When should clean-up operations be brought to a close - HOW CLEAN IS CLEAN? [1]

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INTRODUCTION

At the outset of a major oil spill, it is hard to imagine how shorelines inundated with the thick black pollutant will ever be cleaned or that they will ever return to their original condition. Two facts are known as a result of these unfortunate experiences: first, these shorelines are eventually cleaned and second, that nature plays a very large part in that cleaning process. Whatever the scale of nature's part in this process there is always a very strong desire for society to accept responsibility for the repair of the damage to the environment and to attempt to accelerate the natural healing process through human intervention. Response to shoreline oiling focuses on protection of key resources and removal of bulk oil from the shoreline. Once gross contamination has been removed, carefully targeted clean-up activities may be able to limit pollution damage and influence the pace of natural recovery. How far this can be achieved and when such efforts should be abandoned are the subjects of this paper.

Damages resulting from an oil spill can affect a wide range of resources including not just the environment but also the local economy and amenities; the services provided by the marine environment to society as a whole. Conflicts between the demands of these different sectors have to be resolved, for example, between environmental and amenity concerns where an aggressive cleaning technique may quickly restore the aesthetic appearance of a shoreline at the cost of a protracted recovery of environmentally important resources. Measures to mitigate the impact of a spill on each of these sectors and the selection of the best, most effective clean-up techniques must consider the possibility that such operations themselves may cause additional damage beyond that caused by the oil.

[1] The views expressed in this paper are those of the authors and do not necessarily reflect those of CEDRE or the individual directors and members of ITOPF.

There is also the cost of the clean-up to be considered. In many spills clean-up operations make up an important part of the overall cost, in terms of both money and effort. A further conflict between those who are legally obliged to pay for the clean-up and those demanding further cleaning is a common feature of oil spills. This is particularly pertinent to the discussion here since it is generally found that the law of diminishing returns applies to clean-up operations much as it does to other experiences in life. As the clean-up progresses and the amount of oil remaining on the shoreline decreases so the costs of removing that remaining oil increase exponentially.

Such conflicts seriously jeopardise the likelihood that the spill response can be brought to a successful conclusion to the satisfaction of all those affected. The authorities charged with responding to such incidents are in need of tools to guide decisions not only on what clean-up techniques should be used or indeed whether any clean-up at all should be undertaken, but most contentiously, when should the clean-up be terminated. This paper reviews approaches to the question so aptly coined by the Americans, "How Clean is Clean?" and provides some background to the answer, "It depends".

OUTLINE OF THE ISSUES AT STAKE

The first issue to address is the widespread expectation that every last drop of oil spilled should be removed from the environment at large. From the knowledge of how oil behaves when spilled at sea, it is known that the oil very quickly becomes widely distributed through the three environmental compartments; air, water and land. The volatile components evaporate into the atmosphere; a portion disperses into the sea, where it is further degraded by bacteria and other micro-organisms, and a portion is incorporated into sediment over wide areas. Clean-up operations can only address oil, which is accessible, for example, remaining on the sea surface or stranded on shorelines.

The requirement to remove every last trace of the spilled oil is clearly unrealistic. Not only could it never be physically achieved but also the removal of every last drop is not necessary for the restoration of the affected area to a state which allows the same *"use"* to be made of the area as before the spill. Although major spills are nearly always associated with distressing levels of wildlife casualties, many of the fears and concerns for longer term damage have been shown to be misplaced. Studies conducted following spills throughout the world have shown that with very few exceptions, the damage caused by oil spills is both localised and transitory. This nevertheless does not stop pressure from politically motivated groups making demands for unrealistic levels of clean-up and hailing each event as an "ecological disaster". Those charged with carrying out the clean-up may be drawn to respond by pursuing highly visible and vigorous clean-up campaigns in order to be seen to be doing something in the face of such public distress articulated through the media.

Such pressure is quite understandable and authorities faced with response to spills within such an emotionally charged atmosphere can look for technical advice and assistance from the scientific community. This guidance must provide a clear and easily understandable explanation of why particular clean-up measures are being pursued or, in the context of bringing a clean-up operation to a close, why continued clean-up would bring no further benefits. Such technical advice is likely to hinge on the risk that further clean-up would do more harm than good or on the determination that clean-up operations have reached an adequate level to restore the services provided by the affected area. These services can be best considered in terms of the normal use of the affected environment, provision of natural habitat, amenity use and economic exploitation.

