persistent when spilled due to their greater proportion of non-volatile components and high viscosity. Such oils have the potential, therefore, to travel great distances from the original spill location, causing widespread contamination of coastlines and damage to amenity areas, fishing gear and wildlife, mainly through physical smothering. As a consequence, the cleanup of heavy oil spills can be extremely difficult, extend over large areas and be costly. This is well illustrated by the recent ERIKA and NAKHODKA spills in France and Japan, respectively. It is also demonstrated by the TANIO, which broke up off the north coast of Brittany, France in 1980. In this case the cleanup of the 14,500 tonnes of heavy fuel oil cargo that contaminated over 200 km of the Brittany coastline was in many ways just as difficult as for the 223,000 tonnes of crude oil from the AMOCO CADIZ which had contaminated the same area two years earlier. The problem of dealing with heavy oils is also the reason why bunker spills from non-tankers can often cause problems that are far greater than might be suggested by the amount of oil spilled.

Between the two extremes of gasoline and heavy fuel oil there are many intermediate crude oils and refined products that are transported by tankers and used in a variety of marine engines. It is therefore important when a spill occurs to know the exact type of oil involved and its characteristics. This can sometimes be difficult to determine with certainty during the early stages of a spill, leading to confusion and unreliable predictions.

SELECTING THE APPROPRIATE RESPONSE

Knowledge of the type of oil and predictions of its probable movement, behaviour and fate are vital in order to evaluate the risk to coastlines and the likely impact of a spill on environmental and economic resources. It is essential to carry out such an evaluation before deciding on the most appropriate strategy and the required scale of any response. Failure to do so prior to mobilising cleanup resources can result in considerable embarrassment at a later stage for those in charge if it should transpire that the equipment and materials are inappropriate in the circumstances. This can render the response ineffective and lead to problems in recovering the costs from other parties.

Monitoring

If the evaluation indicates that the oil will remain offshore where it will dissipate and eventually degrade naturally, monitoring the movement and fate of the floating slicks to confirm the predictions may be sufficient or indeed all that is feasible. On this basis, many of the largest tanker spills over the last 20 or so years, including the ATLANTIC EMPRESS, ABT SUMMER, CASTILLO DE BELLVER and ODYSSEY, did not require a major cleanup response. In other cases, like the BRAER in the Shetland Isles, UK in January 1993, a combination of light crude oil and severe weather conditions can also dramatically reduce the need for and feasibility of a cleanup response, even when very large quantities of oil (in this case 85,000 tonnes) are spilled close to the coast.

Response Operations at Sea

If the evaluation of the spill suggests that the oil does pose a serious threat to coastal resources, the next stage is to consider the most appropriate cleanup techniques and the best sources of the required equipment, trained operators and all the other components of a major response operation. Two main strategies are available for combating oil on the surface of the sea: containment and recovery, and chemical dispersion.

Containment and Recovery

The use of floating booms to contain and concentrate floating oil prior to its recovery by specialised skimmers is often seen as the ideal solution since, if effective, it would remove the pollutant from the marine environment. Unfortunately, this approach suffers from a number of fundamental problems, not the least of which is the fact that it is in direct opposition to the natural tendency of the oil to spread, fragment and disperse. Thus, even if ship-borne containment and recovery systems are operating within a few hours of an initial release (which is rare) they will tend to encounter floating oil at an extremely low rate.

Wind, waves and currents, even quite moderate ones, also limit the effectiveness of recovery systems on the open sea by making correct deployment difficult and causing oil to splash over the top of booms or be swept underneath. Even when oil has been concentrated within a boom the problems are not over since many skimmers are only effective with a limited range of oil types, with severe limitations on the pumping of viscous oils and "mousse".

Because of all these limiting factors it is rare, even in ideal conditions and with the greatly improved equipment available today, for more than a relatively small proportion (10-15%) of spilled oil to be recovered from open water situations. In the case of the EXXON VALDEZ, for example, where enormous resources were dedicated to offshore oil recovery, the percentage was at most 9%.

