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The Dynamic Balance Between Experts and the Public in the Assessment of Hazards: Ocean Incineration - The U.S. Experience

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The Dynamic Balance Between Experts and The Public in the Assessment of Hazards: Ocean Incineration - The U.S. Experience

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ABSTRACT

Understanding environmental threats posed as a byproduct of technology has become an important role for our federal governmental agencies. This study examined environmental hazard assessment in theory and in practice.

Discussion established the unique nature of environmental hazard assessment as compared to financial or natural hazard assessment. This first section examined advantages and shortcomings of four methods to judge the tolerability of environmental hazards: Natural Baselines, Risk/Cost/Benefit Analysis, Revealed Preferences, and Expressed Preferences. The differences in perspectives between *expert* risk assessors and the lay public was highlighted.

For the case of ocean incineration of liquid hazardous wastes the dilemma faced by agencies in selecting an assessment process was shown to be partially resolved by agency reaction to interest groups. Several agencies were involved in the assessment process including: the Air Force, the Maritime Administration, three separate branches of the Environmental Protection Agency, and the Congressional Office of Technology Assessment. Eight agency hazard assessment reports authored by these agencies were reviewed. A correlation was established between interest groups and hazard perspectives. The balance struck between expert and public hazard perspectives for each of the reports was determined. The major legal, bureaucratic, factual, and political factors influencing the balancing process was observed. The changes in the balance over time was shown to correlate with changes in the relative strength of interest groups.

Two additional findings are noted. First, in a real world case example the public placed considerable weight on the role of management in forming its hazard determination

for a technology. Second, there was a direct correlation between an agency's distance from the management of a technology and the *quality* of the balancing done by the agency - as defined by placing weight on both hazard perspectives.

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Chapter I

INTRODUCTION

Hazard assessment is the "process by which society informs itself about threats to humans and what they value".[1] There are many types of hazards which society assesses in order to mitigate their effects. In recent years, society has attempted to identify and control the negative side effects of technology affecting environmental quality. Hazard assessment for environmental protection has become an important role for the federal government.

Environmental hazard assessment of specific activities or technologies are performed by and for federal agencies according to a variety of legal and political triggers to determine the overall tolerability of the activity and identify areas where threats can be minimized. For example, the National Environmental Policy Act of 1969 (NEPA)[2] requires that an assessment be made of all major federal actions with the potential to create significant impact on the environment. Regulatory programs may require an assessment of hazards. An agency has considerable discretionary powers to assess risks within their general agency mission.

There are several ways to perform an environmental hazard assessment. Substantively, assessments can be differentiated by two parameters which have an effect on the outcome of the assessment. First, the hazard's *scope* - the breadth of the causes and effects to be evaluated - has an effect on the assessment. Second, selecting among four methods of judging the tolerability of a hazard partially affects the outcome. These meth-

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[1] Hohenemser, Christoph Roger E. Kasperson and Robert W. Kates, Causal Structure, 1985

[2] U.S. Congress, National Environmental Policy Act of 1969 42 USC §§4321 et.seq., 1969

ods include: Natural Baselines, Risk/Cost/Benefit Analysis, Revealed Preferences, and Expressed Preferences.

Given that various methods produce results of varying acceptability - agencies are confronted with a dilemma - which method should they select? If one method were clearly preferable as tested by standard academic criteria the answer would be easy. This is not, however, the case. Alternately, agencies can select a method and scope based upon who likes it. Each of the methods and changes in scope can be roughly associated with a constituency. In broad terms which will be expanded upon later, the public is in favor of the methods and scope which account for social factors. Technicians, risk experts, prefer the methods and scope which can be quantified, tested and reproduced.

This paper will examine the resolution of this dilemma for a specific technology - ocean incineration of hazardous wastes. This technology has been the subject of considerable controversy between the experts and the public. Implicit in this discussion on *policy* is the validity of both of these perspectives.[3] Agencies have balanced expert and public risk concerns in individual reports and over the entire course of U.S. involvement with ocean incineration. During this period the balance made between expert and public risk perception has shifted in the hazard assessment reports made by agencies. This paper will document the shift in the balance from reports which emphasize expert opinion to those which place more weight on public risk evaluation. Central to this discussion of the balancing of perspectives will be the investigation of how federal agencies incorporate social values into the hazard assessment. It will be demonstrated that the agency risk balancing process is influenced by the strength of political constituencies.

The investigation of this central thesis provides a framework for discussing several important questions in "real world" environmental hazard assessment, including: What specific discretionary powers are employed by agencies which allow them to respond to

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[3] Green, Harold P., The Role of Law in Determining Acceptability of Risk, 1980 , pp.255-267

shifts in the relative political strength constituency groups? What are the methodological differences used in the assessment of hazards and which constituencies do they favor? Is it possible to perform an environmental hazard assessment in an asocial manner? Is it advisable to do so?

This paper is outlined as follows. Chapter 2 deals with hazard assessment methods. It establishes the need for and the specific nature of hazard assessments for environmental policy. The differences, shortcomings, potential constituencies and use of an assessment's scope and method of tolerability judgement will be examined outside the context of a specific case. The sufficiency of the four methods of tolerability judgement - Natural Baselines, Risk/Cost Benefit Analysis, Revealed Preferences and Expressed Preferences - will be measured using a list of criteria important to any academic study. It will be shown that no single method matches all of the criteria.

The third chapter describes the rationale and procedure for the case study. Ocean incineration as a treatment method for hazardous waste will be introduced. The steps necessary to prove the thesis that Agency assessments of ocean incineration were subject to the influence of constituency groups will be listed and the method for proving each explained.

Chapters 4, 5 and 6 evaluate the balancing of public and expert risk reports prepared during three temporal phases of the overall societal mood toward ocean incineration: the viable option phase, the public opposition phase and the balanced hazard phase, respectively. For each of these periods several discrete agency hazard assessments will be evaluated. For each of the reports the balancing of public and expert risk perception will be discussed. At the end of each chapter the individual reports will be ranked against one another for incorporation of public and expert opinion. A fourth phase which has no reports - the withdrawal of ocean incineration from the U.S. market will be explained in Chapter 6.

Chapter 7 concludes by reviewing the evidence for each step in the proof of the hypothesis. Some implications of the current nature of Agency environmental hazard assessment, as revealed in the ocean incineration case, will be outlined.

Chapter II

THE NATURE OF ENVIRONMENTAL HAZARD ASSESSMENT

Risk assessment has recently become a widely used term in the field of environmental policy. Basically, risk assessment relates to understanding environmental threats so that proper corrective measures can be taken. A more thorough understanding of the term and related terms is important, however, to fully grasp the policy implications associated with the assessment and management of environmental impacts.

Hazard assessment is the "process by which society informs itself about threats humans and what they value".[4] *Risk* is the quantified measure of that threat expressed as conditional probabilities of experiencing harm.[5] *Risk assessment* is the process of quantifying hazards to better understand them and facilitate decisions on the tolerability of the threat. *Quantified risk assessment* is a somewhat redundant term both with respect to itself and and with respect to risk assessment. Quantified risk assessment has come to be distinguished from risk assessment, however, by generally referring to predictive computer techniques which model threat, or a single aspect of that threat, such as probability of a hazardous occurrence or likelihood of exposure using numeric experimental data.

This paper is concerned with assessment within the most general realm - hazards. *Hazard management* is the process by which society decides what to do about threats and takes measures to control or mitigate them.[6] The management of any hazard requires shifts in resource allocations. Hazard management is therefore generally agreed to raise

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[4] Hohenemser, Christoph, Robert W. Kates and Paul Slovic, A Causal Taxonomy, 1985

[5] *ibid.*

[6] Kasperson, Roger E., et.al., Hazard Management, 1985

questions of equity, because different groups of people profit depending upon what management option is selected. Depending on the type of threat, the management/equity issues are often resolved through governmental or political means.

The Hazard Spectrum

Humans have always faced various threats to themselves and what they value, and consequently hazard assessment has a long history. The insurance industry, which began in Roman times,[7] is based upon estimating the likelihood of property damage, a type of hazard, incurred through business transactions. Firms have developed methods to estimate the size and probability of a loss to mitigate or prevent these losses. Today the management of *private financial risk*, through insurance, has a well established methodology.[8]

Society's concern with *natural hazards* has an even longer history. Societies themselves have developed by being aware of and controlling natural threats. Examples of societal response to known natural hazards include: structures to hold back flood waters or preserve water in drought, medicine to combat disease, agriculture to control pests. Where societies have not been able to comprehend and control hazards they have developed institutions, both religious and scientific, in an attempt to explain hazards or make them more tolerable.

Technological hazard assessment and management is new. Technological hazards have been described as "man-made hazards to man":[9] his health, well being, societal institutions, and his surroundings. Prior to World War II, technology which created substantial risk to third parties, either human or the environment, did not exist on a significant scale.[10] Today the list of such technologies is long, and growing rapidly, including:

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7 Berkely, Edmund C., Probability and Statistics, 1961

8 See generally, Long, Matthew, Jr., Risk Management Manual, Vol. 1, 1984

9 Cooper, M.G., Risk: Man-made Hazards to Man, 1985

10 Perrow, Charles, Normal Accidents, 1984 , also Commoner, Barry, The Closing Cir-

nuclear power, super tankers, organic chemical manufacture, genetic engineering, and the specific topic of concern ocean incineration.

There is some evidence that technological hazards have existed as far back as Roman times.[11] Early examples, include: the exposure of the wine drinking public to lead from ceramic glazes, and black lung disease to coal miners. These examples, however, differ from modern technological hazards in one or more of the following aspects:

- the *extent or cause of the damage* was *unknown* at the time of exposure.
- *occupational exposure* was the primary means of contact.[12]
- the capacity for *large scale third party* impact did not exist.[13]
- the technological hazards were *overshadowed* by the unconquered natural hazards.

This list demonstrates the irony of modern technological hazards. To some extent society has become aware of these hazards because of the *positive* aspects of technology. Society has the technology to measure and be aware of the hazards which were previously unnoticed. Technology has conquered many natural hazards which previously overshadowed technological hazards.

Environmental hazards are the particular technological hazards of concern here. Environmental threats of technology have come to be associated with negative physical impacts to humans, biota or their surroundings.[14] Technological impacts which are not

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cle, 1971

[11] Kranzberg, Melvin, Development of the Concept of Technology Assessment, 1969 . See also, Nriagu, Jerome, Lead and Lead Poisoning in Antiquity, 1983

[12] Starr argued that occupational exposure has been dealt with within the traditional market model by higher wages paid to exposed populations. See Starr, Chauncey, Social Benefit versus Technological Risk: What Is Our Society Willing to Pay For Safety?, 1969

[13] Perrow, Charles, Normal Accidents, 1984

[14] U.S. Congress, National Environmental Policy Act of 1969 42 USC §§4321 et.seq., 1969 as interpreted in *Metropolitan Edison Co. vs. People Against Nuclear Energy* (103 S.Ct. 1556 1983) where the court refused to acknowledge the potential psychological damage from the restart of the Three Mile Island reactor as an environmental impact because there was no physical effect.

considered environmental include: changes in social institutions, redistribution of wealth, and changes in social welfare, unless there is some identifiable physical effect. The threat of television induced violence is not, for example, thought of as environmental hazard. These non-physical impacts are excluded because they require a different and less rigorous methodology for measurement of impacts.[15]

Management of Hazard Types

The assessment and management of environmental hazards is fundamentally different from the assessment and management of either private financial hazards or natural hazards. The attributes of environmental hazard management will be discussed in relation to the management of the more familiar hazards.

The differences between financial and environmental hazard management are several. The cost of environmental damages is external to the financing structure of the free market entrepreneur, so-called externalities. The individuals and environment exposed to modern technological risks often cannot select whether or not to be exposed. Consequently, the management of these risks is necessarily socio-political rather than strictly economic. Moreover, the quantification of environmental hazard is more complex than the assessment of private financial hazard. The identification of victims is difficult.[16] The probability factor for large scale catastrophic accidents is difficult to assess because of the lack of historical precedent.[17] The costs cannot always be adequately measured or compensated in monetary terms.[18]

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[15] See generally, Graham, Julie and Roger E. Kasperson, Television a Social Hazard, 1979 , p.427

[16] Schneider, Keith, The Data Gap, 1985

[17] Perrow, Charles, Normal Accidents, 1984

[18] While it is acknowledged that some economists *do* measure social cost in monetary terms, the method is not universally accepted. See generally, Shrader-Frechette, K.S., Science Policy, Ethics, and Economic Methodology, 1985

Environmental hazard management is, however, similar to financial hazard management in one crucial element. We, as a society, have the ability to avoid these threats - if we can adequately understand the social cost/benefit tradeoffs. This is not always the case with natural hazards, the management of which is also distinct from technological environmental risks.

Many natural hazards have complex, unknown or uncontrollable causes. This is also true of many environmental hazards. Indeed for many impacts, such as declining forest productivity or elevated cancer rates, it is difficult to tell whether the cause is natural, technological, or both, let alone determine the exact cause. The uncertainty over cause reduces society's ability to control these hazards.

Environmental hazards are also similar to natural hazards in that their cause is external to the individual. This external causal factor has been used to explain the driving force behind western man's attempts to conquer nature. Our civilization has advanced in large measure based upon the degree to which we have succeeded. But technological hazards, while external to individuals, are not external to collective mankind. This has led to a quandary. The elimination of risks which have been created as a by-product of the production of goods involves questions of equity. The equitable distribution of goods and risks through the control of the private sector is political. The management of technological hazards including environmental hazards has, therefore, become the responsibility of our political system. The federal government has been particularly involved given the complexity and pervasiveness of these hazards.

The federal government, or any hazard assessor, needs to do three things before managing hazards.

1. Define the threat
2. Gather data on the threat to change hazard to risk

3. Weigh the threat so that a judgement on how and whether to control it can be made.

Each of these steps requires decisions which have ramification on the ultimate tolerability of the threat. Many of the decisions must be made on political rather than purely scientific grounds.

Note that my statements which remove environmental risk assessment from the field of "pure science" are controversial. The National Research Council (NRC) defines risk assessment as "the use of a factual database to define the health effects of exposure of individuals or populations to hazardous materials or situations".[19] This definition, by concentrating on "factual information" appears apolitical. But this technical process is subject to value judgements. For example, the hazards examined have been narrowed from "threats to humans and what they value" to "health effects". Changes in scope of this sort have political ramifications. Further analysis of the three steps of the technical assessment process will be used to substantiate the political nature of environmental hazard assessment.

Defining the Threat

The causes of hazards can be analyzed and quantified at several levels. The most specific causes are the events immediately preceding a negative impact. The broadest causes are the human needs which, when fulfilled, create hazardous situations as a side effect. Coates describes this phenomenon as the higher and lower ordered consequences of hazards.[20] Hohonemser *et.al.* have diagrammed this "causal structure" to describe the various levels at which hazard assessments can be performed (see Figure 1).

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[19] National Research Council, Risk Assessment in the Federal Government: Managing the process, 1983 , p.3

[20] Coates, Vary T., Development of the Concept of Technology Assessment, 1975

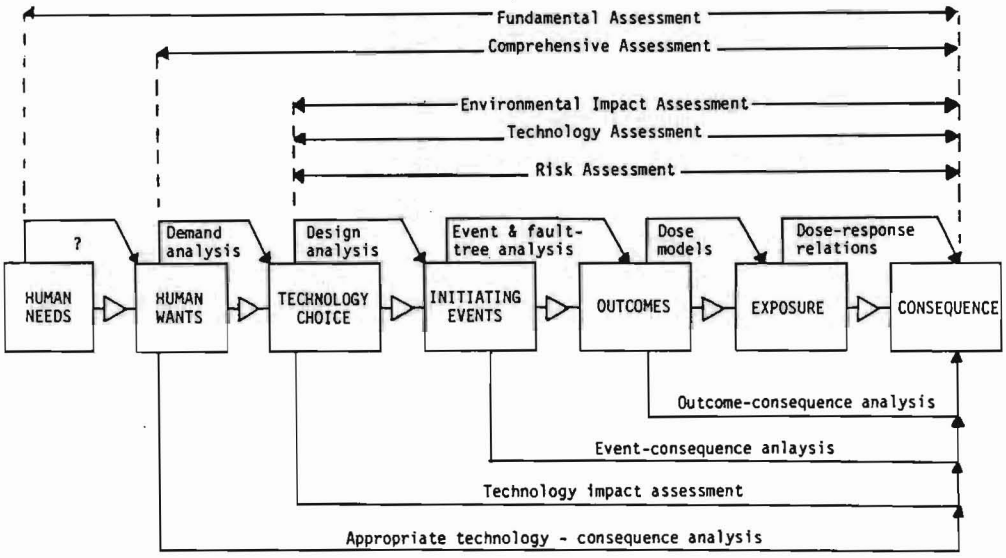

Figure 1: **Causal Structure of Hazards and Various Analysis Modes.** The causes of technological hazards can be examined at several levels - some more direct to the event than others. Changing the focus of the hazard analysis affects the types of information gathered. Some of the analyses are shown. The management options differ widely with the causal level.
Source: Christoph Hohonemser et.al. *op.cit.*, p.40.

The scope of a hazard assessment depends upon the causal level at which the assessment is performed and the number of consequences examined. Negative impacts from technologies occur because: there is a human need or desire to fulfill that need in a certain general manner, the selection of a technology, an initiating an event, an outcome and an exposure. An assessment of the hazard can be performed at any of these levels. Moreover, an assessment can focus on one negative consequence or a number of negative consequences.

Broad assessments are concerned with human wants or needs. There is full accounting of threats, whether or not they are quantifiable. These assessments lead to manage-

ment options which are far-reaching and aimed at changing those wants or needs. They are largely qualitative. Much work in this area tends to argue for controlled technology and conservation. Kates has named the bias of practitioners of *overly* broad risk assessments as the "tip of the iceberg" approach.[21] These individuals sometimes believe that for every known hazard there are several unknown or unknowable ones.

Narrower risk assessments tend to be more quantitative. Results are expressed in comparable reproducible units. Narrow scope hazard assessments try to answer very precisely the probability of a negative impact. These assessments try to determine future risk based upon a known negative effect. Narrow assessment *tends* to focus on human health and ecological risks as opposed to more intangible, subjective and unquantifiable threats. Human health risk assessments, in particular cancer based assessments, are currently the most widely used assessments for environmental policy decisions.

