Boston College Environmental Affairs Law Review

Volume 17 | Issue 4 Article 2

8-1-1990

Reconsidering Ocean Incineration as Part of a U.S. Hazardous Waste Management Program: Separating the Rhetoric from the Reality

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The authors express their sincere appreciation to Winnie Hercules, Legal Secretary, for her continual efforts and untiring patience throughout the writing process. Her spirit and warm sense of humor were unflagging from the first draft to the last.

We are indebted to Stephen J. Sweeney, Research Assistant, for his invaluable help during all phases of the research process. Amanda A. Gibson also provided needed research assistance during the final stages of the development of this Article.

Several people shared portions of their personal libraries and provided comments and constructive criticisms which substantially improved this Article: Dr. H. Suzanne Bolton, Toxicologist, NOAA's Office of Legislative Affairs; Sally A. Lentz, Staff Attorney, The Oceanic Society; Rosalie T. Matthews, President, Matthews Consulting & Construction, Inc.; and Dr. Steven L. Miller, Science Director, NOAA's National Undersea Research Center—Fairleigh Dickinson University, St. Croix, USVI. We also thank: Edward W. Kleppinger; Thaddeus A. Wastler, EPA; Mads-Peter Heide-Jorgensen, Danbiu ApS. (Biological Consultants, Denmark); and The George Washington University National Law Center Professors C. Thomas Dienes and Ralph G. Steinhardt for their helpful comments.

We are grateful to Janus Hillgaard, Greenpeace (Denmark); Eric Corins, The Oceanic Society; Margie Kelly, Greenpeace (U.S.A.); and James Banks, Waste Management, Inc., for providing copies of critical papers.

Finally, we acknowledge Gloria Miccioli and the staff of George Washington University's Jacob Burns Law Library for their cooperation and professional assistance.

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I. INTRODUCTION

Disposal of hazardous waste is both a serious environmental problem and a costly one. In the United States, industry alone produces more than one quarter of a billion metric tons (MT)[1] of Resource Conservation and Recovery Act (RCRA)[2] regulated hazardous

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[1] In 1985, United States industries generated about 275 million metric tons of hazardous wastes that were managed under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §§ 6901–6991i (1982 & Supp. V 1987). U.S. ENVTL. PROTECTION AGENCY, THE HAZARDOUS WASTE SYSTEM, at ES-2 (1987) [hereinafter EPA, HAZARDOUS WASTE SYSTEM]. Reported statistics concerning hazardous waste generation, however, vary considerably. For example, the Congressional Office of Technology Assessment (OTA) estimated that United States production of hazardous wastes was 569 million metric tons in 1985. OFFICE OF TECHNOLOGY ASSESSMENT, FROM POLLUTION TO PREVENTION: A PROGRESS REPORT ON WASTE REDUCTION 19 (1987) [hereinafter OTA, PROGRESS REPORT]. The Chemical Manufacturers Association estimated that its members generated about 212 million tons in 1985. *Chemical Industry Waste Down 20 Percent, CMA Says*, 10 Int'l Env't Rep. (BNA) 361 (July 8, 1987) (questionnaire results from 72% of major chemical producers). Higher numbers suggest that hazardous wastes not regulated by RCRA may also be included in the estimates.

There is evidence to suggest, however, that the aforementioned estimates were inaccurate. Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. § 11023 (Supp. V 1987), required industry to submit more complete data to the Environmental Protection Agency starting in 1988. United States manufacturers reported releasing over 22 billion pounds of toxic chemicals into the environment or to off-site treatment and storage facilities in 1987. *Section 313 Reports of Toxic Emissions Said to Reveal Need for Pollution Prevention*, 20 Env't Rep. (BNA) 154 (May 19, 1989). Estimates of total releases, including those not covered by section 313, may be close to 400 billion pounds or even higher if automobile emissions are included. *Id.* (1989 OTA estimates).

[2] 42 U.S.C. §§ 6901–6991i (1982 & Supp. V 1987).

wastes per year that must be safely managed through treatment, storage, or disposal. Another 300 million metric tons of hazardous wastes are generated[3] and are regulated under the Clean Water Act (CWA).[4] Three of the Environmental Protection Agency's (EPA) ten regions have companies that, combined, generate 219 million MT of the RCRA hazardous wastes.[5] The fifty largest hazardous waste generators produce eighty percent of these wastes, and fewer than five percent of the 21,728 generators together account for nearly all of the wastes produced.[6]

Industry should continue to move toward waste minimization strategies, but for the foreseeable future such efforts are unlikely to significantly reduce waste production.[7] As both our population and consumption per capita rise, our "throw-away" society can be expected to continue to generate massive amounts of hazardous wastes that threaten our already deteriorating environment.[8] Therefore, while source reduction is important and should be pursued, we must focus on what to do with the extant and ever-increasing quantities of hazardous wastes. All options for handling and disposing of hazardous wastes must be considered. These options must be analyzed from a health and safety perspective along with the usual concern for costs. For more than a decade, however, legal developments continuously have reduced the options for management and disposal of hazardous wastes by restricting land and water disposal.

One effect of this trend in environmental laws is to make incineration increasingly more attractive, particularly because it can offer better environmental protection at lower costs than legally acceptable land disposal.[9] Incineration can take place on land or at sea. Land-based incineration has been the traditional method of thermal destruction of wastes in the United States. During the 1970s, ocean incineration began to emerge as a viable disposal technology. More

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[3] These are figures covering RCRA-exempt wastes managed in 1985. *Study Shows States in Three EPA Regions Generate, Handle 80 Percent of RCRA Waste*, 20 Env't Rep. (BNA) 149 (May 19, 1989) [hereinafter *EPA Study*].

[4] 33 U.S.C. §§ 1251–1387 (1982 & Supp. V 1987).

[5] *EPA Study*, *supra* note 3, at 149 (data from EPA 1985 biennial report released May 12, 1989). The three regions are Regions III (mid-Atlantic states), IV (Southeastern states), and VI (Gulf states). *Id.*

[6] *Id.*

[7] *See* Gordon, *Legal Incentives for Reduction, Reuse, and Recycling: A New Approach to Hazardous Waste Management*, 95 YALE L.J. 810, 812–14 (1986); LaCroix, *Waste Minimization: The Goal Is Laudable, But the Meaning Debatable*, 18 Env't Rep. (BNA) 1641, 1641–43 (Oct. 30, 1987).

[8] *See* U.S. ENVTL. PROTECTION AGENCY, THE SOLID WASTE DILEMMA: AN AGENDA FOR ACTION 12 (1988) (draft report of Municipal Solid Waste Task Force, Office of Solid Waste).

[9] OTA, PROGRESS REPORT, *supra* note 1, at 1.

than a dozen western European nations used this technology, with most incineration taking place in the North Sea.

Most experts felt that ocean incineration was a viable method for elimination of liquid hazardous wastes. Ocean incineration looked especially attractive within the context of the available alternative disposal strategies and the need to protect the environment and human health. The United States allowed incineration at sea during the years 1974 through 1982. EPA delayed issuance of a proposed regulation covering ocean incineration until 1985, however, and has never issued a final regulation. A potentially useful technology was intentionally vetoed through agency inaction. The nascent United States ocean incineration industry, unable to get permission to operate, basically died.

The ocean incineration program exemplifies deficient government leadership. Originally, EPA pushed for ocean incineration with inadequate information concerning its potential impact on human health and the environment. The agency issued research permits that seemed to be designed more to produce profits for a single company than to produce usable data. EPA's delay in issuing a regulation also effectively discouraged other companies from entering the field.

In the 1980s, public opinion regarding ocean incineration changed from apathy to opposition. Though the public wanted the benefits of a high-technology lifestyle, it also sought a risk-free life. This aversion of the affected public and of environmentalists to environmental risks associated with ocean incineration was natural. The movement against ocean incineration was encouraged, and sometimes financially supported, by a land-based incineration industry that feared losing business to a low-cost rival. In addition, the principal corporation desiring to incinerate at sea had a major credibility problem. EPA, rather than exercising a leadership role or acting to provide useful information on the relative risks of ocean incineration, took the politically expedient position of doing nothing.

This Article first describes the current status of hazardous waste management and disposal in the United States, including the use of incineration as a disposal option. It next addresses the history, technology, legal regulation, and risks of ocean incineration of hazardous wastes. Finally, the Article assesses the use of ocean incineration for disposal of hazardous wastes. The assessment includes the factors that influenced the decision making process that led to the present ban on ocean incineration. This Article concludes that the United States must continue, with some urgency, to develop and utilize methods that reduce, recycle, treat, and destroy our growing inventory of hazardous wastes, and that all hazardous waste management options, including ocean incineration, should be considered and objectively evaluated.

II. The Hazardous Waste Problem in the United States

Prior to addressing the options for hazardous waste management and disposal, one must first ask whether it is realistic to expect that we could have a society free from hazardous wastes. Clearly, the answer is no—at least projecting into the next few decades.[10] As a goal, however, we should attempt to prevent the creation of hazardous wastes. It is better to avoid the creation of environmental problems than to deal with pollution after it has been created.

A general consensus has developed that a hierarchy of waste management options exists, with each option rated according to its ability to protect the environment.[11] The hierarchy includes:

1. Waste reduction to produce fewer harmful residuals, including process changes and raw materials substitutions;
2. Waste recycling, including resource recovery;
3. Physical, chemical, and biological treatment that results in reduced volume and/or less toxicity;
4. Incineration at high temperature; and
5. Solidification and/or stabilization before land disposal.

This hierarchy is generally accepted by both industry and environmentalists.[12] Disputes typically arise over the criteria used to decide when an option is no longer viable, and a waste generator can move down the hierarchy to select another option. Industry often uses cost as the criterion, seeking an option that is cost-effective in three years or less. Environmentalists often use elimination of all toxic waste as the criterion, demanding waste reduction or recycling in all, or nearly all, situations.[13]

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[10] One study claims that the hazardous wastes generated in 1983 totaling about 266 million metric tons might rise to about 280 million metric tons by 1990, but would be at least 229 million metric tons even with the maximal national effort for waste reduction. CONGRESSIONAL BUDGET OFFICE, HAZARDOUS WASTE MANAGEMENT: RECENT CHANGES AND POLICY ALTERNATIVES 43 (1985) [hereinafter CBO STUDY].

[11] *See* Wolf, *Source Reduction and the Waste Management Hierarchy*, 38 JAPCA 681 (1988).

[12] *Id.* at 682; *see also* Reitze, *Environmental Policy—It Is Time for a New Beginning*, 14 COLUM. J. ENVTL. L. 111, 134–35 (1989).

[13] Wolf, *supra* note 11, at 682.

Techniques to prevent pollution, rather than end-of-the-pipe controls, are finally getting governmental attention.[14] The U.S. Congressional Office of Technology Assessment (OTA), the National Academy of Sciences (NAS), and the major environmental litigation organizations have issued strong statements in support of waste minimization programs.[15] In June, 1989, Senator John Chafee introduced the Municipal Solid Waste Source Reduction and Recycling Act, which proposed the establishment of source reduction and recycling as the preferred methods for managing solid wastes.[16] This is one of several such legislative proposals.[17]

A further push for waste minimization stems from the "Superfund," the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).[18] The Superfund Amendments and Reauthorization Act (SARA) requires that states assure EPA that their hazardous waste treatment and disposal facilities are adequate to handle the wastes that they expect to generate over the next twenty years.[19] After October 17, 1989, EPA cannot obligate Superfund money to states for remedial actions unless they have an EPA-approved "Assurance of Hazardous Waste Capacity Plan."[20] For waste-exporting states, there must be a reasonable match between their export and import quantities.[21] Such a requirement puts additional pressure on the states to find new ways to dispose of hazardous wastes.[22]

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[14] SCIENCE ADVISORY BOARD, U.S. ENVTL. PROTECTION AGENCY, FUTURE RISK: RESEARCH STRATEGIES FOR THE 1990S, at 5 (1988).

[15] *See* Freeman, *Hazardous Waste Minimization,* 38 JAPCA 59 (1988); White, *EPA Program for Treatment Alternatives for Hazardous Waste,* 35 JAPCA 369, 371 (1985) (studies to be conducted by EPA Treatment, Recycling, and Reduction Program).

[16] S. 1112, 101st Cong., 1st Sess. 135 CONG. REC. S6014–16 (daily ed. June 1, 1989).

[17] *See RCRA Reauthorization Action: Luken Offers Plan Emphasizing Waste Minimization,* ENVTL. POL'Y ALERT, Aug. 23, 1989, at 12; *First-Ever Market-Based Used Oil Recycling Bill Seen as Test for Other Wastes,* INSIDE EPA, June 23, 1989, at 13 (waste oil recycling quota bills).

[18] 42 U.S.C. §§ 9601–9675 (1982 & Supp. V 1987).

[19] Superfund Amendments and Reauthorization Act of 1986, Pub. L. No. 99–499 tit. I § 104(k)(9)(A), 100 Stat. 1613, 1621 (codified at 42 U.S.C. § 9604(c)(9)(A) (Supp. V 1987)).

[20] Taimi, *EPA Issues Guidance to State Officials for Hazardous Waste Capacity Assurance Project,* 39 JAPCA 130 (1989).

[21] *EPA Issues Draft Guidance to States on Showing Adequate Treatment Capacity,* 19 Env't Rep. (BNA) 964, 965 (Sept. 9, 1988); *cf. State Officials Blast EPA Capacity Guidance, Predict Suits, Civil War on Hazardous Waste,* 19 Env't Rep. (BNA) 1899 (Jan. 27, 1989); *States Negotiate Regional Agreements to Meet Future Treatment Capacity Needs,* 20 Env't Rep. (BNA) 742 (Sept. 1, 1989).

[22] *See* Brown, *Developing Model State Legislation for Hazardous Waste Reduction,* ENVTL. L. (ABA), Fall 1989, at 1.

Until the mid-1970s, hazardous waste disposal was not viewed as a significant problem. Traditionally, wastes were either stored at the site where they were generated, shipped off-site and dumped in landfills, deposited underground using injection wells, or dumped into the ocean.[23] Today, land disposal of hazardous wastes has become increasingly difficult and expensive. Existing sites are running out of space, and new facilities are rarely permitted because of intense political opposition by people living near a proposed facility.[24] Known as the NIMBY ("not in my back yard") or LULU ("locally unwanted land use") syndromes, this opposition has imposed a national gridlock on the siting of new facilities.[25] Such opposition is not entirely irrational given the record of disposal sites that have created environmental problems.[26] As a result, however, the United States is unable to deal with a hazardous waste problem that will not disappear. The necessary but increasingly restrictive legal constraints being placed on all forms of hazardous waste disposal exacerbate the disposal problem.

III. Disposal Options

A. *Nonthermal Disposal Options*

1. Land Disposal

Over time, EPA's regulatory, permitting, and enforcement programs have restricted the use of hazardous waste management practices that do not sufficiently protect the environment and human health.[27] As a consequence, the short-term ability of EPA to handle

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[23] U.S. Envtl. Protection Agency, Environmental Progress and Challenges: EPA's Update 78 (1988) [hereinafter EPA, Progress Update].

[24] *See* Steinhart, *Down in the Dumps*, 102 Audubon 290, 290–91 (1986); Detroit Audubon Soc'y v. City of Detroit, 696 F. Supp. 249, 251–52, 255 (E.D. Mich. 1988), *rev'd sub nom.* Ontario v. City of Detroit, 874 F.2d 332, 344 (6th Cir. 1989) (remanding to Michigan state courts) (discussed in *Detroit Incinerator Case Remanded for State Court Review of Challenges*, 20 Env't Rep. (BNA) 114 (May 12, 1989)).

[25] *See* Brion, *An Essay on LULU, NIMBY, and the Problem of Distributive Justice*, 15 B.C. Envtl. Aff. L. Rev. 437, 437–38 (1988); Tarlock, *Anywhere But Here: An Introduction to State Control of Hazardous-Waste Facility Location*, 2 UCLA J. Envtl. L. & Pol'y 1 (1981); Tarlock, *Siting New or Expanded Treatment, Storage, or Disposal Facilities: The Pigs in the Parlors of the 1980s*, 17 Nat. Resources Law. 429, 433–34 (1984).

[26] *See* EPA, Progress Update, *supra* note 23, at 78.

[27] Office of Policy, Planning & Evaluation, U.S. Envtl. Protection Agency, Assessment of Incineration as a Treatment Method for Liquid Organic Hazardous Wastes: Summary and Conclusions 6 (Mar. 1985) [hereinafter EPA, Incineration Assessment: Summary and Conclusions].

and manage hazardous wastes has been reduced severely. Environmental laws that restrict disposal to air and water increase the amount of hazardous wastes that must be disposed of on land; all wastes must go somewhere.[28] Most hazardous wastes have been placed on land, where they often create environmental problems, especially groundwater contamination.[29] The Congressional Budget Office estimated that industry spent approximately $5 billion in 1983 for hazardous waste disposal; yet, these expenditures were insufficient to provide adequate protection of the environment.[30] Current land disposal methods are clearly ineffective considering the increasing amount of wastes and already have caused widespread environmental degradation.[31] The shrinking availability of land for such disposal has hastened the trend away from the use of these disposal methods.[32]

The federal environmental laws applicable to land disposal, particularly the Resource Conservation and Recovery Act (RCRA),[33] its 1984 amendments—also known as the Hazardous and Solid Waste Amendments of 1984 (HSWA),[34] and CERCLA,[35] are changing hazardous waste disposal practices. In the 1984 RCRA amendments, Congress created a phased program by which EPA would reduce the use of land for hazardous waste disposal.[36] The goal of these amendments was that "reliance on land disposal should be minimized or eliminated, and land disposal, particularly landfill and surface impoundment, should be the least favored method for managing hazardous wastes."[37] Under RCRA, EPA is required to set pretreatment requirements that reduce the toxicity of wastes.[38] RCRA has several other components as well: it prohibits storage of wastes in

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[28] *See id.* at 56; CBO STUDY, *supra* note 10, at 47.

[29] National Groundwater Pol'y Forum, *Groundwater: Saving the Unseen Resource*, in THE CONSERVATION FOUND., GROUNDWATER PROTECTION 105 (1987).

[30] CBO STUDY, *supra* note 10, at xii. The Budget Office estimated 1983 expenditures between $4.2 and $5.8 billion. *Id.*

[31] EPA previously estimated that the United States generates more than 264 million tons of hazardous wastes per year. *Incineration of Hazardous Wastes at Sea: Hearings Before the Environment, Energy, and Natural Resources Subcomm. of the House Comm. on Government Operations*, 98th Cong., 2d Sess. 3 (July 12, 1984) (statement of Representative Barbara Boxer) [hereinafter *House Hearing 1984*].

[32] EPA, HAZARDOUS WASTE SYSTEM, *supra* note 1, at 3-3.

[33] 42 U.S.C. §§ 6901–6991i (1982 & Supp. V 1987).

[34] Pub. L. No. 98-616, 98 Stat. 3221 (1984) (codified as amended in scattered sections of 42 U.S.C.).

[35] 42 U.S.C. §§ 9601–9675 (1982 & Supp. V 1987).

[36] *See* Pub. L. No. 98-616, 98 Stat. 3221 (1984).

[37] 42 U.S.C. § 6901(b)(7) (Supp. V 1987).

[38] *Id.* § 6924(m).

excess of specified time and quantity limits;[39] it restricts and subjects to permit requirements the disposal of hazardous wastes in salt formations or caves;[40] and it prohibits landfill disposal of bulk or non-containerized liquid wastes.[41] The overall aim of these environmental laws is to eliminate the land disposal of hazardous wastes.

The program established in the 1984 RCRA amendments has three phases. The first phase of the land disposal ban began November 7, 1986, when EPA introduced the regulatory program for land disposal prohibitions and treatment standards for specified solvent and dioxin wastes.[42] The second phase banned land disposal of wastes on the "California list" after July 8, 1987.[43] The California list consists of categories of wastes previously banned by California that subsequently have been incorporated into RCRA.[44] These include free liquids associated with sludge, heavy metals, acids with pH less than two, polychlorinated biphenyls (PCBs), and halogenated organic compounds. California wastes, with the exception of halogenated organic wastes, must be rendered into a solid to be disposed of legally in a landfill.[45]

The third phase of the land disposal ban is a schedule for disposal restrictions of wastes not dealt with in phase one or phase two.[46] The schedule ranks each hazardous waste according to its volume and toxicity, with the most harmful regulated first. EPA promulgated a plan in 1986 that would regulate "one-third" of the ranked and listed hazardous wastes by August 8, 1988, "two-thirds" by June 8, 1989, and the remaining wastes by May 8, 1990.[47] In May, 1988, EPA promulgated proposed regulations for restrictions on the first "one-third" of the list,[48] and finalized them on August 17, 1988.[49] The land ban on the "second-third" of the wastes was finalized on June 8, 1989.[50] The final "one-third" had regulations proposed in November, 1989, and final regulations are expected by May, 1990.[51]

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[39] *Id.* § 6924(j).
[40] *Id.* § 6924(b).
[41] *Id.* § 6924(c).
[42] 40 C.F.R. § 261.31 (1989).
[43] *Id.* § 268.
[44] 42 U.S.C. § 6924(d) (Supp. V 1987).
[45] 51 Fed. Reg. 19,300 (1986).
[46] 42 U.S.C. § 6924(g)(4) (Supp. V 1987).
[47] *Id.*; *see also* 51 Fed. Reg. 44,713, 44,740 (1986).
[48] 53 Fed. Reg. 17,578 (1988).
[49] *Id.* at 31,138.
[50] 54 Fed. Reg. 26,594 (1989).
[51] *EPA May Propose Most Stringent Treatment in Upcoming RCRA Land Ban*, INSIDE EPA, Oct. 20, 1989, at 3; *EPA Land Ban Rule Proposes Most Stringent Standards for Large Waste Group*, INSIDE EPA, Nov. 17, 1989, at 1 [hereinafter *EPA Land Ban Rule*].

The term "thirds" here is a misnomer. In the "first-third" rule, EPA issued treatment standards for only thirty-nine hazardous wastes. In the "second-third" rule, EPA issued treatment standards for sixty-seven hazardous wastes. In the "third-third" rule are some 350 hazardous wastes.[52]

At the same time that restrictions on the generators of hazardous wastes targeted for land disposal have become more stringent, EPA has promulgated more restrictive technical and permit standards for landfills and other disposal units that receive hazardous wastes.[53] These amendments set standards to prevent migration of toxic material into groundwater by requiring landfills or surface impoundments to have double liners and leachate collection systems between the liners.[54] In 1986, the rules to control and detect leachate were tightened again.[55] Land disposal facilities must meet even more stringent permit requirements by November, 1986.[56] Of approximately 1600 land disposal facilities with interim status permits, only 492 applied for a final permit.[57] Thus, over two-thirds of the land disposal sites chose to close or operate illegally rather than meet the new permit requirements. As with the regulations governing generators, these rules discourage land disposal.

Other common ways to dispose of hazardous wastes also are being limited. For example, the export of hazardous wastes has come under increased scrutiny.[58] The 1984 RCRA amendments prohibit

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[52] *EPA Land Ban Rule*, *supra* note 51, at 1; *Procedural Difficulties Predicted for Third-Third Rule—The 'Really Big One'*, 20 Env't Rep. (BNA) 1261 (Nov. 10, 1989).

[53] The basic regulations were issued in 1982. In 1985, the rules were amended to reflect the statutory changes made to RCRA in 1984. 50 Fed. Reg. 28,702 (1985) (codified at 40 C.F.R. § 264 (1989)).

[54] 42 U.S.C. § 6924(o) (Supp. V 1987).

[55] 52 Fed. Reg. 20,218 (1986).

[56] 40 C.F.R. § 270.73(c) (1989).

[57] Hahn, *An Evaluation of Options for Reducing Hazardous Waste*, 12 HARV. ENVTL. L. REV. 201, 223 (1988); *see also* Noll, Haas & Patterson, *Recovery, Recycle and Reuse*, 36 JAPCA 1163 (1986).

[58] With disposal costs ever increasing, and land-based dump sites scarce, exporting toxic wastes has become an increasingly attractive alternative as the United States and the European nations become overwhelmed by refuse. EPA estimates that roughly 2.2 million tons of garbage cross borders annually. At this time, no international agency monitors where the wastes go or what occurs after they are dumped. However, the United Nations Environment Programme (UNEP) gathered in Geneva in 1988 to try to agree on international safeguards to cover this toxic trade. Boroughs, *Dirty Job, Sweet Profits*, U.S. NEWS & WORLD REP., Nov. 21, 1988, at 54. In March, 1989, representatives of 116 countries approved a global convention aimed at limiting the dumping of hazardous wastes across national boundaries. But only 34 countries, mostly the developed nations, appear ready to sign the convention.

the export of hazardous wastes until EPA is notified and the receiving country consents to accept the wastes.[59] New bills that propose further restrictions on export of hazardous wastes are introduced regularly.[60] Some of the proposed legislation seeks to limit waste exports to Canada, currently the largest recipient of hazardous wastes from the United States.[61]

Increased controls over land disposal will not end, in the foreseeable future, the need for hazardous waste disposal in the United States.[62] This country will continue to create hazardous wastes in large quantities despite waste minimization efforts, especially since such efforts receive more publicity than money. For example, in its fiscal year (FY) 1988 budget request, EPA requested $398,000 for waste minimization efforts. This figure is about 0.03% of EPA's operating budget of $1.5 billion, and is less than EPA spent in FY 1986 for waste minimization.[63]

If waste reduction and/or recycling is not going to play a meaningful role in hazardous waste management in the near future, then the estimated quarter billion metric tons of hazardous wastes that are produced each year must be managed through treatment, storage, or disposal.[64] For industry, land disposal involves dealing with the impact of the federal laws previously discussed. It also requires

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Third World nations appear reluctant because they feel the convention does not go far enough. *116 Nations Approve Global Pact on Transborder Shipments of Waste*, 19 Env't Rep. (BNA) 2516 (Mar. 24, 1989).

[59] 42 U.S.C. § 6938(d) (1982 & Supp. V 1987). Corresponding regulations are found at 40 C.F.R. § 262 (1987).

[60] *EPA Waste Export Plan Would Allow Shipments to Countries with Weaker Laws*, INSIDE EPA, May 19, 1989, at 7 [hereinafter *EPA Plan*]; *see also* UNITED NATIONS ENVIRONMENT PROGRAMME, BASEL CONVENTION ON THE CONTROL OF TRANSBOUNDARY MOVEMENT OF HAZARDOUS WASTES AND THEIR DISPOSAL (1989).

[61] *EPA Plan*, *supra* note 60, at 7; *House Bill Would Require Foreign Countries to Manage U.S. Waste Exports by U.S. Standards*, 20 Env't Rep. (BNA) 195 (June 2, 1989). For an analysis of the status of this subject, see Handley, *Hazardous Waste Exports: A Leak in the System of International Legal Controls*, 19 Envtl. L. Rep. (Envtl. L. Inst.) 10,171 (Apr. 1989).

[62] EPA and the states also face increased quantities of hazardous wastes as they bring heretofore unregulated sources into the regulatory sphere. For example, some 30,000 educational institutions in the United States generate 2000 to 4000 metric tons of hazardous wastes a year. Yet, only 62 schools were fully permitted under RCRA. *Up to 4,000 Tons of Hazardous Waste Generated by U.S. Schools Annually, EPA Says*, 20 Env't Rep. (BNA) 177 (May 26, 1989).

[63] OTA, PROGRESS REPORT, *supra* note 1, at 9. There are 17 organizations within the federal government, however, that are engaged in waste minimization research and development. Cranford, *Federally Sponsored Waste Minimization Research and Development for Hazardous and Non-Hazardous Wastes*, 39 JAPCA 34 (1989).

[64] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 6.

dealing with state laws concerning hazardous wastes,[65] such as California's well-publicized Proposition 65,[66] other California laws enacted recently,[67] and toxics use reduction acts recently enacted in Massachusetts and Oregon.[68] Land disposal also exposes responsible parties to tort liability, including joint and several liability for the effects of other generators' wastes when hazardous wastes are comingled.[69] If wastes are disposed on a generator's site, the wastes may affect the land's future marketability[70] as well as the present insurability of the business.[71]

What, then, are the options that do not require traditional land disposal? There are three major choices: deep-well injection, discharge to surface water or the oceans, and incineration.[72]

2. Deep-well Injection

EPA estimates about twenty-five million metric tons (MT) of the 303.6 million MT of hazardous wastes generated in the United States each year are disposed of in deep wells.[73] This accounts for less than ten percent of all RCRA hazardous wastes. Deep-well disposal occurs primarily in Texas, Louisiana, Illinois, Ohio, and Indiana. Most

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[65] Lennett & Greer, *State Regulation of Hazardous Waste*, 12 ECOLOGY L. Q. 183 (1985).

[66] Proposition 65 was approved on November 4, 1986 as a voter initiative and is codified at CAL. HEALTH & SAFETY CODE §§ 25249.5–.13 (West Supp. 1990).

[67] L. STEWART, CALIFORNIA HAZARDOUS WASTE ENFORCEMENT: A PRACTICAL GUIDE (1988).

[68] *State Toxic Waste Proposal Mandating Reduction Plans Seen as National Model*, INSIDE EPA, July 7, 1989, at 6. Oregon, with the passage of a landmark Toxics Use Reduction Act, joined Massachusetts as the only two states to mandate pollution prevention planning. Hansen, *Pollution Prevention Planning: A New Mandate for Oregon's Environment*, 6 ENVTL. F. 30 (Sept./Oct. 1989).

[69] *See* Bayer, *Joint and Several Liability*, 21 TRIAL 56 (1985); Note, *Joint and Several Liability for Hazardous Waste Releases Under Superfund*, 68 VA. L. REV. 1157 (1982).

[70] *See* Evans, *Environmental Audits of Real Property Before Purchase*, 3 NAT. RESOURCES & ENV'T 20 (1988).

[71] *See* GENERAL ACCOUNTING OFFICE, HAZARDOUS WASTE: THE COST AND AVAILABILITY OF POLLUTION INSURANCE (Oct. 1988) (GAO/PEMD–89–6); Pendygraft, Plews, Clark & Wright, *Who Pays for Environmental Damage: Recent Developments in CERCLA Liability and Insurance Coverage Litigation*, 21 IND. L. REV. 117 (1987).

[72] Wastes that are handled under any of the tested options can be treated first biologically or chemically to reduce volume and/or toxicity and/or to make them more stable. OFFICE OF TECHNOLOGY ASSESSMENT, OCEAN INCINERATION: ITS ROLE IN MANAGING HAZARDOUS WASTE 85 (1986) [hereinafter OTA, OCEAN INCINERATION].

[73] EPA, HAZARDOUS WASTE SYSTEM, *supra* note 1, at ES–4. An injection well means a "well" into which "fluids" are being injected. 40 C.F.R. § 146.3 (1989). A "well" refers to a bored, drilled, or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension. *Id.* Injection wells are further classified on the basis of the wastes injected into them. *Id.* § 146.5.

deep wells are located at the sites where the wastes are generated.[74] There are currently only thirteen commercial deep-well systems in operation, eleven of which are located along the Gulf Coast of Texas and Louisiana.[75] Both RCRA[76] and the Safe Drinking Water Act (SDWA)[77] regulate deep-well injection, which also has been restricted as a disposal option.

The HSWA[78] included a ban on deep-well injection of hazardous wastes, effective August 8, 1988, unless well operators or owners can demonstrate that the wastes will not affect adversely human health or the environment.[79] Regulations prohibit injection if wastes will migrate from an injection zone during the time wastes remain hazardous.[80] Solvents, dioxins, and the "California list" were to be controlled at injection wells by August 8, 1988.[81] As previously noted, the first "one-third" of all other RCRA ranked and listed wastes were to be controlled by August 8, 1988.[82] The "second-third" of the ranked and listed wastes were to be regulated by June 8, 1989, and all other ranked and listed wastes are subject to a May 8, 1990 control date.[83]

Similarly, EPA imposed new technical requirements on deep-well injection of hazardous wastes under the SDWA Amendments of 1986.[84] These amendments toughened the Underground Injection Control Program of the SDWA[85] that had been implemented with the promulgation of regulations in 1980.[86] Under the SDWA and associated regulations, wells that inject wastes into, or above, underground sources of drinking water were to be plugged by May,

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[74] EPA, HAZARDOUS WASTE SYSTEM, *supra* note 1, at 3–4.

[75] *Id.* at app. C.

[76] 42 U.S.C. § 6924 (Supp. V 1987).

[77] *Id.* § 300h-7.

[78] Pub. L. No. 98-616, 98 Stat. 3221 (codified as amended in scattered sections of 42 U.S.C.).

[79] 42 U.S.C. § 6924(f) (Supp. V 1987).

[80] GENERAL ACCOUNTING OFFICE, HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS 37 (1987) (GAO/RCED–87–170) [hereinafter GAO, INJECTION WELL CONTROLS]. The "no migration" provision has become controversial as EPA has produced a draft proposal that would allow some migration. *Land Ban—EPA Draft Proposal Expands Industry Exemption*, ENVTL. POL'Y ALERT, Apr. 19, 1989, at 17.

[81] 42 U.S.C. § 6924(g)(4) (Supp. V 1987).

[82] *Id.*

[83] *Id.* § 6924(g)(4)(B)–(C) (Supp. V 1987)).

[84] Pub. L. No. 99-339 (codified at 42 U.S.C. §§ 300h to 300h-7 (Supp. V 1987)).

[85] 42 U.S.C. §§ 300h to 300h-4 (1982).

[86] OFFICE OF GROUND-WATER PROTECTION, U.S. ENVTL. PROTECTION AGENCY, FACT SHEET: GROUND-WATER PROVISIONS OF THE SDWA AMENDMENTS OF 1986 (1986); Gray, *The Safe Drinking Water Act Amendments of 1986: Now a Tougher Act to Follow*, 16 Envtl. L. Rep. (Envtl. L. Inst.) 10,338 (Nov. 1986).

1985. Class I wells, which inject hazardous wastes below the deepest underground sources of drinking water, are subject to a comprehensive permit program.[87]

These new requirements, however, may not have much effect on hazardous waste disposal because there are only 181 active wells and only seventeen of these are commercial wells.[88] Most wells handle only on-site generated waste. The General Accounting Office (GAO) estimates that about fifty-nine percent of the 290 million tons of hazardous wastes generated in the United States each year are injected as a liquid into deep wells.[89] The GAO figure is highly suspect and differs from EPA's estimate that less than ten percent of the hazardous wastes is deep-well injected.[90]

Underground injection of waste is attractive to industry because it costs less than land filling. At noncommercial facilities, underground injection costs range from $10–18 per ton, while landfill disposal costs range from $50–500 per ton.[91] Moreover, the new environmental regulations are not expected to have much impact on costs of operating existing wells.[92] Because there are few commercial deep wells, and the siting of new deep wells will be subject to increasingly stringent environmental requirements, however, a major move by hazardous waste generators to use commercial deep-well injection is unlikely.

3. Discharge to Surface Water

The discharge of hazardous wastes to surface waters is the legal system's least-favored option. Discharges to the ocean are severely restricted by existing law and are becoming even more so.[93] In the past, hazardous wastes were often discharged to the ocean.[94] Since

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[87] 40 C.F.R. §§ 144–148 (1989).

[88] GAO, INJECTION WELL CONTROLS, *supra* note 80, at 3, 13. GAO says there are 17 commercial injection wells and EPA says there are 13. *See supra* text accompanying note 75. The reason for the discrepancy may be that EPA does not count wells found in states where the state has taken over the primary responsibility of administration.

[89] GAO, INJECTION WELL CONTROLS, *supra* note 80, at 8. Of the remaining hazardous wastes, 35% is placed in ponds or other surface impoundments, and six percent is placed in landfills or buried. *Id.* Note that estimates of U.S. hazardous waste generation vary among the governmental agencies, and the quantity has been increasing each year.

[90] EPA, HAZARDOUS WASTE SYSTEM, *supra* note 1, at ES–4.

[91] GAO, INJECTION WELL CONTROLS, *supra* note 80, at 8.