While at-sea recovery rates may be low when viewed as a percentage of the total volume spilled, the benefit of such operations can be maximised by targeting the heaviest oil concentrations and areas where collection will reduce the likelihood of oil impacting sensitive resources or contaminating shorelines that will be particularly difficult to clean. This requires a strategic approach to oil spill combat, as well as close control of the containment and recovery operations (using suitable helicopters or fixed-wing aircraft). Unfortunately, such an approach is rare with the result that any oil collected is unlikely to reduce significantly the extent of the spill's overall impact on coastal resources or the problems faced by those responsible for shoreline cleanup.

Whilst containment and recovery of oil on the open sea is frequently of marginal benefit, a higher degree of success can be achieved in sheltered coastal areas and where floating slicks are concentrated within port areas or by natural features. Equally, improved rates of recovery may be achieved in the event of an on-going release from a tanker, offshore platform or other static source since more time will be available to mount an effective response operation close to the spill source where the oil is fresh and more concentrated. However, even in such circumstances, adverse weather and sea conditions, logistical problems, equipment malfunction, the difficulty of conducting cleanup operations during the hours of darkness and a variety of other factors will usually result in a significant quantity of oil escaping.

Dispersants

The main alternative to containment and recovery of floating oil is to try to enhance natural dispersion through the use of chemical dispersants. This is one technique where there have been major advances over the past 30 years, especially in terms of improved, low-toxicity products and more effective application systems.

As with containment and collection, the rapid spreading and fragmentation of oil spilt on the open sea tends to work counter to the effective application of dispersants. However, the likelihood of success can be increased by using aircraft which are able to deliver the chemical more rapidly than ships and with greater precision on to the thickest concentrations of oil or those slicks posing the most significant threat to sensitive resources. The success of such a strategy was illustrated in the SEA EMPRESS incident when the use of about 450 tonnes of dispersant was judged to have removed at least 18,000 tonnes of crude oil from the sea surface, thereby greatly reducing the quantity of oil available to impact sea birds and the coastline.

While the aerial application of dispersant can be highly effective, it does require aircraft of the appropriate type equipped with specialised spraying equipment, as well as large stocks of suitable dispersant chemical. These are unlikely to be immediately available unless the use of dispersant is an integral part of the relevant contingency plan. Without such pre-planning delays are inevitable in a major spill while the required equipment and materials are sourced. This may render the strategy inoperable since, in the event of a large instantaneous release, the natural weathering of the oil and the formation of "mousse" will rapidly render slicks increasingly resistant to dispersant treatment.

In considering a dispersant strategy it also has to be recognised that some types of oil such as heavy fuel oil and viscous crude are less amenable to dispersant treatment from the outset. This does not always stop those in charge from continuing with spraying operations long after there is

any technical justification for doing so, usually on the mistaken assumption that it must be having some effect and that, whatever the technical arguments, it satisfies the need to be “seen to be doing something”.

The TORREY CANYON resulted in dispersants achieving a world-wide reputation for being environmentally damaging. Despite the greatly improved products that are available today and repeated demonstrations that, in open sea conditions, small dispersed oil droplets are rapidly diluted to below concentrations likely to cause biological damage, the use of dispersants is still severely restricted in many countries. In reality, the issue is one of policy and priorities rather than science. Thus, the decision on dispersant usage should be based on a comparison of the probabilities of significant damage being caused by floating oil slicks (e.g. to birds and amenity beaches) as against dispersed oil droplets (e.g. to plankton and fisheries), in order to establish whether the use of chemical dispersants will result in a "net environmental benefit". The decision making process also needs to recognise the relative ineffectiveness of other at-sea cleanup options.

Regrettably, such considerations are frequently not addressed adequately at the contingency planning stage. In the highly-charged atmosphere following a major oil spill it is virtually impossible to resolve any major differences of opinion, thereby reducing the possibility of mounting an effective operation within the limited time-scale available. The result can be a response that falls far short of the best that existing technology should allow.

Other Techniques

Whilst containment and collection, and chemical dispersion have remained the two main techniques for dealing with oil at sea for three decades, alternative approaches have been invented and re-invented over the same time period.

