FACTORS AFFECTING THE COST OF OIL SPILLS

by

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INTRODUCTION

The NAKHODKA and ERIKA oil spills in Japan and France, respectively, have once again focused the attention of politicians, regulators, the media and claimants on the potentially high cost of such events and the adequacy of the current international compensation arrangements. As will be explained by another speaker at the Conference, this has led to a proposal for a Supplementary Fund that would offer additional compensation to that provided under the 1992 Civil Liability Convention and 1992 Fund Convention.

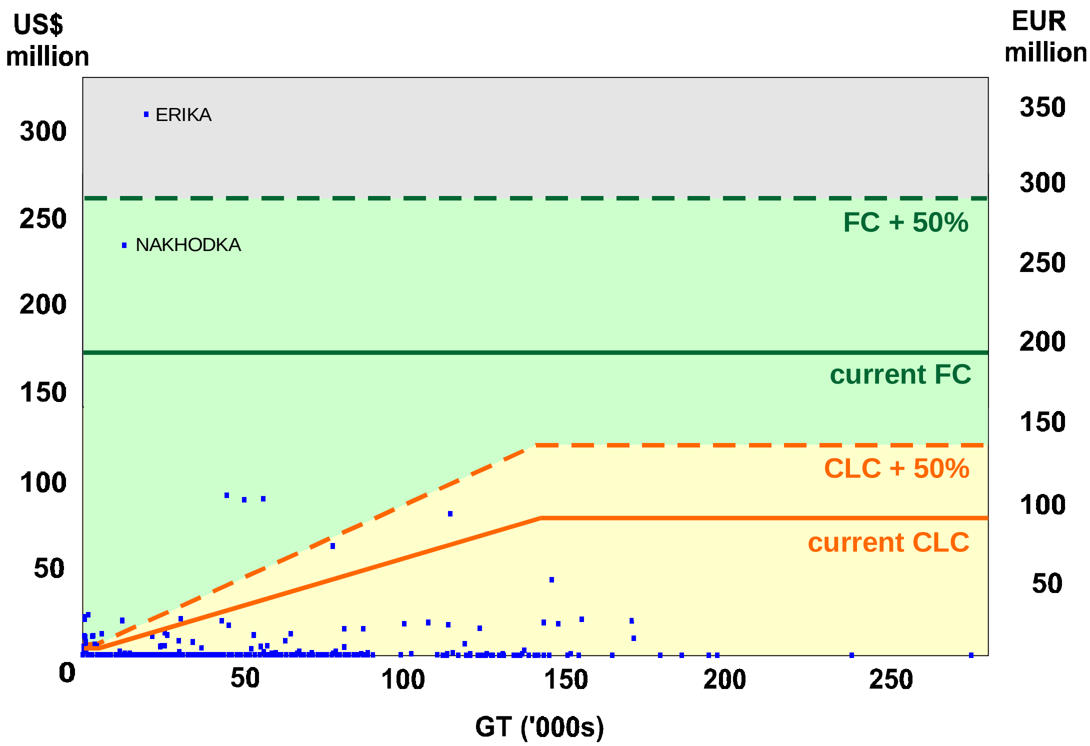
In order to provide a factual basis for the discussion on the need for and appropriate level of this Supplementary Fund, the International Group of P&I Clubs, in conjunction with ITOPF, conducted a study of the cost of tanker spills during the ten-year period 1990 - 1999. The results of the study provide a helpful starting point for a more general examination of the technical factors that, in combination, can give rise to great variation between the costs of individual incidents. These factors include:

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

An understanding of the relative importance of these various factors can help focus spill prevention programmes, the development of realistic oil spill contingency plans and the delivery of a cost-effective response.

STUDY OF THE COST OF OIL SPILLS, 1990 - 1999

For the purpose of the study conduct by the International Group of P&I Clubs and ITOPF, data on the cost of clean-up and damage in 360 tanker spills occurring outside the USA between 1990 and 1999 were obtained from individual P&I Clubs, the IOPC Funds and Cristal Limited. All cost data was 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 incorporated into a database which allowed various analyses to be carried out. The results of one such analysis, comparing the costs of individual incidents outside of the USA to the limits of liability under the 1992 Civil Liability and Fund Conventions, and the 50% increased limits that will come into effect on 1st November 2003, is shown over the page in graphic form.