Another important factor to be considered is the cost effectiveness of continued clean-up. The cost of the operations to clean shorelines should not present an impediment to meeting the public expectation of clean beaches. However, if further expenditure is not necessary to meet the goals of the clean-up operation or these goals are not technically feasible, then continued expenditure represents a waste of resources, both human and financial.

i) Environment

Efforts made to restore the natural environment are directed towards the removal of the pollutant as a first step in promoting the recovery of biological communities. Recovery is an important concept; when can an injured environment be said to have recovered? One definition states that "Recovery is marked by the re-establishment of a healthy biological community in which the plants and animals characteristic of that community are present and are functioning normally", (IPIECA, 1991). This clearly may not be the same as the pre-spill condition. The pre-spill condition is actually not known in many cases and in any case marine ecosystems are in a continuous state of flux. It is a normal phenomenon for the balance of species distribution to change, in some cases quite dramatically. Plankton blooms provide an example when a massive increase in population occurs in response to seasonal changes in the availability of nutrients and light. The pre-spill condition is therefore essentially a moving target and the widely held aspiration, that the environment should be returned to the condition that existed prior to the spill, can be seen to be very difficult to deliver.

The first question is then whether human intervention can accelerate recovery and as a first step, whether such measures can accelerate the natural processes that bring about the removal of oil. For example, gasoline spilled in the open sea evaporates quickly, before any response operation can be mounted. In the case of an oiled rocky shoreline exposed to rough seas, while it may be possible to enhance the rate of oil removal by hot water washing or the use of chemicals, it is unlikely that such aggressive clean-up techniques can enhance the rate of biological recovery.

One review of spills over a 25 year period indicated that the expected times for biological recovery of three years for rocky shores and five years for salt marshes, were unaffected by clean-up measures, (Sell et al., 1995). However, this review did propose arguments in favour of pursuing clean-up measures to promote biological recovery (as opposed to meeting socio-economic concerns - see below) in cases of heavy smothering or toxic subsurface deposits. For example, the removal of heavy fuel oil from rocky shorelines using high pressure washing might be justified under some circumstances. The natural removal of this persistent oil can be quite slow and its presence may prevent or delay the successful recolonisation of such habitats where a clean substrate would encourage resettlement by juvenile stages of barnacles and algae. Similarly, the rapid removal of free oil from mangrove stands using low pressure, high volume water flushing may mitigate long term damage.

There is always the risk that the use of an inappropriate technique will cause more harm than good or similarly, that to continue cleaning beyond a certain point will cause additional damage. Incidents when overzealous clean-up has led to increased damage and consequent delayed recovery are numerous. Examples include the use of heavy equipment on soft substrates, (JAN and SEA EMPRESS); the removal of oily substrate from wetlands (AMOCO CADIZ); hot water washing of cobble and shingle shorelines (EXXON VALDEZ) and the use of toxic chemicals to disperse the oil, (TORREY CANYON). In every spill judgements have to be made in the light of the potential damage a clean-up technique may cause. For example, removal of oily stains from a sea wall may require the combined use of chemicals and hot water or, for particularly resilient stains, sand blasting might be considered. In the first instance it is clear that any biota surviving the oil spill would be removed by the cleaning. However, as well as destroying any remaining biota, the second approach would risk physical damage to the protective surface of the concrete facing.

The dichotomy between the desire to remove more oil from the marine environment, minimising the risk of further damage, and damage caused by continuing the clean-up itself has to be addressed. Following a spill in the Middle
East, fresh crude oil penetrated the pebble and shingle substrate to depths of more than one metre. Natural cleaning of the superficial sediments took place relatively quickly but because sea conditions remained calm, no disturbance of the lower sediments occurred. It was judged that if sea conditions did become sufficiently strong to displace the overlying pebbles, any remaining oil would be dispersed in the turbulent seas. However, the desire to remove as much oil as possible from the shoreline drove a decision to remove the buried oil by moving away the overburden and flushing out the oil from the sediment. This approach was likely to have set back the recovery of the littoral environment, which was showing good signs of recovery and recolonisation by infauna.

There are a variety of possible reasons for such decisions: -

- lack of information or understanding of the likely effects;

- lack of dialogue between technical experts and operational teams;
- political and media pressure to "be seen to doing something";
- deliberate policy for important tourist resorts where amenity value rates a higher priority than environmental considerations.