One such alternative approach is *in-situ* burning, which has recently received renewed attention, particularly in the USA. The theoretical attraction of *in-situ* burning is that it could overcome the difficulties of pumping oil from the surface of the sea, as well as the problems associated with storing it and the associated water. However, the technique requires the floating oil to be contained and concentrated in fire-resistant booms before setting it alight. This remains a fundamental problem and so in practice it will be very difficult in most major spills to collect and maintain sufficient thickness of oil to burn. As the most flammable components of the spilled oil evaporate quickly, ignition can also be difficult. Residues from burning may sink, with potential long-term effects on sea bed ecology and fisheries. Closer to shore or the source of the spill, there may be health and safety concerns as a result of the risk of the fire spreading out of control or atmospheric fall-out from the smoke plume.

Whilst *in-situ* burning has serious limitations, it may well have application in particular circumstances (e.g. oil trapped in ice). The same general comment can be made about other techniques that regularly attract attention, such as sinking agents, chemicals that solidify oil, and bacteria and nutrients to enhance natural biodegradation. Whilst each can be shown to be effective in the laboratory and under highly controlled test conditions, in reality they all have severe limitations in a major marine oil spill on the open sea, usually due to the fundamental problems associated with the rapid spreading, fragmentation and movement of slicks.

Protecting Sensitive Resources

The protective booming of sensitive coastal resources, such as mariculture facilities, power stations and ecological and wildlife sites of particular importance, is a response option which can be highly successful. Similarly, simple measures such as surrounding fish cages with weighted

plastic sheeting can afford a high degree of protection from floating oil. In the recent TREASURE spill in South Africa, a novel protective technique involved the installation of temporary fencing on an offshore island in order to stop adult penguins in a major breeding colony from reaching the nearby sea which was contaminated by floating oil slicks.

It is rare that protective strategies are employed to full advantage during an actual spill, usually due to inadequate planning. Thus, if such a defensive strategy is to be employed with success, there must be agreement at the contingency planning stage as to which resources are to be given priority for protection. It must also be ascertained in advance that their protection is feasible since otherwise it may be discovered during an actual incident that, for example, the currents are too strong for booms to be anchored in the desired configuration.

These simple and obvious lessons, as well as the importance of regularly maintaining booms after deployment to check their configuration and to remove accumulated oil, have been demonstrated repeatedly at numerous past spills around the world. However, they are rarely addressed adequately during contingency planning. It is also regrettable that priorities and protective strategies that have been agreed during the planning process are frequently forgotten during an actual incident or, worse, are overturned due to political interference or pressure brought to bear on the On-Scene Commander by special interest groups or the media.

Shoreline Cleanup

It is impossible to protect an entire coastline and every sensitive resource with equal success and so in a major oil spill some contamination of coastal areas is virtually inevitable, unless winds and currents carry the oil offshore where it breaks down naturally.

Shoreline cleanup needs to be carried out in accordance with a clear strategy that takes account of the characteristics of the particular oil, the level of contamination and the relative environmental, economic and amenity sensitivities of different locations. Effort should first be directed to areas which have the heaviest concentrations of mobile oil, which might otherwise move under the influence of changing winds and currents, leading to a greater length of coastline becoming contaminated.

The removal of floating oil from harbours and elsewhere where it becomes concentrated is relatively straightforward, using a combination of specialised booms and skimmers and locally-available resources such as vacuum trucks and similar suction devices, so long as there is good access. Mobile oil trapped along inaccessible parts of a coastline poses more difficult problems. If it is highly persistent and therefore resistant to natural breakdown and dissipation it will act as a reservoir for contaminating additional stretches of the coast or for re-oiling previously cleaned areas, either with bulk oil or with tar balls, as winds and currents change. Some persistent heavy oils also have the potential to sink in shallow water after picking up sediment in inshore waters, in the surf zone or after temporarily stranding on beaches. Such sunken oil can be re-mobilised by storms, thereby re-contaminating previously cleaned areas.