Cost of non-US tanker spills (1990-1999) in relation to 1992 CLC and Fund limits

It is evident from the above graph that the estimated total cost of only two incidents during the 10-year period covered by the study - the NAKHODKA and ERIKA - exceeded the current limits of the 1992 Civil Liability and Fund Conventions, 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 Civil Liability Convention alone. This percentage increases to 96% under the 2003 increased limits. Interestingly, analysis of the total costs of all 360 incidents demonstrates that they would have been shared equally between shipowners under the 1992 Civil Liability Convention and by oil receivers under the 1992 Fund Convention.

What is noteworthy in the context of this paper is that there is clearly no relationship between spill cost and size of tanker (which might in turn be considered indicative of spill volume). Indeed, some of the most expensive spills have been caused by relatively small tankers. The remainder of this paper explores the reasons for this by considering various technical factors that in combination determine the costs of clean-up and damage.

NATURE OF INCIDENT

Type of Oil

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.

All oils are a complex mixture of components with differing properties. When oil is spilled on to the surface of the sea it undergoes a number of physical and chemical changes (collectively termed "weathering"), at the same time as it spreads, moves and fragments. 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 an oil's persistence. Ultimately, the marine environment assimilates spilt oil through the long-term process of biodegradation. The fate and effects of any particular type of oil and the clean-up requirements depend primarily, therefore, upon the combined physical and chemical properties of its components.

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 well illustrated by the BRAER incident in the Shetland Isles, UK in January 1993. A combination of light crude oil and severe weather conditions resulted in the entire cargo of 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 very low, especially relative to the 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 spills of all time - ERIKA and NAKHODKA in 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, maximising the opportunity for spreading and widespread coastal contamination.

The high costs 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 posed by spills of heavy oil is 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 a 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. All such effects will, however, usually be highly localised and short-lived as the toxic components are also the ones that evaporate most rapidly. Fish and shellfish also rapidly lose 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 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 and Rate of Spillage

The amount of oil spilled is clearly an important factor in determining costs. Thus, given no variation in other factors such as type of oil, location and economic resources at risk, a 100,000 tonne spill will result in far wider contamination, will require a far more extensive clean-up response and cause greater damage than, say, a 10,000 tonne spill. On the other hand, the three largest tanker spills of all time - ATLANTIC EMPRESS off Tobago, West Indies in 1979 (287,000 tonnes), ABT SUMMER off Angola in 1991 (260,000 tonnes) and CASTILLO DE BELLVER off South Africa in 1983 (252,000 tonnes) resulted in very low clean-up and damage costs because none of the spilled oil contaminated coastlines. This emphasises the inappropriateness of simplistic comparisons between the cost of individual spills based on the single parameter of spill volume. Regrettably, such spurious extrapolations are often made in an attempt to justify the level of claims for clean-up costs or alleged damage in a new incident.

The rate of spillage 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 vessel 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. This is illustrated by the BETELGEUSE, a tanker that exploded and sank at a terminal in South-West Ireland in 1979 with a tragic 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 a period of some 21 months until the wreck was fully removed. 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 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. This emphasises the need for a thorough evaluation of the probable movement, fate and threat posed by an oil spill before mobilising a costly response that may prove unnecessary if the oil is likely to dissipate naturally before reaching coastal waters or other resources at risk. When a tanker spills oil far from the coast the response will therefore normally be confined to aerial surveillance of the slick to monitor its movement and dissipation in order to check that the predictions 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, as was the case in the previously-mentioned incidents of ATLANTIC EMPRESS, ABT SUMMER and CASTILLO DE BELLVER.

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 both a clean-up response at sea and a successful salvage operation. They will also help 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 impact (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

At-Sea

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 the public, politicians and 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 by available techniques. Added to this are the limitations on containment and collection systems imposed by winds, waves and currents, and the problems posed for the effective use of chemical dispersants by high viscosity oils and the rapid formation of water-in-oil emulsions ("mousse"). These technical realities frequently fail to deter those in charge from deploying numerous oil recovery ships or dispersant spraying vessels and aircraft in order to satisfy the criterion that they must be "seen to be doing something". In extreme cases an ineffective at-sea response may be continued for a long period, leading to high clean-up costs for little or no benefit.

