SUNKEN OIL AND THE REMOVAL OF OIL FROM SUNKEN WRECKS

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ABSTRACT

Following the technical triumph of removing most of the oil from the sunken wreck of the PRESTIGE, interest and expectations have been raised in equal measure. Since 2005 there have been a number of incidents worldwide involving sunken wrecks containing oil, as well as a smaller number of pollution cases in which oil spilled from ships has sunk due to its high specific gravity. The response to such incidents poses unique challenges and reference is made to ITOPF's database of historical spills in order to demonstrate how attitudes and the policies for dealing with these cases have changed.

The problems posed by oil in wrecks or on the seabed straddle the disciplines of ship salvage and conventional spill clean-up. Whilst the technology used in recovering such oil differs, the rationale for determining whether or not certain measures have merit is in large part based on an assessment of what is technically reasonable. These principles are reflected in the development of the IOPC Funds' technical guidelines for the removal of oil from sunken wrecks. This paper explores the evolution of response policy with reference to key shipping incidents involving sunken wrecks and sunken oil. In the course of this review, the conflicts between public expectations and technical limitations are highlighted.

INTRODUCTION

The topic of this paper can be encapsulated in the general heading "Sub-sea Operations" encompassing both recovery of pollutants from the sea bed and the issues surrounding their removal from sunken wrecks. Both threads of this general topic introduce technical and policy problems different from those which have to be faced with pollution incidents occurring on the sea surface or a shoreline. While techniques for the sub-sea recovery of pollutants exist, enormous technical difficulties have to be overcome for these to be cost effective. One of the key difficulties is determining the extent or quantity of the actual or potential pollutant. In the case of oils or similar chemical pollutants this is related to the techniques currently available for reliably mapping their distribution on the sea bed. In the case of sunken wrecks the corresponding difficulty is determining the quantities and locations of oil or chemical cargo remaining onboard. From a policy perspective decisions have to be reached on the levels of expenditure which should be reasonably incurred to meet the risk of pollution damage, whether this threat is posed by cargo of a sunken wreck or a pollutant which has already found its way onto the sea bed. While an assessment of the risks posed can be undertaken on the basis of technical criteria and this can provide guidance on the most appropriate course of action, such decisions are now increasingly driven by public perceptions of risk.

LOCATION AND RECOVERY OF OIL AND CHEMICALS FROM THE SEA-BED

Oils and chemicals with similar physical properties and low solubility can make their way to the seabed through a number of different mechanisms:-

i) The specific gravity of the pollutant becomes greater than seawater through the incorporation of sediments either most usually, as a result of being stranded on sand shorelines and washed back into near-shore waters or in rare instances, becoming entrained with high levels of suspended solids during storm conditions.
ii) The oil sinks following a fire which not only consumes the lighter components but also results in heavier pyrogenic products as a consequence of the high temperatures associated with the fire.
iii) The pollutant is released directly onto the seabed which sticks to it through mechanical adhesion.
iv) The pollutant has an initial specific gravity already greater than that of sea water as in Low API [gravity] Oils, LAPIO.

In the BRAER incident (Shetland, UK, 1993) 85,000 tonnes of the volatile Gullfaks crude were lost in hurricane winds, generating very turbulent sea conditions which stirred up bottom sediments and suspended them in the water column. Despite the volatility of this crude oil, it was later estimated that some 30,000 tonnes[1]of oil were deposited in the sediments around Shetland and some of it as much as 120 km from the wreck site associated with silt off Fair Isle. Given that the oil was distributed over an estimated 6,900 sq km and the consequent relatively low oil content, the recovery of the oil from the sediment would have been quite impractical.