> During the past decade the body which has exercised the greatest influence over risk assessment practice within EPA has been the Cancer Assessment Group of the Office of Research and Development.[22]

Several related criticisms have been levelled against practitioners of overly narrow hazard assessment. Narrowing the scope limits the management options.[23] A narrow focus also tacitly condones the causal structure above the assessment level which has created the hazardous situation. Kates labels these individuals "body counters", those who only believe a hazardous situation exists when human mortality statistics prove it.[24]

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21 Kates, Robert W., Hazard Assessment Art Science, and Ideology, 1985

22 Yosie, Terry, EPA's Risk Assessment Culture, 1987 , p.529. See also U.S. Environmental Protection Agency, Risk Assessment and Management: Framework for Decision Making, 1984 , and generally, the series of articles in *Science*, April 17, 1987, Vol 236, No.4799.

23 Hohenemser, Christoph Roger E. Kasperson and Robert W. Kates, Causal Structure, 1985

24 Kates, Robert W., Hazard Assessment Art Science, and Ideology, 1985

Gathering Data

Once the threat has been defined, an assessor must gather data on the probability and magnitude of the consequence. Three types of data seem to be particularly important.

1. Where human health is the primary consequence of concern, *mortality data* often serves as an indicator of the total health threat.
2. Concern over general environmental degradation leads researchers to collect information on pollutant concentration levels or, less frequently, ecological information on species health or diversity.
3. Concern for protecting social values, whatever they may be, leads to the collection of data on public perception of hazards.

The manner in which data are collected depends upon the nature of the environmental hazard. For existing threats, of which society has become aware only after the technology is implemented, much of the work will be gathering historic information or control data outside of the influence of the technology to compare with data on the impacts of the technology. For proposed technologies, the data gathering stage involves more predictive methods, usually based on similar technologies. Gathering this sort of information allows the hazard to be classified as a risk.

The importance of risk classification is perhaps best made clear by a simple analogy to physics. Heat is a real phenomena, but without degrees and a temperature scale our means to understand and control heat is limited. Similarly, while hazards are a real phenomena, classification of risk allows for the establishment of a social tolerability scale for the purpose of hazard management.

Risks are then prioritized on a scale so that their tolerability can be determined. The scale links the assessment and management of hazard. The judgement of hazard tolerability concerns the assessment insofar as the risk value of the assessed hazard affects the tolerability. The judgement of tolerability is also part of the management process. Should a control or mitigation measure be instituted or not?

Four techniques and associated scales have been proposed to judge the tolerability of environmental hazards.[25]

1. Natural Baselines
2. Risk Cost Benefit Analysis (RCBA)
3. Revealed Preferences
4. Expressed Preferences

The selection of a particular tolerability scale has a substantive effect on the favoring or disfavoring particular interests.

A brief discussion of the procedure for each method will follow. The following criteria will be used to illustrate the differences between the methods.

- *applicability* to all threats
- *quantification* which allows for *comparisons* among hazards
- *reproducible results*
- *sound explicit assumptions*
- *result provide useful information for risk management decisions.*

These criteria are intended to show the relative strengths and weaknesses of each method.

Natural Baselines

Natural Baselines describe environmental conditions which are present naturally, without man's influence or at least without the influence of a specific disturbing factor. These conditions may be expressed chemically, as a concentration of a possible contaminant, and/or biologically, as measured either as individual or ecosystem health and diversity. Human health data may also be used as a baseline. Baseline data are compared with data after a disturbing element has been introduced to measure the impact of that element. Often several sets of baseline data are taken to more fully understand the processes at

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[25] As listed in Shrader-Frechette, K.S., Risk Analysis And Scientific Method: Methodological and Ethical Problems with Evaluating Societal Hazards, 1985 , pp.3-15

work.

Risks are judged as intolerable using this method when a proposed hazard generator is believed to cause an unacceptable impact, as measured by a shift from the natural baselines.[26] This belief may be founded on actual or projected impacts. Effects may be projected based on anticipated contamination output and known effects of contaminant levels.

Natural Baselines are useful for risk management. They have been widely used in the development of environmental pollution standards.[27] Once a cause and effect has been determined for a contaminant level it can be reproduced and applied to other situations. Natural Baselines are applicable to a wide range of environmental impacts.

This method does not explicitly apply social values to the judgement of tolerability which may be considered as both a strength and a weakness. It is a strength insofar as it simplifies the description of a risk, making standards easier to develop. Social factors are, however, important in a full assessment of threats to humans and what they value.[28]

A major, unavoidable difficulty in the use of Natural Baselines for judging the tolerability of environmental hazards lies in the complexity of cause and effect pollution relationships. There are two general ways around this problem, both of which weaken Baseline type studies. First, assumptions and extrapolations can be made to standardize information to make it more applicable to a wider range of situations. These assumptions and extrapolations introduce accuracy problems.[29] Second, baselines can be developed for specific hazard generators and impact data can be gathered until an impact occurs. In this case resources are spent on research which could have gone to hazard investigation if a

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[26] Holdgate, M.W., A Perspective of Environmental Pollution, 1979

[27] Lippman, Morton and Richard B. Schlesinger, Contamination Criteria and Exposure Limits, 1979 , pp.270-310

[28] Shrader-Frechette, K.S., Risk Analysis And Scientific Method: Methodological and Ethical Problems with Evaluating Societal Hazards, 1985 , pp 3-15

[29] Target Exposure, Risk and Holdgate, M.W., A Perspective of Environmental Pollution, 1979 , Chapter 6 Establishment of Goals and Standards, pp.140-163

more forward looking assessment method were chosen.[30]

Risk Cost Benefit Analysis

Risk Cost Benefit Analysis (RCBA) methodology[31] is well developed having roots in the management of financial hazards. The process consists of several discrete steps. The potential damages and benefits for a specific project are enumerated. Monetary values are assigned to each consequence. The monetary value of a cost or benefit is weighted for probability of occurrence. This value is then discounted for time; the value of some future money calculated in present dollar terms. RCBA in public policy strongly resembles RCBA in private financial management. They are not, however, equivalent. Economists have invented *social cost* and *social benefit* variables to account for values external to traditional market theory.[32] Environmental risks are accounted for as the sum of the probable negative social cost. Actions are judged as tolerable where the total social benefit exceeds total social cost - a positive net present value. Other models focus on social cost alone as expressed in terms of potential health effects.

This economics based approach to hazard assessment and management is appealing because of its elegant simplicity. The costs and benefits are all quantified in the same unit, money. The results of RCBA from one set of actions, therefore, can be readily compared to those from another set of actions. For example, if we could solve the RCBA equation for two technologies which dispose of toxic wastes, we could easily determine which technology would be preferable. Moreover, the monetary end result from RCBA is meaningful; it can also be used to establish an insurance schedule to pay for losses should

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30 Burroughs, R.H., OCS Oil and Gas: Relationships between Resource Management and Environmental Research, 1981

31 See generally, Sasson, Peter J. and William Schaeffer, Cost Benefit Analysis - A Handbook, 1978 , See also Long, Matthew, Jr., Risk Management Manual, Vol. 1, 1984

32 Shultze, William D., Ethics, Economics and the Value of Safety, 1980

they occur.[33] Finally, RCBA is appealing because it forces the analyst to explicitly enumerate potential variables which influence the cost/benefit ratio. Once listed and evaluated the model permits reproduction of results or experimentation with different combinations of weights for variables, so-called "sensitivity analysis". The model's flexibility creates a feeling of control, and a means to incorporate new information.

The limitations of RCBA lie in the simplifying, often implicit, assumptions one must often make to quantify hazards in dollar terms. This results in practitioners of RCBA overlooking or improperly measuring hazards which do not fit within the monetary risk model. The controversial assumptions and simplifications may include:[34]

- Voluntary and involuntary exposure to risk are equated.
- Human life is given a monetary value.[35]
- A clean environment is given a monetary value.
- The future is worth less than the present.
- Threats to human dignity or social structures are not measured.

The assumptions necessary to produce results are not universally accepted. Changes in these assumptions produce considerable variation of results. Further, Risk Cost Benefit Analysis does not explain the nature of hazards.

Revealed Preferences

Revealed Preferences is a method first introduced by Starr in 1969 explicitly for the purpose of assessing technological hazards.[36] The method operates on the premise that soci-

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[33] Haimes, Yacov Y, Risk Benefit Analysis in a Multiobjective Framework, 1981

[34] See generally Perrow, Charles, Normal Accidents, 1984 , Haimes, Yacov Y, Risk Benefit Analysis in a Multiobjective Framework, 1981 , and Shrader-Frechette, K.S., Science Policy, Ethics, and Economic Methodology, 1985

[35] Kahn, Shulamit, Economic Estimates of the Value of Life, 1986

[36] Starr, Chauncey, Social Benefit versus Technological Risk: What Is Our Society Willing to Pay For Safety?, 1969

ety is willing to tolerate levels of risk which are equivalent to the levels which it has tolerated in the past - the *revealed preference.* This preference level is described by plotting several factors for several hazard producing activities. Hazards are equated with mortality - either described as the ratio of deaths per individual activity or deaths per time of exposure. The benefit level which justifies a risk is expressed in dollars. For voluntary activities the amount of money spent on the activity is equated with its benefit. For involuntary activities the contribution of the activity to the persons annual income is equated with its benefit. The assumptions used to derive this monetary value vary both substantively and qualitatively with the risk generator described. Figure 2 was developed by Starr.[37]

This plot was used to generate the following principles:

1. "The public is willing to accept voluntary risks roughly 1000 times greater than involuntary risks." (Note the distance between functions separating voluntary and involuntary activities.)

2. "The statistical risk of death from disease appears to be a psychological yardstick for establishing the acceptability of other risks." (Note that activity above the average "P_f", or probability of fatality, line viewed as voluntary.)

3. "The acceptability of risk appears to be crudely proportional to the third power of its benefits." (Note slope of voluntary/involuntary curves $R \sim B^3$.)

These results are meaningful because they can be applied to proposed activities.

In general, Starr's work is noteworthy because it is creative and thought provoking. Following the publication of his 1969 paper, the number of academics interested in quantitative risk assessment increased substantially. The concept of a revealed preference has an intuitive appeal to risk managers who wish to manage risks for the overall social good. Comparisons can be made among several risks. Moreover, the revealed preference method sets out to explain the nature of societal response to risk.

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[37] Starr, Chauncey, Social Benefit versus Technological Risk: What Is Our Society Willing to Pay For Safety?, 1969

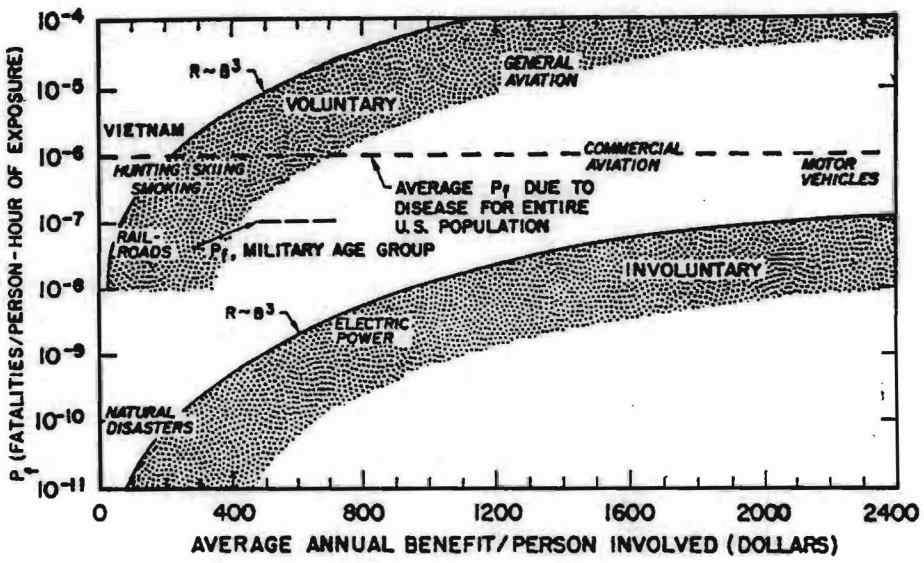

Figure 2: **Revealed Risk Preference.** Risk (R) plotted against benefit (B) for various kinds of voluntary and involuntary exposure to hazardous activity. The 11 data points were used to substantiate general principles. The crudeness of the data - both in terms of number of points and the actual placement of activities on this fatality/dollar benefit plane has been the subject of subsequent research.
Source: Chauncy Starr, *op.cit.* p.1234

The method's assumptions though largely explicit are, however, controversial. A basic assumption is that society's tolerance to risk is static; past societal behavior is acceptable under present circumstances. The method cannot, therefore, deal with fundamentally different hazards. Perrow argues that the catastrophic potential of some new technologies, notably nuclear power and weapons, is fundamentally different.[38] Some of the specific assumptions which are used to associate a monetary value with societal benefit

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38 Perrow, Charles, Normal Accidents, 1984

39 Shrader-Frechette, K.S., Risk Analysis And Scientific Method: Methodological and

or risk also circumspect.[39] These give rise to data points which may not be correct.[40] The importance of correct data points is particularly important given the broad generalizations which are drawn from sometimes scant data. Researchers have found that the simple mathematical relationships proposed by Starr are not bourne out by repeat experiments.[41]

A final problem with the revealed preferences method is that the number and type of hazards and hazardous activities to which the method may be applied is circumscribed by the availability of data on historical risks. Occupational exposure to disease is fairly traceable through records. Data on non-occupational exposure to life threatening hazards is inadequate. Historical data on nonfatal human hazards and threats to what humans value - clean environment and social institutions, is extremely scanty. Even if one could find a present day means to determine an historical relationship between hazardous exposure and damages the relevance to risk assessment would be questionable. Modern day discoveries would not provide evidence of a conscious social decision that a level of risk was preferable; there would be no *revealed* preference.

Expressed Preferences

Expressed preferences surveys individuals to determine tolerable risk levels. Because the method relies on opinion it is also referred to as *perceived risk* analysis. Expressed preferences attempts to measure threats to humans and what they value in a broader and more direct sense than the other risk tolerability methods. The generalized approach is to ask people what they feel is risky and why. Specific research is not, however, quite that

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Ethical Problems with Evaluating Societal Hazards, 1985 , p.??

40 See general critical discussion of revealed preferences in Chapter 18 of McCormick, Norman J., Reliability and Risk Analysis, 1981 pp.367-374

41 Otway, H.J. and J.J. Cohen, Revealed Preferences: Comments on the Starr Risk Benefit Relationships, 1975 and Fischhoff, Baruch, Paul Slovic and Sarah Litchenstein, Weighing the Risks, 1979

broad. For example, Slovic, Fischhoff and Lichenstein in their work asked participants "to consider the risk of dying (across all U.S. society as a whole) as a consequence of this activity or technology." This "perceived risk of dying" measure, while broader than risk based on mortality figures, is less broad than the researchers stated purpose to examine "threats to humans and what they value". Non-mortal health threats and threats to the quality of life are still not directly addressed.

Which risks are perceived as the greatest varies tremendously between lay persons and experts.[42] Expert evaluation of the risk closely resembles the historic mortality data. Public perception of risk is more complex, involving a subtle weighing of several hazard characteristics, including the extent to which the risks are known to science and the likelihood of fatality of the activity.[43] Mathematical methods have been used to group the individual characteristics, allowing for a simplified description of the perceived risk. The two overriding factors which contribute to lay persons perception of risk are *Dread* risk and *Unknown* risk. (See Figure 3)

"Dread risks" are those which combine the following risk characteristics: globally catastrophic, uncontrollable, not easily reduced, involuntary, not equitable, have fatal consequences, risk increasing and pass a high risk to future generations. "Unknown risks" are: not observable, unknown to those exposed, effect delayed, new, and unknown to science. These two factors correlate directly with the magnitude of overall risk expressed by lay persons.

Expressed preferences strength lies in its insight into the social complexity of risk. Lay persons do not use mortality statistics as a yardstick for the "risk of dying". Lay persons are most frightened of activities where the consequences surrounding the hazardous event are unknown or dread. Notably, the public worries much more about the worst

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[42] Slovic, Paul, Baruch Fischoff and Sarah Litchenstein, Rating the Risks: The Structure of Expert and Lay Perceptions, 1982

[43] Nine for some studies latter expanded to 18.