Once the oil is no longer mobile and has stranded on shorelines a combination of cleanup techniques is normally used. Such operations once again usually rely on locally-available equipment and manpower, rather than specialised equipment. Shoreline cleanup is usually highly labour intensive and not a 'high-tech' business. Thus, bulk oil can usually be removed without difficulty from hard-packed sand beaches using a combination of well-organised cleanup teams assisted by front-end loaders and road-graders, so long as care is taken not to remove excessive quantities of uncontaminated sand or to mix the oil deeply into the beach substrate. Secondary and

final cleaning options can include sieving (to remove tar balls), as well as techniques such as flushing with sea water and harrowing to remove residual staining or other light contamination.

Greater problems are caused where oil penetrates deeply into shorelines consisting of boulders, cobbles or gravel since it is rarely practical to do more than remove surface accumulations. If amenity or wildlife concerns dictate a more thorough cleanup, the most effective technique is likely to be sea water flushing, with the containment and collection of any oil that is released using booms and skimmers. However, if the residual oil is very persistent or if a higher degree of cleanliness is required then it may be necessary to resort to more 'aggressive' techniques such as high pressure (hot or cold) water washing or even sand blasting. On cobble beaches it may be appropriate to bulldoze the contaminated beach material into the surf zone to benefit from natural cleanup processes, such as clay-oil flocculation. In circumstances where residual oil on shorelines might pose a threat to breeding colonies of marine mammals or birds such as penguins, and where other techniques might cause damage through greater disturbance, it may be appropriate to cloak oily haul-out areas and access routes with some form of natural sorbent, such as peat.

In many cases with rocky shores it will be most appropriate and least damaging to the flora and fauna to leave natural processes such as wave action and scouring to deal with any residual oil over a longer period of time, despite the fact that the weathered oil on the rocks may create a visual but incorrect impression of continuing environmental impact. A similar approach of leaving residual oil to weather and degrade naturally is usually recommended for sensitive shoreline types such as salt marshes and mangroves which have been shown to be more easily damaged by the physical disturbance caused by cleanup teams and vehicles than by the oil itself.

The concept of balancing environmental sensitivities against socio-economic factors (e.g. fisheries, tourism) in order to determine the most appropriate techniques and level of cleanliness (sometimes referred to as "net environmental benefit analysis") is well known and widely accepted. It is frustrating, therefore, that such issues are frequently not adequately addressed in contingency plans or are ignored by those in charge of actual operations. As a result, shoreline cleanup is often not carried out with the degree of care and control that is warranted. This can mean that operations are unnecessarily prolonged, that excessive amounts of material are generated for disposal, that additional environmental and economic damage is caused, and that the cost of cleanup and third party damages is higher than it should be.

Termination of cleanup

All cleanup activities should be constantly evaluated to ensure that they remain appropriate as circumstances change. Once any operation has been shown to be ineffective, likely to cause unacceptable additional damage to environmental or economic resources, or the costs begin to greatly exceed diminishing benefits it should be stopped.

Regrettably, there are frequently strong pressures on those in charge of response operations to adopt other non-technical criteria to decide when to terminate a response measure. Thus, on many occasions the ineffectiveness of offshore oil combating techniques and the inappropriateness of cleaning certain types of shorelines will be ignored and as many resources as possible deployed in an attempt to persuade politicians, the media and public that everything possible is being done to deal with the problem. The fact that the operations may be ineffective or more damaging to the environment than the oil is often not a persuasive argument. Equally, the requirement that every trace of oil must be removed to assuage public anger and to meet the demands of politicians is neither possible nor environmentally sound. The fact that it is also likely to result in exorbitant cleanup costs is unlikely to be a major concern for those making the demands unless, of course, they will have to directly bear the costs, in which case a greater degree of realism may prevail. In

this regard it is important to note in passing that the technical justification of response measures ("reasonableness") is fundamental to the effective operation of the international compensation Conventions, including the 1992 Civil Liability and Fund Conventions.

WILDLIFE RESCUE AND REHABILITATION

The collection, cleaning and rehabilitation of oiled birds, marine mammals and other animals is a now a common and high profile feature of many oil spills. Whilst individual animals may be saved, the rationale for such operations is usually based more on animal welfare considerations than on any expectation of promoting the recovery of populations. This depends, of course, on the species in question and the long-term survival potential of rehabilitated and released individuals.