In many oil pollution incidents for example, VOLGENEFT 248 (Turkey, 1999), ERIKA (France, 1999), PRESTIGE (Spain, 2002) oil stranded on sandy shorelines was washed back into the sea through wave action and the oil/sand mixture sank in near-shore waters. In both the ERIKA and PRESTIGE incidents efforts were made to recover this oil manually using divers but efficiency was low. In the VOLGENEFT 248 divers were also used but an ingenious contract condition, as well as more clement conditions, encouraged better efficiency. In that case the contractor was rewarded according to the oil content of the material that was recovered on a sliding scale so that the reward increased as the deposits of oil became scarcer. Of the 850 tonnes potentially available, 368 tonnes were recovered[2].

The HAVEN incident (Italy, 1991) provides an example of oil which although initially buoyant sank as a result of the ensuing fire which characterised the incident. It was estimated that some 10,000 - 50,000 tonnes[3] of the 144,000 tonnes of Iranian Heavy Crude on board, sank to the bottom and was distributed over a wide area between the two sections of the wreck, 10 km apart. A number of studies have been undertaken to map the distribution of the oil on the bottom and establish damage both to fisheries and the natural environment attributable to the incident. A rough indication of the distribution of sunken oil was achieved by undertaking short trawling operations and recording the presence and quantity of oil in the trawl. Acoustic data was also analysed, but neither method allowed for a quantitative determination of sunken oil and as yet attempts to recover oil from the sea-bed have been restricted to near-shore waters. Although studies found that the environmental damage was relatively limited[4], the area of traditional fishing grounds contaminated by the sunken oil was no longer available and this is thought to have caused a substantial drop in catch in the years following the incident[2].

As a result of hostilities which occurred in Lebanon during the summer of 2006, the storage tanks of the Jieh electricity generating station were destroyed and the oil within set on fire. An estimated 15,000 tonnes of Intermediate Fuel Oil from the storage tanks was lost into the sea. Again in this incident the physical properties of the oil suggested it would be buoyant and indeed much of the oil did float and drifted north contaminating the Lebanese coastline. However, a proportion of the oil sank close to the storage tanks as consequence of the effects of the fire. As part of the international response coordinated by IMO, divers were deployed to collect the oil manually and one team reported recovering some 200 tonnes[5].

In Sweden during the winter of 1986, the tanker THUNTANK V[6] grounded and lost some 350 tonnes of heavy fuel oil. Bottom damage resulted in the oil flowing from the damaged tanks onto the seafloor and due to its high viscosity at low temperature some 20 – 40 tonnes adhered to the seabed. Attempts were made to recover the oil using a hydraulic lift system but were initially not very effective. As the seawater warmed up during the following year the oil became less viscous and was progressively released from the seabed by natural processes.

In each of these cases described above where attempts were made to recover the oil its location was relatively easy to discern, usually because it was in clear, shallow water. In the case of the HAVEN one of the challenges that remains is the reliable mapping of the oil on the seabed.

In December 2005 a barge, DBL 152, capsized off the Texas coast, USA and lost up to 10,000 tonnes of a fuel oil which had a specific gravity of 1.04, sufficiently higher than that of seawater to cause it to sink. Initially the oil pooled under the up-turned barge but a few days after the barge capsized, a storm distributed the oil over a much wider area. Attempts were made to map the oil using a number of different technologies including Side-Scan Sonar and other acoustic methods, a video mounted on a Remote Operated Vehicle (ROV) and a technique developed in the ATHOS 1 spill in the Delaware River the previous year, the Vessel Sorbent Oil Recovery System, V-SORS.

Methods which relied on sophisticated technology suffered from a number of failings including the very limited field of view provided by the ROV and the difficulties of interpreting imagery produced by acoustic methods, in particular distinguishing oil from other features on the bottom. In contrast, V-SORS was a low technology approach comprising sorbents weighed down with chain and dragged along fixed lengths of the seabed. After a number of such drags along pre-determined GPS tracks, a picture of the distribution of the oil was built up. There were also a number of shortcomings to the V-SORS technique, the most important of which was that the technique did not identify the precise location of pooled oil. The technique was only able to indicate that somewhere along a known track the sorbents had passed through an accumulation of oil. In addition, it proved difficult to calibrate the level of oiling of the sorbents recovered at the end of a track with the quantity of oil on the sea bed. Broad categories of contamination were used to target further inspections by divers. Nevertheless, the technique did provide the most reliable approach to monitoring the extent and movement of the oil as it progressively dispersed over time.

