FACTORS THAT DETERMINE THE COST OF OIL SPILLS

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ABSTRACT

The NAKHODKA and ERIKA oil spills in Japan and France, respectively, have once again focused attention on the potentially high cost of such events and the adequacy of the current international compensation arrangements. This prompted a study by the International Group of P&I Clubs of the costs of 360 oil spills occurring outside of the USA between 1990 and 1999. The results of the study, as well as examples drawn from specific incidents, provide a good basis for examining the technical factors that, in combination, give rise to great variation between the costs of individual incidents. One of the most important factors is the type of oil, coupled with the physical, biological and economic characteristics of the spill location. However, other factors such as the amount spilled and rate of spillage; weather and sea conditions; time of the year and the effectiveness of clean-up can also be crucial in determining the overall cost of an incident. One conclusion is that it is inappropriate to make cost comparisons between fundamentally different oil spill events by reference to a single parameter, such as the total amount of oil spilled.

INTRODUCTION

There is always considerable interest in the cost of marine oil spills. The reasons for such interest are many and include academic study, the prioritisation of spill prevention and preparedness programmes, and assessment of the adequacy of insurance cover and

The views expressed in this paper are those of the authors rather than of ITOPF's Directors, Members and Associates.

compensation arrangements. This last reason surfaces most often after major oil spills when the attention of politicians, regulators and the media is focussed on the potentially high cost of such events and the possibility that claimants will not be fully compensated. Such was the case after the ERIKA oil spill off France in 1999, generating various initiatives aimed at improving the international oil spill compensation arrangements provided by the 1992 Civil Liability Convention (CLC) and 1992 Fund Convention. In order to provide a factual basis for consideration of some of the proposed initiatives, the International Group of P&I Clubs (P&I Clubs) conducted a study of the cost of tanker spills during the ten-year period, 1990 - 1999. The results of the study provide a helpful starting point for a more general examination of the technical factors that, in combination, give rise to great variation between the costs of individual incidents.

STUDY OF THE COST OF OIL SPILLS, 1990 - 1999

For the purpose of the study, data on the cost of clean-up and third party damages in 360 tanker spills occurring outside the USA between 1990 and 1999 were obtained from individual P&I Clubs, the IOPC Fund and Cristal Limited (the administrator of the CRISTAL voluntary oil spill compensation agreement which ceased operating in 1997). All cost data were converted into US dollars according to published exchange rates. In cases where not all claims had been settled a "best estimate" was used. The resulting costs were then analysed within various scenarios. The results of one such analysis, comparing the costs of individual incidents outside of the USA to the limits of liability under the 1992 CLC and Fund Conventions, and the 50% increased limits that will come into effect on 1st November 2003, are shown in figure 1.