There are exceptions: the recent spill of 2,450 tonnes of heavy fuel oil cargo from the BALTIC CARRIER off Denmark demonstrates 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, 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.

These two examples demonstrate that the actual cost-effectiveness of an at-sea response will depend upon many factors including the nature of the incident; the availability of trained personnel and required equipment and materials; the number of vessels, aircraft and specialised equipment employed; and, perhaps most importantly, the effectiveness of the pre-spill planning and the control of the actual operations.

It is frequently assumed that any oil removed at sea, however small the quantity, will reduce coastal contamination and thereby the costs associated with shoreline clean-up. This is not necessarily the case. Consider, for example, a hypothetical spill of 5,000 tonnes of a medium crude oil, the fate of which might be as follows:

- 30% (1,500 tonnes) might evaporate rapidly and hence be removed.
- 30% of the remaining 3,500 tonnes (1,050 tonnes) is recovered or dispersed at sea (an optimistic figure by most past experience).
- 2,450 tonnes remains.
- However, this remaining oil will typically form a water-in-oil emulsion to the extent that each tonne of oil will take up some four tonnes of water, resulting in over 12,000 tonnes of "mousse" being available to strand on the shoreline.

Thus, despite the apparently successful clean-up at sea, over double the quantity of oil originally spilled arrives on the coast. Clearly, the quantity would have been even greater had there not been any at-sea clean-up. However, the true benefit of an at-sea response and a related programme of coastal protection by using booms cannot be judged on the basis of the percentage of oil removed or a simple analysis of the costs. In reality it will depend on whether or not the operations have reduced the overall length of shoreline contamination, have prevented the oiling of shoreline types that would be particularly difficult to clean, or have reduced the impact on sensitive resources (both natural and high-value economic resources).

If such positive and cost-saving results are to be achieved there has to be a strategic approach to at-sea response and shoreline protection. This demands a high level of pre-spill planning to identify those resources that should be afforded priority for protection and the most appropriate response strategies (possibly at different times of the year), based on an understanding of the limitations of the techniques available. It also requires a very high degree of control of the actual clean-up operations to ensure that resources are deployed according to the plan and that the strategy can be amended as circumstances change. Regrettably, such a level of strategic control is rare. The more usual approach is for the limited resources available to be spread thinly in an uncoordinated attempt to protect all the coastline with little resultant benefit but high costs.

On Shore

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 resulting from a single spill are compared directly. However, such comparisons are frequently not strictly valid as they 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 two 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 frequently 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 obtained 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) and ease of access. The type and amount of oil involved, the time of year, prevailing weather conditions (e.g. ice) and other factors will also influence the ease with which bulk oil can be removed.

As the degree of contamination is progressively reduced more and more effort is required to effect a significant improvement. The operation therefore becomes one of diminishing returns with costs escalating rapidly as the amount of remaining oil decreases and the operation moves into the secondary and final 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 to 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. As soon as 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.

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.

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 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 clean-up is often not carried out with the degree of care and control that is warranted.

This problem can be particularly evident when those in charge of response operations bow to pressure to adopt non-technical criteria to decide the nature and extent of a response. In such instances the inappropriateness of cleaning certain types of shoreline 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 is neither possible nor environmentally sound.

Failure to adopt 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 problem now in most spills) and result in exorbitant clean-up costs. This is unlikely to be a major concern for those making the demands unless they will have to directly bear the extra costs, in which case a greater degree of realism may prevail.

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 translate into an uncertain and variable response, unclear command and control, and a lack of co-ordination.

Such co-ordination and management problems are never overcome by inviting all interested parties to serve on one or more committees during an incident so that they can 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 large, unwieldy spill management teams, delayed decision making and, frequently, the adoption of inappropriate or conflicting 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 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 and knowledgeable people to direct the shoreline clean-up response and to provide expert technical advice 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. This can particularly be a problem if those in charge perceive an overwhelming requirement to "be seen to be doing something" to satisfy political, media or commercial considerations, even when they have been advised that the measures would be largely ineffective.

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 avoidable 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.