The desire to protect the image of a particular area, or the company or agency engaged in the clean-up, is often cited as the reason why clean-up operations are continued without any technical justification. However, the public is likely to question the competence of those responsible for prolonged clean-up operations. Indeed, contrary to a message of reassurance that the visible presence of clean-up teams is intended to portray, the teams simply draw attention to the fact that shorelines may still be polluted.

ii) Amenity

In contrast to environmental concerns, amenity concerns focus primarily on the aesthetic appearance of the coastline and its availability for recreational use. These concerns tend to drive clean-up measures to extremes, particularly at important tourist sites with the result that environmental considerations are often overridden and aggressive clean-up techniques are used to produce the desired results quickly. Such an approach should be restricted to the immediate area of high amenity value during the tourist season. The selection of clean-up techniques and the time over which they are prosecuted are driven by quite different concerns in remote areas, where there is no easy public access.

The desired measure of how clean is clean is that the perception is met that the oil is no longer present, generally through the test that any oil remaining cannot be seen, smelled or felt on sand or solid surfaces. This approach is incorporated into the European Community Bathing Waters Directive 76/160/EEC, which provides the criteria for *European Blue Flag* beaches and requires that for mineral oils there is "no film visible on the surface of the water and no odour".

Although this pragmatic approach addresses the principal public concerns, authorities responsible for reopening amenity beaches may be concerned that this approach does not adequately address issues of public safety. The issue is simply whether the public using a beach after an oil spill is at risk from exposure to potentially carcinogenic components of the oil in either beach substrate or seawater. Such concerns have largely driven attempts to define *clean* in terms of a set level of hydrocarbons or more specifically, Polynuclear Aromatic Hydrocarbons (PAH), in the beach substrate or sea water.

Attempts to make operational decisions on such quantitative basis are fraught with difficulties. The first is that there is no agreement on the levels of either oil or PAH which represent a risk to public safety. Suggested target levels for oil in sediment range from 100mg/kg (AMERICAN TRADER) to 5mg/kg (EXXON VALDEZ) (Tebeau,

1995). In the case of AMERICAN TRADER, the level was derived from a standard used for residential development lands and was used in conjunction with tests relying on sight, touch and smell. In the EXXON VALDEZ incident the standard was not concerned with human health but rather with anticipated biodegradation rates and in any event was not pursued.

A practical sampling regime, which can be used to realistically represent levels of oil on an operational basis, is also elusive. The oil content of a beach substrate is likely to vary through orders of magnitude depending on where samples are taken, e.g. surface swash lines may approach 100% oil while a few millimetres below the surface of a wet hard-packed beach, levels might be expected to be close to background. Background levels will also vary not only with time but also with the location of the shoreline in relation to other hydrocarbon inputs to the marine environment such as urban sewage discharges. All these factors conspire to make the quantitative determination of *clean* on an operational basis an impracticable proposition and authorities have to fall back on a more pragmatic approach. Given the sensitivity of the human senses, if sight or smell can not detect any remaining oil, it is not present in sufficient quantities to cause concern.

iii) Economy

One obvious economic effect of a spill is the potential impact on income derived from amenity value of the shoreline but concerns also arise due to other uses made of the marine environment such as fishing and coastal industries. The primary issues in respect of economic concerns depend upon what use is made of the water resource. Thus for fishing, the removal of bulk oil from the sea surface is generally sufficient to allow a fishery to be reopened. For shellfish and caged fish, it is the concentration of oil in the water column which is of more concern. High concentrations present a risk of toxic effects and even low levels may taint or impart an oily flavour to the product. Some industries using seawater for cooling are able to tolerate quite high levels of oil in water without serious effects while other processes demand very high water quality, for example, the production of salt from seawater.

One clear difficulty throughout the sector is the lack of guidelines in terms of levels which can be tolerated. In the case of industrial cooling water, facilities are often closed as a precaution when, had reliable guidelines been available, it might have been possible to maintain operations throughout the incident.