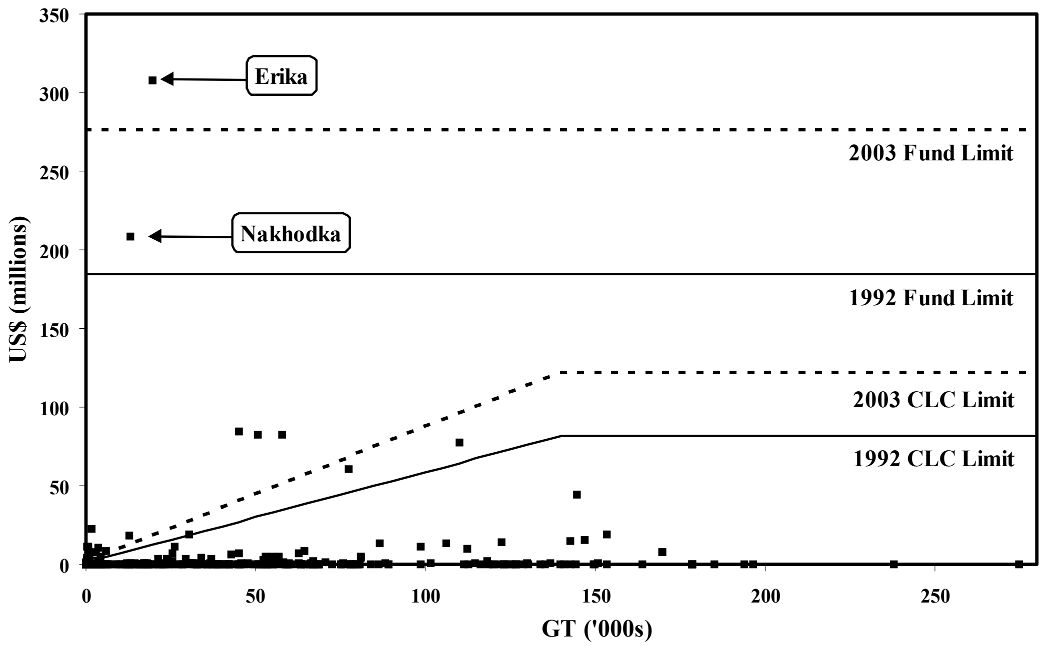

Figure 1. Cost of non-US tanker spills (1990-1999) in relation to current 1992 CLC and Fund limits and those which will come into effect in November 2003 (+50%)

It is evident from figure 1 that the estimated total cost of only two incidents during the 10-year period covered by the study - the NAKHODKA in Japan and ERIKA in France - exceeded the current limits of the 1992 CLC and Fund Convention, although the NAKHODKA would have fallen below the 2003 increased limits. The vast majority (95%) of the other 358 cases would have been fully compensated under the terms of the 1992 CLC alone. This percentage increases to 96% under the 2003 increased limits.

It is also evident that there is no relationship between spill cost and size of the tanker from which the oil originated, with some of the most expensive spills having been caused by relatively small tankers. This lack of relationship between these two parameters is not surprising since, although tanker size is indicative of potential spill volume, it is rare that an entire cargo is lost as a result of an accident.

FACTORS THAT DETERMINE THE COST OF OIL SPILLS

Previous ITOPF papers presented to International Oil Spill Conferences have reviewed various aspects of the cost of oil spills (see White & Nichols, 1983; Moller, Parker & Nichols, 1987; Moller, Dicks & Goodman, 1989; Grey, 1999; and Purnell, 1999). Other authors have also addressed the same topic, including Etkin (1999) who reviewed the interacting factors that affect the cost of cleaning up spills in order to establish a cost-estimation model.

There is general agreement that the main technical factors influencing the cost of spills are:

- type of oil
- physical, biological and economic characteristics of the spill location
- weather and sea conditions
- amount spilled and rate of spillage
- time of the year
- effectiveness of clean-up

The interactions between these factors are complex, which makes cost predictions based on simple parameters very unreliable, as discussed in the remainder of this paper.

Type of Oil Spilled

Of the various individual factors that determine the seriousness and therefore the ultimate cost of an oil spill, one of the most important is the type of oil.

In general, light refined products (e.g. gasoline, diesel) and light crude oils do not persist on the surface of the sea for any significant time due to rapid evaporation of the volatile components and the ease with which they disperse and dissipate naturally, especially in rough seas. This is illustrated by the BRAER incident in the Shetland Isles, UK in January 1993. A combination of 'light' Gullfaks crude oil and severe weather conditions resulted in the entire cargo of some 85,000 tonnes being dispersed naturally with minimal shoreline contamination, even though the tanker was stranded on the coast. Clean-up costs in this case were therefore extremely low (about US$ 0.5m), especially in relation to the large quantity of oil involved.

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. As a consequence, the clean-up of heavy oil spills can be extremely difficult, extend over large areas and be costly. This is illustrated by two of the most expensive tanker spills of all time – the ERIKA and NAKHODKA off France and Japan, respectively. Both involved relatively small amounts of oil (some 17,500 tonnes in the case of the NAKHODKA and about 20,000 tonnes in the ERIKA) spilled some distance from the coast. Severe weather impeded offshore recovery operations, allowing the highly persistent oil to spread over a large area of sea, leading eventually to extensive coastal contamination.

The high cost of cleaning up spills of heavy fuel oil relative to the quantity spilled is also demonstrated by the TANIO, which broke up off the north coast of Brittany, France in 1980. In this case the clean-up 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 and costly as for the 223,000 tonnes of crude oil from the AMOCO CADIZ which had contaminated the same area almost exactly two years earlier.

The particular problems of spills of heavy oil are also the reason why spills of bunker fuel from non-tankers are increasingly the focus of attention around the world and why the resulting costs can be far greater than might be suggested by the amount of oil spilled.