While the oil remained in pools, diver-directed suction pumps were used to recover the oil but substantial quantities of water and bottom sediment were also recovered with the oil. The method required a number of separation stages to remove excess water but the separation of the three phases; oil, water and bottom sediment proved very difficult even after transfer to a holding tank ashore. Very soon after the recovery system had been assembled and operations begun, a weather pattern developed which eventually brought operations to a close. A series of depressions passed through the area generating weather conditions exceeding the operational capability of the recovery systems. The passage of each weather system brought with it further dispersal of the oil such that the pools decreased in size and moved. This in turn called for a new survey to target the highest concentrations of oil, the recovery systems; dive platform, pumps and separation tanks, had to be re-established over these and divers re-deployed. As a result, the operation was abandoned to be reassessed in the spring. However, by the following year, the oil was so widely distributed and largely dispersed that no further recovery operations were conducted although monitoring using V-SORS did continue for some time.

One of the most pertinent considerations in reaching the decision to abandon recovery operations was the recognition that the oil which could be accounted for on the bottom represented a very small proportion of that which had been lost. Damage resulting from the incident would have already occurred and continuing operations to recover a diminishing quantity of oil would have had an insignificant benefit in terms of minimising further damage. Another important consideration was that the costs of continuing these operations were disproportionate to the mitigation of any damage that could have been achieved.

RECOVERY OF OIL AND CHEMICAL FROM SUNKEN WRECKS

Almost 1 in every 5 incidents attended by ITOPF over the last five years has involved sunken wrecks and the removal of oil or chemicals from below the sea surface or at least consideration of the feasibility of such operations. The decision to remove potential pollutants from sunken wrecks usually depends on the outcome of a qualitative risk assessment which can be summarised by two questions i) will oil or chemicals be released into the marine environment and if so, ii) what are the consequences of such a release likely to be? Liability for meeting the costs of such operations is governed by a number of conventions including 92' Civil Liability and Fund Conventions for tankers, the '96 HNS Convention for chemicals and the 2007 Wreck Removal Convention for incidents not covered by the other two Conventions. (It should be noted that the latter two conventions are not yet in force). If the costs are to be met under the provisions of one of these conventions then a third question can be asked, namely; are the removal costs proportionate to the potential costs of the likely consequences of leaving the pollutant in place? Part of the answer to this latter question lies in assessing the level of difficulty to successfully remove pollutants and indeed, whether or not removal operations are feasible at all.

Criteria intended to provide guidance are included within the body of the Wreck Removal Convention for all types of ships, whereas the '92 IOPC Funds' governing body[7] has developed criteria to be taken into account in the specific case of oil removal from sunken tankers as follows;

A. Factors relating to the situation and condition of the sunken ship, such as:

- The likelihood of the release of the remaining oil from the ship, for example because of damage to its structure, corrosion, etc.;
- The quantity, type and characteristics of the oil remaining on board the ship;
- The stability of the seabed at the location of the ship.

B. Factors relating to the likelihood, nature and extent of the possible damage, such as:

- The likely pollution damage which would have resulted from the release of the remaining oil from the ship, especially in relation to the cost of the removal operation;
- The extent to which areas which were most likely to be affected by a release of the remaining oil from the ship were vulnerable to oil pollution damage, either from an economic or an environmental point of view;
- The likely environmental damage which would have resulted from the release of the remaining oil from the ship.

C. Factors relating to the feasibility of the operation, such as:

- The technical feasibility and likelihood of success of the operation, for example taking into account visibility, currents, the presence of other wrecks in the vicinity and whether the ship was at a depth at which operations of the kind envisaged were likely to be carried out successfully;
- The likelihood of a release of a significant quantity of oil from the ship during the removal operation.