In terms of human health, the lack of taint in seafood provides a useful guide but again prescribed levels for safe human consumption in products such as salt and shellfish would assist authorities regain public confidence. While it is not possible to define a threshold concentration which is risk-free, it should be recognised that a variety of carcinogenic compounds are regularly consumed in other foods such as smoked products and vegetables. Recent experiences in the United States have led to levels of indicator compounds being proposed for safe reopening of fisheries based

on a risk assessment assuming an acceptable cancer risk of 1 in 100,000 during a five year exposure (Mauseth et al., 1997).

iv) Costs

A key factor which has to be considered in determining when to terminate the clean-up is whether further cleaning is cost effective. An illustration of the issue is provided by an analysis of a European spill, which found that 10% of the oil removal costs accounted for removal of 90% of the oil, while 90% of the costs were expended on removal of the remaining 10%. Another example drawn from a Far East experience, (see Table 1) clearly demonstrates that the law of diminishing returns applies to oil spill clean-up, (Moller et al., 1987).

TABLE 1 Clean-up costs for a spill in the Far East
(from Moller et al., 1987)

Clean-up period	Oil quantity collected (t)	Unit cost ($/t)
Stage 1	2,270	748
Stage 2	200	4,069
Stage 3	20	712,835

The international oil pollution compensation regimes of the 1969 Civil Liability Convention and the 1971 Fund Convention and amendments under the '92 Protocols to those Conventions, are intended to provide adequate compensation to victims of oil pollution. However, to qualify for compensation under the international regimes measures taken and the costs of those measures must be *reasonable*. Although not defined in the Conventions, measures taken are considered *reasonable* if, on the basis of a technical assessment of the circumstances prevailing at the time the decision is made, there is a likelihood that the measures taken will successfully mitigate pollution damage. As a general rule, reasonable measures would be expected to enhance the natural process of oil removal. While the interpretation of what is meant by *reasonable* calls for difficult judgements to be made, there clearly comes a point in each clean-up operation when the expenditure to achieve only a marginal further improvement is disproportionate to the benefits derived. Such expenditure would be considered unreasonable and as such, inadmissible for compensation.

This has particular relevance to the level of cleaning required in environments which are already degraded. The following example of debris on a sandy recreational beach provides an illustration of the issue. During the winter months when the beach has little utilisation, flotsam and jetsam are allowed to accumulate. Prior to the summer season the local authorities routinely collect and dispose of the accumulated debris. If this shoreline debris were inundated with oil as the result of a spill, it would generally be accepted that the disposal of the now oiled debris would form part of the reasonable

costs of cleaning the shoreline. However, under different circumstances in which the level of pollution was only light and scattered tar balls associated with the same spill event were washed onto the beach, the question can be asked whether the costs of removal and disposal of this lightly oiled debris should be considered as reasonable costs which should be reimbursed by the polluter?

Finally, it should be recognised that the funds available for clean-up are finite. In most tanker spills this is not an issue because the funds available through the compensation regimes mentioned above are usually more than adequate to meet the likely costs. However, there are rare instances in major tanker spills or in spills from other sources when the equitable distribution of available financial resources does become an issue.

GUIDING PRINCIPLES

From the discussion of the main issues above, a number of general principles can be elucidated which can be used to guide decisions on when clean-up operations should be terminated. These are summarised below:

Use or function of the affected shoreline

The *use* of the affected area is foremost amongst the factors determining the level of cleanliness necessary to bring it back to a condition sufficient for it to function normally. The shoreline may provide an important biological function as for example, salt marshes; it may support a natural habitat particularly valued by society and protected as a national or regional natural reserve; other shorelines provide a recreational function or may support coastal industries. Normal operations of an industrial port are unlikely to be impaired by residual staining left after a clean-up operation whereas a similar level of staining on a recreational shoreline could adversely affect the success of a tourist resort.

Environmental sensitivity and shoreline type

The environmental sensitivity of the affected ecosystems to contamination by oil is likely to weigh heavily on the decision to terminate clean-up. Different habitats and shoreline types have varying sensitivities, as do the species, which they support. Exposed rocky shorelines are far less vulnerable to the effects of oil pollution than sheltered, muddy environments. In tropical regions, mangrove stands can be severely damaged by oil and take many years to recover.

" More harm than good"

Clean-up operations which are likely to cause more harm than good or cause more damage than the oil itself are to be avoided. Examples include the cleaning of salt marshes where rutting and erosion caused by the use of heavy vehicles can lead to long term damage to fragile substrates and where even the use of manpower can result in trampling of the root stocks. Alternative, less damaging strategies are required for such sensitive environments, including reliance on natural cleaning.