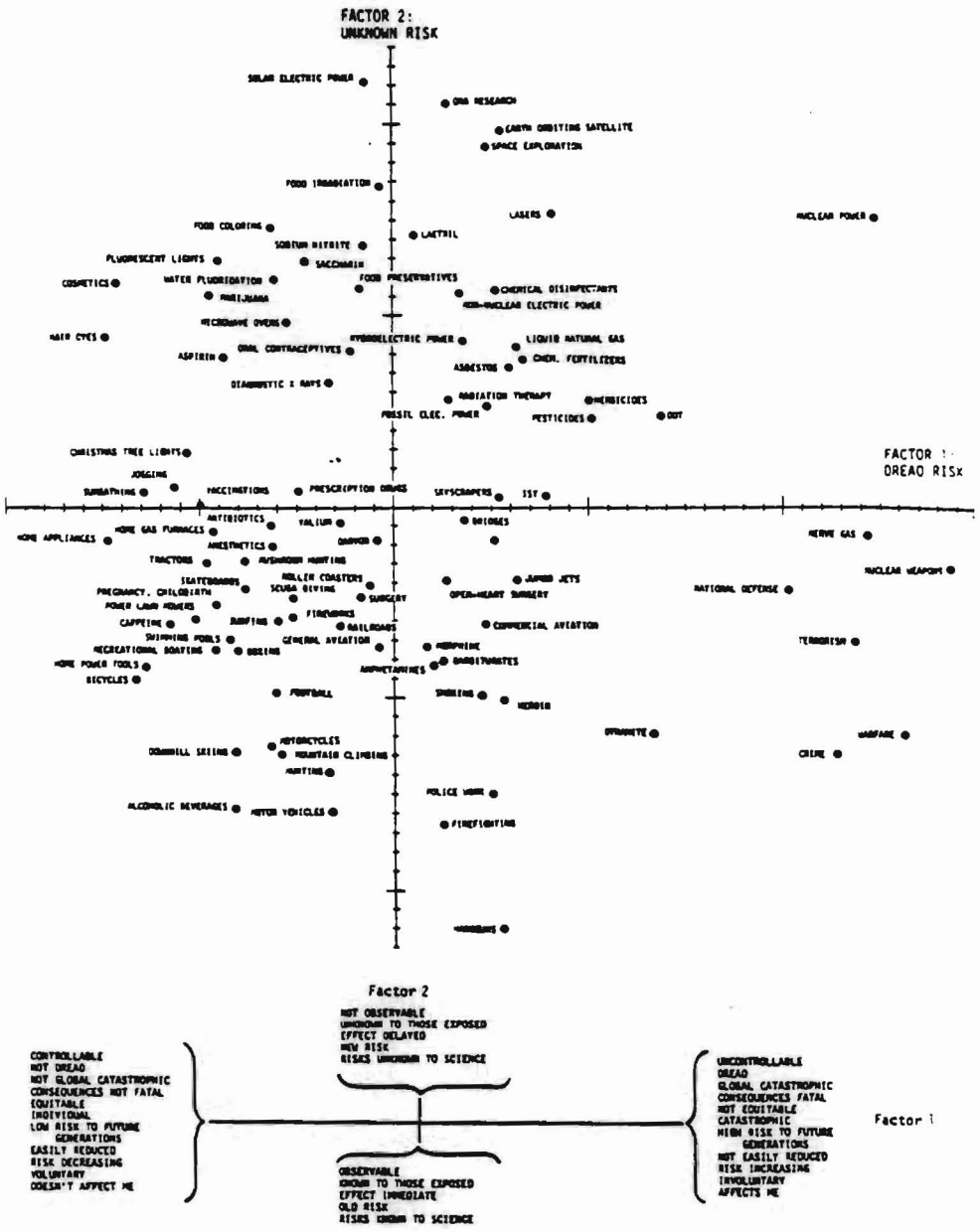

Figure 3: **Perceived Risk.** Hazard locations on Factors 1 and 2, "Dread" and "Unknown" risks. The diagram beneath the figure illustrates the characteristics that comprise the two factors. From Slovic, Paul, Baruch Fischhoff, and Sarah Litchenstein, Characterizing Perceived Risk, 1985

case possibilities than do experts.

Expressed preferences weaknesses lie in the validity of survey techniques. Surveys may not adequately capture public opinion because of the wording of the questionnaire, the manner in which it was delivered, or the sampling method. Respondents may not be adequately informed on the issue and is therefore incapable of forming a reasoned answer.

In conclusion, none of the methods currently proposed for judging the tolerability of environmental hazards is clearly preferable from an academic standpoint. None fulfill all of the criteria. None are bias free. None totally resolve the problem of comparing low probability high risk events with chronic risks. None totally explains the nature of hazards. None accounts well for non-mortal threats to humans. Moreover, they often produce conflicting results when comparing hazard priorities among methods. Sometimes results can even conflict using the same method depending on the scope of hazards considered.

The finding that there is no academically perfect method for gathering data on the tolerability of an environmental hazard, nor of determining a hazards scope, is made more significant by the previous discussion of environmental hazard assessment generally. We have made several observations. Environmental hazard management is inherently political because it requires the equitable distribution, to society as a whole, of risks which have been produced as a by-product of the production of goods by a sector of the society. The process of assessment and management are clearly linked. Assessment methods are malleable in that they vary in the weight they place on social values and the resultant tolerability of the hazard. These considerations demonstrate the difficulty faced by an environmental hazard assessors. On the one hand they must inform society about risks in such a way that various risks can be prioritized. Yet, they must also be aware of equity concerns by which society evaluates the level of threat.

Chapter III

PROCEDURE FOR CASE STUDY

TESTING THE BALANCE OF EXPERT AND PUBLIC OPINION

In this chapter we shall move from the domain of hazard assessment approaches to the case study of ocean incineration of hazardous waste. The case study is necessary to examine how hazards are actually assessed. A key question in examining real world environmental hazard assessments is -- How do federal agencies incorporate social values into hazard assessments? In other words, how do federal agencies balance public and expert risk perception? For the case of ocean incineration, it will be shown that the balance is significantly affected by political pressure from private industry interest groups and environmental groups.

Ocean incineration of liquid hazardous waste is a good case study to test this balance for several reasons. Many assessments have been performed by various agencies over a twelve year period. The volume and temporal span of reports allows for understanding the effects of factors which influence the balancing process. The case demonstrates particularly well the difference between expert and public opinion. Experts have generally been in favor of ocean incineration as a means of reducing hazards from noxious chemical wastes. The public has overlooked the technology's "anti-hazardous" purpose and has been quite opposed to this technology.

The proof that political pressure influences the agency balance of public and expert risk perception of ocean incineration requires examination of several topics.

1. A correlation must be established between interest groups and a specific hazard perspectives:

a. between the public involved with ocean incineration and the incorporation of public opinion as described by Expressed Preference research.

b. between industrial interest and the incorporation of expert opinion

2. The factors influencing the balance between public and expert opinion for each report must be established.

3. A correlation between changes in the balance between public and expert opinion within the reports and relative strength of interest groups over time must be established.

4. It must be shown that apparent shifts in the balancing of risk are discretionary on the Agencies' part and not due to:

   a. changes in legislative mandate

   b. changes in the facts known about ocean incineration

The significance and method of testing each of these subproofs will be discussed generally before presenting data from the eight agency reports examined in this study.

Correlations Between Hazard Perspectives and Interest Groups

The discussion of environmental hazard assessment methods has shown us that the public and risk experts evaluate riskiness from vastly different standpoints. The public places emphasis on threats to social values regardless of how well they can be quantified as evidenced by concern for "dread" and "unknown" risk factors. Risk experts evaluate riskiness predominantly based upon projected or predicted mortality figures, and where those are not available, they place greater importance on the reliable quantification of other risk factors. For the case of ocean incineration correlations are hypothesized between these two theoretical risk perspectives and two real world interest groups.

The lay public hazard perspective, as described in expressed preference research, will be shown to be similar to the hazard perspective of the involved public and environmental

public interest groups which represent them. That part of the public involved with ocean incineration will be shown to incorporate "dread" and "unknown" risk factors into their hazard determination. Empirical data will also show that the public considers social values beyond those identified by expressed preference research.

Industrial proponents of the technology, both producers of hazardous waste and incinerator ship owners, are hypothesized to have a similar hazard perspective to risk experts. The basis for this correlation stems from industry's predisposition toward RCBA. Industry is, as discussed above, accustomed to financial RCBA models for the management of financial hazards. Industry is also disinclined to account for social values which would create costs to them. This predisposition against the incorporation of social values also leads industry toward evaluation based on the Natural Baselines method which purposefully tries to avoid social factors. The types of data gathered for these tolerability methods are highly quantified, and mortality data is often preferred.

Another way to describe the tendency of industry to use methods similar to expert risk assessors lies in their common desire to make the assessment process asocial - to stop or separate the hazard assessment process before management implications are considered. Industry's desire to limit social consideration is explained above in light of private financial considerations. Academic risk experts have another reason for wanting to devalue the importance of social considerations. Traditional academic disciplines attempt to study phenomenon under controlled conditions to understand basic processes. As such, simplifying assumptions are often necessary. As shown in the academic discussion on tolerability scales, in the field of hazard assessment it is common to simplify the role of social factors in the evaluation of risk. This is particularly true for the Natural Baselines and RCBA methods of judging risk tolerability and somewhat true of the Revealed Preferences method.

These correlations between ocean incineration interest groups and hazard perspectives will be substantiated by empirical data from the reports. This is particularly important for the correlation between industry proponents and expert assessors. While the general statement can be made that industry always tries to argue in a quantified manner that downplays the importance of social values, it does not necessarily follow that the risk numbers, or mortality concentration of pollutants or other information will strongly support the industry's position. This will, however, be shown to generally be the case for ocean incineration.

Where the risk numbers found by experts coincide with the interests of industry we can expect the two positions to be similar. Where the two groups may differ, however, is on the acceptable quality of quantified risk information. The quality of quantified information is a difficult factor to determine. At the onset, the term "reliable quantification" was used. That term will be expanded in this discussion to include three points.

- The extent of quantification. Nominal data is of less value than ordinal data.
- Relevance to threat. Sometimes quantified information is presented which is of poor quality because it is not relevant to the perceived threat.
- Backup support. Information which is well substantiated by other work is taken to be of higher quality than poorly cited data.

In summary, we can expect the following correlations between interest groups and hazard perspectives. Public perception of the risks of ocean incineration should correlate with general public perception of hazards as determined by expressed preference research. The case study will expand the types of social values considered important in risk perception. Industrial perception of ocean incineration should correlate with expert risk perception insofar as both limit the role of social factors and place importance on risk quantification. These two groups may be differentiated by the quality of acceptable quantified information as defined.

Factors Influencing the Balance of the Public and Experts

Determining that the balance struck in hazard assessment reports by agencies between expert and public opinion is influenced by the relative strength of interest groups requires two sub-determinations. First, the balance for each report must be determined. Second, the legal/bureaucratic factors influencing that balance must be understood. Discussion of the laws concerning ocean incineration will focus on two issues. First, the role of the mandatory review processes of NEPA and MPRSA in incorporating public and expert opinion will be examined. Second, the role played by legislation in defining the scope of hazards will be discussed.

Two administrative or bureaucratic factors also have a particular role in influencing the manner in which agencies balance public and expert risk opinion. Quite significant is the observation that agencies are reactive to public involvement. Agencies do not, for the most part, try to anticipate public concerns. If the public does not raise concerns they tend to be overlooked. Finally, the role of an agency's mission and management interest in the technology in the balancing of public and expert opinion will be highlighted.

Changes in Balance Over time

The balancing of public and expert opinion will be shown to be affected by the overall "mood" of society towards the technology. This mood, which has evolved over ocean incineration's 15 year history in the U.S. can be described by four temporal phases. Though these phases overlap and their endpoints are somewhat indistinct, recognition of their existence facilitates discussion and analysis. The first three of these phases have produced hazard assessments and will be used as the organizational focus for the chapters which follow and present information from the specific assessments. These are defined as:

1. **Viable Option.** During the period from 1973 to roughly 1981 ocean incineration was generally considered a viable option for the disposal of liquid organic hazard-

ous wastes. During this period several assessments were performed, many taking the form of Environmental Impact Statements. The Maritime Administration (MARAD) underwrote a $64 million loan to build two incinerator ships. The reports analyzed will include three EIS's and one report on the results from a test burn in the Gulf of Mexico.

2. **Public Opposition.** From again roughly 1981 to the present considerable public opposition has been voiced against ocean incineration and several public hearings have been held in accordance with various regulations. One public hearing report and one summary of public opinion have been selected for detailed analysis.

3. **Reconsideration.** From about 1983 to 1987 the federal government re-evaluated its position on the risks of ocean incineration. Four test burns were cancelled and regulations were stalled. Two risk assessments were produced as discretionary informational documents. Both of these will be reviewed.

4. **Withdrawal** Foreshadowed in November 1985 by the default on the MARAD loan, 1988 brought a significant point of withdrawal from ocean incineration. In December 1987, the largest industry proponent of ocean incineration announced it was no longer interested in the American market. EPA soon followed in January by shelving its ocean incineration regulatory program. There are no reports from this period.

The relationship between the balancing process and the relative strength and interest of the environmental groups and industry will be discussed for each period.

Discretionary Changes in Balance

To strengthen the proof that the agency risk assessment process for ocean incineration is influenced by political pressure one should examine alternative reasons for changes in the balance. First, it will be established that the changes in balance were not the result of

changes in the law regarding ocean incineration. Second, the known facts about the risks of ocean incineration will be shown to have remained relatively constant and therefore would not justify a shift in the balance.

Analyses of these topics will show the agency ocean incineration assessment process to be influenced by political concerns. The tolerability judgement by the agencies has shifted over the years in response to growing public opposition. This trend will be documented by reviewing several agency hazard assessments in detail. Specific items to be discussed for each report include: the nature of the report's legal trigger, the balance struck between public and expert opinion, discretionary actions taken by the agency which effect the balance, and the factual and public opinion climate surrounding the assessment process.

Chapter IV

OCEAN INCINERATION AS A VIABLE OPTION

The first phase of domestic policy toward ocean incineration of hazardous waste took place in 1973 when ocean incineration became a viable option. Ocean incineration was technically an option in 1969 when the Dutch first burned waste in the North Sea. The technical viability is based on incineration which reputedly reduces 99.99% of liquid toxic organic compounds to: hydrochloric acid, carbon dioxide and water. The only harmful constituent of these three dominate by-products is the acid which would deposited on, and neutralized by, sea water. Harmful, much less concentrated byproducts, may include: heavy metals, unburned waste and Products of Incomplete Combustion (PICs). This engineering option was virtually unnoticed in the United States until 1972 because much of the waste which would be a candidate for incineration was legally dumped directly into the sea.

In that year the legal picture changed. The MPRSA[44] was passed and ocean dumping was prohibited without a federal permit to be given only when human health and the marine environment were not affected.[45] Regulations promulgated in 1973 prohibited or phased out virtually all ocean dumping of liquid organic chemical waste.[46] Less environmentally damaging disposal methods needed to be sought. Therefore, the once economically prohibitive method of incineration became more attractive. Shell Chemical, which had once dumped waste at sea, was the first to express an interest in ocean incineration.

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44 Marine Protection Research and Sanctuaries Act of 1972 33 U.S.C. 1401 *et. seq.* ; October 23, 1972; P.L. 92-532; 86 Stat. 1052.

45 33 U.S.C. §§1412 and 1414

46 40 C.F.R. §220 *et. seq.*

This initial phase can be characterized by four activities. The Air Force's use of ocean incineration to burn the stocks of the herbicide Agent Orange.[47] EPA's involvement with Shell Chemical to burn liquid organochloride wastes in the Gulf of Mexico.[48] The Maritime Administration's decision to underwrite loans for the construction of incineration vessels.[49] EPA's designation of a site in the Gulf of Mexico for ocean incineration.[50] Each of these actions will be discussed separately. The purpose is to examine how the administrative, legal, factual and political settings affect the process of hazard assessment, especially the balancing of public and expert opinion.

The discussion will begin by describing the requirements for hazard assessment contained within the National Environmental Policy Act. The Environmental Impact Statements (EIS) produced by Air Force, MARAD and the EPA are the principal public risk assessment documents during this period.

EIS as Hazard Assessment

Many hazard assessments performed by the federal government take the form of an environmental impact statement. NEPA required all *major* federal actions with *significant* potential impact on the environment must be evaluated prior to deciding to go through with them.[51] The differences between hazard assessment methods described in Chapter 2 and EIS's are, however, notable.

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47 U.S. Air Force, Final Environmental Impact Statement. Disposition of Agent Orange Herbicide by Incineration, 1974

48 U.S. Environmental Protection Agency, Office of Water and Hazardous Material, Disposal of Organochlorine Wastes by Incineration at Sea, 1975

49 U.S. Maritime Administration, Final Environmental Impact Statement. Maritime Administration Chemical Waste Incineration Ship Project, 1977

50 U.S. Environmental Protection Agency, Office of Water and Hazardous Materials, Final Environmental Impact Statement of Designation of a Site in the Gulf of Mexico for Incineration of Chemical Wastes, 1976

51 §102(2)(c) NEPA and amended CEQ guidelines from Aug.1, 1973 and EO 11514

The scope of an EIS is limited by a judicial affirmation to a proposed project. They must not be so narrow as to consider only one piece of a larger project - so called segmentation.[52] Neither must they be so broad as to affect policy programs.[53] The scope of assessment therefore is often an assessment of a technological choice. At this level the agency must list a series of alternatives to the plan and enumerate the impact of each and why they have not been selected.[54] Accordingly, Agencies are not inclined to look at whether to go forward with a proposal, but rather how.

NEPA does not explicitly require the use of a particular method to judge the tolerability of hazard. The law requires that certain information be gathered to identify potential hazards but not that those hazards be systematically compared.[55] The agency retains more power if it does not make open tolerability statements because openness invites critical discussion. This often results in a catalog of related risk information without much tolerability analysis.

Congress recognized the importance of public and expert opinion to hazard assessment by incorporating certain review mechanisms into the EIS process. An agency is required to prepare a draft EIS, circulate it, respond to comments and hold hearings.[56] The substantive effect of the review process varies because agencies are given considerable flexibility on the decisions reached following the EIS process. If taken to court, the judge exam-

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[52] In Wisconsin Environmental Decade v. State (94 Wis.2d 263, 288 N.W. 2d 168 (Ct. App. 1979) the standards for project segmentation and separability were set. The specific ruling held that a project, a sewer system interceptor could be considered independent of line extension of the sewer system.

[53] Kleppe v. Sierra Club (427 U.S. 390 1976) held that Agencies did not have to prepare a broad EIS for entire programs - here a regional coal leasing program - but only specific projects.

[54] 40 C.F.R. §1506

[55] For discussion of substantive requirements of NEPA see Anderson, Frederick,R. Daniel R. Mandelker, and A. Dan Tarlock, Environmental Protection: Law and Policy, 1984 pp.752-754

[56] 40 U.S.C.S. §4332 notes 56-59

ines only whether the final decision made by the agency was "arbitrary" or "capricious".[57]

Two early environmental impact statements performed by agencies whose primary mission is not environmental -- the Air Force and MARAD. These will be compared with two early EPA reports - the Shell burn report and the EIS for the Gulf of Mexico site designation.

Air Force EIS

The Air Force performed an EIS for ocean incineration in connection with its effort to destroy stockpiles of Agent Orange.[58] The chemical, a defoliant, was used by the Air Force during the Vietnam war. In April 1970, the herbicide's use was suspended because of evidence that exposure leads to tissue damage and birth defects. A year later, the Department of Defense assigned the Air Force the responsibility of disposing the remaining stocks. A total of 2.3 million gallons, 1.4 million stored at Johnston Island and 860,000 gallons stored at Gulfport, Mississippi of drummed material were to be destroyed.