The collection, transport, handling and care of injured and ill animals requires trained personnel if further distress is to be avoided. The cleaning and feeding of animals is also very labour intensive. However, well-meaning volunteers can sometimes be more of a hindrance than a help, especially if they try to operate independently of 'professional' animal welfare groups and veterinary surgeons, or if they are unwilling to undertake training, follow orders or carry out menial tasks. Wildlife rehabilitation can also be expensive and consideration needs to be given to its funding at an early stage.

In many countries wildlife rehabilitation remains an *ad hoc* business, with groups often acting in a competitive manner. It is also a topic that is frequently not addressed adequately in national, regional and local contingency plans, leading to poor co-ordination and management of operations. There would seem to be considerable merit in addressing this issue in a more structured manner, thereby ensuring that best practices from around the world are followed in order to optimise prognosis and cleaning arrangements.

HEALTH AND SAFETY

The health and safety of clean-up workers (including those engaged in wildlife rehabilitation) should always be a primary consideration, especially if unskilled labour or volunteers are employed. Whilst it can sometimes be taken to extreme levels, for example by dressing workers in protective clothing that makes it difficult for them to work or exposes them to the likelihood of heat exhaustion, appropriate personal protective clothing and equipment should always be supplied. This will normally include boots, lightweight overalls, gloves and other simple precautions to avoid contact with the oil. Life vests will be needed if operating on water and hard hats if there is a risk of falling objects. In some cases respirators may be necessary if the oil is fresh and there is a high level of vapours.

Among the other issues requiring attention might be protection from hazardous material (e.g. sewage, discarded hypodermic syringes) at cleanup sites where both oil and other floating waste naturally collects. It will also be necessary to make arrangements to decontaminate, feed and accommodate the workers, and to ensure appropriate rest and relief periods for all those involved in the response operations, including those in charge.

Sensible guidelines on these and other matters relating to health and safety should be readily available and drawn to the attention of all involved. Where they are not available, as is the case in many parts of the world, they should be developed as part of contingency planning, with advice from suitably qualified medical and safety specialists from industry.

DISPOSAL OF OILY WASTE

The minimisation of waste generation through well-controlled cleanup operations is vital. Considerable attention should therefore be devoted to avoiding the unnecessary removal of uncontaminated water, sand, stones and other beach material. Similarly, the technical feasibility and cost-effectiveness of treating lightly contaminated beach material on site should always be explored. This has the benefit of reducing the amount of material for transportation and disposal, as well as potential erosion problems that could subsequently lead to the need for beach replenishment programmes.

Despite all such efforts, at-sea recovery and shoreline cleanup will always generate substantial amounts of oil and oily waste which need to be temporarily stored, transported and ultimately disposed of in an environmentally-acceptable manner. This may result in liquid oil and oily water being reprocessed at a refinery or being used as low-grade feedstock in some industrial processes. Other disposal final routes include landfill, land farming, incineration or use of the stabilised material in construction projects.

The disposal of oily waste often continues long after the cleanup phase is over, especially if the material falls under regulations designed to deal with highly toxic or hazardous waste. In such circumstances it is even more regrettable when the relevant government agencies have been reluctant to address the issue at the contingency planning stage, with the result that when a spill occurs cleanup operations have to be suspended until at least a temporary storage solution is worked out. This is an issue that needs to be addressed urgently in many countries.

MANAGEMENT OF SPILL RESPONSE

The technical aspects of dealing with an oil spill, as well as the prompt availability of well-maintained and appropriate equipment with trained operators are clearly important. However, the effectiveness of the response to a major spill will ultimately depend on the quality of the contingency plan and the organisation and control of the various aspects of the cleanup operation. Numerous difficult decisions as well as compromises will be required throughout the response operation, and the widely differing requirements of a multitude of governmental and private organisations, as well as public and political pressures, will need to be reconciled.