The nature of the damage caused by a spill will also vary according to the type of oil. Light refined products may constitute a fire and explosion hazard if spilled in confined situations, leading to a wide variety of third party claims due, for example, to temporary closure of port areas or nearby industry. Such oils also tend to be more toxic than heavier oils. This can lead to mortalities of marine plants and animals if high concentrations of light oil enter the water column through wave action and are not rapidly diluted by natural sea movements. Similarly, such oils may bring about the tainting of edible fish, shellfish and other marine products, as occurred in the BRAER where the main affected product was high-value farmed salmon which could not be sold. This was the major component of the US$ 50m compensation claims for fisheries impacts. All such effects will, however, usually be highly localised and short-lived in the case of light oils since the toxic components are also the ones that evaporate most rapidly. Fish and shellfish also quickly lose (‘depurate’) the oil components that cause taint once clean water conditions return.

Heavy crude, emulsified crude and heavy fuel oils, whilst generally of lower toxicity, will constitute a threat to seabirds and other wildlife (for example on shorelines) that become physically coated or smothered. Amenity areas, fishing gear, mariculture facilities and other structures can also be contaminated, sometimes over very extensive lengths of coastline due to the highly persistent nature of the oil. Further problems can arise if the already high density of the heavy oil increases further (for example due to the incorporation of sediment in coastal waters) to the extent that residues sink. This can result in the prolonged contamination of the sea bed, forming a reservoir for the fouling of bottom fishing gear and repeated re-oiling of cleaned amenity areas as the sunken oil is remobilised after storms. All these problems can result in extended clean-up costs and large third party damage claims for economic loss, as illustrated by the spills of heavy fuel oil cargo from the NAKHODKA and ERIKA.

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. The fate and effects of all these oils, as well as the requirement for clean-up, will vary greatly, ultimately affecting the costs of any incident.

Amount Spilled

The amount of oil spilled is clearly an important factor in determining costs. Thus, given no variation in other factors, a 100,000 tonne spill will result in far wider contamination, will require a far more extensive clean-up response, cause greater damage and result in substantially higher costs than, say, a 10,000 tonne spill. However, the relationship is not linear. This was explored by Etkin (1999), who showed that the clean-up costs on a per tonne basis decreased significantly with increasing amounts of oil spilled. Thus, the relative cost of cleaning up small spills is much greater than for large spills. We have discerned a similar trend in our own analyses.

The existence of such a trend makes it tempting to conclude that is legitimate to calculate average costs of spills of different sizes. However, such a simplistic approach ignores the underlying complexity and inter-relation between the factors that give rise to the considerable variation in the cost of similar sized incidents, which can be several orders of magnitude. This illustrates why simple comparisons between the costs of individual spills based on the single parameter of the cost per unit of spill volume can be highly misleading. This does not necessarily prevent some people making such comparisons and using spurious extrapolations in an attempt to justify the level of claims for clean-up costs or alleged damage in a new incident.

Pattern of Spillage

As well as total spill volume, the pattern of oil loss can be important. For example, the clean-up operation required in response to a single large release of oil may be considerable but may be completed in a matter of weeks. The associated damage to marine resources and amenities may also be short-term. However, the same quantity of oil lost over several months from a damaged tanker close to the coast may require the maintenance of a major clean-up effort, repeated cleaning of amenity areas and long-term effects on fishery resources and tourism. The best example of this remains the BETELGEUSE, a tanker that exploded and sank at a terminal in South-West Ireland in 1979 with a large loss of life. Because of an on-going release from the various parts of the wreck it was necessary to maintain a comprehensive clean-up response consisting of oil collection and chemical dispersal at sea, defensive booming of sensitive shorelines and regular beach clean-up for some 21 months. Considering that the total amount of oil spilled during this period probably amounted to no more than 1,500 tonnes, it is clear that the cost of the response was far in excess of what it would have been had the same quantity of oil been spilled in a single release.

