

DIFFERENCES IN RISK PERCEPTION: HOW CLEAN IS *CLEAN*?



*An Issue Paper Prepared for the
1997 International Oil Spill Conference*

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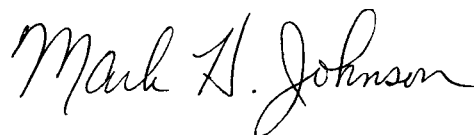
PREFACE

The 1997 International Oil Spill Conference sponsors, American Petroleum Institute, US Coast Guard, US Environmental Protection Agency, International Maritime Organization, and International Petroleum Industry Environmental Conservation Association, commissioned issue papers covering three topics of special importance to the oil spill community. The sponsors assigned responsibility for general management and oversight, scope definition, peer review, and publication of these issue papers to the Program Committee.

The goals of these papers are to stimulate open discussion of complex and controversial issues, and balance diverse positions of stakeholders. Each topic addresses varying scientific/technical and sociopolitical concerns. Therefore, each paper differs as to depth of study and breadth of conclusions. The views and opinions presented are those of the authors solely and do not represent the views, opinions, or policies of the International Oil Spill Conference or its sponsors.

During the 1997 Conference, each of the three issue paper topics will be the subject of a special panel session. Publication of these issue papers as separate companion documents to the Conference Proceedings continues the International Oil Spill Conference Technical Report Series. The Technical Reports are published biennially in conjunction with the International Oil Spill Conference.

It is the Program Committee's hope that each issue paper topic furthers substantive discussion and serves as a catalyst for solutions to the topics discussed.



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ABSTRACT

This paper, drawing upon the scientific literature, aims to identify key points and clarify issues relevant to oil spill response and the question of when it is reasonable to stop cleaning. There is no consensus on definitions of *clean* and the acceptability of predicted natural cleaning timescales; human intervention is justified if the natural timescale is agreed to be unacceptably long.

No cleanup method is a panacea, and different ecological and socio-economic interests may have conflicting needs. Net Environmental Benefit Analysis (weighing cleanup advantages and disadvantages as far as possible in the contingency planning process before a spill occurs) is advocated as a way forward.

Most documented shore recovery times are over timescales of one to five years, regardless of whether they were cleaned or not. Prolonged recovery times of up to 20 years or longer may result from extremes of either aggressive cleanup or uncleaned, heavy oiling. Beyond a certain point, expenditure of money on cleanup and restoration will not have a beneficial effect on recovery because inherent timescales for some ecological processes cannot be accelerated.

It is important to promote understanding and more constructive involvement with the media and public before a spill occurs. Suggested methods include producing information material and involving environmental groups in contingency planning processes.

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EXECUTIVE SUMMARY

In the aftermath of an oil spill, what should drive the cleanup response and when is it reasonable to stop cleaning? This paper aims to identify key points and clarify issues to facilitate policy development. The following areas of interest emerged from consideration of the oil spill literature.

BACKGROUND LEVELS OF HYDROCARBONS AND THE DIFFICULTY OF DEFINING *CLEAN*

Hydrocarbons (both biogenic and petrogenic) are ubiquitous, so *clean* cannot be defined as a complete absence of petroleum hydrocarbons. Different definitions can relate to specified concentrations of hydrocarbons or other criteria, and they can address different perceptions of risk. Definitions for a particular situation are a matter for consensus among the interested parties, and in writing them, the various resources in the area of concern should be considered.

PROCESSES AND TIMESCALES FOR NATURAL CLEANING

Natural cleaning processes can remove oil from shorelines over timescales ranging from a few days to more than 20 years depending on a number of factors, notably the relative exposure of the shore to wave energy. Decisions about the acceptability of predicted natural cleaning timescales must be made by consensus; human intervention is justified if the natural timescale is agreed to be unacceptably long.

HUMAN INTERVENTION — EFFECTIVENESS OF COMMON CLEANUP METHODS FOR REMOVING OIL FROM THE ENVIRONMENT

Many years of international experience have demonstrated the limitations of cleanup methods. No method is a panacea, and in the case of any large coastal spill, shore oiling is almost inevitable. This in turn may lead to highly visible and often labour-intensive shore cleanup, and the possibility that some oil can be removed only by aggressive methods that damage the shore structure and/or organisms.

TOXICOLOGICAL CONSIDERATIONS FOR CLEANUP

Crude oils and oil products vary widely in toxicity. There is particular concern about the toxicity of dispersed oil in the water column, but field exposures for both untreated and

chemically treated oils typically are lower than exposures required to cause mortality or behavioural effects for many species in open water. There is a greater risk in shallow water which restricts flushing and the dilution potential.