Outside of the USA and a few other countries, government authorities generally assume responsibility for organising and controlling the cleanup of a major ship-source spill, either using their own resources or those available from private organisations. There are many good reasons why government authorities are best placed to take the lead in responding to spills from ships, not the least being that such spills often involve vessels in innocent passage whose owners do not have an operational capability in the affected country. The responsibility for protecting a country's interests also ultimately must rest with government authorities since they alone are in a position to determine priorities for protection and cleanup in the particular circumstances. The international compensation Conventions were in part created to encourage such authorities to assume the responsibility for responding to spills of persistent oil from tankers by safeguarding the financial exposure of responders through the 'polluter pays' principle.

Problems can sometimes arise, however, because of the fact that oil spill response is not normally a core activity for most government authorities, due largely to the fact that serious events are an infrequent occurrence. The organisational structure for responding to oil spills therefore tends to

follow administrative structures created for other purposes. This is particularly evident when it comes to shoreline cleanup, where the responsibility usually falls on a multitude of local and regional government authorities. In harbour areas some responsibility may also fall on the port authority and on the users of terminals and other facilities. This is frequently a recipe for organisational confusion, especially if insufficient effort has been devoted prior to a spill to developing an integrated and consistent approach. This is essential bearing in mind that it is highly probable that otherwise some groups will devote considerable effort to contingency planning, training and the maintenance of an appropriate level of resources, whereas others will conclude that the level of risk does not justify the effort and cost, especially in comparison with other priorities. In the event of a major spill these differences will translate into an uncertain and variable response, unclear command and control, and a lack of co-ordination.

Such spill management problems are not overcome by inviting all interested parties to serve on one or more committees and thereby participate in the decision-making process (whether or not they are technically qualified to do so). Whilst this may be democratic, it usually leads to very large, unwieldy spill management teams, delayed decision making and, frequently, the adoption of inappropriate response strategies. It is preferable that the legitimate concerns of all interested parties in relation to oil spill response techniques and priorities are addressed during contingency planning, leaving a single On-scene Commander and a small team to direct operations during an actual incident from a secure single command centre that has all the necessary communications and other equipment. Ideally, this command structure should cover both at-sea and shoreline response. It should have the support of experienced technical and scientific advisors that are part of a larger management team that looks after individual parts of the operation, as well as logistic support, record keeping and financial control. These last two aspects are vital in connection with cost recovery from other parties.

The provision of sufficient experienced people to provide expert technical advice and to direct parts of the cleanup response will be a specific problem facing some authorities and other groups. The infrequency of spills and the regular reassignment of personnel in some organisations can mean that those who are called upon to deal with a spill will have never seen one before and so have to learn 'on the job'. This is fine if they are willing to listen to advice from 'outside' experts so that due account is taken of the extensive experience and technical knowledge that is available nationally or internationally. All too often this is not the case, with those in charge preferring to learn their own lessons and thereby repeat the mistakes of past spills

CONTINGENCY PLANNING

A major oil spill will inevitably present those in charge with numerous, complex problems, some of which will be non-technical in nature. There is a greater likelihood that prompt and effective response decisions will be made if considerable effort has been devoted in advance of any spill to the preparation of comprehensive, realistic and integrated contingency plans for different levels of risk. Issues which are difficult to resolve in 'peace time' are likely to become major conflicts in the highly charged atmosphere following a major spill when everyone should be working together with the common purpose of cleaning up the oil as effectively as possible with the minimum of damage to the environment and economic resources.

Unfortunately, as this paper has attempted to illustrate, contingency plans frequently fail to adequately address a wide range of key issues such as the identification of sensitive environmental and economic resources, priorities for protection and clean-up, agreed response strategies for different sea and shoreline areas at different times of the year, temporary storage sites and final

disposal options, and command and control. Increasingly there is also a need to manage the legitimate interests of the media in a way that ensures that they receive regular factual updates, without interfering with the control and conduct of the actual cleanup response.

All too often contingency plans are little more than a list of contact points (often with out-of-date names, organisational structures and telephone numbers) and generic information. They frequently adorn someone's bookshelves (especially if they are suitably glossy in appearance!) and are only 'dusted off' in an actual incident when their inadequacy rapidly becomes apparent.