Concurrent with drafting an impact statement the Air Force decided to refer the Agent Orange problem to their Scientific Advisory Board (AF SAB).[59] The *ad hoc* committee was to provide a review mechanism for the EIS which was internal and yet removed from the direct management of the problem. This discretionary review mechanism serves two purposes - technical advice and friendly criticism.

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[57] See generally, "Chapter VII, The National Environmental Policy Act Section D. Adequacy" in Anderson, Frederick,R, Daniel R. Mandelker, and A. Dan Tarlock, Environmental Protection: Law and Policy, 1984 , pp.752-788.

[58] U.S. Air Force, Final Environmental Impact Statement. Disposition of Agent Orange Herbicide by Incineration, 1974

[59] U.S. Air Force Scientific Advisory Board, Report of the Air Force Scientific Advisory Board ad hoc Committee on the Disposition of Agent Orange, 1974

The committee's technical advice was particularly useful for this problem which lay outside the Agency's expertise. The AF SAB described and evaluated the alternatives for Agent Orange disposal including several means of biological/chemical degradation, incineration and sale or donation to a foreign country. Evaluation was performed using modified Risk/Cost Benefit Analysis. The treatment and liability cost for each alternative was weighed against the effectiveness of the destruction technique. Effectiveness was measured by speed, completeness and reliability of destruction. Risks peculiar to a technology, such as extensive handling, were also mentioned. The SAB concluded that incineration, the third most expensive technology out of seven alternatives was preferred.

The Board made eight recommendations on the Draft EIS.

1. evaluate the worst case of emissions release
2. include data from prior burns
3. characterize the hydrochloric acid plume
4. take precautions to avoid damaging reef if incineration or drum cleaning is performed at Johnston Island
5. all stores should be destroyed together
6. evaluate the catastrophic risk potential
7. unnecessary considerations should be deleted
8. perform a full-scale test burn

These concerns address both public risk perception, such as catastrophic risk, and expert concerns, including better characterization of emissions. Each of these concerns was responded to in the Final EIS.

The scope of the Final EIS is quite impressive beyond these responses. It is broad enough to encompass the full range of potential impacts including: transportation, drum cleaning, building and demolition of a treatment facility. The public health risk posed by unburned Agent Orange was described. Moreover, the risks from the incineration process itself were extensively quantified including: probable content and dispersion of stack emissions, fugitive emissions and a worst case scenario.

The broad yet quantified approach seems to have pleased both expert and public risk assessors. Judging by the responses to the Draft EIS included in the report a general consensus appears in support of ocean incineration. Note also that the circumstances surrounding the Agent Orange burn were about as good as they could get in favor of ocean incineration. There was a consensus to destroy the waste. The proposal was to burn a large uniform stockpile of material, therefore, the incineration process would be simpler and destruction efficiency known with more accuracy than for a complex waste stream. Moreover, consenting to burn the stockpile could not be construed as a consent for a large program; it was a one shot deal. The proposal was by the government and not by industry. Private firms are sometimes viewed with more skepticism because the profit motive conflicts with concern for the public health and the environment. Finally, the proposed incineration location was remote, in the central Pacific Ocean. There was not therefore a vocal local constituency opposed to the burn.

The agreement to burn Agent Orange, and the subsequent successful burn, further established ocean incineration as a viable option for the disposal of liquid organic hazardous wastes. As evidence that ocean incineration was considered a viable option we look to the Maritime Administration's actions.

MARAD EIS

MARAD was approached by At-Sea Incineration for a low cost guaranteed loan of $64 million under Title XI Merchant Marine Act of 1970.[60] The federal government's underwriting or financial backing of this significant environmental activity was viewed as an action meriting review under NEPA.

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[60] U.S. Maritime Administration, Final Environmental Impact Statement. Maritime Administration Chemical Waste Incineration Ship Project, 1977 p.I-3

MARAD's review mechanism is more typical of most EIS's in that it did not utilize an *ad hoc* review committee. The corresponding FEIS reflects less concern with public or expert opinion. The MARAD scope of impacts included: the construction or conversion of incinerator vessels, their operation, maintenance and scrapping. Though this scope appears complete for the identification of potential hazards, the detailed analysis places certain caveats or restrictions on the scope which precludes full enumeration of hazards. The omitted hazard factors include: infrastructure, upset conditions, and discussion of broad alternatives to destructive technologies. These three issue are typical of the types of public concerns raised later in the ocean incineration debate and are discussed more fully in Chapter 5.

Infrastructure. This EIS did not consider the environmental impacts of the infrastructure necessary to support ocean incineration vessels. Incinerator vessels would require storage capacity for hazardous material near port. Any new facility for the storage for ultimate treatment of hazardous wastes is viewed as unnacceptable by local residents. This is particularly true where the wastes are not locally generated, and hence the area is not enjoying the economic benefits of the waste generating industry. Moreover, recent studies have concluded that fugitive emissions during storage, loading and tank cleaning would be great enough to warrant construction of a new facility dedicated to offshore incineration despite its attendant environmental impacts.[61,62]

Upset Conditions. The scope of hazard impacts considered is weighted towards "normal operation" of the incinerator ship. The EIS relies heavily on the EPA's data of Shell's first test burn, including the EPA's entire report as a second volume of the FEIS. The quality of the information within this report has been contested and will be discussed

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61 Marcus, Henry S., Incinerator Ships: the Difficulty in Optimizing the System Versus Optimizing the Vessel Design, 1984

62 U.S. Congress, Office of Technology Assessment, Ocean Incineration: Its Role in Managing Hazardous Waste, 1986 , p.110 discusses the option proposed by Seaburn Inc. to utilize intermodal tanks, the contents of which would only be mixed on-board to avoid land based fugitive emissions.

more fully below. Another demonstration of MARAD's emphasis on normal operation is lack of a worst case scenario for spills.

Alternatives. The alternatives to ocean incineration of hazardous wastes are also indicative of a limited scope which tends to advance the project. Alternatives considered include: physical, chemical, thermal or biological treatment, "ultimate" disposal (direct, theoretically contained, release into the environment) or no project. Discussion of these alternatives assumes that the waste will continue to be generated.

Limiting the number of hazards considered works in favor of the proposal while not addressing public concerns. The causal level at which the EIS performed, the selection of a technology, precludes the discussion of more fundamental questions. An advantage of a more limited scope, as has been pointed out in the theoretical discussion, is that it allows for greater quantification.

The MARAD EIS is, however, far less quantified than the Air Force EIS. The document is very descriptive and thorough in the enumeration of hazards but no attempt is made to even place an ordinal value on the various risk factors. It is strange, for example, that the discussion of the environmental impacts from mining the metal to build the ship is given more space than the impacts from potentially harmful constituents dispersed at sea. These were covered with unsupported statements like "The Chemical Waste Incinerator Ship project will have a beneficial impact on the long term productivity of the sea."[63]

MARAD's quantified discussion of alternative technologies was limited. Seeming to follow the methodology of RCBA, MARAD listed the cost of the other thermal technologies, but not the physical or chemical technologies. Ten separate cost units were used, some of which were incomparable.[64] Furthermore, no effort was made to quantify social cost or social benefit. The EPA commented on the problem of various monetary units. MARAD

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[63] U.S. Maritime Administration, Final Environmental Impact Statement. Maritime Administration Chemical Waste Incineration Ship Project, 1977 p.VII-1

[64] Specifically including: $/MT/day, $/lb/hr, $/kg/hr, $/liter, $/ton dry solids, $/ton liquid, $/gallon, $/hr/unit, cents/kg, $/hourly capacity

responded by noting that the numbers were developed by the EPA.

The National Science Foundation commented on the lack of quantification of risk factors in the MARAD EIS suggesting the use of a probability matrix and the use of cost benefit information to clarify the effect of a serious spill.[65] The FEIS disregarded these concerns.

> MARAD concurs with the possible utility of such data if it can reasonably be developed, but has concluded that development of such information is beyond the scope of this environmental impact statement.[66]

This response demonstrates substantive limitations of NEPA's procedural review requirements to incorporate outside opinion. Agencies have the discretionary option not to incorporate comments based upon their internal evaluation of the comment. Where the volume and agressiveness of comments is low the agency can afford to not respond to some comments.

Comments to the draft impact statement and the responses to them, such as this, are indicative of the agency's balance of expert and public opinion. They also document the level of concern outside the agency. In this specific report, the EPA's comments were the most extensive.

Among the other respondents one sees minimal interest from the coastal states- four responding on single page no comment forms. Two, Maryland and Oregon, briefly mentioning a single concern, port loading effects and the potential impact of burning waste other than organochlorides, respectively. California, responding late, mentioned concern for the cumulative chronic impact of ocean incineration on the marine environment. Note that none of the Gulf states off whose coast the first load had been burned raised any objection.

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65 U.S. Maritime Administration, Final Environmental Impact Statement. Maritime Administration Chemical Waste Incineration Ship Project, 1977 IX-53

66 U.S. Maritime Administration, Final Environmental Impact Statement. Maritime Administration Chemical Waste Incineration Ship Project, 1977 IX-55

Also silent was the environmental community. Comments were solicited from the Environmental Defense Fund, Resources of the Future and the Water Pollution Control Federation. The National Wildlife Federation which had taken an active role in the decision to regulate ocean incineration under the MPRSA was not, however, notified. Neither were the national groups with a particular concern for the marine environment. Indeed, only comments received from a non-governmental source were from the American Eagle Foundation. This group which repeatedly refers to itself as a "national environmental organization" is an anomaly. Its position is that of unabashed support for the ocean incineration business. MARAD, in the list of comment solicitations, separated the Foundation from the traditional environmental groups. The group seems to have no independent political or environmental life outside of the ocean incineration issue. Their comments are noteworthy, however, to point out that in the beginning the "environmental" voice concerning ocean incineration was soft or positive.

In summary, the public or expert perception of risks from ocean incineration were not well addressed in the EIS, but neither were they raised by many respondents.

Shell Chemical Burn

Roughly concurrent with the MARAD and Air Force involvement with ocean incineration the EPA was beginning its extensive and multi-faceted involvement with ocean incineration. The Agency's role began on a reactive, not a pro-active basis. In 1974, Shell Chemical requested to burn 16,000 MT of mixed liquid organochloride wastes in the Gulf of Mexico.[67] Prior to this point the EPA did not have any plans to use ocean incineration as part of a hazardous waste management strategy.[68] Indeed, EPA's initial response to

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[67] U.S. Environmental Protection Agency, Office of Water and Hazardous Material, Disposal of Organochlorine Wastes by Incineration at Sea, 1975

[68] See generally, U.S. Environmental Protection Agency, Hazardous Waste Division of the Office of Solid Waste, Incineration in Hazardous Waste Management, 1975 . Ocean incineration is only given cursory mention in the introduction of this report.

Shell was that they had no jurisdiction over ocean incineration. This action prompted the National Wildlife Federation to raise a formal objection with the EPA. The Federation maintained that ocean incineration constituted ocean dumping and therefore required a permit. EPA consented.[69]

The EPA chose to allow the Shell burn, and subsequent applications, under their research and interim ocean dumping permit regulations.[70] This gave EPA the opportunity to gather data on the incineration process without regulations specific to ocean incineration. It also allowed commercial sized burns. It bears repeating that this was a reactive approach to risk assessment and management. The Agency allowed burning before determining the risk. An assessment of the technology could have been performed using data from the North Sea experience where the Vulcanus and other vessels had been operating for six years as the Air Force, and to a lesser extent MARAD, did in their EIS. Alternatively, the Agency could have interpreted the research permit regulations more strictly - only allowing small burns where "the scientific merit of the project outweighs the potential environmental or other damage that may result from such dumping".[71]

EPA's first published ocean incineration hazard assessment comprises the results from the Shell first test burn. The format and contents of this assessment varies markedly from the EISs previously examined. The differences stem largely from differing legal trigger and accordant review processes. The *Disposal of Organochlorine Wastes by Incineration at Sea* is not an EIS. It was prepared on a discretionary basis as a justification of the EPA's decision to grant a research permit. Because of the peculiar nature of this trig-

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[69] §101(a) of the Act bars the unpermitted "transportation from the United States" of "any. . . material for the purpose of dumping it into ocean waters," and §3(f) defines dumping to mean "a disposition of material." as argued in a letter from Congressman Dingell to the EPA and cited in Kamlet, K.S., Ocean Disposal of Organochlorine Wastes by At-Sea Incineration, 1981 p.299

[70] 40 CFR §220.3(e)

[71] For general discussion see, Bakalian, Allen, Regulation and Control of United States Ocean Dumping: A Decade of Promise, An Appraisal for the Future, 1984

ger the report more closely resembles a lab report than a policy hazard assessment.

The assessment's scope is limited to the effects of incinerator emissions of organochloride wastes under normal operating procedures. Specifically, hazards were limited to emissions monitored during non-upset conditions: hydrochloric acid and residual unburned waste or Principle Organic Hazardous Constituents (POHCs). The impacts are further limited to the two specific burns at the Gulf of Mexico.

The potential for negative impacts due to changes in pH and chlorinity, and the deposition of organchlorides and trace metal levels is identified and discounted as negligible.[72] A quantified description or weighing of the risks is therefore unnecessary. This "no risk" conclusion, while valid for this set of results is overly optimistic for judging the technology as a whole. This report ignores the potential cumulative impacts, accompanying infrastructure, fugative emissions or catastrophic risk potential of routine ocean incineration.

Moreover, the validity of the monitoring methods has been subject of much criticism. The criticism has been raised not as part of the review process, as with the EISs examined, but rather raised outside the report.[73] This detached criticism is due to a lack of formalized review procedures for the assessment of the test burn. The EPA itself admitted problems with the monitoring methods of the first test burn.[74] The Agency did not, however, allow these concerns to preclude the burning of a second "test" shipload of wastes of approximately 4,200 metric tons.

EPA's reliance on information provided by the permittee also brings into question the merit of the report. While it is recognized that industry often supplies information to agencies, including during the EIS process, this report is more explicitly guided by industry

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[72] U.S. Environmental Protection Agency, Office of Water and Hazardous Material, Disposal of Organochlorine Wastes by Incineration at Sea, 1975 , pp. 59-74

[73] Kamlet, K.S., Ocean Disposal of Organochlorine Wastes by At-Sea Incineration, 1981 and U.S. Congress, Office of Technology Assessment, Ocean Incineration: Its Role in Managing Hazardous Waste, 1986

[74] U.S. Environmental Protection Agency, Office of Water and Hazardous Material, Disposal of Organochlorine Wastes by Incineration at Sea, 1975 pp.2,39,48

input than are the other reports reviewed. Shell Chemical provided the laboratory analysis and conclusions for several aspects of the report.[75] For example, a Shell scientist was the *only* reference used in the determination that ocean incineration would have no effect on migratory birds.[76] While this does not necessarily mean that the conclusions were incorrect it does raise a conflict of interest question. Shell's opinion cannot be as trusted as an external risk expert.

Questions of administrative procedure are also raised by the function of this report. It was prepared to determine whether Shell could burn their wastes in an environmentally sound manner. Half of the waste, 8400 metric tonnes, was burned in the process of making that decision! Moreover, this report, in the absence of other broader hazard assessments performed by the Agency, served to sanction the technology. MARAD appended the entire 225 page volume to its EIS to supply the background evidence that ocean incineration was not harmful. Until supplemented by the Environmental Impact Statement designating the Gulf of Mexico Site for incineration two years later in 1976 this report was the *functional* equivalent of a general hazard assessment.

Gulf of Mexico Site Designation EIS

The EPA prepared an EIS for the designation of an incineration site in the Gulf of Mexico. It differs from the other EIS reports for three legal/bureaucratic reasons. The report was prepared voluntarily by the agency. It was prepared by the lead regulatory agency for incineration. The assessment utilizes pre-existing risk guidelines - those developed for direct ocean dumping.

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[75] U.S. Environmental Protection Agency, Office of Water and Hazardous Material, Disposal of Organochlorine Wastes by Incineration at Sea, 1975 pp. 62,66,69,74,74.

[76] U.S. Environmental Protection Agency, Office of Water and Hazardous Material, Disposal of Organochlorine Wastes by Incineration at Sea, 1975 p.74

EPA did not feel that the EIS was legally required because of the court's ruling on functional equivalence of regulatory programs.[77] The court decided that where a specific regulatory program serves the same purpose as an EIS that an EIS did not need to be performed. In this case, EPA felt that the ocean dumping regulations under the MPRSA were "functionally equilavent" to NEPA's requirement for an EIS. NEPA was designed primarily to get agencies to consider the potential negative impacts of all projects. The ocean dumping program was designed to consider and lessen environmental impacts from potential pollutants released at sea. The Agency performed the EIS anyway to satisfy public concerns.

Site designation was an important step for the development of a routine ocean incineration program. To comply with the MPRSA, EPA had to designate sites based upon the generalized ocean dumping criteria and develop specific regulations for incineration. The procedural assessment process for this report cannot, therefore, be separated from the overall regulatory program.

EPA's Use of Criteria in Hazard Assessment.

EPA used three similar sets of ocean dumping risk criteria to deterimine the acceptability of the proposed site - "general criteria", "specific criteria", and "impact categories". (See Appendix B for full listing.) Each of these sets of criteria came from the proposed ocean dumping regulations which were adopted in January 1977 after the publication of the EIS.[78]

The "general criteria" for site selection relate to the scope and tolerability scales. They establish types of risks which are to be evaluated. The risks considered by the "general criteria" are economic and to a lesser degree biological.

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[77] Maryland vs. Train (1976 DC Md) 4/5 F Supp.116

[78] 40 CFR 228; 33 USC §1412 - 1418; 42 FR 2482 January 11, 1977 except as noted.

> Locations and boundaries of disposal sites will be so chosen that temporary perturbations in the water quality or other environmental conditions caused by disposal operations affecting mixing zones anywhere within the site can be expected to be reduced to *normal ambient seawater levels* or to undetectable contaminant concentration or effects before reaching any *beach, shoreline*, marine sanctuary, or known geographically limited *fishery* or *shell fishery.*[79]

The use of the term "normal ambient seawater levels" would indicate the primary method for judging tolerability would be the Natural Baseline method. Note that there is no direct mention of public risk concerns in these general criteria.