Location

The location of a spill can have a considerable bearing on the costs of an incident since it will determine the requirement for and extent of the clean-up response, as well as the degree of damage to the environment and economic resources. All oils, if they remain at sea long enough, will dissipate through natural processes. When a tanker spills oil far from the coast the response will therefore often be confined to aerial surveillance of the slick to monitor its movement and dissipation in order to check that predictions of its probable fate are correct. The cost of responding to oil spills under these circumstances can therefore be low, even when a complete cargo of crude oil is lost from a VLCC. This is illustrated by the fact that the three largest tanker spills of all time - ATLANTIC EMPRESS off Tobago, West Indies in 1979 (287,000 tonnes), CASTILLO DE BELLVER off South Africa in 1983 (252,000 tonnes) and ABT SUMMER off Angola in 1991 (260,000 tonnes) - resulted in very low clean-up and damage costs because no significant quantities of oil reached coastlines. Had a similar volume and type of oil been spilled near a sensitive coastline (as, for example, occurred in the AMOCO CADIZ in France in 1978), the requirement for clean-up would have been entirely different, as would have been the impact on fisheries, tourism and other sensitive economic and environmental resources. The costs would have therefore been much greater.

The physical characteristics of the spill site (e.g. prevailing winds, tidal range, currents, water depth) as well as its distance from the coast are important since they have a considerable bearing on the feasibility of mounting a clean-up response at sea and a successful salvage operation. They will also in part determine the extent of shoreline contamination, which is one of the most important factors in determining costs. The high cost of the shoreline clean-up in both the ERIKA and NAKHODKA incidents was due in large part to the extensive coastal contamination (some 400 km in the ERIKA and over 1,000 km in the NAKHODKA), which in turn was a result of the highly persistent nature of the oil and its spread from an incident location that was some distance offshore.

Similarly, the vulnerability of different shoreline types, the extent to which they are self-cleaning, the feasibility of undertaking manual clean-up (e.g. accessibility, likelihood of clean-up causing more damage than the oil itself), the availability and cost of local labour and many other site-specific factors influence the cost of oil spill clean-up.

Socio-economic factors and resources at risk vary both within and between countries. Some areas will be of high national or even international importance for fishing, mariculture, tourism, other industries or conservation, whereas others will only rank as locally important. Seasonal differences will also occur in the sensitivity of these resources to oil pollution and therefore the economic impact of a spill. This in turn will help determine the requirement for and extent of the clean-up.

Clean-up Response

As a general rule, considerable effort and money is devoted to trying to deal with oil spills at sea, in a laudable attempt to prevent the damage and public outcry often associated with extensive pollution of inshore waters and shorelines.

As already discussed, oil spills will on occasions dissipate naturally and not pose a threat to sensitive coastal resources. On other occasions there may be little that can be done due to bad weather or other particular circumstances. The decision not to respond, however, is a difficult one, especially as it is likely to be viewed by politicians, public and the media as unacceptable. An active response is therefore often adopted even when technical opinion is agreed that it is unlikely to have a significant benefit. This is usually due to the fact that oil spilled on the surface of the sea spreads rapidly, thereby extending over an area that is too great to be countered effectively by available techniques. Added to this are the limitations on containment and collection systems imposed by winds, waves and currents, and the severely reduced effectiveness of chemical dispersants on high viscosity oils and water-in-oil emulsions ("mousse"). Responding in such circumstances can lead to high clean-up costs for little or no benefit in terms of mitigating the oil's impact on coastlines and sensitive resources.

There are exceptions: the spill of 2,450 tonnes of heavy fuel oil cargo from the BALTIC CARRIER off Denmark demonstrated that considerable success can be achieved offshore when conditions are favourable and the recovery operation is well co-ordinated. In this case, approximately 900 tonnes, i.e. one-third of the volume spilled, was collected by a fleet of twelve recovery vessels from three countries. This greatly reduced the extent of shoreline contamination. Similarly, in the SEA EMPRESS incident in Wales, UK in 1996, a combination of natural and chemical dispersion, the latter resulting from the application of about 450 tonnes of dispersant from aircraft, was judged to have been instrumental in removing 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.

It is often stated that shore clean-up is much more costly than offshore clean-up. This may indeed appear to be the case if the costs of the two operations in a single spill are compared directly. However, such comparisons frequently take no account of the fact that offshore clean-up is almost invariably incomplete leaving the bulk of the oil to be dealt with on the shore. Thus, a fairer comparison of costs should take into account the success rate of the operations by relating the costs to the amount of oil removed. When considered on this basis it is apparent that shoreline clean-up can frequently be highly cost-effective.

One reason why shore clean-up is often relatively cheaper than an at-sea response is that it usually relies on manual recovery methods and locally-available equipment. In contrast, offshore clean-up requires considerable amounts of expensive equipment, vessels, aircraft and trained operators, which may have to be sourced from distant locations. However, a more important factor determining the cost of shoreline clean-up is the extent to which cleaning is required before the contaminated area will be considered acceptable.