In reality, the final product is less important than the actual process of contingency planning. Thus the main benefit comes from gathering all the necessary data, consulting and getting to know all potential interests, and resolving potential disputes in a calm atmosphere. For this reason it is important that those who will be required to implement the plan should also be closely involved in its preparation, with outside consultants only being used to give advice on structure, content, technical issues and alternative approaches.

The preparation of contingency plans and enhanced co-operation between various interested parties (including between governments and the oil and shipping industries) is a key element of the International Convention on Oil Pollution Preparedness, Response and Cooperation, 1990 (OPRC). One facet of this Convention is the enhanced availability of cleanup resources from neighbouring governments, possibly through bi-lateral, multi-lateral, regional or other agreements, or from international co-operatives or oil industry stockpiles.

Whilst 'outside' resources and trained operators may be required in order to supplement local capability in the event of a major spill, total reliance should never be placed on their availability. This is especially so if arrangements have not been put in place to ensure the rapid mobilisation and transport of 'outside' resources, to facilitate their entry into a country and to agree the financial basis on which they are provided. It also needs to be recognised that the effective deployment of cleanup equipment mobilised from other locations, including neighbouring countries and oil industry tier 3 stockpiles, is dependent upon the existence of an effective local, regional or national contingency plan. Without the foundation of an organisational structure, adequate logistic support (e.g. transport, suitable boats, oil storage facilities) and clearly-defined response policies and strategies in the area requiring assistance, tier 3 resources will, at best, be of limited value and may, at worst, be unusable.

Contingency plans should be regularly tested and updated. A spill will inevitably identify issues that need to be addressed and it is important that this is done before memories fade and interest wanes. Regular training of personnel at all levels and the testing of equipment is essential. Spill drills and exercises can be valuable in this regard, so long as they are not too ambitious and include a large element of surprise and realism, with all 'players' being willing to admit their mistakes in the final 'wash-up'. All too often this is not the case, with exercises seemingly being more designed to serve a public relations requirement (even to the extent of virtually being scripted), with everyone being assured of glowing reports for their performance.

CONCLUSIONS AND CHALLENGES FOR THE FUTURE

Major marine oil spills from both tankers and other types of ship are rare events. However, further effort is still required in terms of prevention, since once oil is spilled on to the surface of the sea there is no technological solution and the best that we can do is to mitigate the damage. For this reason no oil spill cleanup operation will ever be viewed as a total success, especially in the eyes

of politicians, the media and the public whose attention is inevitably grabbed by dramatic and distressing images of blackened beaches and oil-soaked wildlife, and by the impact that such events can have on those whose livelihoods depend on a clean sea and coastline.

Given the fundamental problems of combating oil on the surface of the sea, the best that we can strive for is that everyone involved will co-operate in mounting the most effective response that current technology and the circumstances of a particular incident will allow. However, as this paper has sought to explain, this is rarely the case. Despite great advances over the past thirty years in response strategies, specialised equipment and materials, and in our understanding of the fate and effects of oil spills and the limitations of cleanup techniques, the mistakes of previous spills continue to be regularly repeated. To a large extent, this is due to problems connected with the organisation and management of spill response and to the tendency of those in charge to be more influenced by political, media and public perceptions and pressures than by technical realities. It also reflects the continuing inadequacy of contingency plans in many areas of the world.

The challenge for the future is therefore clear. Far more effort needs to be put into ensuring that the lessons of past spills and the accumulated technical knowledge that exists around the world are taken fully into account in future response operations. This can only be achieved through developing improved organisational structures, as well as realistic, integrated and well-rehearsed local, area and national contingency plans. It is time that we recognised that we can achieve far greater improvements in oil spill response by applying what we know already rather than by simply seeking small incremental improvements in techniques, however valuable these may be. We also need to stop approaching each major spill as though it poses unique problems.

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| 5 "Use of Skimmers in Combating Oil Pollution" | 6 "Recognition of Oil on Shorelines" |
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