[92] *Id.* at 47.

[93] *See generally* COUNCIL ON ENVTL. QUALITY, 16TH ANNUAL REPORT OF THE COUNCIL ON ENVIRONMENTAL QUALITY 262–64 (1987) (discussing U.S. and international legal mechanisms for controlling marine pollution).

[94] *Id.* at 262.

1972, a discharge from a point source or a floating craft into the navigable waters[95] of the United States has required a permit under the Federal Water Pollution Control Act, now known as the Clean Water Act (CWA).[96] No permit can be issued unless the permit-issuing authority, which can be EPA or an authorized state agency, determines that the discharge will not cause unreasonable degradation of the environment.[97]

Under the CWA, few hazardous substances are regulated directly,[98] because most controls are imposed as limitations on effluent discharges by industry.[99] The CWA focuses on 129 toxic priority pollutants. This list of pollutants developed from a 1976 consent decree between the Natural Resources Defense Council (NRDC) and EPA[100] requiring the regulation of sixty-five compounds or classes of compounds.[101] The consent decree also required regulation of effluents from twenty-one industrial categories[102] which have been reorganized subsequently into thirty-four primary industries.[103] These priority pollutants also are incorporated into the RCRA and CERCLA regulatory programs. Among the point sources that the CWA regulates are publicly-owned treatment works (POTWs),[104] which, in turn, must impose pretreatment requirements on the discharges of hazardous industrial wastes they receive.[105] The Toxic

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[95] The "navigable waters" are defined as the waters of the United States including the territorial seas, generally out to three miles from shore. 33 U.S.C. § 1362(7) (1982).

[96] *See id.* §§ 1342–1343 (1982 & Supp. V 1987). As rules governing water discharges tighten, the quantity of wastes disposed of on land or in the air increases. EPA regulations issued in 1987 directed over 1000 facilities to reduce their surface water discharges by over 130 million pounds. These regulations were upheld in Natural Resources Defense Council v. EPA, 539 F.2d 1068 (5th Cir. 1989). *See EPA Directed to Explore Total Recycling to Eliminate Toxic Wastes*, NRDC NEWSLINE, May–June 1989, at 2.

[97] 40 C.F.R. § 125, subpart M (1989).

[98] 33 U.S.C. § 1317 (1982 & Supp. V 1987).

[99] *Id.* §§ 1311, 1316.

[100] Natural Resources Defense Council v. Train, 8 Env't Rep. Cas. (BNA) 2120 (D.D.C. 1976).

[101] *Id.* at 2129–36.

[102] Gaba, *Regulation of Toxic Pollutants Under the Clean Water Act: NPDES Toxics Control Strategies*, 50 J. AIR L. & COM. 761, 772 (1985).

[103] 40 C.F.R. § 122, app. A (1989).

[104] POTWs that have a National Pollutant Discharge Elimination System (NPDES) permit, persons holding an ocean dumping permit under the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), and permitted Underground Injection Control Program facilities under the SDWA are all considered to be in compliance with RCRA. T. WAGNER, THE COMPLETE HANDBOOK OF HAZARDOUS WASTE REGULATION 156 (1988).

[105] *See* Arbuckle, Vanderver & Randle, *Water Pollution Control*, in ENVIRONMENTAL LAW HANDBOOK 244 (9th ed. 1987); Garrett, *EPA's Amendments To General Pre-Treatment Regulations*, 19 Env't Rep. (BNA) 2530 (Mar. 24, 1989); Gold, *EPA's Pretreatment Program*, 16 B.C. ENVTL. AFF. L. REV. 459, 468 (1989).

Substances Control Act (TSCA)[106] also regulates certain specified pollutants, including PCBs,[107] chlorofluorocarbons (CFCs),[108] and asbestos.[109]

The Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA, or the Ocean Dumping Act)[110] prohibits ocean dumping, except by permit, in any United States ocean waters by any vessel registered by the United States, or by any vessel sailing from United States ports.[111] The statute completely prohibits the dumping of any radiological, chemical, or biological warfare agent, or any high-level radioactive wastes.[112] The MPRSA also requires the Administrator of EPA to enforce the "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter," commonly known as the London Dumping Convention (LDC).[113] The LDC annexes prohibit the ocean dumping of mercury and cadmium and their substances, organohalogen substances including DDT and PCBs, persistent plastics, oil, high-level radioactive wastes, and chemical and biological warfare agents. Additionally, the LDC requires special permits for other heavy metals, cyanides and fluorides, and medium and low-level radioactive wastes.[114] Congress has amended the Ocean Dumping Act to regulate oil taken on board vessels for the purpose of dumping at sea.[115]

Overall, the effect of these laws—the CWA, TSCA, and MPRSA—is that ocean dumping of industrial wastes declined from five million tons in 1973 to 0.3 million tons in 1986.[116] Ocean dumping may be restricted further after the passage of the Ocean Dumping Ban Act of 1988,[117] which makes it illegal to dump sludge or industrial wastes into the ocean after December 31, 1991.[118] This law could increase

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[106] 15 U.S.C.A. §§ 2601–2671 (West 1982 & Supp. 1989).

[107] 15 U.S.C. § 2605 (1982).

[108] 40 C.F.R. § 762 (1989).

[109] 15 U.S.C.A. §§ 2641–2655 (West Supp. 1989).

[110] 33 U.S.C.A. §§ 1401–1445 (West 1986 & Supp. 1989).

[111] *Id.* §§ 1412–1414b.

[112] *Id.* § 1412(a) (West Supp. 1989).

[113] *Id.* § 1412(a)(I); *see also* CONGRESSIONAL RESEARCH SERV., ENVIRONMENTAL PROTECTION: AN HISTORICAL REVIEW OF LEGISLATION AND PROGRAMS OF THE ENVIRONMENTAL PROTECTION AGENCY 56 (1983) (Report No. 83–34–ENR) [hereinafter CRS, HISTORICAL REVIEW].

[114] CRS, HISTORICAL REVIEW, *supra* note 113, at 56.

[115] 33 U.S.C. § 1401(c) (1982).

[116] EPA, PROGRESS UPDATE, *supra* note 23, at 69.

[117] 33 U.S.C.A. § 1414(b) (West Supp. 1989).

[118] Currently only one company, Allied Signal Inc., continues to dump in the ocean. Allied dumps about 59,000 wet tons of acidic wastes in the ocean every year according to a permit application the firm filed with EPA. Allied has been dumping wastes into the ocean for about 20 years. Wastes are dumped at a site about 15 miles off-shore of New Jersey. EPA officials

the attractiveness of incineration as a disposal option. But, as is discussed more fully below, because EPA considers ocean incineration to be ocean dumping, this law has been construed by the United States as a ban on ocean incineration as well.[119]

Without belaboring the point, the use of surface waters as a disposal medium is no longer a viable option for generators of hazardous wastes. Legal restrictions on releases to land and water result in pressure for discharges to the atmosphere. This situation emphasizes the attractiveness of incineration as an option for hazardous waste disposal.

B. Incineration

Incineration is a destruction technology that reduces quantities of wastes and generally appears to be preferable to storage in landfills, injection into wells, or dumping. EPA defines incineration as "a

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said Allied has assured them that dumping will cease by the end of 1992. *Reagan Signs Law Restricting Ocean Disposal of Sewage Sludge, Industrial, Medical Wastes*, 19 Env't Rep. (BNA) 1485 (Nov. 25, 1988).

The DuPont Co. has dumped acidic wastes resulting from the manufacture of titanium dioxide at a site 106 miles off the New Jersey coast since 1968. Although the company filed a permit application with regional EPA officials to continue that practice, it withdrew the application in July, 1988, when it announced that it would cease dumping wastes in the ocean. *Id.*

The Ocean Dumping Ban Act also increases the civil penalties for illegal dumping of medical wastes in the ocean. 33 U.S.C.A. § 1415(a) (West Supp. 1989). In 1988, Congress also passed the United States Public Vessel Medical Waste Anti-Dumping Act of 1988, which prohibits dumping of medical wastes into the ocean by public vessels six months from the date of enactment. *Id.* §§ 2501–2504.

There are also nine local governments, three in New York State, including New York City, and six in New Jersey, that dump sludge into the ocean. A few other local governments, such as Boston and San Diego, pipe sewage into the ocean that has undergone only primary treatment. These local governments now are required, under court orders, to stop these practices. The Ocean Dumping Ban Act will end the dumping of eight million wet tons of sludge a year into the disposal site 106 miles from the New Jersey shore. *Id.* § 1414a(b). One problem with New York City sludge is that it contains high concentrations of cadmium, copper, lead, mercury, nickel, silver, and PCBs. Mayor Koch of New York estimated that it would cost about $500 million to build incinerators to burn this sludge if land sites could be found. Marshall, *The Sludge Factor*, 242 SCIENCE 507, 508 (1988).

On April 19, 1989, the six New Jersey ocean dumpers sued EPA to prevent the imposition of penalties under the Ocean Dumping Ban Act. Passaic Valley Sewage Comm'rs v. Reilly, No. C 89–1670 (D.N.J. filed Apr. 19, 1989); *see also Ocean Dumping: First Agreement Reached in Federal Effort to End Illegal Dumping*, ENVTL. POL'Y ALERT, June 14, 1989, at 37. In response, EPA simply negotiated lower standards.

Sewage sludge dumping in the ocean by Westchester County, New York will end December 31, 1991. At the same time, New York City will reduce its dumping by 20% and halt all dumping by June 30, 1992. *Ocean-Dumping Days Ending for New York*, Wash. Post, June 24, 1989, at A14, col. 1.

[119] *See infra* notes 411–13, 826–28 and accompanying text.

controlled oxidation process that uses flame combustion to combine hazardous wastes with oxygen, thus converting the wastes to less hazardous materials."[120] Ideally, incineration converts organics to carbon dioxide and water vapor. However, if air is insufficient, carbon monoxide is produced. If chlorinated organic compounds, such as PCBs, are combusted, hydrogen chloride and chlorine are also produced. Incineration of other liquid hazardous wastes may produce metals, sulfur, organically bound nitrogen, and other substances.[121] In addition, highly toxic products of incomplete combustion (PICs), such as dioxin and dibenzofuran, may form and be emitted as gases or particulates.[122] Waste incineration has three major benefits: (1) the process actually destroys most of the wastes rather than just disposing of, or storing, them; (2) it can be used to dispose of a variety of wastes; and (3) it is reasonably competitive in cost when compared with other disposal methods.[123]

Hazardous wastes typically occur as organic liquids or sludges. Incineration can only be used to destroy a small portion of these hazardous wastes. The most frequently cited estimate of RCRA regulated hazardous waste generation per year in the United States is EPA's 1981 figure of 264 million MT.[124] This figure increased in 1986 to 303.6 million MT, partly because it included twenty-five million MT that were deep-well injected under the SDWA regulatory program.[125] Approximately six million MT of these wastes are incinerable liquid wastes. The amount of wastes potentially incinerable increases by adding materials such as waste oils regulated by RCRA since 1984, PCBs controlled under TSCA, industrial scrubber sludges, and air pollution control dusts. A 1986 study by Arthur D. Little, Inc. estimated incinerable liquid wastes to be at least ten million MT per year.[126] The Office of Technology Assessment esti-

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[120] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 36.

[121] U.S. ENVTL. PROTECTION AGENCY, ASSESSMENT OF INCINERATION AS A TREATMENT METHOD FOR LIQUID ORGANIC HAZARDOUS WASTES, BACKGROUND REPORT I: DESCRIPTION OF INCINERATION TECHNOLOGY 1, 2 (1985) [hereinafter EPA, INCINERATION ASSESSMENT: BACKGROUND REPORT I].

[122] *Id.*

[123] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 11.

[124] *Id.* at 13; *see also* OTA, OCEAN INCINERATION, *supra* note 72, at 63 (citing WESTAT, INC., NATIONAL SURVEY OF HAZARDOUS WASTE GENERATORS AND TREATMENT, STORAGE AND DISPOSAL FACILITIES REGULATED UNDER RCRA IN 1981 (1984) (report prepared for the EPA Office of Solid Waste)).

[125] EPA, HAZARDOUS WASTE SYSTEM, *supra* note 1, at ES–4.

[126] OTA, OCEAN INCINERATION, *supra* note 72, at 65–66 (citing ARTHUR D. LITTLE, INC., OVERVIEW OF OCEAN INCINERATION (1986) (prepared for the Office of Technology Assessment)).

mated that as much as ten to twenty percent of the hazardous wastes generated in the United States each year could, in theory, be incinerated.[127] According to EPA's 1986 estimate, however, only 2.1 million MT, less than one percent of all RCRA hazardous wastes, were incinerated.[128]

Most of the existing RCRA hazardous waste incinerators are located on-site where the wastes are generated. There are over 175 such incinerators that burn 1.7 million MT of hazardous wastes each year.[129] In addition, fourteen commercial incinerators burn 0.4 million MT of the hazardous wastes generated each year.[130] Currently, there are only two permitted incinerators for burning wastes containing dioxin.[131]

EPA's assessment of incineration technology noted that the efficiency of incineration, whether on land or at sea, is determined by performance, not design.[132] Currently, testing has shown that incinerators can destroy at least 99.99% of the indicator compounds used to assess performance.[133] EPA acknowledges a lack of complete knowledge regarding this technology, and notes the need for continuing research.[134] Nevertheless, EPA believes that incineration is a valid option and the best available approach to handle liquid hazardous wastes. EPA also believes that incineration provides for effective protection of the environment and human health.[135]

Further, EPA projects that the demand for both commercial and on-site incineration will increase because of restrictions imposed by the 1984 RCRA amendments and because of other factors such as generators' increasing concerns with long-term tort-based liability stemming from environmental contamination associated with land disposal, costly Superfund clean-up activities, and declining landfill

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[127] *Id.* at 9.

[128] EPA, HAZARDOUS WASTE SYSTEM, *supra* note 1, at ES–4.

[129] *Id.* at 2–5. The number of incinerators, however, varies in EPA reports. For example, the head of EPA's Office of Water Regulations and Standards said there were 273 hazardous waste incinerators. *EPA Plan Would Require BAT Standards for Hazardous Waste Treatment Facilities*, 20 Env't Rep. (BNA) 741 (Sept. 1, 1989).

[130] EPA, HAZARDOUS WASTE SYSTEM, *supra* note 1, at 2–5.

[131] These are mobile incinerators run by EPA. One was scheduled to cease operation in May, 1989, and EPA planned to use the other one only for experiments. *Incinerator Used to Burn Dioxin Waste Will Be Shut Down in Spring By Agency*, 19 Env't Rep. (BNA) 1906 (Jan. 27, 1989).

[132] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 3.

[133] *Id.*

[134] *Id.*

[135] *Id.*

capacity.[136] However, there is now a major push by environmentalists to prohibit incineration where possible and to get EPA to agree that source separation[137] is the "best available control technology" (BACT) for incinerators.[138] Source separation would keep materials, such as automobile batteries, that produce dangerous lead emissions, from being incinerated. The overall effect of acceptance of such a position is difficult to predict. Environmentalists have demanded source separation as a way to defeat incinerator construction.[139] But, if source separation reduces the amount of metals present in waste streams, it should make the residues from the incineration of organics much less toxic[140] and increase the acceptability of incineration as a disposal option. Currently, EPA is considering requiring material separation for incinerators subject to New Source Performance Standards (NSPS)[141] under section 111 of the Clean Air Act.[142]

Incineration can be used on any substance that can be burned,[143] including hazardous wastes, municipal wastes, sludge from POTWs, hospital wastes, and various miscellaneous wastes generated by small businesses or apartment houses, for example, which can be burned on-site. This last category largely has been outlawed by state air pollution controls implementing the Clean Air Act.[144]

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[136] *Id.* at 14.

[137] Source separation is more likely to be considered within the scope of the Clean Air Act than recycling. *See EPA May Call for Source Separation of Waste in Future Municipal Incinerator Air Permits*, 20 Env't Rep. (BNA) 432 (June 16, 1989).

[138] *See Environmentalists Launch Push to Get Mandated Recycling for Incinerators*, INSIDE EPA, May 26, 1989, at 9–10.

[139] *See EPA Region X Calls for Recycling as Possible Incinerator Permit Condition*, 19 Env't Rep. (BNA) 2565 (Apr. 7, 1989); *Cities Scrap Plans for Incinerators, Paving Way for Recycling*, INSIDE EPA, Sept. 9, 1988, at 15.

[140] Sommer, Kenney, Kearley & Roos, *Mass Burn Incineration with a Presorted MSW Fuel*, 39 JAPCA 511 (1989).

[141] *Reilly Rejects National Requirement of Recycling for Incinerators*, INSIDE EPA, June 16, 1989, at 3.

[142] 42 U.S.C. § 7411 (1982 & Supp. V 1987).

[143] As an extreme example, in India many of the dead are cremated and their ashes dumped in the Ganges River. About 10,000 bodies sent to the river are only partially burned, creating a serious pollution problem. The government plans to build more crematoria, but the low-caste "doms" who have supervised cremations in India for centuries oppose this plan. Yerkey, *Living and Dying with Ganga Ma*, SIERRA, May/June, 1988, at 16.

[144] 42 U.S.C. §§ 7401–7642 (1982 & Supp. V 1987); *see also NRDC Petitions EPA to Shut Down Incinerators in New York Apartment Houses*, 18 Env't Rep. (BNA) 1988 (Jan. 8, 1988). Municipal ordinances also have been used to control the use of apartment incinerators. *See* Oriental Blvd. Co. v. Heller, 27 N.Y.2d 212, 265 N.E.2d 72, 316 N.Y.S.2d 226 (1970). Hospital wastes are incinerated primarily to prevent transmission of disease. While these wastes may be hazardous because of their potential for disease transmission, this subject is outside the scope of this Article. *See* Brunner & Brown, *Hospital Waste Disposal by Incin-*

About twenty-one percent of all sludge from POTWs is incinerated.[145] As of 1984, there were 268 sludge incineration facilities of which 156 are fully operational.[146] The others are either no longer in service, under construction or startup, being retrofitted, or used only seasonally.[147] EPA's policy for funding POTW projects requires that recycling and reuse of sludge be the options of choice, if economically feasible.[148] This policy tends to make land application of the sludge seem more environmentally desirable. Sludge high in chemical contamination, however, is less desirable for land application because of possible contamination of plants used for human consumption or for livestock feed. Likewise, highly toxic sludge is not appropriate for incineration because toxic air pollutants may be released.[149]

Municipal solid waste is heterogeneous, with a composition that varies with time of year and geographic location.[150] On average, about one-third of these wastes are paper and paperboard.[151] Yardwastes comprise nearly twenty percent by weight of municipal wastes.[152] Although incineration of some municipal solid wastes may emit hazardous substances, most of the wastes are not hazardous. Incineration of municipal wastes requires a design to deal with different conditions than those found in incinerating hazardous wastes. The scope of this Article, however, is limited to incineration of liquid hazardous wastes.

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eration, 38 JAPCA 1297 (1988); Allen, Brenniman, Logue & Strand, *Emission of Airborne Bacteria from a Hospital Incinerator*, 39 JAPCA 164 (1989).

145 *Ocean Dumping Ban*, ENVTL. POL'Y ALERT, May 31, 1989, at 27.

146 GANNETT FLEMING ENVTL. ENG'RS, INC., SLUDGE MANAGEMENT STUDY: BLUE PLAINS WASTEWATER TREATMENT PLANT 2-7 (1989) (Draft Environmental Impact Statement).

147 More restrictive sludge incineration rules were expected to be proposed in 1989. *Sludge Incineration Rules*, ENVTL. POL'Y ALERT, Nov. 2, 1988, at 13.

148 Under section 405(d) of the Water Quality Act of 1987, EPA must establish regulations for the disposal of sludge. EPA issued its sludge proposal on January 19, 1989. The proposal was seriously criticized by a scientific review panel. The incineration proposal is currently being reviewed separately by EPA's Science Advisory Board. *EPA Sludge Reviewers Find Risk Assessment Flawed, Too Stringent*, INSIDE EPA, May 26, 1989, at 5.

149 EPA's proposed sludge incineration rules have become controversial. *See EPA's Science Advisors: Sludge Incineration Risk Assessment Too Conservative*, INSIDE EPA, Sept. 1, 1989, at 12; *Sludge Incineration*, ENVTL. POL'Y ALERT, Sept. 6, 1989, at 23; *Environmentalists Hit EPA Sludge Rule As Contrary to Agency Composting Goal*, INSIDE EPA, Sept. 8, 1989, at 7.

150 *See* SCIENCE ADVISORY BD., U.S. ENVTL. PROTECTION AGENCY, EVALUATION OF SCIENTIFIC ISSUES RELATED TO MUNICIPAL WASTE COMBUSTION 20 (1988) (Report of the Environmental Effects, Transport and Fate Committee).

151 Steinhart, *supra* note 24, at 104.

152 *Id.*

Hazardous wastes are not only burned in incinerators, they also are burned in boilers and industrial furnaces. Most of these wastes are generated on-site.[153] In 1981, twice the quantity of wastes burned in incinerators was disposed of in furnaces including industrial boilers, cement kilns, iron-making furnaces, and light-weight aggregate and asphalt plants.[154] A wet-process cement kiln is considered best for hazardous waste incineration because the process uses high temperatures for relatively long time periods to drive off moisture from the cement slurry.[155] In 1983, there were over 1300 facilities using hazardous waste-derived fuels totaling 230 million gallons per year.[156] The waste treatment industry has been litigating for more stringent regulation of boilers and industrial furnaces.[157] In October, 1989, EPA proposed new regulations under RCRA for these incineration methods.[158]

Recycling operations are exempt from the stringent regulations of RCRA. Determining what constitutes recycling, however, is controversial. For example, Marine Shale Processors, Inc. (Marine Shale) has been burning soils contaminated with creosote and dioxin and other hazardous wastes for about one-half the price charged by their competitors.[159] Marine Shale maintains that it is recycling hazardous wastes into an aggregate ash, alleged to be nontoxic, which it sells to the construction industry.[160] Marine Shale's detractors,

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[153] Oppelt, *Incineration of Hazardous Waste: A Critical Review*, 37 JAPCA 558, 566–67 (1987).

[154] *Id.* at 566.

[155] *Detroit Cement Maker Gets State Approval to Burn Liquid Hazardous Waste in Cement Kiln*, 20 Env't Rep. (BNA) 176 (May 26, 1989). "[H]azardous wastes can be burned in cement kilns as an integral part of the production process . . . [whereby] [c]hlorinated combustion products get tied up in the cement itself, thereby minimizing toxic emissions." Zurer, *Incineration of Hazardous Wastes at Sea: Going Nowhere Fast*, CHEMICAL & ENGINEERING NEWS, Dec. 9, 1985, at 30.

[156] Oppelt, *supra* note 153, at 567.

[157] Petro-Chem Processing, Inc. v. EPA, 866 F.2d 433 (D.C. Cir. 1989); Hazardous Waste Treatment Council v. EPA, 861 F.2d 277 (D.C. Cir. 1988); *see also EPA Rule on Banning Waste in Cement Kilns Survives Challenge by Industry Group, Firm*, 19 Env't Rep. (BNA) 1903 (Jan. 27, 1989).

[158] 54 Fed. Reg. 43,718, 43,719 (1989). The EPA does not regulate land-based hazardous wastes consistently. Hazardous waste incinerators are regulated under Subpart O of 40 C.F.R. § 264, while industrial furnaces burning hazardous substances are regulated under 40 C.F.R. § 260. EPA is proposing to make the standards for burning hazardous wastes as uniform as possible. 54 Fed. Reg. 43,718, 43,719 (1989).

[159] *Incineration Company, Sham or Not, Points Out Major Loophole in EPA Policy*, ENVTL. MANAGER'S COMPLIANCE ADVISOR, May 9, 1988, at 1 [hereinafter *Incineration Company*]; *Waste Processing—Action: Hearing on Marine Shale*, ENVTL. POL'Y ALERT, Apr. 20, 1988, at 10.

[160] *Incineration Company*, *supra* note 159, at 1.

environmentalists as well as regulated incinerator operators, claim that the sales are not relevant because they constitute such a small portion of the revenue derived from burning the hazardous wastes. Rather, they suggest that Marine Shale is taking advantage of a loophole in RCRA that exempts from RCRA's provisions facilities that recycle hazardous wastes into a nontoxic product.[161] Marine Shale paid $1 million in fines as settlement of a suit brought by the United States. This deal resulted in criticism of the Department of Justice by members of Congress, EPA, and environmentalists.[162]

EPA's proposed rules governing the burning of hazardous wastes in boilers and industrial furnaces may make such disposal less attractive.[163] Also, burning hazardous wastes for energy recovery, which is presently unregulated, soon may be treated legally the same way as burning wastes for destruction.[164] RCRA standards for particulate matter also will be imposed on boilers and industrial furnaces.[165] Thus, the movement is toward greater inclusion in the RCRA permitting process.[166]

Organic compounds can be destroyed through incineration, but producing a well-designed incinerator and operating it properly is a challenge for both the design engineer and the operator. The "Three

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[161] Christrup, *Nasty Business: The Marine Shale Masquerade*, GREENPEACE, May/June, 1989, at 14, 15. Marine Shale was subject to permit revocation by the State of Louisiana. *State Revokes Permit from Major Waste Handling Facility, Threatening Shutdown*, INSIDE EPA, June 2, 1989, at 12. Challenges were required to be made at the administrative level. *Louisiana Court Rules on Challenges by Marine Shale Processors to DEQ Actions*, 20 Env't Rep. (BNA) 824 (Sept. 15, 1989). The Department of Justice settled a federal case for minor penalties, which settlement has become controversial. *EPA Sources Reportedly Upset by Lack of Indictment in Recent DOJ Settlement*, INSIDE EPA, Aug. 18, 1989, at 1; *Marine Shale Reaches Agreement with U.S. Department of Justice*, 39 JAPCA 1165 (1989); *DOJ, EPA Blasted for Lax Civil Enforcement During Marine Shale Criminal Investigation*, 20 Env't Rep. (BNA) 959 (Sept. 29, 1989).

[162] *EPA Officials Blast Justice Over Failure to Gain Marine Shale Indictment*, ENVTL. POL'Y ALERT, Aug. 23, 1989, at 19.

[163] *See* 54 Fed. Reg. 43,718 (1989).

[164] *Incineration Company*, *supra* note 159, at 1. Refuse-derived fuel plants and pyrolysis plants have not yet proved to be financially feasible or environmentally attractive. *See* Susskind, *Standard Setting By Consent: A Case History*, ENVTL. L., Summer 1986, at 1 (ABA Newsletter).

[165] *Burning Hazardous Waste*, ENVTL. POL'Y ALERT, Jan. 25, 1989, at 7.

[166] In June, 1989, EPA announced that it would separate proposed regulations governing the burning of hazardous wastes in boilers and industrial furnaces from the revised regulation on incinerators. *EPA to Issue Boiler, Furnace Proposal Independent of Incinerator Regs*, INSIDE EPA, June 9, 1989, at 2. EPA divided the regulation to avoid further delay after OMB rejected the incinerator package and the Environmental Defense Fund filed a lawsuit for failure to promulgate regulations for boilers and industrial furnaces. *Id.*; *see also* Environmental Defense Fund v. EPA, 852 F.2d 1316 (D.C. Cir. 1988).

Ts" of incineration are temperature, time, and turbulence.[167] If an organic substance is made hot enough, for long enough, with adequate air, it will oxidize to carbon dioxide, water, and a haloacid, usually hydrochloric acid. The variables, unfortunately, are not independent. Increasing air supply decreases temperature and/or residence time.

The design characteristics of an effective incinerator include: (1) efficient atomization of the wastes; (2) a thorough mixing of wastes and air through high turbulence; (3) a method to ensure that all molecules have the minimum residence time necessary for oxidation; and (4) a scrubber to remove acid gases and uncombusted particulates from the gas stream.[168] Analysis of the scrubber water provides an effective way of monitoring destruction efficiency. It also provides a way of capturing unburned material if a malfunction occurs that does not trigger an automatic shutdown.[169]

The major components of a hazardous waste incineration system are: waste preparation and feeding, combustion chamber(s), air pollution control, and residue/ash handling.[170] Preparation of wastes prior to burning is necessary to put wastes into a form that will allow them to be burned effectively.[171] For example, mixing wastes with varying BTU values creates wastes that burn readily and minimizes the need for external sources of heat energy for complete combustion.

Economic constraints further limit the wastes that can be burned, even if theoretically incinerable. For example, wastes that must be supplemented with auxiliary fuel to burn may be uneconomical to incinerate.[172] Thus, wastes with a high water content are costly both to transport and to incinerate and are more commonly deep-well injected or incinerated at the location where generated.[173] It is also necessary to limit the concentration of heavy metals and substances such as chlorine,[174] which produce toxics when burned and therefore increase costs of air pollution control.

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[167] EWK CONSULTANTS, INC., OCEAN INCINERATION OF HAZARDOUS WASTE: A CRITIQUE ii (1983) (prepared by Dr. Edward W. Kleppinger and Desmond H. Bond) [hereinafter EWK, OCEAN INCINERATION].

[168] *Id.* at iii.

[169] *Id.*

[170] Oppelt, *supra* note 153, at 562.

[171] *See id.* at 562–63.

[172] *See* OTA, OCEAN INCINERATION, *supra* note 72, at 55–57.

[173] *Id.* at 57.

[174] *See id.*

The physical form of the waste and its ash content determine the type of incinerator necessary.[175] Incinerators typically are characterized on the basis of their combustion chamber. Among the most utilized types are liquid injection, rotary kiln, fixed hearth, and fluidized bed.[176] Rotary kiln incinerators, which can destroy solid wastes, slurries, containerized wastes, and liquids, are the type used at most commercial off-site facilities.[177] Liquid injection incinerators are used to destroy pumpable liquid wastes. This is the technology utilized in ocean incineration, which is used primarily for disposing of liquid hazardous wastes.[178]

The first federal standards for air pollution control for incinerators were regulations promulgated under the New Source Performance Standards (NSPS) of the Clean Air Act.[179] The NSPS established a time-averaged particulate emission limit of 0.08 grains per dry standard cubic foot (gr/dscf), corrected to twelve percent CO_2 for all incineration units constructed after August, 1971, that have charging rates greater than fifty tons per day.[180] Many state and local governments have imposed additional opacity standards[181] and, in some instances, more stringent particulate controls.[182]

Hazardous waste incinerators came under the more focused regulation of RCRA when technical standards were proposed in December, 1978.[183] The initial requirement for a land-based incinerator is to obtain a RCRA permit. This requires obtaining a "Part A permit"[184] which must be followed by a "Part B permit" by November

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[175] Oppelt, *supra* note 153, at 563.

[176] *Id.* at 562. There are also emerging alternative technologies for hazardous liquid organic waste incineration. They include: (1) the high temperature electric reactor; (2) wet air oxidation; (3) the molten salt reactor; (4) the plasma arc; (5) supercritical water; and (6) molten glass incineration. Only the first three have costs that are comparable to existing technologies. U.S. ENVTL. PROTECTION AGENCY, ASSESSMENT OF INCINERATION AS A TREATMENT METHOD FOR LIQUID ORGANIC HAZARDOUS WASTES, BACKGROUND REPORT II: ASSESSMENT OF EMERGING ALTERNATIVE TECHNOLOGIES 3 (1985).

[177] Oppelt, *supra* note 153, at 563.

[178] *Id.*

[179] 42 U.S.C. § 7411 (1982 & Supp. V 1987).

[180] Oppelt, *supra* note 153, at 559.

[181] Opacity is the state of a substance which renders it partially or wholly impervious to the rays of light. Opacity as used in air pollution regulations refers to the obscuration of an observer's view. A. REITZE, ENVIRONMENTAL LAW 3–110 (2d ed. 1972).

[182] *See, e.g.*, City of Miami v. City of Coral Gables, 233 So. 2d 7 (Fla. Dist. Ct. App. 1970); Oriental Blvd. Co. v. Heller, 27 N.Y.2d 212, 265 N.E.2d 72, 316 N.Y.S.2d 226 (1970); State v. Lloyd A. Fry Roofing Co., 9 Or. App. 189, 495 P.2d 751 (1972).

[183] 43 Fed. Reg. 58,946 (1978). In 1980, proposed regulations were promulgated and in 1981 performance standards were proposed. 46 Fed. Reg. 7678 (1981). On June 24, 1982, interim final standards were published. 47 Fed. Reg. 27,516 (1982).

[184] 40 C.F.R. § 270.13 (1989); *see also* R. HALL, T. WATSON, R. SCHWARTZ, N. BRYSON &

8, 1989.[185] Part A permits require compliance with a number of federal statutes.[186] Part B permits have both general requirements[187] and specific requirements for incinerators.[188]

As part of the permitting process, the RCRA regulations impose performance requirements on land-based incinerators. Permit applicants must perform a waste analysis as part of their trial burn and submit the results to EPA.[189] Applicants also must verify that wastes fed to the incinerator are within the permit limits.[190] A hazardous waste incinerator must achieve a destruction and removal efficiency (DRE) of 99.99% for each principal organic hazardous constituent (POHC).[191] POHCs are selected from a waste's constituents to represent those that are present in large quantities and/or pose the greatest difficulty to incinerate.[192] For specified "very hazardous substances," a DRE of 99.9999% must be achieved.[193] This requirement also applies to PCBs burned under TSCA authority.[194] An

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R. DAVIS, RCRA HAZARDOUS WASTE HANDBOOK 9–13 (8th ed. 1989) [hereinafter RCRA HANDBOOK].

[185] 40 C.F.R. §§ 270.14–.29 (1989); *see also* RCRA HANDBOOK, *supra* note 184, at 9–15.

[186] *See* 40 C.F.R. § 270.13 (1989). Permits must comply with the hazardous waste program under RCRA, 42 U.S.C. §§ 6921–6934 (1982 & Supp. V 1987), the Underground Injection Control Program under the SDWA, 42 U.S.C. §§ 300h to 300h-4 (1982 & Supp. V 1987), the National Pollutant Discharge Elimination System (NPDES) Program under the FWPCA, 33 U.S.C. § 1342 (1982 & Supp. V 1987), the Prevention of Significant Deterioration (PSD) of Air Quality Program under the Clean Air Act, 42 U.S.C. §§ 7470–7491 (1982), the Nonattainment Program under the Clean Air Act, 42 U.S.C. §§ 7501–7508 (1982 & Supp. V 1987), the National Emission Standards for Hazardous Air Pollutants (NESHAP), 42 U.S.C. § 7412 (1982 & Supp. V 1987), pre-construction approval under the Clean Air Act, 42 U.S.C. § 7411 (1982 & Supp. V 1987), the ocean dumping permit program under the MPRSA, 33 U.S.C. § 1412 (1982 & Supp. V 1987), the dredge and fill program under the FWPCA, 33 U.S.C. § 1344 (1982 & Supp. V 1987), and other relevant environmental permits, including state permits. 40 C.F.R. § 270.13(k) (1989). Many federal environmental statutes include provisions that delegate permit procedures to the states, such as section 110 of the Clean Air Act. 42 U.S.C. § 7410 (1982 & Supp. V 1987). Other federal laws that may also apply and should be evaluated in the permitting process include: the Wild and Scenic Rivers Act, 16 U.S.C. §§ 1271–1287 (1982 & Supp. V 1987); the National Historic Preservation Act of 1966, 16 U.S.C. §§ 470 to 470w-6 (1982 & Supp. V 1987); the Endangered Species Act, 16 U.S.C. §§ 1531–1544 (1982 & Supp. V 1987); the Coastal Zone Management Act, 16 U.S.C. §§ 1451–1464 (1982 & Supp. V 1987); and the Fish and Wildlife Coordination Act, 16 U.S.C. §§ 661–668ee (1982 & Supp. V 1987).

[187] 40 C.F.R. §§ 261.1, 270.14 (1989).

[188] *Id.* §§ 264.340–.351, 270.19.

[189] *Id.* §§ 264.341, 270.14, 270.62.

[190] *Id.* §§ 264.341, 264.345.