The "specific factors" for site selection provide an opportunity for public risk concerns to be raised. Note that two of these factors (4&5) relate to the assessment of the *management* of the technology, specifically - the types and quantities of waste and packing, the feasibility of monitoring and surveillance. These "specific criteria" address the public concern for control of technology and some of the infrastructure concerns. Some of the public concerns not addressed include: onland transportation and loading problems, extent of knowledge of specific site and worst case scenario. Nonetheless, when looking at the specific criteria deference seems to be made to public and expert risk concerns.

The "impact categories"[80] supercede the public concerns for risks mentioned in the "specific criteria". The impact categories are the operative criteria - they are the ones upon which EPA will decide whether ocean incineration is acceptable or not. The EPA proposed to "maintain or increase existing rates of disposal" unless or until the conditions of Impact Category One are met.[81] These conditions can be summarized as:[82]

- The accumulation of waste near a beach or sanctuary.

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79 40 CFR 228.5(b); as cited in U.S. EPA *op. cit*

80 40 CFR 228.10

81 40 CFR 228.11 as cited *ibid.* p. 23. Note that the call here to "maintain or increase" disposal rates represented the extant regulatory scheme which was dropped in revisions of 1978. 43 FR 1071, January 6, 1978.

82 For full text see Appendix B

- Impact on the population of *valuable commercial* or *recreational* species or species *essential* to the propagation of such species.
- Impairment of the taste or odor of above species.
- Toxic concentration present outside disposal site more than four hours after disposal.

These impact categories places emphasis on economic factors, and to a lesser degree, potential health effects to humans or the marine environment. Note that effects on biota which are not essential to the support of commercially valuable species are not considered.

The use of three separate, overlapping lists of ocean incineration criteria which comprise different issues and risks makes it difficult to determine what factors are actually important to EPA. The Agency appears to be balancing a wide range of concerns but on closer examination the important criteria are largely economic. This is, however, only part of the framework for the actual decision. Examination of the EIS itself also demonstrates the extent to which public and expert opinion is considered.

The differences between this EIS and previous assessments would seem to encourage the incorporation of more public opinion in the report. This *voluntary* report is the first assessment prepared by the lead regulatory agency which examines the impact of a proposed routine incineration program. This EIS is, therefore, an appropriate medium for the agency to discuss and dispel public fears of the technology.

Public concerns were addressed more fully in this report to the extent that the description of the marine environment was more complete. The majority of the assessment comprises a descriptive geography of the site's chemistry, physical properties and biology. Notably, this is the first report to discuss the role of the surface microlayer -- the top millimeter skin of the ocean important in ocean/air gas exchange which may be a critical habitat for supporting the plankton community and potentially could accumulate pollutants, particularily toxic metals, to a degree which would disrupt plankton life with wider consequences to the entire marine ecosystem. The scientific community has acknowledged

this risk but agreement has not yet been reached on the importance of the surface microlayer, nor the potential impact from ocean incineration.[83] Many advocate further research. EPA, however, substantively dismisses the impact of ocean incineration on the surface microlayer.[84]

Two new issues were raised by industry: regional acid rain and stratospheric ozone. These concerns were incorporated at the written request of Shell Oil Company, in an unsolicited comment on the draft environmental impact statement. While these issues are potentially problematic for alternative waste disposal technologies, they are not issues for ocean incineration. It is significant to this study on the balance of perspectives , however, that the EPA responded to these two issues within the text of the FEIS. It demonstrates how the agency acts in a reactive capacity to the shaping of hazard concerns. The agency did not independently raise the ozone or acid rain issue in the alternatives section, but waited for an outside interest to do so.

Compared with the other assessments made during this period, the site designation is broader on the issues addressed but less broad on the alternatives considered. The major decision was between sites, not between technologies. The NEPA "no action" requirement was intended to force consideration of other technologies. The only other alternative discussed, however, was direct ocean dumping -- and that was discussed only on one page. EPA's fulfillment of the no action requirement here does not answer the general public concern that the least environmentally damaging method for waste disposal has been selected.

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[83] U.S. Environmental Protection Agency, Scientific Advisory Board, Report on the Incineration of Liquid Hazardous Wastes, 1985 , pp.32-33

[84] U.S. Environmental Protection Agency, Office of Water and Hazardous Materials, Final Environmental Impact Statement of Designation of a Site in the Gulf of Mexico for Incineration of Chemical Wastes, 1976 , p. 58

In general, beyond raising and dismissing the issue of the surface microlayer, the EPA continued to overlook several public concerns. The Agency relies heavily on information from the Shell burn report and the MARAD environmental impact statement instead of widening the scope of concerns. The Shell burn report, again used in its entirety as an appendix, is used to substantiate the minimal impact of normally operating ocean incineration.[85] MARAD's report is deferred to on matters concerning the probability and effect of a severe spill.[86] The major public concerns that continued to go unaddressed include: infrastucture impacts, upset conditions during burning, spills serious consideration of alternative technologies, and effects from burning complex wastes dissimilar from the Shell wastes.

From the perspective of expert risk assessors this EIS has merits, particularly if one is an advocate of the natural baseline method. The descriptive geography of the report establishes a baseline to compare with post incineration conditions. The theoretical problem of which baseline to select is, however, apparent in this study. For example, in discussing the improbable impact due to acid rain from ocean incineration activities the report refers to "naturally occuring acidic sulfur (SOx) and nitrogen (NOx) as well as chloride in salt spray". The first two of these pollutants are largely anthropogenic. The selection of acid rain as the baseline also seems to indicate social acceptance of the condition - which is not true.

Beyond the controversy over the use of natural baselines, this report is better substantiated than the Shell Burn Report. A wide variety of sources external to EPA and the generators of the hazardous waste are tapped for information. Of particular note is the better cited discussion of the possible impact of ocean incineration on migratory birds.

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[85] Appendix G, under separate cover U.S. Environmental Protection Agency, Office of Water and Hazardous Materials, Final Environmental Impact Statement of Designation of a Site in the Gulf of Mexico for Incineration of Chemical Wastes, 1976

[86] U.S. Environmental Protection Agency, Office of Water and Hazardous Materials, Final Environmental Impact Statement of Designation of a Site in the Gulf of Mexico for Incineration of Chemical Wastes, 1976 p.74a

Twelve articles were used to substantiate that the site is an unlikely migratory route as opposed to the single citation supplied by Shell Chemical in the earlier report.[87]

Summary of Viable Option Period

To summarize the first phase of ocean incineration development one can look at the starting players. The generators and owners of liquid hazardous waste both public and private were the initial proponents of ocean incineration. The federal government responded in a reactive manner to their suggestions. State governments and the public seemed unaware that the strong legislative mandate prohibiting ocean dumping in the MPRSA would lead to the attractiveness of ocean incineration. They were not actively involved during this initial phase.

The EPA assessments performed during this period proceeded under the assumption that ocean incineration was a viable option for the disposal of liquid organic hazardous wastes - many of which had proviously been dumped directly at-sea. This assumption is evidenced by several actions. The agency chose to allow a limited number of commercial scale burns while gathering information on the impact of incineration. The scope of their assessments during this period was fragmented - there was no single document that looked at the potential threat from the public's perspective: from the point of origin to the long-term effects of burning, including low level chronic effects and the impacts of associated infrastructure. Tolerability judgments were made mostly on the basis of economics, modified informal RCBA, and natural baselines. The overall methods used during this period therefore were more appealing to expert rather than lay assessors, though notably problems were raised on the professionalism of some methods by outsiders. The empirical correlation between expert assessment of ocean incineration's risks and industrial proponents interests was established.

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87 U.S. Environmental Protection Agency, Office of Water and Hazardous Material, Disposal of Organochlorine Wastes by Incineration at Sea, 1975 p.65

EPA's slant toward industry and expert hazard assessment can be explained by the lack of involvement of "the public" during this initial period. The comment that agencies can act in a reactive fashion is even more true of the public which is in turn reactive to government actions. Until lay persons become directly aware of potentially dangerous activities "in their own backyard" they did not act. During this initial phase there were no well organized local or regional anti-ocean incineration groups. The National Wildlife Federation was the only true environmental organization to take up the cause.[88]

The differences among the assessments during the viable option period stem largely from differences in the nature of the trigger. At the beginning of this chapter, two triggers were given - NEPA and the ocean dumping regulations. Upon closer examination it becomes important to be more specific because discretionary actions in the procedure and the influence of related requirements effect the outcome of the assessment.

The three EISs are differentiated as follows. At its discretion the Air Force EIS was performed using a Scientific Advisory Board thus changing the internal review process. EPA's EIS for the Gulf of Mexico site designation was discretionary under NEPA but closely tied to the procedural and substantive requirements of the ocean dumping regulations. MARAD's EIS was an impact statement made on a specific project without an internal review process.

Ranking Public Concerns

Ranking these assessments for the incorporation of public risk concerns does not involve a simple quantifiable scale. However, one can make general conclusions. The Agent Orange EIS was better at incorporating public concerns than the Gulf of Mexico EIS. It had a

[88] One might argue that Ken Kamlet of the Federation commented on ocean incineration from a different perspective than a lay person and could not be considered as their representative. Kamlet's perspective was more shaped by awareness of alternatives than the general public's. This is substantiated by the fact that the Federation, after receiving objections from its membership, changed its position to one more critical of ocean incineration. (Sally Lentz, Staff Attorney for the Oceanic Society, personal communication.)

broader scope - specifically it considered worst case scenarios, infrastructure problems, several substantively different alternatives and acknowledged difficulties in knowing risks precisely. The Air Force's Scientific Advisory Board played a role in pointing out these concerns.

The Gulf of Mexico EIS did not address public concerns well. It measured risks based upon wide ranging criteria which were developed for ocean dumping generally. The use of these criteria, was biased toward economic concerns despite acknowledging the importance of non-mortal threats to humans and their values. This EIS was an opportunity for the lead management agency to understand and allay where possible, public opposition to the technology at an early stage. Instead, the Agency addressed those issues which were raised by the parties most directly involved at this stage - industry proponents.

MARAD's EIS was notably bad at incorporating risks which are important to the lay public. MARAD overemphasized the environmental impact of building and dismantling the ship while deferring to EPA on the risks of the incineration process itself. The Shell test burn report is the document which deals with public fears over ocean incineration most inadequately. The risks of the technology generally are implied to be the same as the measurable effects of emissions from a controlled test burn under good operating procedures.

What does this say about the review process and the role of NEPA in performing assessments which are satisfactory to the public? First, the agencies have considerable of discretion under NEPA. They can, but do not have to, change the review process to more fully account for public concerns. They can also focus narrowly on the immediate known effects of a proposed project. The requirements of NEPA are not sufficient to force agencies to consider "potential perceived hazard" though at least they must nominally respond to specific concerns raised.

Variations in the incorporation of social risk factors explains why this series of reports which varies substantively on the tolerability of ocean incineration. There is a direct correlation between the omission of social factors and the attractiveness of the technology. The MARAD and Shell Burn reports are the most strongly in favor of ocean incineration. The Gulf of Mexico report advocates the technology while pointing out a few possible problem areas. The Air Force report arrives at acceptance of ocean incineration as the best available alternative only after extensive discussion of the costs and risks associated with other technologies.

Ranking Expert Concerns

As with lay concerns, the ranking of the incorporation of expert concerns must be informal. Both the Air Force EIS and the Gulf of Mexico EIS have commendable attributes in regards to the consideration of expert concerns. These EISs' evaluation of the alternative disposal methods clearly quantified risks and costs. The site designation EIS contained a significant amount of baseline information on several variables. The Shell burn report, while the most technical of the assessments, has received criticism on its methodology and the validity of its results.[89] MARAD's methodology once again ranks as the poorest assessment. The cost figures for incineration methods represent the only systematic attempt made to quantify risk variables.

Even more than with public concerns, NEPA requirements offer considerable substantive flexibility for the incorporation of quantifiable "meaningful" assessments. The review process for NEPA forces agencies to recognize and respond to any public concerns raised. There is no equivalent regulatory requirement which forces agencies to perform assessments in a quantifiable manner. As long as the EIS does not reach arbitrary or capricious conclusions it has the latitude to dismiss the methodological comments and recommendations of outside experts. MARAD's dismissal of the NSF's request for a prob-

[89] See note 64

ability matrix of impacts is a good example of this.[90] NEPA's lack of substantive requirements limits the law's usefulness in forcing decisions to be made in a rational manner considering the potential environmental impacts.

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[90] U.S. Environmental Protection Agency, Office of Water and Hazardous Materials, Final Environmental Impact Statement of Designation of a Site in the Gulf of Mexico for Incineration of Chemical Wastes, 1976 , p.IX-53 see discussion in text p.38

Chapter V

PUBLIC OPPOSITION

The assessments reviewed thus far were performed before ocean incineration had become contested. Neither of the first two Shell Burns, nor the Agent Orange burns met with broad based public opposition. Public opposition seems to have been ignited in 1981 when 7,000 metric tonnes of PCB laden waste burned in the Gulf after receiving a research permit. In December 1983, an EPA field hearing in Brownsville Texas for another research permit, turned out more than 6,400 people opposed to another proposed test burn. This was the largest attendance ever at an EPA field hearing. Since that hearing the anti-ocean incineration lobby has remained consistently vocal and placed the political viability of the technology into jeopardy.

It is beyond the scope of this study to determine the exact reason for the dramatic change in expressed public perception of risks. Key players are as diverse as: the press, local activists, the national environmental groups, the presidential administration. Substantively, one might speculate that the public became involved because of fear of burning PCBs as opposed to chemicals with less well known toxic effects. Or perhaps mistakes were made in the 1981-1982 burn, or maybe national interest groups took a more involved position because the EPA was beginning to move forward with a regular permitting process. Or fears from Love Canal and other environmental nightmares directed attention away from optimistic progressive legislative era to protection from improper disposal. Any or all of these factors may have had a partial effect on the growth in public position.

The EPA has conducted several public hearings on the issue of ocean incineration beyond the Brownsville hearing. Two documents from this period will be used to summa-

rize public opposition, an EPA Hearing Officers Report[91] and EPA's Office of Policy Planning and Evaluation's (OPPE) synopsis of public sentiment to incineration of hazardous materials.[92] These reports have been selected for analysis because they are compiled reports of comments and therefore represent public opinion as interpreted by the agency. Moreover, because they are relatively recent, public opinion is more developed than in earlier hearings.[93]

A public hearing record can be viewed as a form of hazard assessment which is markedly different than an EIS or report on a specific burn. A public hearing is a hazard assessment as it has been defined - the manner in which society informs itself about threats to humans and what they value. In fact, public hearing records closely resemble the method of expressed preferences for the determination of risk tolerability; they are analyses of expressed risk perception of the public.

There are, however, differences. The academic method of expressed preferences involves a random sample of the population. Public hearings generally turn out those who already aware and concerned about an issue. Expressed preferences has been used most widely to rank a broad range of issues according to several factors. Public hearings focus on one issue. They do not explicitly enumerate risk factors. Expressed preferences research has concentrated on hazards which are side effects of a technology. In this case, the technology's sole purpose is to reduce a hazard - yet the public seems to be even more afraid of incineration that of the hazardous chemicals to be burned.

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[91] U.S. Environmental Protection Agency, Hearing Officer's Report on the Tentative Determination to Issue the Incineration-At-Sea Research Permit, 1986

[92] U.S. Environmental Protection Agency, office of Policy, Planning and Evaluation, Assessment of Incineration as a Treatment Method for Liquid Organic Hazardous Wastes: In 5 Volumes, 1985

[93] Public Hearing Officer's reports are hard to obtain. I have made repeated phone requests to Darryl Brown of EPA's Office of Water, the person responsible for distributing these reports. These were not responded to despite the fact that according to the regulations (40 CFR 222.8), copies are to be distributed free to anyone who makes a specific request. Copy was finally obtained through the Oceanic Society, a private environmental interest group.

Public opposition to ocean incineration is a direct reading of risk perception. The term direct does not, however, imply simplicity. When viewing the record on risk perception directly through hearing testimony, or through press reports and personal communication, it is difficult to determine the extent to which media, organizational efforts of particular individuals or interest groups should be counted in shaping perception. One simply cannot say, for example, that sixty percent of the population is opposed to ocean incineration due to catastrophic risk of spillage. Researchers must perceive the perception. I see no way around this methodological problem, other than to avoid discussion of public opinion, which is an unacceptable alternative given its tremendous impact on the assessment process.

Test Burn Hearing Report

The test burn hearing officer's report was prepared because section 222.8 of the Ocean Dumping Regulations requires a summary of public opposition and policy recommendations based on that opposition. This study will not comment on the policy recommendations insofar as they deal with management and not assessment. The hearing specifically concerned Chemical Waste Management proposal to burn 708,958 gallons of fuel oil mixture containing 10-30% PCBs mixture stored in Alabama in the North Atlantic on board the vessel Vulcanus II. The hearings were held during January 1986 after a tentative decision by EPA on December 5, 1985 to issue a research permit for the burn.[94]

The represented public for the series of hearings is shown in Table 1. The largest single identifiable group represents "public interest" or environmental groups. Public interest groups are different than the general public. They have shown a previous interest in environmental concerns which may mean that they have more knowledge in the area and probably means that they are less tolerant of environmental hazards than the general public. The number of respondents from government agencies demonstrates that when a large number of people become involved in an issue it behooves them to take a stand.

[94] 50 F.R. 51360, December 16, 1985

Because activists are also voters one would expect the government positions to be swayed by the the most voluminous arguments. Industry and labor have concerns where hazards affect their job safety, or the technology may affect their job security. Those affiliated with professional organizations and academia may by swayed by public concerns or the offering of expert opinion.

Group	**# of Letters**
No affiliation	1234
Congress Rep. or Senate	18
Federal Agencies	2
Governors	2
State governmental entities	24
Local governmental entities	52
Public interest/Environmental	223
Industry/Labor	75
Professional	2
Academia	12

Table 1: **Affiliation of Public Represented during a Test Burn Hearing Process.**

Source: U.S. EPA Hearing Officer's Report

The scope of risks brought up in the hearing is broader than for the reports examined in the previous chapter. Lay persons did not feel confined to discuss only matters concerning the specific research burn in question. Rather, in the public's mind, the hearing was on ocean incineration as a treatment method for hazardous material generally. Some of the concerns raised by the public are explainable within the context of research in expressed preferences and some are not. Lay person concern over unknown or new risks is reflected by concern over the emphasis on the potential impact to the surface microlayer and the possible synergistic impact of ocean incineration near the "106" sludge dumpsite and that generally not much is known about the oceans. Similarly, concern for dread risk

is demonstrated by mention of spills, both routine and large, and the use of PCBs as a candidate for incineration.