D. The cost of the operations, especially in relation to the likely pollution damage which would have resulted from the release of the remaining oil from the ship.

These criteria were developed following the IOPC Funds' experience of the PRESTIGE and SOLAR 1 (Philippines, 2006) incidents, the circumstances of which were quite similar but the decisions reached by the IOPC Funds' Executive Committee on the admissibility of claims for the costs of oil removal were different. In the case of the PRESTIGE the Executive Committee decided that the costs of undertaking measures to assess the risk posed by oil remaining in the wreck were admissible but that the costs for the actual removal of oil were not[8].

Although the PRESTIGE oil was more persistent, reaching as far as the UK and perhaps even the Netherlands, the cargo of both PRESTIGE and SOLAR 1 were fuel oils with the potential to persist both as a whole oil or as a stable water-in-oil emulsion. However, the key considerations were the proximity and risk of damage to sensitive resources.

In the case of the PRESTIGE the seafood production industry along the Galician coast was by far the most valuable economic resource potentially at risk from oil pollution and the mussel cultivation industry concentrated in Rias Baixas was of particular significance. The wreck was 170 nautical miles offshore at a depth of more than 3,500 metres and this far offshore coastal fishing was a lesser concern and concentrations of sea birds were also likely to be low to nil in the vicinity of the wreck site. The soluble components of the oil were minimal and so hydrocarbon inputs to the environment would have been limited to the formation of tarballs as the oil weathered. In order for damage on a significant scale to have been suffered by the tourism industries of the Atlantic Islands or the Galician seafood industry, a substantial quantity of oil would need to have been lost from the wreck within a short space of time and the risk of such a release was assessed to be low.

In the case of SOLAR 1 the resources of Guimaras Island were also particularly sensitive to oil pollution. In evaluating the threat of oil released from the wreck causing further damage to the economic and environmental resources of the island, a number of factors had to be taken into account. The location where the vessel sank was 630 metres deep and only some 10 nautical miles (18.5 km) from the shore, and as in PRESTIGE, depending upon the rate of release and weather conditions, the experience of the initial incident demonstrated that oil could reach the shoreline.

Coastal fishing is practised within 15 km of the shore and the presence of oil and oily sheens on the water would have interfered with fishing particularly at night. In addition, oil reaching the shoreline would have disrupted fish and shellfish gathering from the fringing reef along the southern coast of the island. Some of these reefs dry out at certain states of the tide and so there was also the risk of contamination of the reefs themselves to consider. From our investigations to date, the impact of the oil on mangroves does not appear to have been severe. However, the experience of other incidents where similar habitats have been repeatedly oiled indicates that greater damage can be inflicted by chronic multiple oiling than by a single acute episode. The other factor in the case of SOLAR 1 which strongly influenced the outcome of the risk assessment was that the vessel sank in an area where frequent seismic activity was prevalent whereas PRESTIGE sank in an area of the seabed judged to be stable.

In reaching their decision to accept the costs of extracting oil from SOLAR 1 as admissible, the 1992 IOPC Fund's Executive Committee* weighed the proximity of vulnerable economic and environmental resources, the uncertainty over the quantity of oil remaining and the unknown consequences of frequent seismic activity against the moderate projected costs of oil removal from a lesser depth than PRESTIGE. At the time this decision was made, the amount of oil remaining in the wreck was unknown and the costs involved in inspecting the wreck were estimated at little less than the costs of oil removal. Thus, a two-stage operation would not confer any substantial savings. In the event, only nine tonnes[9] of oil were recovered at a cost of about US$6 million.

In the case of the PRESTIGE a novel approach derived from oilfield technology, a Reservoir Performance Monitoring tool, was used to determine the quantity of oil remaining in the tanks. The tool emits a cloud of high energy neutrons which interact with materials encountered releasing gamma ray radiation, the energy levels of which are indicative of the materials encountered. Electronic processing of the return signals allowed the oil–water interfaces to be located. In the SOLAR 1 incident this technology could not be applied because the vessel was half-buried in mud and removal of the mud risked destabilising the wreck.