[191] *Id.* § 264.343; *see also* Lee, Huffman & Oberacker, *An Overview of Hazardous/Toxic Waste Incineration*, 36 JAPCA 922 (1986).

[192] 40 C.F.R. § 264.342 (1989).

[193] 44 Fed. Reg. 31,551 (1979).

[194] 40 C.F.R. § 761.70 (1989).

incinerator producing more than 1.8 kilograms per hour of hydrogen chloride (HCl) must not emit more than the larger of 1.8 kilograms per hour or one percent of the HCl in the stack gas.[195] Particulate emissions are limited to 180 milligrams per dry standard cubic meter (0.08 grains/dscf).[196]

A permit for a new hazardous waste incinerator must establish conditions necessary to meet the applicable standards.[197] Operating requirements must specify conditions in six categories: (1) the carbon monoxide concentration in the exhaust gas; (2) the waste feed rate; (3) the combustion temperature; (4) the appropriate indicator of combustion gas velocity; (5) the allowable variations in incinerator system design; and (6) other necessary operating requirements.[198] The first four of these operating requirements must be monitored by the incinerator operator.[199]

Obtaining a permit for a hazardous waste management facility requires compliance with a considerable body of regulatory law[200] in addition to the specific requirements for incinerators.[201] Furthermore, the 1984 RCRA amendments mandate that all hazardous waste permits include all necessary controls to protect human health and the environment. This open-ended legal authority is known as the "omnibus authority."[202] To date, regulations to implement this provision have been delayed by the Office of Management and Budget (OMB).[203]

Critics consider permitting incinerators under RCRA to be slow, subjective, uncertain, expensive, and complex.[204] Even when a fa-

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[195] *Id.* § 264.343(b).

[196] *Id.* § 264.343(c).

[197] *Id.* § 264.344.

[198] *Id.* § 264.345.

[199] *Id.* § 264.347.

[200] *Id.* §§ 124, 270.

[201] *Id.* § 270.19.

[202] 42 U.S.C. § 6925(c)(3) (1982 & Supp. V 1987).

[203] *EDF Warns States on Incinerator Permits*, 39 JAPCA 485 (1989). Draft hazardous waste regulations under RCRA subpart O would establish carbon monoxide limits, control toxic metals, and create tighter requirements on risks. *Key Congressmen Urge EPA to Rethink Superfund Policy Review*, INSIDE EPA, Sept. 23, 1988, at 1, 10. EPA's proposed rules for hazardous waste incinerators were rejected by OMB. *Incinerator Rules: OMB Rejects EPA Proposal, Saying Benefits Do Not Justify Costs*, ENVTL. POL'Y ALERT, Mar. 22, 1989, at 20; *see also OMB Rejects Proposed Incinerator Regs, Citing High Costs, Low Return*, INSIDE EPA, Mar. 10, 1989, at 2.

[204] *See, e.g.*, Boomer & Trenholm, *Common Deficiencies in RCRA Part B Incinerator Applications*, 37 JAPCA 275 (1987) (common deficiencies exist in engineering descriptions, process monitoring, gaseous emission monitoring, automatic waste feed cutoff systems, waste

cility is given a permit, the permit is generally so restrictive that the incinerator often cannot operate without violating the permit.[205] The average time spent obtaining a permit for a new incinerator is three years.[206] Since 1981, almost 100 incinerators have terminated operations.[207] Of the fifty-seven companies in the hazardous waste incineration business in 1981, twenty-three have gone out of business, ended incineration activities, or put considerably less emphasis on incineration.[208] Under RCRA, interim status (Part A) incinerators must have obtained Part B permits by November 8, 1989,[209] although the regulations governing the Part B permits had not been issued as of May, 1989. EPA does not have the personnel or the budget to handle the RCRA permit work.[210] Thus, indirect pressure to leave the incineration field continues to be exerted on operators.

Environmental problems associated with incinerator operations derive from air emissions from the stack, contaminants collected by the air pollution controls, and bottom ash from the combustion chamber. Stack emissions are considered the most severe problem.[211] The expert consensus is that incinerators can be designed and operated to meet applicable environmental laws.[212] When properly operated, incinerators pose little risk to human health. The greatest risk is associated with emissions of metals that are difficult to detect. But metals do not pose much risk for they barely exceed the one-in-a-million action level for cancer risk used by EPA to trigger regulatory actions.[213] POHCs and PICs pose an even smaller risk of two to six

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characterization, sampling and analysis, and quality assurance/quality control); Lee, *Potential Problems with the Current RCRA Incineration Permit Process*, 35 JAPCA 1076 (1985).

[205] Lee, *supra* note 204, at 1076.

[206] Oppelt, *supra* note 153, at 561.

[207] *Id.* at 562. Of the 220 existing hazardous waste incinerators in the United States, about 125 facilities in 34 states have yet to receive final operating permits. *EDF Warns States on Incinerator Permits*, 39 JAPCA 485 (1989).

[208] Oppelt, *supra* note 153, at 562.

[209] 42 U.S.C.A. § 6925(c)(2)(A) (West Supp. 1989); *see also* 40 C.F.R. §§ 270.14–.23 (1989).

[210] *See* Doucet, *Incineration of Hazardous Waste: Critical Review Discussion Papers*, 37 JAPCA 1017–18 (1987).

[211] Air emissions also come from hazardous waste land disposal. EPA has estimated that there are 1.6 million tons of atmospheric emissions annually from such sources. This is about equal to the tonnage of volatile organic compounds emitted by industrial processes. Zegel, *An Overview of Hazardous Waste Issues*, 35 JAPCA 50, 51 (1985).

[212] *See* EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 3; Oppelt, *supra* note 153, at 576.

[213] A 10^{-6} cancer risk is comparable to the risk from having one x-ray in a hospital. Lee, *Incineration of Hazardous Waste: Critical Review Discussion Papers*, 37 JAPCA 1011, 1013 (1987).

orders of magnitude less than the cancer risk associated with metals.[214]

Some experts see basically no differences between the combustion of hazardous wastes and the combustion of fossil fuel in the emissions of PICs,[215] although the variability from source to source may be high. A recent study found dioxin emissions, which seem to be a major concern of those opposed to incinerators, to be an emission risk that comes primarily from automobile exhaust pipes.[216] While environmental problems from incinerators are relatively minor, there is enough uncertainty concerning the actual operation and monitoring of incinerators to encourage opposition to their use.[217]

Limits on the technology used for monitoring incinerator emissions complicate the problem of assuring the public that incinerators are being properly operated. To obtain a RCRA permit for operating a hazardous waste incinerator, a carefully monitored trial burn is required.[218] If legally adequate performance is demonstrated, EPA issues a permit specifying the operating requirements to assure burning under conditions similar to those found during the test burn.[219] These permit parameters establish CO levels in the stack gas, waste feed rates, combustion zone temperatures, gas flow rate (residence time in the combustion zone), and air pollution control operating conditions.[220] These operating parameters are required to ensure that wastes will be effectively destroyed, even under "upset" conditions.[221] There have been more than 100 trial burns that indicate that a large variety of hazardous wastes can be incinerated and that the incinerating facility can still conform to regulatory requirements even under upset conditions.[222] Furthermore, RCRA permits require that all hazardous waste feeds be shut off automatically during an upset.[223]

The present regulatory approach has several major weaknesses: it demands a rather accurate knowledge of the POHCs in the wastes being burned; compliance after the trial burn is obtained through

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[214] *Id.*
[215] *See id.* at 1012.
[216] *Id.*
[217] *See, e.g.*, Christrup, *supra* note 161, at 14.
[218] 40 C.F.R. §§ 264.340-.351 (1989).
[219] *Id.* §§ 264.344-.345.
[220] *Id.* § 264.345.
[221] *See* Doucet, *supra* note 210, at 1017.
[222] *Id.*
[223] Lee, *supra* note 213, at 1014.

controls imposed on operating conditions that may not reflect emissions accurately; and it does not fully address the formation of products of incomplete combustion (PICs).[224] Determining the extent of harmful emissions from an incinerator is an expensive, time-consuming process. Successful incineration requires that proper conditions be maintained during the burn. But failures can occur. The challenge is to meet the "Three Ts" of incineration—time, temperature, and turbulence—that are appropriate for the substances being burned.[225] A successful burn is achieved by ranking POHCs based on how difficult they are to burn and then selecting an appropriate burning regime that will destroy the most difficult to burn POHC present in the wastes.[226] The biggest problem is that the composition of the wastes may not be fully known or the POHC ranking system may not be accurate.

After selecting an appropriate burn regime, various incineration surrogates are used to keep operations within legally acceptable limits.[227] There are three common approaches. First, CO and total hydrocarbon can be continuously monitored.[228] Despite its common usage, however, little or no correlation exists between these surrogate emissions and the organic emissions sought to be controlled.[229] Second, indicator additives that do not appear in the waste, such as Freon or sulfur hexafluoride, can be used. By comparing the amount of the indicator before and after combustion, combustion efficiency can be determined. Unfortunately, the indicator chemical effectively may be destroyed while PICs are produced in improper concentrations due to differences in their combustion characteristics.[230] The third approach, which is less common, involves using POHC/PIC soups. Stable POHCs that produce stable PICs are used as standard test mixtures (soups) for incineration performance certification. The

[224] Dellinger, *Incineration of Hazardous Waste: Critical Review Discussion Papers*, 37 JAPCA 1019 (1987). The formula for Destruction Efficiency (DE) is as follows: DE = input–output/input x 100%. If all of a quantity of hazardous chemicals were incinerated and turned into dioxin, the incineration would be perfect and the DE would be 100% even though all of the burned chemicals were turned into a different, more harmful chemical. This result could not happen, but it illustrates a significant weakness of the DE concept.

[225] *See* Williams, Becker & Girovich, *3-D Flow Modeling of a Hazardous Waste Incinerator*, 38 JAPCA 1050 (1988).

[226] *See* Dellinger, *supra* note 224, at 1020–21.

[227] *Id.* at 1022.

[228] *See, e.g.*, Staley, Richards, Huffman, Olexsey & Dellinger, *On the Relationship Between CO, POHC, and PIC Emissions from a Simulated Hazardous Waste Incinerator*, 39 JAPCA 321 (1989).

[229] *Id.* at 323.

[230] *See* Dellinger, *supra* note 224, at 1022.

difficulty with this approach lies in the lack of understanding concerning the relative incinerability of POHC mixtures and the fact that stable POHCs may pass a test that less stable components of the waste might fail.[231]

The final subsystem of hazardous waste incineration is residue and ash handling.[232] The type and quantity of ash produced by incineration depends on the composition of the wastes being burned. Solid wastes create more ash than liquid wastes. Incinerators that use air pollution controls generate sludges and effluents from wet scrubbers and dusts from dry scrubbers or other collection devices.[233] The land-based incinerator regulation[234] and the proposed regulation for ocean incineration define ash and other residues as hazardous wastes and impose the requisite control requirements.[235] Under RCRA, however, a variance can be granted if the residue is shown to be non-hazardous.[236] Residues also can be delisted on a case-by-case basis under the 1984 RCRA amendments.[237]

The major controversy concerning incinerator ash is whether ash from municipal incinerators should be regulated as RCRA hazardous waste.[238] Currently, many facilities claim that they are exempt under RCRA section 3001(i)(G), which would allow them to be regulated under the less stringent subtitle D if the wastes are household wastes or commercial solid wastes even if the wastes fail an EPA toxicity test. This issue is presently an unresolved question as neither the courts nor EPA have ruled.[239]

Incineration technology has improved considerably in the past decade. Stringent regulatory requirements can now be met. Nonetheless, political opposition to the siting of incinerators is intense.[240]

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[231] *See id.*

[232] Oppelt, *supra* note 153, at 566.

[233] *See id.*

[234] 40 C.F.R. §§ 264.270–.283 (1989).

[235] 50 Fed. Reg. 8222 (1985).

[236] *See* 40 C.F.R. §§ 261.3(d), 264.351, 265.351 (1989) (defining nonhazardous waste).

[237] *Id.* § 260.22.

[238] *See Florio Introduces Bill to Regulate Air, Ash Generated by Municipal Garbage Incineration*, 19 Env't Rep. (BNA) 294, 295 (July 1, 1988). The extent to which the use of municipal incineration expands may depend on how the disposal of waste ash is treated. If it is considered hazardous waste under Subtitle C of RCRA, as many environmentalists desire, the additional costs may slow growth in the use of incinerators. *See Municipal Ash Bill Stalls in Markup; Florio Says He Will Offer 22 Amendments*, 19 Env't Rep. (BNA) 467 (Aug. 5, 1988); *Environmentalists, EPA Differ in Interpreting Results of Study on Municipal Incinerator Ash*, 18 Env't Rep. (BNA) 1963, 1965 (Jan. 1, 1988); *Municipal Incinerator Ash Disposal*, ENVTL. POL'Y ALERT, Apr. 20, 1988, at 9.

[239] *See* INSIDE EPA, May 12, 1989, at 16.

[240] *See* Russell, *Environmental Racism*, 11 AMICUS J., Spring 1989, at 22.

Such opposition is fueled by the uncertainties and technological limitations concerning monitoring despite the fact that the relative risk from incineration is low compared to disposal alternatives. Ocean incineration offers a significantly lower risk than the already low human health risk associated with land-based incineration because of its greater distance from human populations.[241] This particular approach to incineration, the incineration at sea of liquid organic hazardous wastes, has been the subject of intense debate and is the focus of the next section.

IV. OCEAN INCINERATION

A. *Introduction*

Ocean incineration usually is considered appropriate only for liquid organic hazardous wastes.[242] Although up to twenty percent of all hazardous wastes are theoretically incinerable, only about eight percent are suitable for ocean incineration.[243] The liquid injection technology used in ocean incineration makes this alternative less versatile than land-based incineration, which, by using rotary kilns, also can burn solids and sludges.[244] Liquid injection incinerators can handle a large volume of wastes, but the wastes must be in a form in which they can be pumped and introduced into the incinerator as small droplets.[245] In addition, incinerable wastes must have the physical form, energy content, and hazardous properties appropriate for the particular incineration technology being used.[246] Ocean incineration is especially useful for destruction of highly chlorinated liquid wastes that are difficult to destroy in land-based incinerators.[247] Polychlorinated wastes, while comprising less than ten percent of incinerable hazardous wastes, are some of the most toxic.[248] Wastes with a high metal content, however, may be inappropriate for disposal through incineration.[249]

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[241] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 1.

[242] *See* OTA, OCEAN INCINERATION, *supra* note 72, at 3.

[243] *Id.* The wastes most appropriate for ocean incineration include waste oils, nonhalogenated solvents, halogenated solvents, other organic liquids (often referred to as RCRA "K" wastes), and polychlorinated biphenyls (PCBs). *Id.* at 71.

[244] *See* EPA, INCINERATION ASSESSMENT: BACKGROUND REPORT I, *supra* note 121.

[245] OTA, OCEAN INCINERATION, *supra* note 72, at 55.

[246] *Id.*

[247] *Id.* at 3.

[248] *Id.* at 4.

[249] *See supra* note 140, *infra* notes 454–60, 521, 541–43, 776 and accompanying text.

The chemical, petroleum, and coal industries produce the great majority of the incinerable liquid organic wastes,[250] at least half of which is generated by industries situated along the Gulf and Middle Atlantic Coasts. Coastal proximity is one factor making these wastes suitable for ocean incineration.[251] Moreover, the amount of wastes generated at these sites is expected to increase in the future, even after accounting for waste reduction and recycling efforts.[252] Increases will occur in part because nonincinerable wastes are more suitable for waste reduction, recycling, and recovery.[253]

An additional factor affecting the quantity of wastes available for ocean incineration is the amount disposed on-site where generated. Because ocean incineration is off-site, the extent of its use is at best inversely proportional to on-site disposal. An EPA analysis found that at least ninety percent of present liquid waste incineration was at on-site facilities.[254] This practice, therefore, introduces considerable uncertainty concerning the potential market for ocean incineration.[255]

Nevertheless, using a midpoint estimate for liquid hazardous waste incineration, EPA projected a need for thirty-three incinerator ships with a capacity of 50,000 MT per ship per year or eighty-two land-based incinerators with a capacity of 20,000 MT per year.[256] Although these projections are not easily verifiable, a shortfall in present and future capabilities for incinerable waste management had been asserted until only recently.[257] The land-based incineration industry claimed otherwise,[258] despite the fact that it then expanded

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[250] OTA, OCEAN INCINERATION, *supra* note 72, at 66.

[251] *Id.*

[252] *Id.* at 69–71 (citing MINNESOTA WASTE MANAGEMENT BD., REVISED DRAFT HAZARDOUS WASTE MANAGEMENT PLAN (1984)).

[253] *Id.*

[254] *Id.* at 73 (citing U.S. ENVTL. PROTECTION AGENCY, ASSESSMENT OF INCINERATION AS A TREATMENT METHOD FOR LIQUID ORGANIC HAZARDOUS WASTES, BACKGROUND REPORT III: ASSESSMENT OF THE COMMERCIAL HAZARDOUS WASTE INCINERATION MARKET (1985)).

[255] *Id.*

[256] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 60.

[257] EPA, HAZARDOUS WASTE SYSTEM, *supra* note 1, at 4-1; *see also* Wybenga, *A "Burning" Issue: Ocean Incineration*, 39 PROC. OF THE MARINE SAFETY COUNCIL 143 (1982).

[258] *Incineration of Hazardous Waste at Sea, Hearing Before the Subcomm. on Fisheries and Wildlife Conservation and the Environment and the Subcomm. on Oceanography of the House Comm. on Merchant Marine and Fisheries*, 98th Cong., 1st Sess. 234 (Dec. 7, 1983) (statement of Robert C. Gregory, Vice President and Technical Director, Rollins Environmental Services, Inc.) [hereinafter *House Hearing 1983*]. In opposition to ocean incineration, the Cousteau Society testified that the London Dumping Convention (LDC) requires a showing of need. It claimed there was no need, because both Rollins Environmental Services, Inc. and ENSCO, Inc. had excess capacity. The Cousteau Society appended letters from executives of

its capacity between 1985 and 1987.[259] Future demand for incineration ultimately may decline, however, as some harmful chemicals, such as PCBs, no longer are manufactured and because of an increase in the use of industrial boilers and furnaces for hazardous waste disposal.[260] But, demand could increase quickly if the rules described previously[261] concerning boilers and industrial furnaces become more stringent and thereby direct hazardous wastes to other disposal options.

The capacity of the waste treatment and disposal industry is, of course, a function of the stringency of the laws applied to them. If, for example, EPA imposed regulations as strict as those proposed for ocean incineration to land-based incineration, some land-based incinerators could be forced out of business.

Compared to land-based incineration, ocean incineration technology is in its infancy. At present, the combined capacity of all ocean incineration ships in the world could burn only a small portion of the United States' incinerable hazardous wastes. Ocean incineration presents most of the problems associated with land-based incineration, although it poses fewer public health problems because it distances incineration from population concentrations. However, ocean incineration presents at least four types of problems not as extensively associated with land-based systems: (1) the use of ports to transfer hazardous wastes to ships creating additional potential for accidents;[262] (2) the potential impact of the emissions on the ocean ecosystems;[263] (3) incineration of wastes by using ships at sea complicates monitoring and enforcement; and (4) additional legal constraints from international laws concerning at-sea operations. As is discussed below, most of these concerns are not associated only with the ocean incineration option.

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both land-based incineration companies that attested to the ability of those companies to handle the incineration of wastes proposed for ocean incineration. *Ocean Incineration, Hearings Before the Subcomm. on Environmental Pollution of the Senate Comm. on Environment and Public Works*, 99th Cong., 1st Sess. 565–88 (1985) (statement of the Cousteau Society) [hereinafter *Senate Hearing 1985*].

[259] *From Shortage to Surplus, The Changing State of Incinerator Capacity*, ENVTL. MANAGERS COMPLIANCE ADVISOR, May 23, 1988, at 6 [hereinafter *From Shortage to Surplus*]. In 1989, Rollins Environmental Services had the capacity in place to increase incineration volumes by 30–40%. VALUE LINE INVESTMENT SURVEY 353 (2d ed. June 30, 1989).

[260] *From Shortage to Surplus*, *supra* note 259, at 7.

[261] *See supra* notes 158, 163–66 and accompanying text.

[262] *See* MARITIME ADMIN., U.S. DEP'T OF TRANSP., PLANNING A PORT INTERFACE FOR AN OCEAN INCINERATION SYSTEM (1986) (Report No. MA RD 760–85046) (prepared by Henry Marcus and Maurice Glucksman).

[263] Land-based incineration, however, can also affect the oceans with the fallout of emissions transported as air pollution from these facilities.

B. History

Ocean incineration—the concept of using floating furnaces to burn liquid hazardous wastes at sea—began in 1969 as an alternative to dumping wastes directly into the ocean. Ocean incineration was developed by some European countries because of a shortage of land for disposal and because ocean incineration was considered environmentally preferable to most land disposal options for hazardous wastes.[264] A modified chemical tanker, the *Matthias I*, first burned organochlorine waste in the North Sea.[265] The wastes incinerated at sea increased from 4000 tons per year (t/y) in 1969 and stabilized at about 100,000 t/y in the 1980s.[266]

During the 1970s and the early 1980s, two additional incinerator ships, the *Matthias II* and the *Vulcanus I*,[267] successfully operated off the coast of Europe in the North Sea.[268] About 320 voyages were made, and about 650,000 metric tons of hazardous wastes were incinerated.[269] No collisions, groundings, rammings, fires, or other accidents occurred, nor were there any spills at port while loading wastes onto these ships.[270] In 1983, the *Matthias II* lost its right to operate when West German authorities detected high levels of dioxin in its incineration exhaust gases.[271] Another vessel, the *Matthias III*, operated briefly between 1975 and 1977, but was sold in 1979 for scrap in Spain because test burns showed that it was unsuitable for the incineration of organohalogen wastes at sea.[272] In 1979, a new vessel, the *Vesta*, owned by Lehnkering Montan Transport A.G. of the Federal Republic of Germany, began operation in the North

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[264] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 23.

[265] Asmus & Johnson, *A Sea of Troubles: Where Will Ocean Incineration Turn Up Next?*, GREENPEACE, March/April 1988, at 7. The West German chemical companies, Bayer and Solvey et Cie, employed the ship. The *Matthias I* was decommissioned in 1975. Helsing, *Offshore Disposal of Hazardous Waste*, ENVTL. REG. ANALYST, July 1980, at 2, 3.

[266] EUROPEAN COUNCIL OF CHEM. MFRS.' FED'NS, INCINERATION AT SEA: HISTORY, STATE OF THE ART AND OUTLOOK 3 (1985) [hereinafter CEFIC, INCINERATION AT SEA].

[267] OTA, OCEAN INCINERATION, *supra* note 72, at 193. The *Vulcanus* was renamed the *Vulcanus I* when *Vulcanus II* was built.

[268] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 78. The Oslo Dumping Convention regulates, in part, incineration activities in the North Sea. *See* Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, Feb. 15, 1972, 932 U.N.T.S. 5 [hereinafter Oslo Dumping Convention].

[269] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 78.

[270] *Id.*

[271] The ship was reportedly emitting 40–50 grams of dioxin per incineration journey. Bunin, *Ocean Incineration—The Case for a Global Ban*, STICHTING GREENPEACE COUNCIL 1, 4 (1988).

[272] International Maritime Organization, *Incineration At Sea*, SCIENTIFIC GROUP ON DUMPING, 7TH MEETING, Agenda Item 10 (LDC/SG.7/10/5) (Sept. 12, 1983); *see also* Bunin, *supra* note 271, at 4.

Sea.[273] In 1982, the *Vulcanus II* was constructed for Ocean Combustion Services of the Netherlands.[274] Ocean Combustion Services became a wholly-owned subsidiary of Chemical Waste Management, Inc. (Chem Waste) in 1980. Thus, the two *Vulcanus* ships effectively became the property of Waste Management, Inc. (Waste Management), the parent company of Chem Waste. The two *Vulcanus* ships and the *Vesta* are the only ocean incineration vessels remaining in operation today.[275]

Before any corporation could begin incinerating hazardous wastes in waters of the United States, Congress passed the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), also known as the Ocean Dumping Act.[276] The MPRSA regulates the transportation of material from the United States for the purpose of dumping into ocean waters, and prohibits ocean dumping of wastes without a federal permit from vessels registered in the United States.[277] The purpose of the MPRSA is to place a strict limit on the dumping into ocean waters of any material that will "adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities."[278]

Under the MPRSA, EPA issued two types of permits—short-term "research" permits and "special" (commercial operating) permits.[279] In evaluating applications for ocean dumping permits, EPA must consider a number of environmental factors as well as the alternatives to ocean dumping.[280] Although EPA began promulgating ocean dumping regulations in 1973, and issued its first permit in 1974,[281] it did not publish complete regulations governing the issuance of both types of permits until 1977.[282] Under these regulations, EPA may issue a permit only if the agency determines that there are no practicable improvements that will reduce adverse impacts and there are no practicable alternatives available that have less adverse environmental impact or potential risk.[283]

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[273] Bunin, *supra* note 271, at 4.

[274] CEFIC, INCINERATION AT SEA, *supra* note 266, at 4, 11.

[275] Nassos, *The Problem of Ocean Incineration: A Case of Modern Mythology*, 18 MARINE POLLUTION BULL. 211 (1987).

[276] 33 U.S.C. §§ 1401–1445 (1982 & Supp. V 1987).

[277] *See id.* §§ 1411–1412.

[278] *Id.* § 1401(b).

[279] *Id.* § 1412(b); 50 Fed. Reg. 8231 (1985).

[280] 33 U.S.C. § 1412(a).

[281] 38 Fed. Reg. 8726 (1973) (proposed Apr. 5, 1973); *see also* Note, *The United States Environmental Protection Agency's Proposal for At-Sea Incineration of Hazardous Waste—A Transnational Perspective*, 21 VAND. J. TRANSNAT'L L. 157, 172 (1988).

[282] 40 C.F.R. §§ 220–223 (1988).

[283] *Id.* § 227.16(a).

In 1985, EPA proposed rules modifying its ocean dumping regulations concerning ocean incineration and provided for three types of permits:[284] research permits with a duration up to six months;[285] emergency permits where urgent action is required to protect human health;[286] and operating permits that would take the place of "special" permits and would be issued after a needs assessment that required a comparative evaluation with land-based incineration.[287] In response to EPA's request for comments on the proposed regulation, the Oceanic Society submitted lengthy comments generally opposing ocean incineration on behalf of a national coalition of thirty-five environmental organizations.[288]

After the first ocean dumping regulations under the MPRSA were issued in 1973,[289] Shell Chemical Company (Shell) was prohibited from dumping its untreated organochlorine wastes into the ocean.[290] Therefore, Shell began storing its wastes in above-ground storage tanks in Texas, and in 1974 hired Ocean Combustion Services to incinerate the wastes at sea using the *Vulcanus I* incinerator vessel.[291]

On January 23, 1974, EPA released a legal memorandum stating that it lacked regulatory authority over ocean incineration because the MPRSA provided no specific language giving EPA such authority, and the legislative history did not indicate that Congress intended airborne pollutants to be within the purview of the MPRSA.[292] Nonetheless, Congressman John D. Dingell, a principal author of the MPRSA, and the National Wildlife Federation (NWF) convinced EPA that it had jurisdiction over incinerator ships as "indirect" ocean dumpers.[293] On October 3, 1974, EPA issued a re-

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[284] 50 Fed. Reg. 8222 (1985) (to be codified at 40 C.F.R. §§ 220, 227, 228, 234) (proposed Feb. 28, 1985).

[285] *Id.* at 8231, 8259 (to be codified at 40 C.F.R. § 234).

[286] *Id.* at 8232, 8259.

[287] *Id.* at 8231, 8259.

[288] OCEANIC SOCIETY, JOINT COMMENTS OF ENVIRONMENTAL AND OTHER CITIZEN ORGANIZATIONS IN RESPONSE TO THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S DRAFT REGULATIONS ON OCEAN INCINERATION (1985) [hereinafter OCEANIC SOCIETY, JOINT COMMENTS].

[289] 38 Fed. Reg. 8726 (1973).

[290] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 24.

[291] *Id.* at 24.

[292] Kamlet, *Ocean Disposal of Organochlorine Wastes by At-Sea Incineration*, in OCEAN DUMPING OF INDUSTRIAL WASTES 298–99 (B. Ketchum, D. Kester & P. Park ed. 1981).

[293] *Id.* at 299. This interpretation was based on EPA's concern that the failure to regulate recently developed waste disposal techniques involving ocean incineration would frustrate the purposes of the MPRSA and the London Dumping Convention. *Id.* at 300. Thus, EPA determined that ocean incineration of wastes was under the purview of the MPRSA, as amended. *Incineration of Hazardous Waste at Sea: Hearing Before the Subcomm. on Ocean-*

vised legal memorandum reversing its position, and stating that the Ocean Dumping Act applied to ocean incineration.[294]

EPA had issued an Ocean Dumping Regulation in 1973, but because the MPRSA did not provide specific technical criteria for incineration activities, EPA issued ocean incineration permits under the MPRSA using administrative and technical guidelines derived from the London Dumping Convention (LDC).[295] Under the LDC, ocean incineration is considered a method of dumping and is, therefore, subject to that Convention.[296] The Oslo Convention, which deals in part with dumping in the North Sea, also considers ocean incineration subject to its dumping provisions.[297]

In October, 1974, regulatory activities began with a joint proposal by EPA, the NWF, and Shell to evaluate incineration at sea as a viable alternative to ocean dumping, land disposal, or land-based incineration of highly toxic substances.[298] EPA issued a number of research or interim permits for incineration at sea between 1974 and 1982. Although EPA made a tentative decision to issue "special" permits for at-sea incineration under the existing ocean dumping regulations in late 1983, it abandoned the effort to issue permits by the spring of 1984.

Between 1974 and 1982, EPA issued permits for four series of ocean burns, three in the Gulf of Mexico and one in the Pacific Ocean, conducted on the *Vulcanus I*.[299] The first series of burns occurred during 1974 and 1975 when Shell conducted two research burns[300] and two operational burns in the Gulf of Mexico under federal per-

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ography of the House Comm. on Merchant Marine and Fisheries, 100th Cong., 1st Sess. 58 table 1 (1987) [hereinafter *House Hearing 1987*].

[294] Kamlet, *supra* note 292, at 300.

[295] *Id.* The London Dumping Convention is an international agreement containing specific regulations governing ocean incineration. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, 26 U.S.T. 2403, T.I.A.S. No. 8165 [hereinafter London Dumping Convention]. For a review and analysis of this convention, see Note, *supra* note 281, at 162–169.

[296] London Dumping Convention, *supra* note 295.

[297] Oslo Dumping Convention, *supra* note 268; *see also* Note, *supra* note 281, at 161.

[298] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 25. On October 10, 1974, EPA added a new site in the western Gulf of Mexico to the list of approved ocean dumping sites for controlled high temperature incineration of organic chloride wastes. *EPA Approves Site of Ocean Burning*, 4 Envtl. L. Rep. (Envtl. L. Inst.) 10,200 (1974) [hereinafter *EPA Approves Site*]. The burn site was designated under authority of section 102(C) of the MPRSA. *Id.*

[299] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 25.

[300] Research permits are issued for burns in cases when the impact and processes of disposal are not fully understood. *EPA Approves Site*, *supra* note 298, at 10,200.

mits.[301] Both EPA and the National Oceanic and Atmospheric Administration (NOAA) monitored these initial burns.[302] Based on the data and experience derived from these burns, EPA rated the use of ocean incineration for the disposal of organochlorine wastes "a success and an environmentally acceptable practice when closely monitored and regulated."[303] EPA had analyzed seawater samples in the incineration area and was unable to detect any change over background levels of pollutants analyzed.[304]

EPA's sanguine evaluation, however, was unwarranted. The EPA surveillance plane had a piston fail as it was taking off, and the NOAA research vessel, *Oregon II*, that was monitoring the burn, had personnel and equipment problems.[305] Other technical problems involving monitoring on the *Vulcanus I* were pervasive.[306] Subsequent burns in the series provided additional data, but the data were not interpreted universally as favorably as EPA interpreted the data.[307] Because of acknowledged shortcomings in monitoring the first burn, a second "research" permit was granted, and the burn occurred between December 2 and December 9, 1974.[308] EPA then approved two additional burns that occurred between December 19 and December 26, 1974, and between December 31, 1974 and January 4, 1975.[309]

On July 8, 1976, pursuant to the National Environmental Policy Act,[310] EPA issued the Final Environmental Impact Statement (FEIS) designating the Gulf of Mexico Incineration Site.[311] In 1977, the second series of burns of organochlorine wastes on the *Vulcanus I* took place in the Gulf of Mexico.[312] The destruction efficiency (DE) for total hydrocarbons ranged from 99.991 to 99.997%.[313] The DE

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[301] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 25.

[302] EPA monitors were stationed on the *Vulcanus* itself, on a nearby Coast Guard ship, and in the air. *EPA Approves Site*, *supra* note 298, at 10,200.

[303] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 25. The incineration that took place disposed of 4200 metric tons of waste, and Shell reported no change in the acidity of the sea at the burn site and a DE above 99.9%. *EPA Approves Site*, *supra* note 298, at 10,200.

[304] OTA, OCEAN INCINERATION, *supra* note 72, at 179.

[305] Kamlet, *supra* note 292, at 302–303.

[306] *Id.* at 302.

[307] *See* EWK, OCEAN INCINERATION, *supra* note 167.

[308] Kamlet, *supra* note 292, at 303–04.

[309] *Id.* at 304; *see also* OTA, OCEAN INCINERATION, *supra* note 72, at 179.

[310] 42 U.S.C. §§ 4321–4370 (1982 & Supp. V 1987).

[311] *House Hearing 1987*, *supra* note 293, at 58.

[312] OTA, OCEAN INCINERATION, *supra* note 72, at 179.

[313] *Id.*

for the major waste constituent, trichloropropane, ranged from 99.92 to 99.98%.[314] This test burn produced the first evidence of an environmental impact caused by ocean incineration.[315] Tests showed evidence of temporary stress on one fish enzyme system,[316] but this impact was attributed subsequently to shipboard handling of the fish.[317] The Office of Technology Assessment interpreted the result as a need for caution and further monitoring.[318]

The third series of burns occurred in 1977 when the United States Air Force had its stock of the herbicide Agent Orange incinerated approximately 332 kilometers west of Johnston Atoll in the Pacific Ocean.[319] The waste contained about equal amounts of 2,4-D and 2,4,5-T contaminated with dioxin (TCDD).[320] About 10,400 metric tons (MT) were destroyed in three burns.[321] According to EPA, the DE was 99.999% and could have been higher because the detection limits of the sampling instruments did not allow a more precise measurement.[322] Dioxin in the emissions was below detection limits in the first and third burns and was only detected in samples for the second burn in this series.[323] Dioxin levels that were detected were so low, however, they may have been caused by sampling errors.[324] The limited environmental monitoring showed no impact on plankton.[325]

An interesting aspect of this burn concerned the legal gymnastics utilized to allow it. Because EPA interpreted the Ocean Dumping Act to include incineration, Agent Orange would appear to have been banned by the absolute prohibition applied to the dumping of chemical warfare agents by the LDC.[326] Nevertheless, EPA rationalized the issuance of the permit by saying it was not the warfare agent that was being dumped but only its combustion products.[327]

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[314] *Id.*

[315] *Id.*

[316] *Id.* at 181.

[317] *See* Connor, *At-Sea Incineration: Up In Smoke?*, 27 OCEANUS 70, 71 (1984).

[318] OTA, OCEAN INCINERATION, *supra* note 72, at 181.

[319] 50 Fed. Reg. 8223 (1985). The site was designated by EPA solely for this purpose and only for the length of time necessary to complete the operation. U.S. ENVTL. PROTECTION AGENCY, INCINERATION OF CHEMICAL WASTES AT SEA (1983).

[320] OTA, OCEAN INCINERATION, *supra* note 72, at 181.