The removal of bulk oil from a heavily contaminated shoreline is relatively straightforward and can often be accomplished quickly, subject to the type of shoreline (e.g. rock, sand, mud), ease of access and other incident- and site-specific factors.

As the degree of shoreline contamination is progressively reduced more and more effort is required to effect a significant improvement. The operation therefore becomes one of diminishing returns with rapidly escalating costs as the operation moves into the secondary and final clean-up phases. It is for this reason that shoreline clean-up costs cannot be related directly to the degree of initial contamination: a lightly impacted area may still require a broadly similar amount of secondary and final cleaning as a heavily impacted area. The overall costs therefore depend to a large extent on when the operation is terminated.

Termination of Clean-up

All shore clean-up activities should be constantly evaluated to ensure that they remain appropriate as circumstances change. Any operation should be stopped once if it 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.

The standards set for clean-up vary from country to country and from area to area within a country and are usually related to the nature of the contaminated shoreline, its usage and national attitudes. Thus, amenity beaches oiled just before or during the holiday season will usually need to be cleaned rapidly to a high level to permit their use in order to minimise lost income by hoteliers and others involved in the tourism industry. This may require the use of ‘aggressive’ clean-up techniques such as bulldozers on sandy beaches and high pressure washing of nearby rocks, even at the risk of causing additional environmental damage. On the other hand, areas like salt marshes and mangrove swamps that are of great ecological importance may be better left to clean themselves naturally in view of their sensitivity to physical disturbance, as would result from a major clean-up operation. Similarly, it will usually be 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 on rocky shores in remote areas.

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 on a site-by-site basis (sometimes referred to as "Net Environmental Benefit Analysis") is well known. When followed it can help ensure that clean-up is carried out with the degree of care and control that is warranted, and that additional damage and high costs are avoided. Failure to adopt such technical criteria for determining when the shoreline clean-up operations should be terminated will invariably prolong the clean-up, increase the amount of material for disposal (a major and costly problem now in most spills) and result in excessive clean-up costs.

Management of Response Operations

The organisational structure for responding to oil spills within individual countries tends to follow administrative structures created for other purposes. This is particularly evident when it comes to shoreline clean-up, 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 operators of terminals and other facilities. This is frequently a recipe for confusion, especially if insufficient effort has been devoted prior to a spill to developing an integrated and consistent approach. In the event of a major spill these differences will usually translate into an uncertain and variable response, unclear command and control, and a lack of co-ordination. The establishment of one or more committees to allow all interested parties to participate in the decision-making process during an incident (whether or not they are technically qualified to do so) may be democratic but is rarely an effective solution. It usually leads to large, unwieldy spill management teams, delayed decision making and, frequently, the adoption of inappropriate response strategies and excessive costs.

When the oil is on the water or on the shore informed and decisive leadership is required, with authority vested in an appropriate individual or in a small command team, so that an effective response consistent with the contingency plan is initiated promptly. The individual or small command team will need to be supported by experienced technical and scientific advisors that are part of a larger management team that looks after individual elements 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 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 be inexperienced and so have to learn ‘on the job’. This is not a problem if they are willing to listen to advice from experts and thereby benefit from the extensive experience and technical knowledge that is available internationally. All too often this is not the case, with those in charge preferring to learn their own lessons and thereby repeat the costly mistakes of past spills.

CONCLUSIONS

Various technical factors in combination determine the actual costs of any particular incident and simplistic comparisons between different events based on a single parameter such as quantity of oil spilled can be highly misleading. Type of oil, location of the spill and the characteristics of the affected area are generally the most important technical factors influencing the costs of both clean-up and damage. However, the quality of the contingency plan and of the management and control of the actual response operations will also be crucial. Poor management can result in the mistakes of previous spills being repeated, leading to additional damage to the environment and economic resources and excessive costs. Reacting to political, media and public perceptions and pressures, rather than basing decisions on technical realities, can also escalate the cost of any incident beyond what would be considered "reasonable" under the international compensation Conventions. An understanding of the relative importance of the various factors that determine the cost of spills can help focus spill prevention programmes, the development of realistic oil spill contingency plans and the delivery of a cost-effective response.

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