An aspect to the character of perceived risk which is readily apparent in a case study, but is not widely discussed in the academic literature, is the impact of proposed risk management on the perceived risk. Several of the commenters objections were not directed at the threat of environmental or public health risk due to the hazardous materials itself but rather to the lack of sound management. The public did not feel that there was a management organization in place which could deal with emissions or emergencies. Specific complaints were raised about: the number of agencies with overlapping jurisdictions, the lack of training for company and agency personnel, the adequacy of monitoring programs and the importance of insurance liability and financial solvency of companies.

None of these management issues are considered in traditional academic hazard assessment because researchers attempt to assess the technology outside the context of management. The difference between traditional academic and policy hazard assessments is comparable to laboratory biology vs. field ecology. In the more remote studies researchers attempt to control the variables affecting a phenomenon to understand some basic process. The limitation of the academic studies is, however, that they can remove fundamentally important factors which limit the relevance of their findings.

Realistically, there is a definite relationship between risk management and probable damage. For example, the impact from a spill is greater is greater if cleanup and control is not well organized or performed. As established by Starr's work,[95] acceptance of damage varies with the amount and type of compensation. The likelihood of damage, chronic or catastrophic is affected by the performance of ongoing monitoring and maintenance programs. Politically, public concerns can stop or delay projects even if those concerns are not measurable.

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95 Starr, Chauncey, Social Benefit versus Technological Risk: What Is Our Society Willing to Pay For Safety?, 1969

Risk minimization was a second theme of the connection between assessment and management. The public was less willing or unwilling to accept risks where they could be minimized. In the specific case, the wastes for this burn out of the port of Philadelphia were to have originated in Alabama. The public felt wastes should be more local to reduce transportation risks. The public was also concerned about long term risk minimization. It was argued that acceptance of the PCB research burn would condone a regular ocean incineration program. Ocean incineration in the longterm was seen as unfavorable insofar as it did not encourage the more environmentally acceptable alternatives of waste recycling and waste reduction.

Risk distribution was also an important factor in public perception of risk which can be derived from the Hearing Officer's comments. The public did not feel that it was right to bear the risks from non-regionally generated wastes. Pennslyvanians did not benefit from the jobs created in producing the materials which created the waste, but withstand the increased threat. Second, individuals who live particularly close to a facility face a higher risk than do members of the general public. They are therefore even less tolerant, the Not-In-My-Backyard syndrome.

In summary, the Hearing Officer's Report represents a totally different type of assessment than previous reports. It focuses on public risk perception rather than formally modelling hazard potential in an asocial manner. By concentrating on public opinion the hearing officer's report sheds light on hazard characteristics which are not apparent in the general research of expressed preferences of technological hazards. Specifically, the public was concerned with the effect of perceived poor management on the magnitude of the hazard, especially on regards to emergency response, risk minimization and risk distribution. These latter two issues also demonstrate the concern the public has for equitable management of risk.

Public Opinion Report by OPPE

In 1984, EPA's Deputy Administrator requested the Agency's Office of Policy, Planning and Evaluation (OPPE) to prepare a report on hazardous waste incineration. The resultant report, on both land and sea based incineration comprised five volumes, including one on public concerns.

The scope of the OPPE's 1985 public opinion report is much more detailed and comprehensive than the Hearing Officer's Report. OPPE evaluated opposition to 14 land based incineration proposals and both extant ocean incineration proposals. Hearing records were reviewed and interviews were conducted with people of note in the hearing or recommended by EPA Regional Administrators. For ocean incineration 80 interviews were held.

From the interviews OPPE compiled the public concerns and listed those concerns from most to least mentioned. This list further demonstrates the complexity of perceived risks. I have grouped these specific concerns into seven risk types in Table 2.

The first three risk characteristics have been discussed previously. *Conventional* risks are defined as those which are accepted as problematic and modelled by risk experts. Conventional risks include potential public health or economic impacts and the possibility of hazard releases which are assumed to lead to impacts. *Dread* or *Unknown* risks are defined as per expressed preference research. Next, three types of management related risk characteristics are mentioned by the interviewers. *Specific management* concerns, of which there are several, relate to the specific manner in which the ocean incineration program is administered. *General management* concerns relate to how ocean incineration is being managed in a broad context. Referring back to Hohonemser's causal structure (Figure 1) general management risk types address questions at the comprehensive or fundamental level. The third management related issue, *Minimization and Distribution* of risk is a subcategory of specific management issues, but is worthy of separate mention because -

LEAST MENTIONED <----------> MOST MENTIONED

RISK	SPECIFIC CONCERN
Conventional	Spills - routine during transportation and handling
Dread	Spills - catastrophic
Unknown	Effects unknown
Management Specific	Perceived poor management of EPA's regulatory projects • burns allowed before regulations issued • regulatory controls inadequate • liability at sea not clearly established • monitoring problems at sea
Special Geography	Gulf of Mexico site special
Management specific	Company credibility
Unknown/conventional	Inadequate technology
Conventional	Adverse economic impact
Management specific	Inadequate emergency response capability
Conventional	Potential environmental effects of air emissions
Conventional	Unsuitable port site
Management general	Lack of national hazardous waste management strategy
Special Geography	Need to protect oceans as public resource
Minimization/Distribution	Importation of outside waste

Table 2: **Public Concerns.**

Specific Concerns and General Risk Types of the Public Toward Ocean Incineration - Listed from most to least frequently mentioned. The specific concerns are taken from OPPE *op.cit.* Risk types were assigned by the author.

the issue was particularly important in the Hearing Officer's Report and it is distinguished by the equity questions involved. Finally, a *special* value is placed on the most threatened resource. Oceans are singled out as being more geographically valuable than other unnamed potential disposal areas.

The risk characteristic groupings are useful because they allow for analysis of the relevance of previous work in the expressed preferences to a real world technology. Conversely, they also permit generalization of specific ocean incineration related risk concerns into categories of wider applicability. The risk characteristic groupings applied here are

intended to be taken somewhat loosely. Arguably, one or another risk concern may fall between two groups, or other categories could be defined. Shifts of this sort, however, are assumed not to be large enough to invalidate the following observations.

- The OPPE interviewed public *is* concerned about conventional type risk. Several types of conventional risks were raised by the public as the most important risk concern.
- As predicted by expressed preference research, dread and unknown risks play a major role in the determination of riskiness.
- The management of a technology affects the public's risk assessment.
- Geographically, oceans are an example of areas which are viewed as particularly threatened.

Agencies can only address public concerns insofar as they know what they are. The OPPE's listing of public ocean incineration concerns, and the ability to generalize about perceived risk characteristics from this list, goes a long way to identify important issues and their relative magnitude.

This report, like the Hearing Officer's Report, does not address expert risk concerns - but it was not intended to. The full OPPE report addresses expert risk concerns in other volumes to be discussed in the next chapter in conjunction with other reports also prepared after public opposition to ocean incineration had been mounted.

Chapter VI

OCEAN INCINERATION RECONSIDERED

Broad based public opposition to what was once considered a fairly straightforward technological choice has produced not only a real delay in the implementation of ocean incineration but also a shift in the assessments done by federal agencies. Balancing expert and public risk concerns is the dominant theme for the next phase of ocean incineration. Three reports will be examined from this period. The first, the OPPE report, was introduced above in connection with its background report on public concerns about incineration.[96] Particular attention will be paid to the use of quantified risk assessment within the report. The second is the EPA's Scientific Advisory Board's (SAB) study.[97] The third, entitled "Ocean Incineration as a Treatment Method for Hazardous Waste" was prepared by the Congressional Office of Technology Assessment.[98]

OPPE Report

The OPPE report is by far the longest and most detailed study of ocean incineration to date. It comprises 952 pages, and six volumes, and four major subject areas including;

- Incineration technology
- Market considerations for incineration

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[96] EPA, Office of Policy, Planning, and Evaluation, Assessment of Incineration as a Treatment Method for Liquid OrganicHazardous Wastes:Background Report V: Public Concerns Regarding Land-Based and OceanBased Incineration., 1985

[97] U.S. Environmental Protection Agency, Scientific Advisory Board, Report on the Incineration of Liquid Hazardous Wastes, 1985

[98] U.S. Congress, Office of Technology Assessment, Ocean Incineration: Its Role in Managing Hazardous Waste, 1986

- Comparisons of risks from land based and ocean based incineration
- Public concerns regarding incineration

The report attempts, for the first time, to explore fully incineration technology as a treatment method of hazardous waste. It was published in March 1985, more than 11 years after the first commercial scale burn in U.S. waters. It is also the first report to incorporate a quantified risk assessment model into the overall assessment.

Quantified Risk Assessment as Hazard Assessment

The use of a quantified risk assessment model is significant. It is part of a larger movement within EPA to base environmental policy on risk priorities - quantified values of threats.[99] The use of quantified risk information tends to reduce the importance of many social factors which the public considers during the assessment of a threat. In this specific case, the threat from ocean incineration is functionally equated to the anticipated increase of cancer deaths. This risk, cancer mortality, was not even directly mentioned by the public in either the Hearing Officer's or OPPE's public opinion reports.

When Ruckelshaus was reappointed to administer the Agency in 1983 he supported increased use of quantified risk assessment for two main reasons:[100]

- Quantified Risk Assessment allows for comparison and prioritization of hazards. EPA's need to prioritize became apparent as the number and complexity of environmental statutes and regulations it was responsible for grew. Moreover, the number of chemicals known and in commerce is phenomenal.
- Quantified Risk Assessment has been recommended as an apolitical method of assessment. The rationale being that because risk models stop short of making tolerability judgement they are apolitical.[101]

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99 Jorling, Thomas C., The Future of Public Waste Disposal, 1986

100 See William Ruckelshaus in U.S. Environmental Protection Agency, Risk Assessment and Management, 1984

The inability of risk assessment used for public policy to be apolitical was discussed in chapter two and need not be repeated. The discussion can be furthered, however, by looking at the specifics of the OPPE's quantified risk assessment for bias.

The quantified risk assessment performed by OPPE attempts to place a numeric value on the risks from ocean and land based incineration[102]. Two waste streams, Polychlorinated biphenyls (PCBs) and Ethylene dichloride (EDC) are selected for the analysis for several reasons.[103] The cancer and marine toxic and bioaccumulative risk for the compounds was felt by OPPE to be relatively well known. They are typical of wastes to be burned. They have different dispersion characteristics in the environment. EDC floats and volatilizes rapidly. PCBs sink, persist and bioaccumulate.

The theoretical end result of the quantified risk assessment model is a number which represents the summation of all probable impacts due to exposure to ocean incineration. For this model the impacts considered had three dimensions - the release point for wastes, the specific type of waste and the type of impact considered. These dimensions were broken up as follows:

Release Point

- land transportation
- transfer and storage
- ocean transportation
- incineration (including disposal of scrubber water)

Waste Type

- unburned waste
- products of incomplete combustion (PICs)
- Metals
- HydroChloric Acid

Impact

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101 National Research Council, Risk Assessment in the Federal Government: Managing the process, 1983

102 U.S. Environmental Protection Agency, office of Policy, Planning and Evaluation, Assessment of Incineration as a Treatment Method for Liquid Organic Hazardous Wastes: In 5 Volumes, 1985

103 EPA, Office of Policy, Planning, and Evaluation, Assessment of Incineration as a Treatment Method for Liquid Organic Hazardous Wastes: Summary and Conclusions, 1985 , p.73

- Human Health
  - Acute
  - Chronic
- Environmental health
  - acute
  - chronic

The model does not attempt to fill each cell. Some cells, such as release of PICs at any point prior to combustion, are irrelevant. Others, such as the chronic or acute impact of incineration on terrestrial ecosystems were dismissed because of the lack of data. Still others, such as any releases due to the land transportation component of incineration were not analyzed because it was assumed that the risks would be comparable between the technologies.

Given the dismissals or cursory treatment of some impacts, the overwhelming emphasis of the model lies in a comparison of the increased mortality due to cancer of the "most exposed individual" (MEI) to chronic stack release as summarized in Table 3.

Location	PCB Waste	EDC Waste
Land Based System		
Texas	2.37E-5	2.63E-5
Arkansas	3.25E-5	3.65E-5
Ocean Based System		
Coastline	6.37E-7	1.06E-6
Chickasaw, Alabama	2.02E-8	4.97E-10

Table 3: **Summary of Incremental Human Health Risks to Most Exposed Individual (MEI).**

Author's Note: Numbers are expressed in terms of increased probability of mortality due to probable incineration activity. Various sites are selected to represent expected highest risk areas.
Source: OPPE Report, Number 4, Exhibit 8-5, p.178; for discussion of units see OPPE Report, Number 4, Vol 2, Appendix D for land based systems; and Appendix G for ocean based systems.

Stated verbally, the expected increased risk of dying due to the operation of a land based hazardous waste incinerator ranges from 3 chances in 100,000 to one in one million. Incremental risks due to ocean incineration range from one in one million to six in ten million at the coast and less than two per 100 million at the port facility. The report goes on to compare these results with the overall risk of air toxics in the country - given at four to six chances in ten thousand.[104] Accordingly, the risk of incineration systems to the MEI is *three orders of magnitude lower* than the overall risk to the general public of air toxics.

Three orders of magnitude (1000 fold) is a tremendous difference. Given that difference, it is surprising that the public opposition could not be calmed by the figure. This can be explained by the differences in risk perception between the public and experts. The model's final analysis does not incorporate the many factors which have been outlined as important to the lay public. The model places more faith in the EPA than the public does, for example, when it makes the statement:

> Releases from land based incineration can also include scrubber wastes containing substantial quantities of Cl and metals. Because the disposal of scrubber sludge, brine and waste water are regulated by the EPA uncontrolled releases of these materials in hazardous form seems unlikely.[105]

Regulations, no matter how stringent, are not taken by the public at face value as being adequate to protect health and environment.

A second assumption which is indicative of the model's optimistic risk picture relates to the storing and loading of wastes for ocean incineration. The model assumes that Chemical Waste Management's Emelle, Alabama facility would be replaced by a new integrated storage facility at Chicksaw, Alabama. Through a sensitivity analysis, rerunning the model under different numeric conditions, it is estimated that the Emelle facility would

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104 U.S. Environmental Protection Agency, Office Air and Radiation and OPPE, The Magnitude and Nature of the Air Toxics Problem in the U.S.Draft Report, 1984 as cited in OPPE *op.cit.*

105 OPPE Report, Vol 4, *op.cit.*, p. 6-12

lead to 60% greater releases for the land transportation section, slightly more than double the releases due to pump failures, and more than seven times greater fugitive emissions than the Chicksaw facility.[106]

There are three reasons that the assumption of a new storage/transfer station are troubling. First, given the difficulty of permitting any hazardous waste facility, let alone one associated with ocean incineration, it is quite possible that local political opposition could stop the permitting at Chickasaw. In that case the relevant risk figures would be as those for Emelle. Second, the release data generated for Chickasaw is entirely hypothetical. Empirical data from the facility may be quite different. The third reason is the most significant but least obvious. The investment in a new, large scale facility explicitly for ocean incineration would tend to favor the technology as a fairly long term solution to the liquid hazardous waste problem. As established by the OPPE public opinion report the public is concerned that ocean incineration not interfere with the development of less environmentally threatening treatment methods or the phasing out of untreatable hazardous materials.

The adequacy of the quantified risk assessment model to the lay public can be derived even though there are no published comments. The model does not account for several factors which lay persons find important. The assumptions necessary to produce results for a quantified model run contrary to the lay person's concern over unknown risks. Moreover, some of the assumptions about management or conditions are not acceptable to the public. The single mortality number de-emphasizes distributional aspects of risk and negates equity questions involving the voluntariness of risk. The ocean's perceived "special value" is not explicitly dealt with. In conclusion, it can be said that lay persons are as disinclined towards the quantified risk approach as expert assessors are of public opinion surveys.

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[106] *ibid.*, pp. 4-8

The quantified risk assessment is a step forward from an expert risk assessment perspective. This quantified risk assessment model is the first attempt to quantify the risk of ocean incineration in terms of mortality. If the results from this model are taken to the next step in the process, the judgement of tolerability, we see that they can be most efficiently used in risk cost benefit analysis. If one assigns a value to a human life, it becomes a simple matter to utilize mortality statistics directly in a cost/benefit equation. Even if one does not assign a dollar value to the life, the mortality figures can be used in a comparative sense with other technologies for which such information is available. This emphasis toward RCBA is evidenced in the broader OPPE report insofar as a complete market analysis is included for land and ocean incineration.[107]

The overall strength of the OPPE report lies in the credible efforts to assess both quantified risk and public opinion. For the first time EPA acknowledged the importance of both expert and lay opinion and made a concerted effort to define each. It is also the first time that the agency published a broad assessment of the technology rather than a report specifically linked to an ocean incineration proposal.

It is significant that this report is both discretionary and reactive. There is no legislation which forced the EPA to prepare the report, not NEPA, not MPRSA. The Agency acted in response to the tremendous amount of public pressure applied at the various hearings on specific incineration proposals. As such, the reports are a more direct response from an agency than generally seen. Usually the public pressure is applied on Congress which passes laws to direct the agency. In this case no laws, either on the use of risk assessment or on ocean incineration, have been passed to date.

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107 EPA, Office of Policy, Planning, and Evaluation, Assessment of Incineration as a Treatment Method for Liquid Organic Hazardous Wastes: Background Report III: Assessment of the Commercial Hazardous Waste Incineration Market, 1985

SAB Report

The EPA's Scientific Advisory Board report provides a unique point of contrast to the OPPE report. Superficially, the reports are similar, given that they have the same trigger. Administrator Ruckelshaus approached the board in 1983 asking for an analysis of the human health and environmental effects of ocean incineration and a few months later Deputy Administrator Alm expanded that request to include land based facilities. The approach of the SAB and the resulting report are, however, somewhat different.