Oil characteristics - toxicity, persistence and rate of natural cleaning

Light refined oils, such as diesel, and fresh crude oils tend to be more toxic than heavy fuel oils or weathered crudes. However, these lighter, more toxic oils are less persistent. The persistence of a particular type of oil determines the likelihood that natural cleaning can provide a mechanism for its removal within an acceptable time frame. Persistence is a function of both oil type and exposure. Low viscosity oils and oils stranded on exposed shorelines are unlikely to persist for extended periods. Any intervention in terms of clean-up operations should be to enhance natural processes.

Seasonality

The importance and use of a shoreline may vary at different times of year. Shorelines utilised only at certain times of the year by migratory birds provide one such example while tourist beaches are another. A tourist beach oiled during winter months may require only removal of gross contamination in the knowledge that with winter storms, natural cleaning will have removed all traces of oil before the season starts again in the summer.

Net Environmental Benefit Analysis (NEBA)

The idea of drawing all these strands together is encapsulated in the concept of net environment benefit analysis. Reaching a decision on whether further clean-up is likely to cause more harm than good, calls for conflicting factors to be balanced and the best compromise to be sought. This may be a qualitative review of alternative strategies or an exhaustive quantitative study, although the latter is unlikely to provide useful answers within the time scale required for most clean-up operations.

The key elements of NEBA are

i) a good understanding of the fate and effects of oil on the ecology of the subject environment as well as of the strengths and weakness of the proposed clean-up methods, including natural cleaning;

ii) an assessment of the environmental outcomes of using a particular technique compared with those of natural cleaning;

iii) weighing the advantages and disadvantages with reference to the ecological value and human uses of the environmental resource to decide the optimum clean-up strategy, (Baker, 1997).

Feasibility at reasonable cost

Lastly the feasibility of removing the oil has to be considered. It may not be physically possible to remove any further oil or to remove sufficient to derive any significant benefit to the affected resource, for example, oil submerged at depth. A further constraint may be that no significant improvement be made without incurring disproportionate costs. In the context of reimbursement under the Civil Liability and Fund Conventions, it is important that authorities engaged in spill response are aware that recovery of costs is constrained by such costs being determined as *reasonable*. ITOPF staff attending on site at the time of the spill response can provide advice on how this concept is likely to be interpreted.

TABLE 2 Suggested Guidelines for Determination of Clean
(from Baker, 1997)

Resource	Definitions of clean
Food organisms (e.g., fish, shellfish, seaweed) and water that may be abstracted for human consumption.	Must meet statutory quality specifications (chemical tests), and pass sensory tests for taint.
Amenity beaches and structures (e.g., jetties and slipways).	No visible oil. No oil that rubs off on people or boats.
Water surface (as used by birds and mammals).	No visible oil slicks or sheens that could adhere to feathers or fur.
Subsurface water (as habitat for fish, corals, seagrasses, aquaculture species, etc.).	Oil concentrations should not exceed normal background levels. Must not be toxic to key species.
Shoreline (as habitat for algae, mangroves, molluscs, crustaceans, etc.).	Need not be visibly clean, but remaining residues must not inhibit ecological recovery through toxic or smothering effects.
Shoreline (as an ecosystem interacting with other aquatic nearshore ecosystems).	Remaining residues must not be mobile such that they will leach out into nearshore waters.

POSSIBLE APPROACH TO CONFLICT RESOLUTION - CONSENSUS BUILDING

Those responsible for determining when a clean-up operation should be brought to a close have to achieve a delicate balance. A compromise has to be struck between the expectations of the public, politicians and the media reflecting concerns over the environment, the local economy and recreational resources, against the level of cleaning that is feasible within the limitations of available clean-up techniques and within the constraints of the costs of operation being reasonable. While the principles set out above are helpful in many cases, there are of course circumstances in which the competing interests of different sectors or interest groups cannot be reconciled. An example, might be the conflict between oyster farmers adjacent to an amenity shoreline where tourism interests pursue the use of dispersants, jeopardising the sale of oysters to those same tourists.