[321] *Id.*

[322] *Id.*

[323] *Id.*

[324] *Id.*

[325] *Id.*

[326] Kamlet, *supra* note 292, at 307.

[327] *Id.*

The last series of burns occurred in 1981–1982 under a research permit issued jointly to Chem Waste and Ocean Combustion Services,[328] which owns the *Vulcanus I*. These burns were conducted on the *Vulcanus I* off the coasts of Texas and Louisiana and were the first attempt by a United States corporation to incinerate PCBs at sea.[329] The first burn of the series produced inconclusive data due to major problems with sampling and analysis.[330] According to EPA, the second burn was successful with a DE for PCBs of 99.99989% and no detectable increases in PCB levels in water samples or organisms.[331]

In December, 1980, Chem Waste and Ocean Combustion Services applied for another joint permit to burn liquid PCBs,[332] and in July, 1981, they applied for a permit to destroy "organohalogen liquid chemical compounds referred to as 'soup.'"[333] In November, 1981, Chem Waste and Ocean Combustion Services applied for a permit to incinerate liquid DDT at sea.[334] In May, 1982, public meetings were held by EPA in Mobile, Alabama and Brownsville, Texas on the applications for the various permits to burn PCBs, "soup," and DDT. About fifty citizens expressed strong opposition to the ocean incineration concept at the Brownsville meeting, and ten to fifteen citizens at the Mobile meeting also opposed ocean incineration.[335] On August 5, 1982, EPA announced that another public hearing would be held in Brownsville, Texas to cover the same subjects as the previous public meetings.[336] During August 17–19, 1982, EPA allowed a second research burn of PCBs on the *Vulcanus I*.[337] On August 31, 1982, the second Brownsville hearing took place, but EPA decided to defer action on the permit applications until all of the PCB research burn data could be analyzed.[338]

Because of the delays, the *Vulcanus I* sailed to Australia and burned 1.6 million gallons of mixed chemical wastes and 250,000

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[328] *See* Note, *supra* note 281, at 173.

[329] *Id.*; U.S. ENVTL. PROTECTION AGENCY, AT-SEA INCINERATION OF PCB-CONTAINING WASTES ONBOARD THE M/T VULCANUS (1983) (EPA-600/57-83-024).

[330] OTA, OCEAN INCINERATION, *supra* note 72, at 181.

[331] *Id.* at 181–82.

[332] *Id.*

[333] *Id.*

[334] WASTE MANAGEMENT, INC., CHRONOLOGY OF EPA PROCESSING OF U.S. OCEAN INCINERATION PERMITS PRIOR TO DECEMBER, 1980 at 1, 7 (1984) [hereinafter WASTE MANAGEMENT CHRONOLOGY].

[335] *Id.* at 7–8.

[336] *Id.* at 8.

[337] *Id.*

[338] *Id.*

gallons of PCB wastes pursuant to the LDC as well as Australian regulations.[339] In December, 1982, the Chem Waste/Ocean Combustion Services permit application was changed to substitute the *Vulcanus II* for the older *Vulcanus I*. While waiting for United States approval, the *Vulcanus II* incinerated wastes in the North Sea in February, 1983.[340] For nearly a year, EPA evaluated data and made requests for supplemental information. In October, 1983, EPA made a tentative decision to issue three "special" permits to Chem Waste and Ocean Combustion Services.[341]

In 1983, the political tide began to turn against ocean incineration. The 1981–1982 Chem Waste/Ocean Combustion Services permits had been issued after an expedited permit procedure involving an attorney named James Sanderson, who, at that time, was under investigation for unrelated conflicts of interest.[342] Sanderson was reportedly a paid part-time advisor to EPA Administrator Anne Gorsuch Burford and was Gorsuch's choice for EPA's number three job,[343] while simultaneously representing CWM on the *Vulcanus* issues.[344] Allegedly, Sanderson wrote the permit conditions for the *Vulcanus* burns in the United States while working under contract with Gorsuch.[345] After the 1981 burn on board the *Vulcanus I*, EPA scientists apparently had serious questions about the reliability of the data obtained. The permits did not require appropriate research, so EPA

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[339] *Id.* at 9.

[340] *House Hearing 1987*, *supra* note 293, at 58.

[341] WASTE MANAGEMENT CHRONOLOGY, *supra* note 334, at 10–11; *see also* 50 Fed. Reg. 8223 (to be codified at 40 C.F.R. pts. 220, 227, 228, 234) (proposed Feb. 28, 1985); OTA, OCEAN INCINERATION, *supra* note 72, at 182. EPA published a tentative determination to issue special and research permits to Chem Waste on October 21, 1983. 48 Fed. Reg. 48,986 (1983). The special permits would have authorized incineration of 300,000 metric tons of mixed chlorine wastes on the *Vulcanus I* and *II* over a three-year period at the Gulf of Mexico Incineration Site. *Id.* A six-month research permit would have authorized the *Vulcanus II* to incinerate DDT. *Id.*; *see also House Hearing 1987*, *supra* note 293, at 58.

[342] *See* Vallette, *Waste Management, Inc.: The Greenpeace Report*, GREENPEACE USA 1, 11 (1987); Gordon, *Firm Represented by Gorsuch Crony Gets Quick Action*, United Press Int'l, Feb. 18, 1986; Peterson & Kurtz, *EPA Speeds Friend's Permit*, Wash. Post, Feb. 19, 1983, at 1, cols. 5–6; Schneider, *The Leper Ships: Incinerator Sent to Sea*, OCEANS, May 1984.

[343] A. BURFORD & J. GREENYA, ARE YOU TOUGH ENOUGH? 1, 82, 87–88 (1986); Peterson & Kurtz, *EPA Speeds Friend's Permit*, Wash. Post, Feb. 19, 1983, at 1, cols. 5–6. The number three job did not then exist; it was a new position conceived by Burford, which she likened to "a mini-OMB within EPA, sort of my own Office of Management and Budget." A. BURFORD & J. GREENYA, *supra*, at 87.

[344] *Ocean Incineration, Hearings Before the Subcomm. on Environmental Pollution of the Senate Comm. on Environment and Public Works*, 99th Cong., 1st Sess. 108, 113 (1985) (testimony of Sue Ann Fruge on behalf of the Gulf Coalition for Public Health, Harlingen, Texas).

[345] GREENPEACE U.S.A., OCEAN INCINERATION OF TOXIC WASTE CHRONOLOGY (n.d.).

had to pay an additional $300,000 for a second analysis.[346] EPA paid an additional $300,000 for a second analysis because the expedited permit did not require that Chem Waste cover such costs.

In 1982, Greenpeace revealed that the *Vulcanus I* permit to incinerate "only PCBs in fuel oil" was changed at the last minute to include "other organic components."[347] Because of this change, the permit allowed wastes contaminated with dioxin to be burned.[348] Ocean incineration thus became part of the so-called "Sewergate" controversy that led to the replacement of Anne Gorsuch by William Ruckelshaus as EPA's Administrator.[349]

The National Wildlife Federation endorsed ocean incineration of wastes in the Gulf of Mexico in 1983,[350] although most other environmental organizations actively concerned with ocean incineration

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[346] Anderson, *Firms Compete for Incineration of Waste at Sea*, Wash. Post, Oct. 9, 1982, at C15.

[347] From December, 1981 through January, 1982, Chem Waste burned nearly 70,000 gallons of PCB waste in the Gulf of Mexico under the EPA research permit. Vallette, *supra* note 342, at 12. The *Vulcanus* also burned 40,000 gallons of dioxin-contaminated leachate from Hyde Park, New York. *Id.* Under the original research permit, this incineration of dioxin would have been illegal. *Id.* "However, someone added the phrase 'and other organic components' to the list of [chemicals] permitted in the research burn. Despite a full internal investigation, the EPA's Inspector General was unable to determine why the change was made, and who made it." *Id.*

[348] Vallette, *supra* note 342, at 12.

[349] *See* A. BURFORD & J. GREENYA, *supra* note 343, at 257. Additionally, in March, 1984, EPA investigated two high-level but unnamed EPA officials who owned substantial Waste Management stock. One, who worked with the EPA toxic substances division, owned $29,000 in Waste Management stock. The other Waste Management investor worked for EPA's water quality division. Vallette, *supra* note 342, at 40 (citing Gibson, *EPA Probes Stock Held By Employees*, Chicago Tribune, Mar. 2, 1984).

[350] *Waste Incineration in Gulf of Mexico Endorsed by National Wildlife Federation*, 14 Env't Rep. (BNA) 1390 (Dec. 2, 1983). The National Wildlife Federation's position on ocean incineration at sea was stated as:

—The destruction and/or treatment of persistent toxic wastes, such as organohalogens, should be favored over disposal- or dispersal-oriented solutions.

—Incineration at sea, like incineration on land, can be an acceptable, even exemplary, means of managing certain waste types when properly conducted and monitored.

—From an environmental standpoint, it cannot be said that land-based incineration (of chlorinated organics, for example) is categorically preferable to incineration at sea, or vice versa; they each have their advantages and their drawbacks.

—Incineration at sea, with appropriate safeguards, should be promoted as one of an array of environmentally acceptable waste management alternatives; its suitability in a given instance must, however, be determined on a case-by-case basis.

Letter from Jay D. Hair, Executive Vice President, National Wildlife Federation, to Ms. Elizabeth Otto, Greenpeace U.S.A. (July 12, 1983) (on file with the *Boston College Environmental Affairs Law Review*).

opposed it. The leading environmental opponents were the Oceanic Society and Greenpeace.[351] Regional environmental organizations also opposed ocean incineration,[352] as did the land-based incineration industry,[353] fishermen and shrimpers,[354] and the tourism industry.[355]

In 1979, EPA banned PCB production and in 1980 prohibited its disposal in landfills. At the time of the PCB research burns on the *Vulcanus I*, only two companies were licensed to incinerate PCBs—Energy Systems Company (ENSCO) in Arkansas, and Rollins Environmental Services, Inc. (Rollins) in Deer Park, Texas—each on a scale of about 200,000 gallons per month.[356] These land-based firms were angry at the size of the *Vulcanus*'s permit because they had to satisfy EPA's permitting requirements with more time-consuming and expensive procedures.[357]

Rollins, a large waste-disposal company that incinerates on land, could lose clients should EPA allow ocean incineration.[358] Rollins, incorporated in Wilmington, Delaware, retained former Delaware Representative Thomas Evans, who in turn hired National Strategies Marketing Group, Inc., run by Robert Beckel, to organize opposition to incineration at sea.[359] Beckel then formed two organizations, one called the Alliance to Save the Ocean, to fight Waste Management on the Gulf Coast,[360] and the other called the Ocean

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[351] Lentz, *Environmental Effects of Ocean Incineration: An Uncertain Science*, in OCEANIC SOCIETY, SOURCES OF POLLUTION AND ITS IMPACT ON ENVIRONMENTAL QUALITY 117 (1986).

[352] *See, e.g.*, *House Hearing 1983*, *supra* note 258, at 67 (statement by Sue Ann Fruge, Gulf Coast Coalition for Public Health).

[353] Opposition to at-sea incineration comes from land-based incinerator companies including Rollins Environmental Services, Energy Systems Co. of Dorado, Arkansas (ENSCO), SEA Chemical Services, IT Corp., Abco Industries, and Waste Technology, Inc., which have most of the land-based incinerator capacity in the United States. *Ocean-Based Incineration of Hazardous Wastes, Hearing Before the Subcomm. on Commerce, Transportation, and Tourism of the House Comm. on Energy and Commerce*, 97th Cong., 1st Sess. 50 (1981) (statement of Melvyn Bell, President of ENSCO); *see also* Connor, *supra* note 317, at 74.

[354] *See, e.g.*, *House Hearing 1983*, *supra* note 258, at 71 (statement of Deyaun Boudreaux).

[355] *See, e.g.*, *House Hearing 1983*, *supra* note 258, at 73 (statement of Jane Rosamond, Mayor Pro Tem, South Padre Island, Texas).

[356] Omang, *Ship to Begin Burning PCBs in Gulf of Mexico*, Wash. Post, Dec. 1, 1981, at 4.

[357] Omang, *Floating Chemical Destroyer Ready to Sail for EPA*, Wash. Post, Dec. 18, 1981, at A33.

[358] Shabecoff, *The Guerilla Fighter and the Lobbyist*, N.Y. Times, July 6, 1985, at L5.

[359] *Id.*; *see also* MacKay, *All's Fair in Politics and Wastes*, WORLD WASTES, Oct. 1, 1985, at 42; Thomas, *Peddling Influence: Lobbyists Swarm over Capitol Hill*, TIME, Mar. 3, 1986, at 26.

[360] MacKay, *supra* note 359, at 42. Reportedly, Beckel arranged a telephone bank to make calls to local citizens on the Gulf Coast under the name of the "Alliance to Save the Ocean." This paper organization was so transparent that the Gulf Coast Coalition, also fighting ocean incineration, rejected its help. *Id.*; *see also* Zurer, *supra* note 155, at 32.

Tourism Council, located in San Francisco, to fight on the West Coast.[361]

Thus, in effect, a land incinerator bankrolled "dummy" local environmental organizations to stir up public opposition to ocean incineration. While Rollins may have influenced local decisions regarding ocean incineration, it appears that the company had minimal impact on policy direction at the concerned national environmentalist organizations such as the Oceanic Society and Greenpeace. It is interesting to note that, in 1981, Waste Management unsuccessfully attempted to take over Rollins Environmental Services, Inc.[362] If Waste Management had succeeded, it would have controlled nearly ninety percent of the off-site hazardous waste incineration industry in the United States and would have co-opted the main opponent to ocean incineration.[363]

In February, 1983, EPA participated in incineration tests in the North Sea.[364] The new ship, *Vulcanus II*, burned waste from vinylchloride production. The waste was eighty-four percent chlorine and therefore presented a difficult challenge to thermal destruction. The *Vulcanus II* successfully destroyed the wastes with a DE of 99.998% for carbon tetrachloride and a DE of more than 99.999995% for trichloroethane.[365]

The opposition to ocean incineration came to a head at the third public hearing in Brownsville, Texas on November 21, 1983 and in Mobile, Alabama on November 22 and 23, 1983. EPA reported that 6488 people registered at the two hearings.[366] Most of the attendees

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[361] MacKay, *supra* note 359, at 42. Two members of the Ocean Tourism Council testified at the July, 1989 EPA hearing in San Francisco without revealing their connections to Beckel. *Id.*

[362] In 1981, Waste Management, Inc., with 1980 revenues of $560 million, attempted to acquire Rollins Environmental Services, a much smaller concern with 1980 revenues of $32 million. *Waste Disposal's Aggressive No. 1*, CHEMICAL WEEK, Aug. 12, 1981, at 40; CHEMICAL MARKETING REP., July 13, 1981, at 9, col. 4. However, the parties failed to reach a definitive agreement and the deal fell apart. Wall St. J., Aug. 14, 1981, at 8, col. 3.

[363] Vallette, *supra* note 342, at 43 (citing Atlas, *Firm Poised to Clean Up*, Chicago Tribune, Aug. 2, 1981; Storch, *Waste Management Merger Off*, Chicago Tribune, Aug. 14, 1981).

[364] OTA, OCEAN INCINERATION, *supra* note 72, at 182.

[365] *Id.*

[366] Proposed Ocean Incineration Regulation, 50 Fed. Reg. 8223 (1985). 6278 people registered at the Brownsville hearing (123 testified), and 214 people registered at the Mobile hearing (26 testified). *House Hearing 1984*, *supra* note 31, at 34. At that time, the Brownsville hearing was the largest public hearing in EPA history. OTA, OCEAN INCINERATION, *supra* note 72, at 3 n.1. More recently, an EPA public hearing in Asheville, North Carolina, concerning the Pigeon River, reportedly drew more than 7000 people, most of them supporting the polluter, Champion International Corporation. Satchell, *Fight for Pigeon River*, U.S. NEWS & WORLD REP., Dec. 4, 1989, at 27, 32.

opposed the granting of permits.[367] By the close of the comment period on January 31, 1984, EPA had received 2039 letters and postcards.[368]

On April 23, 1984, the EPA hearing officer for the Brownsville and Mobile public hearings recommended that EPA: (1) deny the special permits at this time because of the lack of information concerning (a) the need for ocean incineration, (b) the availability and capability of alternatives, and (c) the risks of ocean incineration; (2) issue a research permit only for DDT and PCB incineration to determine whether a DE of 99.9999% can be achieved; (3) deny the research permit until Alabama completes a coastal zone consistency determination; and (4) delay all special permits until EPA issues ocean incineration regulations.[369] In May, 1984, the EPA Assistant Administrator for Water issued a final "determination," which accepted the hearing officer's recommendations and formally denied the permits.[370]

In July, 1984, the House Subcommittee on Environment, Energy and Natural Resources, of the Committee on Government Operations, held a hearing in San Francisco on ocean incineration.[371] In November, 1984, another company, Environmental Oceanic Services Corporation, submitted an application for an ocean incineration permit.[372] EPA then promulgated a Proposed Ocean Incineration Regulation, published in the *Federal Register* in February, 1985, which modified the ocean dumping provisions and provided specific criteria and standards regarding the permits for designation and management of ocean incineration sites.[373] Environmentalist opposition to the Proposed Ocean Incineration Regulation was substantial.[374]

In March, 1985, EPA released an Incineration Assessment that included a comparison of risks from land-based and ocean-based

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[367] Wilczynski, *Should We Give Ocean Incineration a Chance?*, 3 RENEWABLE RESOURCES J., Summer 1985, at 10.

[368] Proposed Ocean Incineration Regulation, 50 Fed. Reg. 8223 (1985).

[369] WASTE MANAGEMENT CHRONOLOGY, *supra* note 334, at 11; *see also* Blumm & Noble, *The Promise of Federal Consistency Under § 307 of the Coastal Zone Management Act*, 6 Envtl. L. Rep. (Envtl. L. Inst.) 50,047, 50,052 (Aug. 1986).

[370] 50 Fed. Reg. 8223 (1985).

[371] WASTE MANAGEMENT CHRONOLOGY, *supra* note 334, at 13.

[372] *House Hearing 1987*, *supra* note 293, at 59.

[373] Proposed Ocean Incineration Regulation, 50 Fed. Reg. 8222 (1985) (to be codified at 40 C.F.R. §§ 220, 227, 228, 234). For a broad discussion of the proposed regulatory scheme, see INCINERATION-AT-SEA TASK FORCE, CRITERIA AND STANDARDS DIVISION, U.S. ENVTL. PROTECTION AGENCY, SUMMARY OF PUBLIC COMMENTS ON THE PROPOSED OCEAN INCINERATION REGULATION (50 F.R. 8222, February 28, 1985) (1985) [hereinafter EPA, COMMENTS ON PROPOSED REGULATION]; Note, *supra* note 281, at 173–80.

[374] WASTE MANAGEMENT CHRONOLOGY, *supra* note 334, at 13.

incineration.[375] One month later, EPA's Science Advisory Board, a group of independent scientists, issued a report on the current knowledge about ocean incineration.[376] Between April and May, 1985, EPA held five public hearings on the Proposed Ocean Incineration Regulation.[377]

Also in 1985, Chem Waste requested a research permit to conduct a "test burn" of PCBs in the Atlantic Ocean, 140 miles east of Delaware Bay, as part of a research study on the impact of ocean incineration on aquatic ecology.[378] Even though EPA used the words "research burns," the proposal was for a nineteen-day burn of 1.6 million gallons of PCB wastes.[379] In December, 1985, EPA published a tentative decision to grant a research permit for the incineration using *Vulcanus II*[380] to incinerate 700,000 gallons of PCB-laden wastes in the North Atlantic using the Port of Philadelphia as a base.[381] Once again, the Oceanic Society, in cooperation with a national coalition of forty-six environmental and other citizen organizations, undertook an analysis and criticized the proposed permit in response to EPA's request for public comments.[382]

Because EPA indicated a willingness to allow Chem Waste to incinerate, Chem Waste sought approval from the proximal coastal states of Delaware, New Jersey, and Pennsylvania. Such approval is required under the Coastal Zone Management Act (CZMA).[383] The CZMA gives states with coastal zone management plans that have

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[375] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27.

[376] ENVIRONMENTAL EFFECTS, TRANSPORT AND FATE COMM., SCIENCE ADVISORY BD., U.S. ENVTL. PROTECTION AGENCY, REPORT ON THE INCINERATION OF LIQUID HAZARDOUS WASTES (1985) [hereinafter SAB REPORT].

[377] *House Hearing 1987*, *supra* note 293, at 59.

[378] *See EPA Denies Permit for Ocean Test Burn by Chemical Waste Management in Atlantic*, 17 Env't Rep. (BNA) 107 (May 30, 1986); *Polychlorinated Biphenyls: EPA Denies Permit for Ocean Test Burn by Chemical Waste Management in Atlantic*, 10 Chem. Reg. Rep. (BNA) 262 (May 30, 1986).

[379] *See* Letter from Alfred B. Devereaux, Assistant Secretary, State of Florida, to Dr. Tudor Davies, EPA (Oct. 17, 1985) (copy on file with the *Boston College Environmental Affairs Law Review*).

[380] Ocean Dumping Permit Program, 50 Fed. Reg. 51,360 (1985). EPA had released its Final EIS for the designation of the North Atlantic Incineration Site (NAIS) on November 25, 1981. On November 17, 1982, EPA proposed the designation of the NAIS. *House Hearing 1987*, *supra* note 293, at 58.

[381] OTA, OCEAN INCINERATION, *supra* note 72, at 182. There was also a second proposed site centered 190 miles east of Daytona Beach, Florida. Another vessel, *Apollo I*, also sought a permit. DEPARTMENT OF ENVTL. REG., STATE OF FLORIDA, FACT SHEET, PCB INCINERATION PROPOSED FOR ATLANTIC OCEAN (1985).

[382] OCEANIC SOCIETY, JOINT COMMENTS OF ENVIRONMENTAL AND OTHER CITIZEN ORGANIZATIONS, IN RESPONSE TO THE ENVIRONMENTAL PROTECTION AGENCY'S PROPOSED OCEAN INCINERATION RESEARCH BURN PERMIT (1986).

[383] 16 U.S.C. § 1456(c) (1988).

been approved by NOAA the right to review federal activities for consistency with the state plan.[384] Pennsylvania granted unconditional approval for a single burn.[385] Delaware approved but imposed modest conditions.[386] New Jersey approved with considerable restrictions, some of which were later withdrawn.[387] Maryland also sought to make a CZMA consistency review and was granted this right by NOAA. Chem Waste then sued EPA and NOAA challenging Maryland's right to participate, but Maryland withdrew its CZMA request prior to a decision.[388] On May 28, 1986, EPA denied the Chem Waste request for the research permit.[389] Thus, as a result of EPA's decision, the suit brought by Chem Waste was dismissed without a ruling on the circumstances under which permit applicants are required to demonstrate CZMA consistency or the rights of states to place conditions on their findings of CZMA consistency.[390]

EPA's decision to follow the hearing officer's recommendations to defer processing of applications for permits to burn hazardous wastes at sea pending completion of the regulation addressing ocean incineration under the MPRSA was challenged in court by Waste Management.[391] An *amicus curiae* brief supporting the states' opposition to ocean incineration was filed by the Oceanic Society in conjunction with the Natural Resources Defense Council, the Environmental Policy Institute, Greenpeace, and the Coast Alliance.[392] On September 16, 1987, the court upheld EPA's temporary permit freeze.[393]

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[384] *Id.*; *see also* Blumm & Noble, *supra* note 369, at 50,048–51.

[385] OTA, OCEAN INCINERATION, *supra* note 72, at 182.

[386] *Id.* at 182–83.

[387] *Id.* at 183.

[388] *Id.*

[389] Ocean Dumping Program, 51 Fed. Reg. 20,344 (1986) (final determination).

[390] OTA, OCEAN INCINERATION, *supra* note 72, at 183.

[391] Waste Management, Inc. v. EPA, 669 F. Supp. 536 (D.D.C. 1987). On December 5, 1986, Waste Management filed suit in the United States District Court for the District of Columbia, alleging that EPA failed to perform a mandatory duty under the MPRSA to consider applications for ocean incineration and that EPA's decision not to consider permit applications until the new regulation was issued constituted a revocation of existing regulations without notice and opportunity for comment. Waste Management requested the court to vacate EPA's decision to defer action on permit applications and to direct EPA to consider applications in accordance with existing regulations, or, in the alternative, to direct EPA to issue a final Ocean Incineration Regulation within 30 days of the court's judgment. In response to the complaint, EPA moved for summary judgment, arguing that its decision to defer the issuance of permits until after final promulgation of the new Ocean Incineration Regulation was reasonable and complied with applicable law. *House Hearing 1987*, *supra* note 293, at 62–63 (statement of Lawrence J. Jensen, Assistant Administrator for Water, USEPA).

[392] OCEANIC SOCIETY, OCEAN INCINERATION CHRONOLOGY OF EVENTS (n.d.) (copy on file with the *Boston College Environmental Affairs Law Review*).

[393] Waste Management, Inc. v. EPA, 669 F. Supp. 536 (D.D.C. 1987). The court held that EPA properly decided to defer processing of ocean incineration permits because: (1) the

In December, 1987, Waste Management abandoned plans to incinerate hazardous wastes at sea off the United States coast.[394] Waste Management cited to the prolonged series of delays in federal rulemaking and new competition from land-based facilities as factors that convinced it to reach its decision.[395]

EPA had also received an application from At-Sea Incineration, Inc. (At-Sea) to burn hazardous wastes on the ship *Apollo I* in the North Atlantic using the Port of Philadelphia as its base.[396] However, in November, 1985, At-Sea's parent company, Tacoma Boatbuilding Company (Tacoma), filed for bankruptcy prior to completion of the two incineration ships, *Apollo I* and *II*.[397] The ship construction contracts provided for Tacoma to maintain title to the vessels during construction, with construction continuing until the ships met all use and certification requirements of all government agencies with jurisdiction.[398] EPA never finalized its regulations, which led in part to At-Sea's default on almost $68 million in loans guaranteed by the United States Maritime Administration (MARAD).[399] The federal government had to pay off the loans in full. However, under the construction contract the ships still belonged to Tacoma; thus, the federal government did not have a valid lien and lost both the $68 million and the security interest in the ships.[400] EPA's failure to regulate helped destroy a business that another arm of the federal government, MARAD, was subsidizing.[401]

Citing budget problems, EPA officials decided to end their ocean incineration program in 1988.[402] In so doing, EPA in effect created

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decision to defer was a rule of agency procedure and therefore exempt from the notice and comment requirement of the APA and thus did not affect the substantive rights of applicants to obtain permits; and (2) EPA's decision was not arbitrary, capricious or an abuse of discretion. *Id.* at 538–43. Thus, EPA could not be compelled to process Waste Management's application to conduct a test burn in the Atlantic Ocean.

[394] *Waste Management Abandons Proposal to Incinerate Hazardous Wastes at Sea*, 18 Env't Rep. (BNA) 1969 (Jan. 1, 1988).

[395] *Id.*; *see also EPA Considers Cutting Costs By Dropping Plans to Issue Ocean Incineration Rules*, 18 Env't Rep. (BNA) 2086 (Jan. 29, 1988) [hereinafter *EPA Considers Cutting Costs*].

[396] *See* Bailey & Faupel, Out of Sight is Not Out of Mind: Public Opposition to Ocean Incineration 9 (1987) (paper presented at the 1987 Meetings of the American Association for the Advancement of Science (AAAS), Chicago).

[397] *Id.* at 6; Bunin, *supra* note 271, at 4, Table 2.

[398] *In re* Tacoma Boatbldg. Co., 81 Bankr. 248, 252–53 (S.D.N.Y. 1987).

[399] *See* Kurtz & Isikoff, *Shipbuilder Defaulting on Loans*, Wash. Post, Nov. 27, 1985, at 1, col. 1.

[400] *See id.*

[401] 50 Fed. Reg. 51,361 (1985).

[402] SeaBurn, Inc. v. EPA, 29 Env't Rep. Cas. (BNA) 1597, 1599 (D.D.C. 1989); *see also EPA Considers Cutting Costs*, *supra* note 395, at 2086.

for itself a line item veto power for a program they deemed politically unacceptable. At present, ocean incineration in the United States is at a standstill, although related activities continue. The Department of Transportation (DOT) adopted safety rules and construction standards for ocean-going hazardous waste incineration vessels on May 4, 1988,[403] but because no ocean incineration is allowed in United States waters, there are currently no vessels to which the rules apply.[404] Regulatory authority over ocean incineration was to be shared by the Coast Guard and the EPA.[405] The Coast Guard has responsibility for navigational safety, and the protection of the ship, the crew, and the marine environment, while EPA has authority to regulate incinerator emissions, permitting, and the designation and management of incineration sites.[406] Unless or until EPA issues final permit regulations, however, no vessels will be subject to any of these rules.[407]

The most recent serious blow to ocean incineration came in the form of a federal district court decision on April 20, 1989.[408] SeaBurn, Inc., a commercial waste disposal company and a subsidiary of Stolt-Nielsen Shipping A/S, an international ocean transport corporation, filed suit against EPA claiming that its indefinite suspension of ocean incineration permit review was tantamount to revocation of existing regulations[409] and, therefore, required compliance with the Administrative Procedure Act (APA).[410] In its decision, the court focused

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[403] *DOT Sets Safety, Construction Standards for Ships Incinerating Hazardous Wastes*, 12 Chem. Reg. Rep. (BNA) 223 (May 6, 1988).

[404] *See id.* These standards regulate the transport of bulk liquid hazardous wastes to be incinerated at sea, transfer of the waste from cargo tanks to the incinerator, and the incineration of the wastes aboard ship. *Id.*

[405] *Id.*

[406] *Id.*

[407] *Id.* at 224. For example, one company left with an active interest in ocean incineration is Stolt-Nielsen, Inc., which claims to be the world's largest bulk chemical carrier. Stolt-Nielsen wants to use new technology for ocean incineration, but awaits EPA's issuance of a final ocean incineration regulation before beginning construction. *Chemical Shipping Firm Still Sees Future for Ocean Incineration of Hazardous Wastes*, 18 Env't Rep. (BNA) 2015 (Jan. 15, 1988).

[408] 29 Env't Rep. Cas. (BNA) 1597 (D.D.C. 1989). SeaBurn, Inc. had initiated the incineration at sea permit application process in October, 1983. *House Hearing 1987*, *supra* note 293, at 58.

[409] 29 Env't Rep. Cas. (BNA) at 1599.

[410] 5 U.S.C. §§ 551–559, 701–706 (1988). It is interesting to note that SeaBurn's ocean incineration proposal had included total containerization from source to burn, barging, and the use of scrubbers. *See Future for Ocean Incineration*, 18 Env't Rep. (BNA) 2015 (Jan. 15, 1988). However, EPA continually rebuffed SeaBurn's proposal. *See, e.g.*, Letters from Jack E. Ravan, EPA Assistant Administrator for Water, to Vincent G. Grey, SeaBurn Pres-

on the Ocean Dumping Ban Act of 1988,[411] which had been enacted after the lawsuit was filed. This Act deleted section 104A of the MPRSA of 1972 and added section 104B, which prohibits the issuance of new dumping permits and phases out the dumping of all sewage and industrial waste by 1991.[412]

SeaBurn contended that incinerator residue was not industrial waste and, therefore, not subject to the ban. EPA claimed that: (1) only the original MPRSA of 1972 defines "dumping," and it does so as "the deposition of material" into the ocean;[413] (2) ocean incineration is dumping because it involves deposition of stack emissions; and (3) stack emissions are included in the broad definition of prohibited materials.[414] Following current administrative law principles, the court supported the reasonableness of EPA's interpretation of the legislative language and history.[415] In addition, the court felt their judicial review should be deferential to an agency's expertise.[416]

C. Ocean Incineration Documents

Three significant United States documents concerning ocean incineration were released in 1985–1986. Two were produced by EPA and the third was the work of the Office of Technology Assessment (OTA) of the United States Congress. The three documents supported the use of ocean incineration as part of a hazardous waste management program.

The first document is a March, 1985, EPA Office of Policy, Planning and Evaluation needs assessment study of incineration which presented a summary of the advantages and disadvantages of incineration as a commercial treatment option for managing liquid organic hazardous wastes.[417] The study provided four main conclusions relevant to this Article. First, the study concluded that "[i]ncineration, whether at sea or on land, is a valuable and environmentally sound treatment option for destroying liquid hazardous wastes, particularly

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ident (May 24, 1984 and July 6, 1984) (copies on file with the *Boston College Environmental Affairs Law Review*); Zurer, *supra* note 155, at 36–37.

[411] Ocean Dumping Ban Act of 1988, Pub. L. No. 100–688, 1988 U.S. CODE CONG. & ADMIN. NEWS (102 Stat.) 5867 (codified in scattered sections of 33 U.S.C.)

[412] 29 Env't Rep. Cas. (BNA) at 1600.

[413] 33 U.S.C. § 1402(f) (1982).

[414] 29 Env't Rep. Cas. (BNA) at 1601.

[415] *Id.* at 1602.

[416] *Id.*; *see also SeaBurn Seeks Federal Court Review of EPA Suspension of Ocean Incineration*, 18 Env't Rep. (BNA) 2434 (Apr. 8, 1988).

[417] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27.

when compared to land disposal options now available."[418] EPA noted that incineration eradicates more than 99.99% of the harmful components of the waste and can destroy more than 99.9999% of wastes of particular importance, such as PCBs.[419] Additionally, the study reported that EPA's risk assessments indicated that incinerators that satisfy the regulatory requirements for waste destruction efficiency create minimal risks to human health and the environment.[420]

Second, the study concluded that "[t]here is no clear preference for ocean or land incineration in terms of risks to human health and the environment."[421] EPA noted that ocean incineration produces human health risks that are significantly lower than the already low human health risks produced by land-based incineration.[422] But EPA recognized the drawback to ocean incineration operations in that a ship accident, although a remote probability, could result in a spill of hazardous wastes that could cause substantial environmental damage.[423]

Third, the study stated that "[a]lthough current commercial and on-site hazardous waste incineration capacities on land are adequate to handle existing demand (except for PCBs), future demand will significantly exceed this capacity as other disposal alternatives are increasingly restricted."[424] EPA noted that, as the 1984 RCRA amendments[425] became more restrictive, available landfills declined, and generators' concerns over long-term liability increased, demands for incineration as an alternative would intensify.[426]

Fourth, the study stated that "[a]lthough previous research has verified the destructive capabilities of incinerators, and risk studies have shown minimal impact on health and the environment, a program of continuing research is needed to improve our current knowledge of combustion processes and effects."[427] EPA noted that additional knowledge is needed concerning combustion byproducts, including their quantities, toxicities, transport, and fate.[428] This in-

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[418] *Id.*

[419] *Id.*

[420] *Id.*

[421] *Id.*

[422] *Id.*

[423] *Id.*

[424] *Id.* at 2.

[425] *See supra* notes 34, 36 and accompanying text.

[426] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 2.

[427] *Id.*

[428] *Id.*

formation could be gathered through improved stack and ambient monitoring, emissions characterizations, and laboratory toxicity testing.[429]

The second important study was released in April, 1985 by the Environmental Effects, Transport and Fate Committee of EPA's Science Advisory Board (SAB).[430] The SAB study, requested by then EPA Administrator, William D. Ruckelshaus, also reviewed and assessed the public health and environmental impacts associated with the incineration of liquid organic hazardous wastes on land and at sea.[431] The SAB concluded that "[i]ncineration is a valuable and potentially safe means for disposing of hazardous chemicals, and EPA has made progress in developing an appropriate regulatory strategy."[432] However, the SAB cautioned that definitive conclusions regarding environmental impacts were lacking, and further research was necessary.[433] Nevertheless, the SAB did not believe that the research questions were significant enough to delay EPA regulation and a strong majority of the board supported EPA in licensing commercial ocean incineration.[434]

In 1986, the Office of Technology Assessment (OTA) published the third relevant study for two congressional committees—the House Committees on Merchant Marine and Fisheries and on Public Works and Transportation.[435] The study concluded that "OTA finds that ocean incineration could be an attractive, though not essential, interim option for managing liquid incinerable wastes, in particular highly chlorinated wastes."[436] The study went on to find that "[f]or highly chlorinated wastes, ocean incineration may be preferable to available alternatives, with respect to human health risks and cost effectiveness."[437] The OTA study advocated the preferred practices

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429 *Id.*

430 SAB REPORT, *supra* note 376.

431 *Id.* Liquid organic hazardous wastes were chosen as the basis for comparison because they are capable of being treated by both land-based and ocean incineration. EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 6.