The differences can be explained in large part by the differences in the mission of the group. The SAB was established by NEPA as a semi-autonomous group to give the EPA technical scientific advice on complex issues at the request of the Administrator.[108] The members of the SAB were to be independent of the agency and therefore more forthright. The OPPE is closer to the management decisions of the Agency. The Office is responsible for budgetary matters as well as more abstract policy.

The scope of the assessment performed by SAB is not unlike that used in the OPPE report for the quantified risk assessment. The committee delineated five steps within the incineration process which could yield releases to the environment and examined the ramifications of each. To this list they also added a separate analysis of the research needs for proper incineration management.

The procedure, however, is quite different from the quantified risk model. Instead of trying to quantify the probability and impact of releases at each step, the SAB analyzed and criticized previous attempts at quantification. Possible sources of error were discussed in considerable detail. For example, several reasons were given to shift from a reliance on Destruction Efficiency (DE) of the Principal Organic Hazardous Constituents (POHCs) at optimal operational conditions as a measure of hazardous stack releases to a method which would incorporate PICs and upset conditions.[109]

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[108] 42 U.S.C. 4365

[109] U.S. Environmental Protection Agency, Scientific Advisory Board, Report on the

Many of the sources for this report were personal interviews with and correspondence with and among EPA personnel. The SAB was also in communication with the OPPE during the period in which it drafted its report. To a certain extent, the information gathered by OPPE was in response to the criticism raised by the SAB. For example, the quantified risk assessment model endeavors to assess the releases from fugitive emissions from all phases of waste management for each technology. This is the first of 12 major recommendations made by the SAB. The full extent to which the OPPE report and subsequent EPA action has fulfilled SAB's recommendations, while of interest and bearing to this study is beyond its scope. The recommendations have complex implications for EPA's administrative structure and the legislation which guides the management of hazardous waste.

The SAB report's review process was not open to the extent that reports were not circulated and commented on. Despite this, the analysis and recommendations respond to many public and expert risk concerns. Many of the public's specific and broad management related concerns were addressed in the report, including the reactive nature of agencies and the problems created from managing programs with overlapping and unclear bureaucratic oversight. Expert concerns for the quantification of releases and appropriate baseline and monitoring information were also discussed. The key factor in creating a report which satisfies both public and expert concerns seems to be the independent *ad hoc* nature of the committee which generated the report.

SAB's report is the most management oriented of all the assessments. It assesses EPA's assessment and management rather than directly assessing the technology. As such it plays a specialized role in the development of ocean incineration assessment. The final report reviewed here uses this specialized information and the detailed risk information provided by OPPE, among other sources, to produce a broad risk assessment that places weight on both public and expert risk perception.

Incineration of Liquid Hazardous Wastes, 1985 pp16-20

OTA Report

The Office of Technology Assessment (OTA) is a Congressional agency established by the Technology Assessment Act of 1972.[110] OTA's purpose is to provide objective analysis of major public policy issues related to scientific and technological change. OTA staff works closely with congressional and agency staff to ensure that major concerns will be addressed. Each project is overseen by a panel of experts from the field studied to ensure objectivity.

In 1984, the Congressional Office of Technology Assessment was requested to perform a report on the role of oceans as a waste disposal medium by the House Committees on Merchant Marine and Fisheries and on Public Welfare and Transportation. The Senate Committee on Commerce, Science and Transportation also endorsed the study. Later the House Science and Technology Committee requested a more full report specifically on ocean incineration. As such, this represents the third discretionary report prepared in this period. The resultant publication was published in August 1986.[111]

Procedurally, the OTA study is similar to SAB's report. An *ad hoc* committee of experts was established to communicate with regulators, the industry and the public on the relevant factors concerning the role of ocean incineration in hazardous waste management. The report synthesizes the comments from these various groups and draws conclusions and makes recommendations from them. As such, it has no formal outside review process but, theoretically, incorporates outside comments directly into the report.

The OTA report differs from the SAB report, and all others reviewed, both in its scope and presentation. This is the first report to assess the appropriateness of ocean incineration at a "comprehensive" as well as a technological level.[112] For example, this report

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110 86 Stat 797; 2 USC 472

111 U.S. Congress, Office of Technology Assessment, Ocean Incineration: Its Role in Managing Hazardous Waste, 1986

112 See Figure 1

questions the effect a full scale ocean incineration program would have on other emerging technologies for liquid organic hazardous waste. The report also places ocean incineration firmly within the context of hazardous waste management generally by referring to two other OTA reports, the then as yet unpublished study of oceans as a waste space[113] and *Toward Serious Reduction in Hazardous Waste.*[114] The discussion of policy also follows this broad plan. Both the general management recommendations brought up in the Hearing Officer's report and the technical recommendations of the SAB and OPPE are reiterated. Attention is also paid to the recommendations of the international community based on the North Sea experience. Extant legislation governing aspects of ocean incineration is laid out with various proposals about how it could be changed.

The OTA report, more than any other, goes beyond balancing risk perspectives - it communicates them. The visual and written style present expert risk information in a manner which is understandable to the lay public. For example, its concise and more readable style contrast sharply with the OPPE report, even though the OPPE report is the source for much of its information. Similarly, the style of the report conveys public risk perception in a manner to be appreciated by risk experts. This report corrects two flaws which prevented maximum risk communication in previous reports. The OPPE reports and the HOR reports dealt with public risk perception as a largely distinct issue, written under separate cover. EIS's and the SAB report did not consciously identify and analyze the lay perspective within the context of the larger assessment.

The differences between the OTA report and previous assessments follows from the differences between legislative and administrative agencies. Congress as a legislative body is less concerned with details than the EPA. Congress is also more directly accessible and therefore accountable to both the lay public and experts and therefore has an incentive to

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[113] U.S. Congress, Office of Technology Assessment, Wastes in the Marine Environment, 1987

[114] U.S. Congress, Office of Technology Assessment, Towards Serious Reduction in Hazardous Wastes, 1986

understand both perspectives. Moreover, the representatives themselves are not likely to be as well versed in the issue as agency experts. Therefore, any report prepared to advise them must be written in a clean, readable form.

The effect of the OTA's scope, organization and presentation should please both public and expert risk assessors. From a lay person's perspective the report is desirable because it includes discussion of specific and broad management issues which may effect risk and a discussion on alternative technologies. The inclusion of OPPE's quantified risk assessment main results would please expert risk assessors. Moreover, the report contains a thorough discussion of waste streams, current disposal options, emerging technologies and incinerator technology itself. This basic information, necessary to judge the relative importance of ocean incineration - to weigh against risk in judging the tolerability of ocean incineration - has been omitted in other reports.

Summary of Agency Balancing Period

In evaluating the incorporation of public vs. expert risk assessment for the three reports, as opposed to the four reports discussed during the viable option period, one is struck by the similarity among the reports. Though they present information from slightly different perspective - OPPE most technical, SAB most conscious of the relationship between assessment and management, and OTA most concise and well written - all three reports endeavor to balance public and expert risk perspectives.

This consistency can be explained by reiterating the similarity of the factors which influence the balance for these reports. Each was prepared on a discretionary basis, using an *ad hoc* committee removed from the direct management of ocean incineration. Each report assessed the technology as a whole, and therefore was influenced by the same set of relevant facts. Moreover, they were prepared almost concurrently, so the public mood toward ocean incineration remained constant.

Public opinion is given considerable weight in these reports. This is not surprising given that discretionary requests for these reports were driven by the tremendous public opposition voiced toward ocean incineration since the Brownsville hearing. The preparation of these assessments represents a more direct response to the public than is generally seen from agencies - which normally act from legislative mandates.

The reports prepared during this balancing period are more removed from the management process than other reports. Unlike EIS's which are prepared and guided by agencies with a specific proposal in mind, or reports which were generated in connection with specific burn permits or the development of a regular ocean incineration program, these reports were prepared by *ad hoc* committees not directly connected to the EPA's office of Water which developed regulations. The assessment process has moved from industry to agencies with regulatory capacity and finally to oversight agencies. From the public's perspective this movement represents a formal acknowledgement of lay concerns.

Expert risk assessment also advanced during this period. A quantitative risk assessment was used for the first time. This model generated numbers representing the probable increased human health risk to a theoretically most exposed individual due to ocean incineration. Expressing the risk of ocean incineration as such, a probable mortality figure, allows for comparison with other mortality figures from other hazardous activities. Mortality figures are also easily used as part of a Risk/Cost/Benefit Analysis. It was noted that the risk of incineration to the Most Exposed Individual as determined by the model is three orders of magnitude lower than the overall risk to the general public from existing levels of toxic air pollutants.

This period of ocean incineration assessments can best be summarized by stating that the assessments were more balanced and more weight was placed on both sides of that balance. By increasing the weight of public opinion the agency could justify - as a success - later actions to curtail its ocean incineration program because the overall assessment of

the technology is more negative. Increasing the weight of expert opinion could serve to justify the agencies' past action and to try to change public opinion. As has been discussed, however, the public does not use mortality figures as a primary measure of riskiness. It is, therefore, understandable that public opinion was not mollified.

Withdrawal from Ocean Incineration

The fourth, seemingly final, phase of the ocean incineration process has no reports prepared by federal agencies. Ocean incineration has been extinguished, at least for the moment. The defeat of ocean incineration in the U.S. was preceded by several actions. In November 1985, At-Sea Inc. defaulted on $68 million in MARAD loans to build two incinerator ships. The Apollo I was 90% complete and Apollo II was 60% complete when the company filed for bankruptcy. During the period when the technology was being reconsidered by agencies four permits were tentatively issued and denied due to public opposition. In May 1986, EPA decided not to grant *any* permits until it successfully issued rules on ocean incineration. Then there was a long pause while the remaining companies waited for EPA to promulgate final regulations. Chemical Waste Management Inc., owner of Vulcanuses I and II, the only ships to operate in U.S. waters, sued the EPA to force the agency to consider a permit pending on the regulations issuance. On September 16, 1987 the judge ruled that the EPA could defer a decision on the permit.[115]

The defeat of ocean incineration followed precipitously. On December 23, 1987 Chemical Waste announced withdrawal of interest in the American market.[116] EPA soon announced that it was examining eliminating the ocean incineration program questioning its need and whether adequate funding was available.[117] The only remaining industry interest is by Sea Burn Inc., division of Stolt-Nielson Inc., but that is only a

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115 *Waste Management Inc. v EPA*, DC DC, No.86-3356

116 BNA Environmental Reporter 1-15-88, p.2015

117 *ibid.*

"paper" proposal as the company has no ships, only plans. Moreover, Seaburn's interest is also linked to a judicial attempt to force EPA to promulgate regulations.[118]

EPA's withdrawal of its ocean incineration program represents a 180 degree shift in the agency's attitude toward the technology. Recall that in 1973 when the agency was approached by Shell Chemical to develop regulations on ocean incineration, the agency stated that it had no authority to do so because the activity was not really harmful enough to constitute ocean dumping. In refusing to promulgate final regulations under MPRSA, the agency implied that it feels ocean incineration is *too* potentially harmful to be allowed in U.S. waters.

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[118] *Seaburn Inc. vs. U.S. EPA* filed March 9, 1988 DC, DC.

Chapter VII

CONCLUSIONS

Ocean incineration's hazard assessment process has shown itself to be both varied substantively and subject to complex factors. Through the course of the 15 years of U.S. ocean incineration history, agency assessments have generally concluded that the technology is a sound and desirable treatment method, while the public has expressed grave reservations about ocean incineration. The weight placed by the agencies on public and expert hazard opinion has shifted.

It was hypothesized at the beginning of this study that these shifts were influenced by the relative strength of public/environmental and private/industrial interest groups. This general hypothesis was broken up into four subproofs to facilitate discussion. First, that a correlation exists between hazard perspective and the interests of groups. Second, that the balance of hazard perspectives by agencies is influenced by certain factors, including: mandated review processes, the legislatively defined scope, the reactive nature of agencies, and the agencies' distance from the management process. Third, that the change in balance over time corresponds to changes in the relative strength of the interest groups. Finally, that agency actions were discretionary, and not forced by changes in the legal or factual settings. The purpose is to examine how the political setting affects the process of hazard assessment.

Correlations Between Hazard Perspectives and Interest Groups

The manner in which agencies balanced expert and public hazard opinion within the individual reports was influenced by the relative involvement and strength of opposing interest groups at the time. It was hypothesized that the hazard opinion of the participating public and environmental groups in the ocean incineration controversy would resemble that predicted by research into expressed preferences of general risks by the lay public. Further, it was hypothesized that industry would try and couch the argument of ocean incineration in a manner similar to risk experts. In the next two sections it will be demonstrated that these correlations exist empirically.

Public Hazard Assessment

Reviewing the hazard assessment reports has shown us that the portion of the lay public which was vocal in the ocean incineration controversy was indeed concerned with social values as predicted from Expressed Preference research. The public is concerned with the "dread" risk of ocean incineration as evidenced by the public's preoccupation with the risk of a catastrophic spill - an accident which would release hazardous material into a fertile estuary. Similarly, the public worries about several "unknown" aspects of the technology, the quantity and effect of PIC's, and the effect of pollutants on the surface microlayer, and the cumulative impact of ocean incineration pollutants and other pollutants at sea.

The case study of ocean incineration has, however, expanded the risk characteristics important to the lay public from those predicted in theoretical Expressed Preferences research.[119]

- *Conventional risks*, those modeled by risk experts, do play a role in the public's overall risk determination. The public and experts were concerned about the human health impacts from routine spills and air emissions. The substantive emphasis of the public on conventional risks is, however, limited. This is evidenced by the mini-

[119] See Table 2

mal impact made on the public by OPPE's quantified risk assessment model. Public opposition was not swayed by finding that the risk of incineration systems to the MEI is three orders of magnitude less than the overall risk posed by toxic air pollution.

- *Management issues* are evaluated by the public at several levels - from company credibility and emergency response routines to the importance of a national hazardous waste management strategy. Moreover, the public was concerned that risks be distributed and minimized across the country. EPA's perceived poor management of its ocean incineration regulatory program figured high in the list of risk concerns.
- *Geographic specialness* of the oceans as a unique natural resource also contributed to the public's risk perception of ocean incineration.

Of all the risk characteristics used by the public, the importance of risk management to the public is most significant to the hypothesis that political considerations influence agency assessments. As established in the section on hazard assessment theory, the management of environmental hazards is inherently political. The linking of assessment and management in the public's mind supports the statement that the assessment process is also political.

Industry/Expert Hazard Assessment

Risk experts and industry proponents were hypothesized to use *quantifiable asocial* risk information. The examination of agency hazard assessment reports has shown that the reports with the least consideration of social factors and the most quantification have indeed tended to side with proponents of ocean incineration.

Let us first re-examine the correlation between reports that do not consider social factors and those which are pro-ocean incineration. Chapter 4 concluded that during the viable option period there was a direct correlation between the extent the reports omitted

social factors and the overall industry advocacy position of the report. The reports which followed also correlate directly. The public opinion reports, which are extensively weighted toward social concerns, are the least favorable to ocean incineration. The quantified risk assessment study performed by OPPE did not model social factors in any systematic way and also came to a pro-industry conclusion. The three reports prepared during the reconsideration of ocean incineration: OTA, EPA's SAB, and the overall OPPE report - while they considered many social factors, did not come up with a strongly negative position. This is in part because the quantified expert risk information counterbalanced the public risk perspective.

The correlation between industry and expert risk perspectives with respect to the quality of quantified information was hypothesized to be limited. Industrial proponents are interested in supplying adequate information to provide decisions to be made according to RCBA or Natural Baseline methods. The data which has been gathered on: the combustion efficiency, concentration of pollutants in the environment, possible human health or biological harm due to those pollutants and the probability and impact of spills; have largely supported industry claims of the relative safety of the technology.

Industry evaluation, however, did differ from the perspective of academic risk experts in the acceptable quality of the research as measured by:

- the extent of quantification
- the relevance of the information
- the thoroughness of the substantiation

Disagreement existed between risk experts and ocean incineration proponents on the extent of quantification in the MARAD EIS. MARAD, acting as an industry advocate in its position to grant vessel loans, disregarded comments from outside risk experts at NSF to create a risk probability matrix including the risk of spills, to evaluate the proposal which would allow for ordinal comparison of risk data. Irrelevant risk data on the lack of

impact that ocean incineration would have on stratospheric ozone and regional acid rain was prepared by industry for incorporation into EPA's FEIS for the Gulf of Mexico. Poorly substantiated industry information was presented in the Shell Burn report where only one industry source was used as evidence that ocean incineration would not have an impact on migratory birds. Throughout the viable option period there is evidence that the agency was inclined toward the industry position insofar as reports included risk information as above. The reports reflect industry rather than expert risk perspectives in these cases.

The correlation between hazard perspectives and interest groups has been established and refined. The public which became involved with ocean incineration has used risk factors as predicted from expressed preferences research in addition to other social factors. Industry proponents have used quantified risk data to argue in favor of ocean incineration. The range of threats considered by industry and experts has also been narrower than those considered by the public. The differences between the public and expert risk perception have been shown to be great both in theory and for an actual case study.

Factors Influencing the Balance Between the Public and Experts

For each hazard assessment report the balance between expert and public risk opinion made by the agencies was discussed in the text. Four significant observations were noted on the factual, legal, administrative and political factors which influence the balancing process.

1. The mandated review process has a substantive effect on the incorporation of public vs. expert opinion.
2. The legislative framework for an assessment influences the balance of public and expert opinion by partially determining the scope of hazards to be considered.

3. Agencies balance hazard perspectives in a reactive manner - they are dependent on the involvement of interest groups.

4. Agencies with significant management responsibilities tend to produce less balanced reports than those which are removed from managing the technology.

The implications of these statements provide proof that agencies are influenced by political pressure during the risk assessment process.

Mandatory Review Processes

The mandatory review processes for ocean incineration are dictated by NEPA and the MPRSA as interpreted by the courts. NEPA requires that: draft EIS's be circulated to a select group of individuals including those from public interest groups; that the agency hold open meetings where oral statements can be made and that written comments be accepted and responded to in the FEIS. Comparison of the three EISs prepared during the viable option period with the Shell test burn report has shown that the NEPA review process has substantive positive effect on the incorporation of lay public opinion - when expressed. NEPA was shown to have less of an effect on the incorporation of expert opinion. There is no legislative requirement which forces the use of quantified information.