A key factor in resolving such disputes is to provide a conduit for the views and concerns of all those affected by the incident to be taken into account in the decision making process. In the United States, building on experiences gained during the EXXON VALDEZ clean-up operation, procedures have been refined through response to subsequent spills. A central element of the procedures adopted for shoreline clean-up is the Shoreline Assessment Team, a field survey team comprising technically competent representatives of the various organisations involved in the shoreline clean-up. This usually includes Federal and State government representatives, a representative of the spiller, or party responsible for meeting the costs, and a representative of the local entity with particular responsibilities or interest in the section of shoreline under inspection, such as a park ranger or town officer. In the first instance the Shoreline Assessment Team is responsible for surveying the affected shoreline and determining the most appropriate clean-up techniques according to the severity of the pollution, the type shoreline and its sensitivity. As the work progresses, members of the team are charged with reaching a consensus on when the operations should be terminated.

The approach was used in the BOUCHARD 155 barge spill in Tampa Bay, 1993, (Owens et al., 1995) and developed further in the response to the MORRIS J BERMAN incident in San Juan, Puerto Rico in 1994 (Tebeau, 1995). In the Tampa Bay spill the affected shoreline was divided into management segments which were subject to repeated sites surveys to monitor progress in the clean-up, including natural cleaning. In Puerto Rico the same approach was used but qualitative criteria were developed for specific shoreline types. Sandy beaches were accepted as clean with no visible oil, oily feel or smell, while for rocky shores and manmade structures removal of gross contamination and reliance on natural cleaning was accepted for areas with poor public access or low recreational usage.