432 SAB REPORT, *supra* note 376, at v.

433 *Id.*

434 *See Senate Hearing 1985*, *supra* note 258, at 394 (statement of Dr. Terry Yosie, Director, Science Advisory Board, EPA).

435 OTA, OCEAN INCINERATION, *supra* note 72.

436 *Id.* at 4.

437 *Id.* at 10. The most important commercial incinerators for very hazardous wastes are the Deer Park, Texas facility of Rollins Environmental Services and the El Dorado, Arkansas facility that is owned by Energy Systems Company (ENSCO). *See First PCB Disposal*

of waste reduction, recovery, and recycling.[438] Nonetheless, the study recognized that ocean incineration could bridge the gap between the practices of the past and the preferred practices of the future which are still in the development stage.[439]

The findings of these three documents, particularly in light of EPA's refusal to issue final permitting regulations, call into question the leadership role of EPA. The process used to produce these documents depended essentially on a limited scientific base of the contractor reports produced after the various test burns.[440] Thus, the limited data, which came primarily from one contractor, were extrapolated to form the major policy-determining documents on the subject.[441] Moreover, the EPA studies were not released for comment until after the proposed rule for ocean incineration were promulgated. When the ninety day comment period for the proposed regulation began running on February 28, 1985, time to respond to these documents was limited[442] because the EPA Incineration Assessment was released on March 28, 1985 and the SAB Report was released on April 5, 1985.

A recent report of the International Maritime Organization (IMO)[443] provides what appears to be the most objective and thorough assessment of the current status of ocean incineration, from both a technological and environmental standpoint.[444] The Working Group of the Joint London Dumping Convention/Oslo Commission (LDC/OSCOM) Group of Experts on Incineration,[445] concerned with incineration technology including combustion and destruction efficiencies, formation of new compounds, and control mechanisms, met

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Facilities, 59 CHEM. & ENG'G NEWS 20 (Feb. 16, 1981); *Rollins Wins PCB Disposal Okay?*, CHEMICAL WEEK, Feb. 4, 1981, at 46.

438 OTA, OCEAN INCINERATION, *supra* note 72, at 4.

439 *Id.*

440 *See id.* at 180.

441 *Id.* TRW Energy and Environmental Division was the major contractor for work on the EPA permitted burns. *Id.*

442 *But see* 50 Fed. Reg. 8224 (1985).

443 The IMO is the Secretariat under the LDC for ocean incineration activities. OTA, OCEAN INCINERATION, *supra* note 72, at 194.

444 INTERNATIONAL MARITIME ORGANIZATION, CONSIDERATION AND ADOPTION OF THE REPORT, REPORT OF THE JOINT LDC/OSCOM GROUP OF EXPERTS ON INCINERATION AT SEA, Agenda item 9, at 1–42, May 13, 1987 (LDC/OSCOM/IAS 2/9) [hereinafter IMO REPORT].

445 The Working Group met under the Chairmanship of Mr. L. Spaans (Netherlands), and included experts from the following countries and international non-governmental organizations which participated in the Working Group: Belgium, Denmark, the Federal Republic of Germany, Italy, the Netherlands, Spain, the United Kingdom, the United States, Greenpeace International, and the Association of Maritime Incinerators (AMI). IMO REPORT, *supra* note 444, at 4.

in April, 1987, and reached several important conclusions. First, they noted that "many land-based incinerators cannot burn highly chlorinated wastes whereas at-sea incinerators can."[446] Second, they "found the performance of marine and land-based incinerators to be similar in terms of the ability to destroy organic compounds."[447] Third, the Group found that, "in the absence of pollution control devices, there is no significant difference in organic emissions from at-sea or on-land incinerators when each is meeting the same performance requirements for [combustion efficiency] CE, temperature and oxygen in the stack."[448] Fourth, "[t]he ability to destroy organic materials in a waste mixture is the same for land and sea incinerators when the requirements of the London Dumping Convention are met, even though the means of achieving this objective are different, i.e., through using different residence times."[449]

Another Working Group devoted to the topic of "Effects on the environment of emissions from incineration at sea and on land"[450] provided the following conclusions in the 1987 IMO report. Hydrochloric acid (HCl) degrades rapidly following release, and in the case of the North Sea little HCl affects either land or water ecosystems.[451] For acute local effects where a plume impinges on a small area of the sea surface, a worst-case scenario[452] noted that pH changes likely would be small. Also, acids emitted from land-based incinerators are largely eliminated (eighty to ninety-nine percent) by gas scrubbers; the remaining acid emissions might deposit and affect the area near

[446] *Id.* at 13.

[447] *Id.* at 14.

[448] *Id.*

[449] *Id.*

[450] The Working Group met under the Chairmanship of Mr. M. Parker (United Kingdom), and included experts from the following countries and non-governmental organizations: Canada, Denmark, the Federal Republic of Germany, Nauru, the Netherlands, the United States, Friends of the Earth International (FOEI), Greenpeace International, and the Association of Maritime Incinerators (AMI). *Id.* at 17.

[451] *Id.* at 19. One estimate suggests that the acid from incineration at sea amounts to only 1 x 10^{-9} of the HCl crossing the North Sea shoreline. *Id.*

[452] *Id.* at 20. The scenario considered a throughput of waste of 20 tons per hour at 60% chlorine content whereby 12 tons per hour of HCl are emitted. The Working Group found that:

> If this were to settle and become mixed in only the surface 10 cm, the buffering capacity of sea water is such that the pH of sea water of [salinity] 30 would be reduced to 6 pH; in 25 cm of water, the reduction would not be more than one pH unit. Natural fluctuations in pH (day/night) can be of this order. Because of the conservative nature of the worst-case scenario, actual pH changes will likely be much smaller.

Id.

the incineration plant, which, depending on its location, may affect ocean or land ecosystems.[453]

Metals in wastes incinerated at sea are not combusted but are released in total to the atmosphere.[454] The behavior of metals cannot be predicted with the same accuracy achievable for gaseous HCl.[455] Using the same worst-case scenario, incineration at the same rate will lead to an increase in seawater concentrations of "grey list" (Annex II of the LDC) metals of less than 10 ug/*l* [= 10 ppb] and Hg, Cd, and As of less than 0.5 ug/*l* [= 0.5 ppb] in the top 10 cm, or less than 4 ug/*l* [= 4 ppb] and less than 0.2 ug/*l* [= 0.2 ppb] respectively in the top 25 cm.[456] For the most toxic metals in each category (copper and mercury, respectively), these concentrations alone would be of the same order as "No Effect Concentration" levels used in United States water quality criteria for offshore incineration sites.[457] If all the metals were to concentrate in the surface microlayer,[458] it might be possible that toxic conditions would occur, but this situation is limited to the area concerned and for a short time frame.[459] However, as is discussed below, bioaccumulation of metals in the lipids of organisms living below the microlayer may be critical.[460]

Incinerator emissions to the North Sea were compared to emissions from all other sources and demonstrated that incinerator emissions account for 0.1–1 percent of total annual inputs at maximum, based on the conservative, low end of measured total emissions.[461] Land-based incinerators are equipped with scrubbers that reduce the metal emissions per ton by eighty to ninety-nine percent, except for volatile mercury. In this respect, land-based incinerators are more effective at controlling metal inputs, although there remains a significant and added problem of treating and/or disposing of the scrubber wastes containing high metal concentrations.[462] Some experts have suggested that, in addition to setting metal concentration limits in the emissions, limiting total input of individual metals prior to incineration at sea should be considered.[463]

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[453] *Id.*
[454] *Id.*
[455] *Id.*
[456] *Id.* at 20–21.
[457] *Id.*
[458] *See infra* notes 685–86 and accompanying text.
[459] IMO REPORT, *supra* note 444, at 21.
[460] *See infra* notes 643, 653 and accompanying text.
[461] IMO REPORT, *supra* note 444, at 21.
[462] *Id.*
[463] *Id.*

The Working Group also addressed the question of the effects of organic emissions by establishing the likely release rates under normal operating conditions and failure modes, as well as determining acute exposure conditions.[464] Most members, however, did not believe that upset conditions would contribute significantly to additional organic emissions.[465]

Total emissions from ocean incinerators were not analyzed and measured, but lists of major emissions from land-based hazardous waste incinerators were available. These lists indicated that ninety percent of emissions of organic substances were likely to be volatile or non-persistent and, thus, unlikely to affect the marine environment.[466] The main concern is for the ten percent of organic emissions, i.e., 0.001 percent of the original waste, that are persistent and non-volatile[467] and could adversely affect the marine environment. The general conclusion, in relation to acute effects, was that although the data suggest that the scale of impact is likely to be small, more information on the composition, persistence, toxicity, and levels of organic emissions is required and needs to be measured utilizing more sophisticated technology that is capable of lower detection limits.[468]

Total releases of organic substances at the North Sea site approximate five tons per year, which is relatively small in comparison to

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[464] *Id.* at 22.

[465] *Id.* The Working Group determined that the incinerator system was overdesigned and combustion efficiency was not greatly affected by most failure modes: "Extreme failures which had so far been identified were generally of short duration (from less than 1 to 10 minutes), although the most extreme case might lead to a failure of one hour." *Id.* These events are expected to lower combustion efficiency by one to two orders of magnitude but were extremely rare (less than once per year). To remain on average within Convention limits of 99.9% destruction, the events would have to occur for between less than ten percent to less than one percent of the time (i.e., once every few minutes to once every few hours). However, the upset events are much rarer than that. *Id.*

[466] *Id.*

[467] Such as chlorinated phenols, HCBs, polycyclic aromatics, etc. *Id.*

[468] *Id.* at 23.

> As an example of potential effects, the Working Group considered the case of dioxins and furans. These were undetectable in emissions during the second PCB burn in August, 1982, in the Gulf of Mexico at a detection limit of 1 ng/m^3; subsequent analyses at lower detection limits detected presence at 0.1 ng/m^3 levels. By contrast, emission at 30 ng/m^3 levels have been reported from one modern land-based incinerator. Both analyses were carried out by experienced analysts. Taking the 1 ng/m^3 as an upper limit and using the worst-case scenario described previously, concentrations in the upper 25 cm of water might reach 0.5 ppt.

Id. Much higher concentrations of dioxins and furans could be found in the surface microlayer, perhaps even reaching levels high enough (in the ppb category) to be toxic. However, this category—the dioxins and furans—contains members of varying toxicity, and UV radiation may increase the rate of photodegradation of organic substances in the surface microlayer. *Id.*

other inputs to the North Sea.[469] Land-based systems, for example, currently incinerate most of the wastes generated in Europe and have both advantages and disadvantages in relation to emission of organic substances.[470] Out-dated systems operating without scrubbers and accepting solid wastes may give rise to higher releases per ton.[471] More modern systems have furnaces which may improve destruction of POHCs but will increase the production of nitrogen oxides.[472] Further, the longer cooling period in these systems may increase production of PICs.[473] General comparisons cannot be made between land and sea incineration because the emissions depend significantly on the nature of the wastes.[474] Land-based incinerators expose local humans to emissions of organic substances, however, and these persistent substances that are deposited on land may not be subject to the same rapid processes of dilution and dispersion that occur at sea.[475] Land and sea systems have similar problems concerning losses of wastes during transportation and with fugitive emissions.

Finally, the Working Group considered the effects of spills, but stated that because the effects they found did not include a probability analysis the conclusions cannot form the basis of decision making.[476] The considerations included a discussion of the human health and ecological effects of a large spill into an enclosed bay or estuary and into the open sea at an incineration site.[477] Large spills of high level PCB wastes would be expected to have major effects on the marine ecosystem, being most severe in a sheltered or enclosed bay region. Such effects would persist because of the character of PCBs, and long-term bioaccumulation effects on marine organisms would be of utmost concern. Open ocean effects would include chronic toxicity and bioaccumulation as well, but dispersion would reduce long-term effects in the spill zone.[478] The effects of EDC wastes would include major acute toxic impacts on the ecosystems but would

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[469] *Id.*
[470] *Id.*
[471] *Id.*
[472] *Id.*
[473] *Id.* at 24.
[474] *Id.*
[475] *Id.*
[476] *Id.*
[477] *Id.* "Two types of material were considered: wastes containing high levels of toxic and carcinogenic, bio-accumulative and persistent material such as PCBs, and alternatively, wastes composed largely of acutely toxic, volatile, non-persistent substances such as EDC tar wastes." *Id.*
[478] *Id.* at 24–25.

exhibit a rapid decrease in effect because EDC wastes are volatile and non-persistent.[479] The Working Group did caution that these statements are preliminary and the issue of spills requires further consideration both in relation to probability and to effects.[480]

D. The Legal Requirements for Ocean Incineration

1. International Aspects

The regulatory program for ocean incineration differs from that governing land-based incineration because the United States has agreed to subject itself to international agreements that require passage of additional domestic laws. The United States is a Contracting Party to the "1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter," commonly known as the London Dumping Convention (LDC).[481] The LDC considers incineration at sea to be ocean dumping and, therefore, subjects incineration to the controls specified in Annexes to the LDC. Incineration at sea is considered an interim disposal method to be permitted until new technologies and/or alternative land-based methods of treatment are available for hazardous waste management.

Technical requirements of the LDC are set out in three Annexes. Annex I lists substances that may not be dumped unless they would be "rapidly rendered harmless."[482] This list includes organohalogens, such as DDT and PCBs, persistent plastics, and oil. Annex I completely bans dumping of high-level radioactive wastes, and chemical and biological warfare agents. Annex II lists substances requiring special care. These substances include heavy metals, cyanides that could present a serious obstacle to fishing or navigation, and medium- and low-level radioactive wastes. Annex III sets forth technical requirements for disposal as well as the required characteristics of dumping sites.[483]

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[479] *Id.* "In fact, multiple shiploads of EDC tars were dumped into the sea during the 1950s to 1970s and there is no evidence of persistent long-term ecological effects that can be attributed to EDC tar." *Id.* at 25.

[480] *Id.*

[481] London Dumping Convention, *supra* note 295. For review and analysis of this Convention, *see* Note, *supra* note 281, at 162–169. The LDC is an international agreement containing specific regulations governing ocean incineration. The LDC came into force on August 30, 1975, following the necessary 15 ratifications. Fifty-three countries are now contracting parties. 50 Fed. Reg. 8228 (1985).

[482] London Dumping Convention, *supra* note 295, Annex 6(B)(4). *See* Note, *supra* note 281, at 165.

[483] 50 Fed. Reg. 8228 (1985).

Much of the hazardous waste incineration to date has taken place in the North Sea.[484] The "Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft," commonly known as the Oslo Convention, in part regulates incineration activities in the North Sea. The Oslo Convention is a regional agreement of European nations that border the North Sea which governs dumping of wastes in the North Sea, the northeast Atlantic Ocean, and a portion of the Arctic Ocean.[485] In 1981, Rule 2.3 was adopted by the Oslo Commission, the governing body of the Oslo Convention, that defined ocean incineration as an interim technology and provides for a meeting of the Commission before January 1, 1990, to establish a final date for the termination of incineration at sea.[486]

European nations are currently rethinking their use of ocean incineration. In November, 1987, the environmental ministers of eight North Sea nations agreed to reduce ocean incineration by sixty-five percent by 1991 and to end the practice by 1994.[487] In June, 1988, the Oslo Commission agreed to terminate incineration in the North Sea. In October, 1988, the LDC countries, led by Denmark, passed a resolution that called for a gradual "phase out" of ocean incineration on a global basis.[488]

The Commission of the European Communities, under the auspices of the European Economic Community (EEC), has also dealt with ocean incineration.[489] The Commission considers incineration to be dumping at sea that should be terminated as soon as possible.[490] Ocean incineration, therefore, is considered to be a temporary disposal option by the EEC to be used only in the absence of practical alternatives of land-based methods of treatment, disposal or elimination. EEC member states are required to submit necessary information to the Commission by January 1, 1990, in order to set a final date for the termination of incineration at sea.[491]

The United States is considering, but has not yet agreed to, an international ban on ocean incineration by the end of 1994.[492] The

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[484] *See* OTA, OCEAN INCINERATION, *supra* note 72, at 17.

[485] *See* Oslo Dumping Convention, *supra* note 268.

[486] *See generally* OTA, OCEAN INCINERATION, *supra* note 72, at 194.

[487] *Total Ban on Incineration in North Sea by 1994 Among Steps Backed by Eight Nations*, 11 Int'l Env't Rep. (BNA) 9 (Jan. 13, 1988).

[488] D. Ditz, International Developments in Ocean Incineration Policy 3, (Sixth Symposium on Coastal and Ocean Management, Charleston, S.C.) (July 11–14, 1989).

[489] OTA, OCEAN INCINERATION, *supra* note 72, at 195.

[490] *Id.*

[491] *Id.*

[492] *Shifting Positions, U.S. Agrees to International Ban on Incineration at Sea*, INSIDE EPA, Oct. 21, 1988, at 11.

interpretation of the 1988 LDC resolution calling for the gradual phasing out of ocean incineration remains controversial. The international trend is toward eliminating ocean incineration, but as of 1987, ten nations were still incinerating at sea.[493] Additionally, be-

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[493] *Official Government Positions on Ocean Incineration:*

Australia	no official position.
Austria	no official position.
Belgium	plans to end ocean incineration by the end of 1994. The ban means that by 1994 Belgium will no longer be a port storage country for waste burned at sea. Eighty percent of the waste burned in the North Sea is stored in, and loaded from, Antwerp harbor.
Canada	is "prepared to consider issuing a dumping permit for incineration at sea."
France	no official position.
Germany	favors a 1995 termination date. Germany has signed an agreement with Belgium which prohibits it from shipping its waste through Antwerp harbor for incineration at sea. The agreement will be effective as soon as Germany sites a portside storage facility. Emden and Bremen are proposed sites.
Ireland	supports ocean incineration in accordance with the U.K. position.
Kiribati	opposes ocean incineration, no official date stated.
Mexico	opposes ocean incineration and would support a ban if it came to a vote at the LDC.
Nauru	opposes ocean incineration, no official date stated.
Netherlands	will stop using ocean incineration by the end of 1990.
New Zealand	no official position.
Nordics	(Denmark, Sweden, Finland, Norway & Iceland) favor a December 31, 1991 termination date, as per the Nordic proposal. They also favor a prohibition on permitting of ocean incineration of any new substances (i.e., PCBs) and oppose any increase in the amount of substances incinerated at sea after 1989.
Portugal	no official position, but the government is negotiating with OCS to establish a portside storage facility for hazardous waste near Lisbon.
Spain	plans to conduct its first burn in October off the coast of Santander. The government claims that the North Atlantic burnsite will be used for Spanish-generated waste only. Spain has signed an agreement with Belgium prohibiting the importation of Spanish waste to be burned at sea. Of course it will be nearly impossible to monitor and restrict the importation of waste from other countries.
Switzerland	favors a 1995 termination date.
U.K.	supports ocean incineration. It submitted a proposal at the Oslo Commission meeting in Cardiff (May 4–6, 1987) to extend the range of substances permitted to be burned at sea and to continue the use of ocean incineration in the North Sea indefinitely.
U.S.A.	will release regulations governing ocean incineration for public comment in September. The U.S. has conducted several "test" burns, but no burns have taken place here since 1982.

COUNTRIES CURRENTLY INCINERATING AT SEA

Austria	Belgium
France	Germany

cause the Oslo Commission decided to terminate ocean incineration by the end of 1994, the ocean incineration industry has been seeking new markets and burn sites including proposed sites located in the South Pacific, especially New Zealand and Australia, the Caribbean, and Southeast Asia.[494]

2. Domestic Aspects

The federal regulatory framework for all domestic aspects of incineration of hazardous wastes is provided primarily by the Department of Transportation (DOT) and EPA.[495] Ocean incineration would be the last phase in a series of hazardous waste management and disposal activities. The other phases require support facilities for transportation, storage, and transfer of wastes. Transportation of hazardous wastes is regulated by EPA under RCRA,[496] and by DOT under authority of the Ports and Waterways Safety Act (formerly the Port and Tanker Safety Act)[497] and the Hazardous Material Transportation Act (HMTA).[498]

Italy	Netherlands
Norway	Spain
Switzerland	U.K.

Note: Germany burns more than half of the total waste burned in the North Sea, although the governmental bureaucrats are pushing for a rapid phase-out. Greenpeace International (Sept. 1, 1987).

[494] Bunin, *supra* note 271, at 1. The 1983 Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region, known as the Cartagena Convention, provides a legal framework for dealing with ocean dumping and pollution under the United Nations Environmental Program's Caribbean Action Plan. *Id.* at 6. Also, the Convention for the Protection of the Natural Resources and Environment of the South Pacific, under the South Pacific Regional Environmental Program (SPREP), provides a legal basis for jurisdiction over ocean dumping in the South Pacific, although it does not specifically regulate incineration at sea. *Id.*

[495] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 3.

[496] 42 U.S.C. §§ 6901–6991i (1982 & Supp. V 1987). "RCRA regulations cover both inter- and intra-state land transportation, and contain standards concerning recordkeeping, reporting, labeling, and containers. RCRA tracks hazardous wastes from generator to ultimate disposal site through the manifest system, and [allows] transportation of hazardous wastes only to approved facilities." *House Hearing 1987*, *supra* note 293, at 68.

> The RCRA regulations apply to any waste storage facility on land, including those used to support land-based and ocean incineration. This includes storage facilities and any waterfront transfer facility that involves storage for more than ten days. A waste generator storing waste on-site for more than 90 days must apply for a RCRA storage permit. A waste transporter storing waste at a transfer facility for more than 10 days must also apply for a RCRA storage permit. If a transporter stores wastes for 10 days or less the facility is considered a transfer facility, not a storage facility.

Id. at 70. Local building codes may impose additional safety and storage requirements. *Id.*

[497] Ports and Waterways Safety Act, 33 U.S.C. §§ 1221–1236 (1982 & Supp. V 1987).

[498] Hazardous Materials Transportation Act, 49 U.S.C. § 1801 (1982). HMTA regulations

EPA and DOT, alone or in conjunction, may bring enforcement actions against transporters of hazardous wastes. Both agencies routinely coordinate investigations and enforcement actions in order to avoid duplication.[499] In practice, EPA generally monitors activities at generator sites and waste management facilities, while DOT monitors all shipping between them, whatever the transportation mode. Thus, the breakdown essentially is that DOT directs the land and water transportation, transfer, and handling of hazardous waste, while EPA focuses primarily on storage, disposal, and treatment.[500]

Within DOT, the United States Coast Guard (USCG) has a particularly crucial role in the control of hazardous waste transportation via water, which can be a supporting link for incineration either on land or at sea. The USCG regulates numerous aspects of hazardous material transportation, including certification of vessel design and construction, annual inspections of vessels, certifications of crews, movements of vessels through ports, surveillance, and spill response.[501] EPA's Proposed Ocean Incineration Regulation, published in 1985,[502] required that ocean incineration vessels meet USCG requirements and have a contingency plan, approved by both the

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govern all modes of transportation—highway, railroad, land, and water—and apply to all commercial transportation of packaged products and bulk shipments, whether interstate or intrastate. *Id.* § 1802(1). The regulations require proper classification of materials, shipping papers, package markings, safety standards for containers or packages, and safety precautions for vehicles. *Id.* § 1804(a). Within DOT, various agencies regulate different aspects of transportation, including the regulation of land transportation by the Federal Highways Administration and water-borne transportation by the United States Coast Guard (USCG). *House Hearing 1987*, *supra* note 293, at 70–71.

"Transfer facilities or activities incidental to transportation activities are regulated under the [HMTA] and the Ports and Waterways Safety Act." *Id.* at 70. "Transfer facilities supporting ships must comply with USCG requirements for all waterfront facilities, plus specific requirements for handling oil, chemicals, and other dangerous cargoes." *Id.* at 70–71. Waterfront hazardous waste facilities that comply with DOT packaging requirements are exempt from the RCRA storage permitting requirements unless the wastes are stored at the facility for more than 10 days. *Id.* at 71.

[499] There are some areas over which only EPA or DOT has jurisdiction. For example, EPA enforces the requirement that transporters clean up any accidental discharges of hazardous wastes, and DOT enforces the requirement of safety feature installations on all motor vehicles. *House Hearing 1987*, *supra* note 293, at 68–69. "To integrate the administration and enforcement of RCRA and HMTA, DOT and EPA executed a Memorandum of Understanding in 1980 that delineates areas of responsibility and coordination on the enforcement of standards applicable to shippers and transporters of hazardous waste." *Id.* at 69.

[500] Handling of Explosives or Other Dangerous Cargoes Within or Contiguous to Water Front Facilities, 33 C.F.R. § 126 (1988) (ports); Standards Applicable to Transporters of Hazardous Waste, 40 C.F.R. § 263 (1988) (transport); Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, 40 C.F.R. § 264.1(g)(9) (1988) (storage); Hazardous Materials Regulations, 49 C.F.R. § 171 (1988) (handling).

[501] *House Hearing 1987*, *supra* note 293, at 69–70.

[502] 50 Fed. Reg. 8222 (1985).

USCG and EPA, detailing the procedures to be followed in the event of a cargo spill. In accordance with these requirements, each vessel's contingency plan must establish response procedures from the point where the land-based transfer facility's contingency plan ends (when wastes enter the vessel) and must continue to the point when the wastes are incinerated.[503]

Both the USCG and EPA would be involved with the cleanup of a spill from an ocean incineration vessel.[504] If a spill did occur, however remote the possibility, then a

> cleanup action would be invoked under both the Clean Water Act (CWA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan) assigns specific responsibilities to [fourteen] federal agencies and mandates Regional Contingency Plans for coordination and role identification at the state level. Under the National Contingency Plan, a [USCG] officer is the predesignated on-scene coordinator for spills and potential spills in coastal and offshore areas, and the EPA is the on-scene coordinator for inland spills, [and NOAA provides scientific advice].[505]

The actual incineration phase, as regulated by EPA, is complicated. Three separate programs in EPA, under three different statutes, deal with hazardous waste incineration.[506] The Office of Solid Waste develops standards and permits for land-based incinerators under RCRA.[507] The Office of Toxic Substances develops standards for, and approves the incineration of, PCBs on land under the Toxic

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[503] *House Hearing 1987*, *supra* note 293, at 69–70.

[504] OTA, OCEAN INCINERATION, *supra* note 72, at 173 (Table 25. Summary of Federal Regulatory Framework for Incineration).

[505] *House Hearing 1987*, *supra* note 293, at 90 (statement of Captain Gordon G. Piche, Chief, Marine Technical and Hazardous Materials Division, Department of Transportation, United States Coast Guard); *see also* 40 C.F.R. §§ 300, 300.23, 300.24 (1989); OTA, OCEAN INCINERATION, *supra* note 72, at 173.

[506] Numerous statutes administered by the Coast Guard and DOT also deal with incineration issues. *See* OTA, OCEAN INCINERATION, *supra* note 72, at 173.

[507] *See* 42 U.S.C. § 6925 (1982). In 1976, Congress passed RCRA, to prevent damage to human health and the environment from the mismanagement of waste. EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 22. RCRA regulates all wastes, including liquid, sludge, and solid, hazardous and nonhazardous, and all methods of management, including disposal, storage, treatment, and recycling. *Id.*; *see also* Buc & Haymore, *Regulating Hazardous Waste Incinerators Under the Resource Conservation and Recovery Act*, 23 NAT. RESOURCES J. 549 (1983). The basic regulatory program was promulgated in January, 1981, 46 Fed. Reg. 7666 (1981), and modified in June, 1982, 47 Fed. Reg. 27,516 (1982).

Substances Control Act (TSCA).[508] Finally, the Office of Water has issued permits for ocean incineration under the Marine Protection, Research, and Sanctuaries Act (MPRSA).[509] In 1985, the Office of Water published a Proposed Ocean Incineration Regulation that would provide more specific criteria to regulate ocean incineration under the MPRSA,[510] but this regulation has not been finalized and, therefore, no permits for ocean incineration are currently available.[511] Thus, under these federal statutes all incineration facilities handling hazardous wastes must obtain permits by which the statutory requirements are applied.[512] The MPRSA implements the international environmental laws acceded to by the United States dealing with ocean incineration.[513]

The proposed regulation for ocean incineration is similar to the RCRA regulation governing land incineration,[514] but generally is more stringent[515] because of additional requirements imposed by international law. In general, the proposed ocean incineration regulation adopted the most stringent requirements of existing regulations under the LDC and added these requirements to domestic law as expressed in RCRA, TSCA, and the MPRSA.[516] The proposed regulation, exclusive of its interpretive Preamble, occupies sixteen pages of the *Federal Register*.[517] In contrast, the land-based incinerator requirements take up only three pages in the *Federal Register*.[518]

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[508] 15 U.S.C. §§ 2605(e) (1988). TSCA was enacted by Congress in 1976 partly in response to concern about potential health hazards from PCB contamination. EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 23. TSCA imposed a ban on PCB manufacture, and in 1978–1979 EPA issued regulations for proper PCB disposal under high-temperature incineration. *Id.* Because TSCA does not require compliance with the Clean Air Act, it was claimed that the Rollins Deer Park, Texas facility could emit air pollutants without regulation by the state under the CAA. Sweeney, *This Town's Not For Burning*, ENVTL. ACTION, Feb. 1982, at 12.

[509] 33 U.S.C. §§ 1412–1414 (1982 & Supp. V 1987).

[510] 50 Fed. Reg. 8222 (1985).

[511] *See supra* notes 402–07 and accompanying text.

[512] "Because it is covered under RCRA, hazardous waste incineration on land is effectively exempted from coverage under the Clean Air Act (CAA). Municipal waste incinerators, however, are subject to the CAA." OTA, OCEAN INCINERATION, *supra* note 72, at 174.

[513] *See supra* notes 113, 481–83 and accompanying text.

[514] *See supra* notes 183–210 and accompanying text.

[515] OTA, OCEAN INCINERATION, *supra* note 72, at 11. ("[In particular], [t]echnical limitations and performance standards, as well as strict requirements for obtaining permits, monitoring, and reporting, tend to be more involved and leave less to the judgment of those issuing permits for ocean incineration.")

[516] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 31.

[517] *See* 50 Fed. Reg. 8222 (1985).

[518] *See* 40 C.F.R. §§ 265.340–265.352 (1989).

Examples of the more stringent requirements imposed on ocean incineration by the proposed regulation which do not have counterparts in the RCRA regulations governing land-based incineration include the following:

(1) more exacting financial responsibility requirements;[519]
(2) a requirement that an applicant prepare an endangered species assessment;[520]
(3) stringent limitations on metal content of wastes including aluminum, iron, and tin which are not generally regarded as hazardous;[521]
(4) stricter requirements concerning trial burns;[522]
(5) the requirement that a full-time EPA observer be present at the burn;[523]
(6) certification of consistency with approved state CZMA programs;[524]
(7) more demanding monitoring, recording, and reporting requirements, including EPA rules on the qualifications of employees;[525] and
(8) yearly inspections of facilities and records by the USCG and on request by EPA.[526]

Significantly, the MPRSA requires a determination of the need for ocean incineration and ocean dumping in evaluating permit applications.[527] This determination involves a comparison between the human health and environmental risks associated with ocean incineration to those associated with practicable land-based alternatives.[528] Need presumptively is demonstrated if ocean incineration poses risks less than or equal to practicable land-based alternatives.[529]

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519 *See* 50 Fed. Reg. 8222, 8233 (1985).

520 *Id.* at 8237.

521 *Id.* at 8243–44.

522 *See id.* at 8236, 8249.

523 *Id.* at 8252. The USCG could require an additional shiprider. OTA, OCEAN INCINERATION, *supra* note 72, at 129.

524 50 Fed. Reg. 8222, 8238 (1985).

525 *Id.* at 8251–52. "The requirements would specify, for example, the frequency of recording and the use of tamper-resistant devices." OTA, OCEAN INCINERATION, *supra* note 72, at 129. "[Also,] EPA would have to renew and approve the qualifications of ocean incineration company personnel involved in monitoring and analyzing waste." *Id.* at 41. "All data from waste analyses and operational monitoring would have to be submitted to EPA." *Id.* at 129.

526 OTA, OCEAN INCINERATION, *supra* note 72, at 129.

527 EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 31; *see also* MPRSA, 33 U.S.C. § 1412(a)(A) (1982).

528 OTA, INCINERATION ASSESSMENT, *supra* note 72, at 129.

529 *See* 50 Fed. Reg. 8222 (1985).

The two incineration technologies most commonly utilized for liquid organic hazardous wastes in Europe and in the United States involve liquid injection and rotary kiln incinerators.[530] There are some differences in design, however, between those used on land and those used at sea. Ocean incineration uses liquid injection incinerators without air pollution control systems.[531] The rationale for this distinction is that there are no proximal human populations at risk and the expectation that hydrogen chloride (HCl) emissions at sea will be rendered harmless by the ocean.[532] Monitoring from previous burns, as well as simulation modeling, indicate that acid gases are neutralized by the ocean, and the particulates can be kept at safe levels by placing limits on the metal content of the wastes to be incinerated.[533]

Thus, ocean incineration has an economic advantage in that it can be performed without using air pollution controls, because seawater can neutralize hydrogen chloride gas emissions.[534] Moreover, fifty-five percent of the land-based incinerators do not have scrubbers and, thus, release metals and other contaminants similar to ocean incinerators much closer to human populations.[535] The absence of pollution control devices on ocean incineration systems also eliminates the production of scrubber water that would have to be managed as a RCRA hazardous waste.[536] Without air pollution controls, the costs of ocean incineration are reduced to less than half that of land-based incineration.[537]

If the proposed regulation was adopted, ocean incinerator operators would have to perform waste analyses to ensure compliance

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[530] *See generally* OTA, OCEAN INCINERATION, *supra* note 72.

[531] *Id.* at 11.

[532] *Id.* Conversely, land incinerators typically have air pollution control equipment in order to meet air emissions standards for HCl and particulates. *Id.*

[533] *Id.* at 41. Wastes containing chlorine present a problem when incinerated because they produce HCl, a highly corrosive and toxic gas that is difficult to control with air pollution equipment on land-based incinerators. *Id.* at 40–41. When burned, liquid wastes produce emissions of such small size and low particle density that air pollution controls are inefficient at capturing them. *Id.* at 160.

[534] *See* 50 Fed. Reg. 8222 (1985).

[535] OTA, OCEAN INCINERATION, *supra* note 72, at 160.

[536] *Id.* at 41. Scrubber waters from land-based incinerators contain hazardous materials and must be disposed of in an environmentally acceptable manner. SAB REPORT, *supra* note 376, at 21. The SAB study noted that some scrubber water was discharged to local sewer systems. Ultimately some of the materials could enter local waterways. *Id.*

[537] *See* Ocean Combustion Service, Inc. (promotional literature for the *Vulcanus*) (available at OCS, BV, Noordsingel 185, 3035 ER Rotterdam, The Netherlands, P.O. Box 171, 3000 AD Rotterdam) [hereinafter OCS Promotional Literature] (land-based incineration costs $181–212 per metric ton (MT) and at-sea incineration costs $80–91 per MT).

with permit conditions.[538] The HCl emission rate for ocean incineration was set at a level that allows a change of ten percent or less in seawater alkalinity in the release zone after initial mixing.[539] The practical effect is that wastes with a high chlorine content even at a rapid feed rate still will not exceed the environmental performance standard, while wastes with greater than a thirty-five percent chlorine content in land-based incinerators cannot be burned and meet current regulatory emission limits.[540]

The absence of air pollution controls on ocean incinerators would allow nearly all metals in the wastes to become air pollutants. Thus, ocean incineration would be limited to wastes that have concentrations of fourteen listed metals[541] that are less than 500 parts per million (ppm) per metal before burning.[542] EPA also put additional limits of 500 ppm for mercury, silver, and copper in the final blended wastes that could be incinerated.[543]

Other considerations further complicate the issue of whether the incineration of wastes with a high chlorine content is desirable. High chlorine liquid wastes burned at sea usually have a high BTU value whose heat value could be used to incinerate other wastes. This approach is used at some land-based incinerators, although many of the older land-based facilities are thermally inefficient. For incineration at sea, it is not feasible to combine waste streams to use high-BTU wastes to burn low-BTU wastes, and consequently heat value is wasted. If high-chlorine wastes are directed to ocean incineration, other sources of energy such as petroleum must be used to incinerate

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[538] 50 Fed. Reg. 8222, 8238 (1985).