The effect of the mandatory review requirements of the MPRSA is less pervasive but also significant. Note here that this study has limited itself to the review requirements of the assessment process and does not deal with the review requirements of proposed or promulgated regulations. The interesting review requirement for our purposes is that of the Hearing Officer's report. The MPRSA legislates that an EPA officer compile public concerns and make recommendation from the hearings held on pending ocean incineration permits and make the report available to those who request it. Analysis of a sample report has shown it to be the most heavily weighed toward public opinion of all of the reports.

Legislatively Defined Scope

As with the mandated review processes, the two major pieces of legislation triggering agency ocean incineration hazard assessments play a significant role in defining the scope, and hence, in determining the balance. NEPA confines discussion of the potential hazards to the technological choice level as described by Hohonemser in Figure 1. Moreover, EIS's deal with specific proposals - often limiting discussion of infrastructural impacts. Public opinion is inclined to desire a broader consideration of risks whereas experts often focus on a more narrow interpretation of a hazard's cause. Therefore, within the context of an EIS it is difficult to fully account for concerns of either the public or the experts.

The MPRSA and associated regulations have similarly defined the scope of hazards to be considered by agencies and thereby affected the balance. Notably, the three sets of general ocean dumping criteria cast considerable weight on economic factors in the determination of ocean incineration's acceptability. These criteria were not developed for ocean incineration and differed from the types of concerns raised by the public in hearings and interviews. Beyond weighing economic factors, the sets of criteria also emphasized factors for use in Natural Baseline risk determination.

Reactive Nature of Agencies

While agencies are under legal obligation to perform certain procedural reviews, as described above, the substantive impact of the review process has been shown to be dependent on the involvement of the relevant interest groups. Neither the legislation nor court interpretation requires that the Agencies search out and pro-actively balance public and expert risk concerns. Rather, as is evidenced by different balances under the same legislative trigger, the weight is affected by the amount of public and industry involvement. Initially, public opposition was not well organized - the MARAD EIS, for example, was not commented on by any environmental group and minimal comments were made by

coastal states. The MARAD FEIS reflects the least concern with public opinion of all the EISs.

Agency Distance from Management Process

There is a direct correlation between an agency's distance from interest in the outcome of ocean incineration and the quality of the balance of expert and public opinion within the report. Quality is defined here as placing equal and considerable weight on both public and expert perspectives.

This is an important observation and one that requires considerable comment. Agencies with a direct stake in the management outcome of the technology produce biased reports in favor of the technology and do not give adequate weight to public concerns. The MARAD report is the best example of this phenomena. Once the decision had been made internally to loan At-Sea Incineration $64 million, MARAD was intimately involved with the success of ocean incineration. The failure of the technology and consequent bankruptcy and default on the loan would, and did, reflect poorly on MARAD.[120] The Agency's interest in promoting the technology is reflected in the report which devalues public concerns.

The other end of the spectrum, agencies without a predetermined management interest in the technology, is occupied by the Air Force and OTA. The Air Force's primary motive as owners of stockpiles of Agent Orange, was in finding the best, safest, and cheapest disposal method. They did not know much about any specific technology before beginning the search, nor did they have an administrative reason to consider ocean incineration above any other technology. The Air Force report was particularly noted among all of the reports prepared during the viable option period for considering both expert and public hazard perspectives in depth.

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120 Howard Kurtz and Michael Iskoff, "The Sinking of $64 Million: Taxpayers Lose as Incinerator Ship Loans Founder.", Washington Post Weekly Edition, December 9, 1985, p33.

OTA was designed to be removed from the management process. It is responsible to Congress and not to an administrative management agency. Moreover, because each report is written by a different *ad hoc* group of specialists in the particular field, no long term tie can develop between the assessors and the managers. Again, as with the Air Force report, this report was noted as the most balanced among the three contemporary reports.

EPA's stake in the outcome of ocean incineration lies somewhere between these two points. EPA's general mission is to manage environmental hazards and specifically to enforce the MPRSA. As a manager the Agency is responsible to institute the programs which it feels - as a risk expert - are least harmful to the environment. Yet the Agency is also responsible to manage hazards according to public opinion. This dual role for EPA is reflected in the range of balances achieved by various departments within the Agency. The Office of Water and Hazardous Substances, which is directly concerned with the promulgation of ocean incineration regulations, produced the Shell Burn Report and the Gulf of Mexico FEIS, both of which were more weighted toward expert rather than public opinion. OPPE and SAB, which are not directly involved with regulatory matters prepared more balanced assessments.

This observation, that an agency's management role has a substantive effect on the outcome of an assessment provides yet another link between hazard assessment and hazard management. As shown in the theoretical section, the environmental hazard management process is inherently political. The closer the bureaucratic link between these two processes, the greater the opportunity for the assessment itself to become politicized.

In summary, We have seen that the agency balance of expert and public opinion is affected by several legal/bureaucratic factors. Agencies operate within a legal framework which affects the assessment process by defining the review process and scope of threats

to be considered. Within the same legal framework an agency may vary the amount of weight placed on public or expert risk opinion dependent on the amount of outside involvement of interest groups. The review processes are established to make agencies react to expressed opinion rather than for agencies to shape opinion. Finally, various agencies may weigh a technology differently dependent upon how intimately involved the agency is with the management of the technology. Where an agency has a stake in seeing the technology succeed, public concerns tend to be devalued.

Changes in Balance Over Time

The history of ocean incineration in the U.S. can be divided into four temporal phases - viable option, public opposition, reconsideration and withdrawal. These phases which are somewhat overlapping can be distinguished by the differences in public mood toward ocean incineration at the time, and differences in assessments prepared by federal agencies. There is a strong correlation between the relative political strength of the ocean incineration interest groups and the consideration of their respective hazard perception within the agency reports. The reports present subtle changes in the scope of hazards and types of information gathered over the entire assessment period. This progression is reflective of increased public involvement and concern.

Viable Option

With the passage of the MPRSA in 1972, direct ocean dumping of liquid hazardous wastes was prohibited. Industries which had previously dumped these wastes at sea were forced to find a new treatment method and consequently ocean incineration became a viable option. Industry presented proposals to EPA and tried to establish this new means to solve their waste disposal dilemma. Meanwhile the public had yet to become involved with the issue of ocean incineration. Neither issue specific, well organized local organizations,

nor general national environmental organizations had taken up the cause during this phase. State governments, off whose coasts the wastes would be burned and through whose ports the waste would be transported did not initially object to the technology, even though they were contacted during the EIS process for the Gulf of Mexico site designation.

The federal government's response to this lopsided initial involvement is apparent in the hazard assessment reports. Concerns which the public would later come to express were for the most part not dealt with in these reports. The scope of hazards of ocean incineration were limited to: specific proposals, normal operating conditions, emissions and routine spills. Impacts of concern were: human health considerations and damage to the marine environment - particularly economic damage to fisheries or beaches. When the environmental hazards were evaluated in this way, the technology appeared to be particularly promising.

Management action taken on the part of federal agencies was based on the assumption that the technology was viable. EPA allowed Shell Chemical to burn 8400 tons of waste during the determination of the technology's safety. MARAD granted a $64million loan for the construction of two ocean incineration vessels. The Air Force burned 2.3 million gallons of stockpiled Agent Orange. Moreover, EPA permitted four other commercial sized burns on a research basis and began to establish ocean incineration as a routinely permitted activity.

Public Opposition

Just as the first phase of ocean incineration's history can be characterized by federal agency reaction to industry action, the second phase can be characterized by public reaction to agency action. Quite rapidly, and without a single clearly identifiable reason, public opposition to ocean incineration became apparent. It is, however, clear that the public only became involved after industry and agencies had made an initial acceptance of the technology and acted accordingly.

The reports prepared and examined during this phase try to characterize public opposition. The scope of risks considered by the public was found to be broad with substantial emphasis on the impact of management and the special value of the oceans as a natural resource. Public hearing records and personal interviews of public ocean incineration opponents were compiled during this period to fully understand the socially perceived hazard presented by ocean incineration.

Public opposition to ocean incineration began to affect management decision toward the technology during this period. Delays began both on pending permits, proposed regulations and formal assessments.

Reconsidering Ocean Incineration

The third phase of ocean incineration differentiates itself from the second, because during this period agencies actively internalized the concerns of the public within their assessments. Public opposition had not diminished. The three reports from this period strongly incorporated both expert and public risk perspectives. The reports treat ocean incineration broadly as a treatment method of hazardous waste and discuss a wide range of alternatives. Management issues are raised. On the other hand expert risk evaluation was also advanced - particularly through the use of quantified risk assessment model.

Notably, the reports during this phase were not prepared by agencies with a direct managerial role for ocean incineration but rather on a discretionary basis by oversight agencies. This shift in the assessments away from the more technical branches of EPA toward the policy branches of EPA and the technical branches of Congress had a substantive impact on the process and outcome of the assessments. Assessments by these bodies incorporate more social factors in keeping with the authoring agency's general goals.

The technical branches of EPA remained in a holding pattern while waiting for the oversight agencies to resolve the ocean incineration controversy. Inaction continued on

permits and final regulations for routine incineration permits were not promulgated. Industry turned to the courts to try, ultimately unsuccessfully, to force action. EPA's action on ocean incineration was blocked by political pressure mounted by public opposition. EPA could not, however, cave in to public pressure entirely because according to its own expert technical assessments, ocean incineration was still a viable option. Therefore, the agency waited until one of the major external interest groups shifted position.

Withdrawal

Delay in the promulgation of regulations, the refusal of EPA to grant permits before promulgating regulations, and a court decision supporting agency inaction, finally caused the major industrial proponent of ocean incineration to withdraw from the U.S. market in December 1987. EPA then formally withdrew from further plans on an ocean incineration program citing a lack of industry interest. This was a management action on the agency's part and was not accompanied by any formal hazard assessment report.

The final withdrawal of ocean incineration as a viable treatment option for liquid hazardous wastes allows one to make observations on the pattern of the assessment process as a whole - rather than at a micro-level through individual reports. Initially, in response to heightened levels of risk intolerability expressed by outlawing direct ocean dumping, industry was the first to become involved in the assessment process. The lay public was unaware and unconcerned about the technology. Agencies proceeded to consider ocean incineration as a viable option based on expert risk information. Increased public opposition brought about a broadened discussion of hazards considered and a formal acknowledgement of social concerns.

Two trends are particularly significant over the history of ocean incineration which demonstrate the political nature of the assessment process. First, we have seen agencies increasingly incorporate social concerns as the public opposition to the technology grew.

Second, we have seen the assessment process move further away from the managerial agencies as public objections increased.

Changes in Balance - Discretionary

The changes in balance of expert and public risk perception seen in Agency assessments over the course of the U.S. history of ocean incineration have been discretionary. These changes are not a response to the other branches of government. The legal framework triggering assessments has not changed. Neither has the factual setting surrounding ocean incineration changed significantly.

The two laws governing the ocean incineration assessment process have not been changed by Congress or Court interpretation. NEPA, which serves as the legal requirement, or "trigger", for many of the assessments has not been radically amended since its passage. Similarly, the relevant passages of the MPRSA have remained intact. Congress, though it has held hearings on the issue[121] has not passed any legislation dealing specifically with ocean incineration. Court interpretation of these laws has only affected the assessment process insofar as it has generally upheld the discretionary rights of agencies.[122]

The facts surrounding the environmental impacts caused by ocean incineration of hazardous wastes have not altered the potential threat from the technology. The results on emissions from each of the test burns have remained relatively constant.[123] There have not been any major spills nor other other catastrophic events which would lead one to empirically question the safety of the technology.

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121 See for example U.S. Congress House Merchant Marine and Fisheries Committee, Hearing on Incineration of Hazardous Wastes at Sea, 1985

122 See discussion, p.32

123 U.S. Congress, Office of Technology Assessment, Ocean Incineration: Its Role in Managing Hazardous Waste, 1986 p. 100

Where Are We Now?

By defeating ocean incineration the lay public won acknowledgement by EPA and the industry of the importance of perceived risk in environmental policy. The public won a sense of accomplishment for standing up to, and defeating, industry. The public won acceptance of the idea that the oceans are an ecosystem of unique value. Certain individuals, those who live closest to potential storage and loading facilities, the MEIs, probably decreased their cancer risk due to exposure to the wastes. The public perceived that it pushed back the limits of acceptable risks.

The public did not win a decrease in overall hazard. Removal of ocean incineration as a choice for the disposal of liquid hazardous wastes reinforces use of current methods including: underground injection wells, land-based incinerators, and "midnight dumping". It also encourages the newer, unacceptable alternative of exportation to third world nations. The public has stymied technological development in the hazardous waste treatment field. The scrutiny and opposition to ocean incineration - a proposal to reduce waste - has been greater than the scrutiny of the hazardous materials/waste production processes themselves.

Risk experts did not win anything by the defeat of ocean incineration. The various studies performed, from emissions monitoring to quantified risk models, which showed ocean incineration as the preferred, currently available treatment method for certain liquid hazardous wastes, were overruled. Experts did not communicate risk information to the public in a form to lessen concern substantially.

The inability of agencies to inform society about risks in such a way that decisions can be made to reduce the overall threat created by a technological activity is a fundamental problem in environmental hazard assessment. The political nature of environmental hazard assessment, as shown here both in theory and in a case study, complicates the situation. Solutions to alleviate this stalemate can only be effective if they are politically practical.

Appendix A

ABBREVIATIONS

AF SAB	Air Force Scientific Advisory Board
APA	Administrative Procedures Act
BNA	Bureau of National Affairs
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
DE	Destruction Efficiency
EDC	Ethylene dichloride
EIS	Environmental impact statement
EO	Executive Order
EPA	Environmental Protection Agency
FEIS	Final Environmental Impact Statement
FR	Federal Register
MARAD	Maritime Administration
MEI	Most Exposed Individual
MPRSA	Marine Protection Research and Sanctuaries Act
NEPA	National Environmental Policy Act
NSF	National Science Foundation
OPPE	EPA's Office of Policy Planning and Evaluation
OTA	Office of Technology Assessment
PCB	Polychlorinated biphenyl
PIC	Product of Incomplete Combustion
PL	Public Law
POHC	Principle Organic Hazardous Constituents
RCBA	Risk/Cost/Benefit Analysis
RCRA	Resource Conservation and Recovery Act
SAB	Scientific Advisory Board

Appendix B

CRITERIA FOR SITE DESIGNATION

40 CFR §228.5 General Criteria

(A) The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.

(B) Locations and boundaries of disposal sites will be so chosen the temporary perturbations in water quality or other environmental conditions caused by disposal operations affecting mixing zones anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentration or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

(C) If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in Sections 228.5-228.6. the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.

(D) The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.

(E) EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf.

40 CFR §228.6 Specific Criteria

(A) In the selection of disposal sites, in addition to other necessary or appropriate factors determined by the Administrator, the following factors will be considered

(1) Geographical position, depth of water bottom topography and distance from coast;

(2) Location in relation to breeding, spawning, nursery, feeding or passage areas of living resources in adult or juvenile phases;

(3) Location in relation to beaches or other amenity areas;

(4) Types and quantities of waste proposed to be disposed of and proposed methods of release, including methods of packing the waste, if any;

(5) Feasibility of surveillance monitoring;

(6) Disposal, horizontal transportation and vertical mixing characteristics of the ocean, including prevailing current direction and velocity. if any;

(7) Existence and effects of current and previous discharges and dumping in the area (including cummulative effects);ulat

(8) Interference with shipping, fishing, recreation, mineral extraction, desalinization, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;

(9) The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys as described in Guidelines for Ocean Disposal Site Baseline and Trend Assessment Surveys;

(10) Potentiality for the development or recruitment of nuisance species in the disposal site.

(11) Existence at or near the site of any significant natural or cultural features of historical importance.

(B) The results of a disposal site evaluation and/or designation study based on the criteria stated in paragraphs (1) - (11) will be presented in support of the site designation promulgation as an environmental assessment of the impact of the use of the site for disposal, and will be used in the preparation of an environmental impact statement for each site where such a statement is required by the National Environmental Policy Act or EPA policy. By publication of a notice, an environmental impact statement, in draft form, will be made available for public comment not later than the time of publication of the site designation as proposed rulemaking, and a final EIS will be made available at the time of final rulemaking.

40 CFR §228.10 Evaluating Disposal Impact

(c) Determination of Severity of Effect

Impact Category I: The effects of activities at the disposal site shall be categorized in Impact Category I when one or more of the following conditions is present.

There is identifiable progressive movement or accumulation, in detectable concentrations above ambient values, of any waste or waste constit-

uent form the disposal site within 12 nautical miles of any shoreline, marine sanctuary designated under Title III of the Act, or critical area designated under Section 102(c) of the Act; or

(i) The biota, sediments, or water column of the disposal site, or any area outside the disposal site where any waste or waste constituent from the disposal site is present in detectable concentration above normal ambient values, are adversely affected to the extent that there are statistically significant decreases in the populations of valuable commercial or recreational species, or of specific species of biota essential to the propagation os such species, within the disposal site and such other area as compared to populations of the same organisms in comparable locations outside such site and are; or

(ii) Solid waste material disposed of at the site has accumulated at the site or in areas adjacent to it, to such an extent that major uses of the site or of adjacent areas are significantly impaired and the Federal or State agency responsible for regulating such uses certifies that such significant impairment has occurred and states in its certificate the basis for its determination of such impairment; or

(iii) There are adverse effects on the taste or odor of valuable commercial or recreational species as a result of disposal activities; or

(iv) When any toxic waste, toxic waste constituent, or toxic by-product of waste interaction, is identified in toxic concentrations above normal ambient values outside the disposal site more than four hours after disposal.

(1) *Impact Category II:* The effects of activities at the disposal site which are not categorized in Impact Category I shall be categorized in Impact Category II.

Source: 40 CFR 228; 33 USC §1412 - 1418; 42 FR 2482, January 11 1977. As cited in 40 CFR §228.6(a) as cited in U.S. Environmental Protection Agency, Office of Water and Hazardous Materials, Final Environmental Impact Statement of Designation of a Site in the Gulf of Mexico for Incineration of Chemical Wastes, 1976 , pp19-20

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