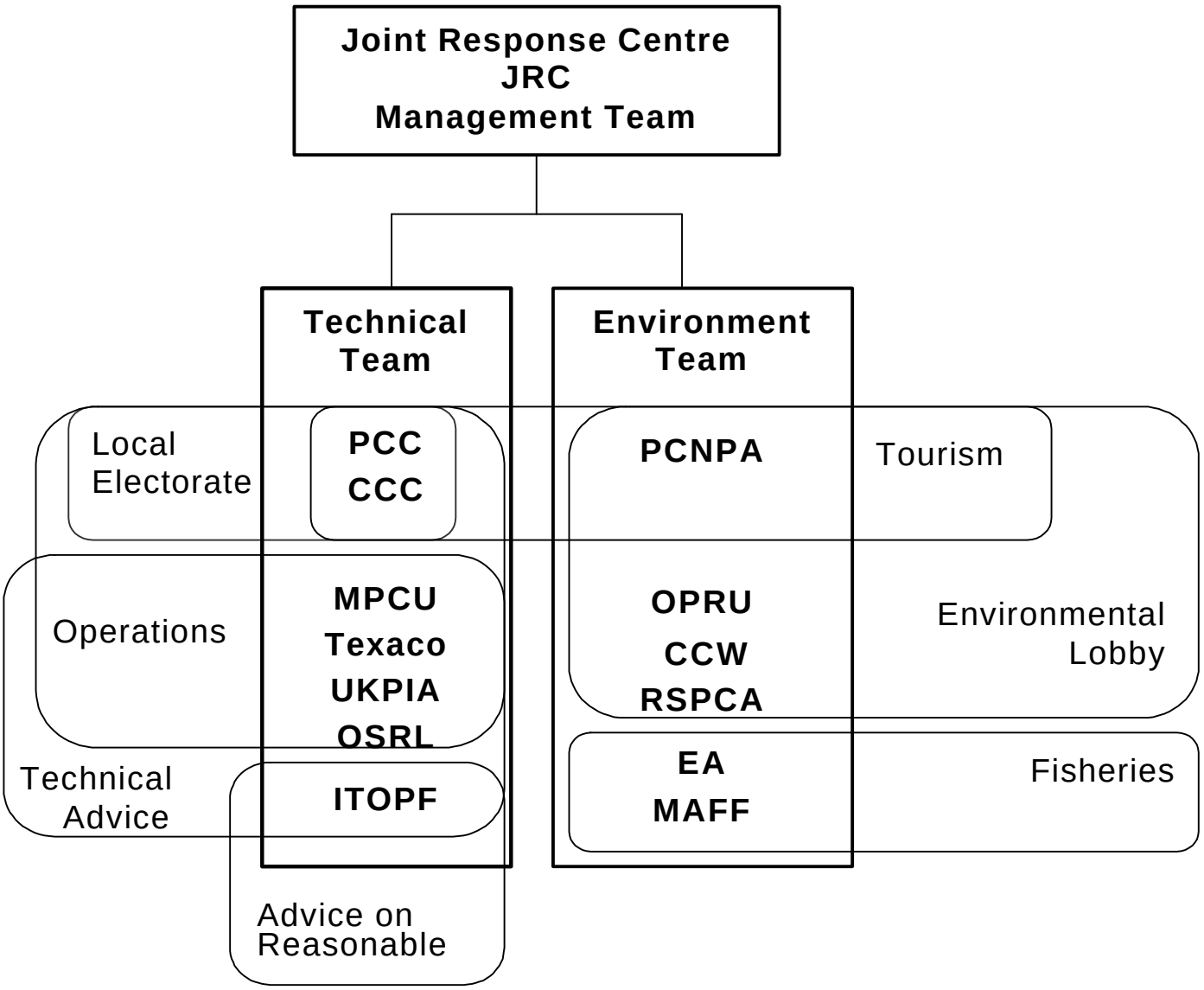
SEA EMPRESS

Although the model used in response to the SEA EMPRESS incident in Milford Haven, Wales, 1996 differed in detail, the concept was similar. The organisation set up to respond to the SEA EMPRESS incident is shown overleaf. The two teams most directly concerned with shoreline clean-up were the Environment and Technical Teams. These two teams maintained a continuous dialogue and as the response developed, essentially became one. Members of these teams were connected to an external network providing points of contact between external bodies and the response organisation. Between them they spanned the myriad interests upon which the spill impinged, for example, environmental lobby groups were in contact with the wildlife rehabilitation teams and also through the statutory bodies of CCW and PCNPA. Commercial fishery interests were in touch with MAFF representatives and amenity concerns were addressed by PCC. Advice on clean-up techniques; their feasibility and limitations, was available through the oil industry (both nationally but more importantly, locally), through the UK government's MPCU and ITOPF. ITOPF staff were also able to provide advice on compensation issues and in particular what measures were likely to be considered reasonable, having direct contact with those stakeholders who foot the bill, the IOPC Fund and the vessel insurers.

Representatives of the two teams made decisions on shoreline clean-up on the basis of monitoring changes in the levels of oiling along the shoreline through repeated site visits. Particularly difficult decisions were addressed by site meetings involving larger groups when discussions amounted to on-site Net Environmental Benefit Analyses with interested parties from a wide variety of organisations working together in an effort to reach consensus.

The successful response to the SEA EMPRESS incident was due to a large extent to the well established oil spill contingency arrangements, which existed in the area. Sensitivities of the various environments were well known in advance of the spill and response strategies had been rehearsed through exercises and previous spill experiences. Most importantly, the core personnel of the environment and technical teams were drawn from the local communities and had developed working relationships prior to the spill through their normal work routines, contingency planning meetings and exercises.

SEA EMPRESS - Shoreline organisation and external nework



PCC	Pembrokeshire County Council
CCC	Carmarthenshire County Council
MPCU	Marine Pollution Control Unit
UKPIA	United Kingdom Petroleum Industry Association Limited
OSRL	Oil Spill Response Limited
ITOPF	International Tanker Owners Pollution Federation Ltd
PCNPA	Pembrokeshire Coast National Park Authority
OPRU	Oil Pollution Research Unit
CCW	County Council for Wales
EA	Environment Agency
MAFF	Ministry of Agriculture, Fisheries and Food

CONCLUSION

Four broad criteria provide a first approach to deciding *how clean is clean*

- Is the remaining oil a potential source of harm to environmentally sensitive resources?
- Does it interfere with the aesthetic appeal and amenity use of the shoreline?
- Is this oil affecting economic resources detrimentally or disrupting economic activities?
- Do the benefits of further cleaning outweigh the environmental and economic costs?

With negative answers to each of these questions, the need for continued clean-up must be open to question.

There are no quantitative values or precise criteria, which provide practical and reproducible guidelines for use in every spill. Key factors to be considered are the ecological value and human uses of these environmental resources, taking into account the seasonal variation in such values and uses. Reaching a decision on an adequate level of cleaning that is acceptable to all those affected relies on an assessment of the precise circumstances of each specific incident and a consensus, balancing the interests of all parties involved. It also calls for a thorough understanding of the fate and effects of the oil spilled and of the sensitivity of the affected environment.

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