[539] *Id.*

[540] OTA, OCEAN INCINERATION, *supra* note 72, at 124. On land, if HCl production exceeds 1.8 kg/hr (approx. 4 lbs/hr), scrubbers must be used to remove 99% or limit emissions to approximately 4 lbs/hr., whichever results in the larger emission. An incinerator with a medium capacity of 1250 lbs/hr with a 99% efficient scrubber could only incinerate waste with up to a 30% chlorine content before exceeding the regulatory limit. *Id.*

[541] The restricted metals are aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, thallium, tin, and zinc. OTA, OCEAN INCINERATION, *supra* note 72, at 122; *see also House Hearing 1987*, *supra* note 293, at 53.

[542] OTA, OCEAN INCINERATION, *supra* note 72, at 122–23. Environmental groups raised objections to the proposed metal limit because metals in the waste stream are not incinerated but are emitted from the stacks and deposited in the ocean or wherever transported via air currents. In response to the criticisms, EPA was considering proposing a generic environmental performance standard for the amount of metals allowed in the final waste mixture so that the ambient marine concentration of a constituent of the emissions would not exceed its applicable water quality criterion or, where there is no applicable water quality criterion, an aquatic life/no effect level. *House Hearing 1987*, *supra* note 293, at 53.

[543] *See* 50 Fed. Reg. 51,362 (1985).

low-BTU wastes.[544] Also, pollution controls used on land-based incinerators act as an additional emergency backup in case of combustion malfunction[545] and make it easier to obtain monitoring information.[546]

EPA's regulatory program for both land-based and ocean incineration is based on performance standards rather than incinerator design requirements.[547] The measure of incinerator performance used by EPA is combustion efficiency (CE).[548] The term CE is really a misnomer, for it is a measure of the relationship between carbon dioxide (CO_2) and carbon monoxide (CO) concentrations.[549] For ocean incineration, a CE of 99.95 +/- 0.05% is required to meet regulations developed under the London Dumping Convention.[550] Land-based PCB incineration must meet a 99.9% requirement,[551] while other RCRA wastes have no specified CE.[552] The CE is a useful measure, although it evolved for evaluation of boiler operation, not hazardous waste incineration. Incomplete destruction of wastes still can occur with a high CE.[553]

The Destruction Efficiency (DE), or Destruction and Removal Efficiency (DRE), is a measurement of the percentage of destruction of each monitored compound in the waste feed.[554] DE/DRE requirements are 99.99% for all compounds except PCBs, dioxins, and dibenzofurans that have a 99.9999% DE/DRE requirement.[555] DE/DRE is measured after air pollution controls have acted on emissions, but because ocean incinerators normally do not have air pol-

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544 *House Hearing 1983*, *supra* note 258, at 234 (statement of Robert Gregory, Vice President, Rollins Environmental Services, Inc.)

545 On the other hand, ocean incinerator ships depend on an automatic feed shut-off if the wall temperature of the combustion chamber drops below 1100° C. CEFIC, INCINERATION AT SEA, *supra* note 266, at 5.

546 Incinerators using air pollution controls emit gases at lower temperatures, thereby making it easier to monitor the emissions.

547 OTA, OCEAN INCINERATION, *supra* note 72, at 123.

548 50 Fed. Reg. 8266 (1985).

549 The formula for calculating combustion efficiency (CE) is as follows: $CE = CO_2\text{–}CO/CO_2 \times 100$.

550 50 Fed. Reg. 8227 (1985).

551 40 C.F.R. § 761.70(a)(2) (1989).

552 50 Fed. Reg. 8227 (1985).

553 EWK, OCEAN INCINERATION, *supra* note 167, at 5-1. One critic of the validity of CE uses as an example a diesel engine which usually has a thermal efficiency in the range of 30–38%. However, the $CO:CO_2$ volumetric ratio in the engine's exhaust is in the range of 1:320 to 1:640. This gives a CE calculation of from 99.7–99.8%, almost as high as the 99.9% specified in the 1981–1982 permit for the *Vulcanus*. *Id.* at 5–2.

554 50 Fed. Reg. 8266 (1985).

555 TSCA PCB Regulations, 40 C.F.R. § 761.70 (1988).

lution controls, there is a slightly more stringent requirement on an ocean incinerator's burning efficiency compared with land-based incinerators.[556] The DE/DRE concept is based on an input/output ratio, however, so the effects of newly created substances, such as the products of incomplete combustions (PICs), are not considered. Thus, DE/DRE measurement cannot evaluate accurately the total quantity of emissions.

The DE/DRE has a general but not precise relationship to combustion efficiency (CE). Generally, DE/DRE will exceed 99.99% if the CE value is at or above 99.95%.[557] Land-based incinerator operators claim to have a much higher DE/DRE than at-sea incinerators. Land-based operators claim a DE/DRE of 99.99999% ("seven 9s"), while they claim that ocean incinerators only have a DE of 99.99% ("four 9s").[558] The ocean incineration industry claims that their DE is comparable to land-based incinerators.[559]

As under the land regulation, DE is measured by using a small number of primary waste components as a base index to represent the overall hazardous waste.[560] The ocean incineration regulation also requires a trial burn to demonstrate conformity with the performance standard and to identify the appropriate operating conditions to be included in the permit.[561]

Past EPA-promulgated test results claimed that properly designed and operated ocean incinerators are capable of meeting EPA's performance standard.[562] Critics have denounced the EPA data.[563] Ac-

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[556] OTA, OCEAN INCINERATION, *supra* note 72, at 124.

[557] International Maritime Organization, *Report of the Eleventh Meeting of the Scientific Group on Dumping* 3 (Apr. 29, 1988).

[558] *Ocean-Based Incineration of Hazardous Wastes, Hearing Before the Subcomm. on Commerce, Transportation, and Tourism, of the House Comm. on Energy and Commerce*, 97th Cong., 1st Sess. 52 (1981), Ser. No. 97–47 (statement of Melvyn Bell, President of Energy Systems Co.).

[559] Ocean Combustion Service Inc., promotional literature: *Ocean Incineration, the Solution to the Problem* (available at OCS, BV, Noordsingel 185, 3035 ER Rotterdam, The Netherlands, P.O. Box 171, 3000 AD, Rotterdam).

[560] Because many of the wastes to be incinerated are complex mixtures of several different compounds, EPA uses a system that selects principal organic hazardous constituents (POHCs), which serve as indicators for the destruction of all constituents. POHCs selected are those considered most difficult to incinerate, with incinerability based on a determination of heat of combustion. EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 12.

[561] *Id.* at 10. Trial burn requirements for land-based incinerators are set forth at 40 C.F.R. § 270.19(b) (1989).

[562] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 12.

[563] Critics say the *Vulcanus I* cannot be properly tested for any of the variables affecting DRE. EWK, OCEAN INCINERATION, *supra* note 167, at 2–5. The 1981 permit issued to the *Vulcanus I* specified a 0.7 second minimum residence time. Earlier permits did not specify a residence time, but the calculated value for the 1977 burn was 0.67 seconds. The only way to

cording to some of those opposed to ocean incineration, a minimum engineering requirement for incinerator combustion chamber residence time is one second, assuming an adequate temperature and oxygen level.[564] Land-based incinerators often overdesign. For example, the ENSCO incinerator at El Dorado, Arkansas has a mean residence time of 4.5 seconds.[565] The *Vulcanus I* claims a calculated residence time of 0.9 seconds at 1200° C.[566] This conforms to the dominant scientific view that only a fraction of a second at 1200° C is required for 100% destruction of an organic molecule.[567] Organic substances detected in emissions, therefore, are created after fragments from the original substances have recombined.[568]

Particulate emissions from land-based incinerators are limited by regulation.[569] This regulation not only acts as a control on particulate matter in general, but also limits important subsets such as heavy metals and PICs.[570] This standard is the same as the municipal incinerator standard for New Source Performance Standards (NSPS) under the Clean Air Act.[571] The Proposed Ocean Incineration Regulation has no specific particulate standard, but instead limits concentrations in wastes to be incinerated. The resultant mixture of incinerator emissions and seawater would have to meet marine water quality criteria.[572]

A subject of concern has been the formation and emission of PICs.[573] Concern arose in the late 1970s when researchers discovered

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compensate for the *Vulcanus I* residency time, which is two to three times below the minimum required for land incinerators, is to reduce feed rate, which, due to this incinerator's design, would further reduce combustion efficiency. *Id.* at 2–3. In addition, the *Vulcanus I* used a vortex/rotary burner that does not have a high combustion efficiency and is not a preferred technique for incinerating PCBs and other high halogen content wastes according to critics. *Id.* at 2–5. However, the at-sea incineration industry disagrees. CEFIC, INCINERATION AT SEA, *supra* note 266, at 5. Despite the questionable engineering of the *Vulcanus* incineration system, EPA concluded that the *Vulcanus* provided an environmentally compatible means of disposing of wastes only one day after completion of the burn on December 2–9, 1974. EWK, OCEAN INCINERATION, *supra* note 167, at 2–3.

[564] EWK, OCEAN INCINERATION, *supra* note 167, at ii.

[565] *Id.*

[566] OCS promotional literature, *supra* note 537.

[567] IMO REPORT, *supra* note 444, at 12 (citing L. SPAANS, INCINERATION OF CHLORINATED WASTE AT SEA, PROCESS AND EMISSIONS (Marien Eco Publication No. 1) (1987)).

[568] *Id.*

[569] The particulate emission limit for land-based incinerators is 180 mg/dscm after correction to seven percent excess air. Incinerator Performance Standards, 40 C.F.R. § 264.343(c) (1989).

[570] *Id.* § 264.343(a)–(b).

[571] OTA, OCEAN INCINERATION, *supra* note 72, at 125.

[572] *Id.*

[573] PICs are substances formed in the process of combustion that were not present in the original waste. EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 12.

chlorinated dioxins and furans in the emissions of many municipal refuse and hazardous waste incinerators.[574] EPA has not regulated PIC emissions because most studies suggest that the reported levels of PICs from well-operated incinerators pose little risk, but the information available is insufficient and warrants more research. For this reason, the Science Advisory Board report recommends a more comprehensive characterization of emissions to provide a more informed and critical risk assessment for both land and ocean incineration.[575] EPA has proposed that emissions from ocean incineration be analyzed for PICs during research burns and, at EPA's discretion, during trial burns as well.[576]

The basic requirement for an incinerator is to assure that the temperature and time in the incinerator is sufficient to burn those wastes most difficult to combust, often termed principal organic hazardous constituents (POHCs). Several valid concerns surround the adequacy of this method. The value of the heat of combustion index has been criticized,[577] in that it does not allow adequate determination of the incinerability of complex mixtures of chemical compounds.[578] Nevertheless, EPA—although continually assessing this system—believes that the heat of combustion measure is the best available method.[579] EPA notes that normal operating temperatures of incinerators greatly exceed the temperatures required to destroy compounds ranked at the top of all incinerability lists, so this issue is not crucial.[580] As with DRE, however, EPA's position on the heat of combustion measure is challenged by those opposed to ocean incineration, and specifically by those opposed to the use of the *Vulcanus* ships.[581]

Another area of concern, the ability of the incinerators to maintain performance, was addressed in the EPA reports. EPA scientists believe the test burn results[582] indicate that destruction efficiencies

[574] *Id.*

[575] SAB REPORT, *supra* note 376, at 7.

[576] EPA INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 32.

[577] *Id.* at 42–43. Heat of combustion is a "theoretical calculation of energy released when waste molecules are combusted. Compounds with a lower heat of combustion are presumed to be more difficult to burn than those with a higher heat of combustion." *Id.*

[578] *Id.* at 13.

[579] *Id.*

[580] *Id.*

[581] *See supra* note 563 and accompanying text.

[582] Since 1974, the *Vulcanus I* was involved in four series of test burns, and in 1983, the *Vulcanus II* was involved in an additional series of test burns in the North Sea. EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 44.

(DE) of greater than 99.99% are attainable.[583] In these burns, however, EPA measured performance only for a short time and under optimal operating conditions.[584] With this in mind, the Science Advisory Board recommended that EPA conduct more specific tests, particularly focusing on the frequency and effects of "upset conditions."[585] The Board concluded that EPA should conduct several research burns under less than optimal conditions to provide emissions information resulting from waste composition anomalies or mechanical malfunctions.[586]

Critics also have questioned both stack emissions monitoring and ambient air environmental monitoring.[587] The criticisms suggest that sampling practices have not been consistent and that analytical techniques have not been proven adequate for ocean systems.[588] For example, staying within the plume during field sampling is difficult, and samples taken at the air-water interface represent only a crude approximation of actual emissions. Monitoring on ocean vessels involves special problems because the absence of air pollution control equipment causes the stack gases to be emitted at extremely high temperatures, which adversely affects sampling equipment.[589] Thus, additional analytical studies should be conducted during research burns. These studies should entail longer sampling times, better quantification of particulates, and more complete characterization of emissions and potential chemical changes as the hot effluent gases enter the cooler air.[590]

Once released into the air, stack gases and particles are transmitted varying distances through the atmosphere until they either are broken down through such mechanisms as photo-decomposition or are deposited at sea or on land.[591] Due to atmospheric transport, however, land incineration potentially can produce more fallout of emissions into the sea than ocean incineration because of the "much

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583 *Id.*

584 *Id.* at 13.

585 SAB REPORT, *supra* note 376, at 2. Upset condition refers to the operation of a hazardous waste incinerator under less than optimal conditions. *Id.*

586 *Id.*

587 EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 13. Ocean incineration involves ambient monitoring. Land-based incinerators have no such requirement under RCRA or TSCA, although some states may require ambient monitoring under the CAA. *Id.* at 48.

588 *Id.* at 13.

589 *Id.*

590 *Id.* at 48.

591 SAB REPORT, *supra* note 376, at 25.

larger quantities of combusted material emitted over land."[592] For example, underregulated on-site and municipal incineration emissions eventually are carried to the sea as air and water pollutants.[593] Thus, assessment of the environmental impact of ocean incinerator emissions needs to consider more fully the impact on oceans of atmospheric transport and fate of emissions from land-based sources.[594]

Another requirement proposed by EPA mandates that EPA shipriders (observers) be aboard the vessel for transport and incineration phases.[595] This requirement would eliminate some of the concern that the monitoring of ocean incineration is so difficult that illegal releases or incomplete burns by unscrupulous operators would go undetected.[596] With an EPA official accompanying every incineration voyage, the likelihood of illegal activity might be reduced significantly. Because burns can occur twenty-four hours a day, more than one observer would be needed on each vessel. A weakness of land-based incineration regulation is that observers are not required under RCRA regulations.

In EPA's Proposed Ocean Incineration Regulation of 1985, the agency limited incinerator emissions so that they "would not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems or economic potentialities or recreational or commercial shipping or boating or recreational use of beaches or shorelines."[597] This requirement was to be met by an applicant using an EPA-approved model to show that receiving water would contain only trace contaminants that would rapidly be rendered harmless.[598] "Trace contaminants" are defined under technical guidelines to the LDC to prevent ocean incineration if the emissions "could cause undesirable effects, especially the possibility of chronic or acute toxic effects on marine organisms or human health or wildlife whether or not arising from their bioaccumulation in marine organisms and especially in food species."[599] Thus,

[592] *Id.* at 29.

[593] *See id.* at 34.

[594] *Id.* at 29–30.

[595] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 32; *see also* 50 Fed. Reg. 8269–70 (1985).

[596] Note, *supra* note 281, at 186 n.182. Some commentators feel that the observer requirement is critical regarding the liability question. Without an observer on board, any damage occurring at sea is unlikely to be discovered and, even if discovered, it will be very difficult to prove. Asmus & Johnston, *supra* note 265, at 7.

[597] 50 Fed. Reg. 8246 (1985).

[598] *Id.*

[599] *Id.* at 8244.

the aim of EPA's regulation was to prevent even small adverse impacts on oceans from ocean-based incineration.

E. Environmental Effects of the Research Burns

The actual data on environmental effects obtained from the few research burns are sparse and inconclusive. The earliest report by EPA's Office of Water and Hazardous Materials in July, 1975[600] provided data derived from two research burns conducted by Shell under its research permit granted on December 12, 1974.[601] During this burn, the waste plume from the stack was monitored for HCl levels six meters above the sea surface.[602] Although seawater is well buffered, HCl was important to monitor because it can increase the acidity (lower the pH) of seawater. Further at-sea incineration would be conditional on a showing that the pH level in the waters near the *Vulcanus* did not drop by more than a 0.5 pH unit and that there were no significant effects upon the marine environment.[603] The maximum HCl concentrations measured ranged from 0.01 to 7 ppm, with the highest levels occurring at 0.4 nautical miles from the ship.[604]

During the second burn in 1975, an EPA aircraft made passes through the plume during the first three days of incineration. The aircraft measured maximum HCl concentration in the *Vulcanus* plume at 3 ppm the first and third day, and 1.8 ppm the second day.[605] Additional grab samples collected in the plume and later analyzed were low in pollutants. In tests for pH and chlorinity in seawater by the *Oregon II*, where the plume touched down, the maximum pH depression was 0.15 units (well within the limit), and the seawater chlorinity increased 500 ppm. The chlorinity of seawater is usually around 20,000 ppm. The research done on the vessel *Orca* found no differences between fallout and control areas.[606] Water samples collected were also analyzed for organochlorides, which

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[600] Kamlet, *supra* note 292, at 304.

[601] *See supra* notes 298–309 and accompanying text.

[602] Kamlet, *supra* note 292, at 304. Monitoring was carried out on the *Oregon II*, a NOAA research vessel, "using a Geomet hydrogen chloride (HCl) monitor supplied and operated by NASA. Sampling was confined mainly to a 90-degree arc downwind of the *Vulcanus*, beginning a few hundred meters behind the ship and extending about three nautical miles." The HCl detector had a minimum detection lower limit of 10 ppb. *Id.* at 304–05.

[603] *Id.* at 301.

[604] *Id.* at 305.

[605] *Id.*

[606] *Id.*

were found to be below the limits of detection,[607] and no significant levels of eight heavy metals were detected.[608]

In addition to monitoring the plume, EPA monitored an area downwind and downcurrent of the incineration site.[609] The results indicated that "no significant changes in pH, chlorinity, organochlorides, trace metals, phytoplankton, chlorophyll-a or ATP could be detected, suggesting the absence of cumulative impacts from the burn."[610] EPA cautions that there was very little marine life in the incineration site, however, which leaves open the possibility that richer marine environments could be affected.[611] Nevertheless, the first use of at-sea incineration in the waters of the United States for the disposal of organochlorine wastes was rated by EPA as a success and an environmentally acceptable practice when closely monitored and regulated.[612]

During the 1977 research burn,[613] when the herbicide Agent Orange was burned, limited biological monitoring took place.[614] Specifically, biological monitoring was confined to the collection of plankton samples in the burn site before and after the initial burn.[615] No differences between pre-burn and post-burn plankton tows could be found.[616] Again, despite the limited environmental monitoring, the at-sea incineration operation was rated an overall success, and the research burn demonstrated that incineration was an environmentally safe disposal method for organochlorines.[617]

More detailed biological monitoring took place during the second Shell operation, conducted in the Gulf of Mexico at the same site as

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[607] *Id.*

[608] *Id.*

[609] *Id.* at 306. This monitoring was conducted by laying out a sampling grid of 16 stations in the area covered by the plume during the last 24 hours of the first burn. *Id.*

[610] *Id.*

[611] *Id.*

[612] *Id.*

[613] *Id.* The Administrator of EPA issued a research permit on April 25, 1977, authorizing the incineration of up to one shipload (4300 metric tons) of the herbicide Agent Orange stocks located at Gulfport, Mississippi. *Id.* at 307. The U.S. Air Force subsequently incinerated 3520 metric tons of Agent Orange in the Pacific Ocean at a site 120 miles west of Johnston Atoll. *Id.*; *see also supra* notes 319–27 and accompanying text.

[614] Kamlet, *supra* note 292, at 308. A final report on the Agent Orange incineration (prepared by TRW, Inc., under contract to the Air Force) was published by EPA in April, 1978. *See* U.S. ENVTL. PROTECTION AGENCY, AT-SEA INCINERATION OF HERBICIDE ORANGE ONBOARD THE M/T *VULCANUS* (1978) (EPA-600/2-78-086); *see also* Kamlet, *supra* note 292, at 307.

[615] Kamlet, *supra* note 292, at 308.

[616] *Id.*

[617] *Id.*

the first series of burns, during March-April, 1977.[618] The results of this monitoring were reported by EPA.[619] In addition, biological studies were carried out by the TerEco Corporation of Texas.[620] Specifically, EPA transported numerous coastal fish, *Fundulus grandis*, to the Gulf incineration site and exposed them within "biotal ocean monitors" (BOMs) to the *Vulcanus* incineration plume while the Shell waste was being burned.[621] Following the burn, the fish livers were reportedly frozen and later assayed for the activities of specified enzymes; only one enzyme showed a significant response to the test.[622]

The TerEco report concluded that the Shell PVC-derived organochlorine waste "generates a definite stress within the organism (i.e., *Fundulus*) either at high concentrations for short periods or low concentrations for long periods."[623] Nevertheless, the report concluded that "incineration of organochlorine wastes has only temporary effects on the marine environment," and that one would expect a potentially serious problem to exist only with "benthic animals that are exposed to toxicants in the sediments for prolonged periods or with pelagic animals that are exposed to repeated injections of toxicants into the water column or with pelagic animals that must drift with a polluted water mass that maintains its integrity for prolonged periods"—conditions not likely to be associated with sporadic, short-lived, at-sea incineration operations.[624] The results, however, do highlight the need for caution and further research into potential impacts of ocean incineration on the marine ecosystem.[625]

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[618] *Id.*

[619] *Id.* at 308–09; *see also* U.S. ENVTL. PROTECTION AGENCY, AT-SEA INCINERATION OF ORGANOCHLORINE WASTES ONBOARD THE M/T *VULCANUS* (1979) (EPA-600/2-77-196).

[620] Kamlet, *supra* note 292, at 309. According to Kamlet, the TerEco Corporation report is unpublished. *Id.*

[621] *Id.*

[622] *Id.* The activities of three enzymes—Catalase, ATP-ase, and Cytochrome P-450—were assayed from the fish livers. *Id.*

> Of these, only the [Cytochrome] P-450 showed a significant response (showing a nearly 3-fold increase in activity relative to controls), although catalase did show some depression. The report noted, however, that exposed fish that were returned live and acclimated for a few days in the laboratory before being tested had depurated and showed control levels of all three enzymes. The report emphasized the importance of selected metabolic enzymes as early warning signals for untoward responses of animals to chemical pollutants in the water column.

Id. (quoting TerEco Corporation report).

[623] *Id.*

[624] *Id.*

[625] *Id.*

In essence, the above monitoring results were the extent of the information available to EPA at the time decisions were made regarding moving ahead with ocean incineration. Clearly, the available information concerning the health and environmental risks was lacking at the time of the test/research burns. Since that time, more data have become available.

V. Health and Environmental Assessments

A. *Health Effects of Land-Based and Ocean-Based Incineration*

Exposures to PCB emissions from land-based and ocean-based incineration can have a significant impact on human health. A 1985 report[626] provided a comparative exposure assessment that focused on the *potential* differences in human exposure from land-based[627] versus ocean-based incineration.[628] For this comparative assessment, the incineration scenarios were devised as follows.[629] Identical liquid injection incinerator facilities,[630] burning PCB-containing wastes,[631] were assumed to be sited on land[632] and at

[626] Holton, Travis & Etnier, *A Comparison of Human Exposures to PCB Emissions from Oceanic and Terrestrial Incineration*, 2 Hazardous Waste & Hazardous Materials 453 (1985).

[627] *Id.* at 454. Exposure pathways considered for land-based incineration were inhalation, terrestrial food chain, and drinking water. *Id.*

[628] *Id.*

[629] *Id.* It was emphasized in the report that the exposure methods utilized were very generalized because it was not possible, nor necessarily desirable, to develop predictive methodologies that address all processes affecting the movement of contaminants through the environment. *Id.* at 458. Rather, the overall goal of the study was to make reasonably conservative assumptions regarding the environmental transport of materials released by land-based and ocean-based incineration. *Id.* Specifically, the study was provided to "represent a reasonable compromise between model complexity and the ability to obtain realistic data characterizing model parameters." *Id.* The details of the specific assumptions, models, and parameters used in the study are beyond the scope of this Article, but are extensively reported in the cited study.

[630] *Id.* at 454. Because engineering stack design criteria for land-based and ocean-based incinerators differ, however, the stack parameters used in the analysis varied accordingly. *Id.* Specifically, the parameters were, for land-based and ocean-based incinerators, respectively: stack height (27.43 m; 10.45 m), stack diameter (2.08 m; 3.40 m), gas exit temperature (366.5° K; 1429° K), and gas exit velocity (6.40 m/s; 15.2 m/s). *Id.* (Table 1). Average heat capacity for the incinerators was 135 x 10^6 BTU/h. *Id.* at 457.

[631] *Id.* at 454. A PCB waste stream consisting of 18.5% Aroclor 1242 was assumed. *Id.* at 453.

[632] *Id.* at 454. The land location chosen for the assessment was a site near Kansas City, Missouri, at 38° 20' latitude and 94° 20' longitude. *Id.* at 457. The number of persons living within the vicinity of the land-based incinerator was obtained from 1980 Census data tapes. *Id.*

sea.[633] The ocean incineration was assumed to occur on a vessel similar to the *Vulcanus*.[634] The study did not consider the impact of PICs or fugitive PCB emissions on total exposure at either site, nor were accidental releases of PCBs considered.[635] Area-specific meteorological, climatological, and geological data were used to estimate PCB concentrations in air, food, and water.[636] The principal pathways considered for land-based incineration were atmospheric[637] and aquatic transport,[638] and ingestion of PCBs that passed through the terrestrial food chain.[639] Ocean incineration would take place hundreds of miles from the nearest land mass,[640] so inhalation and terrestrial food chain pathways were not considered in this analysis.[641] Thus, the only human exposure pathway considered for ocean incineration was the aquatic food chain exposure pathway (i.e., the ingestion of PCB-contaminated finfish and shellfish).[642] The particular

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633 *Id.* at 454. "The at-sea incineration site was assumed to occur within the Gulf of Mexico Incineration Site designated by EPA for ocean incineration (26° 20' latitude and 93° 40' longitude)." *Id.* at 457.

634 *Id.* at 454. The study also assumed, for comparison purposes, that both the land-based and the ocean-based incinerators operated at *Vulcanus I* test burn conditions. *Id.* at 456.

635 *Id.* at 454. Fugitive PCB emissions were not factored in because preliminary investigations indicated that they would be insignificant because of the low vapor pressure of PCBs (e.g., the vapor pressure of Aroclor 1242 is 4.06×10^{-4} mm Hg at 25° C). *Id.*

636 *Id.* at 458.

637 *Id.* The study made human inhalation exposure estimates for land-based incineration using the Atmospheric Transport Model (ATM), a Gaussian plume model developed by Oak Ridge National Laboratory, and the Concentration Exposure Model (CEM). *Id.*

638 *Id.* The drinking water ingestion dose for PCBs emitted during the land-based incineration was calculated using a multi-media, screening-level model (TOX-SCREEN). *Id.* at 461. This model commences with the atmospheric release of pollutants at the incinerator and estimates air, water, and soil concentrations through calculations of "media interaction[s] (e.g., air to ground and surface water deposition, runoff from ground to surface water, leaching from ground to groundwater, and surface water percolation to ground water)." *Id.* at 461–62. Models, however, do not always reflect environmental reality.

639 *Id.* at 458. The study estimated food chain ingestion doses resulting from PCB releases from the land-based incinerator by using a terrestrial food chain exposure model (TEREX). *Id.* at 459. The study derived the agricultural parameters from the 1974 U.S. Department of Commerce county agricultural census. *Id.* at 460. The parameters included inventory estimates for milk and beef cows, and productivity and yield data from seven vegetable and food crop categories. *Id.* Chemical-specific parameters for the PCBs were also calculated inputs for the TEREX model. *Id.*

640 *Id.* at 457. Because the at-sea incineration site in the Gulf of Mexico (183,000 km^2) is centered 196 miles south-southeast of Galveston, Texas and 217 miles southwest of Cameron, Louisiana, the report assumed that there would be little or no impact on nearby land masses. *Id.* This assumption was supported by atmospheric modeling under a range of conditions, including estimates of the long-range transport of PCBs incinerated at sea. *Id.*

641 *See id.*

642 *Id.* The study predicted PCB concentrations in the ocean water column based on a simple two-compartment model consisting of the ocean and the atmosphere. *Id.* at 463. The atmos-

concern that human exposure to PCBs incinerated at sea could be higher than exposures to PCBs from land incineration stems from the fact that bioaccumulation factors for PCBs in fish and shellfish are high.[643]

For land-based incineration, the study determined that the highest uptake (human exposure) for inhalation[644] was 0.32 micrograms per year (ug/y),[645] the maximum value for uptake via ingestion[646] of PCBs in the foodchain pathway was 0.062 ug/y,[647] and the maximum uptake via consumption of drinking water[648] was 0.0032 ug/y.[649] For ocean incineration, the exposure would be much lower. The most-exposed individual would receive about 0.0026 ug/y of PCBs from ingestion of fish and 0.00026 ug/y of PCBs from shellfish.[650]

Thus, the report concluded that, for land-based incineration, "inhalation exposure is at least two orders of magnitude higher; terrestrial food chain exposure is at least a factor of 20 higher; and drinking water ingestion exposure is about equal to that of consuming fish and shellfish (2.9×10^{-9} g/y) from the incineration site area."[651] This assessment indicates that incineration on land leads to higher human exposure to PCBs than does ocean incineration.[652] The report also provides a caveat, however, that the conclusions might be modified if it is shown that the microlayer of organisms on the

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pheric concentrations were calculated based on assumptions of D stability, a 3 m/s boat speed, and a wind speed of 4 m/s. *Id.* at 463, 465. The study calculated ocean concentrations of PCBs using a uniform mixing model with an assumed depth of 75 m. *Id.* at 465. Once PCB concentrations were determined, bioconcentration for fish and shellfish were based on bioaccumulation factors of 4×10^4 and 3×10^4, respectively. *Id.* The study assumed a dietary worst-case scenario based on the assumption that the most-exposed individual receives all of his or her seafood from the 300 km circular incineration site. *Id.*

643 *Id.* at 453.

644 The inhalation uptake calculations assumed a breathing rate of 8322 m^3/y and a 0.65 absorption factor. *Id.* at 465.

645 *Id.*

646 This maximum is a reasonable "worst-case" individual "who would obtain all of his dietary intakes from the most affected (highest concentration and deposition) region." *Id.*

647 *Id.* at 466.

648 "The drinking water ingestion for a maximally exposed individual . . . assumed that this individual drank all of his water from a 1.5 km section of a free-flowing river located directly below the maximum air concentration location. Surface run-off from the river watershed into the river within this 1.5 km section was also considered." *Id.* at 465.

649 *Id.* at 466 (data from Table 10).

650 *Id.* (data from Table 10). Further, these data are conservative in that reasonable considerations that would lower the figures, such as fish migration, sources of other fish, and productivity of the affected area, were not factored in. *Id.*

651 *Id.* at 453.

652 *Id.* Further, the study did not consider the consumption of freshwater fish that would be contaminated with PCBs from land-based incineration that would lead to even higher estimates of exposure from land-based incinerators. *Id.* at 466.

ocean surface is a significant contributor to aquatic food chain bioaccumulation.[653] This concern also applies to the aquatic food chains in freshwater systems impacted by land-based incineration. Nevertheless, this area certainly deserves more research and understanding.

A 1985 profile prepared for Chem Waste by ICF Technology, Inc. also addressed the human health effects associated with PCBs.[654] This study reported that PCBs[655] have low acute mammalian toxicity, and that the primary concern is for the potential effects of long-term exposure.[656] Exposure of workers to high levels of PCBs on the job typically produced an occupational skin disease known as chloracne.[657] Other studies have reported some liver function abnormalities, although none were associated with detectable adverse health effects.[658] Additionally, noncarcinogenic mammalian (non-human) health effects have been demonstrated. The toxic effects of PCBs are more commonly observed after repeated exposures over a long time period.[659] Specifically, skin syndromes, reproductive effects (e.g., altered menstrual cycles, reduced breeding success, and lowered birth rates), and other problems similar to those observed in humans have been associated with PCB toxicity in rodents, monkeys, and other non-human mammals.[660]

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653 *Id.*

654 This profile summarizes the then existing information about the toxicity of PCBs to mammalian species, including humans and aquatic organisms. The profile is based mainly on secondary sources, particularly assessments conducted under the auspices of EPA. ICF Technology, Inc., Profile of the Human Health and Aquatic Toxicity of Polychlorinated Biphenyls (PCBs) (Dec. 13, 1985) (available at ICF Technology, 1850 K Street, N.W., Washington, DC 20006) [hereinafter ICF report].

PCBs enter mammalian systems in several ways. PCBs are readily absorbed through the gut and respiratory system, and slightly less through the skin. For example, studies show that oral absorption in rats is greater than 90%, and dermal absorption of PCBs (those with 42% chlorine) was 15–34% in monkeys. *Id.* at 1 (citing various other studies).

655 PCBs are complex mixtures of chemicals composed of two connected benzene rings with 1 to 10 attached chlorine (Cl) atoms. *Id.* at 1.

656 *Id.* at 5. Commercial PCBs were marketed for various uses according to the percentage of chlorine in the mixture, including: plasticizers, heat transfer fluids, hydraulic fluids, fluids in vacuum pumps and compressors, lubricants, and wax extenders. PCBs are characterized generally by low reactivity, persistence in the environment, and the tendency to be stored for long periods in animal tissues. Because of their widespread distribution, high chronic toxicity, and environmental persistence, PCBs were singled out for stringent regulation. Manufacture of PCBs is now prohibited in the United States, and the handling and disposal of products still in circulation are regulated by EPA. Of significance is the fact that assessment of the hazards of PCBs is complicated by the fact that several different mixtures having different toxicities were produced and utilized by industries.

657 *Id.* at 2.

658 *Id.* at 3.

659 *Id.*

660 *Id.* at 3–4.

Several researchers have studied the carcinogenicity of PCBs in animals. Commercial PCBs have been demonstrated to induce hepatic tumors and to act as tumor promoters in rats and mice.[661] But, there is little data covering the potential carcinogenicity of PCBs in humans.[662] The International Agency for Research of Cancer (IARC) found that some studies suggested that PCBs may be human carcinogens, but determined that the overall evidence is inadequate to conclude a carcinogenic role of PCBs in humans.[663] Nonetheless, the EPA ambient water quality criterion to protect human health is zero for PCBs because they are considered potential carcinogens.[664]

B. *Ecosystem Effects of Incineration and Transport*

In addition to the human health problems associated with incineration, the airborne emissions and the direct discharges can have a significant impact on aquatic ecosystems.[665] Generally, there are two sources of potential impacts on aquatic ecosystems. The first source is the incineration plume and ash released to the aquatic ecosystem at the burn site. These effects can occur in both freshwater and marine habitats. The second source of risks are those associated with potential spills of unburned hazardous wastes in harbors, while at port, en route to the burn site, or at the burn site itself. This source of risks generally would be associated with ocean incineration.