ECOLOGICAL ADVANTAGES AND DISADVANTAGES OF CLEANUP METHODS

Most documented shore recovery times are over timescales of one to five years, regardless of whether they were cleaned or not. Prolonged recovery times of up to 20 years or more may result from extremes — either of aggressive cleanup or uncleaned heavy oiling. If moderate shore cleanup is necessary for overriding reasons (e.g., wildlife or local socio-economic reasons), this cleanup can be done in most cases without prolonging the shore recovery.

SOCIO-ECONOMIC CONSIDERATIONS FOR CLEANUP

Socio-economic considerations include the potential need to clean up amenity beaches and boats, and to minimize the tainting of fish and shellfish. In some cases, the optimum response for ecological resources is not the optimum response for socio-economic resources. The contingency planning process should identify areas of potential conflict and attempt to resolve them as completely as possible before any spill occurs.

NET ENVIRONMENTAL BENEFIT ANALYSIS

Net Environmental Benefit Analysis (NEBA) is advocated to address potential conflicts of interest during the contingency planning process. NEBA weighs the advantages and disadvantages of cleanup responses versus natural cleanup, and weighs the benefits and consequences of different cleanup methods. It accepts that some cleanup responses may cause damage but may be justifiable because of overriding benefits.

PAYING FOR CLEANUP AND RESTORATION

The two primary sources of compensation are international conventions (Convention on Civil Liability for Oil Pollution Damage and International Oil Pollution Compensation Fund Convention) and the US Oil Pollution Act of 1990 (OPA 90). Beyond a certain point, expenditure of funds for cleanup and

restoration will not have a beneficial effect on recovery because inherent timescales for some ecological processes cannot be accelerated. This is likely to be controversial under OPA 90.

PUBLIC PERCEPTIONS AND THE ROLE OF THE MEDIA

Public and media expectations may in some cases be unrealistic, and pressures from these sources may lead to inappropriate cleanup. It is helpful to promote understanding by

producing information material and involving environmental groups in contingency planning processes.

CONCLUSIONS

Decisions regarding definitions of *clean* and assessment of net environmental benefit of cleanup methods should be reached through consensus; all interested parties should participate in the contingency planning process. The need for more education and better communication continues.

SECTION 1

INTRODUCTION

In the aftermath of an oil spill, what should drive the cleanup response, and when is it reasonable to stop cleaning? These are complex questions involving chemical, ecological, socio-economic, and political considerations. There are no simple answers. It is important to identify and build consensus for recommended cleanup protocols. These recommendations should be based on the considerable

experience that has accumulated over the past 30 years. Unfortunately this experience (in the form of published papers) is voluminous and at times so specialized that spill responders may have trouble seeing the forest for the trees. The intent of this paper is to identify key points and clarify issues to facilitate further policy development.

SECTION 2

BACKGROUND LEVELS OF HYDROCARBONS AND THE DIFFICULTY OF DEFINING *CLEAN*

2.1 KEY POINTS

Myers and Gunnerson (1976) concluded that both biogenic and petrogenic hydrocarbons are ubiquitous: This conclusion has been amply justified by subsequent analytical data. Table 1 illustrates that higher concentrations of hydrocarbons in water, sediments, and organisms are found in nearshore waters, particularly in urban and industrialized bays and inlets (because of the proximity to chronic inputs as specified below). It also is clear that sediments or organisms may accumulate hydrocarbons in higher concentrations than does water.

Possible sources of background hydrocarbons include:

- organisms, e.g., leaf waxes and hydrocarbons synthesised by algae;
- natural seeps of petroleum hydrocarbons, such as occur, for example, at Scott Inlet and elsewhere along the northeast coast of Baffin Island (Levy, 1981) and in the Santa Barbara Channel (Spies and Davis, 1979);
- airborne combustion products, either natural (e.g., from forest fires) or man-made (e.g., from the burning of fossil fuels);
- operational discharges (e.g., bilge water) from ships and boats; and
- land-based discharges (e.g., rainwater run-off from roads, sewage discharges).

The interpretation of data on background hydrocarbons must consider a number of variables and analytical methods. Petrogenic and biogenic hydrocarbons can be distinguished only by using the most sensitive analytical methods such as capillary gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS). When the same methods are used, analytical variability within and between laboratories must be recognised (Farrington *et al.*, 1988; Howells *et al.*, 1989; Law *et al.*, 1987; Law and Biscaya, 1994). The interpretation of sediment data must consider the sediment properties, especially grain size and organic matter content, which may influence hydrocarbon adsorption and retention (Law and Fileman, 1985; Little *et al.*, 1987). Interpretation of data from

organisms must consider variables such as size, age, stage of reproductive cycle, and site (e.g., water depth).