In both cases, the decision whether or not to pay compensation in respect of oil removal operations was reached by consensus of the majority of the delegations to the 1992 Fund's Executive Committee. The process is one of considered debate focussed around a paper prepared by the Funds' Director and in both cases ITOPF was invited to prepare a technical report to assist in this process. The Chairman of the Executive Committee has to weigh up the interventions made by delegations to determine whether the Committee is in favour or against the Director's recommendation. The Committee members also have the opportunity to intervene if they disagree with the Chair's summary which by necessity is finely balanced since one of the delegations usually represents the claimants and has the opportunity to articulate their concerns. Thus, decisions are reached qualitatively by strength of argument with each delegation putting different weights on various factors, including quantitative date contained within technical reports, according to their particular point of view.

Similar issues to those which were debated by the IOPC Funds' Executive Committee in the SOLAR 1 and PRESTIGE incidents

* The Executive Committee comprises 15 delegations from states party to the '92 Fund Convention elected by the Assembly of all member states. However, the 11 member states which in the preceding calendar year received the largest quantities of oil (upon which contributions to the Fund are determined) are eligible for seven the 15 seats.

have been raised by a number of other incidents recently. In each of these the two most common difficulties have been determining the quantity of potential pollutants remaining onboard and establishing the feasibility of their removal. The former is one of the key parameters in the initial risk assessment and without this information conservative assumptions have to be made which, as was shown in the SOLAR 1 incident and a number of previous incidents, turned out to be unfounded but only after commitment to removal of remaining pollutants had been made.

With the developing rigour in international and regional legislation including the Wreck Removal and OSPAR Conventions, the European Directive on Environmental Liability and the continuing debate within States party to the Fund Convention, the positions taken previously including government acquiescence to the deliberate scuttling of casualties is likely to be a thing of the past and with the success of the PRESTIGE cargo removal the technical obstacles to cargo removal at great depth have been overcome. However, despite this success, a number of technical difficulties do still remain which need to be overcome before pollutant removal from sunken wrecks becomes routine. In the ECE incident (France, 2006)[10] oil within internal bunker tanks was not accessible using the hot-tapping techniques used successfully in many other incidents. Similarly, in both the SEA DIAMOND (Greece, 2007)[11] and QUEEN OF THE NORTH (Canada, 2006)[12] incidents any remaining oil was thought to be distributed in pockets through the wrecks, having been released from damaged tanks during the sinking. Other difficulties to be overcome include working in high current regimes and affixing pumping equipment to wrecks deformed on sinking by imploding tanks.

The ECE incident off northern France in 2006 provides a clear example of how public attitude is driving the debate. In this case a chemical tanker with a cargo of 10,000 tonnes of phosphoric acid was perceived as an environmental hazard by influential environmental lobbies in France. Public perception was coloured by the quantity involved and emotive words of ‘phosphorous’ and ‘acid’. In fact, Phosphoric acid is used either as a component of, or directly as, a fertiliser. Added to this the environmental lobbyists were able to point to the inherent heavy metal and radioactive Uranium content of the cargo, even though none of these were above background levels. Rigorous risk assessments conducted by both UK and French scientific institutions to evaluate the consequences of leaving the cargo within the wreck found that the risk to the environment was limited to increased acidity within the immediate vicinity of the wreck, however, the political imperative demanded a controlled release of the cargo. Again although it was possible to demonstrate that cargo was being lost from the vessel it was not possible to determine how much was left within the tanks and so, neither the authorities nor the media could be satisfied that there was little merit in further actions to control the release of the cargo. Under the Wreck Removal Convention[13] which as noted previously is not yet in force, the criteria for establishing whether a wreck constitutes a hazard includes the nature of the cargo where a hazard is defined as:-

“any condition or threat that:

(a) poses a danger or impediment to navigation; or
(b) may reasonably be expected to result in major harmful consequences to the marine environment, or damage to the coastline or related interests of one or more States.”