1. Incineration Emission Effects on the Environment

The risks to ocean ecosystems associated with pollutants derived from incineration have not been well documented.[666] A recent study by Sodergren and colleagues attempted to elucidate the role of the marine microlayer as a source for the transfer of chemical pollutants to the biota inhabiting this layer and to describe the movement of the chemicals up the food chain to organisms throughout the marine

[661] *Id.* at 4–5.

[662] Two cases of malignant melanoma among 31 workers heavily exposed and one case among 41 workers less heavily exposed to Aroclor 1254 have been reported. *Id.* at 5 (citing other studies).

[663] *Id.*

[664] *Id.*

[665] *Id.* at 5–6.

[666] *See, e.g.*, U.S. Envtl. Protection Agency Proceedings of the Workshop on the Sea-Surface Microlayer in Relation to Ocean Disposal (Dec. 18–19, 1985) (Airlie, Virginia, BN-SA-2367) [hereinafter Microlayer Workshop].

environment.[667] Several important results were presented in this study. First, the chemical substances introduced into the air following incineration were transferred readily into the water and surface microlayer.[668] Second, the surface microlayer was shown to be considerably contaminated with PCBs following incineration.[669] Third, the results demonstrated that, after one day, an equilibrium between the concentration of PCBs in the air and water was established.[670] Fourth, a rapid uptake of the added compounds (organochlorine residues) by the zebrafish, *Brachydanio rerio* Hamilton-Buchanan, was observed in all experiments.[671] However, it is significant that all fish survived the experimental exposure regimes.[672]

The study provides the first, albeit inconclusive, laboratory demonstration that an airborne emission is directly related to contamination of the microlayer and provides calculations of the quantitative relationship between the source and the degree of contamination.[673] Importantly, the authors suggest that the results may be used to predict the levels of substances in the surface microlayer of the water based on the known concentration in the air.[674] In summary, this study demonstrates that organochlorine residues emitted following incineration over a water surface are rapidly settled, transferred, and enriched in the microlayer.[675] From the microlayer, the pollutants diffuse into the subsurface water and are made available for

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667 Sodergren, Larson & Knulst, *Transport Mechanisms of Organochlorine Residues After Incineration to Air, Water, Microlayer, and Organisms; Final Report to Greenpeace Int'l* 1, 2 (1989).

668 *Id.* at 9. Specifically, the rate of detection varied with the degree of chlorination of the PCBs burned; various PCB congeners were detected in the water within one day. *Id.*

669 *Id.* Specifically, during an exposure time of one week, a mean concentration of 47.7 pg/*l* [= 0.0000477 ppb] was obtained in the air, while the corresponding values in water and the microlayer were 13.4 ng/*l* [= 0.0134 ppb] and 7170 ng/*l* [= 7.17 ppb]. Thus, PCBs emitted to the air were distributed between the water and microlayer of the system, resulting in a mean enrichment of approximately 500 in the surface microlayer. *Id.* at 10.

670 *Id.* With an atmospheric concentration of PCBs of 42 pg/*l* [= 0.000042 ppb], the level in the water was 3.3×10^5 pg/*l* [= 0.33 ppb] after 24 hours. During the next 14 days, the water PCB concentration remained between 3.1×10^5 and 5.4×10^5 pg/*l* [= 0.31–0.54 ppb]. The mean concentration in the surface microlayer was 17.8×10^6 pg/*l* [= 1.78 ppb], with a sample size of seven. However, due to the small sample size, the deviation from the mean was large. *Id.* at 12.

671 *Id.* Significant amounts of PCBs and PICs from trichloroethylene were accumulated by the fish within 48 hours of exposure, and concentration increased with time. The bioaccumulation factors at the end of the experiments were, for PCBs, 7000, and for PIC 1, 2, and 3, 75, 1000, and 10,000 respectively. *Id.*

672 *Id.*

673 *Id.* at 19.

674 *Id.* at 21.

675 *Id.*

organisms, and, rather than being diluted, are concentrated in the lipids of the organisms.[676] Nevertheless, the direct applicability of this laboratory study to aquatic ecosystems still remains unknown. In fact, the authors conclude with the warning that "[d]espite the fact that no biological effects in the field have been connected with PICs, their proven connection with the aquatic food web is of concern, given what is known about chlorinated compounds with similar properties."[677]

The Sodergren study and the TerEco fish enzyme study conducted during test burns are the major sources cited by environmentalists as indicative of the hazards of ocean incineration as it affects the marine environment. Environmentalists have pushed the TerEco fish study far beyond its significance.[678] *Fundulis grandis*, the fish species utilized by TerEco to monitor ocean incineration effects, is a small fish from the coastal lagoons and salt marshes of Texas and Louisiana.[679] The fish were transferred to a new and different habitat as part of the experiment. This experimental design may have been the basis for the observed differences between the control and test individuals.[680] Indeed, the fish would have had even greater enzyme problems if they had been placed at a land-based incinerator site!

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[676] *Id.*

[677] *Id.*

[678] Specifically, one commentator has written that "[i]n sum, there is evidence of adverse impact on at least one fish species, but otherwise virtually no definitive data exists on impacts upon marine organisms from incinerator emissions." Lentz, *supra* note 351, at 122; *see also House Hearing 1987*, *supra* note 293, at 156 (statement of Sally Ann Lentz, The Oceanic Society, on behalf of eight environmental organizations).

[679] Lentz, *supra* note 351, at 132.

[680] The scientific validity of the fish experiment is difficult to assess. All efforts to obtain a copy of the TerEco Report were futile (including repeated requests to EPA, industry, and the environmentalists who stress its significance including the Oceanic Society and others). Although the specific organism selected for the study was a standard bioassay test species, it was not indigenous to the habitats characterized by the burn sites. While we recognize that organisms such as these are often utilized because their responses to toxic substances may have been previously established in other studies, it is not known if the TerEco researchers established a scientifically valid control in the fish study. A valid control would consist of dragging similarly aged fish to those used in the exposure analysis in BOMs behind another vessel *without* exposure to an incineration plume. Such a control would allow for a comparison of affected and control fish enzyme systems, and would enable the separation of stress effects caused by experimental design (i.e., dragging) from actual effects caused by the incineration emissions. It is unlikely that this was done. However, it is important to note that, while direct effects are not realistically tested for by the fish study, indirect effects via the food web (i.e., ingestion of phytoneuston) could occur and would need to be considered. Additionally, direct effects from spills of liquid hazardous wastes could also affect the fish. However, the fish study did not do either of these; rather, it was only attempting to look at direct effects of incineration emissions on three fish enzyme systems.

Further, the use of this "hardy, coastal fish" for determining biological effects in the open ocean was criticized in the discussion of Lentz's Oceanic Society paper.[681] Even if the experimental protocol was valid, the open ocean TerEco data for estuarine fish would be largely irrelevant if the parameters of the experiment are never realized in nature.[682] Additionally, it has been noted that "most fish larvae are not normally directly exposed to the microlayer."[683] Despite the weaknesses of the fish study, it is repeatedly cited by some environmentalist groups as indicative of the harmful effects from incineration.[684] Obviously, with the clear absence of viable data concerning the environmental effects of ocean incineration, more research is warranted and needed.

Questions still surround the role of the surface microlayer[685] in concentrating chemicals deposited on the ocean surface.[686] It has been postulated that chemical pollutants enter the aquatic food chain through the microlayer organisms that typically occupy the lower trophic levels in marine food chains. As noted above in the human health effects section, knowledge of the biology of the microlayer regarding bioaccumulation is necessary for a more complete understanding of PCB transport and fate as it relates to ecosystem effects.

It should be emphasized that some fresh water habitats, particularly free-standing bodies of water such as lakes and ponds, would be similarly affected by chemicals transported through the air. Thus,

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[681] Comments of Mr. Compaan in discussion following paper presentation, reported at Lentz, *supra* note 351, at 132.

[682] This would be similar to showing in a laboratory that, at cold temperatures, polar bears eat penguins. Yet, in nature, polar bears and penguins do not co-exist; rather, they live at polar extremes.

[683] Sodergren, Larson & Knulst, *supra* note 667, at 2. However, near-shore studies provide information that some fish and shellfish, including cod, sole, flounder, hake, anchovy, crab, and lobster, have egg or larval stages that develop in the sea-surface microlayer. George C. Grant, Zooneuston: Animals of the Sea Surface, in Microlayer Workshop, *supra* note 666, at 48.

[684] *E.g.*, Lentz, *supra* note 351, at 122; *House Hearing 1987*, *supra* note 293, at 156 (statement of Sally A. Lentz, The Oceanic Society, on behalf of eight environmental organizations).

[685] According to current theory, the microlayer is a thin (approximately 20 Angstroms) layer of lipids lying above a 0.1 to 1 um layer of polysaccharides and proteins beneath which bacteria and neuston congregate. The microlayer is a dynamic structure, repeatedly broken and reformed by exposure of new water surface and accumulation of materials at the surface. Transport processes between the atmosphere and water occur at the microlayer. IMO REPORT, *supra* note 444, at 19.

[686] The surface microlayer is composed predominantly of bacteria, protozoa, phytoplankton, and zooplankton. Studies have shown that the microlayer is enriched in dissolved and particulate organic chemicals by factors of from two to six orders of magnitude in relation to the subsurface water. Holton, Travis & Etnier, *supra* note 626, at 465; *see also* Lentz, *supra* note 351, at 122.

the effects of pollutants from land-based incinerators on the surface layers of fresh water bodies would, in many respects, parallel those described above for the ocean environment. Land-based incinerators operating in coastally situated areas are also likely to affect significantly estuarine and coastal ecosystems as well as terrestrial aquatic ecosystems. This is of particular significance when considering that these coastal wetlands are among the most productive ecosystems in the world,[687] as well as being home to abundant wildfowl and major spawning grounds for finfish and shellfish. Their importance is underscored by the fact that some regional catches of commercial fish, such as those from the South Atlantic and Gulf Coast fisheries, were estimated to be more than ninety percent estuarine-dependent.[688] This is a subject that needs further attention.

Emissions effects from incineration also could affect both migratory and pelagic (open ocean) birds, although no data are available.[689] Both land-based and ocean-based incinerators could harm birds. Nevertheless, the welfare of marine birdlife must be considered because emissions into the atmosphere may produce avian physiological responses, or otherwise adversely affect migratory patterns.[690]

2. Waste Spill Effects on the Environment

Environmental impact following a spill of industrial wastes containing organochlorine and other organohalogen compounds would be most troublesome in terms of acute effects.[691] The 1985 ICF report concluded that "available data indicate that acute toxicity to freshwater aquatic life probably will occur at concentrations of PCBs above 2.0 ug/*l* [=2 ppb]," and that "[a]cute toxicity to saltwater

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687 ENV'T AND NATURAL RESOURCES POLICY DIV., CONGR. RES. SERV., REPORT ON WETLANDS MANAGEMENT, CRS-45 (1982) (Ser. No. 97–11) (prepared for the Senate Committee on Environment and Public Works by J. Zinnand & C. Copeland).

688 *Id.* at CRS-46 to 47.

689 OFFICE OF WATER REGULATIONS AND STANDARDS, U.S. ENVTL. PROTECTION AGENCY, ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR NORTH ATLANTIC INCINERATION SITE DESIGNATION (1981) (EPA 440/5–82–025, 4–28) [hereinafter EPA ENVIRONMENTAL IMPACT STATEMENT].

690 *Id.* at 4-27 to -29. The birds could be directly affected by short-term atmospheric contamination (primarily HCl) or be indirectly affected by consumption of organisms that have assimilated waste residues. *Id.*

691 Kamlet, *supra* note 292, at 313; *see also* ICF Technology, Inc., Potential Effects to the Delaware River and Estuary Resulting from a Hypothetical PCB Spill from the *Vulcanus II*, at 24 (Dec. 13, 1985) (available at ICF Technology, 1850 K Street, N.W., Washington, DC 20006).

aquatic life will probably occur at concentrations above 10 ug/*l* [=10 ppb]."[692]

Various studies have assessed the effects of spilled PCBs on several different components of freshwater and marine ecosystems. According to such studies, phytoplankton are critical organisms with respect to aquatic contamination with PCBs. For example, a marine diatom absorbed and concentrated PCBs (Aroclor 1242) to levels 900 to 1100 times above the initial marine concentration.[693] In addition, PCB concentrations ranging from 0.1 to 100 ug/*l* [= 0.1 to 100 ppb] reduced growth of both marine and freshwater phytoplankton, altered dominance relationships among algal species, and reduced species diversity.[694]

Invertebrates, which occupy the lower trophic levels in marine and freshwater ecosystems, were also shown to be vulnerable to PCBs. For example, the acute toxicity for freshwater invertebrates ranged from an LC_{50}[695] of 10 ug/*l* [= 10 ppb] (Aroclor 1241) for scud, *Gammarus fasciatus*, to 400 ug/*l* [= 400 ppb] for the damselfly, *Ischnura verticalis*.[696] Additionally, chronic lethal concentrations for freshwater invertebrates were 0.8 ug/*l* [= 0.8 ppb] (Aroclor 1254) for scud, *Gammarus pseudolimnaeus*.[697] For marine invertebrates, the LC_{50} of PCB (Aroclor 1016) values included 10.2 ug/*l* [=10.2 ppb] for the eastern oyster, *Crassostrea virginica*, and 10.5–12.5 ug/*l* [= 10.5–12.5 ppb] for the brown shrimp, *Penaeus aztecus*.[698] In a laboratory experiment consisting of seawater flowing through small aquaria for four months, concentrations of PCBs (Aroclor 1254) at levels of 1 ug/*l* [= 1 ppb] affected the species composition of communities that developed from planktonic larvae.[699]

Available data for freshwater fish suggest that the "early life-stages are particularly vulnerable to the acute toxic effects of PCBs."[700] For example, newly hatched rainbow trout, *Salmo gaird-*

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692 ICF report, *supra* note 654, at 7 (citing U.S. EPA 1980, Ambient Water Quality Criteria for Polychlorinated Biphenyls, Criteria and Standards Division, EPA 440/5–80–068, NTIS PB 81–117798). It is noted that "studies have shown that effects on species composition of invertebrate communities can occur at concentrations as low as 1 ug/*l* [= 1 ppb]." *Id.*

693 *Id.* at 6.

694 *Id.*

695 LC_{50} refers to the median lethal concentration, or concentration at which 50% of the test species individuals die.

696 ICF report, *supra* note 654, at 6.

697 *Id.*

698 *Id.*

699 *Id.*

700 *Id.*

neri, were found to be "the most sensitive freshwater species tested," with a 96-hour LC_{50} of 2.0 ug/*l* [= 2 ppb] (Capacitor 21 (21% chlorine)).[701] In a similar study, the juvenile fathead minnow, *Pimephales promelas*, had an LC_{50} of 7.7 ug/*l* [= 7.7 ppb] (Aroclor 1254).[702] Acute toxicity of PCBs on saltwater fish species has not been adequately demonstrated.[703]

Chronic test data for fish are also available. In fresh water, the most toxic PCB to fathead minnows (Aroclor 1248) gave a threshold value of 0.2 ug/*l* [= 0.2 ppb].[704] Additionally, a chronic value of 1.0 ug/*l* [= 1 ppb] (Aroclor 1254) was derived for the brook trout, *Salvelinus fontinalis*.[705] In a marine environment chronic test, pinfish exposed to 5 ug/*l* [= 5 ppb] PCB (Aroclor 1254) developed ragged fins, fungus-like lesions, hemorrhagic areas around the mouth, and forty-one to sixty-six percent mortality.[706] Additionally, as described previously, a spill could also indirectly affect marine birds through their consumption of organisms contaminated by the spill wastes.[707]

Thus, both land and ocean transportation of PCBs pose severe acute threats to associated aquatic ecosystems in the event of a spill. The ICF report also concluded that chronic exposures at lower levels would "probably induce effects," but relatively limited data are available.[708] Currently, the EPA ambient water quality criterion as twenty-four-hour averages for PCBs to protect freshwater life is 0.014 ug/*l* [= 0.014 ppb], and 0.030 ug/*l* [= 0.030 ppb] to protect saltwater organisms.[709] Nevertheless, potential damages to the environment and aquatic life resulting from a release of a hazardous substance are highly variable. As one commentator has stated, "[d]amages are dependent on the substance that is released, the amount released, chemical and physical characteristics of the substance, environmental conditions at the time of release, the season

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701 *Id.*

702 *Id.*

703 *Id.* at 7. Specifically, acute exposure of saltwater fish to PCB mixtures have not produced data that can be used to obtain 96-hour LC_{50} values because concentrations tested were not sufficiently high. *Id.* For example, 48 hours by PCB levels of 100 ug/*l* (Aroclor 1254) did not affect pinfish (after 90 hours in water to which 100 ug/*l* (Aroclor 1016) PCB was added, 18% of pinfish died). *Id.*

704 *Id.*

705 *Id.*

706 *Id.*

707 EPA ENVIRONMENTAL IMPACT STATEMENT, *supra* note 689, at 4-27 to -29.

708 ICF report, *supra* note 654, at 7.

709 *Id.*

in which the release occurred, and biological and physical characteristics of the location of the release."[710]

VI. The Assessment of Ocean Incineration

Ocean-based incineration systems have four components. Like land incineration, ocean incineration systems include land transportation, transfer and storage operations, and incineration.[711] Ocean incineration also includes two additional steps: (1) loading onto the ship;[712] and (2) ocean transportation.[713] Releases on land from accidents during land transport or at storage facilities are equally probable for land and ocean incineration systems.[714] However, the two additional steps for ocean incineration increase the likelihood of spillage.[715]

Simply described, there are three ways to get wastes onto a ship. Usually wastes are delivered to the dock and pumped to containers on the ships. For example, Waste Management planned to blend its hazardous wastes at Emelle, Alabama and then truck them to the Gulf of Mexico where the wastes would be pumped to the *Vulcanus I*.[716] SeaBurn, Inc. and Environmental Oceanic Services Corporation proposed a second approach using 5000-gallon stainless steel containers that would be filled where generated to avoid dockside handling of the wastes. Wastes from different storage containers can then be mixed and burned after adjustments to obtain the most complete combustion.[717] Any necessary blending would take place at sea.[718] Such standardized intermodal containers are used worldwide to ship diverse liquids and can be transported by rail, truck, barge, and ship.[719] The third approach is based on an integrated system of specialized port facilities designed for ocean incinerator operations.

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[710] *House Hearing 1987*, *supra* note 293, at 35 (statement of Larry Jensen, Assistant Administrator, Office of Water, Environmental Protection Agency).

[711] EPA, Incineration Assessment: Summary and Conclusions, *supra* note 27, at 15.

[712] Ocean-based incineration requires an additional loading step—pumping wastes from an onshore storage facility or from tank trucks through a piping system into the incinerator ship. *Id.* at 71.

[713] Ocean transportation refers to the transport of the wastes by the ship from the pier facility to the burn site. *Id.* at 70.

[714] *Id.* at 16.

[715] Note, *supra* note 281, at 185.

[716] OTA, Ocean Incineration, *supra* note 72, at 109.

[717] *Id.*

[718] *Id.* at 110.

[719] *Id.*

The port facility would be capable of testing, blending, and storing both containerized and tanked wastes.[720] At-Sea Incineration, Inc. and Waste Management, Inc. proposed integrated port systems,[721] but such proposals were never realized as the private sector withdrew from the ocean incineration business in the United States as a result of EPA inaction.

The amount of waste that would be involved in a viable hazardous waste incineration program is dwarfed by the volume of hazardous substances already entering and leaving United States ports.[722] It is estimated that an ocean incineration program would increase the total volume of traffic in hazardous substances by only about 0.03%.[723] According to the United States Coast Guard (USCG), in fiscal year 1983 the total volume of hazardous substances passing through domestic ports was 8701.6 million barrels compared to the estimated 2.18 million barrels of waste that would be carried in a year by six incinerator ships.[724] Even if all the ships operated in the Gulf of Mexico, the hazardous waste transport in the Gulf would increase by only 0.05%. Further, even if petroleum was not considered a hazardous substance, the increase in volume would still only be 0.11%.[725]

Under these circumstances, the risks associated with transferring wastes to a vessel and transporting them to a burn site become very small risks and are no greater than risks routinely accepted by our chemically dependent society. The already low probability of an

[720] *Id.* at 109.

[721] *Id.*

[722] *See House Hearing 1987*, *supra* note 293, at 99 (answers to Representative Lowry's ocean incineration questions presented by USCG Captain R.T. Rufe). For example, the Army Corps of Engineers' Waterborne Commerce of the United States statistics indicate that over 130 million short tons of bulk liquid hazardous materials were moved in and out of the Port of Philadelphia on ocean-going vessels in 1985. The hazardous materials included gasoline, crude oil, benzene, toluene, sodium hydroxide, sulphuric acid, and other chemicals. These cargoes have such hazards as flammability, corrosivity, toxicity (including aquatic toxicity), and carcinogenicity. Assuming an incinerator ship has a carrying capacity of 3500 short tons (the capacity of the *Vulcanus II* assuming a cargo specific gravity of 1.0) and makes 15 trips per year, the ship would move approximately 52,500 short tons of waste per year. This represents about 0.04% of the total amount of liquid hazardous material moved through the Port of Philadelphia in 1985. *Id.* It is important to point out that the economics of transporting hazardous wastes can differ from that of useful, marketable hazardous chemicals. In the former instance, there is no direct monetary incentive not to spill, whereas in the latter instance, if you lose the marketable cargo, you lose money. However, proper liability requirements could eliminate some of this concern.

[723] 50 Fed. Reg. 8226 (1985).

[724] *Id.*

[725] *Id.*

accident could be further reduced by USCG escort and safety procedures that isolate incinerator ships from other port traffic.[726] Additional measures to ensure safe transit could include: limiting transit to daylight hours and specified weather conditions; establishing a moving safety zone around the vessel; and requiring the vessel to broadcast a "Notice to Mariners" to avoid its route.[727]

To minimize transportation-related risks, the responsible federal agencies developed a regulatory system that has worked relatively effectively. As described previously, shipment to the port is controlled by DOT under the Hazardous Materials Transportation Act[728] and its implementing regulations.[729] Transport is also subject to RCRA regulations,[730] which include requirements that transporters clean up any discharge and protect against any hazards to human health and the environment. If wastes are kept at a waste transfer facility for ten days or more, a RCRA permit is required.[731] If wastes are stored at a waterfront transfer facility, they are subject to comprehensive regulation by the USCG.[732] Coast Guard regulations cover the storage, handling, and loading or unloading of hazardous wastes for incineration at sea.[733] In addition to these regulations, the USCG may recommend specific requirements to be included in an EPA-granted incineration permit.[734]

Regulations concerning ship design provide for further protection. Under the Ports and Waterways Safety Act,[735] incinerator vessels must be at least "type II" bulk chemical carriers.[736] Type II chemical carriers have a double hull and store the wastes in several independent compartments. In 1986 and 1987, there were no spills recorded that resulted from a leak or rupture in a type II ship.[737] If standardized 5000-gallon steel containers were used there would be even less risk. Such containers would minimize chemical handling during transfer to the ship. Moreover, these containers would probably

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[726] Connor, *supra* note 317, at 72.

[727] OTA, OCEAN INCINERATION, *supra* note 72, at 38.

[728] Hazardous Materials Transportation Act, 49 U.S.C. §§ 1802–1813 (Supp. V 1987); *see also supra* note 498 and accompanying text.

[729] Hazardous Materials Regulations, 49 C.F.R. §§ 171–179 (1988).

[730] 40 C.F.R. § 263 (1989).

[731] *Id.* § 264.1(g)(9).

[732] 33 C.F.R. § 126 (1989).

[733] *See id.* Oil and oil containing hazardous waste is regulated at 33 U.S.C. § 156 (1989).

[734] 50 Fed. Reg. 8225 (1985).

[735] 33 U.S.C. §§ 1221–1232 (1982 & Supp. V 1987).

[736] *See House Hearing 1987*, *supra* note 293, at 96. Ship type is indicative of a ship's ability to survive damage from a collision or grounding. *Id.*

[737] *Id.*

survive and remain sealed even if there was a collision. Finally, USCG Captains of the Port have extensive powers to impose additional safety requirements as deemed necessary.[738]

EPA conducted a risk assessment case study that compares the environmental and human impact of land-based versus ocean-based incineration.[739] Accidents involving fire or explosion at storage facilities were ignored because the probability of occurrence is low and the risk is similar for both disposal methods. It was expected that eighty-five percent of the releases would be from the incinerator stacks and fifteen percent would come from transportation and handling. The analysis of land transportation used DOT data on tank trucks carrying hazardous waste. The data were applied to the "miles traveled" assumptions for an incineration program. The data project a release of cargo once every four to five years and a container failure every three to four years.[740] Transfer and storage operations could lead to: (1) spills from unloading tank trucks; (2) spills from equipment at waste transfer and storage facilities; and (3) fugitive emissions. Spills of both types were considered to occur infrequently and would be expected to be contained at the facility. Fugitive emissions would be in the range of 1.1 to 1.2 metric tons per year.[741]

The most serious environmental impact associated with ocean incineration would be a spill in port or at sea. Under most circumstances there would be no way to clean up a spill. The acute effects would include the loss of most organisms in and around the spill. Chronic effects would be more widespread and long-lasting, but would depend upon the types of hazardous wastes spilled. The impact of a spill also would vary with the density of the hazardous wastes. Heavy wastes would sink, affecting bottom dwelling organisms, but if a spill occurred in deep water the benthic impact would be minimized.[742] A floating spill would affect a larger area than a sinking spill. The greatest damage would be in the surface microlayer and the organisms using that layer. A spill in a shallow water area probably would be more severe. Volatilization from a surface slick might pose an inhalation risk to humans.[743]

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[738] *See* 50 Fed. Reg. 8225 (1985); *House Hearing 1987*, *supra* note 293, at 92–101 (Representative Lowry's questions with Coast Guard Captain R.T. Rufe's answers).

[739] COUNCIL ON ENVTL. QUALITY, 15TH ANNUAL REPORT OF THE COUNCIL 238 (1984) [hereinafter 15TH CEQ].

[740] *See id.* at 239.

[741] *Id.* at 240.

[742] *See* OTA, OCEAN INCINERATION, *supra* note 72, at 161.

[743] *Id.* at 163–64.

In the 1985 EPA Incineration Assessment, EPA again developed a risk analysis case study that compared the human and environmental exposure and effects likely to result from releases of land-based versus ocean-based incinerators.[744] The assessment allowed comparative evaluation of the different technologies used for land and sea incineration and considered the additional risks that incineration at sea creates from the loading of the ships and the water transport to the incineration site. EPA claimed that because ocean and land-based incineration systems have different physical characteristics and affect different locations and ecosystems,[745] structuring a consistent comparison was difficult and the results of the study were not sufficient to determine the advisability of any specific land-based or ocean incineration proposal.[746]

It is difficult to compare the impacts of emissions from land-based and ocean-based incineration because they affect different organisms and environments. It should be noted that the exhaust of an incinerator burning liquid organic wastes contains little ash content.[747] Plankton can be affected by emissions, however, though no effect has been directly observed from ocean incineration. Incineration can affect fish, but only one burn has been shown to do so. There, the impact was a transient one and probably was due to weaknesses in the design of the study—the experiment may have induced the stress.[748] Benthic organisms could be affected, but given the depth at open ocean burn sites, the effects would be minimal, difficult to detect, and long-term. Birds might be affected by the incinerator plumes, but no evidence of such a problem exists.[749]

In the comparative EPA Incineration Assessment, EPA looked at the possible effects on human health from incinerator releases and fugitive releases from transfer and storage equipment.[750] The anal-

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744 EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 15. This study comprised an integration of existing information with new analyses developed from existing methods and data. EPA noted that since no new research was undertaken, the conclusions are limited particularly by the availability and quality of information on emissions, transport, fate, and effects. Additionally, EPA noting the complex, cross-program nature of the study, had the work extensively reviewed by experts throughout EPA's various offices (e.g., the Offices of Research and Development, Water, Solid Waste, Toxic Substances, Air, Noise, and Radiation, and EPA Regions II, III, IV, V, and VI). *Id.* at 68.

745 *See id.* at 15.

746 *Id.*

747 *House Hearing 1987*, *supra* note 293, at 96.

748 *See supra* notes 621–24, 678–81 and accompanying text.

749 OTA, OCEAN INCINERATION, *supra* note 72, at 162. *See also supra* notes 689–90 and accompanying text.

750 *See* EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at

ysis of human health risks estimated the incremental risk of developing cancer for a hypothetical "most exposed individual" (MEI) who resides at the location of the highest overall risk due to air concentrations resulting from incinerator stack, transfer, and storage releases.[751] These risk estimates assumed continuous exposure for seventy years.[752] The study found that the incremental risks from land-based incineration releases were about three in 100,000 whereas the incremental risks from ocean-based incineration ranged from one in one million to six in ten million.[753] The study also notes that the data and methods used to generate the incremental risk estimates were "highly uncertain" and tended to overestimate projected human health risks.[754]

However, while the absolute risk levels should be considered with caution, using the data for relative risk assessment indicates that land-based emissions of PCBs create forty times more incremental risk to the MEI than do ocean-based emissions, and about thirty times more risk from ethylene dichloride (EDC) waste incineration.[755] In other words, due to the greater distance from populated areas, human health risks from ocean incinerator stack emissions range from thirty to forty times less than risks from land-based stack emissions. The evaluation of the possible environmental effects of stack releases indicated that there would be no measurable effect on the marine ecosystem.[756] Thus, EPA determined that overall human health and environmental risks from ocean incineration are very low. While land-based incineration facilities also generally pose small risks, ocean incineration would provide added safety to both humans and the environment.

The comparative EPA Incineration Assessment looked as well at the effects from ocean transportation releases.[757] Here, increased

15. Fugitive emissions encompass instances of uncontrolled releases from valves, inadvertent minor ruptures in containers or pipes, and small spills that occur during waste storage or transfer operations. SAB REPORT, *supra* note 376, at 1. This term does not apply to major accidents, collisions, explosions, or spills. *Id.*

[751] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 17. For the land-based system, the location of the MEI was based on census data; whereas for the ocean-based system, the MEI was assumed to reside at the point on the coast where modeled concentrations are highest averaged over a year. *Id.*

[752] *Id.*

[753] *Id.* at 18.

[754] *Id.*

[755] *Id.*

[756] *Id.* In fact, EPA determined that background atmospheric flux of PCBs into the Gulf of Mexico was two to three orders of magnitude greater than deposition from incineration of PCBs. *Id.*

[757] Ocean transportation characteristics are unique to the ocean-based system. *Id.* at 71.

caution is warranted owing to the potential risks of spills during the ocean transportation phase of the operation. These risks are unique to ocean incineration but have a low estimated probability of occurrence.[758] The total estimated probability for casualties involving spills of any size was one per 1200 operating years.[759] Note that these estimates were conservative for they assumed that a spill released the vessel's entire contents and that no remedial efforts to clean up the spill from the marine environment were undertaken.[760] Additionally, the tonnage carried by an ocean incineration vessel is small in comparison to commercial shipments of petroleum and other hazardous substances;[761] thus, the increase in risk from an incineration program would be small. However, the low risk found in EPA's study flows from the fact that the transportation risks were estimated using the data concerning the 320 voyages in the North Sea by incineration ships that resulted in no spills. Results were adjusted to show less risk because of restrictions imposed by the USCG and the soft bottom conditions of the Gulf of Mexico—the presumed burn site.[762] While EPA seems sanguine about the risk of spills, the public seems to feel differently. The fear of spill was the major reason for opposition by New Jersey and Delaware to the Chem Waste permit application in 1985.[763]

The EPA Incineration Assessment also characterized possible human effects resulting from spills in the marine environment. EPA found that volatilization of a spill could expose human populations to

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The study characterized possible human health and environmental effects from spills at three sites: Mobile Harbor, Alabama; over the continental shelf in the path to the burn zone; and in the burn zone itself in the Gulf of Mexico. *Id.* at 19. Spill rates were developed for different impact and non-impact type accidents, for four different locations of interest, as well as for different vessel designs, operating restrictions and other parameters. *See id.* at 78–79.

[758] *Id.* at 5, 79.

[759] *Id.* The frequency of spills estimated for any particular location was much less. For instance, the overall spill rate for the pier and harbor area is about one per 3,000 operating years; for Mobile Bay about one per 10,000 operating years; for the coastal zone about one per 4,000 operating years; and for the burn zone about one per 6,000 operating years. *Id.* at 79.

[760] *Id.*

[761] *Id.* For example, the waste cargo carried by the *Vulcanus* would be only about 0.01% of petroleum and hazardous substances transported annually in the Gulf of Mexico area. *Id.* The three working ships today are small. The *Vulcanus* ships, for example, carry only about one-tenth of the cargo of a typical chemical tanker. The *Vesta* is even smaller. *House Hearing 1987*, *supra* note 293, at 197 (statement of Dr. William Y. Brown on behalf of the Association of Maritime Incinerators (AMI)).

[762] 15TH CEQ, *supra* note 739, at 238.

[763] Letter to Henry Longest, Acting Asst. Administrator for Water, U.S. EPA, from government officials of Delaware and New Jersey (June 20, 1985) (copy on file with the *Boston College Environmental Affairs Law Review*).

high concentrations of hazardous constituents for short periods of time.[764] Owing to the acute nature of such an exposure, they compared the estimated dosage received by human populations within the first twenty-four hours after a spill to the Threshold Limit Value (TLV) for the chemicals assumed to be released.[765] The results indicate that spills of an entire cargo of PCBs or ethylene dichloride (EDC) one kilometer from a port could cause human health problems.[766] Spills at other locations, such as the continental shelf or the burn site, would not be expected to cause acute human health problems.[767]

The EPA Incineration Assessment also characterized the potential effects of a spill on a marine ecosystem. The severity of the effects of a spill would vary. For example, spills of PCBs would potentially have much greater effects on a marine ecosystem than spills of EDC.[768] The absence of precise data on this subject warrants the development of a research program. In its study, the Science Advisory Board (SAB) recommended that an evaluation of exposure durations and concentrations be based on both a detailed assessment of environmental transport processes and the habits of the exposed organisms in both aquatic and terrestrial environments.[769] Particular attention should be focused on the role of food webs in evaluating exposure effects.[770] The SAB report also concluded that because the toxicities of emissions and effluents from ocean-based, as well as land-based, incinerators are largely unknown, at a minimum they should be tested on sensitive life stages of representative aquatic vertebrates, invertebrates, and plants of ecological importance.[771]

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[764] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 87.

[765] *Id.* The TLV represents the dosage to which a worker can be exposed with no adverse health effects such as coughing, dizziness, and longer-term health damage. EPA adjusted the TLVs to account for continuous exposure rather than only eight hours per day, and assumed, in all calculations, that the human population was directly downwind from the spill site and that the entire waste cargo of the vessel was released. *Id.*

[766] *See id.* at 87, 88 (Table 7).

[767] *Id.* at 87.

[768] *Id.* at 90. Effects of PCB spills range from being severe in the bay region (e.g., substantial reduction in benthic species and large bioconcentration effects on fish and shrimp) to less severe at the burn site. PCBs are persistent compounds and linger in the environment. Additionally, bioconcentration effects on commercial and recreational marine life would be most severely felt in bay and continental shelf areas. By contrast, EDC spills would have relatively small effects on the marine ecosystem due to a rapid diffusion rate and a relatively low toxicity to marine organisms. Additionally, bioconcentration of EDC is not a significant phenomenon. *Id.* at 89–90.

[769] SAB REPORT, *supra* note 376, at 4.