2.2 ISSUES

In light of the above, the definition of *clean* in the aftermath of an oil spill cannot mean a complete absence of either total hydrocarbons or petroleum hydrocarbons. It therefore is necessary to refer either to specified concentrations or to a variety of other criteria. For example, *clean* may be defined as petroleum hydrocarbon concentrations that:

- do not exceed normal background levels for a particular location;
- do not exceed statutory limits;
- are not lethal to specified organisms;
- do not cause deleterious sublethal effects to specified organisms;
- do not cause tainting of food organisms;
- have no detectable impact on the function of an ecosystem;
- do not impair the human use of an area; and
- are not visible to the human eye.

There are many possible definitions of *clean* that carry different perceptions of risk, including risk to human health, local economies, ecosystem stability, or the productivity of ecosystem components. There are difficulties to overcome with definitions of *clean*, arising partly from the sources of sample variability as described above. In addition, acceptable hydrocarbon concentrations may vary according to the oil type, the degree of weathering, and the relative sensitivities of affected organisms. For example, x grams per square metre of fresh crude oil on a marsh may kill all of species y and 50 percent of species z, but x grams of the same oil stranded on the marsh after weathering at sea may kill nothing.

In the end, however, definitions must include the possibility that petroleum hydrocarbons are present in the environment (albeit in very low concentrations for some situations). It is unlikely that any single definition will serve all interests after a

TABLE 1.
BACKGROUND CONCENTRATIONS OF HYDROCARBONS
(A SELECTED RANGE FROM DIFFERENT MARINE ENVIRONMENTS)

Hydrocarbons analyzed	Location	Sample	Concentrations	References
THC	Northern North Sea Firth of Forth	Water at 1 m	1.2–2.4 ppb 7.4–23.2 ppb	Massie <i>et al.</i> (1985)
THC	England and Wales	Offshore Estuaries	0.7 ppb (mean) 12 ppb (mean)	Law <i>et al.</i> (1994)
Sum of 11 PAH	Southern Baltic Sea	Water at 5 m Water at 9 m	10–180 ppb 9–143 ppb	Lamparczyk <i>et al.</i> (1988)
Petroleum hydrocarbons	Bahia Blanca Bay, Argentina	Water at 1 m	7.5–18 ppb (station means)	Lara <i>et al.</i> (1995)
THC	English Channel	Sediments	0.3–5.6 ppm	Fileman and Law (1988)
THC	Milford Haven, Wales	Sediments	100–700 ppm	Little and McLaren (1989)
Alkanes + aromatics	Narragansett Bay	Sediments	50–700 ppm	Farrington and Quinn (1973)
Sum of 16 PAH	Gulf of Maine	Sediments	10–512 ppb	Larsen <i>et al.</i> (1986)
Sum of 14 PAH	Boston Harbour	Sediments	483–718,364 ppb	Shiaris and Jambard-Sweet (1986)
Sum of 10 PAH	Adriatic Sea, Italy	Sediments	27–527 ppb	Guzzella and De Paolis (1994)
UCM	NE Gulf of Alaska	Mussels	17.6 ppm	Wise <i>et al.</i> (1980)
UCM	North Sea oil platform	Mussels	46–77 ppm	Rowland and Volkman (1982)
UCM	Various USA mussel watch stations	Mussels	3–298 ppm	Farrington <i>et al.</i> (1980)
Sum of 15 PAH	Yaquina Bay, Oregon	Mussels, remote Industrialized area	273.9 ppb (mean) 986.2 ppb (mean)	Mix and Schaffer (1983)
Total petroleum hydrocarbons	Port Phillip Bay, Australia	Flathead fish fillet Liver lipids	7–5,440 ppm 666–2,141 ppm	Nicholson <i>et al.</i> (1994)

THC = Total Hydrocarbons, PAH = Polycyclic Aromatic Hydrocarbons, UCM = Unresolved Complex Mixture (typically comprising higher molecular weight petroleum hydrocarbons). All concentrations have been converted to parts per billion (ppb) or parts per million (ppm) to facilitate comparison. A water density of 1 gm/cm³ has been assumed. Concentrations in sediments and organisms are expressed in terms of dry weight. As these samples were taken in the absence of any specific oil spills, the ranges of concentrations of hydrocarbons may be viewed as background or normal.

spill. For example, visible residues of weathered oil on a rocky shore may be acceptable from an ecological viewpoint because they are not affecting the normal functioning of the ecosystem. This may not be acceptable, however, from a public amenity viewpoint, and companies fear reprisals if measures are not taken in response to public concerns.

It follows that the definitions of *clean* for any particular area following a spill must be determined by the interested parties.

From a practical point of view, *clean* is when stakeholders agree that the spill response has continued long enough. This endpoint depends partly on chemical, toxicological, ecological, and economic criteria; it also includes a political dimension.