However removal measures “……..shall be proportionate to the hazard.”

It is interesting to note that it was the lack of proportionality that defeated the Spanish claim for removal costs in PRESTIGE whereas despite the final outcome and without the benefit of hindsight, the projected costs were accepted as proportional to the threat posed by SOLAR 1 at the time the decision was made to commit resources to removing the cargo.

CONCLUDING REMARKS

Drawing the two threads of this paper together it can be seen that for both pollutants on the seabed and within the hulls of sunken wrecks the key issue is the same. In both cases it is the determination of the quantity and distribution of the pollutant, potential or otherwise, which is the important starting point for a risk assessment. Without this information it is difficult to convince a sceptical and querulous public and media that these circumstances do not necessarily represent an “ecological time bomb”. As has been identified both by delegates to the IOPC Funds’ governing body and in a recent workshop on submerged oil[14], techniques for the reliable measurement of these parameters provide a clear focus for further research work.

Although removal of oil from PRESTIGE demonstrated technologies can be devised for the successful removal of oil from wrecks at great depths, this technology is not uniformly applicable to all circumstances. Building on the success of the PRESTIGE operation to reduce costs and increase the opportunities for the recovery of liquid cargoes from sunken wrecks would be another worthwhile endeavour. The development of cost-effective technologies for the recovery of oil, and chemicals with similar properties, from the seabed is a further clear goal for future R&D work.

REFERENCES:

1 JM Davis & G Topping (eds) (1997) The impact of an oil spill in turbulent waters: The Braer. Proceedings of a symposium held at the Royal Society of Edinburgh, 7-8 September 1995. The Stationery Office, London, UK.).
2 TH Moller, (2002), Recovery of sunken oil in the Sea of Marmara, Proceedings of International Maritime Organization Third R&D Forum on High-density Oil Spill Response, 11-13 March, Brest, France, pp 337 - 343.
3 Amato E., Ausili A., Giannì A., Vacchi M., (2002). Sunken Heavy Oil Residuals in a Bathyal Ecosystem. Proceedings of International Maritime Organization Third R&D Forum on High-density Oil Spill Response, Brest, France, pp 178 -188.
4 Pietrapiana D., Modena M., Guidetti P., Falugi C., Vacchi M., (2002). Evaluating the genotoxic damage and hepatic tissue alterations in demersal fish species: a case study in the Ligurian Sea (NW-Mediterranean). Marine Pollution Bulletin, 44: 238 - 243
5 Pers. Comm.
6 IOPC Fund Annual Report 1988, IOPC Fund, London
7 www.iopcfund.org 92FUND/A/ES.12/8 “Admissibility Criteria Relating to Claims for the Costs of the Removal of Oil from Sunken Ships”
8 www.iopcfund.org 92FUND/EXC.32/6 & 92FUND/EXC.33/8 “ Records of Decisions of the 32nd & 33rd Sessions of the Executive Committee”
9 www.iopcfund.org 92FUND/EXC.37/6 “Incidents Involving the 92 Fund – SOLAR 1”
10 http://www.premar-manche.gouv.fr/services/actualites/communiques/e-docs/00/00/24/07/document_communique.php & http://www.cedre.fr/uk/spill/ece/ece.htm
11 http://www.financialmirror.com/more_news.php?id=7375&type=news “Louis says Greek fine on Sea Diamond was “unfounded and unfair””” 21-06-07
12 “Queen of the North Stays Sunk” http://www.theglobeandmail.com/servlet/story/RTGAM.20070608.wferry0608/BNStory/National/
13 www.imo.org “the Nairobi International Convention on the Removal of Wrecks, 2007”
14 www.crrc.unh.edu/workshops/submerged_oil/submerged_oil_workshop_report.pdf