[770] *Id.*

[771] *Id.* at 5. Particular attention should be devoted to assessing the effects on the organisms

Both laboratory and field studies should be undertaken to ensure that long-term operation of incinerators does not produce significant adverse effects on the marine environment.[772]

The major technological difference between land-based and ocean incineration is the absence of scrubbers on the ocean incineration vessels.[773] The controversy over the need for scrubbers on ocean incineration vessels is clouded by two common misconceptions regarding scrubber technology. The first involves the issue of what particular waste products actually are removed by scrubbers. Scrubbers generally are effective at removing acid gases, but are not always effective at removing residual organic material, such as unburned wastes or PICs.[774]

The second misunderstood issue is that a difference exists between the emissions of organic material that would be allowed under the regulations corresponding to land-based incineration and ocean incineration. The proposed regulation called for the performance of ocean incinerators, like land-based incinerators without scrubbers, to be measured by calculating destruction efficiency (DE). For land-based incinerators utilizing scrubbers, performance is measured by calculating destruction and removal efficiency (DRE), after emissions pass through the scrubber. In the end, the DE standard proposed for ocean incinerators was identical to the DRE standard for land-based incinerators with scrubbers. Emissions from ocean incineration would not be any greater than those allowed for land-based incinerators, even after determining any incidental removal of organic material by the scrubbers. In other words, ocean incinerators would be held to the same overall performance standard.[775]

Thus, any evaluation of the need for scrubbers on ocean incineration vessels should be limited to HCl and appropriate particulate emissions. EPA determined that HCl gases would be rapidly neutralized by seawater, and particulate emissions would be minimal because of the limited types of wastes (e.g., liquid wastes with low metal contents) that would be allowed for ocean incineration.[776]

Another criticism of at-sea incineration concerns the approaches used to clean the ships. When the *Matthias III* was sold, the cleaning

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inhabiting the ocean surface waters that are most proximal to emissions and spill wastes. *See, e.g.*, *id.* at 42–43.

[772] *Id.*

[773] OTA, OCEAN INCINERATION, *supra* note 72, at 11. As of 1986, scrubbers were only used on about 37% of existing land-based incinerators. *Id.* at 101.

[774] *Id.* at 12.

[775] *Id.*

[776] *Id.*

required by the government produced fifteen cubic meters of solids (scales and rusts) that were to be disposed in a landfill in the Federal Republic of Germany, and about 290 tons of liquids with small solid particles that were to be incinerated on the *Vulcanus I*.[777] In June, 1981, the Netherlands authorities revoked the Certificate of Approval for the *Vulcanus I* because of leaking cargo tanks. The ship's owners, Ocean Combustion Services, then took the ship to sea and cleaned the tanks en route to a Spanish shipyard for repairs because no harbor authority would allow such cleaning.[778] This happened again in January, 1983, after the *Vulcanus I* had been operating in Australian waters and needed cleaning before entry to a shipyard in Singapore for repairs.[779] To eliminate this concern, USCG personnel would ensure that any wastes that are not burned at sea are either retained on board for burning during a subsequent burn or are brought ashore for disposal. This process could include supervision of tank cleaning operations to ensure that tanks are washed properly and that leftover wastes are transferred ashore to adequate disposal facilities.[780]

Also of concern regarding the ocean incineration option are the issues of liability limits and financial responsibility requirements.[781] The MPRSA establishes no liability limits for any of the activities it covers, including ocean incineration.[782] Further, the MPRSA does not explicitly authorize EPA to impose a financial responsibility requirement through regulation.[783] Recognizing the need to impose such a requirement, EPA's Proposed Ocean Incineration Regulation, while noncommittal on the issue, sought public comment on a proposed liability range of $50–500 million for ocean incineration permittees.[784] Because the regulation was never finalized, the issue of liability was never resolved.

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[777] International Maritime Organization, *supra* note 272, at 1.

[778] Vallette, *supra* note 342, at 11.

[779] International Maritime Organization, *supra* note 272, at 2.

[780] *House Hearing 1987*, *supra* note 293, at 98 (statement of USCG Captain R.T. Rufe, in response to Representative Lowry's questions).

[781] OTA, OCEAN INCINERATION, *supra* note 72, at 46. Liability requirements are distinguishable from financial responsibility requirements. Liability limits, which are commonly set by statutes, represent specified maximum amounts of money that a party can be legally required to pay for damages. Financial responsibility requirements, which can be set by statutes or regulations, are designed to assure that parties undertaking certain activities have sufficient financial resources to meet liabilities the parties might incur. Thus, the liability limit and the required level of financial responsibility are typically the same. *Id.*

[782] *Id.*

[783] *Id.*

[784] 50 Fed. Reg. 8233 (1985); *see also* CTA, OCEAN INCINERATION, *supra* note 72, at 46–47.

In 1986, however, the Superfund Amendments and Reauthorization Act (SARA) specifically addressed the issues of liability limits and financial responsibility requirements of owners and operators of incinerator vessels.[785] Section 127 of SARA amended sections 107 and 108 of CERCLA in two ways. First, section 127 equated incinerator vessel liability with liability of CERCLA facilities so that an owner or operator of an ocean incineration vessel would be liable for the total costs of cleanup in the event of a spill and up to $50 million for natural resources damages. Second, SARA authorized EPA to require additional evidence of financial responsibility for incinerator vessels commensurate with the risks posed by ocean incineration, transportation, and other pertinent factors, starting with a minimum of $5 million.[786] Further, section 127(g) of SARA added a savings clause to section 106 of the MPRSA, which would allow private citizens to recover damages resulting from noncompliance with the MPRSA or the relevant ocean incineration permit.[787]

In addition, EPA considered establishing a new financial responsibility requirement to be set at a determined amount to ensure that ocean incineration companies have funds available to respond to a spill and any third-party claims and to pay for any natural resources damages. The type of financial responsibility mechanism EPA considered allowing an applicant to use would include any of the mechanisms allowed under CERCLA section 108, including insurance, guarantee, surety bond, or qualification as a self-insurer.[788]

As with most aspects of the ocean incineration option, environmental groups considered these liability provisions inadequate to cover the costs associated with a spill of hazardous substances, including costs to third parties, and suggested a substantial increase in required coverage.[789] Indeed, they cite the 1983 Chem Waste

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[785] *House Hearing 1987*, *supra* note 293, at 54 (memorandum from the U.S. House of Representatives, Committee on Merchant Marine and Fisheries, to the Subcommittee on Oceanography).

[786] 42 U.S.C. §§ 9607(c)(1)(D), 9608(a)(1) (1982 & Supp. V 1986).

[787] *House Hearing 1987*, *supra* note 293, at 54 (memorandum from the U.S. House of Representatives, Committee on Merchant Marine and Fisheries to the Subcommittee on Oceanography).

[788] 42 U.S.C. § 9608(a)(1) (1982).

[789] *House Hearing 1987*, *supra* note 293, at 167–70 (statement of Sally Ann Lentz, the Oceanic Society, on behalf of eight other environmental groups). The environmentalists criticized EPA for relying on an insurance study (Clark, Oppenheimer, and Engineering Computer Opteconomics, Inc., Environmental Insurance Coverage for Ocean Incineration Vessels (1985) (prepared for the Office of Policy, Planning, and Assessment)) that they believed flawed, to determine the cost of cleanup. Specifically, they believe the assumption that any "spilled substances would be oil-like in nature, denser than water and likely to float on the surface"

applications for "special" permits, which proposed coverage of $350 million in liability insurance as a more realistic benchmark indication of a minimum standard than EPA's proposal of $50 million.[790]

A potential problem with these insurance requirements is that marine insurance policies are subject to legal defenses. The issue of exemption from liability for damages resulting from "acts of God," for example, needs to be addressed.[791] The fact that no legal regime exists to cover the cost of damages to marine resources and human health associated with the normal permitted operation of an ocean incinerator also has been criticized.[792] In other words, coverage applies to damage arising from "sudden and accidental events" such as spills, but not to damages from "gradual pollution," such as incinerator emissions.[793] It is argued that, due to the possibility that damages to the environment or human health could arise from ocean incineration apart from a spill, legal provisions should be established to protect potential victims from such risks.[794] However, land-based incinerators also are exempt from mandatory insurance for liability for damages from "gradual pollution."[795] Liability for damages from federally permitted releases should be no different, at least in scope, for land-based incinerators than would be required of ocean incinerators.

If the ocean incineration option is revived, EPA should further investigate the sufficiency of the liability provisions and ensure adequate coverage during the permitting process. Where appropriate, the coverage and requirements should be similar to those placed on land-based incinerators. Further, it is important to note that many of the problems regarding liability that apply to ocean incineration actually reflect the much broader crisis in environmental liability in general.[796]

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does not adequately cover the range of potential chemicals spilled and led to an underestimate of the costs of mitigating or cleaning up a sinking spill. *Id.* at 168–69.

[790] *Id.* at 169.

[791] Marine insurance policies are subject to several legal defenses. For example, such policies usually do not cover damages resulting from acts of God, and most policies provide no coverage unless negligence by the vessel's owner or operator can be proved. OTA, OCEAN INCINERATION, *supra* note 72, at 47.

[792] *House Hearing 1987*, *supra* note 293, at 170; *see also* Vallette, *supra* note 342, at 47.

[793] Thus, damages arising from "federally permitted releases" do not trigger liability requirements, thereby raising the problem of distinguishing damage caused by permitted releases from damage caused by non-permitted releases. OTA, OCEAN INCINERATION, *supra* note 72, at 47.

[794] *House Hearing 1987*, *supra* note 293, at 170.

[795] OTA, OCEAN INCINERATION, *supra* note 72, at 46.

[796] The ever-increasing difficulty in obtaining affordable commercial pollution insurance threatens all waste handlers. *Id.*

Unquestionably, limitations and uncertainties surround the ocean incineration option. For example, the studies did not consider a number of effects that might result from releases from the ocean and land-based system, particularly the potential effects from either system on terrestrial systems,[797] or the impact on oceans from terrestrial emissions. Additionally, the analysis of the quantity of and effects from stack releases is based on a number of assumptions about incinerator performance and scrubber technology derived from limited trial burns. For instance, the data on PIC generation is extremely uncertain and subject to debate.[798] Also, the destruction efficiency (DE) concept may not sufficiently account for the mass of partially destroyed wastes and the mass of compounds newly synthesized during the combustion process.[799] But most of these concerns relate to incineration generally and not just to ocean incineration. Also, many of the assumptions used by EPA were conservative.[800] Thus, if these limitations and uncertainties are diminished in the future through further research and trial burns or if better data become available, then a more accurate assessment of ocean incineration could be achieved.

VII. Discussion

In the 1970s, ocean incineration was heralded as a valuable means of disposing of some types of hazardous wastes. With available landfill capacity for disposing of hazardous wastes rapidly declining and the increase in associated tort and environmental clean-up liability, ocean incineration appeared to be a viable disposal option. For several years, EPA's hazardous waste management policy not only had a pro-ocean incineration tilt, its policy operated in favor of one company, Waste Management; some even called this relationship "incestuous."[801] But this relationship was not surprising or even necessarily undesirable. Both EPA and Waste Management had an interest in seeing hazardous wastes managed, and strict regulation increased the power of EPA and concomitantly the profit potential of the waste management industry.

In the short run, Waste Management benefitted from EPA's stance, although its competitors for ocean incineration business fared

[797] EPA, Incineration Assessment: Summary and Conclusions, *supra* note 27, at 69.
[798] *Id.*; *see also supra* notes 573–76 and accompanying text.
[799] SAB Report, *supra* note 376, at 7; *see supra* notes 554–56 and accompanying text.
[800] EPA, Incineration Assessment: Summary and Conclusions, *supra* note 27, at 69; *see also supra* note 760 and accompanying text.
[801] Bailey & Faupel, *supra* note 396, at 7.

poorly.[802] For example, At-Sea Incineration, which could have produced the most modern incinerator ships, was "helped" into bankruptcy by EPA.[803] SeaBurn, Inc., which may have had the best proposal, received short shrift from EPA's senior management.[804] SeaBurn's plan involved total containerization from source to burn and included air pollution controls as well.[805] Even ocean incineration critics considered SeaBurn's approach to involve less risk.[806]

Much of the conflict surrounding the ocean incineration option was the result of intense competition between the ocean incineration industry, dominated by Waste Management and its subsidiaries, and the land-based incineration industry, led by Rollins Environmental Services, Inc. These organizations aggressively fought to advance their corporate interests and may be considered to have played very "hard ball" in the process.[807] They agreed on nothing, including the need for ocean incineration. Waste Management perceived a large market, with room for all viable disposal techniques,[808] while Rollins and others disputed this claim.[809]

Waste Management participated actively in politicizing the early EPA decision making process and paid for much of the research supporting ocean incineration using the same contractor that EPA relied on to support their original favorable position toward ocean

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[802] *See* Anderson, *supra* note 346, at C15; Anderson, *Agencies Battle Over Disposal Rights*, Wash. Post, Mar. 27, 1975, at E23; *see also supra* notes 396–401, 408–16 and accompanying text.

[803] *See supra* notes 396–401 and accompanying text.

[804] Correspondence between Vincent G. Grey, President of SeaBurn, Inc., and William D. Ruckelshaus, Administrator of U.S. EPA, letters dated April 25, 1984; May 24, 1984; June 18, 1984; and July 6, 1984 (letters on file with the *Boston College Environmental Affairs Law Review*); *see also* Zurer, *supra* note 155, at 36–37.

[805] *See* DeGregorio & Grey, *Seaburn: A New Concept of Chemical Waste Collection and Shipboard Incineration*, 9 STOLTEN 12 (Aug. 1984). SeaBurn Inc.'s proposal involved transporting wastes in standard intermodal tank containers that would have been carried on a specially designed container ship. Wastes would have moved directly from the shipping containers to the incinerator. No wastes would have been carried below deck, and in the event of a collision or sinking, the wastes would be unlikely to leak into the environment. The incinerators would have been horizontally oriented to minimize the air-borne plume and to facilitate monitoring and sampling. Scrubbers would have been used to direct gases to be assimilated in the sea and not become airborne. The ships would have been U.S. built and manned. Letter from Vincent Grey, President of SeaBurn Inc., to Dr. Tudor Davies, EPA (Feb. 18, 1987) (copy on file with the *Boston College Environmental Affairs Law Review*).

[806] *See* Zurer, *supra* note 155, at 30–32.

[807] To some, the ongoing encounter between Waste Management and Rollins was known as "The Shootout at the OK Dump." MacKay, *supra* note 359, at 43.

[808] *See* Nassos, *supra* note 275, at 211.

[809] *House Hearing 1983*, *supra* note 258, at 230 (1984) (testimony of Robert Gregory, Vice President, Rollins Environmental Services).

incineration.[810] While this might be explained as the desire of Waste Management to hire the best people to do their work, the fact remains that much of the favorable scientific information generated by EPA, the industry, and even international organizations[811] has a common source. TRW, Inc., in particular, was a major contractor to both EPA and Waste Management in developing the studies to support ocean incineration.[812]

This potential conflict of interest seems improper.[813] Credibility of at least some of this data is compromised by the apparent discrepancy between the conclusions and the data gathering. For example, in the 1981–1982 *Vulcanus* trip report,[814] it is stated that combustion efficiencies averaged 99.983 and 99.976% in the port and starboard incinerators, respectively. However, the body of the report states that the burn began on December 22, 1981 and continued to January 2, 1982. On December 25, the combustion gas monitoring equipment on the port incinerator became plugged, and no combustion measurements were made after December 27. There were three sampling operations. The first was successful, the second only partially successful, and the third was a total loss. In essence, the conclusions were based on incineration of a single waste sample. These data seem a slender reed on which to support claims of a successful and environmentally sound burn. Unfortunately, this is not an isolated example of the questionable quality of EPA-sponsored research relating to the ocean burns.

During the 1970s, the research that EPA could have used to support an effective and believable regulatory program was not

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[810] *Compare, e.g.*, D.G. ACKERMAN, TRIP REPORT PCB RESEARCH BURN ONBOARD THE M/T *VULCANUS*, DECEMBER 20, 1981–JANUARY 4, 1982 [hereinafter ACKERMAN, TRIP REPORT] *with* D.G. ACKERMAN, R.G. BEIMER & J.F. MCGAUGHNEY, INCINERATION OF VOLATILE ORGANIC COMPOUNDS ON THE M/T *VULCANUS II* (1983).

[811] *See* D.G. ACKERMAN, OCEANIC INCINERATION OF HAZARDOUS WASTES: A STATE-OF-THE-ART DISPOSAL TECHNOLOGY (1987). AMI is a Dutch association whose members own and operate the world's three incineration vessels: the *Vulcanus I* and *II*, and the *Vesta*. Waste Management, through its subsidiary, Waste Management International, owns and operates the *Vulcanus I* and *II*. The *Vesta* is owned by Lehnkering-Montan A.G. of Duisberg, West Germany, a member of AMI, and an independent company in competition with the *Vulcanus* vessels. *House Hearing 1987*, *supra* note 293, at 220 (response by William Y. Brown, Waste Management, to questions posed by Representative Lowry, Subcomm. on Oceanography).

[812] OTA lists two reports done by Ackerman et al., of TRW in 1983; one for EPA, and the other for Chem Waste. OTA, OCEAN INCINERATION, *supra* note 72, at 205.

[813] *Senate Hearing 1985*, *supra* note 258, at 108, 113 (testimony of Sue Ann Fruge on behalf of The Gulf Coast Coalition for Public Health, Harlingen, Texas).

[814] ACKERMAN, TRIP REPORT, *supra* note 810.

done. In the early 1980s, when the tide of public opinion changed, ocean incineration became particularly vulnerable to opposition—mostly based on politics, not science. Because it had the potential to affect an entire region, the nearby port community, communities along the coast near the burn site, and the associated marine environment,[815] the public that feared the risks but anticipated little personal benefit from ocean incineration was aroused.

The ocean incineration controversy that followed shows that the NIMBY syndrome is not limited to local siting issues. When a population, like that of the Rio Grande Valley in Texas, perceived no new jobs, no additional money flowing into a depressed local economy, and envisioned potential harm to the local environment, they were easily convinced to oppose ocean incineration. The potential threat to the Gulf of Mexico aroused the ire of those who made their living from the finfish and shellfish inhabiting the Gulf. With a fishing industry in Texas whose annual catch was valued in 1982 at over $613 million, this reaction is not surprising.[816] Solutions to social problems such as hazardous waste disposal always seem to be opposed by those who will have the activity take place near their turf. When you add to these dynamics an out-of-state corporation like Waste Management which was perceived as an undesirable neighbor, and a well-orchestrated and presumably well-financed[817] opposition by a land-based incineration industry that did not wish to lose business to a low-cost rival,[818] one can understand why more than 6000 people would attend a public hearing to oppose ocean incineration. This opposition, once again, showed that the public can veto any

[815] EPA, INCINERATION ASSESSMENT: SUMMARY AND CONCLUSIONS, *supra* note 27, at 19.

[816] *House Hearing 1983*, *supra* note 258, at 72 (statement of Deyaun Boudreaux, citing National Marine Fisheries statistics). In 1987, testimony stated that the Gulf of Mexico has 40% of the commercial fisheries in the United States, as well as a large portion of the recreational fisheries. *House Hearing 1987*, *supra* note 293, at 114 (statement of Joan Brotman, Gulf Coast Coalition for Public Health).

[817] *See* MacKay, *supra* note 359, at 42–43; *see also supra* notes 358–61 and accompanying text.

[818] Over 50% of all commercial waste disposal and treatment is handled by nine major waste management firms. They are: Browning-Ferris Industries, CECOS International, Chem-Clear, Chemical Waste Management, Conversion Systems, IT Corporation, Rollins Environmental Services, SCA Chemical Services, and U.S. Ecology. *See* CHEMICAL & ENGINEERING NEWS 321 (May 31, 1982). In 1981, these firms operated 27 of the nation's 46 hazardous waste facilities. Only a few of these firms have high-temperature incinerator facilities capable of handling chemicals such as PCBs. These companies compete to destroy hazardous chemicals with waste treatment companies that use chemical detoxifying processes to produce harmless products. Ocean incineration would add a low cost competitor to this industry and so the majority of the industry seeks to prevent it from being given government permits. *Id.*

proposed remedy to environmental problems but seems unable to achieve the consensus necessary to implement a viable solution.

When the public rose up against ocean incineration, EPA failed to exercise a leadership role. In the famous environmental case of *Scenic Hudson Preservation Conference v. Federal Power Commission*,[819] the court set forth the standard for an administrative agency:

> A regulatory commission can insure continuing confidence in its decisions only when it has used its staff and its own expertise in [a] manner not possible for the uninformed and poorly financed public . . . . [T]he Commission has claimed to be the representative of the public interest. This role does not permit it to act as an umpire blandly calling balls and strikes for adversaries appearing before it; the right of the public must receive active and affirmative protection at the hands of the Commission.[820]

In the case of ocean incineration, EPA was not even an honest umpire but made the calls for and against ocean incineration without the use of good science or even a long-term view of the public interest. As public opinion pressured EPA to change its pro-incineration attitude, the public perception of the integrity of EPA and Waste Management became at least as important as the facts. This mood shifted the focus from the technological feasibility of the ocean incineration option to an attack on the credibility of many of the players. A strident distrust of Waste Management was demonstrated by both those who supported and those who opposed ocean incineration.[821]

The focus on Waste Management's overall environmental compliance record prohibited an objective evaluation of the ocean incineration option. The irony is that, following the termination of the United States' ocean incineration program, Waste Management continued to profit from its ocean incineration ships by incinerating overseas. Additionally, because Waste Management is an integrated waste management business, it still can offer customers in the United States its other waste disposal services without fear of ocean incineration competitors offering its customers a lower-cost option. Moreover, Rollins Environmental Services, Inc., one of the big winners in obliterating its potential incineration rivals, has an environmental compliance record that is far from exemplary.[822]

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[819] 354 F.2d 608 (2d Cir. 1965), *cert. denied*, 384 U.S. 941 (1966).

[820] *Id.* at 620.

[821] Summary of Public Comments on the Proposed Research Permit for Incineration at Sea to U.S. EPA by JT&A, Inc. (Contract No. 68–01–6986), April 24, 1986, at 2, 7.

[822] *See, e.g.*, *Senate Hearing 1985*, *supra* note 258, at 352–57 (disclosure statement of Rollins

The public outcry against Waste Management was not entirely the natural flow of outraged citizenry. The land-based incineration industry, including Rollins, publicly spoke out against ocean incineration, and financed local pseudo-environmental organizations to oppose ocean incineration,[823] although their influence on the national environmental organizations is unknown. With the fight for the hazardous waste market at stake, such corporate actions, on both sides, hardly are surprising.

What is most disappointing is EPA's failure to protect the public interest. EPA failed to insist upon use of good science from the many test burns in the 1970s to provide information needed for public policy formulation. When public opinion changed in the 1980s, EPA remained silent despite the absence of significant negative data and the presence of favorable, although somewhat flawed, data concerning ocean incineration that had accumulated world-wide. In the famous case of *Calvert Cliffs' Coordination Committee, Inc. v. Atomic Energy Commission*,[824] Judge Wright criticized the Atomic Energy Commission for not taking "the initiative of considering environmental values at every distinctive and comprehensive stage of the process."[825] In the case of ocean incineration, rather than taking initiative or exercising a leadership role or acting to provide useful information on the relative risks of ocean incineration, EPA took the politically expedient position of doing nothing. EPA took a technology deemed useful by their own in-house studies, as well as outside evaluation, and rejected it without expressed reasons. If such a response was based on data showing that ocean incineration was harmful, perhaps regulation through inaction could have been justified. Thus, EPA ended the use of ocean incineration by refusing to promulgate a regulation without finding fault with this hazardous waste disposal option. The uncertainty concerning the risks to the public from ocean incineration is no greater than the uncertainty surrounding other programs for which EPA has committed many resources (e.g., Superfund). In this case, EPA's inaction was, in essence, an admission that they could not credibly regulate.

Environmental Services, Inc.). Exemplifying the politics and emotions pervading and confusing the ocean incineration debate, in testimony against ocean incineration, a $2.6 billion suit against a *land-based incinerator*, Rollins, was cited as evidence of the problems associated with ocean incineration by a citizen opponent. *House Hearing 1983*, *supra* note 258, at 90–93 (statement of Shirley Goldsmith, President, Calcasier League for Envtl. Action Now); *see also* Wall St. J., Aug. 26, 1985, at 12, col. 3.

[823] *See supra* notes 358–61 and accompanying text.

[824] 449 F.2d 1109 (D.C. Cir. 1971).

[825] *Id.* at 1119.

Furthermore, the United States' use of the Ocean Dumping Ban Act to prevent ocean incineration is stretching a federal statute beyond its scope. Ocean incineration is not ocean dumping. The release of small quantities of air pollution from incinerator ships pales in comparison to the tremendous input of pollutants from land-based air pollution sources, much of which is ultimately deposited directly into the ocean through air transport or indirectly from fresh water runoff. The stretched interpretation of ocean dumping seems even more absurd when the releases from incinerator ships are compared with land-based water discharges that eventually end up in the oceans. For example, PCB releases from one year's operation of the *Vulcanus* to incinerate PCB-containing wastes would result in a discharge of an estimated forty-three pounds of PCBs to the environment.[826] Yet, it has been estimated that 12,281 pounds of PCBs flow into the Chesapeake Bay each year, primarily from non-point source, urban runoff.[827]

The Ocean Dumping Ban Act might only wind up banning ocean incineration. Today, most ocean dumping is of sewage sludge. A successful ban on sludge disposal in the ocean will require building land-based sludge incinerators. Land incinerator proponents will face the same NIMBY gridlock that other incineration proposals have faced.[828] Thus, the Ocean Dumping Ban Act may actually increase the pressure to dump in the sea.

The international community also may be rethinking its opposition to ocean incineration. While the rhetoric of many European nations

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[826] *House Hearing 1987*, *supra* note 293, at 203 (statement of Dr. William Y. Brown, on behalf of the Association of Maritime Incinerators, Appendix I, Background Information on Incineration at Sea).

[827] *Id.* at 205 (citing Basta et al., National Oceanic and Atmospheric Administration, paper presented at Coastal Zone 85, Baltimore, MD, July 30–August 2, 1985). Also, claims of catastrophic effects from a potential spill must be viewed in light of the petrochemical industry's discharges during the 1960s and 1970s of millions of tons of liquid wastes (including chlorinated hydrocarbons), directly into coastal U.S. waters. For example, in 1973, approximately 1.408 million tons of industrial waste were dumped into the Gulf of Mexico. This is the equivalent of a full load of the *Vulcanus* dumped directly into the ocean each day for an entire year. *Id.* at 208 (statement of Dr. William Y. Brown, on behalf of the Association of Maritime Incinerators, Appendix I, Background Information on Incineration at Sea).

[828] For example, in New York City, all but two landfills have been closed, and the sole remaining dump, Fresh Kills on Staten Island, could grow as high as 50 stories by the year 2000, unless the city constructs the five huge incinerators which have been stymied by political delays and lawsuits. The city will have to spend around $500 million to compost or incinerate sludge, which it presently dumps in the Atlantic Ocean. Although the Ocean Dumping Ban Act orders such dumping halted by 1991, municipal officials say they will be unable to meet the deadline. Finder, *Finding Ways to Finish Job of Fixing New York*, N.Y. Times, Dec. 28, 1989, at B1, B6.

has been in favor of phasing out this practice,[829] the actual use of ocean incineration in the North Sea has remained constant at about 100,000 tons per year through the 1980s.[830] Further, the number of companies using the *Vulcanus* ships has increased from two in 1974 to 754 in 1986 as the demand for ocean incineration has shifted from large to smaller companies.[831] Because alternative disposal methods and sites are no easier to obtain in Europe than in the United States,[832] there is reason to suspect that the use of the North Sea for incineration will continue.

Additionally, the Germans and other Europeans have stated, in support of their decision to phase out ocean incineration, that the incineration of hazardous wastes removes the potential to extract and reuse valuable components within the waste.[833] Calling for the phasing out of ocean incineration and not, concomitantly, land-based incineration, is blatantly inconsistent, and demonstrates the political nature of the decision. Both land-based and ocean-based incinerators destroy wastes, removing the potential for reuse of valuable components. Further, ocean incineration certainly can be utilized for those hazardous wastes from which no useful components can be extracted for reuse or recycling, such as highly chlorinated wastes and PCBs.

Thus, the United States' position supporting those in the international community who seek to phase out ocean incineration does not further United States interests.[834] This nation should not negotiate away an important option for our hazardous waste control based on the claim that ocean incineration is not compatible with ocean

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[829] *See House Hearing 1987*, *supra* note 293, at 224–31 (citing PIASECKI & DAVIS, AMERICA'S FUTURE IN TOXIC WASTE MANAGEMENT: LESSONS FROM EUROPE (1987)).

[830] IMO REPORT, *supra* note 444, at 29; *see also* Zurer, *supra* note 155, at 38.

[831] IMO REPORT, *supra* note 444, at 29.

[832] A 1985 survey of member states to the Oslo Convention was undertaken to determine the feasibility of ending ocean incineration in the North Sea. The survey documented that: (1) there is a potential shortfall in the capacity of land-based incinerators and other land-based treatment methods to dispose of the wastes currently being incinerated at sea; (2) spare capacity on land is considered far from sufficient, with very little increase in such capacity expected in the near future; and (3) the major constraint blocking termination of ocean incineration is the lack of land-based capacity for chlorinated hydrocarbon wastes. OTA, OCEAN INCINERATION, *supra* note 72, at 17.

[833] *House Hearing 1987*, *supra* note 293, at 227–28 (citing PIASECKI & SUTTER, ALTERNATIVES TO OCEAN INCINERATION IN EUROPE (1986)).

[834] As in the United States, Europe has opponents of ocean incineration. Even if ocean incineration is phased out in Europe for political reasons, it would not be unwise for the United States to use ocean incineration to serve a specific hazardous waste disposal need. *House Hearing 1987*, *supra* note 293, at 222 (statement of Dr. William Y. Brown, Waste Management, Inc., in response to Representative Lowry's questions).

protection, for this argument is neither supported nor unsupported by the scientific data.

Ocean incineration could be an important component of a hazardous waste disposal program. The present inventory of just PCBs requiring disposal is about 750,000 metric tons.[835] If the concentration of PCBs that makes wastes legally hazardous is lowered by EPA regulatory change, then the amount of waste requiring disposal could triple.[836] Today in the United States there are three large and one small land-based commercial incinerators that can do this work. They have a combined annual capacity of 70,000 tons. The chemical industry can dechlorinate another 40,000 tons per year. Ocean incineration could add 60,000 tons per year from just the *Vulcanus II*, and 90,000 tons per year from the *Apollo I*, if it could be used.[837] The ban on liquid organics going to commercial landfills could add 125,000 tons per year to the demand for incineration. If liquid injection wells are banned, as has been proposed, the 6.5% of hazardous wastes that would be suitable for incineration could increase demand for incineration by another two million tons per year.[838] With this demand, there would be a need for increased incineration capacity even though the land-based incinerators presently may have excess capacity.[839]

A crucial point to stress is that ocean incineration destroys hazardous wastes rather than just relocating them in landfills, injection wells, and lagoons to perpetuate the danger that could potentially harm future generations. While the ocean incineration option has an additional transportation step that presents additional risks, so too does the long-term storage of toxic wastes. It is a matter of social choice to accept this risk element associated with transportation that is tied to the destruction of the wastes rather than allow the wastes to remain a long-term hazard for local populations. Destruction rather than dumping should be a leading consideration when balancing risks against benefits.

Further, because destruction techniques encompass both land-based and ocean-based incineration, it makes little sense to have them regulated by different offices within EPA. Thus, if ocean incineration is given renewed legal viability, it should be regulated by

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[835] Nassos, *supra* note 275, at 212.
[836] *Id.*
[837] *Id.*
[838] *Id.*
[839] *Id.*

EPA's Office of Solid Waste, which currently regulates land-based incineration.[840] Also, land-based incineration regulations should be made as stringent as the Proposed Ocean Incineration Regulation. Even if the ocean incineration program is not revived, there seems to be no reason not to protect the public with a degree of regulatory protection applied to land-based incinerators that already was considered feasible and economically acceptable by those companies desiring to incinerate at sea.

Present-day society has accepted the benefits of useful chemicals, even though the production and use of these substances involves production of hazardous wastes and post-use disposal problems. In the past, industry could make its production decisions on the basis of seeking to maximize their profit while knowing that the costs of both production and disposal would include appreciable external costs that society, not the producer, would eventually pay. Now that these external costs are being paid by society in the form of environmental degradation and adverse impacts on human health, society is attempting to shift them back to the manufacturer and force these costs to be internalized. To the extent that the regulatory process is successful, hazardous waste generators should absorb as much of the real cost as possible. Products will then reflect the costs of protecting our ecosystem. Hopefully, more environmentally benign products will then enjoy a marketplace advantage.

However, zero risk is not achievable by any known waste treatment or disposal option. Only the non-generation of wastes—possible only if society is willing to forego the benefits associated with the products from which the wastes are derived—will give us the desired zero risk.[841] Nearly all alternative types of hazardous waste management and disposal involve the storage and transport of the wastes; accidental spills and emissions can occur during any stage with any option. Issues relating to the incidence of leaks and spills during storage and transport operations are similar for land-based and ocean-based incineration. The unique problems associated with ocean incineration should be further identified, researched, and addressed. Comprehensive, repeated sampling and monitoring is necessary to ensure that transportation and incineration procedures are

[840] 46 Fed. Reg. 7666 (1981); 40 C.F.R. §§ 122, 264, 265 (1989).

[841] "Almost everyone would support reducing wastes at their source in principle, but in practice we're not going to arrive at total source reduction for a long time. Right now we have a backlog of PCBs and chlorinated pesticides. These must be contended with now." Zurer, *supra* note 155, at 31 (quoting Kenneth S. Kamlet, URS-Dalton and former director of NWF's Pollution and Toxic Substances Division).

adequate. Observers must be used to help ensure compliance with all phases. EPA needs to expand its research on the transport, fate, and effects of land-based and ocean-based incinerator emissions through both field and laboratory studies.

No one is claiming that ocean incineration is a panacea. It may be a viable choice, however. If there are shortcomings in destruction efficiencies, monitoring, or in the production of PICs, then we should be working to correct them. A program to develop and improve this technology is needed. We should not, however, blindly condemn ocean incineration when its dangers are similar to those carried out by land-based incinerators in much greater proximity to the public. Ocean incineration of hazardous wastes warrants careful reconsideration as it may be a viable and useful disposal alternative,[842] especially when human health and overall environmental impacts are considered. EPA's decision to forego continuing exploration of the viability of ocean incineration was made in the absence of objective, valid scientific data and in the face of emotional opponents. It is indeed sad that, twenty years after the start of ocean-based incineration, the overriding question remains the same as when it first came into use: is ocean incineration a rational and scientifically valid option? No one—not EPA, not the waste management companies, not the environmental groups, and not society—really knows. Perhaps no one ever will.

VIII. Conclusion

United States regulatory requirements that pose increasingly tighter restrictions on hazardous waste management practices, and thus concomitantly limit options and increase costs, are driving the reconsideration of all hazardous waste management options. We are nowhere near a stage of total source reduction that would make incineration unneeded. Something must be done to manage existing wastes until hazardous waste minimization becomes a reality.

With further research, and proper technology, monitoring, and enforcement, ocean incineration could be a valuable and environmentally sound option for disposing of some liquid hazardous wastes, particularly when compared to land disposal alternatives currently available. This argument is bolstered by the fact that present land-

[842] *Id.* at 42. The ocean incineration controversy actually reflects a wider problem: industry, government, and the public are unable to work with each other toward what should be the common goal of reducing hazards associated with toxic wastes. Mistrust creates an ongoing cycle of reports, hearings, lawsuits, and deluge; yet nothing progresses. *Id.*

based disposal techniques are facing political gridlock due to the ever-increasing NIMBY phenomenon. We need to work within the hierarchy of waste disposal options to reduce the inventory of hazardous wastes. For the present, ocean incineration could give the United States another option. This does not imply that all concerns regarding ocean incineration are unwarranted or even resolved. But, for some of the large amount of liquid hazardous wastes that will nevertheless be produced, incineration in the ocean may be the least harmful option and should be objectively reconsidered.